Methods Protocol

Riparian/Habitat Assessment

Methods:

1. Entering the stream monitors should work downstream and depending on stream length an assessment should be completed every half to one mile.
2. Each site should consist of an assessment of an estimated 15 – 25 yards
3. GPS readings and pictures should be taken at each site
4. At least three pictures per site: one upstream, one directly across the stream from the point at which the monitor is standing, and one down stream
5. GPS information and picture numbers should be recorded
6. Standardized sheets should be completed according to the instructions found in the "Riparian Assessment Instructions" and the "Description of Habitat Parameters" packets (see appendix 4)
7. After returning to lab, compile numerical scores according to "Habitat Assessment Field Data Sheet" to determine the "riparian rating" of the assessed sites

Instrumentation:

1. Standardized Assessment Sheets
2. Garmin 3 GPS unit
3. Digital Camera

Quality Assurance:

1. Standardized field data sheets
2. Standardized instruction packets
3. Same monitor/group of monitors should complete assessment for entire stream

References:

Lockard, Laura A. Personal interview. 14 July 2004.

Appendix IV

1. Description of Habitat Parameters
2. Habitat Assessment Field Data Sheet
3. Parameters to be Evaluated in Sampling Research
4. Riparian Assessment Instructions
5. Riparian Area Assessment Data Sheets

Description of
Habitat Parameters

DESCRIPTION OF HABITAT PARAMETERS

The habitat assessment approach used in this protocol is adapted from EPA's Rapid Bioassessment approach and refined from various applications across the country. The approach focuses on integrating information from specific parameters on the structure of the physical habitat. The field data sheets that summarize the major attributes of each parameter are attached. Specific instruction and training are necessary for an adequate assessment of habitat quality. The following information describes the various parameters used to assess the habitat based on the prevalence of the habitats within the stream--riffle/run prevalent habitats or glide/pool habitats.

If riffle/run habitats are prevalent, the following parameters are used to assess the stream:

(1) *Instream Cover for Fish* includes the relative quantity and variety of natural structures in the stream, such as fallen trees, logs, and branches, large rocks, and undercut banks, that are available as refugia, feeding, or laying eggs. A wide variety of submerged structures in the stream provides the fish with a large number of niches, thus increasing the diversity.

(2) *Epifaunal Substrate for Macroinvertebrates* are essentially the amount of niche space or hard substrates (rocks, snags) available for insects and snails. Numerous types of insect larvae attach themselves to rocks, logs, branches, or other submerged substrates. As with fish, the greater the variety and number of available niches or attachment sites, the greater the variety of insects in the stream. Rocky-bottom areas are critical for maintaining a healthy variety of insects in most high gradient streams.

(3) *Embeddedness* refers to the extent to which rocks (gravel, cobble, and boulders) are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) is decreased. To estimate the percent of embeddedness, observe the amount of silt or finer sediments overlying and surrounding the rocks. If kicking does not dislodge the rocks or cobble, they may be greatly embedded. It may be useful to lift a few rocks and observe the extent of the dark area on their underside.

(4) *Varying Velocity and Water Depth* examines the availability of each of the four primary current/depth combinations: (1) slow-deep, (2) slow-

shallow, (3) fast-deep, and (4) fast-shallow. The best streams in high gradient regions will have all four habitat types present. The presence or availability of these four habitats relates to the stream's ability to provide and maintain a stable aquatic environment. The general guidelines are 0.5 m depth to separate shallow from deep, and 0.3 m/sec to separate fast from slow.

(5) *Channel Alteration* is basically a measure of large-scale changes in the shape of the stream channel. Many streams in urban and agricultural areas have been straightened, deepened, or diverted into concrete channels, often for flood control purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams. Channel alteration is present when the stream runs through a concrete channel; when artificial embankments, riprap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; when dams and bridges are present; and when other such changes have occurred.

(6) The *Sediment Deposition* parameter measures the amount of sediment that has accumulated and the changes that have occurred to the stream bottom as a result of the deposition. Deposition occurs from large-scale movement of sediment caused by watershed erosion. Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals, or result in the filling of pools. Increased sedimentation also results in increased deposition. Usually this is evident in areas that are obstructed by natural or man-made debris and areas where the stream flow decreases, such as bends. High levels of sediment deposition create an unstable and continually changing environment that becomes unsuitable for many organisms.

(7) *Frequency of Riffles* is a way to measure the sequence of riffles occurring in a stream. Riffles are a source of high-quality habitat and diverse fauna, therefore, an increased frequency of occurrence greatly enhances the diversity of the stream community. For areas where riffles are uncommon, a run/bend ratio can be used as a measure of sinuosity. A large degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle the high energy flows that result from storms than are relatively straight streams.

(8) *Channel Flow Status* is the degree to which the channel is filled with water. The flow status will change as the channel enlarges or as flow

decreases as a result of dams and other obstructions, diversions for irrigation, or drought. When water does not cover much of the streambed, the amount of viable substrate for aquatic organisms is limited.

(9) *Condition of Banks* measures whether the stream banks are eroded (or the potential for erosion). Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks and are therefore considered to be unstable. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil.

(10) *Bank Vegetative Protection* measures the amount of the stream bank that is covered by vegetation. The root systems of plants growing on stream banks help hold soil in place, thereby reducing the amount of erosion that is likely to occur. This parameter supplies information on the ability of the bank to resist erosion, as well as some additional information on the uptake of nutrients by the plants, the control of instream scouring, and stream shading. Banks that have full, natural plant growth are better for fish and macroinvertebrates than are banks without vegetative protection or those shored up with concrete or riprap.

(11) *Grazing/Disruptive Pressure* is a measure of disruptive changes to the riparian zone because of grazing or human interference (e.g., mowing). In areas of high grazing pressure from livestock or where residential and urban development activities disrupt the riparian zone, the growth of a natural plant community is impeded. Residential developments, urban centers, golf courses, and rangeland are the common causes of anthropogenic pressure on the riparian zone.

