Stream Geomorphic Classification, Riparian Area Delineation and Riparian Cover Mapping

Background and Problem Statement

Streams and riparian areas are critical ecosystems. Riparian areas comprise far less than 10% of most western landscapes, yet they are some of the most important ecosystems in terms of productivity and habitat. Current, repeatable, cost-effective, accurate maps and descriptive information are needed to effectively manage these areas.

Riparian Areas are difficult to map over large areas. Riparian areas, since they are typically associated with streams, tend to be long and narrow. Quite often the width of the riparian zone can be as little as only a few meters, yet the length can extend for many miles. For example, our study area contained 250 miles of mapped streams in an area of only 79,000 acres. Consistent mapping over such large areas with sufficiently detailed information for effective resource management is costly.

Project Objectives

The overall objective of this project was to develop and test procedures to derive useful mid-scale stream and riparian information over large areas. Specifically, we wanted to test and develop rapid and cost-effective processes to:

1) **Characterize stream geomorphology (Rosgen Level 1 stream type and Strahler stream order),**
2) **Delineate riparian boundaries, and**
3) **Characterize the vegetation within the riparian boundaries**

for potential application to other areas.

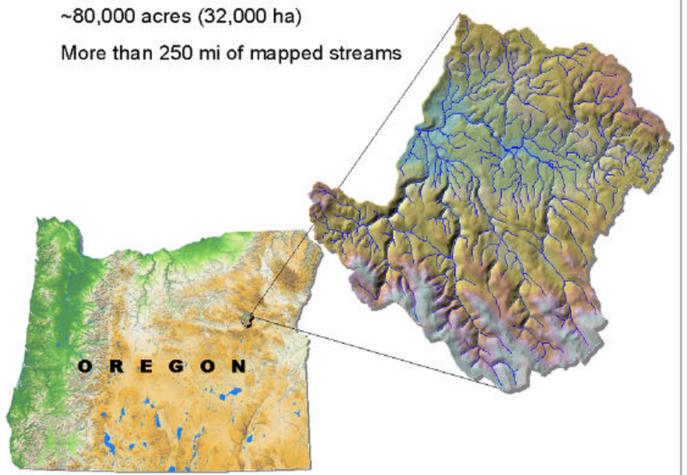
Study Area

Upper Middle Fork John Day River

5th field HUC

~80,000 acres (32,000 ha)

More than 250 mi of mapped streams



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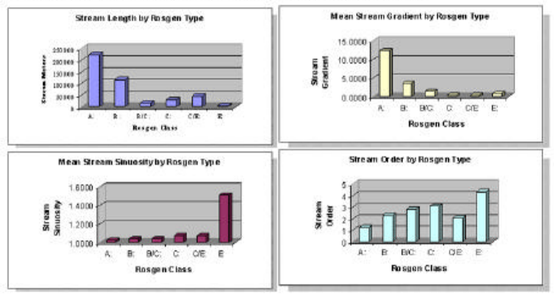
Geomorphic Characterization

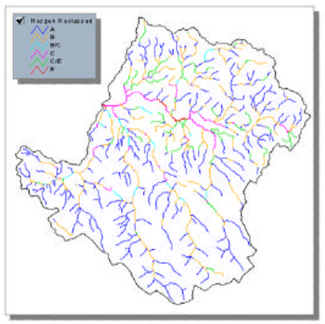
The Geomorphic characterization consisted of two major attributes: 1) The Rosgen Level 1 classification and 2) The Strahler Stream Order classification. Both were generated using existing Arc Macro Language (AML) macro-programs.

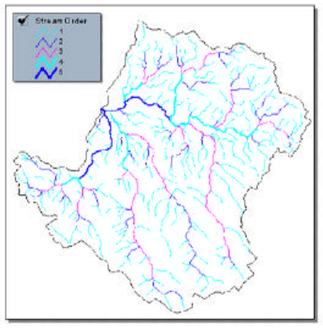
The **Rosgen Level 1** AML requires full coverage of digital elevation models (DEMs) and streams. The AML generates stream attributes for gradient and sinuosity and then uses those attributes to make the classification (see upper figure to right). For our study area, the stream types were: A, B, C and E; where stream gradient decreases from types A to E and stream sinuosity increases from types A to E.

Strahler Stream Order is a relatively simple concept that conveys general information about the regional significance (width, discharge, area drained etc…) of a stream. Streams are ranked from 1st order to 12th based on the number and nature of their tributaries. 1st Order streams have no significant tributaries; a 2nd order stream begins where two 1st order streams join; a 3rd order stream begins where two 2nd order streams join etc… The highest order stream in our study area is 5th order. The Mississippi is the largest order stream in the U.S, ranked as a 10th order.

The stream order AML computes and attaches the Strahler Stream Order to each arc in a cleaned stream arc coverage network (see lower figure to right).







References: Leopold, Luna, Wolman, M. Gordon, and John Miller, 1964. Fluvial processes in geomorphology. W. H. Freeman and Co. San Francisco, 522 p.
Rosgen, Dave, 1994. A classification of natural rivers. Catena, 22, 169-199

Riparian Area Modeling

We modeled the stream riparian area by variably buffering each stream segment based on the geomorphic characteristics of the stream. For example, if a stream was a 1st order Rosgen A type, we estimated its riparian width as only 5 feet. We limited the maximum riparian distance to 200 feet, assuming those larger areas would be photo-interpreted (red text in following table).

