Use of NAIP Imagery to Characterize Riparian Vegetation Health for TMDL and Land Management Purposes

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INTRODUCTION

With numerous streams in Nevada included on the 303(d) List for temperature, the Nevada Division of Environmental Protection (NDEP) has been interested in identifying TMDL-development methods that were better aligned with its limited resources and its desire for more appropriate TMDLs. Given significant concerns about the appropriateness of the temperature water quality standards that led to the 303(d) listings, NDEP sought an approach that relied on a surrogate for stream temperature. Research shows that both Idaho and Oregon have successfully used riparian vegetation health as a surrogate target for their temperature TMDLs. Building off of examples from Idaho and Oregon, NDEP developed a similar approach that took advantage of BLM riparian vegetation survey results, and tested the approach on a small stream in northern Nevada.

METHODS

For over 25 years, BLM has been characterizing riparian vegetation health (including bank cover) on Nevada public lands. A key element of this project was to test the ability to develop a predictive relationship between characteristics derived from the 2006 NAIP imagery and the BLM bank cover ratings. To test the ability to use NAIP imagery for assessing vegetation conditions, a series of information was extracted from the NAIP images for selected BLM survey sites in northeastern Nevada. While BLM has performed over 700 surveys, only 46 were considered appropriate for seeking a relationship between the NAIP imagery and the habitat survey data (specifically bank cover) for purposes of this TMDL. The primary reasons for selecting these sites were: 1) BLM surveys were performed at these sites within one year of 2006 NAIP imagery acquisition (2005-07); and 2) these BLM survey sites had not experienced wildfires between the time of imagery acquisition and bank cover surveys.

In performing the bank cover surveys, BLM establishes 5 transects spaced 100 feet apart (Figure 1). At each transect, bank cover ratings are visually estimated for both the left bank and right bank extending 50 feet upstream and downstream of the transect. Ratings vary from 0.5 to 2.0 as shown in Table 1 and Figure 2. The overall bank cover rating (as % of optimum) for the site is equal to the sum of the 10 subreach cover ratings divided by the optimum score of 20 (BLM, 2002).

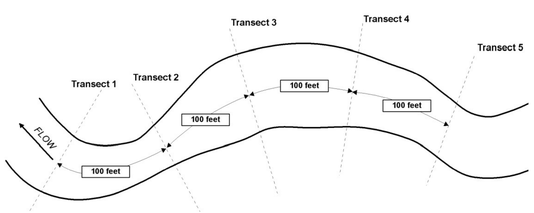

Figure 1. Transect Layout for BLM Habitat Surveys

Table 1. Streambank Cover Ratings and Descriptions (BLM, 2002)

Rating	Type	Description
0.5	Exposed	Bank is covered with scattered low to medium shrubs, forbs, or grasses, or bank is exposed.
1.0	Grass	Bank is medium to heavily covered with low to medium shrubs, forbs, or grasses, or a combination of these plants
1.5	Brush	Banks have scattered trees and/or tall (>7 feet) shrubs. A scattered density is considered to have 2 or more 10-foot openings. A few trees or tall (>7 feet) shrubs scattered along the streambank does not warrant a rating of 1.5.
2.0	Forested	Bank is medium to heavily covered with trees and/or tall (>7 feet) shrubs. Banks with no more than one continuous 10-foot opening are considered medium density. In addition to one 10-foot opening, there may be several smaller openings less than 10 feet in length.

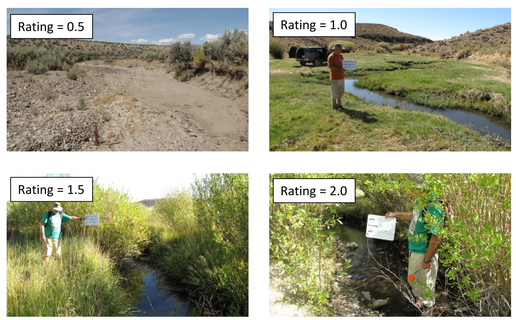

Figure 2. Bank Cover Rating Examples

BLM commonly uses a stream's riparian condition rating to guide their grazing management decisions. For example, BLM has established long term objectives for streams which include a riparian condition rating in the good to excellent (65% of optimum or higher (BLM, 2007).

The first step in developing a predictive relationship involved extracting information from the imagery associate with each of the 500-foot survey sites. Using GIS software, 10-foot buffers were digitized for on each side of the stream site. While the actual riparian areas are often less than 10 feet wide, the 1 meter resolution of the NAIP imagery makes it difficult to analyze to a finer level.