(12) The *Riparian Vegetative Zone Width* measures the width of natural vegetation from the edge of the stream bank (riparian buffer zone). The riparian vegetative zone serves as a buffer zone to pollutants entering a stream from runoff, controls erosion, and provides stream habitat and nutrient input into the stream. A relatively undisturbed riparian zone reflects a healthy stream system; narrow, far less useful riparian zones occur when roads, parking lots, fields, lawns, bare soil, rocks, or buildings are near the stream bank. The presence of "old fields" (i.e., a previously developed fields allowed to convert to natural conditions) will rate higher than fields in continuous or periodic use. Paths and walkways in an otherwise undisturbed riparian zone may be judged to be inconsequential to destruction of the riparian zone.

Habitat Assessment Field Data Sheet

HABITAT ASSESSMENT FIELD DATA SHEET

Habitat Parameter	Category: Optimal	Suboptimal	Marginal	Poor
1 Instream Cover (Fish)	Greater than 50% mix of boulder, cobble, submerged logs, undercut banks, or other stable habitat.	30-50% mix of boulder, cobble, or other stable habitat; adequate habitat.	10-30% mix of boulder, cobble, or other stable habitat; habitat availability less than desirable.	Less than 10% mix of boulder, cobble, or other stable habitat; lack of habitat is obvious.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Epifaunal Substrate	Well-developed riffle and run; riffle is as wide as stream and length extends two times the width of stream; abundance of cobble.	Riffle is as wide as stream but length is less than two times width; abundance of cobble; boulders and gravel common.	Run area may be lacking; riffle not as wide as stream and its length is less than 2 times the stream width; gravel or large boulders and bedrock prevalent; some cobble present.	Riffles or run virtually nonexistent; large boulders and bedrock prevalent; cobble lacking.
SCORE ___	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.	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.
SCORE ___	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	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).
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
:6 Channel Alteration	No channelization or dredging present.	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.	New embankments 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.
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 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from coarse gravel; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, coarse sand on old and new bars; 30-50% of the bottom affected; sediment deposits at obstruction, constriction, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	[illegible]			

Habitat Parameter	Category: Optimal	Suboptimal	Marginal	Poor
#7 Frequency of Riffles	Occurrence of riffles relatively frequent; distance between riffles divided by the width of the stream equals 5 to 7; variety of habitat.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream equals 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 between ratio >25.
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
#8 Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach have areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; on side slopes, 60-100% of bank has erosional scars.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
#9 Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of the streambank surfaces covered by vegetation.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
10 Grazing or Other Disruptive Pressure	Vegetative disruption, through grazing or mowing, minimal or not evident; almost all plants allowed to grow naturally.	Disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of streambank vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
#10 Riparian Vegetative Zone Width	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 ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Total Score ___

		Bank Height			Bank Angle			Density of Roots			Particle Size		
Site #:	RB	L	M	H	L	M	H	L	M	H	L	M	H
Site Type:	LB	L	M	H	L	M	H	L	M	H	L	M	H

Width of Stream (Feet) 10-25___ 26-50___ 51-100___ 101-150___ 150+___
Length of Site (Feet) 0-50___50-100___101-250___251-500___501-1000___1000+___

RB Dist. Erosion to Structure (Feet) 0-25___ 26-50___ 51-100___ 100+___
RB Structure Type - House___ Garage___ Bridge___ Culvert___ Road___ Other__________
LB Dist. Erosion to Structure (Feet) 0-25___ 26-50___ 51-100___ 100+___
LB Structure Type - House___ Garage___ Bridge___ Culvert___ Road___ Other__________

Side	Right Bank	Left Bank
Length Bank		
Height Bank		
Adjacent Land Use Pasture/Fenced/ Machine Accessible		
Soil Texture		
Stream Alignment		
Vegetation		
Stream Gradient		
Slope		
Slope Depo Bar		
Position of Erosion Feature	Lat:	Lon:
Picture #'s Taken:		
Comments:		

		Bank Height			Bank Angle			Density of Roots			Particle Size		
Site #:	RB	L	M	H	L	M	H	L	M	H	L	M	H
Site Type:	LB	L	M	H	L	M	H	L	M	H	L	M	H

Width of Stream (Feet) 10-25___ 26-50___ 51-100___ 101-150___ 150+___
Length of Site (Feet) 0-50___50-100___101-250___251-500___501-1000___1000+___

RB Dist. Erosion to Structure (Feet) 0-25___ 26-50___ 51-100___ 100+___
RB Structure Type - House___ Garage___ Bridge___ Culvert___ Road___ Other__________
LB Dist. Erosion to Structure (Feet) 0-25___ 26-50___ 51-100___ 100+___
LB Structure Type - House___ Garage___ Bridge___ Culvert___ Road___ Other__________

Side	Right Bank	Left Bank
Length Bank		
Height Bank		
Adjacent Land Use Pasture/Fenced/ Machine Accessible		
Soil Texture		
Stream Alignment		
Vegetation		
Stream Gradient		
Slope		
Slope Depo Bar		
Position of Erosion Feature	Lat:	Lon:
Picture #'s Taken:		

Parameters to be Evaluated
In Sampling Research

Parameters to be evaluated in sampling reach:

1 EPIFAUNAL SUBSTRATE/AVAILABLE COVER

high and low gradient streams Includes the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna. A wide variety and/or abundance of submerged structures in the stream provides macroinvertebrates and fish with a large number of niches, thus increasing habitat diversity. As variety and abundance of cover decreases, habitat structure becomes monotonous, diversity decreases, and the potential for recovery following disturbance decreases. Riffles and runs are critical for maintaining a variety and abundance of insects in most high-gradient streams and serving as spawning and feeding refugia for certain fish. The extent and quality of the riffle is an important factor in the support of a healthy biological condition in high-gradient streams. Riffles and runs offer a diversity of habitat through variety of particle size, and, in many small high-gradient streams, will provide the most stable habitat. Snags and submerged logs are among the most productive habitat structure for macroinvertebrate colonization and fish refugia in low-gradient streams. However, "new fall" will not yet be suitable for colonization.

