4. Dairy Creek

4.1 Introduction

Dairy Creek is a tributary to Chorro Creek, which flows through El Chorro Regional Park, and is the site of a cattle exclusion project (Figure 4.1). The land has a history of grazing without creek corridor protection, and in many areas the riparian vegetation was damaged. The NRCS partnered with the San Luis Obispo County Parks Department to fence and revegetate the mile-long riparian corridor through the park. BMPs implemented at Dairy Creek included cattle exclusionary fencing with water gaps and riparian revegetation. Re-vegetation included planting arroyo willows (*Salix lasiolepis*) and coast live oaks (*Quercus agrifolia*). Improvements to the lower mile of creek were completed during the summer of 1994, with the remaining upper half-mile of creek fenced during the summer of 1995.

In the past, approximately twenty head (pers comm. J. Guidetti, 2002) of cattle grazed on the 750-acre property. The fencing encloses the riparian corridor on both sides of the creek, excluding it from the grazing areas. Two water gaps were left between the lower and upper cattle fencing and just below the upper Dairy Creek site (DAU) to allow cattle access to the creek for water. The number of acres available for grazing has been reduced from 750 to less than 400. Of the 750 acres previously grazed, 150 acres have been designated as a botanical area. A large portion of the park was developed as a golf course beginning in 1995 and completed in 1997. The lower mile of the creek was fenced in July of 1994 to protect the creek, to improve water quality, and to eliminate cattle access to the golf course area. The BMP strategy for Dairy Creek is referred to as ‘cattle fencing with water gaps’ as apposed to the ‘total cattle exclusion’ at upper Chorro Creek and ‘rotational grazing with riparian pastures’ at Chumash Creek. The pre-BMP data set includes results from June 1993 to June 1996. The post- BMP period is July 1996-June 2001.

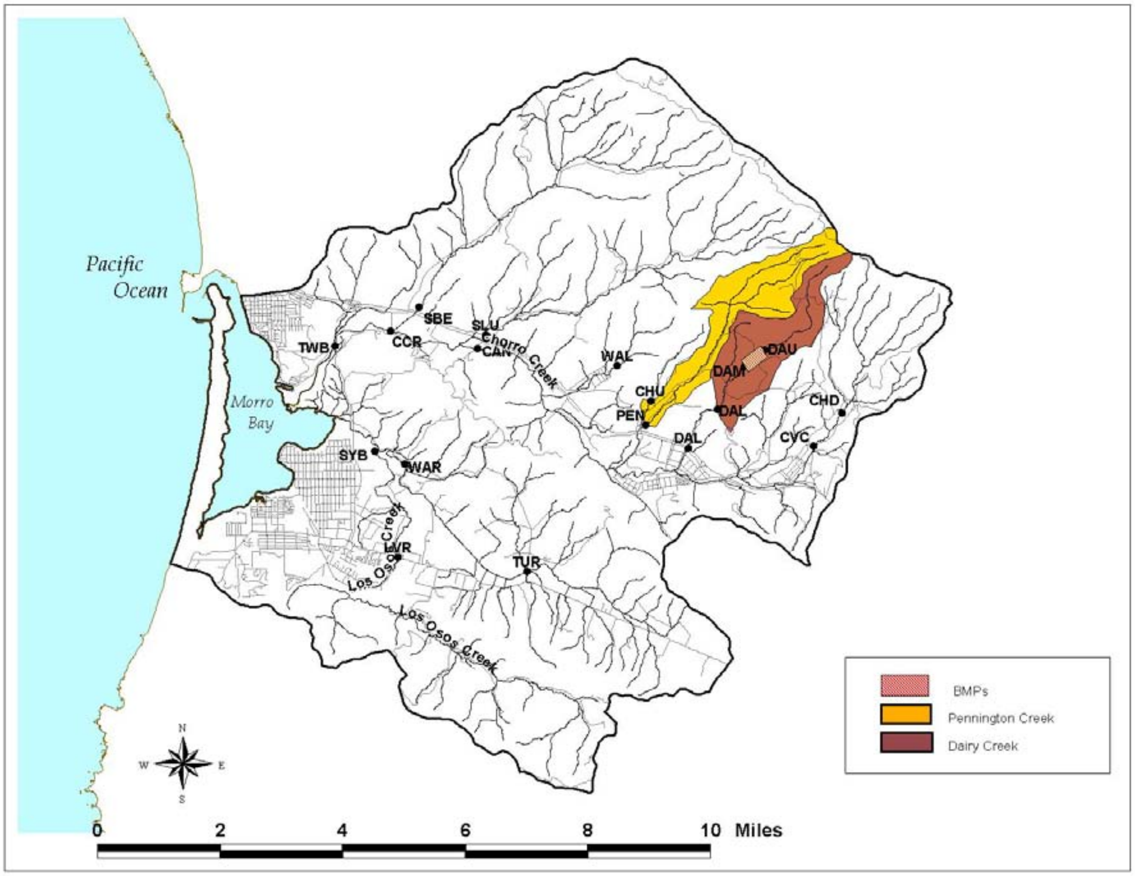


Figure 4.1 Dairy and Pennington Creek watersheds and BMP evaluation project location.

4.2 Methods

4.2.1 Even-interval water quality sampling

Dairy Creek was sampled biweekly at three different locations for nitrate, phosphate, and fecal coliform bacteria and weekly during the winter season for these parameters and suspended sediment. These locations included the upper (DAU) and lower (DAM) ends of the open space area and the lower end of El Chorro Park (DAL) below the open space area and the golf course. Pennington Creek (PEN) was also sampled at regular intervals at Pennington Creek (PEN) to provide reference data for Dairy Creek.

Pennington Creek serves as the control creek for Dairy Creek. The watershed is of similar size, although the lower half has not been grazed for a number of years. In addition, the upper watershed of Pennington Creek, owned by Cal Poly State University, is in relatively good condition compared to Dairy Creek, which is owned by the California Military Department. Unlike most of Dairy Creek, Pennington Creek supports a well-shaded corridor, with limited cattle access in the sample area. The upper half of Pennington Creek is grazed as part of Cal Poly's Escuela Ranch. PEN was sampled using the same regime as DAL, DAM, and DAU.

Stream flow was measured with a pygmy flow meter by staff and volunteer monitors at the DAM and PEN sites. Flow was extremely low throughout the winter in 1993-94 on both Dairy and Pennington Creeks, never reaching one cubic foot per second during winter sampling efforts. In contrast, in 1994-95 Pennington Creek had flows so high data collection was not possible at times. Moderate rainfall during the 1995-96 season resulted in comparable flows for DAM and PEN. Logarithmic stream flow from Dairy and Pennington Creeks is strongly correlated (R^2=81.6%, $p<0.0001$). See Figure 4.2 for a fitted line plot. In several instances when flows were too high to be measured in one of the creeks, they were modeled using the relationship between the two creeks.

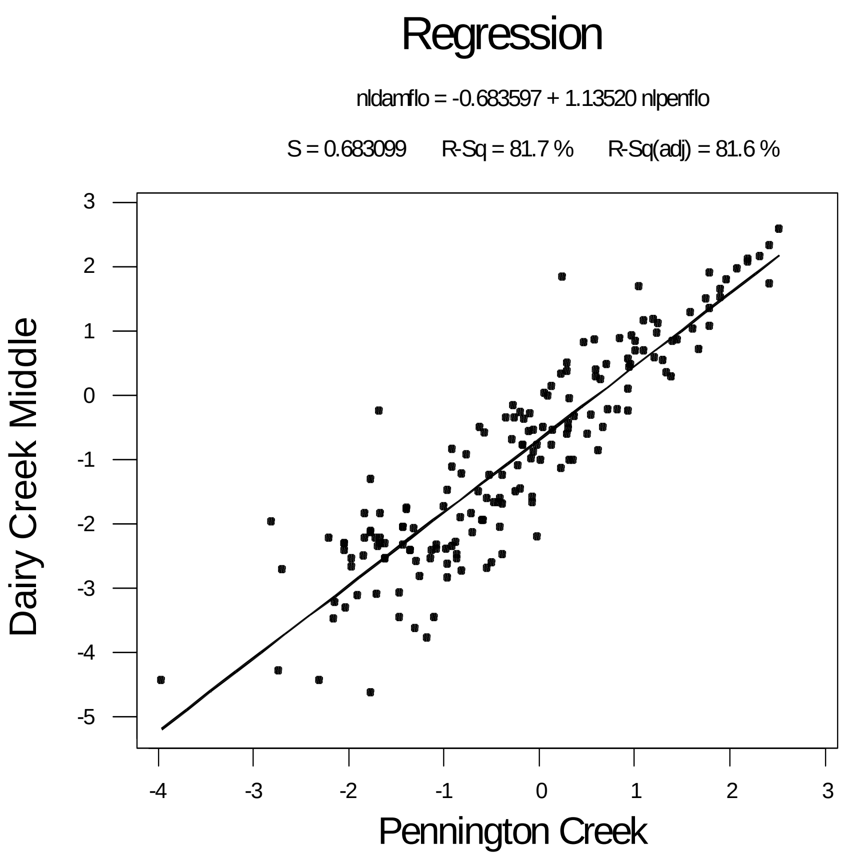


Figure 4.2. Fitted line plot for Dairy Creek Middle and Pennington Creek natural logged flow.

Data analyses performed on Dairy Creek (DAM) and Pennington Creek (PEN) were the same as those used for Chumash and Walters Creeks. For all normally distributed data and data sets without censored data, a repeated measure linear regression was used and for all other data a repeated measures binary regression was used.

