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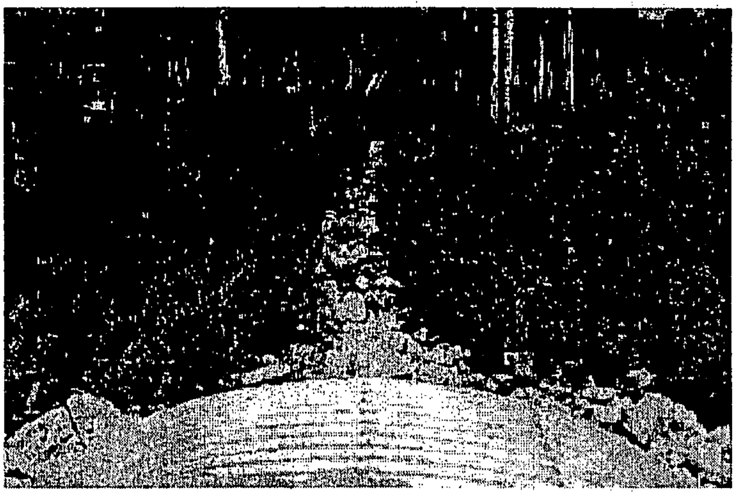
FINAL REPORT

Benthic Macroinvertebrates: Application of the California Stream Bioassessment Procedure in Reaches of Bear Creek

Placer County, California



Prepared for:

Alpine Meadows Ski Corporation
P.O. Box 5279
Tahoe City, CA 96145

Prepared by:

Ian Chan
P.O. Box 1268
Tahoe City, CA 96145

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EXECUTIVE SUMMARY

This report provides information on the benthic macroinvertebrate communities in reaches of Bear Creek, Placer County, CA. Surveys were designed to provide a rapid bioassessment of potential impacts attributable to operations at Alpine Meadows Ski Resort as well as to establish baseline biological and physical habitat conditions in Bear Creek for comparison with future monitoring data. Field sampling was conducted July 16, 2001 following the California Stream Bioassessment Procedure (CSBP) for Non-Point Source Pollution. Replicate samples were collected from representative riffle habitats at three sampling sites spaced throughout the watershed. Macroinvertebrate data were entered into the Ecological Data Application System (EDAS) database, which serves as a national inventory for rapid bioassessment analysis. Physical habitat and water quality data were also collected per the CSBP protocols.

Approximately 90,600 benthic invertebrates were collected from the three sample sites in Bear Creek. Of these, 2,707 individuals were identified, representing 12 taxonomic orders. The average sample contained 37.9 taxa. Organisms tolerant of impairment comprised only 5.0 percent of the average sample while intolerant organisms comprised 48.2 percent. Common taxa included ephemerellid mayflies (*Drunella* spp.), midges (chironomid tribes Orthocladiinae and Tanytarsini), apataniid caddisflies (*Apatania* spp.), and baetid mayflies (*Baetis* spp.).

Overall CSBP metrics characterize a robust benthic macroinvertebrate community in Bear Creek. Richness, composition, tolerance/intolerance, and functional feeding group metrics describe a diverse benthic fauna, indicative of relatively good water quality. No acute evidence of impairment from ski resort operations was detectable using rapid bioassessment techniques. Physical habitat and water quality data collected as part of this survey support this assessment.

The lowermost site (at the bottom of the Bear Creek watershed) showed some signs of impairment relative to the upper two sites, but still supported a diverse invertebrate community indicative of moderate water quality. An increased capacity to tolerate impairment at the bottom of the watershed may be attributable to the presence of additional land and water uses in the middle and lower watershed that augment cumulative impacts downstream. In the context of resort-specific impacts, concerns regarding the delivery of road- and parking lot-borne sources of inorganic pollution to Bear Creek appear manageable.

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1.0 INTRODUCTION

Alpine Meadows Ski Corporation contracted with Ian Chan, a private aquatic ecologist, to conduct benthic macroinvertebrate surveys of Bear Creek, Placer County, CA, including reaches potentially affected by ski resort operations. Field collections were made July 16, 2001 following the California Stream Bioassessment Procedure (CSBP). The primary objective of these surveys is to provide a rapid assessment of benthic community structure as an indication of existing biological as well as physical habitat conditions at each sampling location. These data also provide valuable baseline information for spatial and/or temporal comparisons in the context of future monitoring efforts.

Although resort operations that may affect physical/chemical water quality in Bear Creek are regulated by the Lahontan Regional Water Quality Control Board (e.g., established thresholds for chloride ion concentrations do exist), it is unclear how activities such as snow removal and storage, road sanding and salting, or vehicle traffic and parking may affect biological communities downstream. Rapid bioassessment provides an ecological snapshot of environmental conditions based upon the structure of entire biological communities that manifest cumulative effects of upstream land and water use activities. As such, it provides a powerful tool for watershed monitoring in particular, and resource management in general.

2.0 METHODS

2.1 Site Selection

The basic conceptual design called for samples to be spaced longitudinally along Bear Creek, from the headwaters to the confluence with the Truckee River, in order to facilitate bioassessment of any impacts that may follow an attenuating pattern downstream, or vice versa. Because the delivery of road- and parking lot-borne material (e.g., sand, salt, etc.) from the resort area is a primary concern, the uppermost site was selected above the main lodge and parking area, near the headwater reaches. This site was chosen to be upstream of as many resort influences as possible, including a recently replaced culvert at the main parking lot crossing. The second (middle) site was selected to be just below the ski resort parking area in order to capture its influence. The third (lowermost) site was selected immediately above the Truckee River confluence to encompass any and all potential influences within the Bear Creek watershed.

A key consideration during site selection was locating sample-able areas that were both representative (of riffle habitats typical of that reach) and comparable (to sample areas in other reaches), notwithstanding inherent differences that exist between headwaters and lower reaches (e.g., elevation, stream width, gradient, etc.). This unavoidable trade-off is most successfully balanced by maintaining a high level of consistency in sampling effort. Fortunately, the robustness of rapid bioassessment as an analytical tool enables comparisons across differences far greater than those found within Bear Creek during this survey.

Site locations were selected as follows (see Figure 1):

- upstream of the main lodge and parking area in the southern fork of the Bear Creek headwaters adjacent to the Meadow chairlift (BEAR1);
- downstream of the parking area below the Ginzton Bridge, just above the subdivision (BEAR2); and
- immediately upstream of the Truckee River confluence (BEAR3).

2.2 Field Data Collection

2.2.1 Benthic Macroinvertebrate Sampling

Benthic macroinvertebrate samples were collected on July 16, 2001 following a modified version of the Non-point Source Sampling Design of the California Stream Bioassessment Procedure (CSBP) for wadeable streams (CDFG 1999). The standard Non-point Source Sampling Design requires a minimum of five sample-able riffles at each site. From these riffles, three are chosen at random and sampled. Three collections are then made along randomly determined transects in the upper third of each riffle and combined to form one composite sample. All three riffles at a site are sampled in this manner, yielding a total of three samples from each site.

Standard CSBP provisions for randomizing transect locations were not applicable in Bear Creek due the small size of the stream, the predominance of boulder substrate, and a consequent lack of sizeable contiguous riffles in the study area. All sample locations within the three sites (BEAR1, BEAR2, and BEAR3) had fewer than the minimum five riffles to choose from at random. Therefore, we relied upon the randomized "spot sampling" method for selecting sample locations. Under this modification of the CSBP, a maximum number of sample-able "spots" are identified within existing riffle habitats of a particular reach (or patches thereof), as opposed to contiguous riffles. A number of these spots, representing the equivalent amount of surface area as in a standard riffle sample, are chosen at random and sampled (i.e., three "spots" per composite sample). Collections made using this method are grouped with the three downstream-most, three middle, and three upstream-most "spots" as composites such that in the end, each site is still represented by three samples.