Selected References Wesche et al. 1985, Pearsons et al. 1992, Gorman 1988, Rankin 1991, Barbour and Stribling 1991, Plafkin et al. 1989, Platts et al. 1983, Osborne et al. 1991, Benke et al. 1984, Wallace et al. 1996, Ball 1982, MacDonald et al. 1991, Reice 1980, Clements 1987, Hawkins et al. 1982, Beechie and Sibley 1997.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/Available Cover **(high and low gradient)**	Greater than 70% (50% for low gradient streams) 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).	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.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

1a. Epifaunal Substrate/Available Cover--High Gradient

Optimal and Poor Range Photos

1b. Epifaunal Substrate/Available Cover--Low Gradient

Optimal and Poor Range Photos

2a EMBEDDEDNESS

high gradient streams Refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) is decreased. Embeddedness is a result of large-scale sediment movement and deposition, and is a parameter evaluated in the riffles and runs of high-gradient streams. The rating of this parameter may be variable depending on where the observations are taken. To avoid confusion with sediment deposition (another habitat parameter), observations of embeddedness should be taken in the upstream and central portions of riffles and cobble substrate areas.

Selected References Ball 1982, Osborne et al. 1991, Barbour and Stribling 1991, Platts et al. 1983, MacDonald et al. 1991, Rankin 1991, Reice 1980, Clements 1987, Benke et al. 1984, Hawkins et al. 1982, Burton and Harvey 1990.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
2.a Embeddedness **(high gradient)**	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.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

2a. Embeddedness--High Gradient

Optimal and Poor Range Photos

2b POOL SUBSTRATE CHARACTERIZATION

low gradient streams Evaluates the type and condition of bottom substrates found in pools. Firmer sediment types (e.g., gravel, sand) and rooted aquatic plants support a wider variety of organisms than a pool substrate dominated by mud or bedrock and no plants. In addition, a stream that has a uniform substrate in its pools will support far fewer types of organisms than a stream that has a variety of substrate types.

Selected References Beschta and Platts 1986, U.S. EPA 1983.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
2b. Pool Substrate Characterization **(low gradient)**	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 submerged vegetation.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

2b. Pool Substrate Characterization--Low Gradient

Optimal and Poor Range Photos

3a VELOCITY/DEPTH COMBINATIONS

high gradient streams Patterns of velocity and depth are included for high-gradient streams under this parameter as an important feature of habitat diversity. The best streams in most high-gradient regions will have all 4 patterns present: (1) slow-deep, (2) slow-shallow, (3) fast-deep, and (4) fast-shallow. The general guidelines are 0.5 m depth to separate shallow from deep, and 0.3 m/sec to separate fast from slow. The occurrence of these 4 patterns relates to the stream's ability to provide and maintain a stable aquatic environment.

Selected References Ball 1982, Brown and Brussock 1991, Gore and Judy 1981, Oswood and Barber 1982.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
3a. Velocity/ Depth Regimes **(high gradient)**	All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (slow is <0.3 m/s, deep is >0.5 m).	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).
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

3a. Velocity/Depth Regimes--High Gradient

Optimal and Poor Range Photos

3b POOL VARIABILITY

low gradient streams Rates the overall mixture of pool types found in streams, according to size and depth. The 4 basic types of pools are large-shallow, large-deep, small-shallow, and small-deep. A stream with many pool types will support a wide variety of aquatic species. Rivers with low sinuosity (few bends) and monotonous pool characteristics do not have sufficient quantities and types of habitat to support a diverse aquatic community. General guidelines are any pool dimension (i.e., length, width, oblique) greater than half the cross-section of the stream for separating large from small and 1 m depth separating shallow and deep.

Selected References Beschta and Platts 1986, USEPA 1983.

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
3b. Pool Variability **(low gradient)**	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

3b. Pool Variability--Low Gradient

Optimal and Poor Range Photos

4 SEDIMENT DEPOSITION

high and low gradient streams Measures the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. Deposition occurs from large-scale movement of sediment. Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals, or result in the filling of runs and pools. Usually deposition is evident in areas that are obstructed by natural or manmade debris and areas where the stream flow decreases, such as bends. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms.

Selected References MacDonald et al. 1991, Platts et al. 1983, Ball 1982, Armour et al. 1991, Barbour and Stribling 1991, Rosgen 1985.

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
4. Sediment Deposition **(high and low gradient)**	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.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

4a. Sediment Deposition--High Gradient

Optimal and Poor Range Photos

4b. Sediment Deposition--Low Gradient

Optimal and Poor Range Photos

5 CHANNEL FLOW STATUS

high and low gradient streams The degree to which the channel is filled with water. The flow status will change as the channel enlarges (e.g., aggrading stream beds with actively widening channels) or as flow decreases as a result of dams and other obstructions, diversions for irrigation, or drought. When water does not cover much of the streambed, the amount of suitable substrate for aquatic organisms is limited. In high-gradient streams, riffles and cobble substrate are exposed; in low-gradient streams, the decrease in water level exposes logs and snags, thereby reducing the areas of good habitat. Channel flow is especially useful for interpreting biological condition under abnormal or lowered flow conditions. This parameter becomes important when more than one biological index period is used for surveys or the timing of sampling is inconsistent among sites or annual periodicity.

Selected References Rankin 1991, Rosgen 1985, Hupp and Simon 1986, MacDonald et al. 1991, Ball 1982, Hicks et al. 1991

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
5. Channel Flow Status **(high and low gradient)**	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

5a. Channel Flow Status--High Gradient

Optimal and Poor Range Photos

5b. Channel Flow Status--Low Gradient

Optimal and Poor Range Photos

Parameters to be evaluated broader than sampling reach:

6 CHANNEL ALTERATION

high and low gradient streams Is a measure of large-scale changes in the shape of the stream channel. Many streams in urban and agricultural areas have been straightened, deepened, or diverted into concrete channels, often for flood control or irrigation purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams. Channel alteration is present when artificial embankments, riprap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; when dams and bridges are present; and when other such changes have occurred. Scouring is often associated with channel alteration.

Selected References Barbour and Stribling 1991, Simon 1989a, b, Simon and Hupp 1987, Hupp and Simon 1986, Hupp 1992, Rosgen 1985, Rankin 1991, MacDonald et al. 1991.

