

# User's Guide for the Rapid Assessment of the Functional Condition of Stream- Riparian Ecosystems in the American Southwest

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Cover Photograph: Calf Creek, Grand Staircase-Escalante National Monument. This is a recovering system that not seen livestock grazing for decades. This assessment protocol was designed to help understand and measure the status and functionality of these types of streams and riparian ecosystems. *Photo by Mike Hudak.*

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## Summary

Stream-riparian ecosystems are among the most productive, biologically diverse and threatened habitats in arid regions, including the American Southwest. Standardized assessment protocols are needed in order to effectively measure the current health and functional condition of these ecosystems, as well as to serve as a guide for future restoration and monitoring programs. However, most existing survey methods either focus on only a limited subset of the different components of the ecosystem, base their evaluations upon some hypothesized future state rather than upon the current conditions of the reach, and/or rely heavily upon subjective judgments of ecosystem health. We describe an integrated, multi-dimensional method for rapid assessment of the functional condition of riparian and associated aquatic habitats called Rapid Stream-Riparian Assessment (RSRA). This method evaluates the extent to which natural processes predominate in the stream-riparian ecosystem and whether there is sufficient terrestrial and aquatic habitat complexity to allow for the development of diverse native plant and animal communities.

The Rapid Stream-Riparian Assessment involves a quantitative evaluation of between two to seven indicator variables in five different ecological categories: water quality, fluvial geomorphology, aquatic and fish habitat, vegetation composition and structure, and terrestrial wildlife habitat. Each variable is rated on a scale that ranges from "1", representing highly impacted and non-functional conditions, to "5", representing a healthy and completely functional system. Whenever possible, scores are scaled against what would be observed in control or reference sites that have similar ecological and geophysical characteristics, but which have not been heavily impacted by human activities. The protocol was designed to be used both by specialists and by non-specialists after suitable training. It is particularly appropriate for small to medium sized streams and rivers in the American Southwest, but with slight modification it also should be applicable to reaches in other temperate regions and geomorphic settings.

# **1. Introduction to the User's Guide for the Rapid Assessment of the Functional Condition of Stream-Riparian Ecosystems in the American Southwest.**

Stream-riparian zones are some of the most productive and important natural resources found on public and private lands. These ecosystems are highly valued as habitats for fish and wildlife, as a water source for human communities, for recreation, and for many different economic uses. This is particularly true in arid and semi-arid regions like the American Southwest, where riparian areas support a biotic community whose richness far exceeds the relative total land area that these systems occupy.

Because of both the ecological importance of riparian areas and their heavy utilization by humans, there is a need for assessment methods that can be used to objectively evaluate the existing conditions of the stream-riparian ecosystem, detect at-risk components, prioritize management strategies and/or possible restoration activities if problems are discovered, and then be used to objectively monitor any future changes within the system. An effective assessment protocol must include consideration of the interactions among stream, fluvial wetland, and riparian habitats (here referred to as the stream-riparian ecosystem), as well as the potential impacts of upstream and adjacent upland areas.

The Rapid Stream-Riparian Assessment (RSRA) utilizes a primarily qualitative assessment based on quantitative measurements. It focuses upon five functional components of the stream-riparian ecosystem that provide important benefits to humans and wildlife, and which, on public lands, are often the subject of government regulation and standards. These components are: 1) water quality and pollution, 2) stream channel and flood plain morphology and the ability of the system to limit erosion and withstand flooding without damage, 3) the presence of habitat for native fish and other aquatic species, 4) vegetation structure and composition, including the occurrence and relative dominance of exotic or non-native species, and 5) suitability as habitat for terrestrial wildlife, including threatened or endangered species.

Within each of these areas, the RSRA evaluates between two and seven variables which reflect the overall function and health of the stream-riparian ecosystem. The basis for the inclusion of the individual indicators is briefly summarized in Table 1. A more complete discussion of the variables, including selected references, can be found in Stevens et al. (2005)<sup>1</sup>. Definitions of key terms used in Table 1 are provided at the end of the User's Guide; illustrations of selected variables accompany the directions for scoring those indicator variables that are included in Section 3.

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<sup>1</sup> Stevens, L.E., Stacey, P.B., Jones, A. L., Duff, D., Gourley, C., and J.C. Catlin. 2005. A protocol for rapid assessment of southwestern stream-riparian ecosystems. Proceedings of the Seventh Biennial Conference of Research on the Colorado Plateau titled *The Colorado Plateau II, Biophysical, Socioeconomic, and Cultural Research*. Charles van Riper III and David J. Mattsen, Ed.s pp 397-420. Tuscon, AZ: University of Arizona Press.

Table 1: RSRA indicator variables and the reasons for including them in the protocol.

CATEGORY AND VARIABLE	JUSTIFICATION FOR INCLUSION IN RSRA ASSESSMENT
Water Quality: <b>Algal growth</b>	Dense algal growth may indicate nutrient enrichment and other types of pollution which may result in decreased dissolved oxygen in the water column and affect invertebrates and the ability of fish to spawn.
Water Quality: <b>Channel shading and solar exposure</b>	Solar exposure affects stream temperature and productivity. Decreased streambank vegetation cover, increased channel width, and reduced stream depth increases exposure, raises water temperatures and impacts aquatic life. Native trout usually require cool stream temperatures.
Hydrogeomorphology: <b>Floodplain connection and inundation frequency</b>	Channels that are deeply downcut or incised result in a reduced frequency of overbank flooding into the adjacent flood plain during peak runoff or stream flows. The absence of flooding lowers water tables, reduces nutrient availability in the floodplain, decreases plant germination, growth and survivorship, and may lead to the loss of riparian vegetation and the invasion of upland species.
Hydrogeomorphology: <b>Vertical bank stability</b>	Steep and unstable vertical banks dominate many southwestern streams, limiting the physical dynamics of aquatic ecosystems and increasing erosion and sediment loads through sloughing off of soils during high flow events. Steep banks may limit wildlife access to water.
Hydrogeomorphology: <b>Hydraulic habitat diversity</b>	Fish and aquatic invertebrate diversity and population health is related to habitat diversity. Features such as oxbows, side channels, sand bars, gravel/cobble bars, riffles, and pools can provide habitat for different species or for the different life stages of a single species.
Hydrogeomorphology: <b>Riparian area soil integrity</b>	Riparian soils reflect existing stream flow dynamics (e.g., flooding), management practices, and vegetation. It affects potential vegetation dynamics and species composition, as well as wildlife habitat distribution and quality.
Hydrogeomorphology: <b>Beaver activity</b>	Beavers are keystone species in riparian systems because they modify geomorphology and vegetation, and reduce variance in water flows and the frequency of floods. Beaver dams and adjacent wet meadows provide important fish and plant nursery habitat.
Fish/Aquatic Habitat Qualifier: <b>Loss of perennial flows</b>	Fish and most aquatic invertebrates require perennial or constant flows to survive. Streams that were originally perennial but are now ephemeral no longer provide habitat for these species unless there are refuges that never dry out (e.g., permanent pools).
Fish/Aquatic Habitat: <b>Pool distribution</b>	Fish use pools, with reduced current velocity and deep water, to rest, feed and hide from predators. Many species use gravel-bottomed riffles to lay their eggs. The number, size, distribution, and quality of pools, and pool to riffle ratios indicate the quality of fish habitat. 1:1 pools to riffle ratios are generally considered to be optimum.
Fish/Aquatic Habitat: <b>Underbank cover</b>	Underbank cover is an important component of good fish habitat, used for resting and protection from predators. A number of aquatic invertebrates also use these areas. Underbank cover usually occurs with vigorous vegetative riparian growth, dense root masses, and stable soil conditions.
Fish/Aquatic Habitat: <b>Cobble embeddedness</b>	Low levels of gravel and boulder embeddedness on the channel bottom increase benthic productivity and fish production. The filling of interstitial spaces between rocks with silt, sand, and organic material reduces habitat suitability for feeding, nursery cover, and spawning (egg to fry survival) by limiting space and macroinvertebrate production. Increased embeddedness often reflects increased sediment loads and altered water flow patterns.
Fish/Aquatic Habitat: <b>Diversity of aquatic invertebrates</b>	The density and composition of aquatic invertebrates are strong indicators of stream health, including temperature stresses, oxygen levels, nutrients, pollutants, and sediment loads. Larvae and adult macroinvertebrates provide critical food for fish and other invertebrate and vertebrate species in stream-riparian ecosystems.

Table 1: Continued from the previous page.

CATEGORY AND VARIABLE	JUSTIFICATION FOR INCLUSION IN RSRA ASSESSMENT
Fish/Aquatic Habitat: <b>Large woody debris</b>	The amount, composition, distribution and condition of large woody debris (LWD) in the stream channel and along the banks provides important fish habitat for nursery cover, feeding, and protective cover. Streams with adequate LWD generally have greater habitat diversity, a natural meandering shape and greater resistance against high water events.
Fish/Aquatic Habitat: <b>Overbank cover and terrestrial invertebrate habitat</b>	Overhanging terrestrial vegetation is essential for fish production and survival, providing shade, bank protection from high flows, sediment filtering, and input of organic matter. Overbank cover also is important for terrestrial insect input (drop) into streams, which is a key source of food for fish.
Riparian vegetation: <b>Plant community cover and structural diversity</b>	High cover and structural diversity of riparian vegetation generally indicates healthy and productive plant communities, high plant species diversity and provides direct and secondary food resources, cover, and breeding habitat for wildlife. This affects avian breeding and foraging patterns in particular. Good structural diversity can also reduce flood impacts along banks.
Riparian vegetation: <b>Dominant shrub and tree demography (recruitment and age distribution)</b>	The distribution of size and age classes of native dominant species indicates recruitment success, ecosystem sustainability, and wildlife and fish habitat availability. When one or more age classes of the dominant species are missing, it indicates that something has interrupted the natural process of reproduction and individual plant replacement. In time, this may lead to the complete loss of the species in the area as older individuals die off and are not replaced by younger plants.
Riparian vegetation: <b>Non-native herbaceous and woody plant cover</b>	Non-native plant species profoundly influence ecosystem structure, productivity, habitat quality, and processes (e.g., fire frequency, intensity). Strong dominance by non-native plants may eliminate key attributes of wildlife habitat quality, and may limit ungulate and livestock use.
Riparian vegetation: <b>Mammalian herbivory impacts on ground cover</b>	Ungulate herbivores can affect riparian soils, ground cover, and general ecosystem condition. Utilization levels >10% in riparian zones retard vegetation replacement and recovery. Moderate and higher levels of grazing almost always increase soil compaction and erosion.
Riparian vegetation: <b>Mammalian herbivory impacts on shrubs and small trees</b>	Ungulate herbivores can affect recruitment of woody shrub and trees by clipping or browsing the growing tips of the branches. Continued high levels of utilization lead to the death of the plant and over time can cause the loss of all shrubs and trees in a local area.
Terrestrial Wildlife Habitat: <b>Riparian shrub and tree canopy cover and connectivity</b>	Riparian shrubs and trees often grow in dense patches that provide food, thermal cover, predator protection and nesting or breeding habitat for terrestrial wildlife, including many invertebrates, amphibians, reptiles, birds and mammals. These patches are often absent in riparian areas that have been heavily utilized by livestock and other ungulates, or that have been damaged by other human activities. As a result, many native wildlife species may no longer be able to survive in the area. Patches of dense vegetation, both native and exotic, also plays a key role in trapping sediment during periods of over-bank flow.
Terrestrial Wildlife Habitat: <b>Fluvial habitat diversity</b>	Natural processes create a diversity of fluvial landforms, including terraces, bars, oxbows, wet marshes and fluvial marshes, that provide habitats for different species of terrestrial wildlife. Conversely, in a highly degraded system with extensive erosion and downcutting, there may be only a single fluvial form: a straight and single-depth channel and steep banks without vegetation.

