CALIFORNIA STREAM BIOASSESSMENT PROCEDURE

(Protocol Brief for Biological and Physical/Habitat Assessment in Wadeable Streams)

The California Stream Bioassessment Procedure (CSBP) is a standardized protocol for assessing biological and physical/habitat conditions of wadeable streams in California. The CSBP is a regional adaptation of the national Rapid Bioassessment Protocols outlined by the U.S. Environmental Protection Agency in "Rapid Bioassessment Protocols for use in Streams and Rivers" (EPA 841-D-97-002). The CSBP is a cost-effective tool which utilizes measures of the stream=s benthic macroinvertebrate (BMI) community and its physical/habitat characteristics to determine the stream=s biological and physical integrity. BMIs can have a diverse community structure with individual species residing within the stream for a period of months to several years. They are also sensitive, in varying degrees, to temperature, dissolved oxygen, sedimentation, scouring, nutrient enrichment and chemical and organic pollution. Biological and physical assessment measures integrate the effects of water quality over time, are sensitive to multiple aspects of water and habitat quality and can provide the public with a familiar expression of ecological health.

The purpose of this Protocol Brief is to introduce the techniques of bioassessment to aquatic resource professionals and, hopefully, to encourage them to incorporate measures of biological and physical/habitat into their water quality programs. The use of this procedure will ensure that the data they generate can be used by state regulatory agencies and will be compatible with a statewide bioassessment effort. The Protocol Brief is only a summary and does not contain all the information that may be required to implement a bioassessment program. Additional information and updates on bioassessment can be obtained by visiting the **California Aquatic Bioassessment Web Site at www.dfg.ca.gov/cabw/cabwhome.html**.

CALIFORNIA DEPARTMENT OF FISH AND GAME SCIENTIFIC COLLECTING PERMIT

Anyone who collects fish, amphibians, or invertebrates from the waters of the state must have in their possession a DFG Scientific Collecting Permit. The permit can be obtained from the DFG License and Revenue Branch in Sacramento (916 227-2225). Those people conducting bioassessment in California should specify on the permit application, that they will take freshwater invertebrates (authorization 5) and incidental fish (authorization 6) and amphibians (authorization 8). It is also advisable to contact the local Game Warden and District Fisheries Biologist at the closest Regional Office prior to collecting. Starting in summer 1999, everyone indicating that they will be conducting bioassessment in California will receive the most recent version of the CSBP Protocol Brief and an Access[7] database program to store, process and return a copy of the collected data.

FIELD PROCEDURES FOR COLLECTING BMI SAMPLES AND ASSESSING PHYSICAL/ HABITAT QUALITY

The CSBP can be used to detect aquatic impacts from point and non-point sources of pollution and for assessing ambient biological condition. The sampling unit is an individual riffle or riffles within a reach of stream depending on the type of sampling design used. Riffles are used for collecting biological samples because they are the richest habitat for BMIs in wadeable streams. **The BMI sampling procedures described in this Protocol Brief are intended for sampling wadeable, running water streams with available riffle habitats.** There are approved modifications of this procedure for narrow (< 1m) streams, wadeable streams with sand or mud bottoms and channelized streams. There are also procedures for lentic or still water environments. Contact DFG or visit the California Aquatic Bioassessment Web Site for more information.

Point Source Sampling Design

There will be discernable perturbations, impacting structures or discharges into the stream with point sources of pollution. The sampling units will be individual riffles within the affected section of stream and an upstream unaffected section. At least one riffle in the unaffected section should be sampled and one or more riffles in the affected section depending on the amount of detail that is required on downstream recovery. The riffles used for sampling BMIs should have relatively similar gradient, substrate and physical/habitat characteristics and quality. **One sample will be collected from 3 randomly chosen transects in each riffle**.

FIELD EQUIPMENT AND SUPPLIES

- Measuring tape
- D-shaped kick net (0.5mm mesh)
- Standard Size 35 sieve (0.5mm mesh)
- Wide-mouth 500 ml plastic jars
- White sorting pan and forceps
- 95% ethanol
- California Bioassessment Worksheet (CBW)
- Physical/ Habitat Quality form
- Chain of Custody form
- Random number table
- pH, temperature, DO and conductivity meter
- Stadia rod and hand level/ clinometer
- Densiometer/ Solar Pathfinder
- GPS unit or watershed topographic map

Use the following step-by-step procedures for collecting BMIs using the point source sampling design:

Step 1. Place the measuring tape along the bank of the entire riffle while being careful not to walk in the stream. Each meter or 3 foot mark represents a possible transect location. Select 3 transects from all possible meter marks along the measuring tape using a random number table. Walk to the lowest transect before proceeding to Step 2.