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration **(high and low gradient)**	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

6a. Channel Alteration--High Gradient

Optimal and Poor Range Photos

6b. Channel Alteration--Low Gradient

Optimal and Poor Range Photos

7a FREQUENCY OF RIFFLES (OR BENDS)

high gradient streams Is a way to measure the sequence of riffles and thus the heterogeneity occurring in a stream. Riffles are a source of high-quality habitat and diverse fauna, therefore, an increased frequency of occurrence greatly enhances the diversity of the stream community. For high gradient streams where distinct riffles are uncommon, a run/bend ratio can be used as a measure of meandering or sinuosity (see 7b). A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms. The absorption of this energy by bends protects the stream from excessive erosion and flooding and provides refugia for benthic invertebrates and fish during storm events. To gain an appreciation of this parameter in some streams, a longer segment or reach than that designated for sampling should be incorporated into the evaluation. In some situations, this parameter may be rated from viewing accurate topographical maps. The "sequencing" pattern of the stream morphology is important in rating this parameter. In headwaters, riffles are usually continuous and the presence of cascades or boulders provides a form of sinuosity and enhances the structure of the stream. A stable channel is one that does not exhibit progressive changes in slope, shape, or dimensions, although short-term variations may occur during floods (Gordon et al. 1992).

Selected References Hupp and Simon 1991, Brussock and Brown 1991, Platts et al. 1983, Rankin 1991, Rosgen 1985, 1994, 1996, Osborne and Hendricks 1983, Hughes and Omernik 1983, Cushman 1985, Bain and Boltz 1989, Gislason 1985, Hawkins et al. 1982, Statzner et al. 1988.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
7a. Frequency of Riffles (or bends) **(high gradient)**	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.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7a. Frequency of Riffles (or bends)--High Gradient

Optimal and Poor Range Photos

7b CHANNEL SINUOSITY

low gradient streams Evaluates the meandering or sinuosity of the stream. A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms. The absorption of this energy by bends protects the stream from excessive erosion and flooding and provides refugia for benthic invertebrates and fish during storm events. To gain an appreciation of this parameter in low gradient streams, a longer segment or reach than that designated for sampling may be incorporated into the evaluation. In some situations, this parameter may be rated from viewing accurate topographical maps. The "sequencing" pattern of the stream morphology is important in rating this parameter. In "oxbow" streams of coastal areas and deltas, meanders are highly exaggerated and transient. Natural conditions in these streams are shifting channels and bends, and alteration is usually in the form of flow regulation and diversion. A stable channel is one that does not exhibit progressive changes in slope, shape, or dimensions, although short-term variations may occur during floods (Gordon et al. 1992).

Selected References Hupp and Simon 1991, Brussock and Brown 1991, Platts et al. 1983, Rankin 1991, Rosgen 1985, 1994, 1996, Osborne and Hendricks 1983, Hughes and Omernik 1983, Cushman 1985, Bain and Boltz 1989, Gislason 1985, Hawkins et al. 1982, Statzner et al. 1988.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
7b. Channel Sinuosity **(low gradient)**	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 2 to 3 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

7b. Channel Sinuosity--Low Gradient

Optimal and Poor Range Photos

8 BANK STABILITY (condition of banks)

high and low gradient streams Measures whether the stream banks are eroded (or have the potential for erosion). Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks, and are therefore considered to be unstable. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of sediment movement and deposition, and suggest a scarcity of cover and organic input to streams. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

Selected References Ball 1982, MacDonald et al. 1991, Armour et al. 1991, Barbour and Stribling 1991, Hupp and Simon 1986, 1991, Simon 1989a, Hupp 1992, Hicks et al. 1991, Osborne et al. 1991, Rosgen 1994, 1996.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
8. Bank Stability (score each bank) **Note: determine left or right side by facing downstream** **(high and low gradient)**	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

8a. Bank Stability (condition of banks)--High Gradient

Optimal and Poor Range Photos

8b. Bank Stability (condition of banks)--Low Gradient

Optimal and Poor Range Photos

9 BANK VEGETATIVE PROTECTION

high and low gradient streams Measures the amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone. The root systems of plants growing on stream banks help hold soil in place, thereby reducing the amount of erosion that is likely to occur. This parameter supplies information on the ability of the bank to resist erosion as well as some additional information on the uptake of nutrients by the plants, the control of instream scouring, and stream shading. Banks that have full, natural plant growth are better for fish and macroinvertebrates than are banks without vegetative protection or those shored up with concrete or riprap. This parameter is made more effective by defining the native vegetation for the region and stream type (i.e., shrubs, trees, etc.). In some regions, the introduction of exotics has virtually replaced all native vegetation. The value of exotic vegetation to the quality of the habitat structure and contribution to the stream ecosystem must be considered in this parameter. In areas of high grazing pressure from livestock or where residential and urban development activities disrupt the riparian zone, the growth of a natural plant community is impeded and can extend to the bank vegetative protection zone. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

Selected References Platts et al. 1983, Hupp and Simon 1986, 1991, Simon and Hupp 1987, Ball 1982, Osborne et al. 1991, Rankin 1991, Barbour and Stribling 1991, MacDonald et al. 1991, Armour et al. 1991, Myers and Swanson 1991, Bauer and Burton 1993.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
9. Vegetative Protection (score each bank) **Note: determine left or right side by facing downstream** **(high and low gradient)**	More than 90% of the stream bank 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 stream bank 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 stream bank 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 stream bank surfaces covered by vegetation; disruption of stream bank 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

9a. Bank Vegetative Protection--High Gradient

Optimal and Poor Range Photos

9b. Bank Vegetative Protection--Low Gradient

Optimal and Poor Range Photos

10 RIPARIAN VEGETATIVE ZONE WIDTH

high and low gradient streams Measures the width of natural vegetation from the edge of the stream bank out through the riparian zone. The vegetative zone serves as a buffer to pollutants entering a stream from runoff, controls erosion, and provides habitat and nutrient input into the stream. A relatively undisturbed riparian zone supports a robust stream system; narrow riparian zones occur when roads, parking lots, fields, lawns, bare soil, rocks, or buildings are near the stream bank. Residential developments, urban centers, golf courses, and rangeland are the common causes of anthropogenic degradation of the riparian zone. Conversely, the presence of "old field" (i.e., a previously developed field not currently in use), paths, and walkways in an otherwise undisturbed riparian zone may be judged to be inconsequential to altering the riparian zone and may be given relatively high scores. For variable size streams, the specified width of a desirable riparian zone may also be variable and may be best determined by some multiple of stream width (e.g., 4 x wetted stream width). Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

Selected References Barton et al. 1985, Naiman et al. 1993, Hupp 1992, Gregory et al. 1991, Platts et al. 1983, Rankin 1991, Barbour and Stribling 1991, Bauer and Burton 1993.