Therefore, at each of the three sample sites in Bear Creek, three replicate samples were collected (for a total of 9 samples in all). As explained above, each riffle sample is a composite of three "kick" sample collections. For each of these collections, a 1 by 2 foot area was disturbed and dislodged invertebrates were collected in an 18 by 9 inch rectangular net fitted with a 500-micron (0.5 mm) mesh bag. Each collection lasted 2 minutes, during which the substrate was agitated by hand and thoroughly cleaned to a depth of 4 to 6 inches.

At all sites, the downstream-most samples were collected first and sampling proceeded in the upstream direction. After three "kick" sample collections were made, the material was combined in a 0.5 mm mesh sieve to form a composite sample and any larger detritus, rocks, or sand that could interfere with processing and analysis were carefully removed. Samples were "cleaned" in this manner to the greatest extent possible in the field in order to facilitate better preservation. Samples were then placed into leak-proof plastic containers, filled with a 95% ethanol and labeled inside and out.

2.2.2 Physical Habitat/ Water Quality Sampling

At each of the three sample sites, physical habitat was assessed using the CSBP Physical Habitat Quality Form. Physical habitat data collection was concurrent with benthic macroinvertebrate sampling. Habitat parameters included epifaunal substrate/available cover, embeddedness, velocity/depth regimes present, sediment deposition, channel flow status, channel alteration, bank stability, vegetative protection, and riparian vegetative zone width. The physical habitat scoring criteria in the CSBP are consistent with the nationally standardized method developed by the U.S. Environmental Protection Agency.

Physical habitat and water quality were also described using the CSBP California Bioassessment Worksheet. Physical/chemical parameters assessed included water temperature, conductivity, specific conductance, pH, dissolved oxygen, riffle length, average riffle width, riffle depth (at each collection point), velocity (at each collection point), percent canopy cover, substrate complexity, embeddedness, substrate composition, substrate consolidation, and percent gradient.

Temperature, conductivity, specific conductance, and dissolved oxygen were measured using a YSI model 85 hand held meter. Acidity (pH) was measured using a handheld Oakton pHTester2. Stream flows in Bear Creek were too low at the time of sampling to allow use of a USGS pygmy meter, so stream velocities were measured by repeatedly timing a small twig as it floated a set distance downstream. Site elevations were determined from USGS topographic maps. All sites were photographed for future reference.

2.3 Data Analysis

2.3.1 Benthic Macroinvertebrate Metrics

All 9 benthic samples were enumerated and identified by Jonathan Lee, a private entomologist in Arcata, CA. Benthic macroinvertebrate data were entered into the Ecological Data Application System (EDAS) database, developed by the Environmental Protection Agency & TetraTech, Inc. (TetraTech and EPA n.d.), which serves as a national inventory for rapid bioassessment analysis. A total of 24 metrics were analyzed, as defined in Table 1, including richness measures, composition measures, tolerance/intolerance measures, and functional feeding group measures. Tolerance values for benthic macroinvertebrate taxa were assigned using the most current California Tolerance Value information (CDFG 2001). All metrics were calculated for each of the three replicate samples collected at a given site and then averaged to obtain a mean metric value per site.

3.0 RESULTS

3.1 Benthic Macroinvertebrate Summary

Approximately 90,600 benthic invertebrates were collected from the three sample sites in Bear Creek. Of these, 2,707 individuals were identified, representing 12 taxonomic orders. Common taxa included ephemerellid mayflies (*Drunella* spp.), midges (chironomid tribes Orthocladiinae and Tanytarsini), apataniid caddisflies (*Apatania* spp.), and baetid mayflies (*Baetis* spp.). Also relatively common were chloroperlid stoneflies (*Sweltsa* spp.), rhyacophilid caddisflies (*Rhyacophila* spp.), and ameletid mayflies (*Ameletus* spp.), as well as heptageniid mayflies (*Rhithrogena* spp. and *Epeorus* spp.), nemourid stoneflies (*Malenka* spp.), freshwater mites (Torrenticolidae), ostracods (Cyprididae), oligochaete worms (Naididae), and flatworms (*Dugesia* spp.). An estimated average of 1600 individuals was collected per square foot of substrate sampled.

The average number of taxa per sample was relatively high at 37.9. Insects comprised 87.6 percent of the organisms in the average sample, including 18.7 EPT taxa (and 8.8 Diptera taxa). The dominant and sub-dominant taxon comprised only 21.7 and 13.1 percent of the average sample, respectively, indicating a relatively even distribution of taxa abundances (mean Shannon Evenness was 79.2 percent). Likewise, mean Shannon Diversity was relatively high at 2.88.

Organisms tolerant of impairment comprised only 5.0 percent of the average sample while intolerant organisms comprised 48.2 percent. The mean Sensitive EPT Index was also relatively high at 47.9 percent. Consequently, the overall mean Weighted Tolerance Value for all samples fairly low at 3.2. Generally, tolerance values less than 3.0 are indicative of good water quality, while values between 3.0 and 7.0 are indicative of moderate water quality, and values greater than 7.0 are indicative of poor water quality. An average of 98 percent of the organisms collected had EDAS assigned tolerance values. Predators (mean 29.8%) and collectors (mean 28.9%) were the predominant functional feeding groups in most samples, followed by scrapers (13.6%), filterers (13.2%), and shredders (mean 2.9%).

A summary of macroinvertebrate metrics by site is presented in Table 2. Summary data are based on the mean values for the three replicates collected at each site (i.e., approximately 900 individuals), although EDAS metrics were originally calculated for each replicate sample based upon the 300 individuals enumerated and identified as part of the CSBP sub-sampling protocol.

A complete taxa list for all 9 replicate samples is presented in Appendix A. Dominant and subdominant taxa are identified per replicate in Appendix B.

3.2 Physical Habitat/Water Quality Summary

Substrate complexity and embeddedness were in the optimal range at all sites in Bear Creek. Average substrate composition was: 3.9 percent bedrock, 37.4 percent boulder, 28.7 percent cobble, 22.2 percent gravel, and 10.0 percent fines. Stream gradient averaged 4.6 percent. Average riffle width was 2.7 meters. Depths at sample collection points averaged 0.09 meters and velocity at these points averaged 0.36 meters/second. The mean Physical Habitat Score was 175.7 out of a possible 200.

Recorded stream temperatures ranged from 10.6°C at the headwaters to 16.3°C near the Truckee River confluence, and pH ranged from 8.2 to 8.4 between 0856 and 1445 hrs on July 16, 2001. Dissolved oxygen levels ranged from 6.85 to 7.24 mg/l (at between 57.0 to 74.5% saturation). Specific conductance ranged from 64.2 to 99.3 µS. Salinity was consistently zero (ppt).

A summary of physical habitat and water quality parameters is presented in Table 3. Summary data are based on the mean values for the three replicates collected at each site. Site photographs are provided per replicate in Appendix C. Raw data can be found in the data sheets located in Appendix D.

