

RESULTS OF MONITORING STREAM CHANNELS AND STREAMSIDE VEGETATION, 1994 TO 2008

BEAR VALLEY BASIN - HEADWATERS OF THE MIDDLE FORK SALMON RIVER

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EXECUTIVE SUMMARY

The Bear Valley monitoring program was designed to address issues related to livestock grazing in relation to riparian and aquatic habitats for Chinook salmon, listed as threatened under the Endangered Species Act (ESA). Bear Valley has experienced a long history of livestock grazing. The numbers of livestock gradually declined over the years and the intensity of management increased dramatically in the 1990's. The monitoring program was instituted in 1994 and continued almost annually until 2001. By that year, grazing had ended and monitoring ceased. To assess the effects of non-grazing, a sample was collected at a subset of monitoring sites in 2008. Sites were chosen to represent a cross-section of pastures grazed at varying levels of intensity during the 1990's. The purpose of this report is to summarize condition and trends in the monitoring indicators at the 2008 monitoring sites.

An analysis of the data indicates that trends in riparian indicators in Bear Valley may partly reflect the effects of streamflow on streambank and riparian vegetation. Snow water equivalent, as measured at Banner Summit, shows an increasing trend during the mid and late 1990's with a decline in the 2000's. These trends are consistent with the decline in bank stabilities and substrate fine sediments during the 1990's. The fact that fine sediments remained low in 2008, and bank stabilities recovered slightly by then suggests that the absence of additional land disturbance factors may have helped maintain these conditions in 2008.

With respect to livestock grazing, there is little evidence that the absence of livestock during the 7 years immediately before the 2008 sample indicated a positive trend in riparian indicators. Vegetative and streambank indicators showed no statistically significant change during the monitoring period. There was a slight increase in streambank stability in Bear Valley Creek, but that increase was well within the confidence interval for that indicator. Of greater interest are the trends in substrate indicators prior to 2000. A least-squares fit to the averages for the monitoring sites prior to the year 2000 compared to all years shows a much steeper decline in the earlier time period. The substrate data suggest that much of the improvement to Bear Valley streams occurred during the years of intensive livestock management. By the end of the decade when all grazing ceased, little improvement has occurred. The same cannot be suggested for the other riparian indicators. Bank stability, for example, indicated a decline during the late 1990's at some of the sites, but declines were also indicated at the reference sites (Fir and Porter Creeks), and none of the changes were statistically significant. Ecological status remained essentially static through the years. Winward stability ratings increased (though not significant statistically) over all years, but the 1990's did not see as steep a trend as compared to the 2000's.

Conditions in bank and vegetative indicators show little change through time, but substrates improved dramatically on Bear Valley and Elk Creeks approaching the

habitat objective for salmon streams by 2008 (20%). Changes to substrates may reflect a narrowing of the stream channels by vegetative encroachment, something that appears to be evident at some sites in the photos of Attachment 1.

BACKGROUND AND INTRODUCTION

Monitoring Objectives: The Bear Valley monitoring program was designed to address issues related to livestock grazing in relation to riparian and aquatic habitats for Chinook salmon, listed as threatened under the Endangered Species Act (ESA). A review of the program was conducted in the summer of 1997 by a team consisting of members of the National Riparian Service Team (NRST) and the Bear Valley Collaboration Group represented by participants from interest groups and government agencies. As a result of this review and subsequent meetings, key monitoring questions were identified, among which the following are relevant to the present data collection (5-Year Monitoring Report 1998).

- What are the trends in bank stability?
- What are the trends in stream bank riparian vegetation?
- What are the trends in surface fine sediments?
- What are the trends in visual indicators (photos)?

Grazing History: As summarized in the Bear Valley Watershed Analysis (2000), the area has experienced a long history of livestock grazing. Both sheep and cattle have grazed Bear Valley since 1903 and 1908, respectively. In the 1930's there were about 1,200 cattle and 15,000 sheep. Sheep numbers dwindled and cattle increased after that. By 1951 there were 1600 cattle and 5000 sheep. In 1990 there were 1800 cattle and no sheep. With respect to grazing intensity, from 1957 to 1975 cattle animal unit months (AUMs) averaged 7500 and sheep 3860. Little change occurred during the period 1976 to 1983 with average AUMs of 7580 (cattle) and 3287 (sheep). In the 1960s, a deferred rest rotation system of pasture management was initiated on the Bear Valley C&H Allotment. During the early 1980's, sheep operations became less economically viable. Prices were dropping, and herders were difficult to recruit. These difficulties and the problems of managing a great distance from the home ranch started a gradual conversion of sheep operations to cattle operations. In a five-year period, the actual number of sheep grazing within Bear Valley fell from 5,908 sheep in 1980 to 1,893 in 1984, which was the last year sheep *actually* grazed in the watershed. From 1985 to 2000 several important events occurred:

- The 1987 Deadwood Summit Fire burned 30,780 acres of the Elk Creek C&H Allotment.
- The 1990 BNF Land and Resource Management Plan was completed.
- The 1993 Biological Opinion for ESA-listed chinook salmon and 1996 Biological Opinion for ESA-listed chinook salmon and Steelhead trout were issued.
- The 1998 Biological Opinion and 1999 Biological Assessment for ESA-listed bull trout were issued.

With these events, management of livestock grazing in the basin became more intensive. Permitted cattle numbers were reduced from 1,866 head in 1985 to 1,618 in 1996. Actual use cattle numbers were reduced from 1,865 head in 1985 to 544 in 1996.

After the ESA-listing of threatened fish species in the mid 90's, an extensive fencing program was initiated to exclude or control cattle access to many critical stream reaches. These include:

- Five miles of fence in Big Meadows to restrict access to about 5 miles of upper Bear Valley Creek. (Monitoring site BV7b)
- An electric fence to prevent cattle access to a 1-mile-long critical portion of Cold Creek. (Monitoring site COLD)
- A total of 3.5 miles of fence in the Bear Valley Allotment to insure the integrity of the 10,160-acre Bear Valley Riparian Pasture. An additional 5,600 feet of barriers were constructed within the riparian pasture to prevent cattle from trailing along streambanks. (Monitoring sites BV7a and BV5a)
- The 4,500-acre Elk Creek Riparian Pasture was established with the same goals as the Bear Valley Riparian Pasture, above. (Monitoring sites Elk1a and Elk2b)

From 1997 to 1999, cattle AUM's had been reduced to an average of 3490 per year. During this period average utilization of forage adjacent to stream had declined as compared to prior years. Actual use levels are displayed in Figure 1.