Step 2. Inspect the transect before collecting BMIs by imagining a line going from one bank to the other, perpendicular to the flow. Choose 3 locations along that line where you will place your net to collect BMIs. If the substrate is fairly similar and there is no structure along the transect, the 3 locations will be on the side margins and the center of the stream. If there is substrate and structure complexity along the transect, then as much as possible, select the 3 collections to reflect it.

Step 3. After mentally locating the 3 areas, collect BMIs by placing the D-shaped kick-net on the substrate and disturbing a 1x2 foot portion of substrate upstream of the kick-net to approximately 4-6 inches in depth. Pick-up and scrub large rocks by hand under water in front of the net. Maintain a consistent sampling effort (approximately 1-3 minutes) at each site. Combine the 3 collections within the kick-net to make one Acomposite@ sample.

Step 4. Place the contents of the kick-net in a standard size 35 sieve (0.5 mm mesh) or white enameled tray. Remove the larger twigs, leaves and rocks by hand after carefully inspecting for clinging organisms. If the pan is used, place the material through the sieve to remove the water before placing the material in the jar. Place the sampled material and label (see box) in a jar and completely fill with 95% ethanol. Never fill a jar more than 2/3 full with sampled material and gently agitate jars that contain primarily mud or sand.

Step 5. Proceeding upstream, repeat Steps 2 through 4 for the next two randomly chosen transects within the riffle.

Non-point Source Sampling Design

There will be no obvious perturbations or discharges into the stream with non-point sources of pollution. This sampling design is appropriate for assessing an entire stream or large section of stream. The sampling units will be riffles within a reach of stream. The stream reach must contain at least 5 riffles within the same stream order and relative gradient. **One sample will be collected from the upstream third of 3 randomly chosen riffles.**

Bioassessment Sample Label

Riffle/ Reach Number:_____
Transect Number: _____
Stream Name: _____
Date/ Time: _____
Sample by: _____

Use the following step-by-step procedures for collecting BMIs using the non-point source sampling design:

Step 1. Randomly choose 3 of the 5 riffles within the stream reach using the random number table.

Step 2. Starting with the downstream riffle, place the measuring tape along the bank of the entire riffle while being careful not to walk in the stream. Select 1 transect from all possible meter marks along the top third of the riffle using a random number table.

Step 3. (See Point Source Sampling Design Step 2)

Step 4. (See Point Source Sampling Design Step 3)

Step 5. (See Point Source Sampling Design Step 4)

Step 6. Proceeding upstream, Repeat Steps 2 through 5 for the next two riffles within the stream reach.

Sampling Design for Assessing Ambient Biological Conditions

Assessment of ambient biological condition utilizes both the point and non-point source sampling designs to cover an entire watershed or larger regional area. Ambient bioassessment programs are used to evaluate the biological and physical integrity of targeted inland surface waters. Stream reaches should be established in the upper, middle and lower portions of each watershed and above and below areas of particular interest. Quite often bioassessment is incorporated into an existing chemical or toxicological sampling design. In most cases, the water quality information is being collected at a particular point on the stream. Although there will be the tendency to use the point source design, try to convert to a non-point reach design for biological sampling.

Measuring Physical/Habitat Quality

The physical/habitat scoring criteria is an EPA nationally standardized method. It is used to measure the physical integrity of a stream and can be a stand-alone evaluation or used in conjunction with a bioassessment sampling event. DFG recommends that this procedure be conducted on every reach of stream sampled as part of a bioassessment program. Fill out the Physical/Habitat Quality Form for the entire reach where the BMI samples were collected as part of a non-point source sampling design. Some of the parameters do not apply to a single riffle, so this procedure is usually not performed as part of the point source sampling design. **This procedure is an effective measure of a stream=s physical/habitat quality, but requires field training prior to using it and implementation of quality assurance measures throughout the field season.** A detailed description of the scoring criteria is available through the California Aquatic Bioassessment Web Site.

Measuring Chemical and Physical/Habitat Characteristics

Measurements of the chemical and physical/habitat characteristics are used to describe the riffle environment and help the water resource specialist interpret the BMI data. The information can be used to classify stream reaches and to explain anomalies that might occur in the data. **They are not necessarily a good substitute for a quantitative fisheries habitat survey**.