4.2.2 Rapid Bioassessment

Dairy and Pennington Creeks were sampled annually at four different locations at reaches associated with water quality monitoring sites (DAU, DAM, DAL, and PEN). The methodology was identical to the rapid bioassessment conducted on the Chumash /Walters paired watershed study detailed in Chapter 3 of this report.

4.2.3 Stream profiles

Cross-sectional stream channel profiles were conducted along five permanent stations on Dairy Creek and Pennington Creek. Cross-sections were sampled across their width at one-foot intervals. At each interval, height was recorded along with substrate particle size at a point immediately beneath the stadia rod. Flood plain width, bankfull width, and average bankfull depth was estimated for each channel. Channel entrenchment was calculated as the ratio of flood prone area to bankfull depth. The width/depth ratio was calculated as the ratio of bankfull width to bankfull depth. See the Quality Assurance Program Plann (QAPP) for more detail on definitions of the above parameters.

Substrate size within bankfull width, was determined using the Wolman method (1954) at each cross-section. Particle size data is plotted on a logarithmic scale as a cumulative percentage of size classes. The dominant particle size is defined as the median size of channel materials (or D50), where 50% of the particles sampled were this size or smaller (Rosgen, 1996). The overall substrate size for the reach was determined by calculating the D50 for cumulative pebble size data from all five transects. Additionally, substrate type and size was also evaluated at each foot interval between the floodplain area and the bankfull width.

4.3 Results and Discussion

4.3.1 Even-interval water quality sampling

Stream Flow

Despite a strong correlation between creeks, flow at DAM is most typically lower than PEN. Figure 4.3 displays daily flow for DAM and PEN from 1993 to 2001.

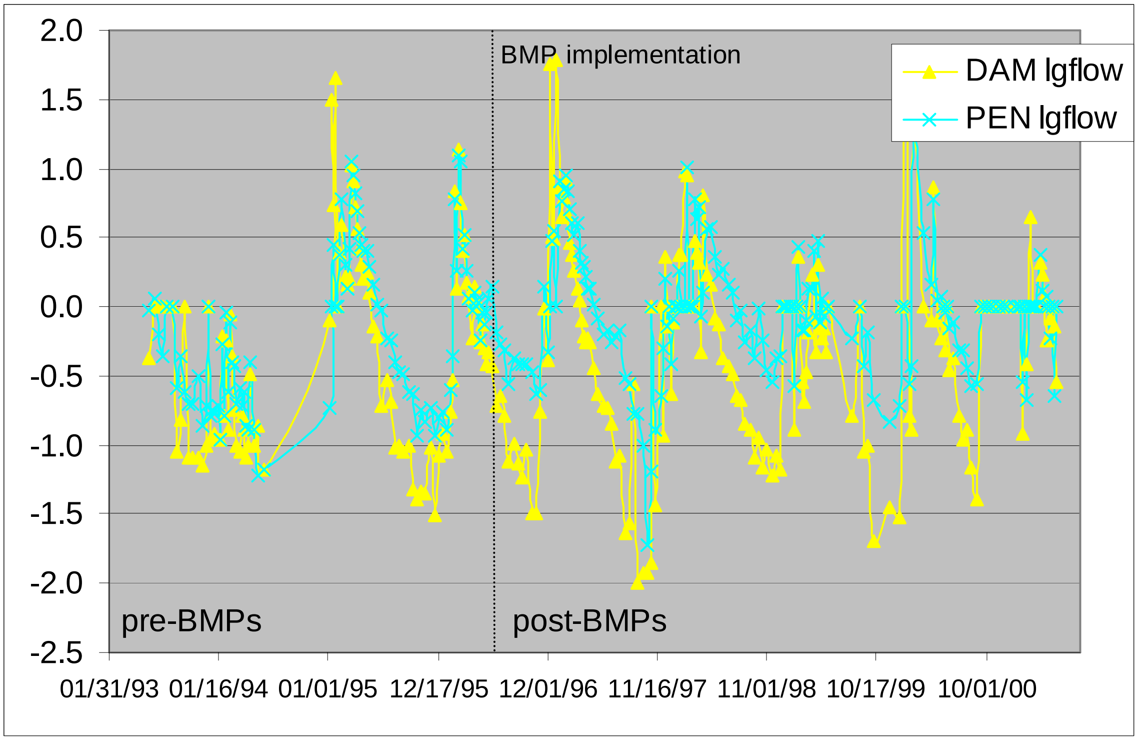


Figure 4.3. Daily flow (cfs) of DAM and PEN from 1993 to 2001.
Note: Flow scale is in natural logarithms.

Water Temperature

Changes in water temperature due to BMP implementation at Dairy Creek Middle (DAM) were detected. The average water temperature at the control creek, Pennington Creek (PEN), from 1993 to 2000 was 14.71°C. Before BMP treatment, DAM water temperature was on average 0.89°C degrees higher than PEN and was found to be statistically different ($p=<0.0001$). In the years following cattle exclusion fencing and revegetation at DAM (1996-2000), water temperature dropped on average 0.50°C and again was found to be statistically significant ($p=0.045$, Table 4.1). Therefore, a change resulting from BMPs occurred.

When data collected at DAM were compared to another control site upstream, Dairy Creek Upper (DAU), results were similar (Table 4.2). DAU mean water temperature between 1993 and 2000 was 15.30°C. DAM mean temperature pre-BMPs exceeded DAU by 0.74°C. . Following BMPs, DAM water temperature dropped on average 0.99°C. Both pre- and post BMPs time periods were statistically significant ($p<0.0001$, Table 4.2). Again, the results indicate a positive influence of BMPs on water temperature. .

Table 4.1. Repeated Measures linear regression results for water temperature °C between DAM and PEN.

Time Period	PEN	DAM	P-value
Pre-BMPs mean	14.71*[1]	15.61	<0.0001***
Post-BMPs mean		15.10	0.045*

*<α=0.05, **<α=0.01, ***<α=0.001 *[1]The mean of Pennington Creek water temperature for the study. It is used as the intercept for the regression model (see Chapter 3, Methods for further detail).

Table 4.2. Repeated Measures linear regression results for water temperature °C between DAM and DAU.

Time Period	DAU	DAM	P-value
Pre-BMPs mean	15.31*[1]	16.04	<0.0001***
Post-BMPs mean		15.06	<0.0001***

***<α=0.001 *[1]The mean of Pennington Creek water temperature for the study. It is used as the intercept for the regression model (see Chapter 3, Methods for further detail).

Figure 4.3 displays yearly means between DAM and PEN from 1993 through 2000.

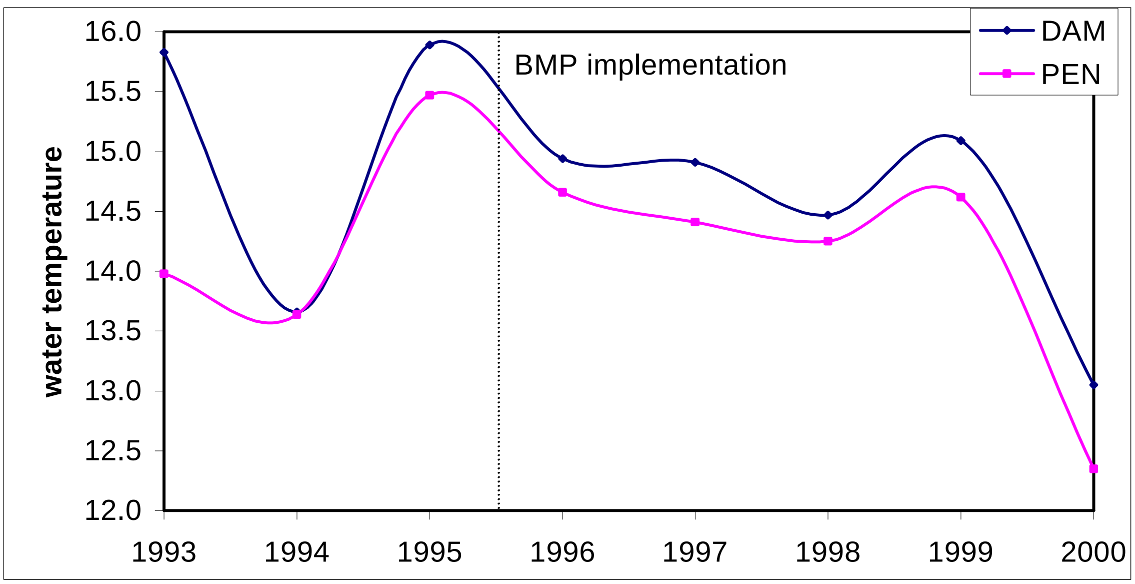


Figure 4.4. Yearly mean water temperature values measured at DAM and PEN from 1993 through 2000. BMPs were implemented in 1994.

Air Temperature

In the post-BMP time period, DAM air temperature on average dropped 0.35°C between DAM and PEN and 0.037°C between DAM and DAU. Neither were found to be significant (α=0.05, Table 4.3 for DAM and PEN and Table 4.4 for DAM and DAU). Because no statistical difference occurred, air temperature results further support that the drop in water temperature was due to BMP implementation. .

Table 4.3. Repeated Measures linear regression results for air temperature °C between DAM and PEN.

