A COMPARISON OF RIPRIAN DATA COLLECTED ON THE CORONADO NATIONAL FOREST 1998-2009

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Riparian areas on the Coronado National Forest have been monitored periodically since 1986. U.S. Forest Service personnel have carried out this monitoring effort as part of the 1986 Forest Plan (USDA 1986). As part of the monitoring, substrate particle size and width to depth ratio were measured. Changes in these measurements between 1998 and 2009 were observed. Possible causes for these changes are described in this paper.

System (RASES) was the data collection method (USDA 1989) used for all sites. At first it was also believed that four of these sites represented channels of unburned watersheds. However, it was later determined that all sites in had at least partially burned since 1994. Further examination of the entire set of data exposes the fact nearly every watershed on the Coronado National Forest has experienced fire to some extent since 1994. Table 1 presents some data about each of the thirteen sample points used in this comparison.

Table 1: Watershed properties for riparian monitoring locations.

Watershed	Total Acres	Percent Burned	Water Slope (percent)	Geology	Uses	History
Canada del Oro	14,496	100%	14%	Granitic, alluvium	Recreation, Grazing	Burned 2003
Cave Creek	25,547	46%	7%	Rhyolite	Recreation, Grazing	Burned 1994
Lower Lyle Canyon	14,022	1%	4%	Granitic, alluvium	Recreation, Grazing	Burned 2009
Lower Redrock Canyon	17,955	29%	2%	Rhyolite, alluvium	Recreation, Grazing	Burned 2002
Lower Scotia Canyon	1,630	35%	7%	Granitic	Recreation, Grazing	Burned 1994
Middle Redrock Canyon	13,836	30%	3%	Rhyolite, alluvium	Recreation, Grazing	Burned 2002
Middle Rucker Canyon	8,683	51%	8%	Rhyolite	Recreation, Grazing	Burned 1994
North Fork Cave Creek	1,180	100%	24%	Rhyolite	Recreation, Grazing	Burned 1994
Sabino Canyon	21,011	89%	8%	Granitic	Recreation	Burned 2003
Upper Lyle Canyon	1,402	8%	8%	Granitic	Recreation, Grazing	Burned 2002
Upper Redrock Canyon	7,407	26%	2%	Rhyolite, alluvium	Recreation, Grazing	Burned 2002
Upper Rucker Canyon	4,667	66%	8%	Rhyolite	Recreation, Grazing	Burned 1994
Upper Scotia Canyon	1,108	4%	7%	Granitic	Recreation, Grazing	Burned 2002

METHODS

Study Area

Over 360 data collection points have been monitored in channels of the Coronado National Forest. Nearly all are ephemeral or intermittent in nature. Thirteen generally intermittent channels were chosen for this comparison. These were chosen because the Riparian Area Survey and Evaluation

Channel Substrate

Pebble counts conducted for the RASES method separated particle sizes into 7 size classes: silt/clay (<0.62 mm), fine sand (0.62 mm-1 mm), coarse sand (1.01 mm-2 mm), gravel (2.01 mm-64 mm), cobble

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(64.01 mm-256 mm), boulder (256.01 mm-2048 mm), and bedrock (>2048 mm). The statistic used to discuss substrate is D50, which is the substrate particle size (mm) at which 50% of the sample is finer.

Width to Depth Ratio

Channel measurements were used to determine the width to depth ratio. Channel width was measured at the apparent bankfull elevation. Channel depth is the mean depth as derived from cross section measurements.

Watershed Size

The watersheds contributing to these data vary from 1,108 to 21,011 acres in size. This variable (alone) prohibits meaningful comparison of data sets between points. Watershed size contributes to channel morphology attributes by providing more or less water to the site. Other variables including drainage pattern, geology, watershed uses, and watershed slope also contribute to channel morphology. In an effort to keep these variables at a minimum, the watersheds chosen for comparison have generally dendritic drainage patterns, are located on granitic or rhyolite formations, have recreation and cattle grazing as primary uses, and (generally) have a slope between 4% and 8%. Two watersheds, Canada del Oro and North Fork Cave Creek, have steeper slopes.

History

The watersheds of all the riparian areas sampled have been at least partially burned since 1994. Observations made by looking at the data are that channels of more recently burned watersheds exhibit substrate and width to depth ratios that appear to be unstable compared to those that burned longer ago. Data collected on watersheds that burned since 1998 were collected before and after the burn event. Data collected in watersheds that burned in prior to 1998 were (of course) collected since the watershed was burned.