4.0 DISCUSSION

Bioassessment provides a snapshot of biological, physical, and chemical conditions in a stream. It is important, however, to understand the spatial and temporal limitations of the methods, the inherent sources of variation they encompass, and ultimately the conclusions drawn from their results. This initial bioassessment of Bear Creek provides baseline information on the status of benthic macroinvertebrate communities at various locations within the watershed. Although it is critical to recognize the scope of natural variation that exists within watersheds (even within sub-watersheds), data collected during the course of this study afford spatial comparisons of how potential impacts from resort operations may affect local stream biota, as well as how cumulative effects from additional land and water uses within the watershed appear to be impacting stream quality near the bottom of the Bear Creek watershed.

4.1 Site Comparisons

Comparison of sites BEAR1 and BEAR2 allows evaluation of potential impacts of resort operations that may be generated in the main lodge and parking area. Potential impacts include activities that may contribute inorganic pollution (primarily sediment and salts) such as road sanding, salting, snow removal, snow storage, vehicle traffic, and parking. The effects of these activities would presumably be captured immediately downstream of the resort (at BEAR2) and be absent upstream (at BEAR1).

However, sites BEAR1 and BEAR2 were very similar overall. Both had relatively high taxa richness (35.7 and 34.7, respectively) and diversity (Shannon Diversity averaged 2.95 and 2.67, respectively) including ample EPT taxa (18.0 and 18.7, respectively). Although diversity was slightly lower at BEAR2 than BEAR1, it was still relatively high. The slight decrease in diversity between BEAR1 and BEAR2 was largely due to the presence of a higher percentage of the dominant taxon at BEAR2 (29.4 versus 15.5% at BEAR1). Although such a reduction in the evenness of taxa abundances is typically considered a negative quality, it is important to point out that the dominant taxon in each BEAR2 replicate sample was the ephemerellid mayfly genus *Drunella*, a highly desirable taxon with no tolerance for impairment (i.e., a tolerance value of zero). Indeed, the mean Weighted Tolerance Value was lower at BEAR2 than at any other site in Bear Creek. Both BEAR1 and BEAR2 had mean Weighted Tolerance Values less than 3.0, indicating good water quality. Both sites also had very high proportions of organisms considered to be intolerant of impairment (53.6 and 69.7%, respectively) and conversely low proportions of tolerant organisms (1.3 and 1.8%, respectively). Thus, CSBP metrics characterize a healthy benthic community at both BEAR1 and BEAR2, with no evidence of impairment discernable immediately below the resort.

As compared to the upper two sites, site BEAR3 at the bottom of the Bear Creek watershed was somewhat distinct. Richness measures were slightly higher at BEAR3 (taxa richness averaged 43.3, and Shannon Diversity averaged 3.01), but composition and tolerance/intolerance measures were much poorer than in the upper watershed. The EPT index at BEAR3 averaged 32.7 percent as compared to 63.5 percent at BEAR1 and 70.4 percent and BEAR2. The Sensitive EPT index was also lower at BEAR3 at 22.4 percent as compared to 52.2 percent at BEAR1 and 69.2 percent at BEAR2. Therefore, not only were there proportionately fewer mayflies, stoneflies, and caddisflies present in the lower watershed, but more of those that were present were tolerant of impairment. The mean percentage of intolerant organisms was 21.4 at BEAR3 as compared to 53.6 at BEAR1 and 69.7 at BEAR2. Conversely, the proportion of tolerant organisms at BEAR3 was 11.9 percent, as compared to 1.3 and 1.8 percent, respectively. The mean Weighted Tolerance Value at BEAR3 was 4.8, more than twice that of the upper two sites, and indicative of moderate water quality. Therefore, CSBP metrics characterize a diverse and still relatively healthy benthic community at BEAR3, but one with increased tolerance to impairment.

This increased capacity to tolerate impairment at BEAR3 likely reflects the presence of additional land and water use activities in the middle and lower Bear Creek watershed (i.e., below the ski resort). The primary land use below the resort is residential subdivisions. Approximately 600 homes exist within the watershed. Municipal water is supplied to the subdivisions by the Alpine Springs County Water District, which diverts and stores spring water from the upper watershed. Another significant land use in the lower watershed is Alpine Meadows Stables. Under permit from the Forest Service, these stables board horses for recreational riding from summer through fall. An estimate of 35 horses may be present in the stables during these months.

The cumulative effects of these additional land and water uses are captured at the downstream-most site (BEAR3). The degree to which the subdivisions, stables, and any other land uses below the ski resort impact water quality in lower Bear Creek is unclear, however it is fair to assume that cumulative influences would be negative, if only minor. CSBP metrics do describe a fairly healthy benthic macroinvertebrate community at the bottom of the watershed, but one that shows more signs of impairment relative to sites higher in the watershed. Mean Weighted Tolerance Values indicate a decrease in overall water quality between the upper and lower watershed from good to moderate.

Certain differences between the upper and lower sites may also be attributable to inherent physical changes that occur between the upper and lower portions of the watershed. Higher in the watershed stream size is smaller, flows are lower, channel gradient is steeper, and substrate size is larger. Bear Creek grows from a first order stream at BEAR1, to a second order stream at BEAR2, to a larger second to third order stream at BEAR3 as more and more tributaries contribute additional surface water downstream. Along the way, stream character changes from a steep, boulder-dominated cascade typical of headwater areas, to a lower gradient, meandering, and more open channel typical of higher order streams.

Consequent changes in benthic macroinvertebrate community structure accompany changing physical habitat parameters. From headwaters to intermediate order streams, primary energy sources typically shift from allochthonous to autochthonous inputs as a decreasing canopy cover yields less leaf litter and less shade, allowing greater instream photosynthesis. Primary food resources shift from coarse forms of particulate organic matter (CPOM) to fine forms of particulate organic matter (FPOM). As a result, the percentage of organisms that specialize in feeding on leaf litter and other forms of CPOM (i.e., shredders) is expected to decline while the percentage of organisms that filter algae and other sources of FPOM from the water column (i.e., filterers) is expected to increase downstream. This trend in functional feeding groups is well illustrated in Bear Creek as the percentage of shredders sequentially decreases, and the percentage of filterers sequentially increases from BEAR1 to BEAR2 to BEAR3 (see Figure 2).

4.2 Potential Ski Resort Impacts

As discussed above, the delivery of road- and parking lot-borne material into Bear Creek is a primary concern. Sand and salt from winter road maintenance eventually enters the stream through runoff. Although the ski resort itself does not salt roads, Placer County and CalTrans apply both salt and sand to surrounding roadways in the winter. Incoming vehicle traffic delivers this material to the resort where it is concentrated in parking area. Snow removal and snow storage activities at the resort then redistribute this material. Because much of the snow removed from the parking lot contains road sand and salt, it is considered "debris," and storage requires avoidance of wetland areas that would provide the most direct delivery to Bear Creek.

This bioassessment did not detect impacts to stream quality immediately below the main lodge and parking lot area. It is likely that any inorganic pollution generated by resort operations is greatest during winter and spring runoff, when sand and salt concentrations are potentially highest. Although this survey was conducted in the summer, significant impacts to water quality would have been detectable (regardless of the timing of their delivery) as the stream biota manifests such impacts in the composition of benthic communities. Water quality was excellent at the time of this survey, with no detectable salinity (in ppt). No significant sediment accumulations were evident immediately below the resort, although it is likely that any sediment deposition would be easily flushed from the steeper channel in the upper and middle watershed. More fine sediments were present in the lower watershed (substrate composition averaged 15% fines at BEAR3), but an increase in the percent composition of smaller substrate sizes would be expected lower in the watershed (see Figure 3).