## ***Indicator Selection***

Four principles guided our selection of the specific variables that are included in the RSRA. First, we focused upon indicators that not only measured the ability of the system to provide specific functions, but that at the same time would reflect other important ecological processes within the stream-riparian system. For example, in the fish habitat section we consider the relative amount of undercut banks along the reach. Undercut banks not only provide important habitat and cover for fish and other aquatic species, but their presence indicates that the bank itself is well vegetated, and that there is sufficient root mass to allow the development of the hour-glass shape channel cross-section typical of most healthy stream systems. This in turn would suggest that the fluvial processes of erosion and deposition along that stretch of the reach are in relative equilibrium.

Second, we focused upon variables that could be measured rapidly in the field and that would not require specialized equipment or training. As a result, the protocol can be conducted not only by specialists, but also by conservationists, agency personnel, ranchers, and interested lay-people that have received some initial training. More detailed methods have been developed for many of the individual indicators included in this protocol. However, because they often require considerable time and expensive equipment, the use of such protocols will often limit the other kinds of information that can be reasonably collected from the reach. Our goal was to obtain an overall picture of the functioning of the system under assessment within a two to three hour period. Should any of the individual components of the reach be found to be particularly problematic or non-functional, the more specialized methods can then be used during later visits to collect additional quantitative information on that variable.

Third, we measure only the current condition of the ecosystem, rather than creating scores that are based upon some hypothesized future state or successional trend. That is, we are concerned with the ability of the ecosystem to provide some important function at the present time, and not whether it would be likely to do so at some point in the future, if current trends or management practices continue. We used this approach because stream-riparian systems are highly dynamic and they are often subject to disturbances (e.g., large flooding) that will alter successional trends and make predictions of future conditions highly problematic.

In addition, by evaluating only current conditions, this protocol can be used as a powerful tool for monitoring and measuring future changes in the functional status of the system. For example, if a reach is rated as in poor condition with respect to a particular set of parameters, reevaluating the system using the identical protocol in subsequent years gives one the ability to measure the effectiveness of any management change or active restoration program and to undertake corrections if the restoration actions are found to be not producing the desired changes. This type of adaptive management approach can be extremely difficult if the evaluation and monitoring measures are based primarily upon the expectations of some future, rather than current, condition.

Fourth, and for similar reasons, we use a quantitative approach to score variables and measure ecosystem health. Many current assessment systems that are based upon dichotomous



categories, such as "functional/non-functional", or "yes/no", can be subjective and difficult to repeat in the same way from one year to the next, or when conducted by different observers. In addition, dichotomous scoring systems often are not able to provide sufficient insight into the ecological processes that may be affecting the ability of the system to provide (or not provide) desired functions that would indicate whether active restoration efforts might be necessary. We used a review of existing assessment and monitoring protocols, extensive external peer-review, and our own individual research experiences to create a five point scale for each variable. The maximum score (5 points) is given when that component of the system is fully functional and healthy, and is what would be found in a similar reach that has not been heavily impacted by humans. The minimum score (1 point) is given when the component is completely non-functional, and when it is not capable of providing the desired ecosystem value of that variable.<sup>2</sup>

### ***Reference Reaches***

Every stream will have its own geologic and watershed characteristics that will necessarily limit both its potential geomorphic form and its ultimate ecological function. For example, streams in narrow bed-rock canyons will never develop the same number of meanders and flood plain width as will similarly sized streams that run through broad alluvial fans. For this reason, we suggest that whenever possible, the stream reach under evaluation should be compared to a reference reach, and the scores given be scaled with respect to that reach. Reference areas should have similar geomorphic, fluvial and biological characteristics to the study reach, and should be as free as possible of current and past human impacts. When this type of reference reach is not available, ratings should be based upon what the observer would expect to see if all physical and ecological processes were occurring without human impact, while allowing for natural disturbance processes that may be characteristic of the system.

### ***Geographic Application***

The RSRA protocol presented here was developed specifically in reference to small and medium sized stream reaches in the Colorado Plateau and in the adjacent areas of the American Southwest. It applies most directly to low and mid-gradient watercourses, and therefore will be most useful in the lower and middle elevation watersheds of this region. Large streams and rivers, as well as those at high elevations in mountainous regions that have high gradients, are often subject to forces and conditions that are not fully considered here and therefore may not be adequately described by this protocol. However, with only slight modification, the RSRA should be applicable to many other parts of the American West, as well as to other arid and semi-arid regions of the world.

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<sup>2</sup> The range of scores used in the RSRA method from 1 to 5 is similar to the functional condition judgments used by the US Bureau of Land Management and other agencies in their "Proper Functioning Condition" (PFC) assessment protocol (USDI 1998). In that system, streams are rated as ranging from either "not in proper functioning condition," which would be equivalent to mean scores of 1-2 in the RSRA, to "in proper functioning condition," which would be equivalent to mean scores of 4-5 in the RSRA. Intermediate scores in the RSRA protocol (>2 - <4) can be considered to be equivalent to the "functional at risk" rating in the PFC protocol. Additional discussion of the similarities and differences between the RSRA and PFC survey protocols is given in Stevens et al. (2005).

## **2. Conducting the Rapid Stream-Riparian Assessment**

The overall approach for assessing stream-riparian health with the RSRA protocol is to:

- A. Identify the specific reach of interest within a watershed
- B. Identify, if possible, a reference area for that reach with similar geomorphology and biotic structure
- C. Collect as much background information on the reach as is available and appropriate
- D. Conduct the protocol in the field

We recommend that the protocol be conducted by a team of at least two or three people, and that each team member read this User's Guide and become familiar with the RSRA Field Worksheet and Score Sheet (Appendices 2 and 3) before beginning the field surveys.

### ***A. Identify the Study Reach of Interest***

The segment of a stream or river that is to be examined should be representative of the area of interest, and it should generally be relatively uniform in character, landform, geology and vegetation. The study reach should be approximately 1 km in length, and, when possible, include at least 3-4 stream meanders. Different reaches within a watershed may have different characteristics due to varying geology, hydrology, elevation, and past histories of land use. In such cases, it is appropriate to conduct separate evaluations in several different reaches. The location of the study stream reach should be representative of the range of conditions found in the watershed and should not be chosen to illustrate particularly good (or bad) conditions that would bias the scores given to the entire stream.

### ***B. Identify One or More Reference Reaches***

Because of the long history of occupation and use by Native Americans and Hispanic and Anglo settlers, it can often be difficult to visualize the natural or unaltered condition of many western streams and rivers. Therefore, whenever possible, reference sites should be identified and visited prior to conducting the protocol on the study reach itself. These sites can also be a good location to train new individuals about general ecological and fluvial processes, as well as in the use of the protocol itself.

In choosing a reference reach, the team should look for systems with the following characteristics: 1) similar geology, elevation, and flow patterns (both in the amount and timing of peak and average water flows) to the study reach; and 2) nearly natural or close to natural conditions and as free as possible from recent and historic human caused disturbances, especially water diversions, roads, livestock grazing, mining, and ground water pumping. Streams that have been subject to recent catastrophic disturbances such as fires or heavy flooding will not usually serve as good reference reaches since they may still be in the process of recovering or reaching a new equilibrium after the disturbance.

In some situations, a good reference site may not be available in the immediate area. In these cases, streams in other watersheds or regions that have similar geomorphic and ecological features can be used to gain a basic understanding of the general fluvial and ecological processes that would be expected in the study reach under unaltered conditions, and can thus offer a reasonable "surrogate" reference site.

### ***C. Collect Background Information on the Reference Reach and Study Reach***

Prior to using RSRA in the field, it is recommended that the user collect some basic, background information on the study reach (see Box 1 for specific suggestions). In a few cases, information gathered ahead of time will be needed to complete a score sheet item; those categories marked optional will be helpful to interpreting the field scores, but are not needed to assign the actual scores themselves.

#### **BOX 1: BACKGROUND INFORMATION TO HELP INTERPRET SITE VISIT**

The information listed below gives a range of data that could be useful in understanding present and past conditions on the study reach. Three kinds of background information are needed to answer specific items in the Score Sheet: whether beavers were historically present in the watershed, whether the stream was historically perennial, and the various species of non-native or exotic plant species that have been reported or are likely to be encountered at the study reach. The other information listed here is not required, but may help to explain why the reach scores the way it does for individual indicators. Not all of the data will be available for any particular reach. Possible sources of information include local land management agencies, state and federal soil and conservation services, local residents, distribution maps of fish and wildlife from past surveys, etc.

##### **Water Quality**

1. (optional) Are there known sources of pollution that should be considered in the evaluation (e.g., upstream mine tailings, water treatment facilities, or livestock feedlots and holding pens)?

##### **Hydro/Geomorphology**

1. (optional) Determine origin(s) of stream flow for the study reach (size of watersheds, springs, etc.).  
Is it likely to be subject to large flows or flooding events?
2. (optional) Determine human alterations of flow (dams, diversions or augmentations).
3. (optional) Determine whether there have been alterations in the upland portions of the watershed that might impact the stream (e.g., timber harvests that might lead to increased sediment loads).
4. (optional) Determine the current sinuosity of study reach. This can be defined as the ratio of the actual distance or length of a channel to the straight line distance between the beginning and end of the study reach, and is best measured using aerial photographs. Such photographs may also show geomorphic evidence of past meanders, which can then make it possible to determine changes in sinuosity over time. Sinuosity information can also be used to place the study reach within various classification schemes, such as the categories developed by Rosgen (D.L. Rosgen, *A Classification of Natural Rivers*, Catena 22 (1994), pages 169-199).
5. **(required)** Indicator 7 considers historic use of the study reach by beavers. Use existing records or recollections by local residents to determine if beavers were ever present on the reach.

## **BOX 1: Continued from page 10.**

### **Fish/Aquatic Habitat (F/A)**

1. **(required)** Perennial Flow (F/A qualifier). In order to answer this question, the user needs to know whether the reach flowed throughout the year in pre-settlement times. Helpful resources include historical literature and interviews with local residents. Obtain information when available on the extent of current dewatering and stream regulation, including the frequency at which water is now completely or partially removed from the stream or spring, or when it is regulated to the point where little to no water flows during drier times of the year.
2. (optional) Obtain information on the native fishes that potentially could occupy the reach, as well as any sensitive, indicator, and state or federally listed species. Are there barriers to fish movement (dams, diversion structures, etc.), either down or upstream from the study reach? Have non-native sport fish been introduced to the watershed or sub-basin?
3. (optional) Are there presence/absence or relative abundance data for aquatic macroinvertebrates from past stream surveys?

### **Riparian Vegetation**

1. **(required)** Indicators 16 and 17 require an understanding of which species are introduced or non-native. In the American Southwest, salt cedar (tamarisk), Russian olive, Russian thistle, and cheatgrass are often common non-native and invasive species. However each area may have individual grass, forb or woody species that are a particular problem. Consult with agency personnel and local residents about such species, and learn to identify them in advance. Pamphlets are often available from government or private groups to help identify local exotic problem species.
2. (optional) Gather information on ungulate impacts to the riparian zone from past management studies, such as forage utilization studies, indications of past problems with grazing, etc.

### **Wildlife/Habitat (WH)**

1. (optional) Obtain a list of current or previously recorded sensitive, indicator, and state or federally listed species in the reach or in the general area.