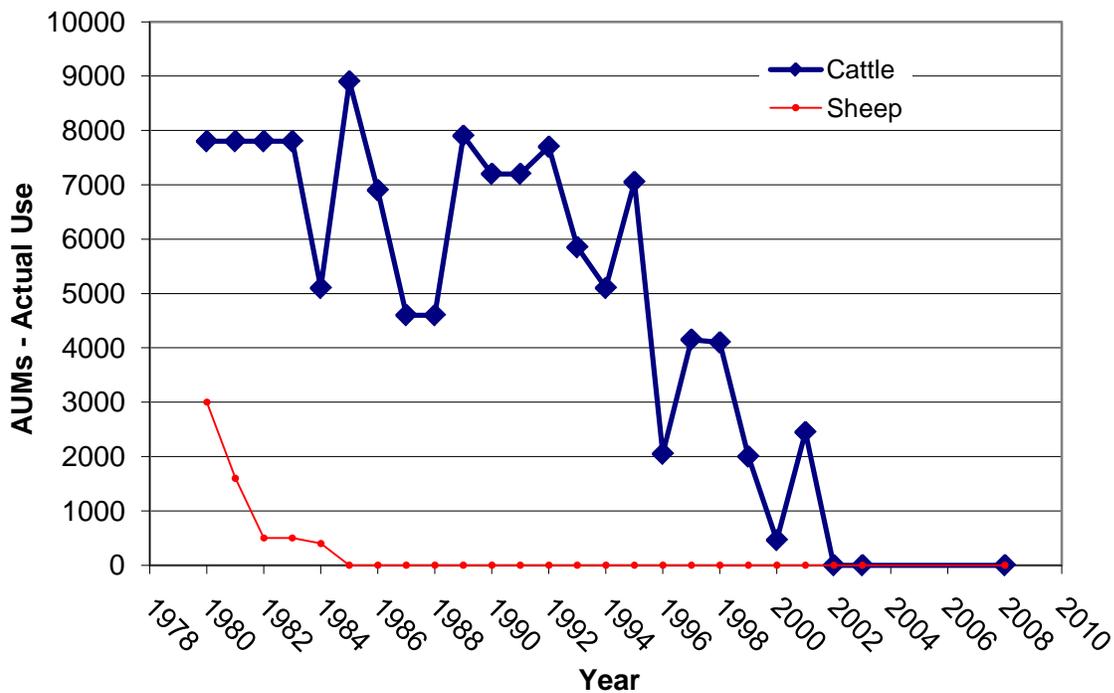


Figure 1. Actual use by cattle and sheep in the Bear Valley Basin, 1980 to 2008 (Bear Valley Watershed Analysis and USDA Forest Service Boise NF data).

By the early 2000's economic conditions and changes to enhance habitats for ESA-listed fishes in the Bear Valley watershed led to the end of livestock grazing. Thus there was no grazing during the 7 years prior to the 2008 sample collection. According to the interagency agreement on the Elk Creek Allotment closure:

“The Forest Service and BPA's objective is to provide for permanent protection and long-term enhancement of aquatic habitat values for fisheries; particularly bull trout, spring-summer Chinook salmon, and Columbia River steelhead listed as threatened or endangered under the Endangered Species Act (ESA). The Forest Service and BPA believe this objective is best met by reducing livestock grazing impacts to aquatic habitat on the Elk Creek C&H grazing allotment. ” - USMemorandum of Agreement between the Boise National Forest and Bonneville Power Administration, 2000).

METHODS

The Bear Valley Monitoring Program and Monitoring Indicators

In 1993, the Boise National Forest began an intensive program for monitoring stream and riparian conditions on grazing allotments in the Bear Valley Basin. Monitoring indicators were selected to help answer a number of key questions, including those listed above. A number of monitoring sites were chosen across the basin, with one or more sites selected for each grazing unit or pasture. Sites were chosen to be representative of the livestock use along streams associated with the most common riparian complexes in the basin. Two reference reaches on Porter and Fir Creeks were selected to be used for comparison with grazed reaches. Livestock access to these areas was limited, at least to cattle in the immediate decades prior to initiating the monitoring program.

In 1997 a monitoring plan was completed in response to a review by the NRST and the Bear Valley Collaboration group. The monitoring questions identified at that time were developed to determine if management actions were achieving desired conditions for bank stability and cover, substrate condition, and riparian vegetation ecological status. Table 1 lists the monitoring sites designated for long-term assessment in the Monitoring Plan.

Table 1. Long-term monitoring sites in Bear Valley Basin

UTM Coordinates - Zone 11					
Site	Easting	Northing	Site	Easting	Northing
BV-8A	620640	4904650	ELK-2B	621566	4920671
BV-7B	621385	4907435	ELK-2A	623202	4923782
BV-7A	622873	4909886	ELK-1A	622626	4919245
BV-6B	624678	4910593	ELK-1B	628800	4918756
BV-6A	625189	4910903	EFCACHE	621207	4907368
BV-5B	627393	4914139	DAGGER1	633143	4925695
BV-5A	628983	4915821	DAGGER2	633090	4925568
BV-3B	630031	4917705	PORTER	619634	4922614
BV-3A	629691	4918636	COLD	633494	4918951
BV-2C	630075	4919034	FIR	636276	4915964
BV-2B	635172	4920622	UBRSKN	619409	4912191
BV-2A	631513	4920335			

In 2008 a subset of these sites was chosen for re-sampling and to estimate long-term trends at those locations. Sites were chosen to represent a cross-section of pastures grazed at varying levels of intensity during the 1990's. Table 2 summarizes sites selected for the 2008 data collection effort.

Table 2. Sites chosen for monitoring in 2008.

SITE	Pasture	Late 90's Grazing Management
BV-7B	Big Meadows	Exclosure
BV-7A	Bear Valley Riparian Pasture	Riparian Pasture
BV-5A	Bear Valley Riparian Pasture	Riparian Pasture
Elk1a	Elk Creek Riparian Pasture	Riparian Pasture
Elk2b	Elk Creek Riparian Pasture	Riparian Pasture
COLD	Poker Meadows Unit	Exclosure
UBSKN	Bearskin Allotment	Deferred rotation
DAGGER	Ayers Unit	Deferred rotation

Bank Stability and Cover: The monitoring technique used to monitor long-term bank stability during the 1990's was a modification of the method described by Platts and others (1987). Bank stability was observed along the entire length of bank within the monitoring reach, not just the intercepts of cross-channel transects. Thus bank stability transects in this procedure run roughly parallel to the stream itself. The lengths of bank on either side of the stream are measured and proportioned into five stability and cover classes (CS – covered stable, CU – covered unstable, US – uncovered stable, UU – uncovered unstable, and FB – false bank) within each identified riparian plant community type. The classes can be easily measured using a two meter measuring rod marked in tenths of a meter and laying the rod along the stream bank at the greenline (first perennial vegetation above the water). Alternately a measuring tape or measuring wheel can be used. Stability class and plant community type are recorded at the same time and to the nearest half meter.

This method was further refined in the Multiple Indicator Monitoring protocol (Burton and others 2008) which was applied in the 2008 sampling effort. Streambank stability is observed on the bank associated with a quadrat plot, and is recorded using one of the stability classes described above. The shift from a continuous transect to a plot was found to have greater observer agreement and is therefore more precise (Burton and others 2008). In addition, individual samples from plots, as opposed to a single transect, are independent allowing more statistical analysis opportunities and the ability to assess cause and effect. The protocol is as follows: At each plot location, classify streambank stability. The following are steps that are used to define the stability/cover class.

1. **What kind of bank?** Is the bank at the plot depositional or erosional?
2. **Where is the bank?** The bank evaluated is equal to the length of frame (50 cm) between the scour line and the top of the first terrace. Typical scour line indicators are the elevation of the ceiling of undercut banks at or slightly above the summer low flow elevation; or, on depositional banks, the scour line is the lower limit of sod-forming or perennial vegetation.
3. **Is it covered? Banks are covered** if there is at least 50% aerial cover of perennial vegetation; cobbles six inches or larger; anchored large woody debris (LWD) with a diameter of four inches or greater; or a combination of the vegetation, rock, and/or LWD is at least 50 percent of the bank area (50 cm wide from scour line to first terrace).
4. **Is it stable? It is stable if none of the following exist:** Either a *fracture* (crack is visibly obvious on the bank); *slump* (portion of bank has obviously slipped down or has been pushed down by trampling or shearing, etc.); or *slough* (soil is breaking or crumbling and falling away and is entering the active stream channel); **or** the bank is steep (within 10 degrees of vertical), and/or bare, and eroding (including bare depositional bars).