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
10. Riparian Vegetative Zone Width (score each bank riparian zone) (high and low gradient)	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

10a. Riparian Vegetative Zone Width--High Gradient

Optimal and Poor Range Photos

10b. Riparian Vegetative Zone Width--Low Gradient

Optimal and Poor Range Photos

5.3 ADDITIONS OF QUANTITATIVE MEASURES TO THE HABITAT ASSESSMENT

Kaufmann (1993) identified 7 general physical habitat attributes important in influencing stream ecology. These include:

- channel dimensions
- channel gradient
- channel substrate size and type
- habitat complexity and cover
- riparian vegetation cover and structure
- anthropogenic alterations
- channel-riparian interaction.

All of these attributes vary naturally, as do biological characteristics; thus expectations differ even in the absence of anthropogenic disturbances. Within a given physiographic-climatic region, stream drainage area and overall stream gradient are likely to be strong natural determinants of many aspects of stream habitat, because of their influence on discharge, flood stage, and stream power (the product of discharge time's gradient). In addition, all of these attributes may be directly or indirectly altered by anthropogenic activities.

In Section 5.2, an approach is described whereby habitat quality is interpreted directly in the field by biologists while sampling the stream reach. This Level 1 approach is observational and requires only one person (although a team approach is recommended) and takes about 15 to 20 minutes per stream reach. This approach more quickly yields a habitat quality assessment. However, it depends upon the knowledge and experience of the field biologist to make the proper interpretation of observed of both the natural expectations (potentials) and the biological consequences (quality) that can be attributed to the observed physical attributes. Hannaford et al. (1997) found that training in habitat assessment was necessary to reduce the subjectivity in a visual-based approach. The authors also stated that training on different types of streams may be necessary to adequately prepare investigators.

The second conceptual approach described here confines observations to habitat characteristics themselves (whether they are quantitative or qualitative), then later ascribing quality scoring to these measurements as part of the data analysis process. Typically, this second type of habitat assessment approach employs more quantitative data collection, as exemplified by field methods described by Kaufmann and Robison (1997) for EMAP, Simonson et al. (1994), Meador et al. (1993) for NAWQA, and others cited by Gurtz and Muir (1994). These field approaches typically define a reach length proportional to stream width and employ transect measurements that are systematically spaced (Simonson et al. 1994, Kaufmann and Robison 1997) or spaced by judgment to be representative (Meador et al. 1993). They usually include measurement of substrate, channel and bank dimensions, riparian canopy cover, discharge, gradient, sinuosity, in-channel cover features, and counts of large woody debris and riparian human disturbances. They may employ systematic visual estimates of substrate embeddedness, fish cover features, habitat types, and riparian vegetation structure. The time commitment in the field to these more quantitative habitat assessment methods is usually 1.5 to 3 hours with a crew of two people. Because of the greater amount of data collected, they also require more time for data summarization, analysis, and interpretation. On the other hand, the more quantitative methods and less ambiguous field parameters result in considerably greater precision. The USEPA applied both quantitative and visual-based (RBPs) methods in a stream survey undertaken over 4 years in the mid-Atlantic region of the Appalachian Mountains. An earlier version of the RBP techniques were applied on 301 streams with repeat visits to 29 streams; signal-to-noise ratios varied from 0.1 to 3.0 for the twelve RBP metrics and averaged (1.1 for the RBP total habitat quality score). The quantitative methods produced a higher level of precision; signal-to-noise ratios were typically between 10 and 50, and sometimes in excess of 100 for quantitative measurements of channel morphology, substrate, and canopy densiometer measurements made on a random subset of 186 streams with 27 repeat visits in the same survey. Similarly, semi-quantitative estimates of fish cover and riparian human disturbance estimates obtained from multiple, systematic visual observations of otherwise measurable features had signal: noise ratios from 5 to 50. Many riparian vegetation cover and structure metrics were moderately precise (signal: noise ranging from 2 to 30). Commonly used flow dependent measures (e.g., riffle/pool and width/depth ratios), and some visual riparian cover estimates were less precise, with signal: noise ratios more in the range of those observed for metrics of the EPA's RBP habitat score (<2).

The US EPA's EMAP habitat assessment field methods are presented as an option for a second level (II) of habitat assessment. These methods have been applied in numerous streams throughout the Mid-Atlantic region, the Midwest, Colorado, California, and the Pacific Northwest. Table 5-1 is a summary of these field methods; more detail is presented in the field manual by Kaufmann and Robison (1997).

Table 5-1. Components of EMAP physical habitat protocol.

Component	Description
1. Thalweg Profile	Measure maximum depth, classify habitat, and determine presence of soft/small sediment at 10-15 equally spaced intervals between each of 11 channel cross-sections (100-150 along entire reach). Measure wetted width at 11 channel cross-sections and mid-way between cross-sections (21 measurements).
2. Woody Debris	Between each of the channel cross sections, tally large woody debris numbers within and above the bankfull channel according to size classes.
3. Channel and Riparian Cross-Sections	At 11 cross-section stations placed at equal intervals along reach length: • **Measure**: channel cross section dimensions, bank height, undercut, angle (with rod and clinometer); gradient (clinometer), sinuosity (compass backsite), riparian canopy cover (densiometer). • **Visually Estimate***: substrate size class and embeddedness; aerial cover class and type (e.g., woody) of riparian vegetation in Canopy, Mid-Layer and Ground Cover; aerial cover class of fish concealment features, aquatic macrophytes and filamentous algae. • **Observe & Record***: human disturbances and their proximity to the channel.
4. Discharge	In medium and large streams (defines later) measure water depth and velocity @ 0.6 depth (with electromagnetic or impeller-type flow meter) at 15 to 20 equally spaced intervals across one carefully chosen channel cross-section. In very small streams, measure discharge with a portable weir or time the filling of a bucket.