### **Human Activities/Impacts**

(optional) Additional data that will be useful to interpret the condition of the reach include information on historical and current land management practices in the area (including the adjacent uplands), past roads in the stream bed or riparian area, timber harvests in the watershed, and current recreational and off-highway vehicle use. The grazing history of the area can also be valuable when available, including livestock capacity, utilization, season of use, animal numbers permitted in Allotment Management Plans for public grazing lands, actual and reported use, reports of trespass grazing, efforts to restrict access of livestock to riparian areas by fencing, etc.

## ***D. Conduct the RSRA field assessment***

### **1. Required Field Gear**

- Copies of RSRA Score Sheet (Appendix 2) and Field Worksheets (Appendix 3), clipboards, pencils.
- Topographic maps of the area, including the watershed upstream from the study reach (both 1:24,000 and 1:100,000 scales are useful). Aerial photos also can be helpful to gain an overall picture of the reach; these are often available at no cost from various internet websites.
- Camera (digital cameras that automatically record the time and date are best) for taking reference photos.
- Stakes or flagging.
- Ocular tube (a "layperson's version" can easily be constructed with an old toilet tissue cardboard roll with "crosshairs" made of thread across one end).
- Global Positioning System (GPS) unit to obtain accurate locations for return visits to the study reach.
- An inexpensive laser level, tripod to hold the level, and a measuring rod or pole about ten feet long for measuring bankfull ratios. A good stick can also be used along with a tape measure.
- Field guides for plants of the region, including exotic species (optional).
- Calculator for determining scores.

### **2. Timing**

The best time to visit both the reference and study reaches is between late spring and early fall, when the riparian vegetation is fully developed and when continuous surface water flows are most critical to wildlife. The best times of day for conducting the survey are from 10:00am to 2:00pm, when the sun is well overhead. Shadows cast over the stream at mid-day are used for one of the indicators.

### **3. Establishment of Transects**

Data will be collected both from the entire 1 kilometer (six tenths of a mile) study reach and along 200 meter sample transects located in the stream channel and on the adjacent banks. The team should first walk the entire reach together. In addition to getting a general sense of the area, the users also will be scoring some of the indicators during the initial walkthrough. Look for a good location to establish the 200m transects for detailed measurements of certain variables. You will collect data from three different but adjacent transects along the same 200m section of the reach: an in-stream transect, a Lower Riparian Zone transect, and an Upper Riparian Zone transect (see below for details). The location of the transects should be representative of the range of conditions found along the study reach. It should not be chosen to illustrate particularly good (or bad) conditions that would thereby bias the scores given the reach.

To set up the transects, first mark the beginning of the in-stream or channel transect with a flag, measure 200 meters either upstream or downstream, and follow the center of the channel when making measurements. Flag the end of the transect (make sure that all flagging and other materials are removed at the end of the survey). Then, using the same starting point, measure 200m along the edge of the channel that marks the beginning of the Lower Riparian Zone. This transect will usually be along the edge of the water or the edge of the channel if the stream is dry. Finally, and again using the same starting point, measure 200m just outside (in the direction away from the stream) of the terrace that marks the boundary between the Lower Riparian Zone (the bankfull location, or area that is flooded during peak flows in most years) and the Upper Riparian Zone (the part of the flood plain that is flooded only irregularly and during exceptionally high flow events; see Figure 1). Because the channel and the terraces may follow different paths, the ending point of all three transects may not be located at the same precise place.

All locations (including the start and end points of the study reach, the starting point and direction [upstream or downstream] of the 200m sample transects, and photo reference points) should be located with a GPS unit and recorded on the Score Sheet. Photographs to illustrate the current conditions at the site should be taken at least at the upstream and downstream ends of the stream reach, at each end of the 200m stream transect looking downstream and upstream, as well as any other location that would be valuable for future comparisons. Photographs should include geologic features and the horizon to make relocation of the photo site easier in the future.

#### **4. Scoring - General Considerations**

The 1-5 point range of scoring values assigned to each indicator on the RSRA Score Sheet either involve specific values for that indicator, or it may use terms such as "few," "slight," "limited," "moderate," "substantial," or "abundant." In both situations, the evaluation team's experience in the reference riparian area(s) is very important to establish a standard of geomorphic consistency and expected values for measurement. A score of "N/A" (Not Applicable) is assigned to variables that are not applicable to the particular reach being assessed. The Field Worksheet in Appendix 3 organizes tasks by the initial whole reach walkthrough and the in-stream and vegetation sample transects. This worksheet will help simplify the observation and data collection process but may not be necessary for highly experienced observers.

Each indicator is measured and the data recorded in the field, along with any additional comments that would assist in future interpretation of results. The most efficient method of scoring involves partitioning tasks among the team. For example, one individual who is well-versed in riparian plants may walk the 200m Upper and Lower Riparian transects, while another team member who is more familiar with fluvial morphology and aquatic habitats can take measurements along the 200m in-stream transect.

After the initial data are collected on the worksheets, all members of the team should meet to discuss their evaluations and scoring assignment for the Assessment Score Sheet, as well as any recommendations the team may make for the possible future restoration of the reach. It is important to emphasize that variables are scored entirely on the basis of existing conditions

within the reach and not on any potential or hypothesized future condition.

An additional worksheet on Human Impacts is included as Appendix 4. This worksheet should be used to take note of various types of human activities and impacts that are occurring on the study reach or adjacent areas. This information is not used in the scoring because the RSRA method is specifically designed to measure the current ecological functioning and condition (health) of the reach, regardless of how those conditions came about. However, it can be useful to take note of human-related impacts in the stream channel and floodplain, as these may explain why certain indicators may receive low functional scores. This information may also provide suggestions for future restoration projects if needed.

## **5. Tallying the Scores and Interpretation**

After completing all the field surveys, the observation team should rate each indicator from 1 to 5, using the scoring definitions on the Score Sheet. Then, for each category, calculate and record the mean score for that set of indicators in that section and on the last page. The overall score for the surveyed stream reach is then obtained by calculating the overall mean of the five category mean scores.

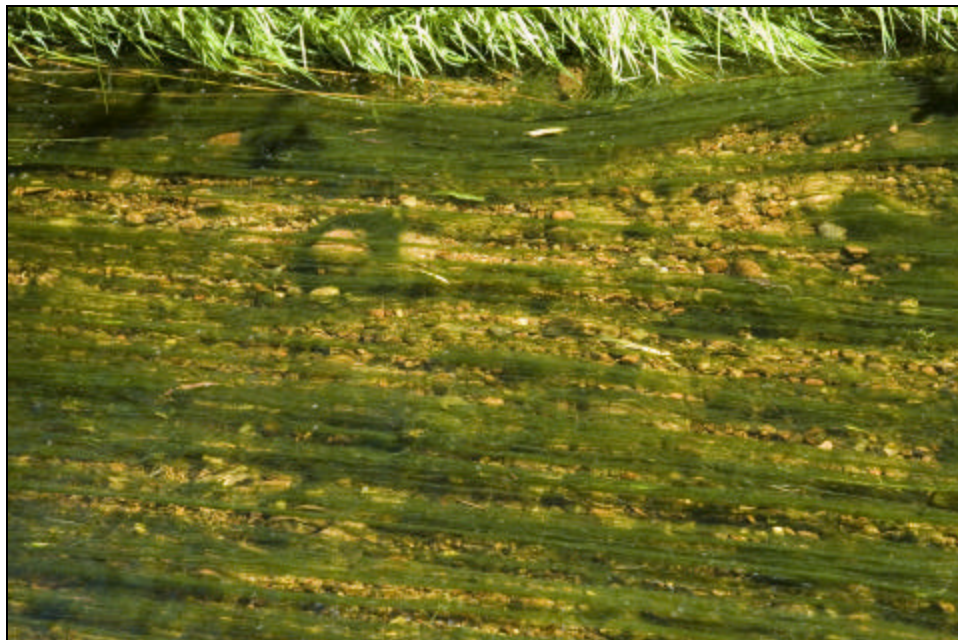
An overall mean score of 1-2 indicates that most or all components of the stream are not functioning and that the reach probably cannot provide many of the values of healthy stream-riparian ecosystems. Scores of 2-4 indicate that some components may be in healthy condition while others are not, and/or that the entire system in general has been impacted by human activities or natural disturbances in the past, but it is now in a transitional state. The direction of the change, and whether the system is improving or getting worse, can only be determined by subsequent visits and monitoring programs. Scores of 4-5 indicate that the ecosystem is healthy and that it matches what would be expected in a geomorphically similar reference reach or in an unimpacted "presettlement" condition. Because of the dynamic nature of stream-riparian ecosystems, it is very unlikely that any reach, even one in pristine condition, would obtain a mean score of 5 for any category or overall, and this should not be expected.

While a single composite site score is desirable for judging site health and developing regional restoration priorities as appropriate, such scores should not constitute the final interpretation of site status. While the overall score may indicate that a stream reach is functioning well, one or more individual indicators may be extremely off balance. Very low individual or clustered scores in an otherwise high scoring system often indicate that there are specific impacts on the stream or riparian area that should be addressed, and which, if not reversed, may eventually lead to an overall decline in the health of the system. For example, a reach may be functioning well physically, but be biologically degraded, in which case the need for restoration action depends on the management goals for that reach, and whether biological functions are important. Alternatively, a reach's hydrology and streamflow patterns may be highly altered but the system might appear otherwise healthy. Thus the interpretation of reach conditions should involve an analysis of the overall scores against the mean category scores and reference conditions to improve understanding of ecological function and management goals for the reach.



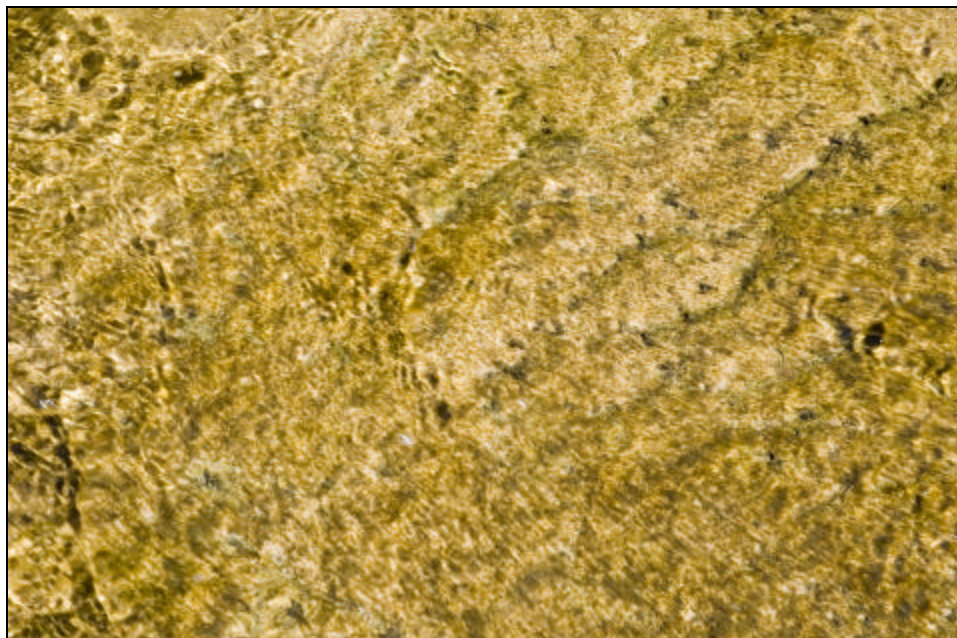
### 3. Specific Directions for Scoring Each Indicator

This section provides detailed instructions for collecting the information needed to score each variable. The instructions are given in the order the variables appear on the Score Sheet. The Field Worksheet organizes the variables according to the physical areas of observations, resulting in a different order.



