A STREAM VISUAL ASSESSMENT PROTOCOL (SVAP) FOR RIPARIAN LANDOWNERS

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Abstract. A user-friendly Stream Visual Assessment Protocol (SVAP) was recently developed in a joint effort by the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture and the University of Georgia. SVAP was designed to be an introductory screening–level assessment method for people unfamiliar with stream assessments. It was designed for use by NRCS field staff who work with agricultural landowners. NRCS is in a key position to influence conservation practices since the organization works with private stakeholders, maintaining more than 2000 field offices throughout the U.S. with a central office in each state. The SVAP measures a maximum of 15 elements and is based on visual inspection of the physical and biological characteristics of instream and riparian environments. Each element is assigned a numerical score relative to reference conditions and an overall score for the stream reach is calculated. A qualitative description of the stream reach is made based on overall numerical score. While SVAP is not intended to replace more robust stream assessment protocols, it provides quick and reliable information for use in NRCS farm assistance programs. It is also an educational tool through which landowners can learn about conservation of aquatic resources. An abridged copy of SVAP is attached as an appendix to this article and the complete document can be found on the web at http://www.ncg.nrcs.usda.gov/tech_notes.html.

Keywords: screening, stream assessment protocol, SVAP, water quality

1. Introduction

Stream assessments are carried out for many different reasons including: (1) detection of changes in stream conditions following a disturbance (natural or anthropogenic) or project implementation (e.g., Best Management Plans); (2) characterization of stream conditions for resource utilization (e.g., impoundments); (3) development of status reports as part of resource inventories, and (4) establishment of reference sites (USEPA, 1996; Yoder, 1995). Assessments provide a ‘score’ on environmental conditions of streams. Additionally, assessments may also provide diagnostic information helpful in identifying sources and causes of stream degradation.

There are many government and voluntary stream assessment and monitoring programs in the U.S.. Information resulting from these programs is used in land management, stream protection and restoration activities. There has been signific-

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ant development in stream assessment methodology over the past 20 yr, and the recent trend has been to move away from strictly quantitative approaches toward qualitative evaluations (Resh, 1991). Traditional biological assessment methods that incorporate in-depth sampling and analysis of numerous metrics have been replaced, in part, by rapid assessment protocols (Taylor, 1997; Resh *et al*., 1995; Resh and Jackson, 1993). These procedures have become very popular (Taylor, 1997) and are widely used by state and federal agencies in the U.S. (Plafkin *et al*., 1989; Barbour *et al*., 1992, 1996; Resh *et al*., 1995) and in other parts of the world (Wright *et al*., 1988; Chessman, 1995; Gowns *et al*., 1995). Despite criticisms of their effectiveness (Taylor, 1997), they provide useful information for many agencies and institutions. However, many of these protocols are region specific and/or require more resources (money, personnel, time, equipment) than are routinely available; consequently, the number of stream assessments conducted is severely limited.

Moreover, simple user-friendly stream assessment protocols have not been available to riparian landholders so that they can assess the environmental status of streams that drain their lands. This is unfortunate given that private lands constitute more than 70% of the entire landmass of the conterminous U.S. and Hawaii (NRCS, 1996). Low-order streams draining private lands represent a disproportionately large share of the fluvial system. Small, first- and second- order streams constitute almost 95% of all identified streams and rivers in the U.S. and account for about 75% of their collective length of 3.2 million miles (Leopold *et al*., 1964). However, sampling points for many of the monitoring and assessment programs (e.g., the U.S. Geological Survey's National Water Quality Assessment Program and Hydrologic Benchmark Network) are generally located on larger streams in order to broadly represent many of the cultural factors influencing water quality (USGS, 1996). Consequently, low-order streams are not included in routine assessments or monitoring programs. Additionally, stream assessments and long-term monitoring programs have been limited to a relatively few representative sites nationally because of budgetary, personnel, and other resource constraints. While these programs monitor many water quality constituents (e.g., fecal coliform, dissolved oxygen, biological oxygen demand, heavy metals, toxins) in large streams, there are few programs which assess ecological conditions of low-order streams. Nevertheless, the influence of these low-order streams on health and integrity of the entire aquatic ecosystem is well known (Burt, 1992).

The goal of this article is to introduce a simple and user-friendly stream assessment tool developed for riparian landowners to assess the environmental status of low-order streams draining their land. This Stream Visual Assessment Protocol (SVAP) was developed by the NRCS (NRCS, 1998a). We will discuss technical aspects of the protocol and identify applications for its use.

2. Development of the SVAP: Background Information

NRCS, a non-regulatory agency of the U.S. Department of Agriculture, is the successor to the Soil Conservation Service (SCS). Formed in 1935 to help the nation's farmers and ranchers implement more efficient and environmentally sound agricultural practices, the initial focus of the SCS was addressing soil erosion problems of crisis proportions. The current NRCS mandate has expanded to include all natural resource concerns on private lands (NRCS, 1996).

NRCS is in a key position to influence conservation practices over a large part of the U.S. It works extensively with agricultural producers and local communities and maintains a central office in each state and more than 2000 field offices (NRCS, 1996). Additionally, it has more than 60 yr of direct field experience working with landowners in a wide variety of environments.

A 1996 survey of NRCS state biologists indicated that less than a third of the state units were active in supporting stream assessments within their states. Most respondents said they would like their field staff to be more active in stream assessments and requested additional support from the NRCS national office. In response, an NRCS Aquatic Assessment Workgroup was formed. Workgroup members identified the need for a simple assessment protocol that could be used as a programmatic and educational tool. Development of the *Stream Visual Assessment Protocol* (SVAP) began in 1997 as a joint effort of the NRCS National Water and Climate Center, seven State NRCS offices, three NRCS Institutes, the US Environmental Protection Agency, and the University of Georgia. After field testing, it was issued in December 1998 (NRCS, 1998a). The SVAP is an introductory screening-level assessment method for people who are unfamiliar with stream assessments. It is not intended to replace more robust protocols. The protocol was developed as a tool to qualitatively characterize stream ecological condition and to help facilitate the work of NRCS personnel who work with riparian landowners. Participation by the landowner in making assessments is encouraged. By participating, the landowner learns about stream processes, signs of impairment, and effects of land use activities on ecological health and integrity[1]. The primary uses of SVAP by NRCS field staff include: 1) inventory and analysis steps in developing a conservation plan; 2) priority setting; and 3) pre- and post-assessments to evaluate the effectiveness of cost-share contracts and conservation plans.

[1] Ecological integrity implies the capacity to support and maintain a balanced, adaptive system (Karr, 1996) whereas ecological health also includes the notion of what society values in the ecosystem (Meyer, 1997).