5.0 CONCLUSION

Bear Creek supports a diverse and productive invertebrate community. No acute evidence of impairment due to ski resort operations at Alpine Meadows was detectable using CSBP rapid bioassessment techniques. Paired comparisons of sites above and below the resort show a high degree of similarity in physical and biological parameters. Biological metrics based upon tolerance/intolerance of impairment actually characterized the highest water quality immediately below the resort. The lowermost site (at the bottom of the Bear Creek watershed) showed some signs of impairment relative to the upper two sites. An increased capacity to tolerate impairment at the bottom of the watershed may be attributable to the presence of additional land and water uses in the middle and lower watershed that augment cumulative impacts downstream. In the context of resort-specific impacts, concerns regarding the delivery of road- and parking lot-borne sources of inorganic pollution to Bear Creek appear manageable.

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California Department of Fish and Game. 2001. *CAMLnet List of Californian Macroinvertebrate Taxa and Standard Taxonomic Effort (revision date 26 November, 2001).* CDFG Water Pollution Control Laboratory. 27 pp.

Tetra Tech, Inc. and Environmental Protection Agency. n.d. *Ecological Data Application System (EDAS).* Database Application Version 2.2.

Table 1. Biological metrics used to describe benthic macroinvertebrate samples collected from Bear Creek following the California Stream Bioassessment Procedure (CSBP).

Biological Metrics	**Description of Metrics**	**Response to Impairment**
	Richness Measures	
Taxa Richness	Total number of taxa (genus or lowest taxonomic level)	Decrease
EPT Taxa	Number of taxa in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)	Decrease
Ephemeroptera Taxa	Number of mayfly taxa	Decrease
Plecoptera Taxa	Number of stonefly taxa	Decrease
Trichoptera Taxa	Number of caddisfly taxa	Decrease
Diptera Taxa	Number of taxa in the order Diptera (true flies)	Variable
Chironomid Taxa	Number of taxa in the dipteran family Chironomidae	Increase
Shannon Diversity	General measure of sample diversity that incorporates richness and evenness	Decrease
Shannon Evenness*	Measure of how evenly taxa abundances are distributed	Decrease
Est. Total # Indiv.*	Estimated total number of individuals collected per sample	Variable
	Composition Measures	
EPT Index	Percent composition of EPT taxa	Decrease
% Baetidae	Percent of organisms in the mayfly family Baetidae	Increase
% Hydropsychidae	Percent of organisms in the caddisfly family Hydropsychidae	Increase
% Dominant taxon	Percent of sample comprised of the most common taxon	Increase
% Sub-dominant taxon	Percent of sample comprised of the second most common taxon	Increase
	Tolerance / Intolerance Measures	
Sensitive EPT Index	Percent composition of EPT taxa with tolerance values 0-3	Decrease
% Tolerant Organisms	Percent of organisms that are highly tolerant of impairment/pollution as indicated by tolerance values of 8, 9, or 10	Increase
% Intolerant Organisms	Percent of organisms that are highly intolerant of impairment/pollution as indicated by tolerance values of 0, 1, or 2	Decrease
Weighted tolerance value	Value between 0 and 10, weighted by abundances of individuals designated as tolerant (higher values) or intolerant (lower values) of impairment/pollution	Increase
	Functional Feeding Groups	
% Filterers	Percent of macrobenthos that filters fine particulate matter	Increase
% Scrapers	Percent of macrobenthos that grazes upon periphyton	Variable
% Collectors	Percent of macrobenthos that collects or gathers fine particulate matter	Increase
% Shredders	Percent of macrobenthos that shreds coarse particulate matter	Decrease
% Predators	Percent of macrobenthos that feeds on other organisms	Variable

*Additional metrics not included in the CSBP.

Table 2. A summary of CSBP biological metrics describing benthic macroinvertebrate samples collected from Bear Creek. Values for each site are averages of three replicate samples.

METRICS	BEAR1	BEAR2	BEAR3
Richness Measures			
Taxa Richness	35.7	34.7	43.3
EPT Taxa	18.0	18.7	19.3
Ephemeroptera Taxa	8.3	8.7	5.3
Plecoptera Taxa	5.7	5.3	5.3
Trichoptera Taxa	4.0	4.7	8.7
Diptera Taxa	8.3	7.3	10.7
Chironomid Taxa	4.0	4.0	5.0
Shannon Diversity Index	2.95	2.67	3.01
Shannon Evenness	0.82	0.75	0.80
Estimated # Indiv/sample	4480	9962	15760
Composition Measures			
EPT Index	63.5	70.4	32.7
% Beatidae	9.3	1.4	4.2
% Hydropsychidae	0.0	0.0	4.4
% Dominant Taxon	15.5	29.4	20.2
% Sub-dominant Taxon	13.0	10.8	15.6
Tolerance/Intolerance Measures			
Sensitive EPT Index	52.2	69.2	22.4
% Tolerant Organisms	1.3	1.8	11.9
% Intolerant Organisms	53.6	69.7	21.4
Weighted Tolerance Value	2.7	2.0	4.8
Functional Feeding Groups			
% Filterers	5.9	7.5	26.1
% Scrapers	14.5	18.7	7.6
% Collectors	34.0	17.8	34.9
% Shredders	5.0	2.5	1.1
% Predators	29.3	45.3	14.7

Table 3. A summary of physical habitat and water quality parameters collected from Bear Creek as part of CSBP protocols.

PARAMETERS	BEAR1	BEAR2	BEAR3
		Physical Habitat	
Elevation (m)	2118	2072	1884
width (m)	2.05	3.62	2.42
depth (m)	0.07	0.09	0.11
velocity (m/s)	0.24	0.36	0.50
%canopy	13.3	11.7	3.3
substrate complexity	18.0	18.0	17.0
embeddedness	18.3	16.7	15.7
substrate consolidation	loose	loose	Loose
fines (%)	5.0	10.0	15.0
gravel (%)	15.0	21.7	30.0
cobble (%)	21.7	21.7	42.7
boulder (%)	56.7	43.3	12.3
bedrock (%)	1.7	10.0	0.0
percent gradient	5.0	6.0	2.7
physical hab qual score	175	176	176
		Water Quality	
date	7/16/01	7/16/01	7/16/01
time	8:56	11:20	14:45
air temp (C)	13.4	12.6	25.6
water temp (C)	10.6	10.7	16.3
pH	8.4	8.2	8.4
DO (%saturation)	57	63.9	74.5
DO (mg/l)	6.85	7.21	7.24
spp. conductance (µS)	64.2	95.9	99.3
salinity (ppt)	0.0	0.0	0.0

Figure 1. Benthic macroinvertebrate sample locations in Bear Creek, Placer County, CA July 16, 2001.