**Photo 1: Algal Growth** (Indicator 1). Strands of filamentous algae in a reach of the Santa Fe River below Santa Fe, New Mexico. The extensive growth of algae in this reach is due to nutrient loading from upstream sources of pollution. If the entire transect resembles this photo, it would receive a score of 1. *Photo by Peter Stacey.*

**Photo 2: Algal Growth** (Indicator 1). A large rock about 3 inches below the water surface in Calf Creek, Utah. Much of the surface of the rock is covered by single-celled algae. This type of algal growth is typical in many undisturbed streams in the American Southwest, and should not be counted while measuring Indicator 1. If the entire transect appears as shown in this photo, it would receive a score of 5. *Photo by Peter Stacey.*





## A. Water Quality

### Indicator 1. *Algal Growth.*

Starting at the beginning of the 200m in-stream transect, walk in the channel about 0.5m from the water's edge and, using the ocular tube, every 2 meters record the presence or absence of filamentous algae. Do not count the single cell algae that may cover the surface of rocks. Calculate the total percent cover of filamentous algae by dividing number of positive hits by 100. See examples in Photo 1 and 2.



**Photo 3: Channel Shading and Solar Exposure,** (Indicator 2). A section of Calf Creek, near Escalante, Utah, that is heavily shaded at noon by overhanging vegetation. Just upstream from the location where this picture was taken, the plant cover is so thick that almost no direct sunlight reaches the surface of the stream. This type of cover is very effective in keeping water temperatures in the stream low. If the entire study reach resembles this photo, it would receive a score of 5.  
*Photo by Peter Stacey.*

**Photo 4: Channel Shading and Solar Exposure,** (Indicator 2). Willis Creek, near Cannonville, Utah. The creek here is wide and shallow, and has almost no shading from overhanging vegetation or from canyon walls. As a result, water temperatures vary widely throughout the day, and can become very warm in the afternoon. Willis Creek is located about 45 miles from Calf Creek (shown in Photo 3), and it carries about the same amount of water for much of the year. If the entire study reach resembles this photo, it would receive a score of 1.  
*Photo by Peter Stacey.*



## **Indicator 2. Channel Shading and Solar Exposure.**

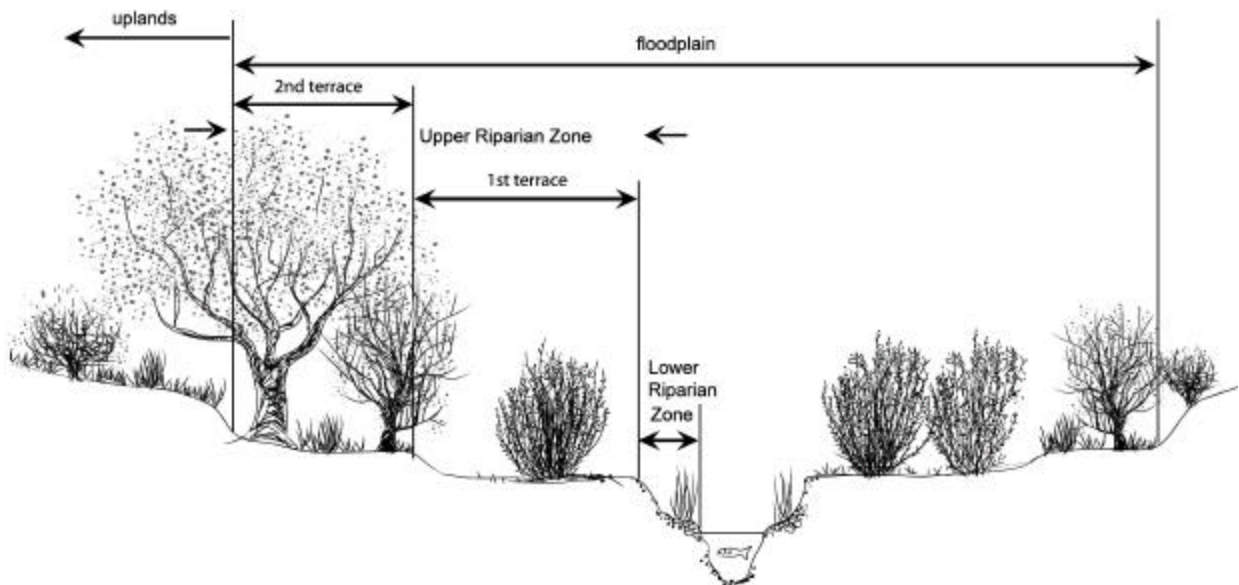
Select three random but representative points along the entire study reach that are not visible from each other and visually estimate the amount of shading over the water surface. Shading can be the result of the landscape (e.g., cliff or canyon walls), or vegetation (e.g., trees and shrubs). Estimate the percent of stream shading within view both upstream and downstream of each observation point, and average those amounts. Record the time of day when this assessment is made (closest to mid-day is best). See examples in Photos 3 and 4.

## **B. Hydrogeomorphology**

### **Indicator 3. Floodplain Connection and Inundation.**

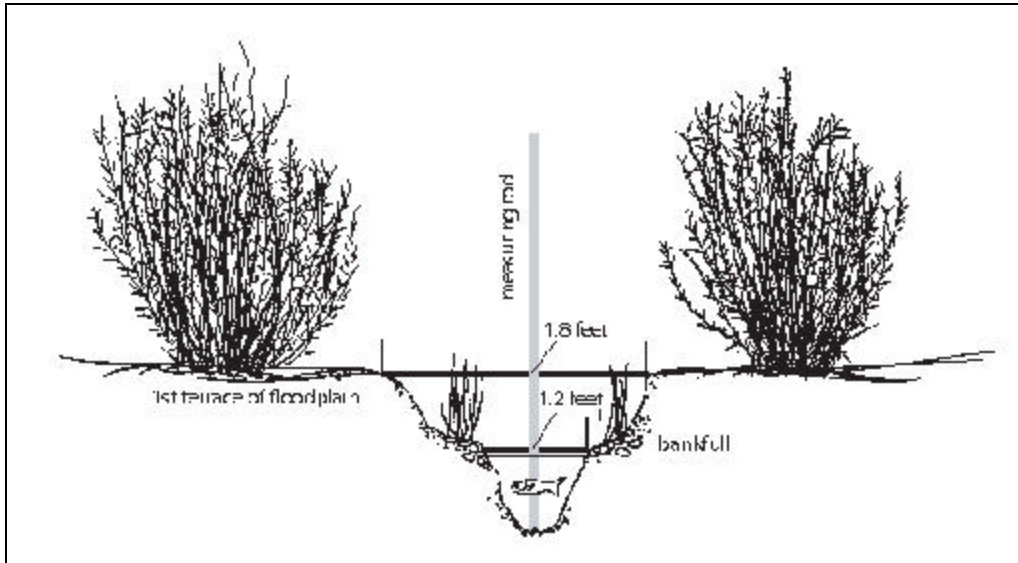
The likelihood that the stream will be able to escape its bank and flow over the flood plain during typical high flow events can be measured by the ratio of the height between the channel bottom and the first terrace that indicates the boundary of the flood plain itself and the distance between the channel bottom and its first bank (bankfull location; see Figures 1 and 2).

To calculate the floodplain-bankfull ratio, choose three random but representative points along the entire study reach. Use a laser level (or a survey instrument if available) to measure the distance between the bottom of the channel and bankfull (in the example in Figure 2, this would

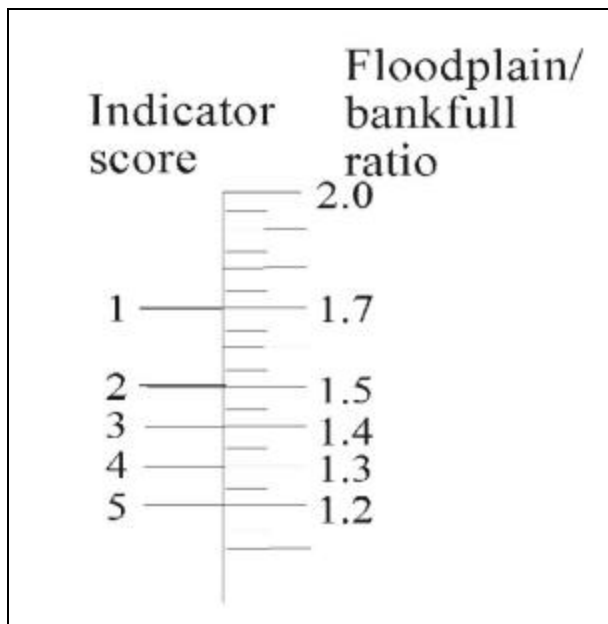


**Figure 1:** Idealized cross section of small and medium sized streams and their associated floodplains in the American Southwest. The scour zone, which is flooded during periods of peak runoff in most years, is also called the Lower Riparian Zone (LRZ), and is used for one of the vegetation transects in this protocol (LRZ transect). The areas of the flood plain that are outside of the scour zone are flooded only during increasingly rarer and increasingly higher flow events. The edge of the first terrace closest to the stream channel marks the inside edge of the Upper Riparian Zone (URZ) as used in this protocol, and a second vegetation transect (URZ transect) is established along this edge. *Illustration by Heidi Snell*

be 1.2 feet). Then measure the distance or height of the beginning or closest part of the floodplain to the channel, and the channel bottom (1.8 feet in this example). Next, divide the floodplain depth by bankfull depth. For Figure 2, 1.8 divided by 1.2 gives 1.5. Use the scoring scale in Figure 3 to determine the score to put on the Score Sheet for this location. In this example, the observed ratio of 1.5 leads to a score of 2. Repeat the measurements at two additional representative locations along the reach, and then take the mean of the three values for the final score for this indicator. The final score indicates the level of connectivity between the stream and its floodplain; a high ratio (and low indicator score) shows less potential for overbank flooding.



**Figure 2:** Method used to measure the ratio between the height above the bottom of the channel to the first terrace on the floodplain and the height of bankfull. This is used for Indicator 3- **Flood plain connection and inundation**. *Illustration by Heidi Snell*



**Figure 3:** Floodplain/bankfull scoring scale. This scale translates the ratio of the floodplain height above the stream bottom divided by the height of the bankfull into an indicator score.



#### **Indicator 4. Vertical Bank Stability.**

Within the 200m in-stream transect, estimate the length of the channel bank where there are actively-eroding, near-vertical cut banks. In fine soils, "sloughing off" of the banks into the channel or flood plain will be obvious. Include both sides of the stream. Estimate the total amount of vertical cut banks on each side of the 200m in-stream transect, and divide by 400m to arrive at the percent cut banks. If the total distance of both banks with vertical banks is 80m, the percent of cut banks would be 20% (80m divided by 400m total). See examples in Photos 5 and 6.