TABLE I
Stream characteristics considered by SVAP

For all streams	For streams only where applicable
Channel condition	Canopy cover
Hydrologic condition	Manure presence
Riparian zone	Salinity
Bank stability	Riffle embeddedness
Water appearance	Macroinvertebrates
Nutrient enrichment	
Barriers to fish movement	
Instream fish cover	
Pools	
Invertebrate habitat	

3. Technical Aspects of SVAP

The SVAP is designed to be a basic assessment guide for non-scientists. It is a ‘first-tier’ assessment in a multi-tiered assessment framework. It is not intended to replace a biological survey or habitat inventory.

The SVAP was developed by drawing on existing visually-based assessment procedures (e.g., Georgia DNR, 1996; USEPA, 1997a, b). It is based on visual inspection of the physical and biological characteristics of instream and riparian environments and entails evaluation of up to 15 stream and riparian elements (Table I). Only those elements that are applicable for a given stream reach are evaluated. The user matches observed conditions to 4 or 5 narrative descriptions provided in the assessment protocol (see Appendix 1). A scoring sheet is used to record evaluations and other site descriptors. A score is assigned to each element based on the narrative descriptions. With the exception of the macroinvertebrate component, each element is rated from 1 to 10; the range of values for the macroinvertebrate element is –3 to 15. Highest scores represent a close match with reference site conditions and low scores represent a poor match. The overall score is the mean of the individual element scores. A qualitative description of ‘excellent’, ‘good’, ‘fair’ and ‘poor’ for each stream reach is assigned based on the overall numerical score. A copy of SVAP is included with this article as Appendix 1.

TABLE II

Summary of field study trials (Note FO refers to 'field office')

Location	No. of sites	No. of replicates	Assessment protocol that SVAP was compared to	Reference	SVAP conducted by	Source of data
CO	1	3	Professional judgment	–	FO personnel	T. Skadeland, NRCS, CO, pers. comm.
GA	9	4–5	Macroinvertebrates, EPT	a,b	FO personnel	S. Davis, Univ. of Georgia, pers. comm.
GA	1	12	Macroinvertebrates	a	FO personnel	L. Justice, NRCS, GA, pers. comm.
GA	1	None	Mussel taxa	c	FO personnel	J. Brim Box, USGS, UT, pers. comm.
GA	10	None	None	–	Engineer	R. Fuller, Univ. of Georgia, pers. comm.
MI	5	None	Professional judgment	–	State biologist	L. Sampson, NRCS, MI, pers. comm.
MI	24	2	GLEAS procedure # 51	d	Students	J. Lessard, Michigan State University, pers. comm.
NJ	3	3, 5, 8	NJIS rating	e	FO personnel	T. Dunne, NRCS, NJ, pers. comm.
NC/SC	90	None	IBI, EPT	f,b	Soil scientist	B. McQuaid, NRCS, NC, pers. comm.
OR	3	None	IBI	f	Scientist	B. Newton, NRCS, OR, pers. comm.
OR	2	3	None	–	FO personnel	B. Newton, NRCS, OR, pers. comm.
VA	56	3	IBI (fish), Ohio QHEI	f,g	FO personnel	B. Teels, NRCS, VA, pers. comm.
WA	3	None	Professional judgment	–	State biologist	B. Streif, NRCS, OR, pers. comm.

[a] Macroinvertebrates, Kellogg, L., 1992.
[b] EPT (Ephemeroptera, Plecoptera, Trichoptera). Plafkin, J. *et al*., 1989.
[c] Mussel taxa, Brim Box and Williams (in press).
[d] GLEAS Procedure # 51 (Great Lakes and Environmental Assessment Section), Michigan Dept. of Environmental Quality, 1997.
[e] NJIS (New Jersey Impairment Score), Kurtenbach, J., 1991.
[f] IBI (Index of Biological Integrity), Karr, J. *et al*., 1986.
[g] QHEI (Quality Habitat Evaluation Index), Rankin, E., 1989.

TABLE III

Summary table of agreement between SVAP and other assessment procedure scores (See Table II for references of the assessment protocols that SVAP was compared to)

Location	No. sites	Assessment protocol that SVAP was compared to	SVAP score[a]	Other procedure score	Correlation coefficient	Procedure conformity
GA	1	Mussel taxa	Good	Good-excellent	na.[b]	Good
GA	9	EPT	na.	na.	0.82	Good
GA	9	Chemicals[c]	na.	na.	0.42–0.05	Poor
MI	11	MIDEQ	na.	na.	na.	Poor
NJ	2	NJIS (macro)	Poor	Moderately impaired	na.	Good
NJ	1	NJIS (macro)	Poor	Not impaired	na.	Poor
NC/SC	90	IBI (macro)	na.	na.	0.19	Poor
NC/SC	90	EPT	na.	na.	0.25	Poor
OR	1	IBI (fish)	Poor	Poor	na.	Good
OR	1	IBI (fish)	Poor	Poor	na.	Good
OR	1	IBI (fish)	Fair	Good	na.	Fair
VA	56	IBI (fish)	na.	na.	0.63	Good
VA	56	Ohio QHEI	na.	na.	0.91	Good

[a] SVAP scores are overall average scores for stream reach.
[b] na. = Not applicable.
[c] Chemicals tested include NH_4-N, NO_3-N and PO_4-P.

4. Evaluation of SVAP

The SVAP has been extensively reviewed and tested in the field. All state NRCS offices were sent draft copies of the SVAP and asked to comment on the protocol. Ten states and the Bureau of Land Management responded. All comments were supportive and they were incorporated into the final version. Field tests to evaluate accuracy, precision, utility and ease of use involved more than 200 sites in the U.S. and 70 individuals (Table II). Sites included: low and high gradient, warm and cold water, perennial and annual streams. NRCS staff, other agency personnel and student volunteers conducted the testing. The majority of participants had little or no training or experience with aquatic resource assessment procedures.

In order to determine accuracy of the protocol, we compared stream assessment ratings from the SVAP with results obtained using other assessment procedures. These included macroinvertebrate indices, fish indices, and other protocols and procedures (e.g., the Ohio Quality Habitat Evaluation Index (QHEI) (Rankinx, 1989), the New Jersey Impairment Score (NJIS) (Kurtenbach, 1991) and the Michigan Great Lakes Environmental Assessment Section (GLEAS) Procedure #51 (Michigan Dept. of Environmental Quality, 1997)), chemical tests, and professional judgment. Table III, which summarizes test results, shows a range of comparison values between SVAP and other assessment procedures. Comparisons were based on the overall numerical index rating or the qualitative description for a stream reach rather than on individual assessment elements. Factors that explain differences in assessment values or scores include: 1) variability in the participant's level of training and experience in stream assessments; 2) use of different drafts of the protocol during field testing; and 3) regional differences in stream types. Lack of training or unfamiliarity with the SVAP protocol generally resulted in higher scores for the SVAP elements. This observation is in keeping with other studies of assessment protocols, especially those based on visual cues (Resh *et al.*, 1995). The narrative scoring descriptions were less clear in earlier SVAP drafts than in later versions and contributed to misinterpretation and/or confusion when elements were scored. Notwithstanding scoring differences, results show that SVAP provided a 'reasonably good' characterization of stream ecological conditions.