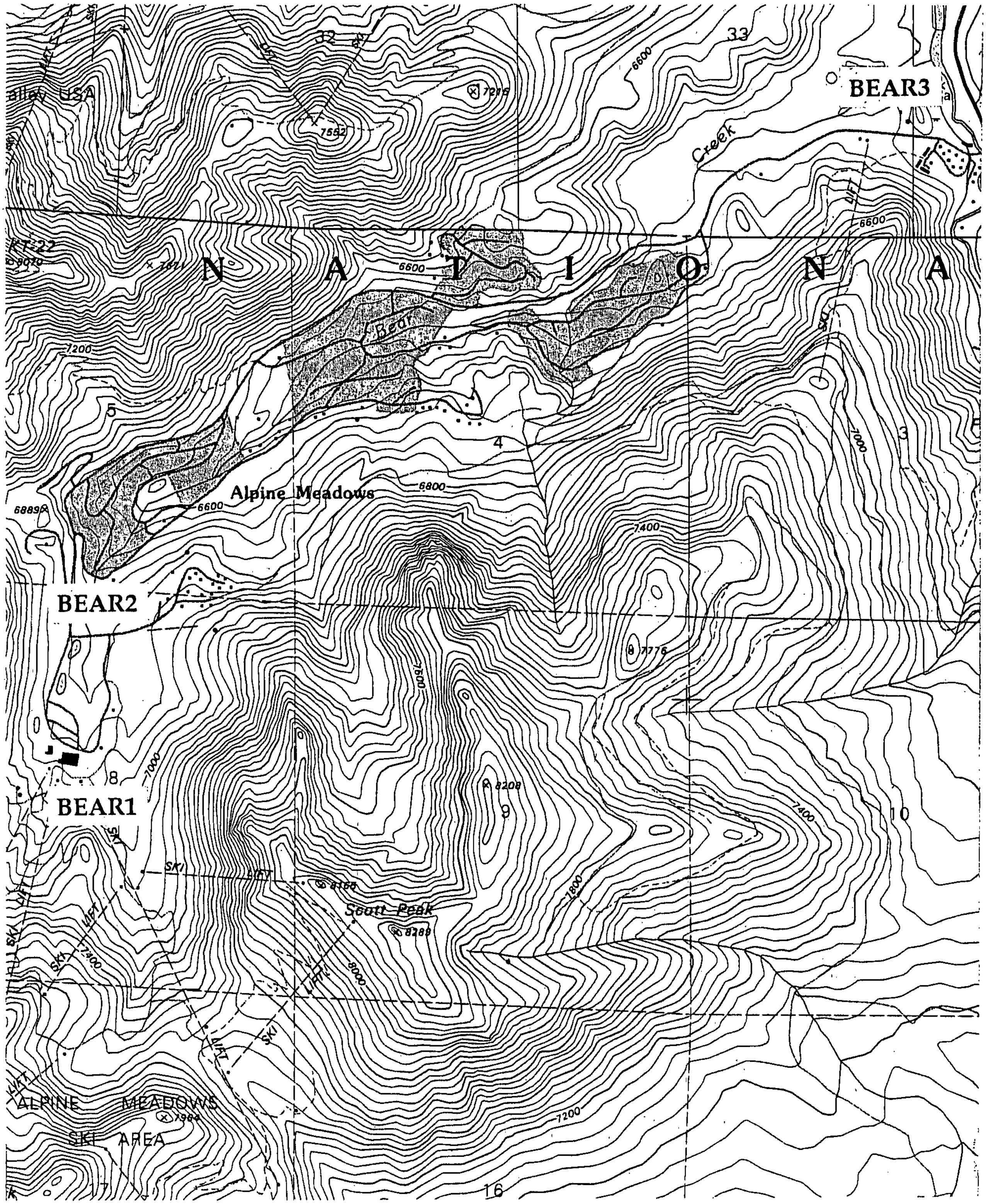


Figure 2. Functional feeding group trends in Bear Creek. Organisms that specialize in filtering fine particulate organic matter from the water column increase while organisms that shred coarse particulate organic matter (e.g., leaf litter) decrease downstream.

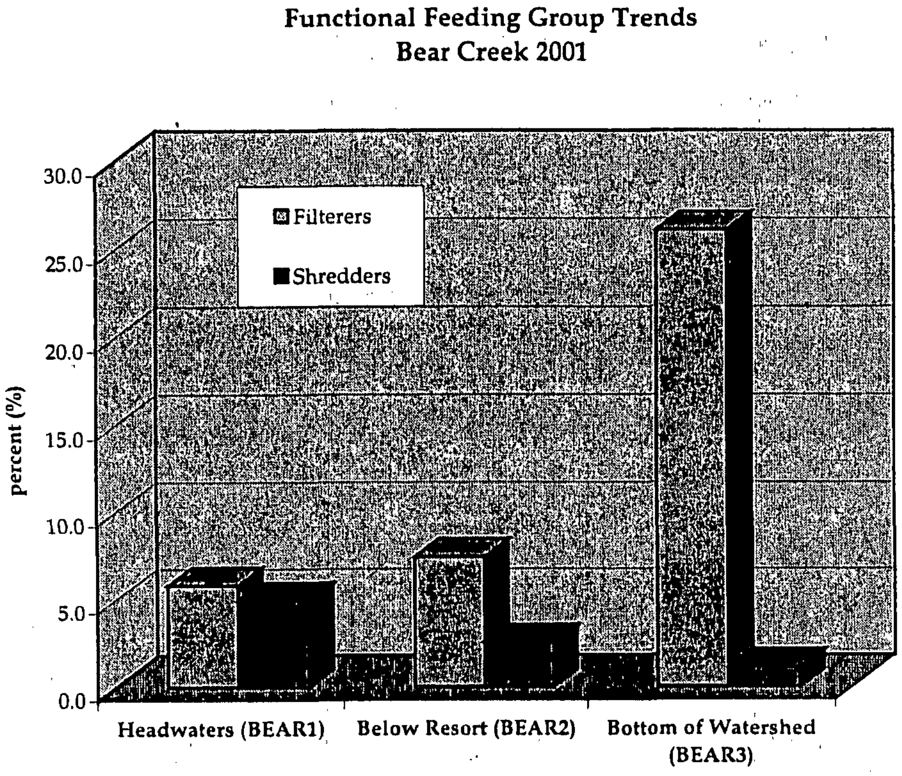
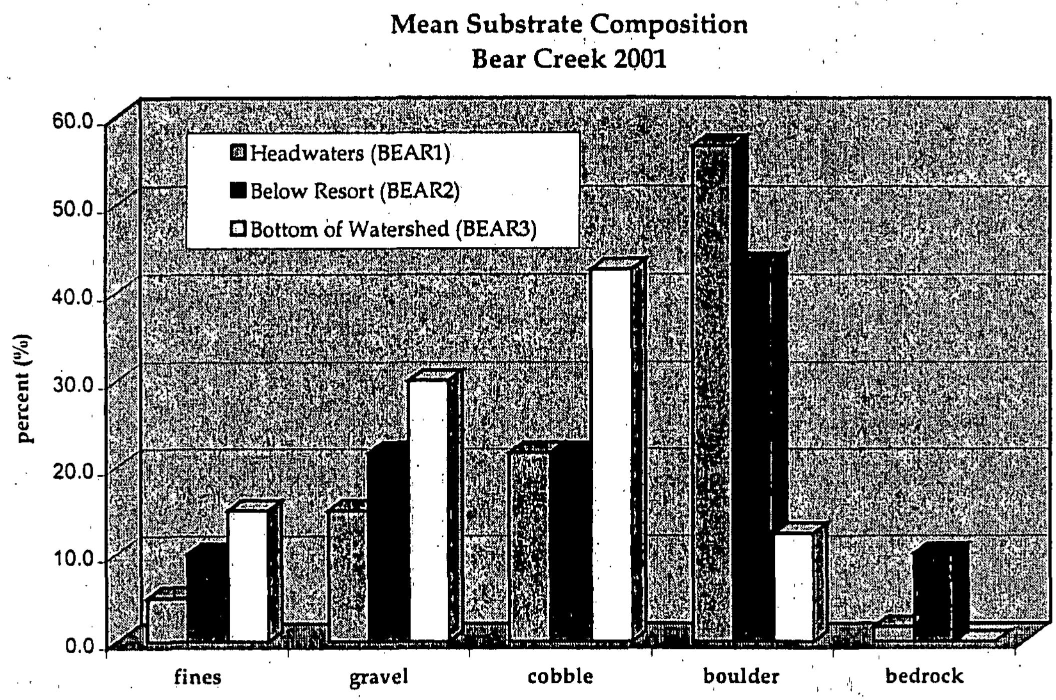


Figure 3. Mean substrate composition in Bear Creek. Substrate sizes gradually decrease downstream.