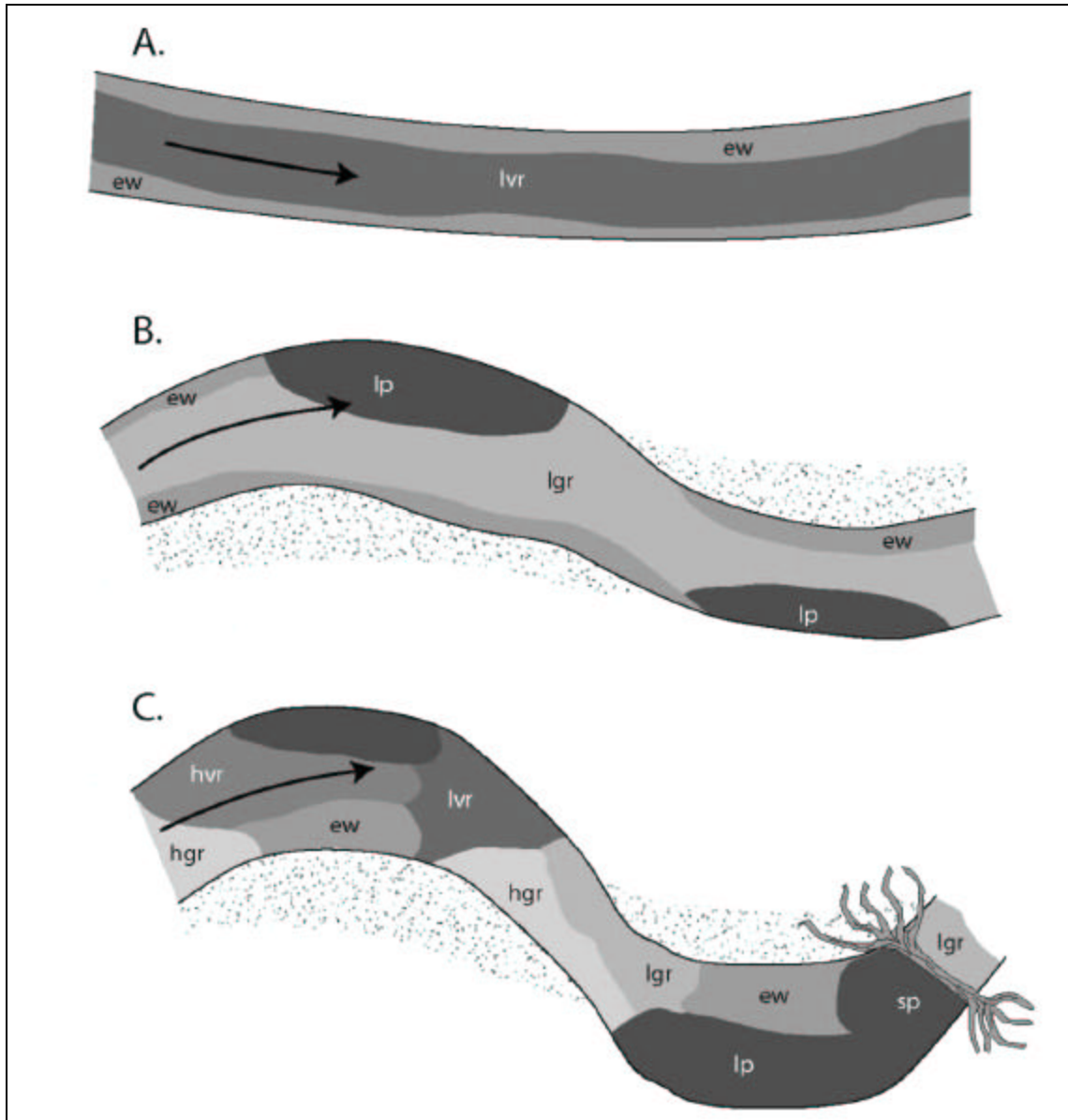
**Photo 5: Vertical Bank Stability** (Indicator 4). A section of the Sevier River near Hatch, Utah. Almost all of the eastern bank of the river is bare soil and shows evidence of vertical instability, including long sections that have recently collapsed into the stream. If the entire in-stream transect resembled conditions shown in the photo, it would receive a score of 1. *Photo by Peter Stacey.*

**Photo 6: Vertical Bank Stability** (Indicator 4). An example where the bank is actively "sloughing off" along the Rio Cebolla in the Jemez Mountains, New Mexico. This reach was being heavily utilized by cattle at the time the photograph was taken. *Photo by Carrell Foxx.*



### Indicator 5. *Hydraulic Habitat Diversity.*

Count the number of distinctive hydraulic and geomorphic channel features observed in the overall reach walk-through. Look for runs, cobble or boulder debris fans, oxbows or other side channels, backwaters, sand-floored runs, or other features that can provide different habitats for fish and other aquatic organisms. Figure 4 gives an example of reaches with different levels of hydraulic feature diversity.



**Figure 4:** Examples of reaches with different levels of **hydraulic habitat diversity** (Indicator 5). Note that the number of different hydraulic habitats tends to increase with the number of meanders. *Illustration by Chad Gourley.*

ew = edge water  
hvr = high velocity riffle  
lgr = low gradient riffle  
sp = scour pool

lvr = low velocity riffle  
lp = lateral pool  
hgr = high gradient riffle



### **Indicator 6. *Riparian Area Soil Integrity.***

During the overall reach walkthrough estimate the extent of soil disturbance in both the lower and upper riparian zones throughout the entire reach. Include both geomorphically inconsistent erosion from human activities (e.g., roads, trails) as well as damage from livestock and from native ungulates such as deer and elk. See examples in Photos 7 and 8.

**Photo 7: Riparian Area Soil Integrity** (Indicator 6). Photo of riparian area soil disturbed by off-road vehicles. *Photo by Liz Thomas.*



**Photo 8: Riparian Area Soil Integrity** (Indicator 6). A section of the riparian area of the Rio Cebolla in the Jemez Mountains, New Mexico, where the soil has been extensively disturbed by ungulate activity. Note the "cow pie" at the bottom center of the photograph. Whenever possible, the source of any soil disturbance found in the reach should be noted. *Photo by Carrell Fox.*

### **Indicator 7. *Beaver Activity.***

Determine during the overall reach walkthrough the extent in the reach of recent beaver activity within the last year, as indicated by tracks, drags, digging marks, cut stems, burrows, dams, and caches.

## **C. Fish/Aquatic Habitat**

When assessing the Fish/Aquatic habitat components of the reach, the observer should walk the entire study reach, and then examine the channel and both banks of the in-stream 200m transect.

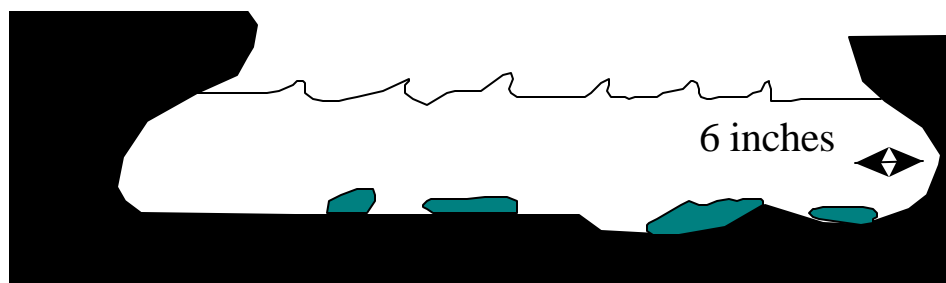
**Qualifier:** If there is no flow currently, but this reach historically supported a fishery, then the entire Fish/Aquatic habitat section receives a score of 1. Continue on to the next section.

### **Indicator 8. *Pool Number and Distribution.***

In a stream that is in dynamic equilibrium, stretches of fast moving and relatively shallow water (riffles) will usually alternate with sections that are deeper and slower moving (pools; see Figure 4). Note and record the number of pools and riffles within the 200m stream transect. Look for geomorphic consistency. For example, a larger number of pools and riffles will occur per unit distance in medium gradient streams, while fewer will be typical of high and low gradient streams.

### **Indicator 9. *Underbank Cover.***

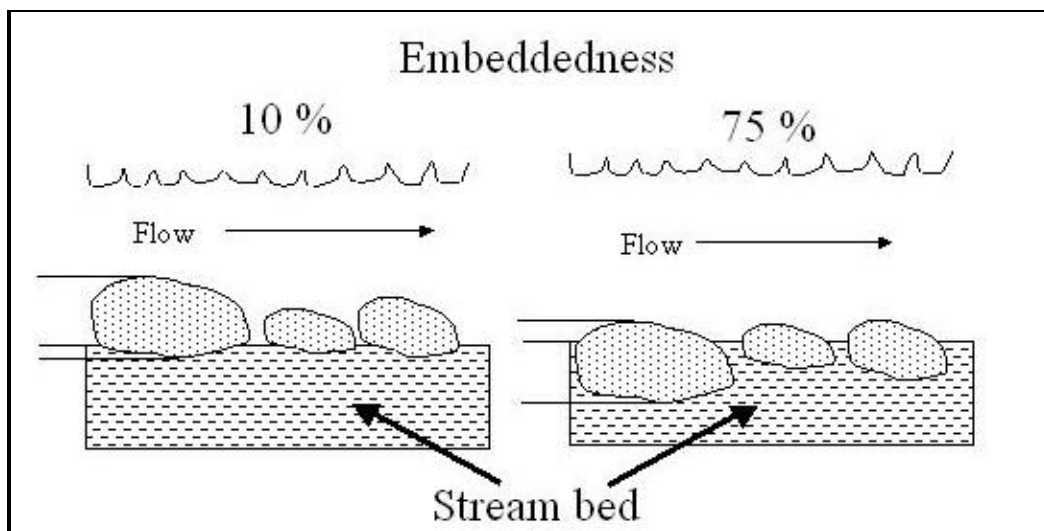
Underbank cover as used here is that amount of bank that has at least a 15 centimeters (6 inch) horizontal distance from the edge of the bank underwater into the undercut (Figure 5). The distance can be estimated by inserting your boot into the undercut. If the bank hits the foot at the ankle height (i.e., if the toe does not hit the undercut before the ankle does), then the undercut is at least 6 inches, and should be counted. Estimate the total amount of underbank cover (undercut) along each bank of the 200m in-stream transect, and divide by 400m to arrive at the percent undercover bank. If the total distance of both banks with undercut is 80m, the percent underbank cover would be 20% (80m divided by 400m total).



**Figure 5:** Underbank Cover measurement. *Illustration by Jim Catlin*

### **Indicator 10. Cobble Embeddedness.**

This measure is defined as the percent surface area of larger particles on the channel bottom (cobbles, larger pebbles and gravel) that is surrounded or covered by sand or silt. To determine embeddedness, randomly select three riffle areas along the reach. Within each area, stand in the middle of the channel and randomly pick up from the bottom six rocks that are 3-8 inches in diameter and note the degree to which each rock was embedded within the substrate. A "sediment line" should be readily visible on the rock, separating that portion of the rock which was resting below the streambed and that above the bed in the flowing water zone (Figure 6). If the sediment line separates the rock halfway between top and bottom, the rating is 50% embedded; 25% of the rock below the line would be 25% embedded, etc. Take the average of all rocks measured to determine the final score.



**Figure 6:** Determining the embeddedness of rocks or cobbles in the stream bed. *Illustration by Jim Catlin*

### **Indicator 11. Aquatic Macroinvertebrate Diversity.**

Sampling for aquatic invertebrates should be done at the same locations in riffle areas where embeddedness is recorded. Pick up and observe the organisms on at least five rocks greater than 6 inches in diameter in each of the three riffle areas. Identify (to the Order only: e.g., stonefly larvae, mayfly larvae, caddisfly larvae, Diptera larvae, beetles, etc.) using the illustrations in Appendix 1 or a suitable field guide. List the Orders found on the worksheet, and note the relative numbers of each.

### **Indicator 12. Large Woody Debris.**

This is defined as wood that is at least partially in the water or located in the active stream channel and that is at least 15cm (approximately 6 inches) in diameter and 1m (approximately 3 feet) in length. Record the number of large woody debris pieces observed within the 200m in-stream transects.