If the streambank as defined in #2, is depositional and mostly covered, it is classified CS, if it is not covered, it is classified UU. If the streambank is erosional and covered with vegetation, it is classified CS if none of the features in #4 are present. If it is not covered with vegetation and one or more of the features in #4 are present, it is classified CU. Likewise, if uncovered but none of the features in #4 are present it is US, otherwise it is classified UU. False banks (class FB) are streambanks that have slumped in the past but have been stabilized by vegetation. They are typically recognized by a bench-like feature located below the top of the bank.

Greenline Vegetation Composition and Woody Species Regeneration: The method used to monitor greenline vegetation during the early years was based upon the technique described in the Region 4 Riparian Evaluation Guide (1992). The Green Line Vegetation Composition sampling procedure was as follows: Sampling begins at the downstream end of the reach on the left side (looking upstream). Sampling proceeds upstream along the greenline using a step transect approach. Enough steps are taken to total 363 feet lineal distance before crossing over to the other bank and proceeding downstream to just across the channel from the starting point. The total number of feet of each vegetation community type is tallied to estimate the vegetation ecological status. A similar transect approach was applied to woody species age classes to estimate woody species regeneration. A comparison to reference sites where vegetation communities approach as close as possible to Potential Natural Condition is used to estimate condition and evaluate long-term trends for the site.

The MIM method used in 2008 is a refinement of the original Riparian Evaluation Guide method of 1992. Those refinements included a shift from riparian communities to dominant and sub-dominant species observed along the greenline at plots. This approach more closely approximates the ecological status, vegetation stability, and wetland indicator status ratings for the vegetation. Community types integrate these values for several species resulting in lower precision. As with bank stability, plot samples are independent and allow for more statistical analyses. In addition, testing has shown that observer agreement is better with plots, increasing the precision of the sampling method. **Dominant** plants are the species having the largest portion of the vegetation composition by cover in the quadrat. To be considered dominant, the plant must represent at least 25 percent of the plant composition by cover within the quadrat. The exception is where a *mature* tree or *mature* shrub overstory occurs. Mature trees or shrubs with *any portion* of the canopy covering the quadrat are considered dominant. **Sub-dominant** plants are those with a lesser composition than dominant plants. Sub-dominant plants do not have to exhibit 25 percent vegetative composition by cover within the quadrat (although it is possible). When two or more plant species, including rock and wood, have about the same amount of plant cover in the plot, and each is over 25 percent of the composition, each is recorded as dominant. The method for estimating woody species age classes and regeneration is essentially the same as the original method except that woody plants are observed on plots rather than along a transect.

Substrate: A pebble counting technique was applied to substrate monitoring in Bear Valley according to the method described in the Region 4 Riparian Evaluation Guide (USDA Forest Service 1992). Substrate composition is estimated at each habitat unit in the reach and pebbles are tallied into 7 size classes: SS - .1 inch or smaller, CF = .1 to .25 inch, GR = .25 to 3 inches, RB = 3 to 6 inches, CB = 6 to 12 inches, BL = 12 to 36 inches, and LB >36 inches. Pebble counts are made across the width of the active channel. Such transects are located perpendicular to streamflow, randomly along an axis parallel to the stream thalweg. They may be located at $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ of the length of a selected habitat unit. At least 100 pebbles are obtained from these transects. For samples collected in the 1990's, transects were chosen in the spawning habitat located just upstream of a riffle crest in the monitoring reach. Unfortunately, such riffle crests shift position through time, making it difficult to replicate the spawning habitat in subsequent monitoring efforts.

The MIM method, once again, is a refinement of the substrate sampling procedure. Tests of the pebble counting technique in the early 2000's indicated that there is operator bias against the fines fraction in the substrate (Bunte and Abt 2001). However, this bias is presumably consistent; therefore, trends through time should

theoretically be detectable. Also, streams with complex substrate size distributions need more samples than those with simple substrates (Bundt and Abt 2001). The authors state that "...the precision of a 100-particle pebble count is usually too low to compare particle-size distributions from different sites or over time...." They suggest a minimum of 200 particles from evenly spaced collection points across the active channel (the non-vegetated portion of the channel). Thus the MIM method includes 20 evenly distributed transects within the monitoring reach. At each transect, 10 pebbles are collected resulting in a total of 200 from the site. The MIM Data Analysis Module estimates the desired sample size using a simple power analysis of the data, including the 200 pebbles collected at each site. This analysis indicated that most stations were adequately sampled with fewer than 100 pebbles. Just one site, BV7b indicated the need to collect more than 100 (113) pebbles. These results suggest that earlier samples of just 100 were usually an adequate sample to assess trends through time.

Precision and Accuracy of monitoring protocols – a comparison of methods used from 1994 to 2001 with the MIM method used in 2008.

The historic monitoring protocols for greenline vegetation and substrate size distribution acquired the exact same indicators, with lower and precision and accuracy. Through time, improvements have made the most recent methods more reliable for predicting trends. An examination of repeatability among observers was conducted by the authors of the MIM protocols in 2007 (*unpublished data*). This test included 7 sites examined by 3 separate teams and included both paced and plot methods for bank stability and greenline vegetation. A confidence interval was calculated for each metric based upon both protocols as shown in table 1.

Table 3. Confidence intervals for greenline metrics using the Continuous Pace and 100-count pebble count method (used from 1994 to 2001) and MIM (used in 2008 – Burton et.al in press).

Metric	CI Continuous and 100 count	CI MIM
Winward stability	0.7	0.16
Ecological Status	8	5
Wetland Rating	5	3
Bank Stability	10	5.2
Percent Fines		11

For substrate fines using the pebble count method, sample size estimates are predicted in the Substrate Module (EXCEL). An examination of the sample sizes, or the number of particles collected from the substrate, indicates that the earlier data,

based on a sample of 100 particles, estimated percent fines with a lower level of precision. The MIM method using 200 particles and applied in 2008, estimates mean percent fines with a precision of + and – 10%. The earlier methods using 100 particles estimates mean percent fines with a precision of + and – 20%. This difference in precision reflects the variability of the substrate size distributions for streams in Bear Valley.

Studies have shown that the Ecological Status Rating, based upon greenline community types, and estimated by pacing results in low repeatability between observers (Coles-Richie et al, 2004). The authors indicate that differences between observers are almost as great as differences between the 6 sites they tested. They suggest that the problem with community types is that it is difficult to distinguish community types in the field. In nature there are no distinct boundaries, which makes it difficult for different observers to consistently identify and measure their lengths by pacing. Another reason for disagreement is the overlap in species composition among community types. Our own tests of repeatability on similar streams on the Boise National Forest supports this observation. Ecological Status estimates from three separate observers ranged from 52 to 66 on Deadwood River and from 46 to 58 on Fawn Creek. Given these levels of variability, small trends in the data are likely not indicative of any real change.

Another issue related to the accuracy and precision of the bank stability data derives from a change in the protocol after the NRST review of 1997. Prior to that sand/gravel bars were recorded as uncovered but **stable**. The NRST recommended that the classification be changed so that sand/gravel bars are recorded as uncovered and **unstable**. After that time, bars were identified in the data, but unfortunately the earlier data did not account for such identification. Also, the MIM protocol used in 2008 classifies un-vegetated bars as uncovered and **unstable**. To account for the change in classification, it was necessary to adjust the data after 1997 so that bars were treated as uncovered but **stable**. The MIM module for 2008 was adjusted to account for this difference in the classification.

