Department of Pesticide Regulation
Environmental Monitoring Branch
1001 I Street
Sacramento, CA 95812
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STUDY #225: Bioassessment Pilot Study to Identify Impacts on the Benthic Macroinvertebrate Community due to Surface Runoff of Pesticides.

I. INTRODUCTION

Pesticides have been detected in various monitoring studies conducted on the San Joaquin River and the Sacramento River by various state and federal agencies. These studies have monitored urban as well as agriculture runoff. Along with other anthropogenic factors, pesticides have the potential to cause adverse impacts to aquatic biological communities. Over the last several decades, zooplankton, cladoceran and benthic invertebrate populations have declined in the Sacramento-San Joaquin Basins, Delta and San Francisco estuary. Pesticides in surface water have been suggested as one factor responsible for those declines (Obrebski et al., 1992; Cooke et al., 1999).

DPR uses chemical analysis to determine the presence of pesticides in surface waters. Acute aquatic toxicity tests on *Ceriodapnia dubia* are used to evaluate potential aquatic toxicity in surface water samples. The standard aquatic toxicity bioassay procedures follow American Society for Testing Materials and EPA guidelines, but potential shortcomings include the following:

- Pesticide inputs to surface water commonly occurs as pulses
- Occasional monitoring may miss these pulses
- Chemical analysis and laboratory toxicity tests do not assess integrated ecological impacts

Benthic macroinvertebrates (BMIs) are useful in evaluating water quality and the overall health of flowing water systems because they are affected by changes in a stream's chemical and or physical structure (Karr and Kerans, 1991). Their large species diversity provides a range of responses to environmental stresses (Rosenberg and Resh, 1993). The diversity and population size of species found in a stream or creek reflect the overall health of the biological community within that aquatic environment, and these population characteristics are used as water quality indicators (State Water Resources Control Board, 2001). Individual species of aquatic macroinvertebrates reside in the aquatic environment for a period of months to several years and are sensitive, in varying degrees, to temperature, dissolved oxygen, sedimentation, scouring, nutrient enrichment and chemical and organic pollution (Resh and Jackson, 1993). This sensitivity to stresses allows them to be effective indicators of specific anthropogenic disturbances (House et al., 1993).

This study will allow the Department of Pesticide Regulation (DPR) to characterize select pesticide concentrations from surface waters as part of the ongoing monitoring in the Central Valley (DPR Protocol #224). It will also allow the department the use of bioassessment as a supplementary tool, in addition to chemistry and toxicity analysis, to assess the ecological impact of pesticides. This study will continue ongoing cooperative efforts between DPR and the Central Valley Regional Water Quality (CVRWQCB) to protect water quality. Moreover, it will leverage limited monitoring resources to provide scientific data concerning pesticides and water quality.

A past collaboration includes bioassessment monitoring in the Sacramento and San Joaquin Valley. Another is the identification of bioassessment reference sites within the San Joaquin Valley watershed. This was a collaboration with CVRWQCB and the Department of Fish and Game (DFG), and included technical input from the State Water Resources Control Board (SWRCB), the U.S. Environmental Protection Agency (U.S. EPA) and Dr. Lenwood W. Hall of the University of Maryland, Wye Research and Education Center.

Currently, bioassessment is used by the CVRWQCB for augmenting water quality assessments throughout the Sacramento and San Joaquin River watersheds. It is supported and used by the Total Maximum Daily Load (TMDL) program and is consistent with the OP Pesticide TMDL Bioassessment Work Plan (CVRWQCB, 2002). These projects continue cooperation, communication, and coordination between DPR and the SWRCB in accordance with the Management Agency Agreement (MAA).

II. OBJECTIVES

The primary objective of this study is to identify potential adverse impacts to the aquatic environment from pesticides at selected central valley stream sites by characterizing the BMI community of agriculture impacted streams in the Central Valley. The secondary goal will be to characterize pesticide concentrations in surface waters in areas of high agricultural use.

III. PERSONNEL

This study will be conducted by staff from the Environmental Monitoring Branch, Surface Water Protection Program under the general direction of Kean S. Goh, Agricultural Program Supervisor IV. Key personnel are listed below:

Project Leader:	Juanita Bacey
Field Coordinator:	Michael Mamola
Senior Scientist:	Frank Spurlock
Peer Review Scientist:	Jay Rowan, CVRWQCB
Laboratory Liaison:	Carissa Ganapathy
Taxonomists:	Bidwell Institute, University of California, Chico
Chemists:	California Dept. of Food and Agriculture

Questions concerning this monitoring study should be directed to Juanita Bacey, Environmental Research Scientist, at (916) 445-3759.