Time Period	PEN	DAM	P value
Pre-BMPs mean	20.55*[1]	20.04	0.0688
Post-BMPs mean		19.68	0.3488

*[1]The mean of Pennington Creek air temperature for the study. It is used as the intercept for the regression model (see Chapter 3, Methods for further detail).

Table 4.4. Repeated Measures linear regression results for air temperature °C between DAM and DAU.

Time Period	DAU	DAM	P value
Pre-BMPs mean	20.04*[1]	19.89	0.5011
Post-BMPs mean		19.85	0.9059

*[1]The mean of Pennington Creek air temperature for the study. It is used as the intercept for the regression model (see Chapter 3, Methods for further detail).

Dissolved oxygen

An increase in dissolved oxygen (ppm) was detected at DAM. Before BMP treatment, dissolved oxygen at DAM was on average 1.75 ppm lower than at PEN. Following BMP implementation, dissolved oxygen (ppm) concentrations at DAM on average increased by 0.90 ppm and were found to be statistically significant (p=<0.0001, Table 4.5).

Comparisons between DAM dissolved oxygen (ppm) concentrations and the upstream control site (DAU) yielded similar results. After BMP implementation, DAM dissolved oxygen concentrations increased on average 0.85ppm (Table 4.6).

Table 4.5. Repeated Measures linear regression results for dissolved oxygen (ppm) between DAM and PEN.

Time Period	PEN-control	DAM-treatment	P value
Pre-BMP mean	9.24*[1]	7.50	<0.0001***
Post-BMPs mean		8.40	<0.0001***

*[1]The mean of Pennington Creek air temperature for the study. It is used as the intercept for the regression model (see Chapter 3, Methods for further detail).

Table 4.6. Repeated Measures linear regression results for dissolved oxygen (ppm) between DAM and DAU.

Time Period	DAU-control	DAM-treatment	P value
Pre-BMP mean	8.46*[1]	7.28	<0.0001***
Post-BMPs mean		8.13	<0.0001***

*[1]The mean of Pennington Creek air temperature for the study. It is used as the intercept for the regression model (see Chapter 3, Methods for further detail).

Turbidity

Turbidity levels at DAM, DAU, and PEN were similar. Prior to BMP implementation, a greater frequency of turbidity samples above the threshold (10 NTUs) were found at DAM than at DAU and PEN (Table 4.10), but the number was not significant**.** Following BMP implementation, no statistical differences were found. Similar results were also found when a threshold of 50 NTUs. Figure 4.6 displays the turbidity results for all three sites together using 10 NTUs as the threshold values.

Table 4.10. Contingency table of the number of turbidity samples above and below the threshold for pre- and post-BMP implementation at DAM, DAU, and PEN (threshold value = 10 NTU). Also included is percentage of samples above and below the threshold, total number of samples, and p values form binary logistic regression analysis. P values for the comparison of DAM and DAU are placed in the DAU column and for DAM and PEN in the PEN column.

		DAM - treatment		DAU - control		PEN - control	
		number	%	number	%	number	%
Pre-BMPs	<10 NTU	94	89	93	88	87	92
	≥10 NTU	12	11	12	12	8	8
	Total	106	100	106	100	95	100
	P value			0.6948		0.0828	
Post-BMPs	<10 NTU	153	87	151	86	146	90
	≥10 NTU	22	13	24	14	16	10
	Total	175	100	175	100	162	100
	P value			0.8897		0.9540	

*α=0.05

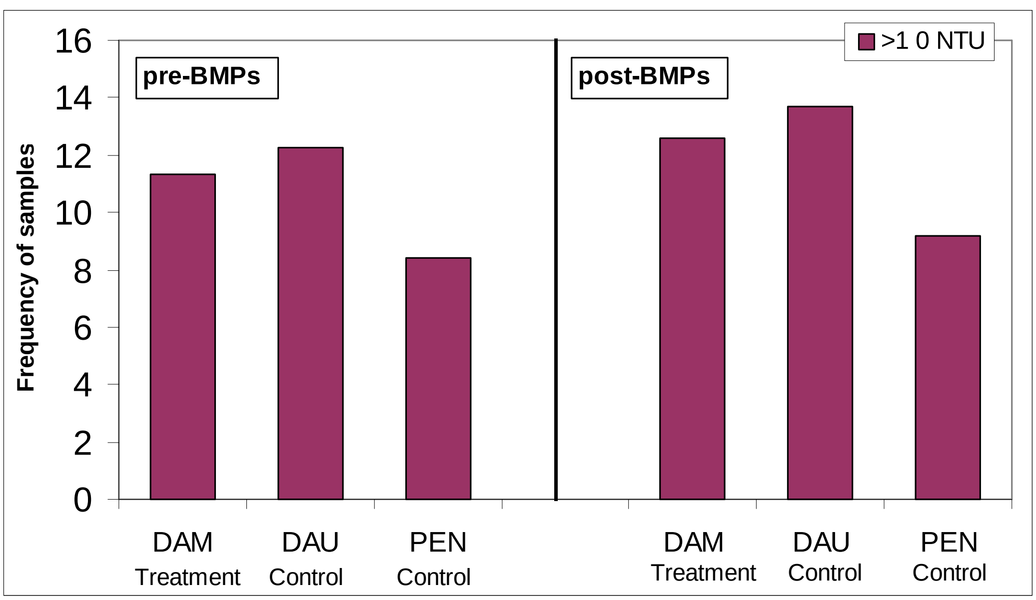


Figure 4.5 Bar chart of DAM, DAU, and PEN turbidity frequencies above the threshold of 10 NTU for pre- and post-BMPs.

Fecal Coliform Bacteria

The Regional Board's Basin Plan recreational water contact objective for fecal coliform (200MPN/100mL) was chosen as a analysis threshold. Statistical differences were found in the pre-BMP time period. Prior to BMP implementation, levels at DAM had a lower probability of exceeding the threshold (p=0.0104, Table 4.7). There was little change in the post-BMP time period (p=0.3571) and no significant differences were found. Results were similar when the fecal coliform level for non-contact recreation (2000MPN/100mL) was used as the threshold value. At either threshold, changes were not detected in fecal coliform bacteria levels at DAM.

Table 4.7. Contingency table of the binomial distribution of fecal coliform bacteria values pre- and post- BMP implementation at DAM, DAU, and PEN during ambient conditions
(threshold value = 200 MPN/100 mL based on the Regional Board Basin Plan recreational water contact standard).
Included is number of fecal coliform bacteria samples found to be equal to or below 200 MPN/100mL and number of fecal coliform bacteria samples found to be above 200 MPN/100mL. Also included is the total number of samples, the percentage of samples in both categories, and p-values for pre- and post-BMPs time periods.

		DAM - treatment		DAU - control		PEN - control	
		number	%	number	%	number	%
Pre-BMPs	<200 MPN	65	61	49	46	43	45
	≥200 MPN	41	39	57	54	52	55
	Total	106	100	106	100	106	100
	P value			0.1553		0.0104*	
Post-BMPs	<200 MPN	104	59	103	59	71	44
	≥200 MPN	71	41	72	41	91	56
	Total	175	100	175	100	162	100
	P value			0.5834		0.9328	

The frequency of fecal coliform bacteria samples above the 200MPN/100mL threshold for DAM, DAU, and PEN is shown in Figure 4.6. Fecal coliform bacteria levels above the threshold at DAM did not change as a result of BMP implementation. Fecal coliform levels above 2000 MPN/100mL did not change significantly between sites (Table 4.6).

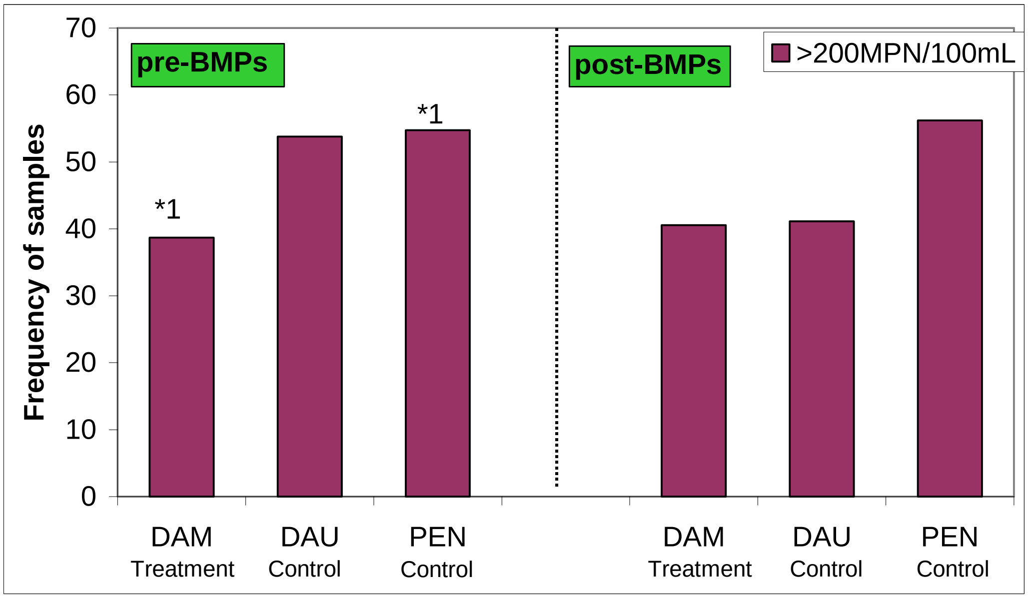


Figure 4.6. Bar chart of DAM, DAU, and PEN fecal coliform frequencies above the threshold of 200MPN/100mL for pre- and post-BMPs.
*1 indicates a significant difference between sites: $\alpha < 0.05$.