**Photo 9: Overbank Cover and Terrestrial Invertebrate Habitat** (Indicator 13). Section of Calf Creek, near Escalante, Utah, with dense vegetation overhanging almost all of the sides of the stream channel. This vegetation provides habitat for insects and other invertebrates, which may then drop into the water column and provide a key input of food for fish and other aquatic life. If the entire in-stream transect resembles this photo, it would receive a score of 5. *Photo by Peter Stacey.*



**Figure 7:** Overhanging vegetation allows insects to drop into the stream. *Illustration by Jim Catlin.*



**Photo 10: Overbank Cover and Terrestrial Invertebrate Habitat** (Indicator 13). In this section of the Paria River northwest of Page, Arizona, there is little vegetation overhanging the banks of the stream channel, and therefore little opportunity for insects to drop into the water column. If the entire in-stream transect resembles this photo, it would score 2. *Photo by Peter Stacey.*

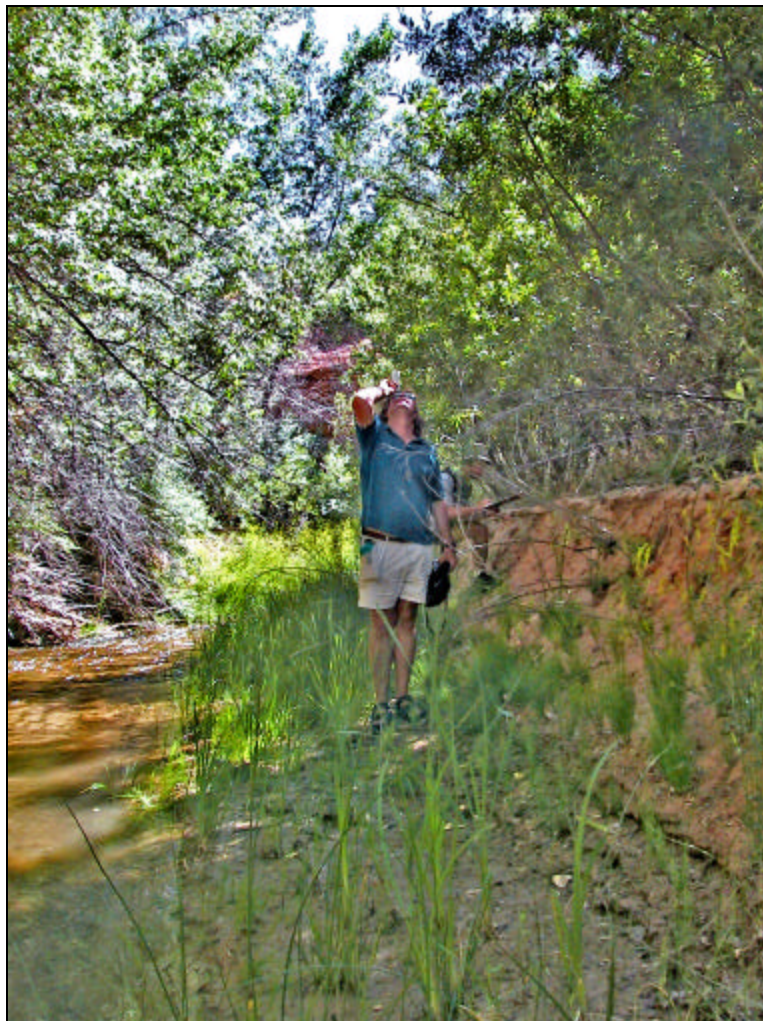
**Indicator 13. *Overbank Cover and Terrestrial Invertebrate Habitat.***

Insects that drop into the stream from overhanging vegetation (Figure 7; Photos 9 and 10) are a key source of food and nutrients for fish and other aquatic life. Visually estimate the distance along both banks of the 200m in-stream transect where there is vegetation (from grass to trees) hanging over the channel. Use the same technique for calculating this measurement as is used in indicators 4 and 9.



## D. Riparian Vegetation

To complete the Score Sheet items in the Riparian Vegetation Section of the assessment, first walk the entire study reach, keeping a list of plant species that you recognize and paying particular attention to exotic species. Next, using the same locomotion and starting point as the in-stream channel transect, measure two 200m long vegetation transects, one for the Lower Riparian Zone (LRZ) and a second for the Upper Riparian Zone (URZ). Both transects should be on the same bank if possible. Mark each end of the transect with a removable flag for easy location. The edge or side of the LRZ transect should be near the water's edge, or channel edge if the stream is dry, while the URZ transect should be located at the edge of the first major terrace (see Figure 1 and Photo 11). Note that the two transects may or may not be parallel to each other depending upon terrain. The assessor(s) should walk and collect data from the LRZ and URZ transects separately.

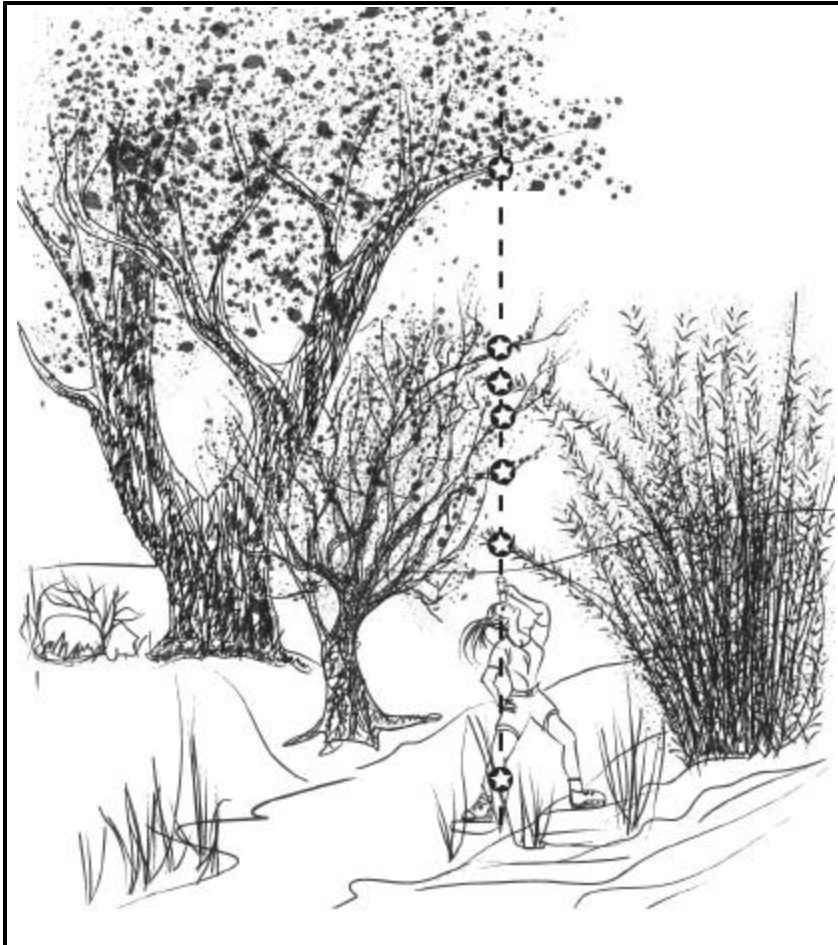


**Photo 11:** Use of ocular tube to measure cover (Indicators 14-15). One of the authors (PBS) taking measurements of cover along a Lower Riparian Zone transect in Kanab Creek. Note that the data are being recorded by a second individual (LES) using a worksheet and clipboard. *Photo by Allison Jones.*

## Indicators 14 and 15. Lower and Upper Riparian Zone Plant Community Structure and Cover.

The presence or absence of vegetation cover observed in each of the four structural layers (ground, shrub, middle canopy, and tall canopy; see Figure 8) should be recorded for both the LRZ and URZ transects. Ground cover is both living grass and herbaceous vegetation, and dead vegetative matter up to 1 meter above the ground. Shrub cover is woody perennial vegetation occurring up to 4 meters above the ground. Middle canopy vegetation is large shrub and small tree cover 4-10 meters above the ground. Tall canopy vegetation is tree cover greater than 10 meters above the ground. The same species (e.g., cottonwoods) may have individuals in different structural layers,

depending on the particular age of the plant.



**Figure 8:** Method of using ocular tube to measure cover in each of the four structural layers used in Indicators 14-15. The four hits in the mid canopy layer are scored as a single “yes” on the worksheet. In this illustration, there is one hit for upper canopy, four for mid canopy and one hit each in the shrub and ground layers. *Illustration by Heidi Snell.*

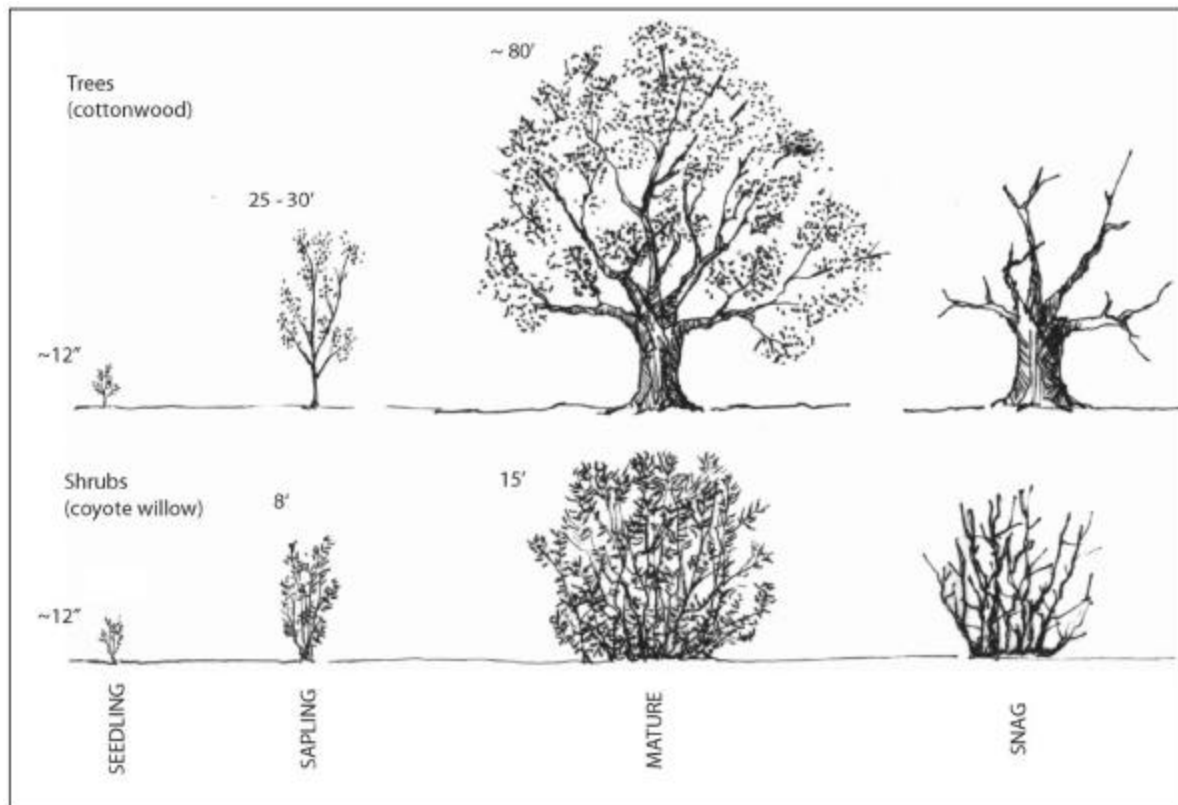
Using an ocular cross-hair tube and the Field Worksheet, walk along the transect and every 2 meters look directly up and down through the tube, and record the presence or absence of plant material (dead or alive) intersecting the vertical sight line of the cross-hairs in each structural layer - ground cover, shrub layer, mid-canopy layer and upper canopy layer (Figure 8 and Photo 11). The line-of-sight through the ocular tube should mimic whether or not a ray of light originating directly overhead will strike any vegetation as it passes through each layer. Use the number of “hits” through the ocular tube for cover in each layer (out of 100 samples along the 200m transect) to determine

percent cover for that layer. Average the scores for the four layers to achieve an overall score. Because local geomorphology can influence the degree of vegetation cover, the scores from the

study reach can be compared with the average values obtained from an appropriate nearby reference site to help guide interpretation.