* Substrate size class and embeddedness are estimated, and depth is measured for 55 particles taken at 5 equally-spaced points on each of 11 cross-sections. The cross-section is defined by laying the surveyor's rod or tape to span the wetted channel. Woody debris is tallied over the distance between each cross-section and the next cross-section upstream. Riparian vegetation and human disturbances are observed 5 m upstream and 5 m downstream from the cross section station. They extend shoreward 10 m from left and right banks. Fish cover types, aquatic macrophytes, and algae are observed within channel 5 m upstream and 5 m downstream from the cross section stations. These boundaries for visual observations are estimated by eye.

Table 5-2 lists the physical habitat metrics that can be derived from applying these field methods. Once these habitat metrics are calculated from the available physical habitat data, an assessment would be obtained from comparing these metric values to those of known reference sites. A strong deviation from the reference expectations would indicate a habitat alteration of the particular parameter. The close connectivity of the various attributes would most likely result in an impact on multiple metrics if habitat alteration was occurring. The actual process for interpreting a habitat assessment using this approach is still under development.

Table 5-2. Example of habitat metrics that can be calculated from the EMAP physical habitat data.

Channel mean width and depth Channel volume and Residual Pool volume Mean channel slope and sinuosity Channel incision, bankfull dimensions, and bank characteristics Substrate mean diameter, % fines, % embeddedness Substrate stability Fish concealment features (aerial cover of various types, e.g., undercut banks, brush) Large woody debris (volume and number of pieces per 100 m) Channel habitat types (e.g., % of reach composed of pools, riffles, etc.) Canopy cover Riparian vegetation structure and complexity

Riparian Assessment Instructions

General Information for Riparian Assessment
***** for complete document go to http://www.dickinson.edu/allarm/scca/studentprojects/riparianprotocol.pdf *****
Introduction

This riparian assessment was created for use by volunteer monitors to locate and compare
riparian zones in need of restoration. This assessment was developed to be used with little to no training or experience in these types of field assessments. The only equipment needed to use this assessment is a map of the watershed, tape measure and the assessment form. This is a nontechnical assessment and should not be used to prove that one site is of exceptional quality versus one site is of very poor quality. It should only give a relative comparison between the sites. It is very easy to over quantify these measures but remember many of the parameters are estimates, not exact data. There may be little or no difference between a site with a rating of 30 versus a site with a rating of 25.

It is hard to compare buffers within different land uses, but this assessment can be used in
all land uses. A buffer within an agricultural area has many different needs and functions than one within a forested area. When there is a substantial change to land use another assessment should be done for that area. Averages should not be taken between very different buffers even if they are on the same stream. When looking at a buffer a fifty to one hundred foot length of stream should be assessed.

Technical Information:

1. Riparian Width
This is a rough measurement of the width of the riparian buffer; this can be directly
measured or estimated. Only include areas uncultivated by humans, do not include mowed lawns or agricultural fields. Though vegetated, these areas may have substantial negative impacts on both the riparian area and the stream. While doing this assessment, remember that the left bank should be distinguished from the right bank while facing downstream.

2. Riparian Density
This a measurement of the density of ground cover associated with the riparian vegetation. Remember that mowed grass or agricultural fields directly adjacent to the stream are not taken into account, even if these areas are very thick in vegetation; include only areas already designated as the buffer. A good way to look at this is to estimate the amount of soil covered by vegetation at a height of one inch above the ground.

3. Riparian Zonation
This is a measurement of the three designated zones of a riparian buffer. It is possible
that a forested area reaches beyond the watershed without the presence of grassy or shrubby areas. Since forested areas are the best known buffer this is not a problem but a substantial indicator of a healthy buffer. These areas should be given the highest ratings. Areas missing only Zone 3 should be rated higher than if either of the other zones were not present.
4. Bank Stability
Pictures taken from EPA Habitat Assessment and Physicochemical Parameters
60 — 100 Percent affected <5 Percent affected
Symptoms of poor bank stability include bank failure due to eroding or collapsing banks and noticeable lack of vegetation. Stable banks show no or little sign of collapsing, often have substantial vegetation and have the ability to limit lateral movement of the channel. While doing this assessment remember that the left bank should be distinguished from the right bank while facing downstream.

5. Sedimentation
Pictures taken from EPA Habitat Assessment and Physicochemical Parameters
>50 Percent of bottom affected <5 Percent of bottom affected
Sedimentation occurs when larger particles settle in slower moving sections of the stream. Over time these particles can accumulate to form point bars and islands.

6. Embeddedness
Pictures taken from EPA Habitat Assessment and Physicochemical Parameters
Embedded Not Embedded
This measures the rate at which sediment accumulates over the entire stream bottom. Because larger particles tend to rise to the top, having a large amount of small particles over large particles indicates rapid sediment deposition. Picture a box of cereal, the larger pieces of cereal are on top of the crumbs, if you were to pour crumbs over the top of the cereal eventually the larger particles would be on the top.

7. Shading
One of the substantial effects of a riparian buffer is to shade the stream during hot periods of the year. This helps to keep the water at a cooler temperature which increases the capacity of the water to hold dissolved oxygen, making better habitat for species. Shading can vary during different periods of the day and the year. When doing an estimate of shading always think about summer vegetation and take into account different angles of the sun. At certain times of the day the sun can have a greater impact than others.

8. Percent Invasive Species
Compare invasive species to other native species and define if they are relatively common or rare in the riparian area. A short list of common Pennsylvania invasive plants is also included. Many of these plants are listed as PA Noxious Weeds.