Precision was determined by comparing stream assessment results obtained by trained individuals who independently assessed the same stream reach. There was only one test case where there were adequate replicates to provide statistically significant results: eleven replicates were compared at a test site in Americus, Georgia. The coefficient of variation was 8.8% for the overall stream score. The largest standard deviations were reported for the hydrologic alteration (2.3), canopy cover (2.4) and observed macroinvertebrate (2.8) elements while the mean standard deviation was 0.5.

5. Application of SVAP

The 1996 Farm Bill incorporates a number of incentive-oriented conservation programs such as the Environmental Quality Incentives Program, the Wildlife Habitat Incentives Program and the Wetlands Reserve Program (NRCS, 1996). These programs are targeted for privately held lands and offer technical and cost-sharing assistance to improve the health and integrity of streams and rivers. The SVAP can be used as a tool to assess stream conditions during the development and implementation phases of these programs. The protocol has also been introduced to other government agencies (e.g., USEPA, U.S. Forest Service, State Environmental Protection and Forestry Units), non-governmental organizations such as volunteer stream monitoring groups (e.g., Adopt-a-Stream) and private environmental businesses (e.g., environmental restoration and engineering businesses) through presentations and field demonstrations. Additionally, with minimal training, the landowner himself/herself can use SVAP to periodically check on changes in stream conditions.

Research shows that training improves the precision and accuracy results of visually-based protocols (Hannaford *et al.*, 1997; Diliey, 1992). Despite the user-friendly quality of SVAP, users should be trained in its use. Critical elements of training can include technical aspects of the SVAP, familiarization with the range of conditions within the study area, identification of reference site characteristics, and basic stream ecology. In order to facilitate training in the use of SVAP, we developed the *Introduction to Steam Ecological Assessment Course* (NRCS, 1998b). This multi-media training course covers an introduction to stream ecology, how to use the SVAP, more advanced assessment protocols, stream classification, reference site selection, and technical support for stream assessments. It also includes field exercises. Materials to conduct the training course were provided to each NRCS state office.

While the national version of SVAP may be used for a wide range of low-order stream types, it can be modified to better reflect local geographic and environmental conditions. Modifying the protocol may result in better precision and accuracy, easier use, and a rating scale that is calibrated to regional criteria for qualitative assessments. Modifications may be made to individual elements and their narrative descriptions and/or to the rating scale for assigning overall qualitative assessments of excellent, good, fair and poor. The simplest approach to modify the protocol is based on professional experience and the judgment of an interdisciplinary team and includes developing, testing and evaluating proposed revisions. A second, more scientifically rigorous approach is an iterative process and involves a series of eight sequential steps. These steps include developing a stream classification system, assessing a range of sites that represent a gradient of environmental conditions, and evaluating the responsiveness of the revised SVAP to a range of stream conditions. Guidance on refining the protocol is included in the complete SVAP document. Despite the benefits of a modified SVAP, substantial revisions may complicate comparisons of SVAP scores obtained using versions based on different criteria and descriptions.

6. Conclusions

Field trials have demonstrated that SVAP is an effective introductory screening-level assessment method of ecological and 'health' conditions on most types of wadeable, low-order streams. While certain parts of this protocol may need to be modified to 'fit' specific local conditions, it can be used as a template for a preliminary assessment of streams throughout the U.S. NRCS field offices are using this protocol while working with landowners to implement conservation and management plans. Additionally, SVAP is being used at long-term ecological research sites (e.g., Coweeta, North Carolina) and is being adapted for use on tropical streams in Beliz (P. Esselman, University of Georgia, *pers. comm.*) and Costa Rica (C. Charpertier, Universidad Nacional de Costa Rica, *pers. comm.*).

The SVAP is intended to be an introductory screening–level assessment method for people unfamiliar with stream assessments and not a replacement for more advanced assessment procedures when they are needed. However, it is a suitable tool for many of the initial stream assessments identified by NRCS, and it also serves as a ‘hands-on’ educational tool when working with the landowner. The principal strengths of SVAP include: 1) user-friendly; 2) low cost; 3) quick turn-around of results; 4) assessment information is easy to understand; 5) minimal training; and 6) procedure is environmentally benign. The complete 36 page NRCS Technical Note 99-1 (which includes the SVAP protocol, supporting documentation and background information) is on the NRCS website at http://www.ncg.nrcs.usda.gov/tech_notes.html. Please note the underscore between *tech* and *notes*.

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Appendix 1. Abridged version of SVAP

NRCS Stream Visual Assessment Protocol

Owner's Name ____________ Evaluator's Name ____________ Date ________

Stream Name ____________________ Waterbody ID Number ____________

Reach Location ____

____

Ecoregion ______________ Drainage Area ______________ Gradient ______

Applicable Reference Site ______________________________________

Land Use within Drainage (%): Row crop _____ Hayland _____ Grazing/pasture ______

Forest _______ Residential ______________

Confined Animal Feeding Operations ________ Cons. Reserve ______________

Industrial ________ Other ________

Weather Conditions – Today ______________ Past 2-5 Days ______________

Active Channel Width ______________________________________

Dominant Substrate: boulder _____ graven _____ sand _____ silt_____ mud ________

Site Diagram

Assessment Scores

Channel Condition	☐	Pools	☐
Hydrologic Alteration	☐	Invertebrate Habitat	☐
Riparian Zone	☐	*Score only if applicable*	
Bank Stability	☐	Canopy Cover	☐
Water Appearance	☐	Manure Presence	☐
Nutrient Enrichment	☐	Salinity	☐
Barriers to Fish Movement	☐	Riffle Embeddedness	☐
Instream Fish Cover	☐	Macroinvertebrates Observed (optional)	☐

Overall Score	< 6.0	POOR
(Total divided by number scored)	6.1–7.4	FAIR
______	7.5–8.9	GOOD
	> 9.0	EXCELLENT

Suspected Causes of Observed Problems ____

____

____

____

Recommendations ____

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Scoring Descriptions

Each assessment element is rated with a value of 1 to 10. Rate only those elements appropriate to the stream. Record the score that best fits the observations you make based on the narrative descriptions provided. Unless otherwise directed, assign the lowest score that applies. For example, if a reach has aspects of several narrative descriptions, assign a score based on the lowest scoring description that contains indicators present within the reach. You may record values intermediate to those listed. Some background information is provided for each assessment element, as well as a description of what to look for. The length of the assessment reach should be 12 times the active channel width.