IV. STUDY PLAN

This study will focus on organophosphate and pyrethroid insecticides (Table 1). These pesticides are commonly found in the Central Valley and generally exhibit high toxicities to invertebrates. Herbicides will also be included because they are ubiquitous. In addition to field sampling, a literature search and review of scientific studies evaluating effects of pesticides and other water quality parameters on BMIs will be conducted.

Sites will be selected based on their potential for ecological impact from surface runoff of pesticides during the irrigation season. They will be sampled May through August 2005. Each sampling site will have an upstream (non-impacted) and downstream (impacted) sampling point, or an irrigation supply input and irrigation runoff output. Both sampling points will be within the same general elevation, have similar physical habitat and water quality parameters. The only major difference between the sites will be that the downstream site will be receiving input from agricultural operations.

The BMI community will be characterized at each site and Toxicity Identification Evaluations (TIEs) will be conducted when sediment toxicity is significant. A comparison of species diversity and population sizes of the BMI community will be made between agriculturally impacted and non-impacted sites within a stream.

The BMI community will be used as an indicator to determine whether the aquatic environment at each site has been compromised. Impacted and non-impacted aquatic sites will be compared. Based on the weight-of-evidence from all data collected we will attempt to determine if the observed impacts are due to pesticides, other measured parameters, or a combination of these.

This study will proceed as follows:

1. Literature search and review will be conducted to identify observable effects of various water quality parameters on BMIs. These parameters will include:
   - Temperature, Dissolved Oxygen, Water Discharge, pH, Turbidity, Metals, Fertilizers, Nitrates, Phosphates, Alkalinity, Pesticides (Pyrethroids, Organophosphates, Herbicides)
2. Monitoring sites will be selected in collaboration with the Central Valley Regional Water Quality Control Board (CVRWQCB). In order to maximize the benefit of limited resources, sites selected will effectively meet the project needs of both CVRWQCB and DPR.
3. Once sites are selected, two artificial substrate Hester-Dendy (H-D) samplers will be placed at each sampling point (up and down stream) and used to monitor BMIs. The first H-D sampler will be analyzed for BMI's and the second will be used as a backup.
   a. Two weeks after placement, and every two weeks thereafter, an additional two H-D samplers will be placed at each sampling point.
   b. H-D samplers will be retrieved for BMI analysis after being submerged a minimum of four weeks.
   c. A combined total of 20 BMI samples will be analyzed for this study.
4. CVRWQCB will use YSI Sondes to measure the following water quality parameters every two hours: pH, EC, DO, temperature, and turbidity
5. CVRWQCB will conduct monthly sediment toxicity testing.
6. When significant toxicity is detected, CVRWQCB will initiate TIE analyses.
7. DPR will collect water for pesticide and nutrient analysis two times a week and sediment for pesticide analysis bimonthly (Table 1).
8. Along with BMI samples and water quality samples, physical habitat parameters will be characterized at both sampling points.
9. BMI taxa will be summarized into biological metrics and impacted and non-impacted sites within the stream will be compared.
10. Pesticide impacts within the BMI communities will be evaluated based on "weight-of-evidence".

V. BENTHIC MACROINVERTEBRATE SAMPLING METHOD

Sampling will be conducted per DPR SOP EQWA006 (Mamola, 2005), Procedure for Collecting Benthic Macroinvertebrates using a Hester-Dendy Sampler.

VI. PHYSICAL HABITAT ASSESSMENT METHOD

A physical habitat assessment Field Data Sheet for low gradient streams will be completed at each site. This data sheet uses scoring criteria as defined by the U.S. EPA (U.S. EPA, 1999). Modified U.S. EPA Physical Characterization, Water Quality Field Data, and Substrate size and Embeddedness data sheets will also be completed at each site (Attachments A-D).

VII. WATER SAMPLING METHOD

Water samples will be collected at both the upstream and downstream sites. Four samples will be individually collected per reach for each chemical screen. All samples collected will be grab samples consisting of a 1-liter amber glass bottle on a grab pole, collected from center channel. The amber bottles will be sealed with Teflon-lined lids. Samples will be transported and stored on wet ice or refrigerated at 4^{o}C until extraction for chemical analysis. Dissolved oxygen, pH, specific conductivity, and water temperature will be measured *in situ* at each site.