Data Analyses: The MIM Data Analysis Module (Burton et.al. 2008) was used to derive metrics for the data collected historically and in 2008. The “Data Analysis Module” is a MS EXCEL file that will import all of the raw data from the “Data Entry Module” and calculate metrics useful for data interpretation. Once data is entered into the module, macros are used to run quality control checks on the data to assure the correct plant codes were recorded and that typographical errors were not entered into the system. The module contains a summary describing how each metric is derived. The following metrics were used to summarize Bear Valley monitoring data:

1. % stable banks
2. % covered banks
3. % saplings and young woody plants

4. % mature woody plants
5. % hydric plants
6. Vegetation erosion resistance index
7. Ecological Status
8. Site Wetland Rating
9. % woody plants
10. % hydric herbaceous plants
11. % fine sediment
12. Median particle size
13. D30 particle size
14. D84 particle size

Selected metrics were further analyzed to assess trends through time and to statistically compare the metric values at monitoring sites with the same values at the reference sites. Four statistics were applied to the data:

Trend: The Regression analysis performs linear regression using the "least squares" method to fit a line through a set of observations. The observations are represented by year (x axis) and the metric value observed that year (y axis). The ***r-squared statistic*** is interpreted as the proportion of the variance in y attributable to the variance in x. It is the fraction of the variation in the metric variable that is accounted for (or predicted by) the independent variable year. The ***F statistic*** is used to evaluate the significance of the regression relationship – the significance of the trend. A ***p*** value is derived to evaluate the significance of F. The lower this value, the more significant the trend. We are looking for p values of .1 or less. In statistical terms, the lower the ***p*** value, the more willing we are to reject the null hypothesis that the trend is not significant.

Comparison to reference: The Two-Sample t-Test analysis tests for equality of the population means that underlie both the sample site and the reference sites. A paired t-Test was used because there is a natural pairing of sample means based on the year of the observation. This analysis performs a paired two-sample Student's t-Test to determine whether observations that are taken at a treatment and observations taken at the paired reference site are likely to have come from distributions with equal population means. This statistic also derives a p value to estimate the probability that the two sample means are equal. The smaller the p value the more willing we are to reject the null hypothesis that the sample means are equal.

In addition, the confidence intervals in Table 3 can also be used to assess whether or not a change was detected. These confidence intervals reflect sources of

variability from repeat tests conducted on the protocols and from sample size adequacy reflecting site variability.

RESULTS

The metric data tables and graphs, including statistical outputs for the selected subset of metrics are contained in the EXCEL file titled “Bear Valley Analysis.xls”. In that file there is a spreadsheet for each of the monitoring sites examined in 2008 as well as metric summaries and statistics for each site and for the reference sites. The following narrative summarizes results of the analysis.

BANK STABILITY: As shown in Table 4, bank stabilities appear to have no overall trend. There was a decline during the late 1990’s at some of the sites, but declines were also indicated at the reference sites (Fir and Porter Creeks). This late 1990’s decline may be due in part to a shift in the way bank stability was classified for in-channel gravel bars as discussed above.

The decline at Elk2b is partly due to the installation of bank revetments at this site in the mid 1990’s. In 1995 the left-side cutbank appeared to have failed as a result of breakdown along the top of the streambank. The main pack trail was located in that position. As a result, tree revetments were installed along the streambank and the trail re-positioned away from the bank margins. These tree revetments provided some protection and increased stability as reflected in the 1996 sample. The flood of 1997 appeared to wash behind the revetments resulting in lowered bank stability at the site. With the revetments still in place, this bank condition has not yet recovered as reflected in the 1999 and 2008 samples.

Table 4. Percent of streambanks classified as “stable” for monitoring sites in Bear Valley, including the reference sites, Fir and Porter Creeks.

<i>Year</i>	<i>BV5a</i>	<i>BV7a</i>	<i>BV7b</i>	<i>BV8a</i>	<i>ELK1a</i>	<i>ELK2b</i>	<i>DAG-GER</i>	<i>Upper Bear-skin</i>	<i>COLD</i>	<i>References</i>
1994		59%	99%		78%	95%				
1995	71%	48%	82%		66%	75%				
1996	83%	63%	76%	100%	88%	84%				97%
1997	65%	53%	66%	97%	87%	50%				86%
1998	75%	62%	71%	98%	63%		81%	77%	92%	77%
1999	65%	57%	73%	100%	69%	48%	70%	94%	94%	79%
2001	88%		80%	100%			82%	89%	97%	
2008	82%	67%	78%		75%	53%		92%	86%	

Results of statistical trend analyses for bank stability are shown in Table 5. At no site is the long-term trend (1994 to 2008) significant.

Trend statistics are presented in Table 5. At no site was the long-term trend statistically significant.

Table 5. Bank stability trend statistics for selected monitoring sites in Bear Valley. None of the long-term trends were significant.

STATION	REGRESSION COEFFICIENT	SIGNIFICANCE OF TREND 1995 - 2008
BV5A	0.18	0.35
BV7A	0.39	0.10
BV7B	0.07	0.54
BV8A	0.14	0.54
ELK1A	0.11	0.82
ELK2B	0.38	0.19
DAGGER	0.07	0.83
COLD	0.55	0.26
UBRSKN	0.47	0.53

Compared to reference conditions, several of the monitoring sites had bank stabilities significantly lower in value during the 1990's as highlighted in red in table 6. By 2008 bank stability some of the monitoring sites were mostly approaching the mean reference bank stability value, and BV8a and Upper Bearskin Creeks exceeded it.

Table 6. Comparison of bank stability at monitoring sites with those at reference sites in Bear Valley. Significant differences are highlighted in red. Bank stability in 2008 is also displayed as is the average bank stability for reference sites (Reference Value).

STATION	t STATISTIC	PROBABILITY (P)	2008 Stability	Mean of References
BV5A	-3.15	0.026	82%	85%
BV7A	-5.59	0.006	67%	85%
BV7B	-3.10	0.027	78%	85%
BV8A	3.24	0.02	100%	85%
ELK1A	-1.62	0.12	75%	85%
ELK2B	0.03	2.92	53%	87%
DAGGER	-0.33	0.40		85%
COLD	6.31	0.01	86%	85%
UBRSKN	3.67	0.08	92%	85%

The graph of bank stabilities at monitoring and reference sites over time is shown in Figure 2. Bank stabilities were in the 70% to 80% range during most of the 1990's and dropped to around 65 to 75 by the turn of the century. These however are within the confidence interval of 10%. Reference site stabilities were in the 80% to 95% range. Bank stability on Elk and Bear Valley Creeks rebounded slightly in 2008 and declined in tribs. None of these trends, however is statistically significant.