APPENDIX A. Master taxa list for replicate benthic macroinvertebrate samples collected from Bear Creek, Placer County, CA, July 16, 2001.

	BEAR1			BEAR2			BEAR3		
TAXA	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3
ARTHROPODA									
INSECTA									
COLEOPTERA									
Dytiscidae									
Oreodytes							7	6	3
Elmidae									
Narpus								2	
Optioservus							1	1	
DIPTERA									
Ceratopogonidae	1						2	9	7
Chironomidae									
Chironominae									
Chironomini							3	1	5
Tanytarsini	16	21	16	12	16	38	77	44	54
Diamesinae	1	3	2	3	5	4	3	4	5
Orthocladiinae	44	55	36	41	15	23	54	33	61
Tanypodinae	4	4	17	1	1	3	7	1	3
Dixidae									
Dixa	1								
Empididae			1						
Chelifera		1		1	3				1
Clinocera								1	
Oreogeton	1			1					
Pelecorhynchidae									
Glutops					2				
Psychodidae									
Pericoma							1	1	3
Simuliidae									
Simulium				1	1		2	2	15
Thaumaleidae									
Thaumalea		2			1				
Tipulidae									
Antocha							4	2	2
Dicranota	4	2	2		2	2			
Hesperocanopa			2						
Hexatoma			1			1	1	1	1
Limonia	1								
Rhabdomastix		1							
EPHEMEROPTERA									
Ameletidae									
Ameletus	20	12	23	6	3	13	1		
Baetidae									
Acentrella								1	
Baetis	29	13	41	8	3	2	13	16	9
Diphetor	1								
Ephemerellidae									
Caudatella				6					3
Drunella	27	51	37	81	126	58	6	6	7
Serratella	1	1	1		2	4		3	
Timpanoga							1		
Heptageniidae									
Cinygma	1	1	4		1	1			
Cinygmula	10	5	8	2	3	6			
Epeorus	2		2	29	17	5			
Rhithrogena	14	19	21	9	5	6	1		1
Leptophlebiidae									
Paraleptophlebia		2		1	3	2	7	6	5
PLECOPTERA									
Chloroperlidae									
Sweltsa	11	6	13	7	14	20	7	5	5
Leuctridae				1				1	
Nemouridae									
Malenka	12	15	9	2	1	10	2	1	2
Visoka		2	1						
Zapada		1				1		2	
Perlidae									

APPENDIX A continued. Master taxa list for replicate benthic macroinvertebrate samples collected from Bear Creek, Placer County, CA, July 16, 2001.

	BEAR1			BEAR2			BEAR3		
	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3
Doroneuria	8	11	9	2	4	4	2	3	1
Perlodidae	14	5	2	6	5	4	1		
Frisonia	1	6	1	3	9			2	1
Isoperla	4	1		1		14	7	1	3
Skwala								3	
TRICHOPTERA									
Apataniidae									
Apatania	13	6	22	31	14	40	9	6	3
Brachycentridae									
Amiocentrus							2		1
Micrasema							12	10	14
Glossosomatidae									
Agapetus							11	20	3
Glossosoma								1	
Hydropsychidae									
Hydropsyche							4	17	19
Hydroptilidae									
Hydroptila							6	3	2
Ochrotrichia							5	1	
Lepidostomatidae									
Lepidostoma	2	3	2	3		2		2	
Limnephilidae									
Allocosmoecus								1	
Chyranda					1				
Ecclisomyia	7	4	3	2	3	5			
Onocosmoecus						1			
Psychoglypha						1			
Philopotamidae									
Wormaldia								2	
Rhyacophilidae									
Rhyacophila	17	11	13	12	13	10	2	2	5
CRUSTACEA									
COPEPODA									
Harpacticoida								2	
OSTRACODA									
Podocopa									
Cyprididae	1	5	1	1	2		9	19	14
Cypridopsidae						1			
ARACHNOIDEA									
Acarina									
Arrenuroidea		1							
Aturidae								2	1
Feltriidae					1		1		1
Hydryphantidae	4	4		4		5		5	
Hygrobatidae		1	1	2	3	1		10	2
Lebertiidae		2	1	1	4	3	2	3	2
Limnocharidae	1								
Sperchonidae	1	3	2	2	2		3	4	2
Torrenticolidae	3	6		11	2	8	6	13	5
ANNELIDA									
OLIGOCHAETA									
HAPLOTAXIDA									
Enchytraeidae	3	1		1	8	3		1	3
Naididae							16	12	23
LUMBRICULIDA									
Lumbriculidae			1					4	1
PLATYHELMENTHES									
TURBELLARIA									
TRICLADIDA									
Planariidae									
Dugesia	17	9	5	6	4	3	2	4	1
NEMATODA	3	4	2		1		1		1
Total # specimens identified:	*300*	*300*	*302*	*300*	*300*	*304*	*301*	*302*	*300*

APPENDIX B. Dominant and subdominant taxa are identified per replicate benthic macroinvertebrate sample collected from Bear Creek, Placer County, CA July 16, 2001.

Sample	Dominant	Subdominant	%Dominant	%Subdominant
BEAR1.1	Orthocladiinae	*Baetis*	14.7	9.7
BEAR1.2	Orthocladiinae	*Drunella*	18.3	17.0
BEAR1.3	*Baetis*	*Drunella*	13.6	12.3
BEAR2.1	*Drunella*	Orthocladiinae	27.0	13.7
BEAR2.2	*Drunella*	*Epeorus*	42.0	5.7
BEAR2.3	*Drunella*	*Apatania*	19.1	13.2
BEAR3.1	Tanytarsini	Orthocladiinae	25.6	17.9
BEAR3.2	Tanytarsini	Orthocladiinae	14.6	10.9
BEAR3.3	Orthocladiinae	Tanytarsini	20.3	18.0

Appendix C. Site photographs from replicate benthic macroinvertebrate sample collection points at site BEAR1, July 16, 2001.

BEAR1.1

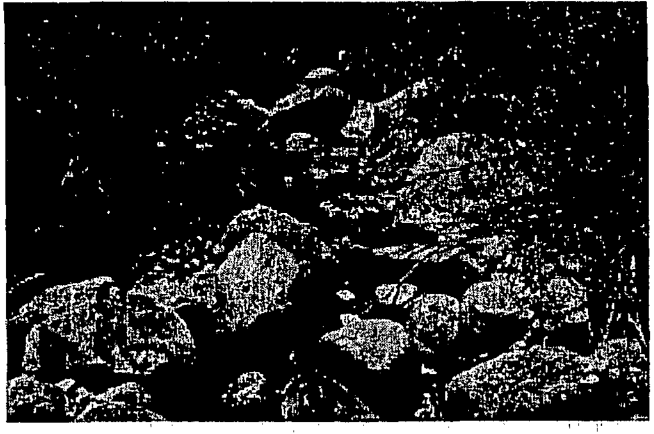
BEAR1.2

BEAR1.3

Appendix C continued. Site photographs from replicate benthic macroinvertebrate sample collection points at site BEAR2, July 16, 2001.