RESULTS

Channel Substrate

All data collection locations exhibit measured changes in the D50 channel substrate measurements. Of the 13 locations, 8 have D50 in the same particle size class (gravel for example) for both sample dates in spite of the difference in measured sizes. Two locations had a larger size class in 2009 than in 1998. Table 2 presents the particle size measurements for the respective sample date.

Width to Depth Ratio

As with the substrate data, all data collections exhibited measured changes in width to depth ratio. Of the 13 locations, 5 were similar on both sample dates, 4 were smaller, and 4 were larger. The width to depth ratios are shown in Table 3.

DISCUSSION

Channel Substrate

Maintaining the same particle size class can be interpreted as an indicator of a stable watershed and channel. Of those channels that retained the same particle size class over both sampling dates, all except Lower Lyle Canyon have been recovering from fire within the watershed for more than 8 years. Lower Lyle Canyon was burned in 2009, but only to the extent of 1% of the watershed upstream from the sample location. Of the three channels that have had a change in size class from a larger size class to a smaller one, two locations were in watersheds that burned severely in 2003. These two, Sabino Canyon and Lower Canada del Oro, appear to have active sediment transport occurring during recent runoff events. Lower Redrock Canyon had a measured change in D50 from 4.5 mm to 1 mm, technically a change from the finest gravel designation to coarse sand. There is no evidence of degrading conditions such as pools filling with fine material as there is Sabino Canyon and Lower Canada del Oro in Lower Redrock Canyon. The two locations that have larger particle size classes were burned in 1994. There is evidence that these locations had elevated levels of fine material move through the system after fire, but watershed recovery has provided for fine material to be moved out, leaving coarser material in recent events.

Width to Depth Ratio

Width to depth ratio can be used to interpret channel stability. Large width to depth ratios indicate more erosive energy stress is being placed near the banks compared to smaller width to depth ratios (Rosgen and Silvey 1994). Of those channels that maintained a similar width to depth ratio for both sample dates, watershed history is variable, ranging from burning in 1994 to burning in 2003. Those channels developing larger width to depth ratios also

have a variable history, but all were burned since 2002 indicating a generally shorter recovery period. The channels with developing smaller width to depth ratios were all burned prior to 2003, indicating a generally longer recovery period.

Table 2: Particle size measurements.

Channel	D50 1998 (mm)	D50 2009 (mm)	Particle Size Class
Canada del Oro	105	1	Changed from Cobble to Sand
Cave Creek	28	34	Gravel
Lower Lyle Canyon	8	12	Gravel
Lower Redrock Canyon	4.5	1	Changed from Gravel to Sand
Lower Scotia Canyon	30	10	Gravel
Middle Redrock Canyon	7	2	Gravel
Middle Rucker Canyon	20	64	Changed from Gravel to Cobble
North Fork Cave Creek	23	500	Changed from Gravel to Boulder
Sabino Canyon	90	16	Changed from Cobble to Sand
Upper Lyle Canyon	7	45	Gravel
Upper Redrock Canyon	7	10	Gravel
Upper Rucker Canyon	22	32	Gravel
Upper Scotia Canyon	0.1	1	Sand

Table 3: Width to depth ratios.

Riparian Area	width:depth ratio 1998	width:depth ratio 2009
Canada del Oro	46.9	48.5
Cave Creek	33.4	24.2
Lower Lyle Canyon	65.6	89.2
Lower Redrock Canyon	26.5	21.1
Lower Scotia Canyon	18.5	17
Middle Redrock Canyon	30.3	40.7
Middle Rucker Canyon	20.2	24.5
North Fork Cave Creek	13.5	6.5
Sabino Canyon	66.5	105.4
Upper Lyle Canyon	14.1	8.2
Upper Redrock Canyon	33.5	43.9
Upper Rucker Canyon	34.1	30.6
Upper Scotia Canyon	15.7	8.2

CONCLUSIONS

There are many variables to consider when assessing channel stability following a wildfire in the watershed. The size of the watershed, watershed slope, and extent of the wildfire all play a role in channel stability. Time, however, appears to be a recurring factor for both substrate particle size and width to depth ratio recovery. Longer time periods since a disturbance generally produce data indicating more stable conditions.

REFERENCES

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