VIII. SEDIMENT SAMPLING METHOD

Sediment samples will be collected at both the upstream and downstream sites. Sediment samples will be collected using a 24-inch long by 2-inch diameter polycarbonate cylinder tube. One end of the tube will be thrust into the sediment and then removed. The top 2 cm of the sediment collected in the tube and placed into a 1-pint clear glass jar.
If access to the stream is not possible due to water depth, then a Teflon pole and cup will be used to capture the top 2 cm of sediment. This process will be repeated several times until the jar is at least one-half full.

IX. MACROINVERTEBRATE AND CHEMICAL ANALYSIS

Bidwell Institute at the University of California, Chico, will perform macroinvertebrate identification. Quality control will be conducted in accordance with previously established California Department of Fish and Game procedures. A sub-sample of 500 macroinvertebrates will be identified to genera and, when possible, to species.

The California Department of Food and Agriculture's Center for Analytical Chemistry will perform chemical analysis of water. Quality control will be conducted in accordance with SOP QAQC001.00 (Segawa, 1995). Ten percent of the total number of analyses will be submitted with field samples as blind spikes. The reporting limit is the lowest concentration of analyte that the method can detect reliably in a matrix blank. Comprehensive chemical analytical methods will be provided in the final report.

X. DATA ANALYSIS

Macroinvertebrate analysis procedures are based on the U.S. EPA's multi-metric approach to bioassessment data analysis. A taxonomic list of the BMIs identified in each sample will be generated along with a summary consisting of BMI metrics. General statistical analyses methods such as paired t-tests and multivariate ANOVAs will be used to compare significant differences between up and downstream sites.

XI. TIMETABLE

Field Sampling:	June through August, 2005
Final Report:	June 30, 2006

XII. BUDGET

Bioassessment Analysis	Cost at $567/sample			
BMI identification (Includes overhead)	2 streams x 2 samples x 5 events	20 samples	=	$ 11,340
Chemistry Analysis	Cost at $300/sample			
OPs	2 sites x 2 samples x 2/wk. x 18 wks	122 samples	=	43,200
Pyrethroids (water)	2 sites x 2 samples x 2/wk. x 18 wks	122 samples	=	43,200
Pyrethroids (sediment)	2 sites x 2 samples x 5 events	20 samples		6,000
Herbicides	2 sites x 2 samples x 2/wk x 18 wks	122 samples	=	43,200
Quality Control Blind spikes	12 sample x 3 analysis	36 samples	=	10,800
Total				**$157,740**

XIII. REFERENCES

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U.S. EPA. 2001. Environmental Monitoring and Assessment Program – Surface Waters: Western Pilot Study Field Operations Manual for Wadeable Streams. U.S. EPA. April, 2001.

TABLE 1. METHOD TITLES, METHOD DETECTION AND REPORTING LIMITS OF OPS AND HERBICIDES

Organophosphate Pesticides in Water - Method: GC/FPD

Compound	Method Detection Limit (µg/L)	Reporting Limit (µg/L)
Azinphos methyl	0.0099	0.05
Chlorpyrifos	0.0109	0.04
Diazinon	0.011	0.04
DDVP (dichlorvos)	0.0098	0.05
Dimethoate	0.0079	0.04
disulfoton	0.0093	0.04
ethoprop	0.0098	0.05
Fenamiphos	0.0125	0.05
Fonofos	0.008	0.04
Malathion	0.0117	0.04
methidathion	0.0111	0.05
Methyl Parathion	0.008	0.03
Thimet (Phorate)	0.0083	0.05
Profenofos	0.0114	0.05
Tribufos	0.0142	0.05

Triazines/Herbicides in Water - Method: LC/MS/MS

Compound	Method Detection Limit (µg/L)	Reporting Limit (µg/L)
Atrazine	0.020	0.05
Bromacil	0.031	0.05
Diuron	0.022	0.05
Hexazinone	0.040	0.05
Metribuzin	0.025	0.05
Norflurazon	0.019	0.05
Prometon	0.016	0.05
Prometryn	0.016	0.05
Simazine	0.013	0.05
DEA	0.010	0.05
ACET	0.030	0.05
DACT	0.016	0.05