BEAR2.1

BEAR2.2



BEAR2.3

Appendix C continued. Site photographs from replicate benthic macroinvertebrate sample collection points at site BEAR3, July 16, 2001.

BEAR3.1

BEAR3.2

BEAR3.3

APPENDIX D.

Data sheets from California Stream Bioassessment Procedure benthic macroinvertebrate surveys of Bear Creek, Placer County, CA, July 16, 2001

CALIFORNIA STREAM BIOASSESSMENT PROCEDURE
CHAIN OF CUSTODY (COC) RECORD

Project Name: BEAR CRK / ALPINE MDWS　Date/ Time: 7/16/01

Watershed Name: BEAR CRK　Boiassessment Lab: JOHN LEE

Sample Number	Lab Number	Sample Date	Sample Description
BEAR 1.1		7/16/01	BEAR CRK (S FORK HDWTRS) NR MEADOW
BEAR 1.2		"	"
BEAR 1.3		"	"
BEAR 2.1		"	BEAR CRK BETW GINZTON & SUBDIV
BEAR 2.2		"	"
BEAR 2.3		"	"
BEAR 3.1		"	BEAR CRK ABOVE CONFL F TRUCKEE
BEAR 3.2		"	"
BEAR 3.3		"	"

Sampled by: (sign and date) 7/16/01	Relinquished by: (sign and date) 7/24/01	Received by: (sign and date) J Lee 7/27/01
~~Received by~~: Reliquished by: (sign and date) J Lee 8/27/01	Received by: (sign and date)	Received by: (sign and date)

Address of Sampler:

IAN CHAN
P.O. BOX 1268
TAHOE CITY, CA
96145

Address of Project Advisor:

←

CALIFORNIA DEPARTMENT OF FISH AND GAME
AQUATIC BIOASSESSMENT LABORATORY

WATER POLLUTION CONTROL LABORATORY
REVISION DATE – MAY, 1999

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/ STREAM: BEAR CRK HOWTRY

DATE/ TIME: 7/16/01 0856

~~COMPANY/ AGENCY~~: BEAR 1

SAMPLE ID #: BEAR 1.1 – 1.3

SITE DESCRIPTION: S FORK NR MEADOW CMR

SAMPLING CREW

JC
LY

SITE INFORMATION

GPS Coordinates:
Latitude:
Longitude:
Elevation:
Ecoregion:

COMMENTS:
ALONG MEADOW BETWEEN CULVERTS
ROAD ALONGSIDE 5 10 – 12° SLOPE
SEGMENTS [illegible] TYPICALLY
LESS SLOPE (PER SEGMENT)
1.1 – 1.3 ENCOMPASSES ~~300~~ m below CULVERT)
250

CHEMICAL CHARACTERISTICS

AIR TEMP: 13.4°C
Water Temperature: 10.6°C
COND / Specific Conductance: 46.6 µS / 64.2
pH: 8.4
Dissolved Oxygen: 57% / 6.5 mg/L
0.0 ppt

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO:
DFG/ WPCL
2005 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2858
website: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/ REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(record Physical/ Habitat Characterisics in Riffle 1 column)

Non-Point Source Sampling Design

Reach Length:
Physical Habitat Quality Score: 175

Physical/ Habitat Characteristics

	1.1 ~~Riffle 1~~	1.2 ~~Riffle 2~~	1.3 Riffle 3	
Riffle Length:				
Transect Location:				
Avg. Riffle Width:	6.9	5.75	7.5 ft	→ 6.7166
Avg. Riffle Depth:	3"	3"	2"	→ 0.222 ft
Riffle Velocity:	0.83	1.66	0.433	→ 0.777 f/s
% Canopy Cover:	15	15	10	→ 13.33%
Substrate Complexity:	18	18	18	→ 18.0
Embeddedness:	18	18	19	→ 18.33
Substrate Composition:				
Fines (<0.1"):	5	5	5	→ 5
Gravel (0.1-2"):	20	15	10	→ 15
Cobble (2-10"):	20	25	20	→ 21.66
Boulder (>10"):	55	55	60	→ 56.66
Bedrock (solid):	0	0	5	→ 1.66
Substrate Consolidation:	L	L	L	→ L
~~Percent~~ Gradient:	6%	4%	5%	→ 5%

1.0	1.5	0.5	ft
0.6	0.5	0.5	
0.9	1.2	0.3	
3"	4	2	"
4"	3	2	
2	2	2	

8 3 2 ft 3 ft
7 5 4 2

CALIFORNIA DEPARTMENT OF FISH AND GAME
AQUATIC BIOASSESSMENT LABORATORY

WATER POLLUTION CONTROL LABORATORY
REVISION DATE-- MAY 1999

PHYSICAL HABITAT QUALITY
(California Stream Bioassessment Procedure)

WATERSHED/ STREAM: S F BEAR CRK HDWTRS
DATE/ TIME: 7/16/01
~~COMPANY/~~ AGENCY: BEAR 1
SAMPLE ID NUMBER:
SITE DESCRIPTION: MEADOW

Circle the appropriate score for all 20 habitat parameters. Record the total score on the front page of the CBW.

Parameters to be evaluated within the sampling reach

HABITAT PARAMETER	CONDITION CATEGORY			
	OPTIMAL	SUBOPTIMAL	MARGINAL	POOR
1. Epifaunal Substrate/ Available Cover 175	Greater than 70% (50% for low gradient streams) of substrate favorable for epifaunal colonization and fish cover; most favorable is a mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% (30-50% for low gradient streams) mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% for low gradient streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
	20 19 [✓ 18] 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/ Depth Regimes *(deep<0.5 m, slow<0.3 m/s)*	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	20 [✓ 19] 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status *SEASONAL	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6 of bankfull	5 4 3 2 1 0

Parameters to be evaluated in an area longer than the sampling reach

BEAR 1

HABITAT PARAMETER	CONDITION CATEGORY			
	OPTIMAL	SUBOPTIMAL	MARGINAL	POOR
6. Channel Alteration CULVERTS	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
	[✓ 20] 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends) CASCADE-LIKE RISER	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
	20 [✓ 19] 18 ~~[✓ 17]~~ 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left of right side by facing downstream	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
	Left Bank 10 [✓ 9]	8 7 6	5 4 3	2 1 0
	Right Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zones covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	Left Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
	Right Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities haveimpacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
	Left Bank 10 [✓ 9]	8 7 6	5 4 3	2 1 0
	Right Bank 10 [✓ 9]	8 7 6	5 4 3	2 1 0

ROAD
+
RUN

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/ STREAM: BEAR CRK
~~COMPANY/ AGENCY~~: BEAR 2
SITE DESCRIPTION: FROM GINZTON DOWSTR TO SUBDIV

DATE/ TIME: 7/16/01 1120
SAMPLE ID #: 2.1 – 2.3

SAMPLING CREW

JC
EH

SITE INFORMATION

GPS Coordinates
Latitude:
Longitude:
Elevation:
Ecoregion:
COMMENTS:
REACH EXTDS BETW GINZTON
& BEAR CRK HIGH [illegible] BRIDGE
(2ND [illegible] [illegible])
~200m DWSTR FR GINZTON