Channel Condition

Natural channel; no structures, dikes. No evidence of downcutting or excessive lateral cutting.	Evidence of past channel alteration, but with significant recovery of channel and banks. Any dikes or levies are set back to provide access to an adequate floodplain.	Altered channel; <50% of the reach with riprap and/or channelization. Excess aggradation; braided channel. Dikes or levees restrict floodplain width.	Channel is actively downcutting or widening. >50% of the reach with riprap or channelization. Dikes or levees prevent access to the floodplain.
10	7	3	1

Stream meandering generally increases as the gradient of the surrounding valley decreases. Often, development in the area results in changes to this meandering pattern and the flow of a stream. These changes in turn may affect the way a stream naturally does its work, such as the transport of sediment and the development and maintenance of habitat for fish, aquatic insects, and aquatic plants. Some modifications to stream channels have more impact on stream health than others. For example, channelization and dams affect a stream more than the presence of pilings or other supports for road crossings.

Active downcutting and excessive lateral cutting are serious impairments to stream function. Both conditions are indicative of an unstable stream channel. Usually, this instability must be addressed before committing time and money toward improving other stream problems. For example, restoring the woody vegetation within the riparian zone becomes increasingly difficult when a channel is downcutting – banks continue to be undermined and the water table drops below the root zone of the plants during their growing season. In this situation, or when a channel is fairly stable but already incised from previous downcutting or mechanical dredging, it is usually necessary to plant upland, rather than hydrophytic, species and/or apply irrigation for several growing seasons. Extensive bank-armoring of channels to stop lateral cutting usually leads to more problems (especially downstream). Often stability can be obtained by using a series of structures (barbs, groins, jetties, deflectors, weirs, vortex weirs, etc.) that reduce water velocity, deflect currents, or act as gradient controls. These structures are used in conjunctions with large woody debris and woody vegetation plantings.

What to Look For

Signs of channelization or straightening of the stream may include an unnaturally straight section of the stream, high banks, dikes or berms, lack of flow diversity (e.g., few point bars and deep pools), and uniform-sized bed materials (e.g., all cobbles where there should be mixes of gravel and cobble). In newly channelized reaches, vegetation may be missing or appear very different (different species, not as well developed) from the bank vegetation of areas that were not channelized. Older channelized reaches may also little or no vegetation or have grasses instead of woody vegetation. Drop structures (such as check dams), irrigation diversions, culverts, bridge abutments, and riprap also indicate changes to the stream channel.

Indicators of downcutting in the stream channel include nickpoints associated with headcuts in the stream bottom and exposure of cultural features, such as pipelines that were initially buried under the stream. Exposed footings in bridges and culvert outlets that are higher than the water surface during low flows are other examples. A lack of sediment depositional features, such as regularly-spaced point bars, is normally an indicator of incision. A low vertical scarp at the toe of the stream bank may indicate downcutting, especially if the scarp occurs on the inside of a meander. Another visual indicator of current or past downcutting is high stream banks with woody vegetation growing well below the top of the bank (as a channel incises the bankfull flow line moves downward within the former bankfull channel). Excessive bank erosion is indicated by raw banks in areas of the stream where they are not normally found, such as straight sections between meanders or on the inside of curves.

Hydrologic Alteration

Flooding every 1.5–2 yr. No dams, no water withdrawals, no dikes or other structures limiting the stream's access to the floodplain. Channel is not incised.	Flooding occurs only once every 3–5 yr; limited channel incision, **or** Withdrawals, although present, do not affect available habitat for biota.	Flooding only once every 6–10 yr; channel deeply, **or** Withdrawals significantly affect available low flow habitat for biota.	No flooding; channel deeply incised or structures prevent access to floodplain or dam operations prevent flood flows, **or** Withdrawals have caused severe loss of low flow, **or** Flooding occurs on a 1-year rain event or less.
10	7	3	1

Bankfull flows, as well as flooding, are important to maintaining channel shape and function (e.g. sediment transport) and maintaining the physical habitat for animals and plants. High flows scour fine sediments to keep gravel areas clean for fish and other aquatic organisms. These flows also redistribute larger sediments such as gravel, cobbles, and boulders, as well as large woody debris, to form pool and riffle habitat important to stream biota. The river channel and floodplain exist in dynamic equilibrium, having evolved in the present climatic regime and geomorphic setting. The relationship of water and sediment is the basis for the dynamic equilibrium that maintains the form and function of the river channel. The energy of the river (water velocity and depth) should be in balance with the bedload (volume and particle size of the sediment). Any change in the flow regime alters this balance. If a river is not incised and has access to its flood plain, decreases in the frequency of bankfull and out-of-bank flows decrease the river's ability to transport sediment. This can result in excess sediment deposition, channel widening and 'shallowing', and, ultimately, in braiding of the channel. Rosgen (1996) defines braiding as a stream with three or more smaller channels. These smaller channels are extremely unstable, rarely have woody vegetation along their banks, and provide poor habitat for stream biota. A 'split channel', however, has two or more smaller channels (called side channels) which are usually very stable, with woody vegetation along their banks, and provide excellent habitat. Conversely, an increase in flood flows or the confinement of the river away from its floodplain (from either incision or levees) increases the energy available to transport sediment and can result in bank and channel erosion.

The low flow or baseflow during the dry periods of summer or fall usually comes from groundwater entering the stream through the stream banks and bottom. A decrease in the low-flow rate will result in a smaller portion of the channel suitable for aquatic organisms. The withdrawal of water from streams for irrigation or industry and the placement of dams often change the normal low-flow pattern. Baseflow can also be affected by management and land use within the watershed – less infiltration of precipitation reduces baseflow and increases the frequency and severity of high flow events. For example, urbanization increases runoff and can increase the frequency of flooding to every year or more often and also reduce low flows. Overgrazing and clearcutting can have similar, although typically less severe, effects. The last description in the last box refers to the increased flood frequency that occurs with the above watershed changes.

What to Look For

Ask the landowner about the frequency of flooding and about summer low-flow conditions. A floodplain should be inundated during flows that equal or exceed the 1.5–2.0-year flow event. Evidence of flooding includes high water marks (such as water lines), sediment deposits, or stream debris. Look for these on the banks, on the bankside trees or rocks, or on other structures (such as road pilings or culverts).

Excess sediment deposits and wide, shallow channels could indicate a loss of sediment transport capacity. The loss of transport capacity can result in a stream with three or more channels (braiding).