Table 4.8. Contingency table of the binomial distribution of fecal coliform bacteria values pre- and post- BMP implementation at DAM, DAU, and PEN during ambient conditions (threshold value = 2000 MPN/100 mL based on the Regional Board Basin Plan non-contact water recreation standard).
Included is number of fecal coliform bacteria samples found to be equal to or below 2000 MPN/100mL and number of fecal coliform bacteria samples found to be above 2000 MPN/100mL. Also included is the total number of samples, the percentage of samples in both categories, and p- values for pre- and post-BMPs time periods.

		DAM - treatment		DAU - control		PEN - control	
		number	%	number	%	number	%
Pre-BMPs	<2000 MPN	87	92	92	87	93	98
	≥2000 MPN	8	8	14	13	2	2
	Total	95	100	106	100	95	100
	P value			0.4159		*0.0415	
Post-BMPs	<2000 MPN	150	93	164	94	152	94
	≥2000 MPN	12	7	11	6	10	6
	Total	162	100	175	100	162	100
	P value			0.6492		0.3571	

*α=0.05

Total Coliform Bacteria

The implementation of BMPs at DAM resulted in a significantly higher number of total coliform samples exceeding the threshold of 1000 MPN/100mL. When compared to the upstream control, DAU, or the control creek, PEN, significant differences were found (Table 4.9). Although the difference between DAM and PEN was not statistically significant (α=0.05), p scores of 0.0597 and 0.0865 (Table 4.9) supported the conclusion that a significant change in total coliform bacteria at DAM. However when compared to DAU a significant change was found. This may be due to an improvement in habitat at DAM.

Table 4.9. Contingency table of the number of total coliform bacteria samples above and below the threshold for pre- and post-BMP implementation at DAM, DAU, and PEN (threshold value = 1000 MPN/100mL based on the median of the data set).
Also included is percentage of samples above and below the threshold, total number of samples, and p values form binary logistic regression analysis. P values for the comparison of DAM and DAU are placed in the DAU column and for DAM and PEN in the PEN column.

		DAM - treatment		DAU - control		PEN - control	
		number	%	number	%	number	%
Pre-BMPs	<1000 MPN	68	64	56	53	50	53
	≥1000 MPN	38	36	50	47	45	47
	Total	106	100	106	100	95	100
	P value			0.0192*		0.0597	
Post-BMPs	<1000 MPN	89	51	94	54	81	50
	≥1000 MPN	86	49	81	46	81	50
	Total	175	100	175	100	162	100
	P value			0.0159*		0.0865	

*α=0.05

The frequency of total coliform bacteria samples above and below the threshold of 1000 MPN/100mL for DAM, DAU, and PEN supports that DAM significantly changed as a result of BMP implementation (Figure 4.7). Levels at DAU And PEN remained similar between treatment periods. It is unclear why a significant increase in total coliform bacteria samples over the threshold of 1000 MPN/100mL was found.

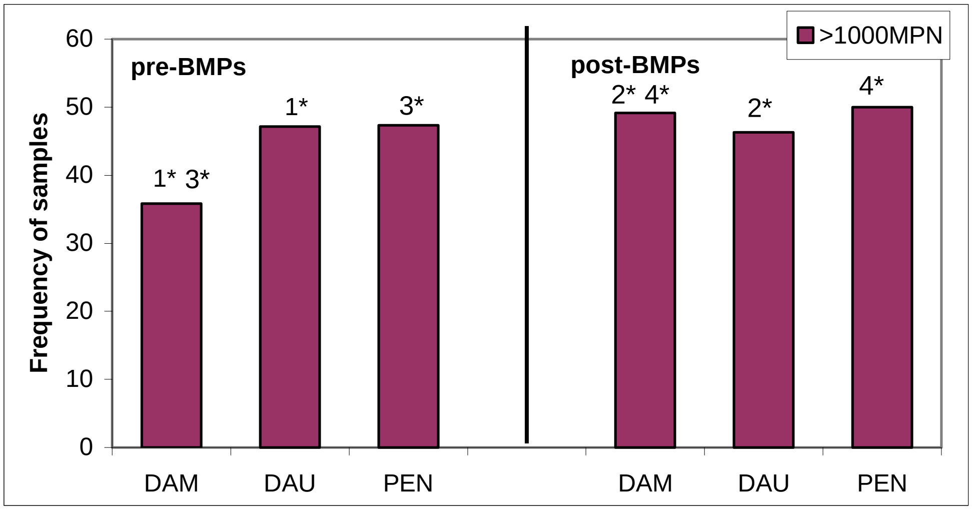


Figure 4.7. Bar chart of DAM, DAU, and PEN total coliform frequencies above and below the threshold of 200 MPN/100mL for pre- and post-BMPs. 1*, 2*, 3*, and 4* indicates a significant difference between sites: p<0.05.

Nitrate-nitrogen

A significantly higher percentage of nitrate samples above the thresholds were found at DAM prior to BMP implementation when compared to DAU (p<0.0001) and to PEN (p=0.0008). The frequency of nitrate-nitrogen above the threshold increased at all of the sites following BMP treatment, but these differences were not significant. (Table 4.11).

Table 4.11. Contingency table of the number of nitrate nitrogen samples above and below the threshold for pre- and post-BMP implementation at DAM, DAU, and PEN (threshold value = 0.700 mg/L).
Also included is percentage of samples above and below the threshold, total number of samples, and p values form binary logistic regression analysis. P values for the comparison of DAM and DAU are placed in the DAU column and for DAM and PEN in the PEN column.

		DAM - treatment		DAU - control		PEN - control	
		number	%	number	%	number	%
Pre-BMPs	<0.700mg/L	82	77	71	67	88	93
	≥0.700mg/L	24	23	35	33	7	7
	Total	106	100	106	100	95	100
	P value			<0.0001***		0.0008***	
Post-BMPs	<0.700mg/L	116	66	104	59	142	88
	≥0.700mg/L	59	34	71	41	20	12
	Total	175	100	175	100	162	100
	P value			0.1016		0.1498	

***α=0.001

Figure 4.8 displays the frequencies of nitrate samples above and below the threshold (0.700 mg/L) at DAM, DAU, and PEN. The increase in nitrate at all of the sites following BMP implementation, is shown.

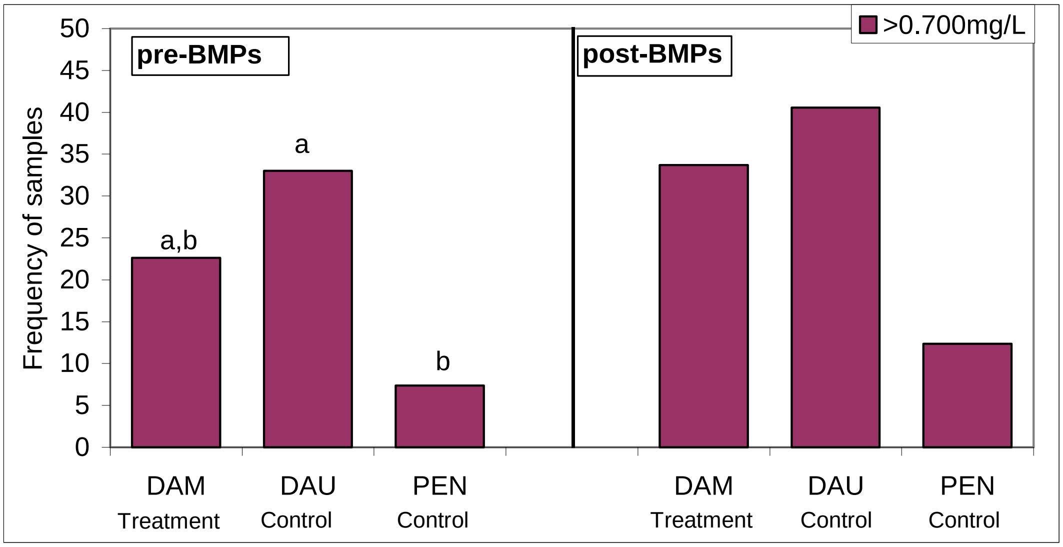


Figure 4.8. Bar chart of DAM, DAU, and PEN turbidity frequencies above and below the threshold of 10 NTU for pre- and post-BMPs. 'a' and 'b' indicates significant differences between sites: $p<0.05$.

Ortho-Phosphate

Table 4.12 shows ortho-phosphate levels before and after BMP implementation. Following BMP implementation, the exceedances at DAM declined, however, this decline was also found at the control (DAU).

Table 4.12 Contingency table of the number of ortho-phosphate samples above and below the threshold for pre- and post-BMP implementation at DAM, DAU, and PEN (threshold value = 0.150 mg/L).
Also included is percentage of samples above and below the threshold, total number of samples, and p values form binary logistic regression analysis. P values for the comparison of DAM and DAU are placed in the DAU column and for DAM and PEN in the PEN column.