Glossary:

Best Management Practices — Methods, measures or practices to prevent or reduce water pollution, including but limited to, structural and non-structural controls, operation and maintenance procedures, and other requirements and scheduling and distribution of activities.
This can include, but is not limited to, stream fencing to prevent animals from being in the stream, no till practices, organic farming and intercropping.

Canopy — The top most layer of a forest formed by mature trees.

Embeddedness — The extent to which gravel, cobble and boulders are sunken into the silt, sand or mud of the stream bottom.

Invasive Species — Organisms that are not native to a given location and can cause problems, which may include a decrease in biodiversity.

Point Bars — Accumulation of sediment formed behind obstructions in the stream. These areas often appear as islands and cause streams to split.

Riffle Zone — Shallow section of stream or river with rapid current and a surface broken by gravel, rubble or boulders.

Riparian Zone — The area directly adjacent to a body of water that provides a transition between aquatic and upland environments. This area is often referred to as a Riparian Buffer, which can include several types of vegetation from grasses to old growth trees.

Sediment — Small particles of weathered rock, soil, organic materials, etc. that can be carried and suspended by runoff or streams.

Stream bank - The portion of the stream cross-section which restricts lateral movement, where the water meets the land.

Stream Channel — The course that water follows while moving downstream, this includes the stream banks and stream bottom.

Stream Order — Helps to give scientist a relative measure of stream size at certain points within a watershed and also may determine species living at that point.
Streams in headwaters without tributaries are designated first order streams. When two first orders streams come together it is then a second order stream. If a first and second order stream combine it is still only a second order stream. Streams must be of the same order when combining to obtain the next larger order.

Instructions for Riparian Buffer Assessment

1. Riparian Width:

This is a measure of the Riparian Zone measured from the edge of the stream channel to the first disturbance. Some examples of disturbances are: Pavement, buildings, agricultural lands or lawn using fertilizers and pesticides, cow pasture, ect.

2. Riparian Density:
This is an estimate of the percent ground cover of riparian vegetation. This is only the percent of ground cover and does not include the canopy.

3. Riparian Zonation:
A three-zone system has been developed to aid in riparian planning which involves the following areas: Zone 1 — Undisturbed Forest, Zone 2 — Managed Forest, Zone 3 — Grass Filter Strip. These zones allow for maximum filtration and effectiveness of the riparian buffer.

Zone 1 is nearest to the stream, its primary purpose is to stabilize the banks and provide aquatic habitat in the way of fallen logs and other debris. This area also serves for shade and is normally best when it has large canopy trees. This area is often missing from Agricultural areas.

Zone 2 is the middle segment that contains a managed forest, which may be harvested, and shrubby vegetation. This area is very important because it is said to remove 50-80% of pollutants. The width of this zone can vary due to and depending on land use and needs of landowners.

Zone 3 is the last segment of the riparian area and is farthest away from the stream. This area is the first line of defense against pollutants and often contains a thick, stiff grass filter area that slows runoff and removes the majority of sediment loads.
(DEP Stream ReLeaf Technical Training Manual)

4. Bank Stability:
This is a measure of the erosion and potential for erosion of the stream bank. Eroded, steep and undercut banks are more likely to collapse and cause sedimentation of the stream.

<5% of bank affected: Rate at this level if bank shows minimal or absence of bank failure and erosion; little chance of future problems; less than 5% affected.

5-30% of bank affected: Rate at this level if small infrequent areas are noticeably eroded or unstable affecting 5-30% of the bank. These areas may be healed over.

30-60% of bank affected: Rate at this level if banks are moderately unstable and 30-60% has noticeable areas of erosion.

60-100% of bank affected: Rate at this level if banks are severely unstable and raw areas are frequent with erosion scars affecting 60-100% of bank.

5. Sedimentation:
This is a measure of sediment accumulating in pools and changes in the stream bottom that may cause formation of islands or point bars.

<5% of bottom affected: Rate at this level if less than 5% of the bottom is affected by sedimentation with very little enlargement of point bars and islands.

5-30% of bottom affected: Rate at this level if 5-30% of bottom is affected and only noticeable enlargement of bars is from fine sediment and gravel.
30-50% of bottom affected: Rate at this level if 30-50% of bottom is affected with moderate deposition of gravel and fine sediment on old and new bars. Moderate deposition of pools frequent and noticeable sedimentation occurring at obstructions, bridges and bends.

>50% of bottom affected: Rate at this level if >50% of bottom is affected with heavy deposits of fine material and there is highly increased bar development. Pools are almost absent due to substantial deposition.

6. Embeddedness:
This parameter refers to the extent to which gravel, cobble and boulders are sunken into the silt, sand or mud of the stream bottom. To measure this simply lift several rocks (approximately 10) from the stream bottom at the cross-section of a riffle zone and measure the percent that was covered by sediment. There should be a noticeable line where the rock begins to be exposed to the flow of water, take an average of these percentages.

7. Shading (Percent of stream shaded by vegetation):
Determine what percent of the stream that riparian vegetation around it shades. Estimate summer vegetation if this is being done in the winter or fall. This includes vegetation that is not very far above the water and may be growing low on the banks or in the stream itself.

8. Invasive Species:
Invasive species tend to disrupt diversity and disrupt the health of the buffer. Estimate the percent of invasive species present compared to native species.

Riparian Buffer Assessment
Your Name: ______________________________
Stream Name: ______________________________
County: ________________________________
Latitude: ___________ Longitude: ___________ Order: _______
Width: ____________ Depth: ______________
Surrounding Land Use: __________________________
Best Management Practices in Use: ____
____
Sketch:

Additional Comments: ____
____
____

1. Riparian Width (in feet):
Left Bank:

>50	*49-40*	*39-30*	*29-20*	*19-10*	*9-0*
5	4	3	2	1	0

Right Bank:

>50	*49-40*	*39-30*	*29-20*	*19-10*	*9-0*
5	4	3	2	1	0

2. Riparian Density (Percent Cover):

100-80	*79-60*	*59-40*	*39-20*	*19-0*
5	4	3	2	1

3. Riparian Zonation (Presence of 3 Zones):
All 3 are present 2 of 3 are present 1 of 3 are present 0 of 3 are present
5 4 3 2 1