Use the following step-by-step procedures to measure chemical and physical/habitat characteristics:
Step 1. Water temperature, specific conductance, pH and dissolved oxygen should be measured at the sampling site using approved standardized procedures and instruments.

Step 2. Record the riffle length determine for the procedure to choose the transect locations. Estimate the average riffle width by averaging several measurements along its length. Measure the riffle depth by placing the stadia rod at several places within the riffle and averaging the measurements.

Step 3. Estimate or measure the entire length of the reach where the three riffles are chosen as part of the non-point source sampling design.

Step 4. Measure the riffle velocity using a flow meter placed in front of the three locations along the transect(s) where the BMI samples were collected. Average the readings.

Step 5. Estimate the percent of the riffle surface that is covered by shade from streamside vegetation (canopy cover) using a densiometer at several places along the riffle and averaging the readings.

Step 6. Determine substrate complexity and embeddedness by applying Parameters 1 and 2, respectively from the Physical/Habitat Quality Form to the riffle where the BMI sample was collected. Use the entire riffle to assess these parameters and make note if the area along the transect(s) is considerably different from the rest of the riffle.

Step 7. Visually estimate the percent of riffle in each of the following substrate categories: fines (<0.1"), gravel (0.1-2"), cobble (2-10"), boulder (>10") and bedrock (solid). Use the entire riffle to assess this parameter and make note if the area along the transect(s) is considerable different from the rest of the riffle.

Step 8. Estimate substrate consolidation by kicking the substrate with the heel of your wader boots to note whether it is loosely, moderately or tightly cemented. The estimate should also take into consideration the hands-on experience obtained from collecting the BMI sample.

Step 9. Measure the gradient or slope of the riffle using a stadia rod and hand level or a clinometer.

Using the California Bioassessment Worksheet

A California Bioassessment Worksheet (CBW) should be filled out for each individual riffle when following the Point Source Sampling Design and for the entire reach when using the Non-point Sampling Design. Use the following step-by-step procedures for filling out the CBW:

Step 1. Enter the watershed and stream name, date and time of sample collection, name of the company or agency collecting the samples, sample identification number(s), and a short site description on the CBW.

Step 2. Enter the names of each crew member in the Crew Member Box.

Step 3. Determine the longitude and latitude coordinates and elevation from a GPS unit or watershed topographic map. Determine which California ecoregion or sub-ecoregion the site is located in by using the U.S. Forest Service map obtained by visiting the California Aquatic Bioassessment Web Site. Record this information and any other comments on the sampling site in the Site Location Box.

Step 4. Record the water temperature, specific conductance, pH and dissolved oxygen measurements in the Chemical Characteristics Box.

Step 5. Record the physical/habitat characteristics in the Riffle/Reach Characteristics Box. For the Point Source Sampling Design, record the riffle length, the 3 transect locations along the riffle and the physical/habitat characteristics information (starting with Ave. Riffle Width) on the lines below the Ariffle 1" column. For the Non-point Source Sampling Design, record the reach length, the total score from the Physical/Habitat Quality Form and all physical/habitat characteristics information on the lines below the Ariffle 1" through Ariffle 3" columns.

Step 6. Record the name and address of the Bioassessment Laboratory that received the samples along with the laboratory sample numbers if they are different than the field sample identification numbers.

Using the Chain of Custody (COC) Form

The Chain of Custody (COC) form is a necessary part of collecting BMI samples. It is an official document for tracking the samples from the field to the laboratory and then to their final storage area. The COC will also provide important information if samples are lost or misplaced. Use the following step-by-step procedures for using the COC:

Step 1. At the end of the field day, record the following information on the COC for each group of BMI samples: program name; watershed name; field ID numbers; sampling dates; and name, address, telephone number and signature of one of the crew members collecting the sample.

Step 2. Field samples and COCs must remain in a locked sample depository until a decision has been made to send them to a bioassessment laboratory for processing.

Step 3. When transporting to a bioassessment laboratory, each group of samples must be accompanied by a COC. Upon delivery, a Bioassessment Laboratory Number will be assigned to each sample. Record this number on the COC and each individual CBW along with the name and address of the bioassessment laboratory. When all samples listed on the COC are accounted for, then the individual delivering the samples will sign the "Released By" portion and the laboratory personnel will sign the "Received By" portion of the COC. The original COC will remain at the laboratory and a copy will be retained by the project supervisor.