**Indicator 16 and 17. Native Shrub and Tree Demography and Recruitment.**

The distribution of age classes (seedlings, saplings or immature, mature, and snags; see Figure 9 and Photo 12) of the dominant native species should be determined during the initial study reach walk-through. The observer also should comment on unexpected demographic conditions, such as the absence of particular age classes of expected dominant species, such as willows and cottonwoods in the American Southwest.



**Figure 9: Age classes of shrubs and trees** used for Indicators 16 and 17. Cottonwoods (*populus* spp) and willows (*salix* spp.) are typical dominant native tree and shrub species in the American Southwest. Other taxa may be the expected dominant species in other regions or in special situations. *Illustration by Heidi Snell.*





**Photo 12: Non-native Herbaceous Plant Species Cover** (Indicator 18). Willis Creek, near Cannonville, Utah. The herbaceous cover in the upper riparian zone in this part of the reach is composed almost entirely of the exotic Russian thistle (*Salsola kali*), with few individuals of native species present. There are no herbaceous plants in the Lower Riparian Zone, so this part of the riparian area is not counted during the measurements. If the study reach resembled this photo, it would receive a score of 1 for Indicator 18.

**Native Tree Demography and Recruitment** (Indicator 17). Note that the woody plant cover in the picture is entirely native, and consists of seedlings and mature cottonwoods. If the entire study reach resembles this photo, it would score 3 for Indicator 17.

**Mammal Browsing on Shrubs and Small Trees** (Indicator 21). This section of the stream is heavily utilized by ungulates. Note the extensive browsing on the cottonwood seedlings as indicated by their heavily branched growth. See a closeup of the browsed sapling in Photo 14. Contrast this with the unbrowsed cottonwood saplings seen in photo 16. *Photo by Peter Stacey.*



**Indicators 18 and 19. *Non-native Herbaceous and Woody Plant Species Cover.***

During the initial study reach walkthrough, visually estimate the cover provided by non-native shrub, tree, and herbaceous plant species relative to that provided by native species. Use the background information on exotic or non-native plants to help identify non-native plants. The cover by a plant is represented by all of the ground area that would be shaded by that plant if the sun were directly overhead. Include both the stream and the Lower and Upper Riparian Zones for this estimate. See example in Photo 12 and 13.



**Photo 13: Non-native Woody Plant Species** (Indicator 19). The Fremont River near Cainville, Utah. The south floodplain of the river is covered almost entirely by non-native shrubs and small trees, primarily salt cedar (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*). A few individuals of the native coyote willow (*Salix exigua*) can be seen just to the left of the bottom center of the photograph. If the study reach resembles this photo, it would receive a score of 1 for Indicator 19, non-native woody plant species. *Photo by Peter Stacey.*



**Indicator 20. *Mammalian Herbivory (Grazing) on Ground Cover.***

This assessment can be performed simultaneously with the assessment of vegetation cover (Indicators 14 and 15), while using the ocular tube method described above. While recording the number of positive and negative cover hits for each structural layer on the Lower Riparian Zone and the Upper Riparian Zone transects, also record each time you see evidence of mammalian herbivore impacts on ground cover. Include both native and non-native plants for this measure, and use the number of "hits" to estimate percent ground cover vegetation that has been grazed or clipped by herbivores. Herbivore impacts on ground cover should also be noted during the overall study reach walkthrough. Grazing can include that which is done by both native and non-native (i.e. livestock) species.



**Photo 14: Mammal Herbivory (Browsing) on Shrubs and Small Trees** (Indicator 21). Sapling cottonwood at Willis Creek, near Cannonville, Utah, that has been repeatedly browsed (also see Photo 15) for at least two growing seasons. Almost every major stem of the plant has been clipped. This produces the typical heavy branching growth pattern. If browsing on more than 50% of the shrubs and trees occurs as shown in this photo for the transect, it would score a 1 for this indicator. *Photo by Peter Stacey.*





**Photo 15: Mammal Herbivory (Browsing) on Shrubs and Small Trees** (Indicator 21). Closeup of a coyote willow stem that has recently been clipped by ungulates on the Rio Cebolla in the Jemez Mountains, New Mexico. *Photo by Carrell Foss.*



**Photo 16: Mammal Herbivory on Shrubs and Small Trees** (Indicator 21). Cottonwoods in an area of North Wash near Lake Powell in southeast Utah show no evidence of livestock browsing for decades. Note the erect growth form of the sapling cottonwoods, with a single main stem (compare with Photos 12 and 14). If the entire transect resembles this photo, it would score 5. *Photo by Peter Stacey.*

**Indicator 21. *Mammalian Herbivory (Browsing) on Shrubs and Small Trees.***

Walk again along both the Lower and Upper Riparian Zone transects and estimate the number of shrubs and trees along those transects whose branches or trunks show signs of browsing (clipped ends, etc.; see Photos 14 and 15 for examples). Compare this to those plants that do not show signs of browsing (Photo 16). Herbivore impacts on shrubs and small trees should also be noted during the overall study reach walk through. Browsing can include that done by both native and non-native (livestock) species.

## E. Terrestrial Wildlife Habitat

In this protocol, the functional condition of the stream reach with respect to its native plant structure and health is covered in the vegetation section of the Score Sheet, while the condition of the aquatic system is covered in the fish/aquatic habitat section. Here, we focus on several additional characteristics of the riparian system that indicate whether or not the reach is likely to provide good habitat for a diversity of native terrestrial wildlife.



**Photo 17: Mid and Upper Canopy Patch Density**

(Indicators 23 and 24). A section of Calf Creek, near Escalante, Utah. The mid-canopy, comprised of many different species of native shrubs and trees, is nearly continuous in this part of the reach. In contrast, there is only a single small patch of upper canopy trees (cottonwoods). This area would provide excellent habitat for riparian wildlife that utilize the mid-canopy part of the vegetation, but it would provide poor habitat for those species that depend upon the upper canopy layer. The latter species are unlikely to be present in this section of the reach. If the entire study reach resembled this photo, it would score 5 for mid canopy and 2 for upper canopy patch density. *Photo by Peter Stacey.*



**Photo 18: Upper Canopy Patch Density**

(Indicator 24). Boulder Creek, near Escalante, Utah. There is a continuous layer of upper canopy trees (cottonwoods) in this section of the creek, even though the bedrock substrate limits the extent of the flood plain so that the canopy is only one to two trees wide. If the entire study reach resembled this photo, it would score 5. *Photo by Peter Stacey.*

### **Indicators 22 and 23. *Shrub and Mid-Canopy Patch Densities.***

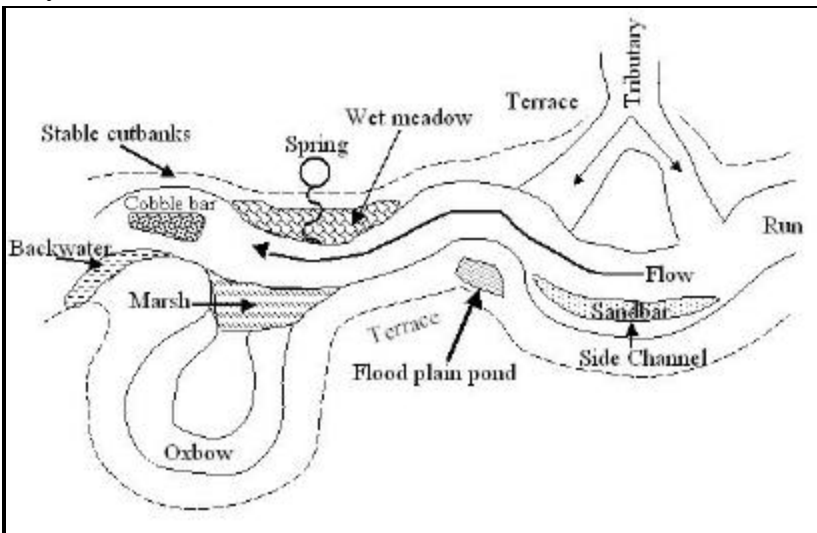
While in a few situations, such as narrow canyons with rock sides, continuous bands of willows and other plants may not be geomorphically possible, most reaches commonly support many such patches, particularly right along the channel. Shrubs are considered here to be woody perennial vegetation occurring up to 4m above the ground. Middle canopy vegetation is large shrub and small tree cover 4-10m above the ground. The frequency and connectedness of patches of both shrubs and mid-canopy trees should be estimated during the overall study reach walkthrough. Include both native and non-native species for these scores. See the example in photo 17.

### **Indicator 24. *Upper Canopy Tree Patch Connectivity.***

Depending on the geomorphic setting, riparian zones often support many areas where there is a continuously connected tree canopy, made up of cottonwoods, tree willows, and/or other tree species. The canopy can be of different height classes depending on the age of the trees, but here is considered to be at least 10m tall. Note the connectivity of upper canopy patches over the full study reach during the overall walkthrough. Include both native and non-native species for this score. See examples in Photo 17 and 18.

### **Indicator 25. *Fluvial Habitat Diversity.***

The different types of riparian landforms that can provide unique habitats for wildlife should be recorded during the overall study reach walkthrough. These include adjacent springs, wet meadows, ox-bows, marshes, cut banks, sand bars, islands in the channel, etc. (see Figure 10). The geomorphic setting can limit the potential number of fluvial landforms present on the reach. Streams and rivers in canyons and very flat meadows generally exhibit a lower diversity of landforms than those with an intermediate gradient and a well-defined flood plain; scores for this indicator should be scaled to what would be geomorphically possible within the specific study reach.



**Figure 10: Fluvial habitat diversity** (Indicator 25). Types of fluvial habitats. Drawing by Larry Stevens.

## Definitions

**Bankfull level.** This is the level that a stream reaches during average peak run-offs or flows for an average year. There are a few indicators that will help the surveyor find the bankfull level. Look for evidence of water flow that has bent vegetation or deposited silt or litter. Often there is an abrupt break between the upper and lower flood plain that marks bankfull levels. The lower areas are often bare soil or contain aquatic and annual vegetation, while the areas above bankfull often contain perennial forbs, shrubs and trees. In the American Southwest, peak annual stream flows often occur at the end of spring runoff (March and April).

**Benthic Invertebrates.** Primarily stream bottom insects that spend all or a portion of their life stages in a stream, but may include other groups (e.g., worms and snails).

**Ephemeral.** A stream that does not flow continuously throughout the year, but only in direct response to precipitation or during seasonal runoffs such as snow melt in the spring. There may be subsurface water flow year round in ephemeral streams. Other streams may flow year round but dry up during the afternoon on the hottest days. Flow resumes at night when temperatures and surface evaporation declines. These streams are considered ephemeral for the purposes of this protocol since most (but not all) aquatic species cannot tolerate even brief periods of exposure to air. See also Perennial.

**Flood Plain Level.** The flood plain is usually a series of terraces above the bankfull level. The first terrace, or active flood plain, is inundated by high flow events that occur on average once or twice every three years. Look for piles of debris to help age the more recent flood events. Additional terraces are usually found on the flood plain that are the result of increasingly rare but larger flow events (see Lower and Upper Riparian Zones, below).

**Fluvial.** Features and characteristics that are the result of the interaction between water and the underlying substrate (rock, soil, etc.).