Riparian Zone

Natural vegetation extends at least two active channel widths on each side.	Natural vegetation extends one active channel width on each side, **or** If less than one width, covers entire flood plain.	Natural vegetation extends 1/2 of the active channel width on each side.	Natural vegetation extends 1/3 of active channel width on each side, **or** Filtering function moderately compromised.	Natural vegetation less than 1/3 of active channel width on each side, **or** Lack of regeneration, **or** Filtering function severely compromised.
10	8	5	3	1

This element is the width of the natural vegetation zone from the edge of the active channel out onto the floodplain. For this element, the word natural means plant communities with (1) all appropriate structural components and (2) species native to the site or introduced species that function similar to native species at reference sites.

A healthy riparian vegetation zone is the most important element for a healthy stream ecosystem. The quality of the riparian zone increases with the width and the complexity of the woody vegetation within it. This zone (1) reduces the amount of pollutants that reach the stream in surface runoff, (2) helps control erosion, (3) provides a micro-climate that is cooler during the summer providing cooler water for aquatic organisms, (4) provides large woody debris from fallen trees and limbs that form instream cover, create pools, stabilize the streambed, and provide habitat for stream biota, (5) provides fish habitat in the form of undercut banks with the ‘ceiling’ held together by roots of woody vegetation, (6) provides organic material for stream biota that, among other functions, is the base of the food chain in lower order streams, (7) provides habitat for terrestrial insects that drop in the stream and become food for fish and habitat and travel corridors for terrestrial animals,

(8) dissipates energy during flood events, and (9) often provides the only refuge areas for fish during out-of-bank flows (behind trees, stumps, and logs).

The type, timing, intensity, and extent of activity in riparian zones are critical in determining the impact on these areas. Narrow riparian zones and/or riparian zones that have roads, agricultural activities, residential or commercial structures, or significant areas of bare soils have reduced functional value for the stream. The filtering function of riparian zones can be compromised by concentrated flows. There should be no evidence of concentrated flows through the zone or, if there are concentrated flows, they should be from land areas appropriately buffered with vegetated strips.

What to Look For

Compare the width of the riparian zone to the active channel width. In steep, V-shaped valleys there may not be enough room for a floodplain riparian zone to extend as far as one or two active channel widths. In this case, observe how much of the floodplain is covered by riparian zone. The vegetation must be natural and consist of all of the structural components (aquatic plants, sedges/rushes, grasses, forbs, shrubs, understory trees, and overstory trees) appropriate for the area. A common problem is lack of shrubs and understory trees. Another common problem is lack of regeneration. The presence of only mature vegetation and few seedlings indicate lack of regeneration. Do not consider incomplete plant communities as natural. Healthy riparian zones on both sides of the stream are important for the health of the entire system. If one side is lacking the protective vegetative cover, the entire reach of the stream will be affected. In doing the assessment, be certain that you examine both sides of the stream and note on the diagram which side of the stream has problems. There should be no evidence of concentrated flows through the riparian zone that are not adequately buffered before entering the riparian zone.

Bank Stability

Banks are stable; banks are low (at elevation of active flood plain); 33% or more of eroding surface area of banks in outside bends is protected by roots that extend to the base-flow elevation.	Moderately stable; banks are low (at elevation of active flood plain); less than 33% of eroding surface area of banks in outside bends is protected by roots that extend to the base-flow elevation.	Moderately unstable; banks may be low, but typically are high (flooding occurs 1 yr out of 5 or less frequently); outside bends are actively eroding (overhanging vegetation at top of bank, some mature trees falling into stream annually, some slope failures apparent).	Unstable; banks may be low, but typically are high; some straight reaches and inside edges of bends are actively eroding as well as outside bends (overhanging vegetaion at top of bare bank, numerous mature trees falling into stream annually, numerous slope failures apparent).
10	7	3	1

This element is the existence of or the potential for detachment of soil from the upper and lower stream banks and its movement into the stream. Some bank erosion is normal in a healthy stream. Excessive bank erosion occurs where riparian zones are degraded or where the stream is unstable due to changes in hydrology, sediment load, or isolation from the flood plain. High and steep banks are more susceptible to erosion and collapse. All outside bends of streams erode, so even a stable stream may have 50% of its banks bare and eroding. A healthy riparian corridor with a vegetated flood plain contributes to bank stability. The roots of perennial grasses or woody vegetation typically extend to the baseflow elevation of water in streams that have bank heights of 6 feet or less. The root mass helps hold the bank soils together and physically protect the bank from scour during bankfull and flood events. Vegetation seldom becomes established below the elevation of the bankfull surface because of the frequency of inundation and the unstable bottom conditions as the stream moves its bedload.

The type of vegetation is important. For example, trees, shrubs, sedges, and rushes have the type of root masses capable of withstanding high streamflow events, while Kentucky bluegrass does not. Soil type at the surface and below the surface also influences bank stability. For example, banks with a thin soil cover over gravel or sand are more prone to collapse than are banks with a deep soil layer.

What to Look For

Signs of erosion include unvegetated stretches, exposed tree roots, or scalloped edges. Evidence of construction, vehicular, or animal paths near the banks or grazing areas that lead directly to the water's edge suggest conditions that may lead to the collapse of banks. Estimate the size or area of the bank affected relative to the total bank area. This element may be difficult to score during high water.

Water Appearance

Very clear, or clear but tea-colored; objects visible at depth 3–6 ft (less if slightly colored); no oil sheen or foaming on surface; no noticeable film on submerged objects or rocks.	Occasionally cloudy, especially after storm event, but clears rapidly; objects visible at depth 1.5–3 ft; may have slightly green color; no oil sheen on water surface.	Considerable cloudiness most of the time; objects visible to depth 0.5–1.5 ft; slow sections may appear pea-green; bottom rocks or submerged objects covered with heavy green or olive-green film, **or** Moderate odor of ammonia or rotten eggs.	Very turbid or muddy appearance most of the time; objects visible to depth <1/2 ft; slow moving water may be bright-green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface, **or** Strong odor of chemicals, oil, sewage, other pollutants
10	7	3	1

This element compares turbidity, color, and other visual characteristics with a healthy or reference stream. The depth to which an object can be clearly seen is a measure of turbidity. Turbidity is caused mostly by particles of soil and organic matter suspended in the water column. Water often shows some turbidity after a storm event because of soil and organic particles carried by runoff into the stream or suspended by turbulence. The water in some streams may be naturally tea-colored. This is particularly true in watersheds with extensive bog and wetland areas. Water that has slight nutrient enrichment may support communities of algae, which will provide a greenish color to the water. Streams with heavy loads of nutrients will have thick coatings of algae attached to the rocks and other submerged objects. In very degraded streams, floating algal mats, surface scum, or pollutants (such as dyes and oil) may be visible.