4. Bank Stability:

Left Bank

<5% bank affected ***5-30% affected*** ***30-60% affected*** ***60-100% affected***

5 4 3 2 1

Right Bank

<5% bank affected ***5-30% affected*** ***30-60% affected*** ***60-100% affected***

5 4 3 2 1

5. Sedimentation:

<5% of bottom affected ***5-30% affected*** ***30-50% affected*** ***>50% affected***

5 4 3 2 1

6. Embeddedness:

<25% cobble surrounded ***25-50% surrounded*** ***50-75% surrounded*** ***>75% surrounded***

5 4 3 2 1

7. Shading:

Complete Adequate Marginal Poor None

5 4 3 2 1

8. Invasive Species

Absent Extremely Rare Somewhat Common

5 4 3 2 1

Total Score:_______________

Works Used:

Applied Vegetation Dynamics Laboratory, School of Biological Sciences, GIANT HOGWEED. <http://www.appliedvegetationdynamics.co.uk/hogweed/>
Invasive Exotic Species, Japanese Honeysuckle <http://www.invasive.org/weeds/JH.html>
National Park Service <http://www.nps.gov>
Pennsylvania DCNR. Invasive Plants in Pennsylvania (Pamphlet). (2000)
Phragmites australis: The Common Reed <http://omega.cc.umb.edu/~conne/leslie/lesliepage.htm>
Purdue University: School of Veterinary Medicine, Johnsongrass. <http://www.vet.purdue.edu/depts/addl/toxic/plant43.htm>
Samuel Roberts Noble Foundation, Common Reed. <http://www.noble.org/imagegallery/grass html/CommonReed.htm>
Schnier, Melissa. Riparian Area Assessment. Penn State University
Stream ReLeaf Technical Training Manual 2001. Contributing organizations include Pennsylvania DEP, Pennsylvania DCNR, NRCS, York County Conservation District Organized by Pennsylvania DEP Bureau of Watershed Management
United States EPA. Rapid Bioassessment Protocol: Habitat Assessment and Physicochemical Parameters . http://www.epa.gov/owow/monitoring/rbp/ch05b.html

Riparian Area Assessment
Data Sheets

Assessment number ______ of ______ for this site

Riparian Area Assessment Data Sheet

Site____ Site ID________________

Stream name____________________________________ County________________

Date__________ Time __________ Water stage conditions______________________

Volunteer names____

Location in the watershed: Headwaters ________ Middle ________ Downstream ________

Distances reported are: (circle one) measured (tape) measured (range finder) estimated

Length of segment assessed______________yards

Stream width: Upstream ___________ Midpoint ___________ Downstream ___________

GPS coordinates (D,M,S): Upstream latitude ___________ Upstream longitude ___________

Downstream latitude ___________ Downstream longitude ___________

If GPS is not available and the site was drawn on a map, please check here ____ and include map

---

Assess both sides **only if the stream is **less** than 100 yards wide!**

Riparian Area

1. Riparian Buffer Width
Score: Left Bank _______ Right Bank _______

Comments:

2. Riparian Vegetation Type
Score: Left Bank _______ Right Bank _______

Comments:

3. Riparian Vegetation Thickness
Score: Left Bank _______ Right Bank _______

Comments:

Bank

4. Bank Vegetation Type
Score: Left Bank _______ Right Bank _______
Comments:

5. Bank Vegetation Thickness
Score: Left Bank _______ Right Bank _______
Comments:

6. Bank Stability
Score: Left Bank _______ Right Bank _______
Comments:

7. Water Pathways
Score: Left Bank _______ Right Bank _______
Comments:

Channel

8. Channel Modification
Score: _______
Comments:

Assess parameters 9-12 **only if the stream is **less** than 100 yards wide!

9. Shading (Canopy Cover)
Score: _______
Comments:

10. In-stream Cover
Score: _______
Comments:

11. Embeddedness (measure in a riffle)
Score: _______
Comments:

12. Aquatic Vegetation
Score: _______
Comments:

The following questions are simply fill-in-the-blank, and do not need to be rated.

Dominant Land Use Outside the Buffer (check only one)

Urban _______
Row-crop agriculture _______
Lawn (residential) _______
Pasture _______
Forest _______

Substrate Classification

Class	Description	Percentage (should total 100%)
Bedrock	Bigger than a car	
Boulder	Basketball to car	
Cobble	Tennisball to basketball	
Coarse Gravel	Marble to tennisball	
Fine Gravel	Ladybug to marble	
Sand	Gritty between fingers	
Fines	Smooth, not gritty	

Site name ______________________

Livestock Use (check one)
Livestock have direct access to stream and heavy use is apparent ______
Livestock are not fenced from stream but heavy use not apparent ______
Livestock present in area but fenced from the stream ______
Not applicable, livestock not present ______

Drain Pipes
Are contributing (as opposed to withdrawing) drainpipes present in the stream? ______ If so, how many? ______

Overall, how would you rate this site? (circle one)

Poor   Marginal   Good   Excellent

Suggestions for improvement of site____
____
____
____

Please draw a simple sketch of the area assessed:

Please give a brief description of the site and decribe PFBC land boundaries:____________
____
____
____

Any additional comments: ____

____

____

____

Scoring of Riparian Assessment

1. Total all of the scores given for parameters 1-12 ________

2. Total number of parameters scored (count 2 if both right and left bank were scored) ________

3. Multiply question 2 by 10 to get the total number of points possible _______

4. Divide your total score for question 1 by your total points possible from question 3 ________

This number is your overall score for the riparian area.

Results:

Score	0-25%	26-55%	56-85%	85-100%
Riparian Rating	Poor	Marginal	Good	Excellent

When comparing sites or when using this assessment for management purposes, remember that it may be helpful to look at the scores for individual parameters as well as the overall score.

Comments on riparian scoring____

____

____

____

____

____

Thank you for helping assess this riparian area! Please return this data sheet to your service provider, or mail it to me directly. Sincerely, Melissa Schnier

Melissa Schnier, 111 Ferguson Bldg., Penn State University, University Park, PA 16802
Phone: (814) 865-1441 email: mzs108@psu.edu