Pyrethroid Pesticides in Sediment
Method: GC/ECD, confirmed with GC/MSD (MG/G)

Fenvalerate/Esfenvalerate	8.0	10.0
Permethrin	6.0	10.0
Bifenthrin	7.0	10.0
Lambda Cyhalothrin	9.0	10.0
Cyfluthrin	8.0	10.0
Cypermethrin	8.0	10.0

Pyrethroid Pesticides in Surface Water
Method: GC/ECD, confirmed with GC/MSD

Esfenvalerate	0.0225	0.050
Permethrin	0.0169	0.050
Bifenthrin	0.00216	0.005
Lambda Cyhalothrin	0.00776	0.020
Cyfluthrin	0.0555	0.080
Cypermethrin	0.0566	0.080

Nutrients (water) Nitrate, Phosphate, Ammonia N, Alkalinity

Attachment A

Physical Characterization

(Modified EPA multi-habitat method)

Study #: ___________________ **Date/Time:**___________________________________

Sampling Crew: _____________ **Location:** ____________________________________

Weather Conditions: ____

Lat:		Long:			
Elevation:		Physical habitat quality score:			
Gradient:					
		Avg. =			
% canopy cover:					
		Avg. =			

<u>Canopy cover</u> = Take 4 measurements at each transect facing each direction (north, south, east & west) and average. Total reach canopy cover = the average of these 11 numbers.

Squares	%	Squares	%	Squares	%	Squares	%
1	4	**7**	29	**13**	54	**19**	79
2	8	**8**	33	**14**	58	**20**	83
3	13	**9**	37	**15**	62	**21**	87
4	17	**10**	40	**16**	67	**22**	92
5	21	**11**	46	**17**	71	**23**	96
6	25	**12**	50	**18**	75	**24**	100

Depth:					
		Avg. =			

Depth is measured in thalweg of each transect and averaged

Comments:	

<u>Watershed features</u>	Description	**<u>Local watershed NPS pollution</u>**	
Forest	________	No evidence	________
Field/Pasture	________	Some potential sources	________
Agricultural	________	Obvious sources	________
Residential	________	**<u>Local watershed erosion</u>**	
Commercial	________	None	________
Industrial	________	Moderate	________
Other	________	Heavy	________

Physical Characterization

(Modified EPA multi-habitat method)

Instream features

- Stream width is considered to be of "typical" width within approximately 5 stream widths upstream and downstream of the center of the reach.

Reach length (m) ______________

Stream width (m) ______________

Sampling reach area (m^2) ______________ (feet x 0.3048m = meters)

Area in km^2 (m^2x1000) ______________ (yards x 0.9144m = meters)

Aquatic vegetation (Indicate the dominant type (%) and record the dominant species present)

Rooted emergent ______________ Free floating ______________

Rooted submergent ______________ Floating algae ______________

Rooted floating ______________ Attached algae ______________

Dominant species present ______________

Portion of the reach with aquatic vegetation

Note: All water chemistry measurements, water and sediment samples are to be collected from the bottom of the reach.

Attachment B

SUBSTRATE SIZE

Study #: ____________________ Date/Time: ________________________________

Sampling Crew: _______________ Location: __________________________________

PARTICLE SIZE CLASS (mm)	5 evenly spaced stabs per transect	
	Tallies	Count
BEDROCK (SMOOTH) (larger than a car)		
Bedrock (rough) (larger than car)		
Large Boulder 1000-4000mm (meterstick to car)		
Small Boulder 250-1000mm (basketball to meterstick)		
Cobble 64-250mm (tennisball to basketball)		
Coarse Gravel 16-64mm (marble to tennisball)		
Fine Gravel 2-16mm (ladybug to marble)		
Sand 0.06-2mm (gritty-up to ladybug size)		
Fines (silt, clay,muck, not gritty)		
Hardpan (firm, consolidated fine substrate)		
Wood (any size)		
Concrete/Asphalt		
Other		