PROFESSIONAL (LEVEL 3) LABORATORY PROCEDURES

The CSBP has three levels of BMI identification. Level 3 is the professional level equivalent and requires identification of BMIs to a standard level of taxonomy, usually to genus and/or species level. **All professional Bioassessment Laboratories should belong to the California Bioassessment Laboratories Network (CAMLnet).** This organization was conceived to provide technical assistance to laboratories and ensure that laboratory efforts are consistent throughout California. Contact DFG or visit the California Aquatic Bioassessment Web Site for information on CAMLnet.

LABORATORY EQUIPMENT

- Dissecting microscopes
- Standard Size 35 sieve (0.5 mm)
- Gridded picking tray
- Wide-mouth glass jars
- Glass petri dishes
- Vials
- Taxonomic Keys
- 70% EtOH/ 5% glycerol
- Fine dissection forceps
- Standardized taxonomic list
- Waterproof paper/ pencils
- Laboratory benchsheets
- Random number generator
- Chain of Custody form

Subsampling

Step 1. Retrieve the sample from the sample depository and cross-check the sample number with the bioassessment laboratory number on the COC.

Step 2. Empty the contents of the sample jar into the # 35 sieve (0.5 mm mesh) and thoroughly rinse with water.

Step 3. Once the sample is rinsed, clean and remove debris larger than **2** inch. Remove and discard green leaves, twigs and rocks. Do not remove filamentous algae and skeletonized leaves.

Step 4. After cleaning, place the material into a plastic tray marked with equally sized, numbered grids (approximately 2x2 inches). Do not allow any excess water into the tray. Spread the moist, cleaned debris on the bottom of the tray using as many grids necessary to obtain an approximate thickness of **2** inch. Make an effort to distribute the material as evenly as possible.

Step 5. Remove and count macroinvertebrates from randomly chosen grids until 300 BMIs are removed. Place the BMIs in a clean petri dish containing 70% ethanol/5% glycerin. Completely count the remaining organisms in the last grid but do not include them with the 300 used for identification. The final count should be recorded on the benchsheet for eventual abundance calculations.

Step 6. The debris from processed grids should be put in a clean Aremnant@ jar and the remaining contents of the tray should be placed back into the original sample jar. Both jars should be filled with fresh 70% ethanol, labeled (bioassessment laboratory number and either Aoriginal@ or Aremnant@) and returned to the sample depository.

Identification of BMIs

Step 7. Identify the 300 BMIs from each sample to the standardized level recommended by CAMLnet using appropriate taxonomic keys.

Step 8. Place identified BMIs in individual glass vials for each taxon. Each vial should contain a label with taxonomic name, bioassessment laboratory number, stream, county, collection date and collector's name. This voucher collection should be labeled and returned to the Sample Depository.

Step 9. Record taxonomic information on a Macroinvertebrate Laboratory Bench Sheet. The bench sheet should include the following information: watershed or project name; sampling date; sample ID number; bioassessment laboratory number; date of subsampling; name of subsampler; remnant jar number; taxonomy completion date; name of taxonomist; taxonomic list of organism and enumeration; total number of organisms; total number of taxa; list of unknowns, problem groups and comments.

Step 10. Maintain a reference collection of representative specimens of all accurately identified BMI taxa.

QUALITY ASSURANCE (QA) PROCEDURES FOR THE FIELD AND LABORATORY

QA for Collecting BMIs

The CSBP is designed to produce consistent, random samples of BMIs. It is important to prevent bias in riffle choice and transect placement. The following procedures will help field crews collect unbiased and consistent BMI samples:

1. In using the CSBP, most sampling reaches should contain riffles that are at least 10 meters long, one meter wide and have a homogenous gravel/cobble substrate with swift water velocity. **There are approved modifications of the CSBP when these conditions do not exist. Contact DFG or visit the California Aquatic Bioassessment Web Site for methods to sample narrow streams, wadeable streams with muddy bottoms and channelized streams.**

2. A DFG biologists or project supervisor should train field crews in the use of the BMI sampling procedures described in the CSBP. Field personnel should review the CSBPs before each field season.