What to Look For

Clarity of the water is an obvious and easy feature to assess. The deeper an object in the water can be seen, the lower the amount of turbidity. Use the depth that objects are visible only if the stream is deep enough to evaluate turbidity using this approach. For example, if the water is clear but only 1 foot deep, do not rate it as if an object became obscured at a depth of 1 foot. This measure should be taken after a stream has had the opportunity to ‘settle down’ following a storm event. A pea-green color indicates nutrient enrichment beyond what the stream can naturally absorb.

Nutrient Enrichment

Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present.	Fairly clear or slightly greenish water color along entire reach; moderate algal growth on stream substrates.	Greenish water color along entire reach; overabundance of lush green macrophytes; abundant algal growth, especially during warmer months.	Pea green, gray, brown water along entire reach; dense stands of macrophytes clog stream; severe algal blooms create thick algal mats in stream.
10	7	3	1

Nutrient enrichment is often reflected by the types and amounts of aquatic vegetation in the water. High levels of nutrients (especially phosphorus and nitrogen) promote an over-abundance of algae and floating and rooted macrophytes. The presence of some aquatic vegetation is normal in streams. Algae and macrophytes provide habitat and food for all stream animals. However, an excessive amount of aquatic vegetation is not beneficial to most stream life. Plant respiration and decomposition of dead vegetation consume dissolved oxygen in the water. Lack of dissolved oxygen creates stress for all aquatic organisms and can cause fish kills. A landowner may have seen fish gulping for air at the water surface during warm weather indicating a lack of dissolved oxygen.

What to Look For

Some aquatic vegetation (rooted macrophytes, floating plants and algae attached to substrates) is normal and indicates a healthy stream. Excess nutrients cause excess growth of algae and macrophytes, which can create greenish color to the water. As nutrient loads increase the green becomes more intense and macrophytes become more lush and deep green. Intense algal blooms, thick mats of algae, or dense stands of macrophytes degrade water quality and habitat. Clear water and a diverse aquatic plant community without dense plant populations are optimal for this characteristic.

Barriers to Fish Movement

No barriers	Seasonal water withdrawals inhibit movement within the reach.	Drop structures, culverts, dams, or diversions (<1 foot drop) within the reach.	Drop structures, culverts, dams, or diversions (>1 foot drop) within 3 miles of the reach.	Drop structures, culverts, dams, or diversions (>1 foot drop) within the reach.
10	8	5	3	1

Barriers that block the movement of fish or other aquatic organisms, such as fresh water mussels, must be considered as part of the overall stream assessment. If sufficiently high, these barriers may prevent the movement or migration of fish, deny access to important breeding and foraging habitats, and isolate populations of fish and other aquatic animals.

What to Look For

Some barriers are natural, such as waterfalls and boulder dams, and some are developed by humans. Note the presence of such barriers along the reach of the stream you are assessing, their size, and whether provisions have been made for the passage of fish. Ask the landowner about any dams or other barriers that may be present 3 to 5 miles upstream or downstream. Larger dams are often noted on maps, so you may find some information even before going out into the field. Beaver dams generally do not prevent fish migration. Look for structures that may not involve a drop, but still present a hydraulic barrier. Single, large culverts with no slope and sufficient water depth usually do not constitute a barrier. Small culverts or culverts with slopes may cause high water velocities that prevent passage.

Instream Fish Cover

>7 cover types available	6 to 7 cover types available	4 to 5 cover types available	2 to 3 cover types available	None to 1 cover type available
10	8	5	3	1

Cover Types: Logs/large woody debris; deep pools; overhanging vegetation;

boulders/cobble; riffles; undercut banks; thick root mats; dense macrophyte beds;

isolated/backwater pools; other: ....

This assessment element measures availability of physical habitat for fish. The potential for the maintenance of a healthy fish community and its ability to recover from disturbance is dependent on the variety and abundance of suitable habitat and cover available.

What to Look For

Observe the number of different habitat and cover types *within a representative subsection of the assessment reach* that is equivalent in length to *five times* the active channel width. Each cover type must be present in appreciable amounts to score. Cover types are described below.

Logs/large woody debris – Fallen trees or parts of trees that provide structure and attachment for aquatic macroinvertebrates and hiding places for fish.

Deep pools – Areas characterized by a smooth undisturbed surface, generally slow current, and deep enough to provide protective cover for fish (75–100% deeper than the prevailing stream depth).

Overhanging vegetation – Trees, shrubs, vines, or perennial herbaceous vegetation that hangs immediately over the stream surface, providing shade and cover.

Boulders/cobble – Boulders are rounded stones over 10 inches in diameter or large ‘slabs’ more than 10 inches in length; cobbles are stones between 2.5 and 10 inches in diameter.

Undercut banks – Eroded areas extending horizontally beneath the surface of the bank forming underwater pockets used by fish for hiding and protection.

Thick root – Dense mats of roots and rootlets (generally from trees) at or beneath the water surface forming structure for invertebrate attachment and fish cover.

Dense macrophyte beds – Beds of emergent (e.g., water willow), floating leaf (e.g., water lily), or submerged (e.g., riverweed) aquatic vegetation thick enough to provide invertebrate attachment and fish cover.

Riffles – Area characterized by broken water surface, rocky or firm substrate, moderate or swift current, and relatively shallow depth (usually less than 18 inches).

Isolated/backwater pools – Areas disconnected from the main channel or connected as a 'blind' side channel, characterized by a lack of flow except in periods of high water.

Pools

Deep and shallow pools abundant; greater than 30% of the pool bottom is obscure due to depth, or the pools are at least 5 feet deep.	Pools present but not abundant; between 10–30% of the pool bottom is obscure due to depth, or the pools are at least 3 feet deep.	Pools present but shallow; between 5–10% of the pool bottom is obscure due to depth, or the pools are less than 3 feet deep.	Pools absent or the entire bottom is discernible.
10	7	3	1

Pools are important resting and feeding sites for fish. A healthy stream has a mix of shallow and deep pools. A 'deep' pool is 1.6 to 2 times deeper than the prevailing depth, while a 'shallow' pool is less than 1.5 times deeper than the prevailing depth. Pools are abundant if a deep pool is in each of the meander bends in the reach being assessed. To determine if pools are abundant, look at a longer sample length than one that is 12 active channel widths in length. Generally 1 or 2 pools typically form within a reach as long as 12 active channel widths. In low order, high gradient streams, pools are abundant if there is more than one pool every 4 channel widths.

What to Look For

Pool diversity and abundance are estimated based on walking the stream or probing from the streambank with a stick or length of rebar. You should find deep pools on the outsides of meander bends. In shallow, clear streams a visual inspection may provide an accurate estimate. In deep streams or streams with low visibility, this assessment characteristic may be difficult to determine and should not be scored.