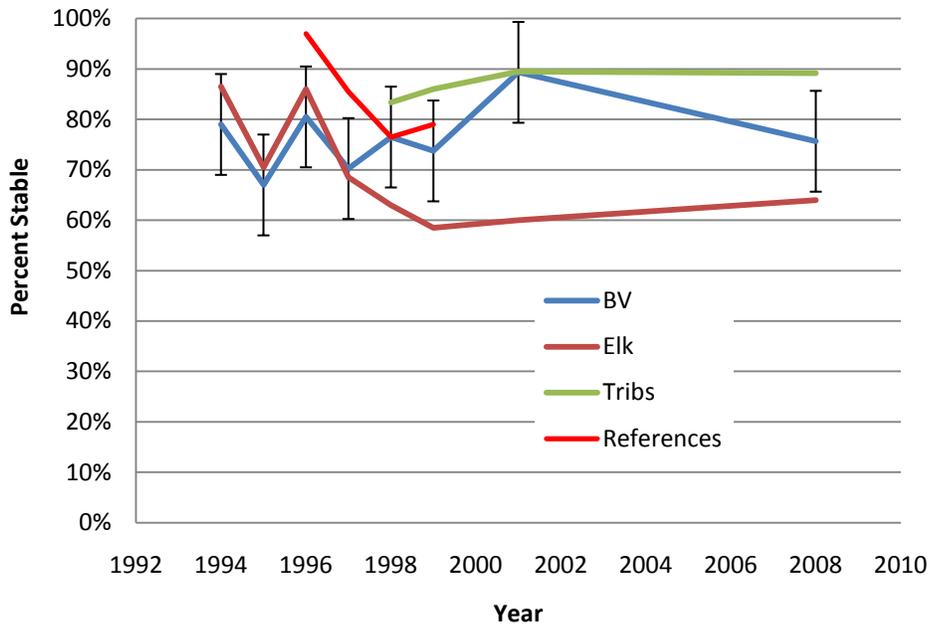


Figure 2. Trends in average streambank stability at monitoring sites on Bear Valley Creek (BV), Elk Creek (Elk), and tributaries (Tribs) as compared with trends at the reference sites Porter Creek and Fir Creek. Confidence intervals (vertical error bars) are shown for Bear Valley Creek indicating that the upward trend is not significant given the imprecision of the earlier methods.

GREENLINE VEGETATION – Winward Stability Rating: This rating, historically referred to as the vegetative stability rating estimates the contribution of the roots of streamside vegetation to bank stability. Species have varying abilities to resist erosion based upon their rooting characteristics, both density and depth or extent. A good description of this rating is contained in the Rocky Mtn Research Station publication General Technical Report 47 (Winward 2000). Positive statistical trends in the Winward Stability Rating have not occurred at most sites in Bear Valley as summarized in Table 8. BV8a and Dagger Creek did show a significant increase in the stability rating.

Table 7. Winward Stability Ratings for stations in Bear Valley, including the reference stations. This metric is scaled between 1 and 10, with 1 the least resistance and 10 the greatest resistance to stream erosion.

<i>Year</i>	<i>BV5a</i>	<i>BV7a</i>	<i>BV7b</i>	<i>BV8a</i>	<i>ELK1a</i>	<i>ELK2b</i>	<i>DAG-GER</i>	<i>COLD</i>	<i>Up-Brskn</i>	<i>Refer-ences</i>
1994		5.56	5.96		7.10	6.19				
1995	5.92	4.88	5.85		6.03	6.05				
1996	6.20	4.99	5.47	6.00	6.24	6.08				7.18
1997	6.03	6.07	5.95	6.04	5.62	6.31				7.57
1998	5.76	5.42	5.71	6.29	6.42		7.15	6.48	8.48	7.17
1999	6.00	7.08	6.75	6.25	7.04	5.86	7.21	6.31	6.27	6.82
2001	7.16		6.72	6.21			7.39	6.61		
2008	6.50	5.25	6.40		6.53	5.73		6.55	6.08	

Table 8. Winward Stability Rating trend statistics for monitoring sites in Bear Valley. Values in red denote a significant positive trend.

STATION	REGRESSION COEFFICIENT	SIGNIFICANCE OF TREND
BV5A	0.27	0.229
BV7A	0.002	0.94
BV7B	0.32	0.1469
BV8A	0.47	0.20
ELK1A	0.01	0.849
ELK2B	0.21	0.37
DAGGER	0.98	0.06
UBRSKN	0.40	0.56

During the 1990's most Winward Stability Ratings were significantly higher at reference sites than at the monitoring sites. Table 9 summarizes these statistics. A negative "t Statistic" indicates that the mean at the stations is lower than the mean value at the reference sites. All stations in Bear Valley and Elk Creeks had mean Winward Stability Ratings that were significant different than the reference sites. By 2008, all monitoring sites still had values less than the Reference Value (mean of reference sites).

Table 9. Comparison of Winward Stability Ratings at monitoring sites with those at reference sites in Bear Valley. Significant differences are highlighted in red. Erosion Resistance Ratings in 2008 are also displayed as is the average for reference sites.

STATION	t STATISTIC	PROBABILITY (P)	2008 Erosion Resistance	Reference Value
BV5A	-6.93	0.003	6.50	7.18
BV7A	-2.41	0.048	5.25	7.18
BV7B	-3.16	0.026	6.40	7.18
BV8A	-5.08	0.01		7.18
ELK1A	-1.92	0.08	6.53	7.18
ELK2B	-4.56	0.01	5.73	7.18
DAGGER	0.90	0.27		7.18
UBRSKN	0.41	0.38	6.08	7.18

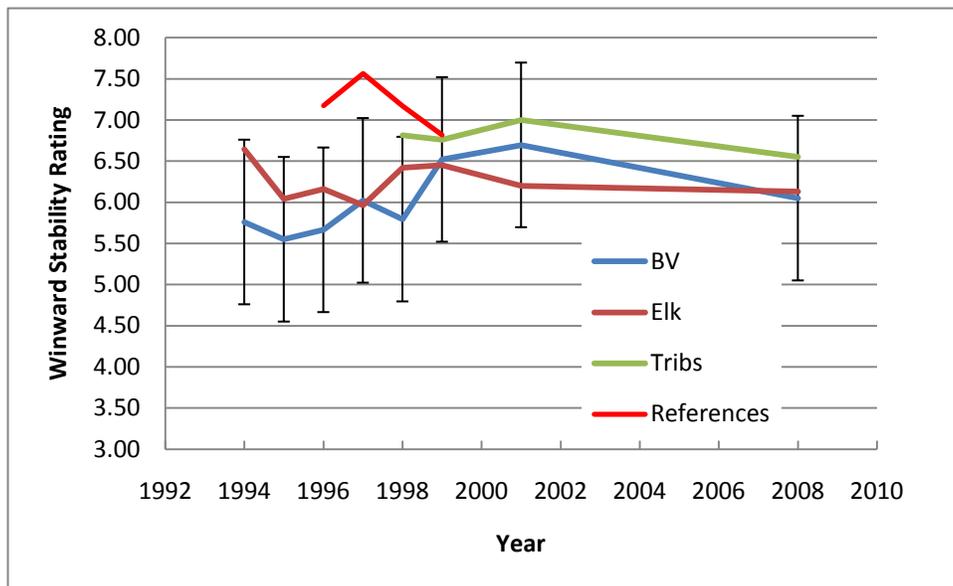


Figure 3. Trends in Winward Stability Ratings as compared with trends at reference sites for stations in Bear Valley Creek (BV), Elk Creek (ELK), and tributaries (Tlibs). Confidence intervals are displayed for the Bear Valley (BV) data.

Trends in the Winward Stability Rating are displayed in Figure 3. Bear Valley stations showed an increase in the late 1990's and early 2000's then declined slightly by comparison in 2008, however as shown by the vertical bars (confidence

intervals) on the Bear Valley data, the trends are within the sampling error. Elk Creek and tributary stations show little or no trend through time. All sites were less than the reference condition during the late 1990's and those in Bear Valley and Elk Creeks were statistically significant (Table 9).

Winward Stability Rating condition classes are shown in Table 10. The ratings for Bear Valley and Elk Creeks fall mostly in the "Mid" class and for the tributaries and references in "High" class.

Winward greenline stability rating
1-2 = Very low
3-4 = Low
5-6 = Mid
7-8 = High
9-10 = Excellent

Table 10. Winward greenline stability ratings (MIM - Burton et. al.2008).