		DAM - treatment		DAU - control		PEN - control	
		number	%	number	%	number	%
Pre-BMPs	<0.150mg/L	19	20	20	19	83	87
	≥0.150mg/L	76	80	86	81	12	13
	Total	95	100	106	100	95	100
	P value					<0.0001***	
Post-BMPs	<0.150mg/L	74	46	99	51	156	96
	≥0.150mg/L	88	54	85	49	6	4
	Total	162	100	175	100	162	100
	P value					0.0002***	

*p<.05, ***p<0.001

Even-Interval Water Quality Conclusions

Water temperature improved at Dairy Creek (DAM). This result is most likely due to shading from riparian vegetation that was planted as part of BMP implementation. Dissolved oxygen levels also significantly improved at DAM. Dairy Creek, although degraded in some localized areas, had a relatively mature riparian plant community at the beginning of the study. In contrast, Chumash Creek (Chapter 4) is still in the early stages of plant succession and although riparian vegetation was planted and water temperature did significantly decrease, the riparian corridor is still relatively undeveloped. This perhaps explains why Chumash Creek had a decrease in dissolved oxygen levels following BMP implementation, while levels increased at Dairy Creek.

Fecal coliform levels at DAM and PEN remained the same before and after BMP implementation, however, fecal coliform bacteria levels at one of the control sites (DAU) improved. The water gaps within the cattle exclusion fencing to allow cattle access to the creek for watering, may contribute to a higher frequency of fecal coliform bacteria levels found above the thresholds. In contrast, fecal coliform levels at Upper Chorro Creek (Chapter 6) declined significantly following BMP implementation. This is most likely due to the 'total cattle exclusion' at this BMP site. For reasons unknown, total coliform bacteria levels increased at DAM.

Turbidity, nitrate-nitrogen, and orthophosphate did not significantly change as a result of BMP implementation at DAM. It is recommended that water troughs be installed at Dairy Creek to prevent Cattle from watering in the creek.

4.3.2 Rapid Bioassessment

Results

As indicated previously, DAM is the treatment site and DAU and PEN are control sites. Both comparisons are used to evaluate the effectiveness of BMPs at DAM.

NMP project staff used an Index of Biological Integrity calculated as part of the Central Coast Regional Monitoring Program. Figure 4.8 shows Index of Biological Integrity (IBI) scores at Dairy and Pennington Creeks. As shown, results were variable at both creeks. During the pre-BMP time period, the Highway 41 Fire burned portions of the Dairy Creek, subwatersheds in August 1994. The adverse effects of the fire on benthic macro-intertebrate assemblages are apparent in 1995. Recovery from the event is also apparent in 1996. The IBI score at the treatment site was higher than at the two control sites in 1996, although additional data is needed to determine effectiveness. Overall IBI scores found throughout the Morro Bay watershed are shown in Chapter 8.

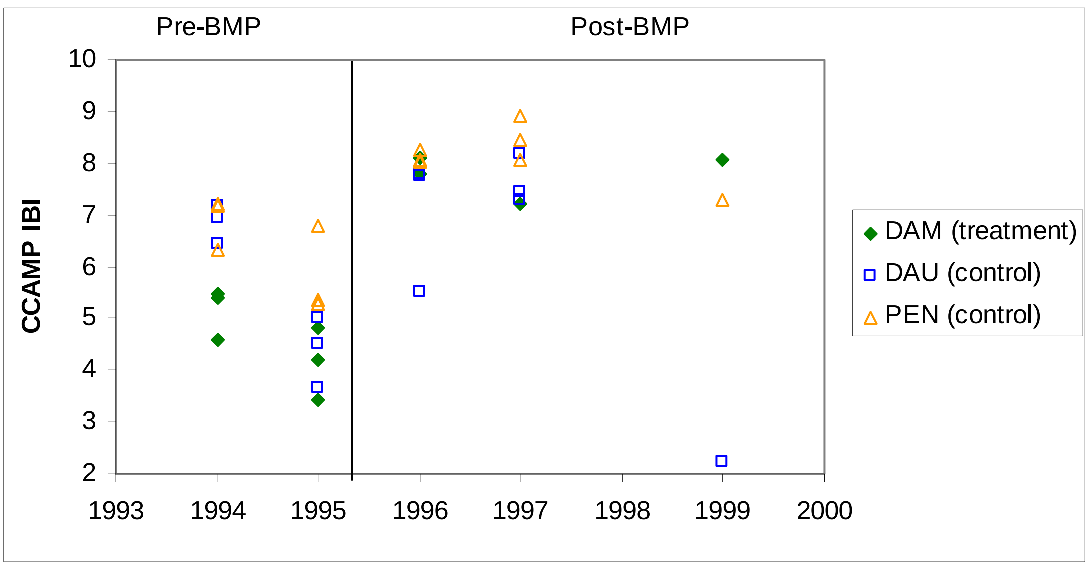


Figure 4.9. Index of Biological Integrity (IBI) scores at Dairy and Pennington Creeks.

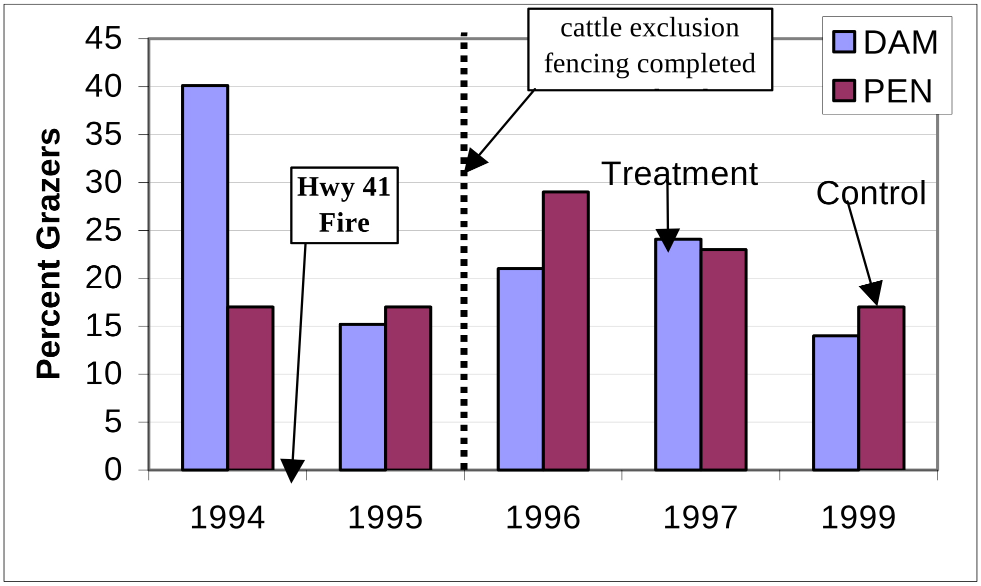
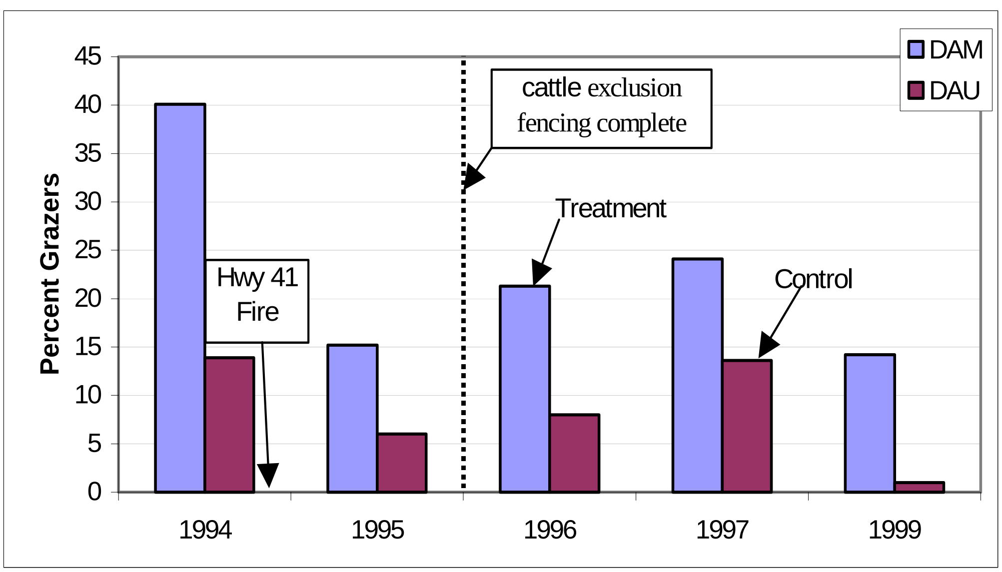


Figure 4.10. The percent of the benthic macro-invertebrate feeding strategy.

Figures 4.10 and 4.11 illustrates grazers found at DAM (the treatment) and at PEN and DAU (the controls) in rapid bioassessment samples from 1994, 1995, 1996, 1997, and 1999. Percent Grazers fluctuated at all sites through the study (Figure 4.9 and 4.10). The dotted lines indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

Figure 4.11. The percent of the benthic macro-invertebrate feeding strategy.



Regional Board staff examined two richness metrices as indicators of water quality for DAM, DAU, and PEN - Taxonomic Richness and EPT Taxa Richness. Taxonomic Richness is the number of taxa (genera and some families in our case) present in a sample. EPT Taxa Richness is the number of taxa representing mayflies (*Ephemeroptera spp*), stoneflies (*Plecoptera spp*), and caddisflies (*Trichoptera spp*) in each sample. These taxa are sensitive and intolerant to pollutants. Their numbers are expected to decrease with disturbance to habitat and increase as water quality and/or benthic macroinvertebrate habitat improves. Taxonomic Richness at DAM and PEN were similar during the years sampled.