Insect/Invertebrate Habitat

At least 5 types of habitat available. Habitat is at a stage to allow full insect colonization (woody debris and logs not freshly fallen).	3–4 types of habitat. Some potential habitat exists, such as overhanging trees, which will provide habitat but have not yet entered the stream.	1–2 types habitat. The substrate is often disturbed, covered, or removed by high stream velocities and scour or by sediment deposition.	None to 1 type of habitat.
10	7	3	1

Cover types: Fine woody debris; submerged logs; leaf packs; undercut banks;

cobbles; boulders; coarse gravel; other: . . . .

Stable substrate is important for insect/invertebrate colonization. Substrate refers to the stream bottom, woody debris, or other surfaces on which invertebrates can live. Optimal conditions include a variety of substrate types within a relatively small area of the stream (5× the active channel width). Stream and substrate stability are also important. High stream velocities, high sediment loads, and frequent flooding may cause substrate instability even if substrate is present.

What to Look For

Observe the number of different types of habitat and cover within a representative subsection of the assessment reach that is equivalent in length to five times the active channel width. Each cover type must be present in appreciable amounts to score.

Score the Following Assessment Elements only if Applicable

Canopy Cover (if applicable)

Coldwater Fishery

>75% of water surface shaded and upstream. 2–3 miles generally well shaded.	>50% shaded in reach, **or** >75% in reach, but upstream 2–3 miles poorly shaded.	20–50% shaded.	<20% of water surface in reach shaded.
10	7	3	1

Warmwater Fishery

25–90% of water surface shaded; mixture of conditions.	>90% shaded; full canopy; same shading condition throughout the reach.	(intentionally blank)	<25% water surface shaded in reach.
10	7	3	1

Do not assess this element if active channel width is greater than 50 feet. Do not assess this element if woody vegetation is naturally absent (e.g., wet meadows).

Shading of the stream is important because it keeps water cool and limits algal growth. Cool water has a greater oxygen holding capacity than does warm water. When streamside trees are removed, the stream is exposed to the warming effects of the sun causing the water temperatures to increase for longer periods of time during the daylight hours and for more days during the year. This shift in light intensity and temperature will cause a decline in the numbers of certain species of fish, insects, and other invertebrates and some aquatic plants. They may be replaced altogether by other species that are more tolerant of increased light intensity, low dissolved oxygen, and warmer water temperatures. For example, trout and salmon require cool, oxygen-rich water. Loss of streamside vegetation (and also channel widening) that cause increased water temperature and decreased oxygen levels have been cited as major contributing factors to the decrease in abundance of trout and salmon from many streams that historically supported these species. Increased light and the warmer water also promote excessive growth of submerged macrophytes and algae that compromises the biotic community of the stream. The temperature at the reach you are assessing will be affected by the amount of shading 2 to 3 miles upstream.

What to Look For

Try to estimate the portion of the water surface area for the whole reach that is shaded by estimating areas with no shade, poor shade, and shade. Time of the year, time of the day, and weather can affect your observation of shading. Therefore, the relative amount of shade is estimated by assuming that the sun is directly overhead and the vegetation is in full leaf-out. First evaluate the shading conditions for the reach; then determine (by talking with the landowner) shading conditions 2 to 3 miles upstream. Alternatively, use aerial photographs taken during full leaf out. The following rough guidelines for percent shade may be used: stream surface not visible – >90; surface slightly visible or visible only in patches – 70–90; surface visible but banks not visible – 40–70; surface visible and banks visible at times – 40; surface and banks visible – <20.

Manure Presence (if applicable)

Intentionally blank	Evidence of livestock access to riparian zone.	Occasional manure in stream or waste storage structure located in the flood plain.	Extensive amount of manure on banks or in stream, **or** Untreated human waste discharge pipes present.
	5	3	1

Do not score this element unless livestock operations or human waste discharges are present.

Manure from livestock may enter the water if livestock have access to the stream or from runoff of grazing land adjacent to the stream. In some communities, untreated human waste may also empty directly into streams. Manure and human waste increase biochemical oxygen demand, increase the loading of nutrients, and alter the trophic state of the aquatic biological community. Untreated human waste is a health risk.

What to Look For

Do not score this element unless livestock operations or human waste discharges are present. Look for evidence of animal droppings in or around streams, on the streambank, or in the adjacent riparian zone. Well-worn livestock paths leading to or near streams also suggest the probability of manure in the stream. Areas with stagnant or slow-moving water may have moderate to dense amounts of vegetation or algal blooms, indicating localized enrichment from manure.

Salinity (if applicable)

Intentionally blank	Minimal wilting, bleaching, leaf burn, or stunting of aquatic vegetation; some salt-tolerant streamside vegetation.	Aquatic vegetation may show significant wilting, bleaching, leaf burn, or stunting; dominance of salt- tolerant streamside vegetation.	Severe wilting, bleaching, leaf burn, or stunting; presence of only salt-tolerant aquatic vegetation; most streamside vegetation salt tolerant.
	5	3	1

Do not assess this element unless elevated salinity due to anthropogenic sources is known to occur in the stream.

High salinity levels most often occur in arid areas and in areas that have high irrigation requirements. High salinity can also result from oil and gas well operations. Salt accumulation in soil causes a breakdown of soil structure, decreased infiltration of water, and potential toxicity. High salinity in streams affects aquatic vegetation, macroinvertebrates, and fish. Salts are a product of natural weathering processes of soil and geologic material.

What to Look For

High salinity levels cause a ‘burning’ or ‘bleaching’ of aquatic vegetation. Wilting, loss of plant color, decreased productivity, and stunted growth are readily visible signs. Other indicators include whitish salt encrustments on the stream banks and the displacement of native vegetation by salt-tolerant aquatic plants and riparian vegetation (such as tamarix or salt cedar).

Riffle Embeddedness (if applicable)

Gravel or cobble particles are <20% embedded.	Gravel or cobble particles are 20–30% embedded.	Gravel or cobble particles are 30–40% embedded.	Gravel or cobble particles >40% embedded.	Riffle is completely embedded.
10	8	5	3	1

Do not assess this element unless riffles are present or are a natural feature that should be present.

Riffles are areas, often downstream of a pool, where the water is breaking over rocks or other debris causing surface agitation. In coastal areas riffles can be created by shoals and submerged objects. (This element is sensitive to regional differences and should be related to reference conditions.) Riffles are critical for maintaining high species diversity and abundance of insects for most streams and for serving as spawning and feeding grounds for some fish species. Embeddedness measures the degree to which gravel and cobble substrate are surrounded by fine sediment. Embeddedness relates directly to the suitability of the stream substrate as habitat for macroinvertebrates, fish spawning, and egg incubation.

What to Look For

This assessment characteristic should be used only in riffle areas and in streams where this is a natural feature. The measure is the depth to which objects are 'buried' by sediment. This assessment is made by picking up particles of gravel or cobble with your fingertips at the fine sediment layer. Pull the particle out of the bed and estimate what percent of the particle was buried. Some streams have been so smothered by fine sediment that the original stream bottom is not visible. Test for complete burial of a stream bed by probing with a length of rebar.