Greenline Vegetation – Ecological Status: Trends and comparison to reference condition were also summarized for the ecological status rating as defined by Winward (2000) and shown in Table 11. This metric is calculated using plant Seral status ratings and Winward's (2000) Riparian Capability Groups. It is further adjusted where a woody overstory component should be present but currently is not present. The rating is categorized into condition classes as shown in Table 12. There is little or no indication of positive trend in this metric at any site. At no site in Bear Valley Creek is the increase in ecological status statistically significant as shown in Table 13. The site at Dagger Creek had a statistically significant decline in the ecological status.

Table 11. Ecological Status ratings for stations in Bear Valley, including the reference stations. This metric is scaled between 1 and 120. Most sites were in the Late or PNC (potential natural community) range (see Table 11). Reference sites were at PNC in all years measured (late 1990's).

Year	BV5a	BV7a	BV7b	BV8a	ELK1a	ELK2b	DAG-GER	COLD	Up-Brskn	References
1994		58	114		86	105				
1995	93	65	89		82	89				
1996	92	61	80	111	86	102				93
1997	75	75	90	111	80	76				99
1998	70	80	69	114	94		103	113	109	93
1999	70	91	101	111	106	49	108	110	117	90

<i>Year</i>	<i>BV5a</i>	<i>BV7a</i>	<i>BV7b</i>	<i>BV8a</i>	<i>ELK1a</i>	<i>ELK2b</i>	<i>DAG-GER</i>	<i>COLD</i>	<i>Up-Brskn</i>	<i>Refer-ences</i>
2001	86		86	113			99	109		
2008	75	78	84		87	63		107	86	

Table 12. Ecological Status ratings (MIM 2008).

<i>Range</i>	<i>Status</i>
0-15	Very Early
16-40	Early
41-60	Mid
61-85	Late
86+	PNC

Table 13. Ecological status trend statistics for sites in Bear Valley (those in red are considered significant positive trends, i.e. $p < .1$).

STATION	REGRESSION COEFFICIENT	SIGNIFICANCE OF TREND
BV5A	0.15	0.39
BV7A	0.20	0.32
BV7B	0.10	0.46
BV8A	0.007	0.89
ELK1A	0.09	0.51
ELK2B	0.15	0.45
DAGGER	0.37	0.59
UBRSKN	0.86	0.07*

* A negative trend was detected

As shown in Figure 4, trends at Bear Valley and Elk Creeks were mostly variable in the 80 to 90 range during the 1990's and declined to 79 in 2008, but none of the trends was significant as indicated in Table 13. Tributary ecological status was higher than at the reference sites during the 1990's and remained at about the same level in 2008.

Ecological status conditions were mostly in the Late range with tributaries showing a PNC rating as suggested by Table 12 and Figure 4.

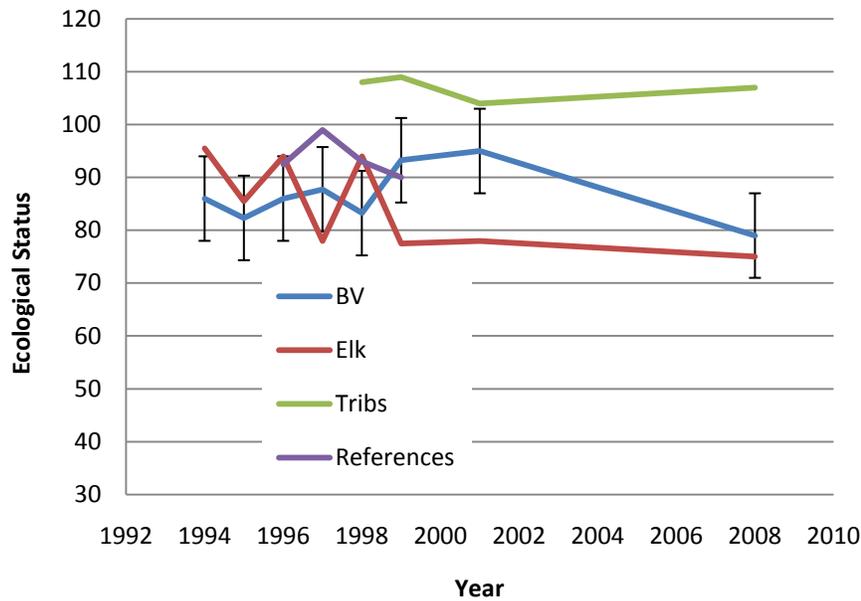


Figure 4. Ecological status trends at monitoring sites in Bear Valley Creek (BV), Elk Creek (Elk), and tributaries (Trib) showing trends in comparison to trends at the reference sites (purple). Vertical error bars display confidence intervals on Bear Valley data.

A comparison to reference conditions for this metric indicated that ecological status was usually lower on Bear Valley and Elk Creeks, but higher in tributaries. In 2008, ecological status at was lower in Bear Valley and Elk Creeks than the mean values at reference sites (see Figure 4). A negative *t* statistic in Table 14 indicates that the reference site ecological status is higher than the value for the indicated station. Thus the ecological status ratings at BV8a, Dagger, and UBRSKN were higher than the reference site ratings.

Table 14. Comparison of ecological status ratings at monitoring sites with those at reference sites in Bear Valley. Significant differences are highlighted in red. Ecological status in 2008 is also displayed, as is the average for reference sites.

STATION	<i>t</i> STATISTIC	PROBABILITY (P)	2008 Ecological Status	Reference Value
BV5A	-2.88	0.032	75	94
BV7A	-2.39	0.048	78	94
BV7B	-1.32	0.140	84	94
BV8A	5.90	0.005		94
ELK1A	-0.38	0.36	90	94
ELK2B	-1.23	0.172	65	94
DAGGER	0.23	0.42		94
UBRSKN	0.84	0.25	86	94

Substrate: The proportion of fine sediments in the substrates of Bear Valley streams is an important indicator as summarized in the Bear Valley Watershed Analysis (2000). This metric was used to evaluate trends and to compare monitoring sites with reference sites in the present analyses. Generally the percent of substrate as fine sediment (less than 6mm in size) has declined through time at the monitoring sites (Table 15). As shown in Figure 5, declining substrate fine sediments occurred mostly in the 1990's. Reference site substrates also declined slightly in the 1990's. Conditions in the Bear Valley Creek sites began to approach the reference site levels by the end of the 20th century. Though declines were apparent in Elk Creek, substrate fines continue to be 25 to 30% higher than at reference sites.

Table 15. Percent fine sediment (<6mm) for stations in Bear Valley, including the reference stations.

<i>Year</i>	<i>BV5a</i>	<i>BV7a</i>	<i>BV7b</i>	<i>BV8a</i>	<i>ELK1a</i>	<i>ELK2b</i>	<i>DAG-GER</i>	<i>COLD</i>	<i>Up-Brskn</i>	<i>References</i>
1994		55%								
1995	39%	31%	33%		54%	42%			39%	
1996	18%	56%	26%		41%	11%			18%	24%
1997	30%	47%	54%		24%	23%			30%	21%
1998	8%	25%	21%		19%		24%	87%	8%	14%
1999	13%	21%	21%		18%	9%	40%	86%	13%	14%
2001	28%	18%	51%				33%	64%	28%	
2008	18%	18%	37%		37%	14%	29%	64%	18%	

In 2008, BV7b and Elk 1a continued to have elevated fines as compared with other sites in those important salmon spawning streams. The higher levels in BV7b may be due to locally lower gradient where substrate fines are naturally deposited. Elk1a on the other hand is located just downstream of the confluence with Bearskin Creek, and stream naturally high in fine sediments. The tributary monitoring site, Cold Creek also has elevated fine sediment levels (64% in 2008). This monitoring site is located on a low gradient "E" channel cut into sands and silts, naturally high in substrate fines. Reference streams are steeper gradient, "C" channels with abundant gravel particles available in the floodplain into which the channels are cut.