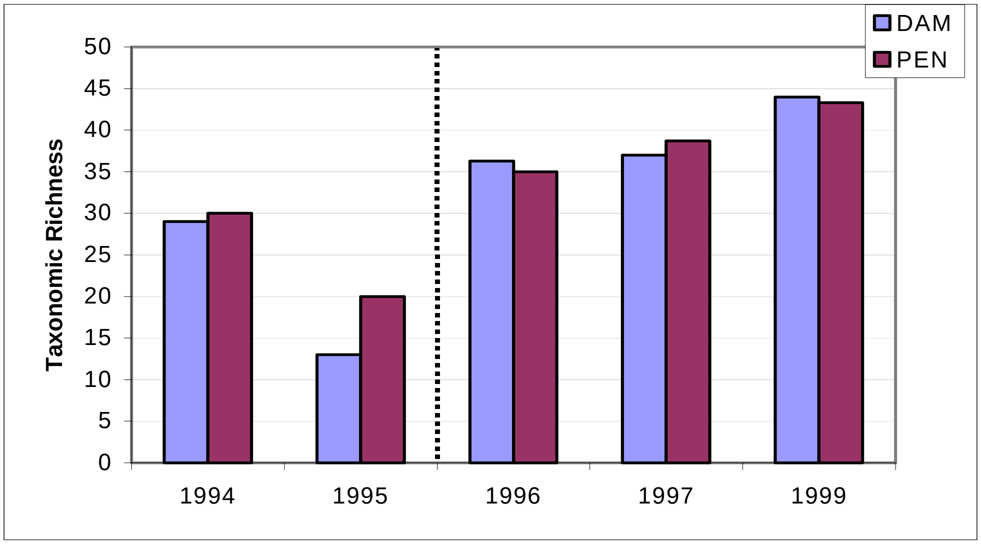


Figure 4.12. Taxonomic richness found in DAM and PEN samples for the years 1994, 1995, 1996, 1997, 1999.
The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

Taxonomic Richness at DAM and DAU were also similar prior to BMP implementation. However, Following BMP implementation, Taxonomic Richness at DAUis less than at DAM. (Figure 4.12). When evaluating Taxonomic Richness as an indicator of water quality, it appears that DAM may be improving due to BMP implementation.

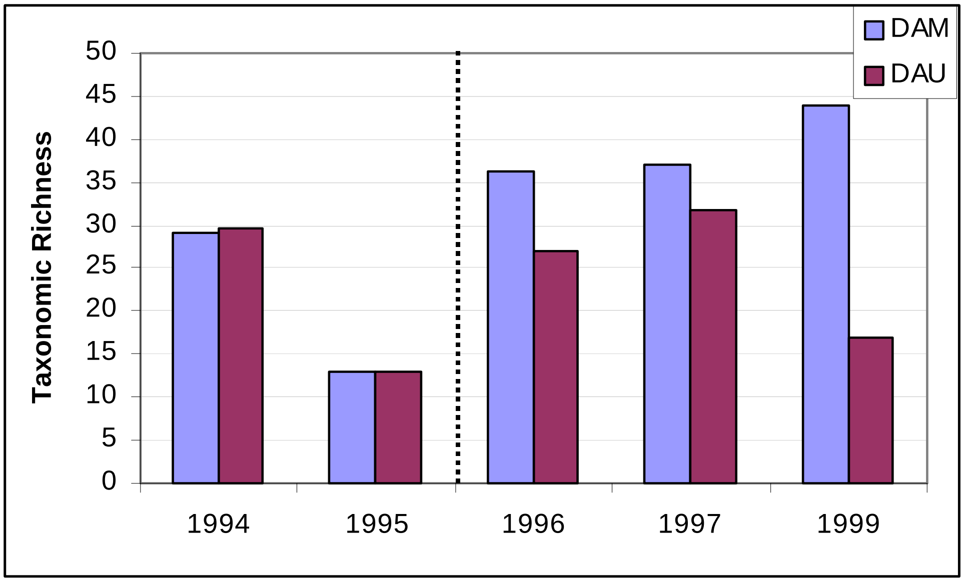


Figure 4.13. Taxonomic richness found in DAU and PEN samples for the years 1994 through 2001 (minus 1998).
The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

After the Highway 41 Fire in1995 the Percent Dominant Taxon increased at DAM, while PEN remained the same as in 1994, possibly due to a greater resilience at this site. (Figure 4.13). From 1996 through 1999, Percent Dominant Taxon were variable at both DAM and PEN. When results at DAM are compared to those at PEN, it is difficult to conclude that any changes are a result of BMP implementation.

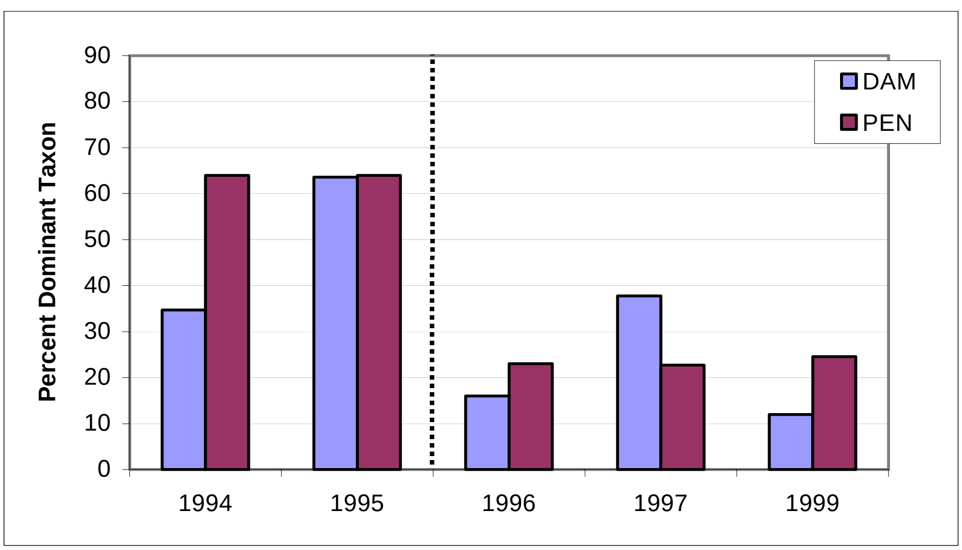


Figure 4.14. Mean Percent Dominant Taxon of DAM and PEN for 1994, 1995, 1996, 1997, and 1999.

A Percent Dominant Taxon is defined as the percent of the sample dominated by the most abundant benthic macroinvertebrate taxon (genera). A decline indicates improvement in benthic macroinvertebrate diversity for this metric. The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

When Percent Dominant Taxon is compared to the other control site (DAU), results suggest that DAM has improved (Figure 4.14) as a result of BMP implementation.

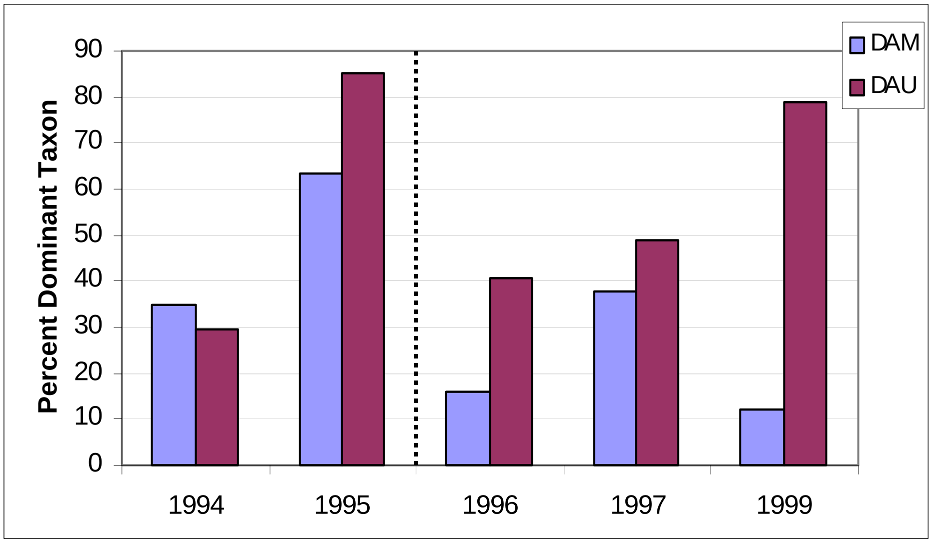


Figure 4.15. Mean Percent Dominant Taxon of DAM and DAU samples for 1994, 1995, 1996, 1997, and 1999.
A percent dominant taxon is defined as the percent of the sample dominated by the most abundant benthic macroinvertebrate taxon (genera). The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

Tolerance Values at DAM and PEN were similar throughout the project (Figure 4.16). Tolerance Values at DAM were consistently higher than those at PEN. The difference between the tolerance values at DAM not change from the pre-BMP period to the post-BMP period relative to PEN. Tolerance Values at DAM were similar to those found at DAU (Figure 4.17).