3. During the training, crew members should practice collecting BMI samples as described in the CSBP. The 2 ft^2 area upstream of the sampling device should be delineated using the measuring tape or a metal grid and the collection effort should be timed. Practice repeatedly until each crew member has demonstrated sampling consistency. Throughout the sampling season, assure that effort and sampling area remain consistent by timing sampling effort and measuring sampled area for approximately 20% of the sampling events. The results should be discussed immediately and need not be reported.

QA for Measuring Physical/Habitat Quality

Physical/habitat parameters are assessed using a ranking system ranging from optimal to poor condition. This rapid ranking system relies on visual evaluation and is inherently subjective. The following procedures will help to standardize individual observations to reduce differences in scores:

1. A DFG biologist or a project supervisor should train field crews in the use of the EPA physical/habitat assessment procedures. Contact DFG or visit the California Aquatic Bioassessment Web Site for a detailed description of the procedures. Field personnel should review these procedures before each field season.

2. At the beginning of each field season, all crew members should conduct a physical/habitat assessment of two practice stream reaches. Assess the first stream reach as a team and discuss in detail each of the 10 physical/habitat parameters described in the EPA procedure. Assess the second stream reach individually and when members are finished, discuss the 10 parameters and resolve discrepancies.

3.Crews or individuals assessing physical/habitat quality should frequently mix personnel or alternate assessment responsibilities. At the end of each field day, crew members should discuss habitat assessment results and resolve discrepancies.

4.The Project Supervisor should randomly pre-select 10 - 20% of the stream reaches where each crew member will be asked to assess the physical/habitat parameters separately. The discrepancies in individual crew member scores should be discussed and resolved with the Project Supervisor.

QA for the Laboratory

Laboratory analysis of macroinvertebrate samples can be a significant cost for bioassessment programs. The CSBP specifies identification of BMIs to a standard level of taxonomy, usually to genus and/or species level. The CSBP also requires subsampling procedures using a fixed count of 300 organisms. Employing these procedures with confidence requires an effective quality assurance program. Complete quality assurance compliance will require a

minimal 10% cost overhead. However, it will allow for testing whether subsampling, organism enumeration and taxonomic identification are consistent and accurate. Use the following procedures in the bioassessment laboratory to ensuring that quality data is produced:

The California Macroinvertebrate Laboratory Network (CAMLnet) - All individuals, private consulting firms and agency personnel using the CSBP laboratory procedures should contact the WPCL for information on CAMLnet. This group consists of personnel from bioassessment laboratories throughout California. The group provides a forum where laboratory procedures are discussed and the BMI taxonomic levels are determined. It also provides taxonomic workshops and assistance with interlaboratory taxonomic verification.

Standard Operation Procedures (SOP) - Each bioassessment laboratory should produce an SOP manual following the procedures outlined in the CSBP, but with detailed instructions specific to each laboratory. The SOP manual should be maintained for all laboratory operations and updated regularly. The assigned personnel and the duties of a Laboratory Supervisor and QA Taxonomist should be specified in the SOP manual. Customized benchsheets should be developed for each phase of subsampling and identification.

Sample Handling and Custody - When samples arrive, laboratory staff should inspect the samples for a sufficient volume of ethanol and labels for pertinent information including water-body name, sample date and time, location, transect number and sampler name. The steps discussed in the AUsing the Chain of Custody (COC)@ section in this protocol should be followed. The sample description information should be recorded in the Laboratory Sample Inventory Log and each sample given a unique identification number. A written and electronic record should be maintained to trace the samples from entry into the laboratory through final analysis. Samples should be stored in the a Sample Repository until processing and returned after processing.

Subsampling - Subsampling involves removing 300 organisms from each sample, or all organisms if the entire sample contains fewer than 300. The procedure to estimate abundance usually requires removing more than 300 organisms from each sample; however, only 300 are retained for identification. The Subsampling Technician systematically transfers organisms from the sample to a collection vial then transfers the processed sample debris (remnant) into a Remnant jar. At least 10% of the Remnant samples should be examined by the QA Taxonomist for organisms that may have been overlooked during subsampling. For subsamples containing 300 or more organisms, the Remnant sample should contain fewer than 10% of the total organisms subsampled. The Remnant for samples containing fewer than 300 organisms should contain fewer than 30 organisms.

Taxonomic Identification and Enumeration - The CSBP requires that all organisms are identified to a standardized taxonomic level using established taxonomic keys and references. The QA Taxonomist should check at least 10% of the samples for taxonomic accuracy and enumeration of individuals within each taxon. The same sample numbers that were selected randomly for the subsampling quality control should be used for this procedure. Misidentifications and/or taxonomic discrepancies as well as enumeration errors should be noted on the laboratory benchsheets. The Laboratory Supervisor determines if the errors warrant corrective action.