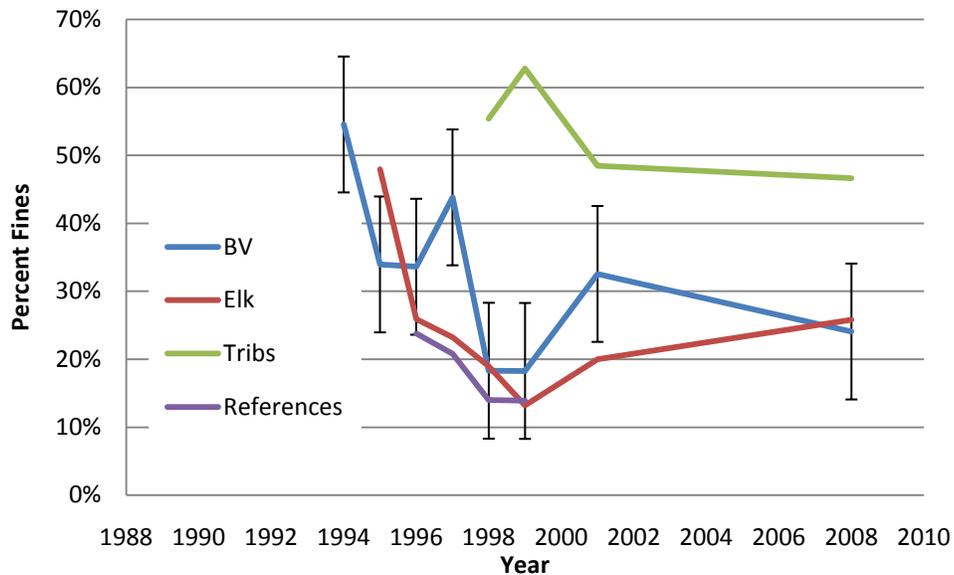


Figure 5. Substrate fine sediment trends at monitoring sites in Bear Valley Creek (BV), Elk Creek (Elk), and tributaries (Tribs) as compared to trends at the reference sites. Error bars indicate the confidence intervals of plus and minus 10% fines.

The declines in fine sediment may reflect the improvements in riparian conditions at the monitoring sites, although that was not indicated by the other metrics shown above.

Table 16. Substrate percent fine sediment trend statistics for sites in Bear Valley (those in red are considered significant positive trends, i.e. $p < .1$).

STATION	REGRESSION COEFFICIENT	SIGNIFICANCE OF TREND
BV5A	0.09	0.52
BV7A	0.48	0.06
BV7B	0.02	0.73
BV8A	NA	NA
ELK1A	0.01	0.84
ELK2B	0.13	0.48
DAGGER	0.00	0.93
UBRSKN	0.09	0.52

A comparison to reference conditions for this metric indicated that substrate fines were higher at the monitoring sites during the 1990's. By 2008, these conditions had reversed at many sites where they were now comparable to or less than the average reference condition(see Table 16). The sites at BV7b and ELK1a were much higher in substrate fines than the reference condition.

Table 16. Comparison of substrate fine sediment levels at monitoring sites with those at reference sites in Bear Valley. Significant differences are highlighted in red. Percent fines in 2008 is also displayed, as is the average for reference sites.

STATION	t STATISTIC	PROBABILITY (P)	2008 Percent fines	Mean of References
BV5A	-0.20	0.426	18%	18%
BV7A	0.18	0.438	18%	18%
BV7B	1.76	0.088	37%	18%
BV8A				18%
ELK1A	-0.20	0.43	37%	18%
ELK2B	-1.60	0.104	14%	18%
DAGGER	1.39	0.15	29%	18%
UBRSKN	-0.20	0.43	18%	18%

Discussion

Trends in riparian indicators in Bear Valley may partly reflect the effects of streamflow on the streambank and riparian vegetation. Snow water equivalent, as measured at Banner Summit, shows an increasing trend during the mid and late 1990's with a decline in the 2000's (Figure 5). These trends are consistent with the decline in bank stabilities and substrate fine sediments during the 1990's. The fact that fine sediments remained low in 2008, and bank stabilities recovered slightly by then suggests that the absence of additional land disturbance factors may have helped maintain these conditions in 2008. These higher snowpack conditions may also explain the increases in ecological status and Winward stability rating in the late 1990's with a slight decline by 2008.

With respect to livestock grazing, there is little evidence that the absence of livestock during the 7 years immediately before the 2008 sample indicated a positive trend in riparian indicators. For the most part, riparian indicators were the same in 2008 as compared with 2000 and 2001. There was a decline in bank stability during the late 1990's at some of the sites, but declines were also indicated at the reference sites (Fir and Porter Creeks). This late 1990's decline may be due in part to a shift in the way bank stability was classified. Of greater interest are the trends in substrate indicators prior to 2000. As shown in Figure 7, a least-squares fit to the averages for the monitoring sites prior to the year 2000 compared to all

years shows a much steeper decline in the earlier time period. The substrate data suggest that much of the improvement to Bear Valley streams occurred during the years of intensive livestock management. By the end of the decade when all grazing ceased, little improvement has occurred. The same cannot be suggested for the other riparian indicators. Bank stability, for example, generally declined during the 1990's and then recovered slightly during the 2000's. Ecological status remained essentially static through the years. Winward stability rating increased over all years, but the 1990's did not see as steep a trend in the 1990's compared to the 2000's.

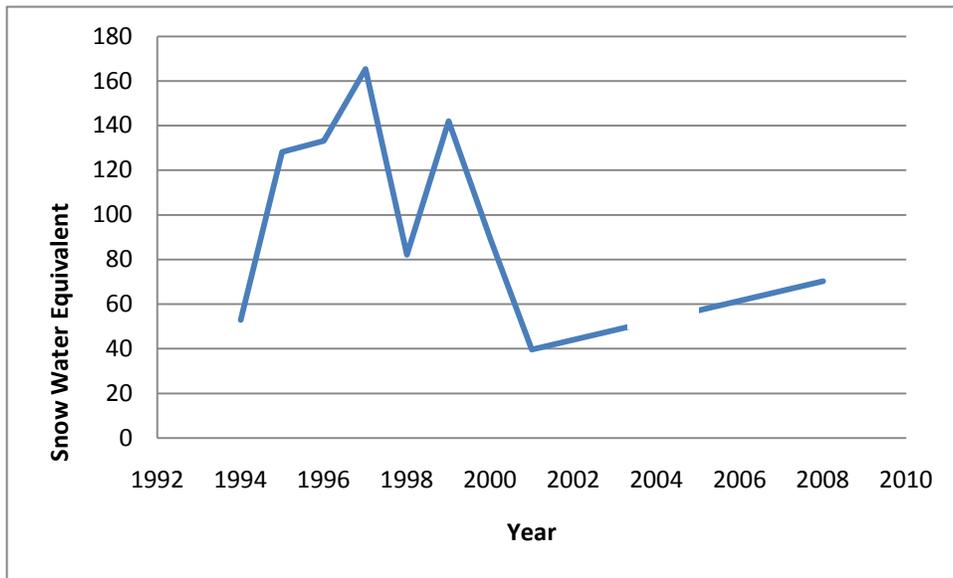


Figure 6. Snow water equivalent (inches) at the Banner Summit Snotel Station for years 1994 to 2001 and 2008, analogous to the monitoring years in Bear Valley (USDA SNOTEL 2010).