For each buffer zone, the following information was derived:

- % of area with riparian vegetation
- % of area with woody vegetation

These metrics were then regressed with the bank cover ratings to develop a predictive linear equation.

% Riparian Vegetation: Health riparian vegetation (grasses, sedges, willows, etc.) within the buffer zones were identified using the Normalized Difference Vegetation Index (NDVI) as calculated from the NAIP imagery:

$$NDVI = \frac{(Near\ Infrared\ Band\ - Red\ Band)}{(Near\ Infrared\ Band + Red\ Band)}$$

Index values can range from -1.0 to 1.0 but vegetation values typically range between 0.05 and 0.07 (BAE Systems, 2004). In determining the percent riparian vegetation values, a NDVI-threshold of 0.05 was utilized to differentiate healthy riparian vegetation from other land covers (Figure 3).

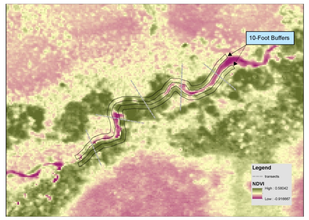

Figure 3. NDVI at Selected Site

% Woody Vegetation: Given the 1-meter resolution of the NAIP, it was difficult to accurately delineate the extent of woody vegetation. Therefore, each buffer was assigned one of five categories of woody cover (0%, 25%, 50%, 75%, 100%) based upon visual estimates from the imagery (Figure 4).

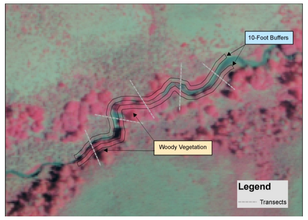

Figure 4. Woody Vegetation at Selected Site

RESULTS

The multiple linear regression between bank cover ratings, % healthy riparian vegetation and % woody vegetation yielded a rather good relationship (R^2 = 0.94):

$$Bank\ Cover\ (\%\ of\ optimum) = (0.478\ \times \%\ Woody\ Vegetation) + (0.264\ \times \%\ Riparian\ Vegetation + 25$$

Using this equation and the 2006 NAIP imagery, bank cover conditions were estimated for 2 streams in northeastern Nevada. Field estimates developed in 2009 per BLM protocols compared well with the NAIP imagery estimates (Figures 5 and 6).

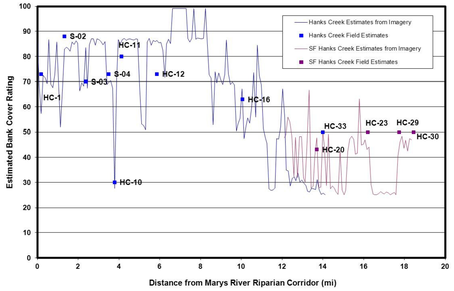

Figure 5. Bank Cover Estimates and Field Measurements for Hanks Creek

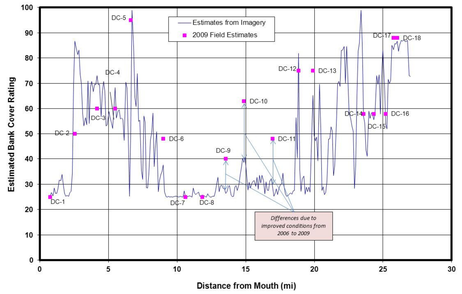

Figure 6. Bank Cover Estimates and Field Measurements for Dixie Creek

Only in one section of Dixie Creek did the 2006 NAIP imagery estimatesdiffer significantly from the 2009 field estimates (Figure 6). This appears to be due to riparian condition improvements that occurred between 2006 and 2009 as the result of grazing management changes.

CONCLUSIONS

Even though the 1-meter resolution of the NAIP imagery made it difficult to exactly identify streambanks and the riparian zone width, a good predictive relationship was developed that is useful in characterizing bank cover conditions over a broad spatial scale. This technique was ultimately used in the development of EPA-approved temperature TMDLs for Hanks and Dixie Creeks in northeastern Nevada (Pahl, 2009).

REFERENCES

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Bureau of Land Management. 2007. Various communications with Carol Evans and Pat Coffin. Elko BLM office.

Pahl, R. 2009. Dixie and Hanks Creek Temperature TMDLs. Nevada Division of Environmental Protection. Carson City, Nevada.

MORE INFORMATION

For more information, contact Randy Pahl at rpahl@ndep.nv.gov or check out the "Dixie and Hanks Creek Temperature TMDLs at: http://ndep.nv.gov/bwqp/file/TMDL_dixie_hanks_temperature.PDF

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