BUFFER DISTANCES (ft)		STREAM ORDER				
		1	2	3	4	5
ROSGEN CLASS	A	5	10	25	40	50
	B	15	23	40	75	125
	B/C	25	50	80	200	200
	C	50	100	20	200	200
	C/E	75	130	200	200	200
	E	120	200	200	200	200

Streams variably buffered using Rosgen and Strahler attributes to define buffer distance. Note: Streams that have a photo-interpreted riparian area are given a very narrow buffer.

Riparian Vegetation Characterization

While the spatial resolution of Landsat Thematic Mapper (TM) satellite imagery is often considered to be too coarse for riparian vegetation mapping, current image processing techniques permit a surprisingly good level of detail and accuracy. Satellite image classification remains a very cost effective means to derive moderately detailed vegetation cover information. In addition, satellite imagery provides the most efficient means to detect changes over the years or within years.

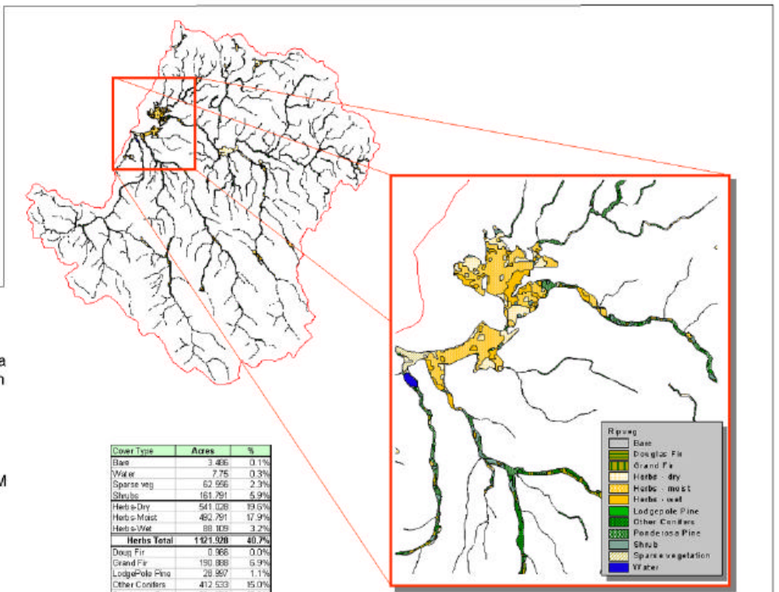
We combined the photo-interpreted riparian polygons (see graphic in upper right of this poster) with a simple 200 meter stream buffer (100 meters per side) to form our initial vegetation analysis area. We used this combined polygon to clip the Landsat TM image as shown at right.

Landsat TM imagery within a combined photo-interpreted buffer and a simple 200 m buffer.

We incorporated an existing classification of forest types (from a recent image processing project on the Malheur National Forest) allowing us to focus our efforts on classifying the non-forest cover types.

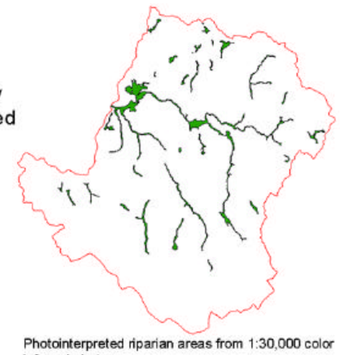
We added a texture band to the TM image, derived from digital orthophotos, to help with the classification. The final classification is shown at right.

Cover Type	Acres	%
Bare	3,406	0.1%
Water	7,75	0.3%
Sparse veg	62,956	2.3%
Shrubs	161,791	5.9%
Herb-Dry	541,028	19.6%
Herb-Mesic	482,791	17.9%
Herb-Wet	88,109	3.2%
Herbs Total	**1121,928**	**40.7%**
Doug Fir	0,966	0.0%
Grand Fir	150,888	5.9%
Lodgepole Pine	28,957	1.1%
Other Conifers	412,533	15.0%
Ponderosa Pine	764,978	27.8%
Conifers Total	**1360,362**	**50.7%**
Total Acres	2755,873	



Riparian Delineation

We used a combined approach to delineate riparian areas. First, we used 1:30,000 scale color infrared photography to delineate all of the large, easily identified riparian areas (see right).



Photointerpreted riparian areas from 1:30,000 color infrared photos.

We then combined the photo-interpreted boundaries with the geomorphology-based modeled boundaries as shown (below):

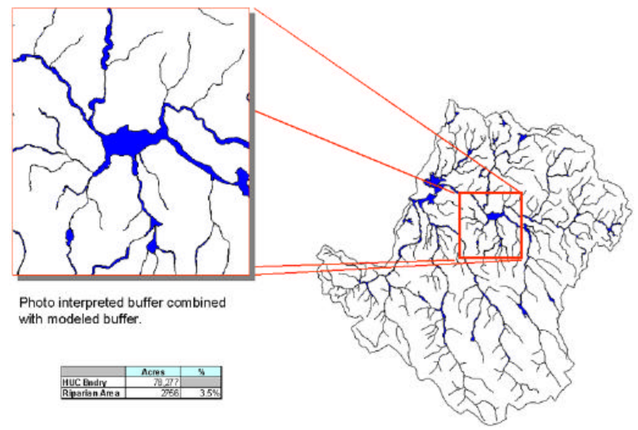


Photo interpreted buffer combined with modeled buffer.

	Acres	%
HUC Bndry	79,277	
Riparian Area	2766	3.5%

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