CHEMICAL CHARACTERISTICS

AIR TEM, 12.6
Water Temperature: 10.7 C
COND / Specific Conductance: 69.6/55.7
pH: 8.2
Dissolved Oxygen: 63.7%/7.21 mg/L
0.0 SAL

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO:
DFG/ WPCL
2005 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2858
website: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/ REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(record Physical/ Habitat Characteristics in Riffle 1 column)

Non-Point Source Sampling Design

Reach Length:
Physical Habitat Quality Score: 174

Physical/ Habitat Characteristics

	2.1 ~~Riffle 1~~	2.2 ~~Riffle 2~~	2.3 ~~Riffle 3~~	
Riffle Length:				
Transect Location:				
Avg. Riffle Width:	10.9	11.6	13.1	→ 11.8666 f
Avg. Riffle Depth:	4.5"	3	3"	→ 0.29166
Riffle Velocity:	1.333	1.300	0.866	→ 1.1666 ft/s
% Canopy Cover:	5	15	15	→ 11.66%
Substrate Complexity:	18	18	18	→ 18
Embeddedness:	18	15	17 roots	→ 16.66
Substrate Composition:				
Fines (<0.1"):	10	10	10	→ 10
Gravel (0.1-2"):	20	15	30	→ 21.66
Cobble (2-10"):	15	20	30	→ 21.66
Boulder (>10"):	55	30	45	→ 43.333
Bedrock (solid):	0	25	5	→ 10
Substrate Consolidation:	L	L	L	→ L
Percent Gradient:	5%	7%	6%	→ 6%
	1.0	1.0	1.3	
	1.5	2.0	4.3	
	0.9	0.9	1.0	
	3.5	4	5	
	6	2	1	
	4	3	3	

CALIFORNIA DEPARTMENT OF FISH AND GAME
AQUATIC BIOASSESSMENT LABORATORY

WATER POLLUTION CONTROL LABORATORY
REVISION DATE-- MAY 1999

PHYSICAL HABITAT QUALITY
(California Stream Bioassessment Procedure)

WATERSHED/ STREAM: BEAR CRK
~~COMPANY/ AGE~~NCY: BEAR 2
SITE DESCRIPTION: GINZTON TO SUBDIV
DATE/ TIME: 7/16/01 1324
SAMPLE ID NUMBER:

Circle the appropriate score for all 20 habitat parameters. Record the total score on the front page of the CBW.

Parameters to be evaluated within the sampling reach

HABITAT PARAMETER	CONDITION CATEGORY			
	OPTIMAL	SUBOPTIMAL	MARGINAL	POOR
1. Epifaunal Substrate/ Available Cover 176	Greater than 70% (50% for low gradient streams) of substrate favorable for epifaunal colonization and fish cover; most favorable is a mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% (30-50% for low gradient streams) mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% for low gradient streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	20 19 [✓ 18] 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
	20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/ Depth Regimes *(deep<0.5 m, slow<0.3 m/s)*	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SEASONAL FLUX	20 19 18 17 16	15 14 13 12 [✓ 11] of bankfull	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated in an area longer than the sampling reach

HABITAT PARAMETER	BEAR 2 CONDITION CATEGORY			
	OPTIMAL	SUBOPTIMAL	MARGINAL	POOR
6. Channel Alteration REMOTE	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
	[✓ 20] 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends) CASCADE LIKE POOL/R SEQ	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
	20 [✓ 19] 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left of right side by facing downstream	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
	Left Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
	Right Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zones covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	Left Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
	Right Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds; clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities haveimpacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
	Left Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
	Right Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/ STREAM: BEAR CRK
DATE/ TIME: 7/16/01 1445
~~COMPANY~~/ AGENCY: BEAR 3
SAMPLE ID #: 311 – 3.3
SITE DESCRIPTION: NR CONFL w TRUKEE

SAMPLING CREW

JC
LH

SITE INFORMATION

GPS Coordinates
Latitude:
Longitude:
Elevation:
Ecoregion:
COMMENTS:
SAMPLED AREA FROM CONFL
UPSTR ~ 200 m TO BOULDER
CASCADE AREA

CHEMICAL CHARACTERISTICS

AIR 20.6°C
Water Temperature: 16.3°C
Specific Conductance: 82.4/99.3µS
pH: 8.4
Dissolved Oxygen: 7.37%/77.4%
0.0

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO:
DFG/ WPCL
2005 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2858
website: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/ REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(record Physical/ Habitat Characterisics in Riffle 1 column)

Non-Point Source Sampling Design

Reach Length:
Physical Habitat Quality Score: 176

Physical/ Habitat Characteristics

	Riffle 1	Riffle 2	Riffle 3	
Riffle Length:	—	—	—	
Transect Location:	—	—	—	
Avg. Riffle Width:	10.3	6.3	7.2	ft → 7.93
Avg. Riffle Depth:	4.331	3.77	3.777	→ 0.30555
Riffle Velocity:	1.333	1.966	1.600	→ 1.6333 ft/
% Canopy Cover:	5	25	65%	→ [illegible]
Substrate Complexity:	18	17	16	→ 17
Embeddedness:	16	16	15	→ 15.66
Substrate Composition:				
Fines (<0.1"):	18	15	12	→ 15
Gravel (0.1-2"):	20	35	35	→ 30
Cobble (2-10"):	35	45	48	→ 42.666
Boulder (>10"):	27	5	5	→ 12.333
Bedrock (solid):	0	0	0	→ 0
Substrate Consolidation:	L	L	L	→ L
Percent Gradient:	3%	3%	2%	→ 2.66
	0.5	2.0	1.3	
	1.0	1.4	2.0	
	1.5	1.5	1.5	
	5	4	5	
	4	3	2	
	4	3	3	

CALIFORNIA DEPARTMENT OF FISH AND GAME
AQUATIC BIOASSESSMENT LABORATORY

WATER POLLUTION CONTROL LABORATORY
REVISION DATE-- MAY 1999

PHYSICAL HABITAT QUALITY
(California Stream Bioassessment Procedure)

WATERSHED/ STREAM: BEAR BRK
COMP~~ANY/ AGENCY~~: BEAR 3
SITE DESCRIPTION: NR CONFL w̄ TWILIGHT

DATE/ TIME: 7/16/01 1630
SAMPLE ID NUMBER: BEAR 3

Circle the appropriate score for all 20 habitat parameters. Record the total score on the front page of the CBW.

Parameters to be evaluated within the sampling reach

HABITAT PARAMETER	CONDITION CATEGORY			
	OPTIMAL	SUBOPTIMAL	MARGINAL	POOR
1. Epifaunal Substrate/ Available Cover — 176	Greater than 70% (50% *for low gradient streams*) of substrate favorable for epifaunal colonization and fish cover; most favorable is a mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% (30-50% for *low gradient streams*) mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for *low gradient streams*) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% *for low gradient streams*) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	20 19 [✓ 18] 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
	20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/ Depth Regimes *(deep<0.5 m, slow<0.3 m/s)*	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status SEASONAL	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1 0

[illegible]

BEAR 3

Parameters to be evaluated in an area longer than the sampling reach

HABITAT PARAMETER	CONDITION CATEGORY			
	OPTIMAL	SUBOPTIMAL	MARGINAL	POOR
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
	[✓ 20] 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
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8. Bank Stability (score each bank) Note: determine left of right side by facing downstream	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
	Left Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 [✓ 9]	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zones covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	Left Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
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10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities haveimpacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
	Left Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
	Right Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0