Organism Recovery - During the sorting and identification process organisms may be lost, miscounted or discarded. Taxonomists will record the number of organisms discarded and a justification for discarding on the laboratory benchsheets. Organisms may be discarded for several reasons including: 1) subsampler mistakes (e.g. inclusion of terrestrial or semi-aquatic organisms or exuviae), 2) small size (< 0.5 mm), 3) poor condition or 4) fragments of organisms. The number of organisms recovered at the end of sample processing will also be recorded and a percent recovery determined for all samples. Concern is warranted when organism recoveries fall below 90%. Samples with recoveries below 90% should be checked for counting errors and laboratory benchsheets should be checked to determine the number of discarded organisms. If the number of discarded organisms is high, then the technician that performed the subsampling should be informed and re-trained if necessary.

Corrective Action - Any quality control parameter that is considered out of range should be followed by a standard corrective action that includes two levels. Level I corrective action includes an investigation for the source of error or discrepancy derived from the quality control parameter. Level II corrective action includes checking all samples for the error derived from the quality control parameter but is initiated only after the results of the Level 1 process justify it. The decision to initiate Level II corrective action and reanalyze samples or conduct quality control on additional samples should be made by the Laboratory Supervisor.

Interlaboratory Taxonomic Validation - An external laboratory or taxonomic specialist should be consulted on a regular basis to verify taxonomic accuracy. External validation can be performed on selected taxa to help the laboratory taxonomists with problem groups of BMIs and to verify representative specimens of all taxa assembled in a reference collection.

Bioassessment Validation - The CSBP recommends at least 10% bioassessment validation where whole samples of 300 identified BMIs are randomly selected from all samples either for a particular project or for all samples processed within a set time period such as each 6 months or a year. The labels should be removed from the vials and replaced with a coded label that does not show the taxonomic name of the BMIs. The validation laboratory or specialist should be instructed to identify and enumerate all specimens in each vial and produce a taxonomic list. There will inevitably be some disagreements between the bioassessment and the external laboratory on taxonomic identification. These taxa should be re-examined by both parties and a resolution reached before a final QA report is written. **DFG is working on this QA technique to determine the acceptable level of misidentification and appropriate corrective actions.**

DATA DEVELOPMENT AND ANALYSIS

The CSBP analysis procedures are based on the EPA:s multi-metric approach to bioassessment data analysis. The EPA is developing procedures for multi-variate analysis of bioassessment data, but that method is not presented here. However, the sampling protocols presented in this document were designed to facilitate the use of multi-variate analysis and more information will be presented when standardizes techniques for California become available.

A taxonomic list of the BMIs identified for each sample should be generated for each project along with a table of sample values and means for the biological metrics listed on the last page of this document. Variability of the sample values should be expressed as the coefficient of variability (CV). Significance testing can be use for point source sampling programs and ranking procedures can be used to compare sites sampled using the non-point sampling design (contact DFG for information on ranking formulas). Ultimately, there will be a regional Index of Biological Integrity (IBI) to compare sample site mean values.

Starting in summer 1999, an Access[7] database program to store, process and return a copy of the collected data will be available. Contact DFG or visit the California Aquatic Bioassessment Web Site to learn more about the availability of regional IBIs and the database program.

BIOLOGICAL METRICS USED TO DESCRIBE BENTHIC MACROINVERTEBRATE (BMI) SAMPLES COLLECTED FOLLOWING THE CALIFORNIA STREAM BIOASSESSMENT PROCEDURE (CSBP)