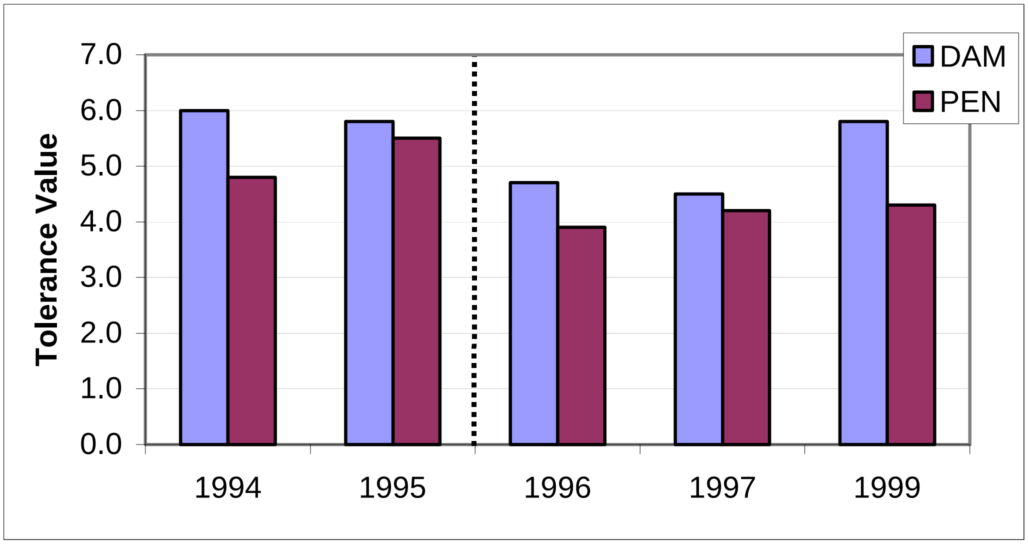


Figure 4.16. Tolerance values for DAM and PEN for 1994, 1995, 1996, 1997, and 1999. The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

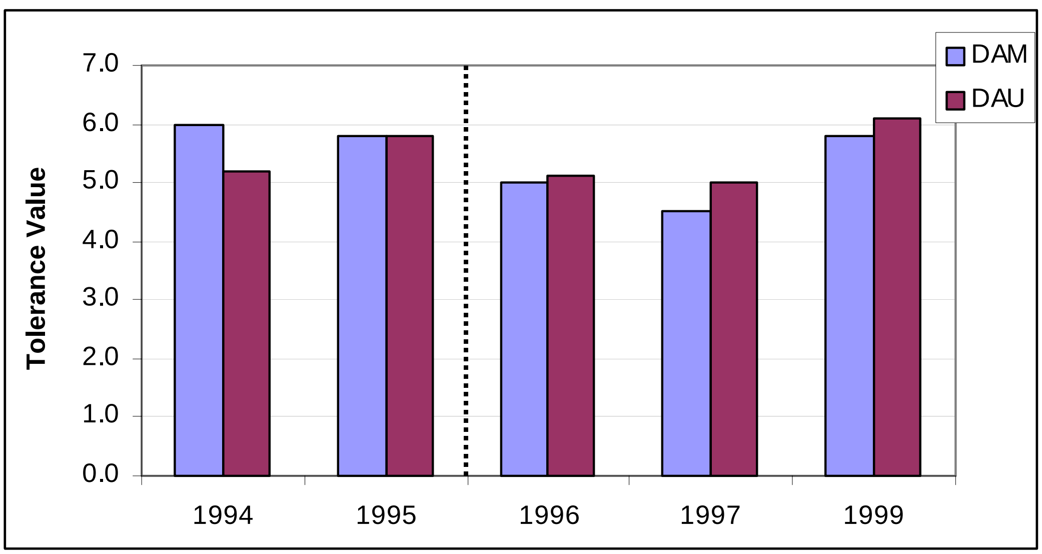


Figure 4.17. Tolerance values for PEN and DAU for 1994, 1995, 1996, 1997, and 1999. The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

Average habitat assessment scores at DAM have increased implying there may be an improvement due to BMP implementation (Figure 4.17). Although due to the qualitative nature of the methods, results are not definitive. During the pre-BMP period, DAM and DAU had similar habitat assessment scores. In the post-BMP time period habitat assessment scores at DAM improved while scores at DAU decreased and scores at PEN remained about the same.

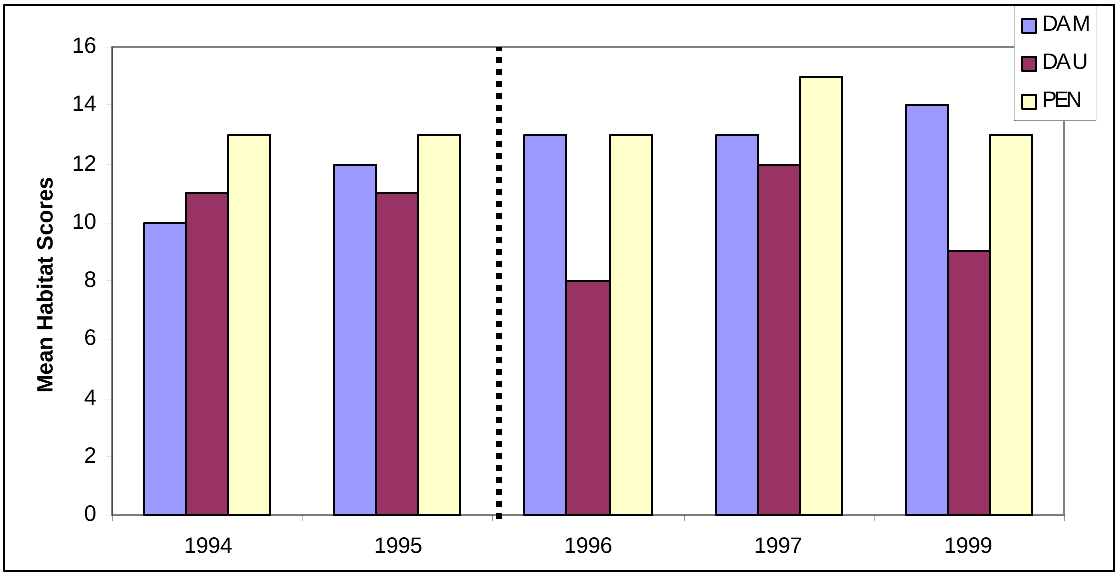


Figure 4.18. Mean Habitat assessment score for Dairy Creek sites DAM, DAU, and PEN between 1994, 1995, 1996, 1997, and 1999.
The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

Rapid Bioassessment Conclusions

While some assessment trends are present, more data is needed to provide a more accurate picture of benthic macro-invertebrate community health at Dairy and Pennington Creeks. Rapid Bioassessment monitoring continue by the Morro Bay Volunteer Monitoring Program in future years and may aid in this effort.

4.3.3 Stream profiles

NMP project staff compared stream profiles at Dairy Creek and Pennington Creek. It does not appear that BMPs have effected stream morphology. Over time, the stream profiles should provide a tool to evaluate long-term trends in stream bank characteristics. Substrate analysis, riparian vegetation survey, stream classifications, photo documentation, and maps of steam profile locations are included in Chapter 8, Watershed-wide Characterization. Figures 4.12-4.16 are representative stream profiles from Dairy Creek and Pennington Creek. Each figure includes selected profiles from between 1993 through 2000.

Figure 4.19 displays Pennington Creek stream profile #2. No significant change has occurred from 1993 to 2000. Streambank erosion in Pennington Creek is shown in Figure 4.19. After the Highway 41 Fire, significant erosion of the left bank occurred.

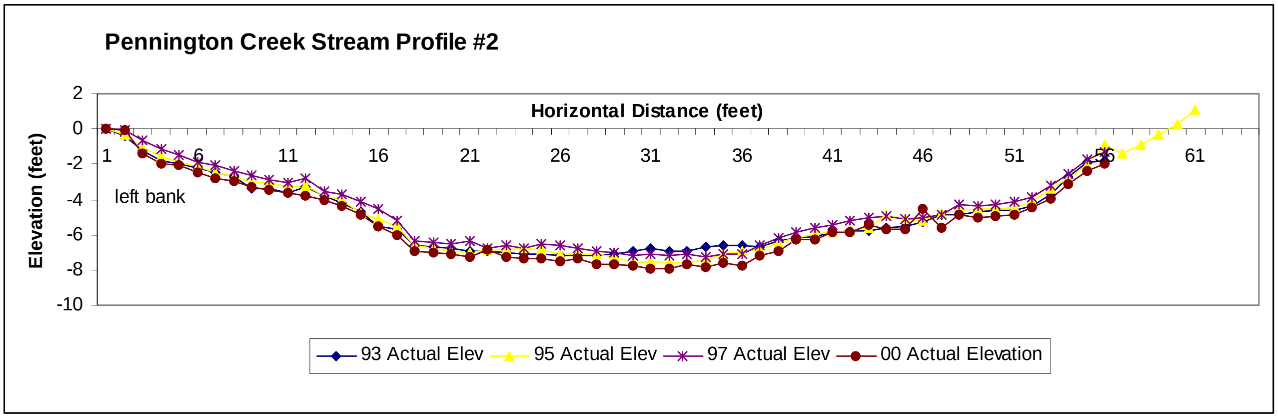


Figure 4.19. Cross sectional profile of Pennington Creek. Profile extends from left bank to right bank and is sampled at 1-foot increments.
The profile samples of 1993, 1995, 1997, and 2000 are shown (other years are left out for easy viewing).