Macroinvertebrates Observed (Optional)

Community dominated by Class 1 or intolerant species with good species diversity. Examples include: caddisflies, mayflies, stoneflies, hellgrammites.	Community dominated by Class 2 or facultative species such as damselflies, dragonflies, aquatic sowbugs, blackflies, crayfish.	Community dominated by Class 3 or tolerant species such as midges, craneflies, horseflies, leeches, aquatic earthworms, tubificid worms.	Very reduced number of species or near absence of all macroinvertebrates.
15	6	2	-3

This important characteristic reflects the ability of the stream to support aquatic invertebrate animals. However, successful assessment requires knowledge of the life cycles of some aquatic insects and other macroinvertebrates and the ability to identify them. For this reason, this is an optional element. The presence of intolerant insect species (cannot survive in polluted water) indicates healthy stream conditions. Some kinds of macroinvertebrates, such as stoneflies, mayflies, and caddisflies, are sensitive to pollution and do not live in polluted water; they are considered Class I. Another group of macroinvertebrates, known as Class II or faculative macroinvertebrates, can tolerate limited pollution and includes damselflies, aquatic sowbugs, and crayfish. The presence of Class III macroinvertebrates, including midges, craneflies and leeches, suggests the water is significantly polluted. The presence of a single Class I species in a community does not constitute good diversity and should generally not be given a score of 15.

What to Look For

You can collect macroinvertebrates by picking up cobbles and other submerged objects in the water. Look carefully for the insects; they are often well camouflaged and may appear as part of the stone or object. Note the kinds of insects, number of species, and relative abundance of each Class of insects/macroinvertebrates. *Note that the scoring values for this element range from –3 to 15.*

Glossary

Active channel width: The width of the stream at the bankfull discharge. Permanent vegetation generally does not become established in the active channel.

Aggradation: Geologic process by which a stream bottom or floodplain is raised in elevation by the deposition of material.

Bankfull discharge: The stream discharge (flow rate such as cubic feet per sec) that forms and controls the shape and size of the active channel and creates the floodplain. This discharge generally occurs once every 1.5 yr on average.

Bankfull stage: The stage at which water starts to flow over the floodplain; the elevation of the water surface at bankfull discharge.

Base flow: The portion of stream flow that is derived from natural storage; average stream discharge during low flow conditions.

Benthos: Bottom-dwelling or substrate-oriented organisms.

Boulders: Large rocks measuring more than 10 inches across.

Channel: A natural or artificial waterway of perceptible extent that periodically or continuously contains moving water. It has a definite bed and banks that serve to confine the water.

Channel roughness: Physical elements of a stream channel upon which flow energy is expended including coarseness and texture of bed material, the curvature of the channel, and variation in the longitudinal profile.

Channelization: Straightening of a stream channel to make water move faster.

Cobbles: Medium-sized rocks which measure 2.5–10 inches across.

Confined channel: A channel that does not have access to a floodplain.

Degradation: Geologic process by which a stream bottom is lowered in elevation due to the net loss of substrate material. Often called downcutting.

Downcutting: See degradation.

Ecoregion: A geographic area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables.

Embeddedness: The degree to which an object is buried in steam sediment.

Emergent plants: Aquatic plants that extend out of the water.

Floodplain: The flat area of land adjacent to a stream that is formed by current flood processes.

Forb: Any broad-leaved herbaceous plant other than those in the Gramineae (Poceae), Cyperacea, and Juncaceae families (Society for Range Management, 1989)

Gabions: A wire basket filled with rocks. Used to stabilize streambanks and to control erosion.

Geomorphology: The study of the evolution and configuration of landforms.

Glide: A fast water habitat type that has low to moderate velocities, no surface agitation, no defined thalweg, and a U-shaped, smooth, wide bottom.

Gradient: Slope calculated as the amount of vertical rise over horizontal run expressed as ft/ft or as percent (ft/100 ft).

Grass: An annual to perennial herb, generally with round erect stems and swollen nodes; leaves are alternate and two-ranked; flowers are in spikelets each subtended by two bracts.

Gravel: Small rocks measuring 0.25–2.5 inches across.

Habitat: The area or environment in which an organism lives.

Herbaceous: Plants with non-woody stems.

Hydrology: The study of the properties, distribution, and effects of water on the Earth's surface, soil, and atmosphere.

Incised channel: A channel with a stream bed lower in elevation that its historic elevation in relation to the floodplain.

Intermittent stream: A stream in contact with the ground water table that flows only certain times of the year, such as when the ground water table is high or when it receives water from surface sources.

Macrophyte bed: A section of stream covered by a dense mat of aquatic plants.

Meander: A winding section of stream with many bends that is at least 1.2 times longer, following the channel, than its straight-line distance. A single meander generally comprises two complete opposing bends, starting from the relatively straight section of the channel just before the first bend to the relatively straight section just after the second bend.

Macroinvertebrate: A spineless animal visible to the naked eye or larger than 0.5 mm.

Nick point: The point where a stream is actively eroding (downcutting) to a new base elevation. Nick points migrate upstream (through a process called headcutting).

Perennial stream: A steam that flows continuously throughout the year.

Point bar: A gravel or sand deposit on the inside of a meander; an actively mobile river feature.

Pool: Deeper area of a stream with slow-moving water.

Reach: A section of stream (defined in a variety of ways, such as the section between tributaries or a section with consistent characteristics).

Riffle: A shallow section in a stream where water is breaking over rocks, wood, or other partly submerged debris and producing surface agitation.

Riparian: The zone adjacent to a stream or any other waterbody (from the Latin word ripa, pertaining to the bank of a river, pond, or lake).

Riprap: Rock material of varying size used to stabilize streambanks and other slopes.

Run: A fast-moving section of a stream with a defined thalweg and little surface agitation.

Scouring: The erosive removal of material from the stream bottom and banks.

Sedge: A grasslike, fibrous-rooted herb with a triangular to round stem, and leaves that are mostly three-ranked and with close sheaths; flowers are in spikes or spikelets, axillary to single bracts.

Substrate: The mineral or organic material that forms the bed of the stream; the surface on which aquatic organisms live.

Surface fines: That portion of streambed surface consisting of sand/silt (less than 6 mm).

Thalweg: The line followed by the majority of the streamflow. The line connecting the lowest or deepest points along the streambed.

Turbidity: Murkiness or cloudiness of water caused by particles, such as fine sediments (silts, clays) and algae.

Watershed: A ridge of high land dividing two areas that are drained by different river systems. The land area draining to a waterbody or point in a river system; catchment area, drainage basin, drainage area.

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