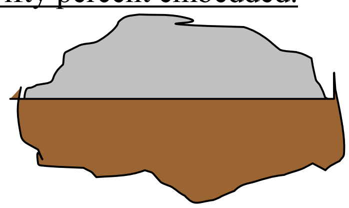
Code	Size Class	Size Range	Description
RS	Bedrock (Smooth)	>4000	Smooth surface rock bigger than a car
RR	Bedrock (Rough)	>4000	Rough surface rock bigger than a car
HP	Hardpan		Firm, consolidated fine substrate
BL	Boulders	>250 to 4000	Basketball to car size
CB	Cobbles	>64 to 250	Tennis ball to basketball size
GC	Gravel (Coarse)	>16 to 250	Marble to tennis ball size
GF	Gravel (Fine)	>2 to 16	Ladybug to marble size
SA	Sand	>0.06 to 2	Smaller than ladybug size, but visible as particles-gritty between fingers
FN	Fines	<0.06	Silt Clay Muck (not gritty between fingers)
WD	Wood	Regardless of Size	Wood & other organic particles
OT	Other	Regardless of Size	Concrete, metal, tires, car bodies etc. (describe in comments)

SUBSTRATE EMBEDDEDNESS

TRANSECT	EMBEDDEDNESS % (5 evenly spaced stabs per transect)					Average
A						
B						
C						
D						
E						
F						
G						
H						
I						
J						
K						

* For particles larger than sand, examine the water surface for stains, markings, and algal coatings to estimate the average embeddedness. Embeddedness is the fraction of a particle's surface that is surrounded by sand or finer sediments on the stream bottom. By definition, sand, silt, clay, and mud are embedded 100 percent; bedrock and hardpan are embedded 0 percent.

<u>Example: Fifty percent embedded.</u>



Attachment C

Water Quality Field Data Sheet

(Modified EPA multi-habitat method)

Study #: ________________________ Date/Time:_________________________________

Sampling Crew: ________________ Location: ___________________________________

Weather Conditions: ____

GPS Coordinates			
Avg reach width		Reach Length	

Water Quality		**Samples**	**#**
Temperature		OP –WAT	
EC		TR – WAT	
DO		PY – WAT	
PH		BU – WAT	
Nitrate		OP -SED	
Phosphate		PY - SED	
Ammonia N		Metals - SED	
Turbidity			
Alkalinity			

Water odors: (i.e. normal, fishy, sewage)	
Water Surface Oils: (i.e. slick, sheen, globs, flecks, none)	
Turbidity: (i.e. clear, slightly turbid, turbid, opaque, stained)	

Diagram of reach

Water Quality Field Data Sheet

(Modified EPA multi-habitat method)

Discharge:
Measured at one channel cross section (representative of the average channel width) within the sampling reach.
Follow procedure as described in SOP FSWA009.00

					VELOCITY					SAMPLING DEPTH(S)					
Dist. From initial point	Width	Depth	.6 or .2/.8	Obser-vation Depth	FPS At Point	V.S. Coef	FPS Mean in Vertical	Area	Dis-charge	WATER DEPTH	0.6	0.2	0.8	Inches to feet	
										0.9	0.5			1	0.08
										1	0.6			2	0.17
										1.1	0.7			3	0.25
										1.2	0.7			4	0.33
										1.3	0.8			5	0.42
										1.4	0.8			6	0.50
										1.5	0.9			7	0.58
										1.6	1.0			8	0.67
										1.7	1.0			9	0.75
										1.8	1.1			10	0.83
										1.9	1.1			11	0.92
										2	1.2			12	1.00
										2.1	1.3				
										2.2	1.3				
										2.3	1.4			Vertical	
										2.4	1.4			Surface	
										2.5	1.5	0.5	2.0	Coef.	
										2.6		0.5	2.1	ratio	
										2.7		0.5	2.2	w/d	Coef
										2.8		0.6	2.2	>1	1.00
										2.9		0.6	2.3	0.50	0.95
										3		0.6	2.4	0.25	0.90
										3.1		0.6	2.5	0.01	0.65
										3.2		0.6	2.6		
										3.3		0.7	2.6		
										3.4		0.7	2.7		
										3.5		0.7	2.8		
										3.6		0.7	2.9		
										3.7		0.7	3.0		
										3.8		0.8	3.0		
										3.9		0.8	3.1		
										4		0.8	3.2		

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION
STATION #________ RIVERMILE________	STREAM CLASS
LAT ____________ LONG ____________	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY	DATE ________ TIME ________ AM PM — REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; 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 not new fall and not transient).	30-50% 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).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	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 <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% 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 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	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.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than 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.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	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)	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.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	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 zone 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.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	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 have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score ______