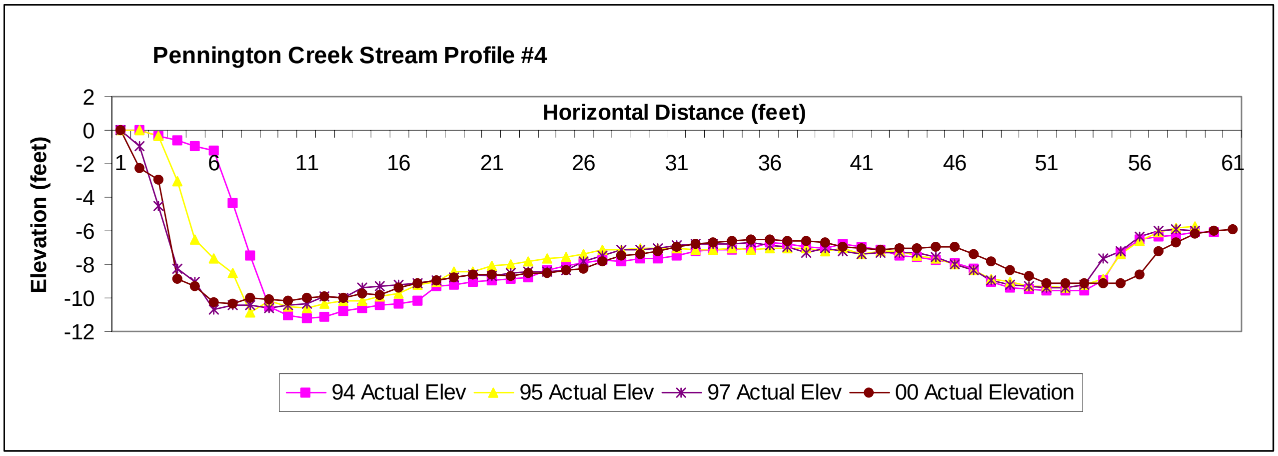


Figure 4.20 Cross sectional profile of Pennington Creek.
Profile extends from left bank to right bank and is sampled at 1-foot increments.

The profile samples of 1993, 1996, and 2000 are provided (other years are left out for easy viewing). This is profile #4 of 5. Three stream profiles along Dairy Creek are shown (Figures 4.20, 4.21, and 4.22). The Highway 41 Fire and heavy rains in the winter of 1994/1995 are responsible for changes in channel shape. Heavy rains in subsequent years also resulted in additional channel modifications at some locations.

Figure 4.20 displays a profile located in the upper portion of Dairy Creek cattle exclusion fence. Dairy Creek at this stream profile experienced erosion in the thalwag (center) of the main channel. The remainder of the channel remained stable. Post-BMPs, no significant degradation resulted, however, rains were lighter than previous years.

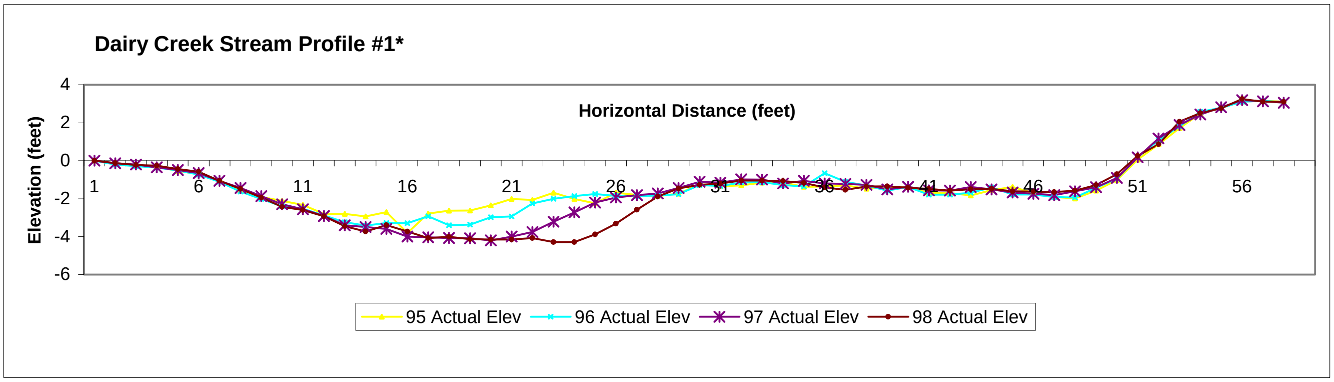


Figure 4.21 Cross sectional profile of Dairy Creek.
Profile extends from left bank to right bank and is sampled at 1foot increments. The profile samples of 1993, 1997, 1998, and 2000 are provided (other years are left out for easy viewing). This is transect #1 of 5.

Dairy Creek stream profile #3 did not experience significant change, even during heavy rain years.

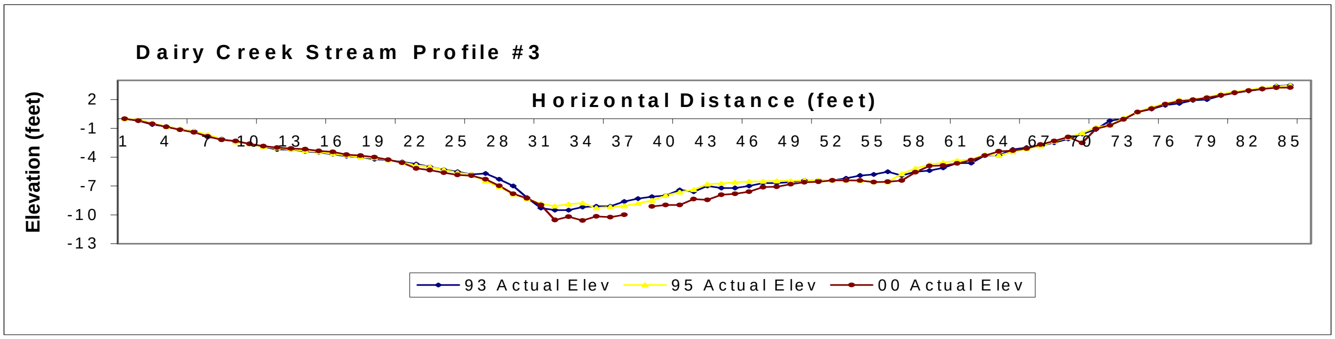


Figure 4.22 Cross sectional profile of Dairy Creek.
Profile extends from left bank to right bank and is sampled at 1foot increments. The profile samples of 1994, 1995, 1997, and 2000 are provided (other years are left out for easy viewing). This is transect #3 of 5.

Figure 4.23 displays Dairy Creek stream profile #4, located at the treatment (DAM) water quality monitoring site. Most of stream profile #4 is stable, however, the main creek channel became deeper during the study. The Highway 41 Fire and the following rains did not result in downcutting of the channel as with many other stream profiles in the Morro Bay watershed.

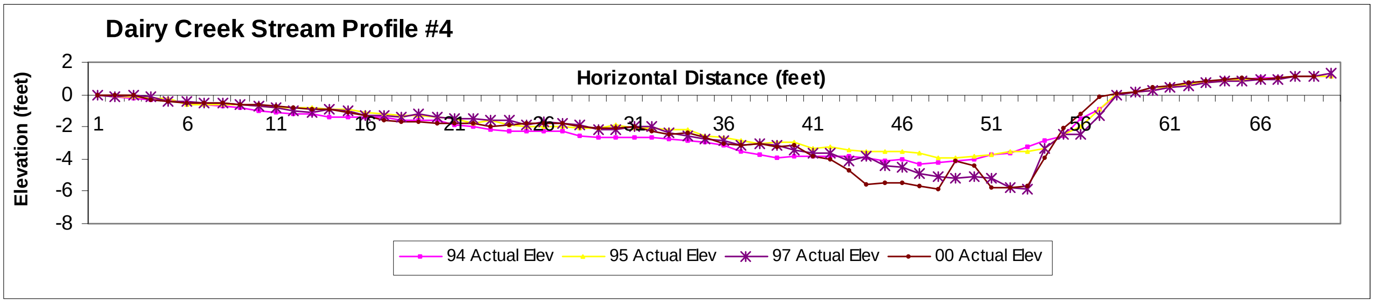


Figure 4.23 Cross sectional profile of Dairy Creek.
Profile extends from left bank to right bank and is sampled at 1foot increments. The profile samples of 1994, 1997, and 2000 are provided (other years are left out for easier viewing). This is stream profile #4 of 5.

Stream Profile Conclusions

The stream profiles did not present any pronounced changes resultant from BMP implementation, but rather provide data for long-term stream morphology. Substrate results and photo documentation are included in the appendix.

4.4 Overall Conclusions

Water temperature improved at Dairy Creek (DAM), most likely due to shading from riparian vegetation planted as part of BMP implementation. Also dissolved oxygen levels significantly improved at DAM. Turbidity, nitrate-nitrogen, and orthophosphate did not significantly change as a result of BMP implementation at DAM.

Fecal coliform levels at DAM and PEN remained the same before and after BMP implementation, however, fecal coliform bacteria levels at one of the control sites (DAU) improved. The water gaps within the cattle exclusion fencing to allow cattle access to the creek for watering, may contribute to a higher frequency of fecal coliform bacteria levels. NMP Project Staff recommend that water troughs be installed at Dairy Creek to prevent cattle from watering in the creek.

While some trends in benthic macro-invertebrate community health are present, more data is required to provide a definitive picture of the effectiveness of BMPs at Dairy Creek. The stream profiles do not appear to be affected by BMP implementation, but rather provide data for long-term stream morphology. Rapid Bioassessment monitoring will continue by the Morro Bay Volunteer Monitoring Program in future years and will aid in this effort.