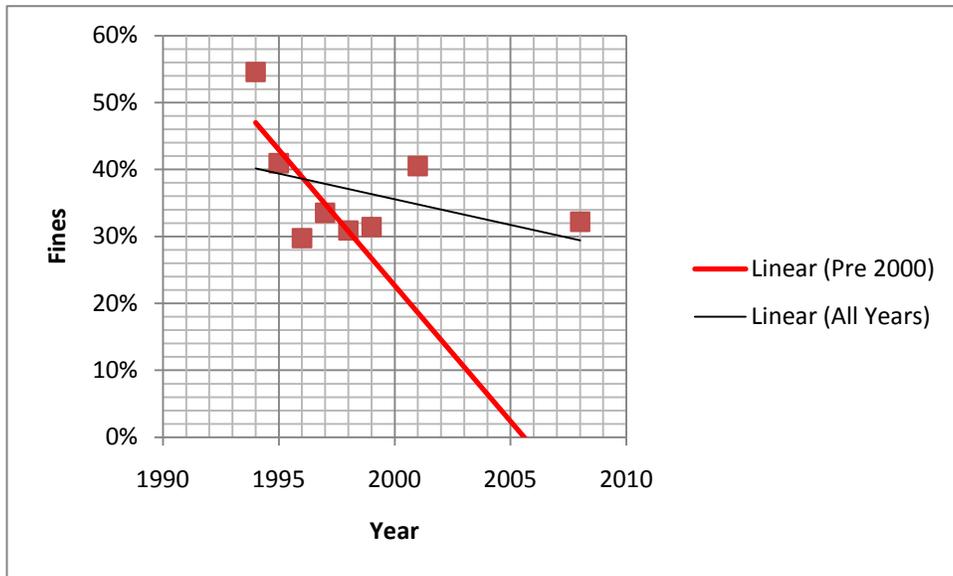


Figure 7. Trends in percent fines (least squares line fit) for monitoring sites in Bear Valley showing a steeper trend for years prior to 2000 than for the all years through 2008'

The condition of riparian indicators was generally lower than that for the reference sites. Many of those differences are statistically significant for Bear Valley and Elk Creeks. The tributaries are comparable to, or even better than the reference sites (e.g. ecological status). Conditions are summarized below:

Bank Stability: Bear Valley Creek was variable from 70 to 90 percent and Elk Creek from 60 to 85% over all the years. Tributaries were in the 80's and references from 80 to 100 percent. The PACFISH riparian management objective for salmon streams was 80% and the PACFISH Biological Opinion of 1995 increased the objective to 90%. Because the bank stability protocol had a poor precision of plus and minus 10%, the variability at the reference sites – 80 to 100% may at least partly reflect observer error, and likely also the imprecision associated with the shift in the protocol during the mid 1990's.

Greenline Vegetation Winward stability rating: The ratings for Bear Valley and Elk Creeks fall mostly in the "Mid" stability class and for the tributaries and references in "High" stability class. However the confidence interval on this rating makes it difficult to definitively conclude that vegetation stability is actually in or below either class. This is because most of the ratings fall in the 6.0 to 7.0 range and the change from "Mid" to "High" is at 6.5.

Greenline Vegetation Ecological Status: Ecological status tends to average in the 75 to 95 range on Bear Valley and Elk Creeks. The lower half of this range, 75 to 85 is in the "Late" category and above that in the "Potential Natural Community" or

PNC category. Reference sites and tributaries were consistently in the PNC category. These conditions reflect the predominance of late seral species on the greenlines in Bear Valley.

Substrate Fines: The analysis indicates that substrate fines were higher at the monitoring sites than at reference sites during the 1990's. By 2008, these conditions had reversed at many sites, where they were now comparable to or less than the average reference condition. In the early 1990's percent fines were in the 45 to 55 percent range on Bear Valley and Elk Creeks. By 2008 substrate fines were in the 20's. Reference site conditions in the 1990's were in the 15 to 25% range. The PACFISH Biological Opinion suggested that for salmon spawning streams, the objective for substrate percent fines should be less than 20%.

ATTACHMENT 1 Photos:



Point bar near BV7b. Photo left was taken in 2000, photo right in 2008. This bar is gradually being covered by perennial vegetation, evidence of vegetative encroachment in the Big Meadow on upper Bear Valley Creek.



Eroding bank at station COLD. The photo on the left was taken in 1993 and photo right in 2000. An electric fence was installed in 1996 to limit livestock access to this portion of Cold Creek. Hydric vegetation increased in density and encroached upon the channel which became narrower and deeper. The 1993 photo was taken early in the year prior to plant growth reflected in the 2000 photo. The important change here appears to be the shift from forbs to grasses.

Transfer Cabin site on Bear Valley Creek located about ½ mile upstream of BV7a. This is a traditional point of cattle concentration where a major crossing of the channel was used while herding livestock. The photo at top was taken in 1986, the one in the center in 1999, and at bottom in 2008. The rail post fence was installed in the early 1990's to deflect cattle concentrations at this location, but the establishment of a riparian pasture here greatly improved riparian conditions at this point during the 1990's. There is evidence, however that hydric vegetation continued to encroach into the channel between 1999 and 2008.



Upper Bearskin Creek Monitoring Site: 1999



2008



Bear Valley Monitoring Site 7B: Upstream View. Little change is evident between 1998 and 2001

1998



1999



2001

Cold Creek monitoring site: mid-reach looking downstream. The bar in the foreground appears to have reduced in size during the 10 year period.



1998

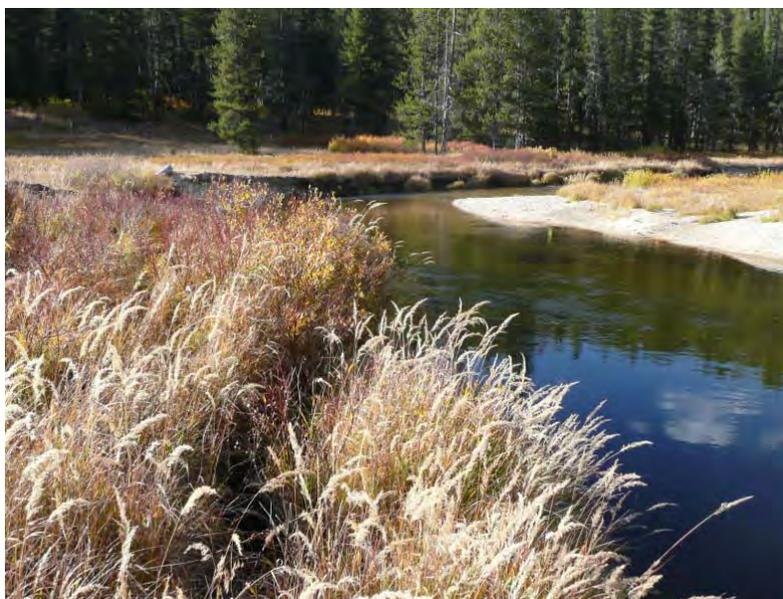


2007

Elk Creek Monitoring Site 2B Upstream View: 1989, and 2008. There appears to be more vegetation on the gravel bar (right side) suggesting possible vegetative encroachment into the channel.



1998



2008

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