Biological Metrics	Description	Response to Impairment
Richness Measures		
Taxa Richness	Total number of individual taxa	decrease
EPT Taxa	Number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders	decrease
Ephemeroptera Taxa	Number of mayfly taxa (genus or species)	decrease
Plecoptera Taxa	Number of stonefly taxa (genus or species)	decrease
Trichoptera Taxa	Number of caddisfly taxa (genus or species)	decrease
Composition Measures		
EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae	decrease
Sensitive EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae with Tolerance Values of 0 through 3	decrease
Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963)	decrease
Tolerance/Intolerance Measures		
Tolerance Value	Value between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) and intolerant (lower values)	increase
Percent Intolerant Organisms	Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1 or 2	decrease
Percent Tolerant Organisms	Percent of organisms in sample that are highly tolerant to impairment as indicated by a tolerance value of 8, 9 or 10	increase
Percent Hydropsychidae	Percent of organisms in the caddisfly family Hydropsychidae	increase
Percent Baetidae	Percent of organisms in the mayfly family Baetidae	increase
Percent Dominant Taxa	Percent composition of the single most abundant taxon	increase
Functional Feeding Groups		
Percent Collectors	Percent of macrobenthos that collect or gather fine particulate matter	increase
Percent Filterers	Percent of macrobenthos that filter fine particulate matter	increase
Percent Scrapers (Grazers)	Percent of macrobenthos that graze upon periphyton	variable
Percent Predators	Percent of macrobenthos that feed on other organisms	variable
Percent Shredders	Percent of macrobenthos that shreds coarse particulate matter	decrease

PHYSICAL HABITAT QUALITY
(California Stream Bioassessment Procedure)

WATERSHED/ STREAM: _____ DATE/ TIME: _____

COMPANY/ AGENCY: _____ SAMPLE ID NUMBER: _____

SITE DESCRIPTION: _____

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	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.
	20 19 18 17 16	15 14 13 12 11	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	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.
	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: _____ DATE/ TIME: _____

COMPANY/ AGENCY: _____ SAMPLE ID #: _____

SITE DESCRIPTION: _____

SAMPLING CREW

_____

_____

_____

SITE INFORMATION

GPS Coordinates

Latitude: _____

Longitude: _____

Elevation: _____

Ecoregion: _____

COMMENTS:

_____

_____

_____

_____

_____

CHEMICAL CHARACTERISTICS

Water Temperature: _____

Specific Conductance: _____

pH: _____

Dissolved Oxygen: _____

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 Characteristcs in Riffle 1 column)

Non-Point Source Sampling Design

Reach Length: _____

Physical Habitat Quality Score: _____

Physical/ Habitat Characteristics

	Riffle 1	Riffle 2	Riffle 3
Riffle Length:			
Transect Location:			
Avg. Riffle Width:			
Avg. Riffle Depth:			
Riffle Velocity:			
% Canopy Cover:			
Substrate Complexity:			
Embeddedness:			
Substrate Composition:			
Fines (<0.1"):			
Gravel (0.1-2"):			
Cobble (2-10"):			
Boulder (>10"):			
Bedrock (solid):			
Substrate Consolidation:			
Percent Gradient:			

CALIFORNIA STREAM BIOASSESSMENT PROCEDURE
CHAIN OF CUSTODY (COC) RECORD

Project Name: _____ Date/ Time: _____

Watershed Name:_____ Boiassessment Lab: _____

Sample Number	Lab Number	Sample Date	Sample Description

Sampled by: (sign and date)	Relinquished by: (sign and date)	Received by: (sign and date)
Received by: (sign and date)	Received by: (sign and date)	Received by: (sign and date)

Address of Sampler:

_____

_____

_____

_____

Address of Project Advisor:

_____

_____

_____

_____

91728	44078	96998	25780	58455	99398	16299	30849	56199	45791
56489	18412	62384	48356	75118	51724	7962	62571	13801	10633
26008	30424	44745	71156	73603	52920	32012	56567	28693	22644
49864	5438	98149	44583	87573	37067	80217	52738	22178	48264
39666	4377	80040	38685	96850	54884	5688	88314	54190	6957
83576	92168	37324	72652	78431	59142	55787	17989	81991	95926
23670	80579	84178	799	71974	99821	43125	50789	90272	35574
87975	76200	53759	19222	76617	25341	85869	89617	14629	31322
26124	80985	95411	51349	9322	52887	66059	93470	20527	91142
89224	48066	62669	15806	9590	64712	2723	42518	14275	12582
16945	56219	70292	83056	84787	39471	8409	60760	16240	38967
68995	89831	64408	65234	45348	53418	23153	7967	3207	90746
83774	11014	22528	147	17261	99443	35455	92555	13866	64339
42548	51674	42715	27867	39232	7665	54904	58891	1231	29431
64710	20643	66849	39263	77285	57101	96155	28881	945	98860
63165	93728	94343	89748	33536	5512	35890	81693	89378	94102
40560	45532	29546	76068	75350	8114	78700	97206	12674	59472
40497	85910	64852	78287	41305	65074	86565	36817	90469	33320
78253	65886	91014	5189	27810	8425	50837	90848	15566	55301
6726	60284	15637	76386	26291	82058	93008	31185	27787	27832
75398	44114	94338	94110	84544	24230	39688	30293	10743	80838
76322	63173	16930	97452	15667	38601	92162	19744	35484	46763
66649	15644	69687	45869	1547	33766	22164	16953	87813	48022
37893	12167	98162	96011	91455	9461	14744	29528	12735	8861
2140	94216	48465	39993	72352	35922	13664	23909	75847	77078
61458	48058	32617	89494	9373	81388	98574	55392	9903	20920
62625	61463	6986	43373	71397	44207	77525	65801	94388	61531
75058	34685	37439	96897	1716	96907	97725	4668	58993	79548
52831	73191	64944	86567	78534	36705	35228	94795	57045	29891
34633	63695	99933	8600	46315	75279	82753	80519	22842	91397
32432	87083	55613	38712	77856	21022	91372	62566	65890	41602
44172	13651	34399	25967	52017	93718	30391	81218	70272	42931
92844	78189	15041	43163	57278	16716	51717	94447	63929	32066
43231	19607	27777	38990	94169	81895	68611	65469	3589	77865
82916	26280	2108	97253	89662	9628	10004	86829	79043	83724
49574	12138	99224	60236	1127	88024	4866	86393	93601	13793
72409	56938	92585	42321	47203	97135	26727	49075	49157	121
77156	14992	87483	53367	56545	34281	63976	56392	43359	57029
34228	59830	28700	56993	50813	66532	58929	84038	99788	77246
98423	49581	30802	87072	90228	63318	80658	92848	37173	88826

18570	29895	7607	89572	52690	70464	20532	50443	64823
2448	67832	89598	62241	8618	57946	20735	91040	44269
99987	97585	40238	5032	99367	24618	99400	42672	64405
19350	20110	40749	42085	32769	66135	87928	50806	64671
62954	20328	99145	25362	57235	21427	61430	91451	31827
25836	69393	13558	631	57294	68296	26794	88383	72800
5704	42530	45130	58296	767	30820	90684	91403	10505
62636	75475	75436	73633	16104	46156	38379	51443	75871
41374	32300	43184	13209	49485	65678	13028	99745	3989
9893	60624	78947	40480	46413	19390	16444	49445	99840
52721	2834	37041	47563	80565	61660	48533	81939	13101
83253	23619	84503	72779	15167	58008	85127	56060	52025
14066	97892	2900	42295	28319	37390	73110	81942	65509
8636	49709	42290	53164	95177	62109	39033	60637	75271
75508	62576	62870	63572	55039	96969	43323	97335	66539
89666	71232	46334	75514	90964	95384	77535	96106	8001
79232	3529	47061	60679	89791	57068	1857	10567	60706
26900	6028	22247	21495	37898	25824	50810	9045	62681
33249	38154	71746	43830	30152	28796	32991	24347	64861
97355	64451	41273	50353	71747	39207	44071	71818	158
64143	21112	59108	53389	12792	54159	35051	47583	8138
89287	55276	10858	47845	69191	3803	16748	47367	50568
26002	83088	53066	87662	23548	83322	42079	91795	20860
51560	56871	81329	1819	50614	56453	30235	19327	50809
20539	28795	1253	98196	76344	24413	87415	68523	53665
62821	77929	69327	82278	45165	94453	23030	45423	96938
27414	66399	10635	6220	6352	87505	6859	77638	64724
78594	7897	16036	6669	83452	15921	12177	83870	5922
83312	64623	31661	52888	11672	9061	3522	26574	15936
32818	28634	4868	49362	51474	18688	42195	10806	88513
20594	4938	77394	96024	8082	86273	37304	35314	26903
18556	6618	27256	28236	14398	28143	79891	25227	45087
77237	24983	15875	82995	90914	94509	99814	29822	66623
95016	65072	72685	47373	82479	21491	84350	73390	42078
18355	78424	41804	11162	73271	28251	40180	89616	91159
14186	45382	75616	47801	29002	57439	39816	85482	6533
52433	31802	66033	3487	22033	86061	31103	20172	68028
38782	19888	12117	38651	27799	98799	77047	67341	12936
14052	30597	29937	27004	14969	11078	22217	30415	41066
8146	80866	770	99774	53536	43431	33634	47960	39999