**Geomorphically inconsistent and consistent.** The term "geomorphic" refers to the shape, structural characteristics, and geology of a stream channel and its adjacent banks and flood plain. Even in a single region, geomorphic characteristics can vary dramatically among different reaches and watersheds. These, in turn, will affect the expected structure and composition of the aquatic and terrestrial plant and animal communities found in that reach. For example, a stream that runs through a narrow and deep rock canyon would not be expected to develop the same number and type of fluvial habitat types (e.g., ox bows, sand bars, side channels) as would the same sized stream that runs through an open area consisting of alluvial deposits and erodable soils. Therefore, scoring of field indicators must include consideration of the geomorphic context. This guide uses the phrase "geomorphically consistent" and "geomorphically inconsistent" to help the user identify unusual situations that may affect checklist indicator scoring, and is a major reason why reference reaches can be so useful.



**Gradient.** Measured by the distance that a stream drops per unit length of its channel. High gradient streams drop quickly over short distances; as a result water velocities in the stream are high and the water column can move larger particles and more rapidly erode the substrate than can lower gradient, slow moving streams. As a result of these differences, high gradient streams also tend to have fewer meanders than low gradient streams.

**Herbaceous plants.** These are non-woody plants (not trees or shrubs). Herbaceous plants are also known as grasses and forbs.

**Hydrogeomorphology.** Features that pertain to the hydrology and/or geomorphology of the stream and its associated flood plain.

**Lower and Upper Riparian Zones.** There are a number of ways to define the riparian zone. As used here, it consists of the flood plain immediately adjacent to the stream or stream channel, and is where plant growth is affected by surface or underground water flows from the stream system. Plants in the riparian zone are usually able to grow with their roots into the water table. Many also require surface water flows in order to germinate from seeds. Outside of the riparian zone, plants may not be able reach the water table, and they do not require underground or surface waters to grow or germinate. This later area is called, in reference to the riparian zone, the uplands (see Figure 1). The riparian zone itself is further divided for the purposes of this protocol into two sections. The Lower Riparian Zone (LRZ) is the area that is immediately adjacent to the stream channel. It is flooded during peak flows every year, and, as a result, soils are almost always saturated. This zone is occupied by wetland and water-loving species of grasses and sedges, as well as various herbs, shrubs and occasionally trees (see Photo 11). The yearly water flows often create small banks or edges at the outside of the Lower Riparian Zone. Above this, and further away from the channel, is the Upper Riparian Zone (URZ), which consists of the upper terrace(s) of the flood plain. The first terrace of the URZ which is closest to the channel is overtopped by floods only every 1-2 years under normal or unaltered conditions. As one moves further away from the channel, the frequency of flooding becomes progressively less, because the amount of water flow required to reach the higher elevations becomes progressively greater. The URZ extends up to the top of fluvial deposits such as water-borne sand and gravels. While riparian water-loving plants and trees occur in the URZ, it is generally characterized by increasing abundance of upland species that have very deep root systems and do not always need to have water near the surface to germinate or flourish.

**Mammalian herbivory.** This term is used to refer primarily to the consumption of vegetation (i.e. grasses and forbs and shrubs) by mammals. Browse is the grazing of woody shrubs and trees, and can also be used as a noun.

**Macroinvertebrates.** Animals without backbones and that are large enough in size to be seen without the aid of a magnifying glass or other tool.

**Perennial.** In perennial streams, there is surface flow of water year-round. Ephemeral streams dry up during some times of the year (although there may still be subsurface flows). In some systems, all but a few pools in a reach may dry up during the hottest part of the year. Fish may

find refuge in the remnant pools, and spread out once continuous flows resume. These streams are considered perennial for the purposes of this assessment protocol.

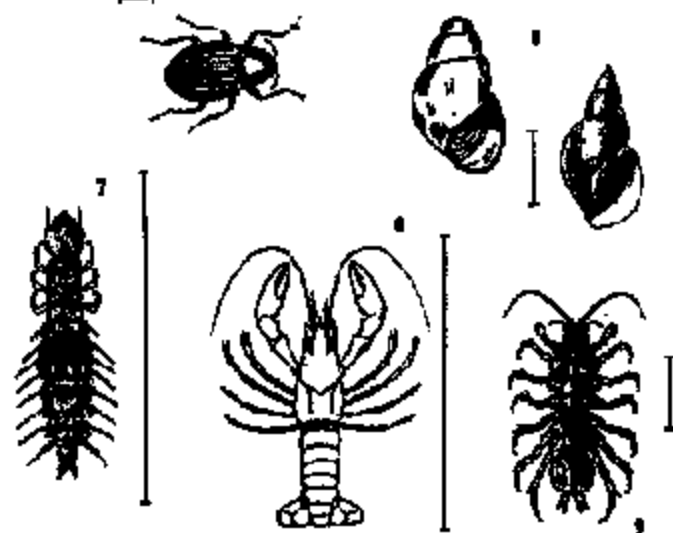
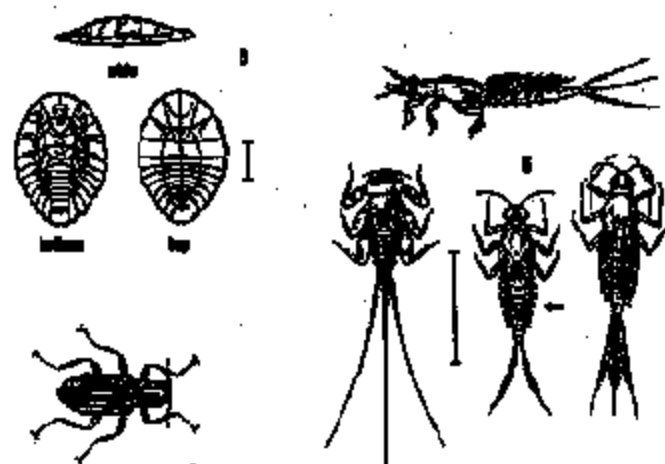
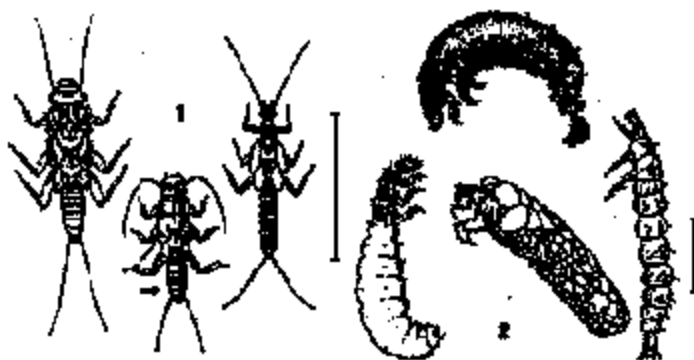
**Sinuosity.** A measure of how much the stream channel meanders within the flood plain or valley bottom. A common measure of sinuosity is the length of a line along the middle of the stream channel (thalweg) divided by the straight line distance between the top and bottom of the sample reach. The greater the resulting value is, the more sinuous the stream. Sinuosity varies greatly depending upon gradient, type of substrate, shape of the natural hydrograph or annual patterns of stream flow, etc., as well as being highly impacted by human alterations of the channel and the stream's hydrograph.

**Succession.** The tendency of plant communities to move through a regular series of species compositions and structures (called seral stages) over time on a specific site, and in the absence of disturbance. Thus, a riparian zone that has been "wiped clean" by a large flood may first be colonized by forbs, then later by grasses and sedges, next by shrubs, and finally by trees. The last stage in succession is called the climax community, or the potential vegetation state. The extent to which succession is an important process in riparian communities is controversial. Some researchers believe stream riparian systems in the absence of disturbances are in dynamic equilibrium and constantly changing at any one location.

**Woody plants.** Shrubs and trees that have woody stems and trunks, and that are generally long lived. New growth is added each year at the tip of the stem, rather than at the base as with grasses.

## Stream Invertebrate Species

### Appendix 1: Benthic Macroinvertebrate Species Orders, Used for Indicator 11 Page 1 of 2.



Bar line indicates actual size

#### Pollution Intolerant Taxa

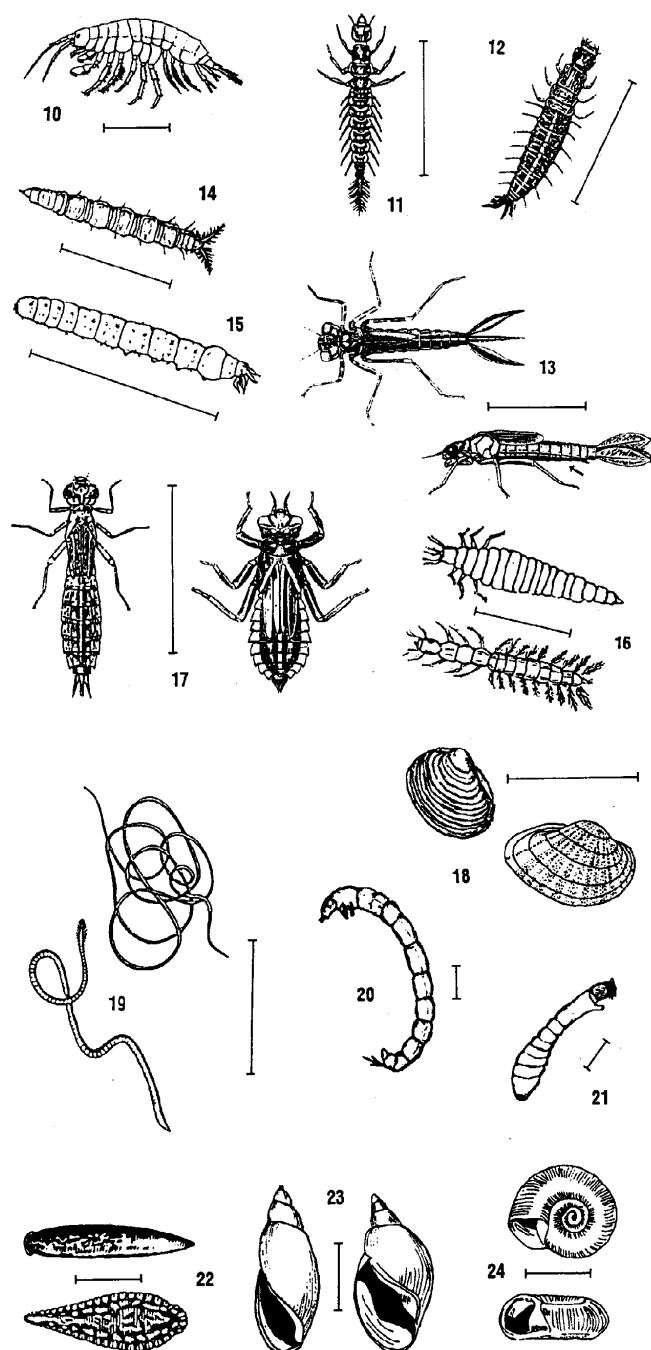
1. Stonefly, Order Plecoptera
2. Caddisfly, Order Trichoptera
3. Water Penny, Order Zygoptera
4. Riffle Beetle, Order Coleoptera
5. Mayfly, Order Ephemeroptera
6. Gilled Snail, Order Prosobranchia
7. Dobsonfly (Hellgrammite)  
Order Megaloptera

#### Somewhat Pollution Tolerant Taxa

8. Crayfish, Order Decapoda
9. Sowbug, Order Isopoda

Source: Isaac Walton League of America published in  
NWCC Technical Note 99-1 Stream Visual  
Assessment Protocol, Dec 1998

## Appendix 1: Indicator 11 Benthic Macroinvertebrate Species Orders, page 2 of 2.



Bar line indicates actual size

In this riparian assessment for those organisms that are listed as "Class," count those as one "order."

### Somewhat Pollution Tolerant Organisms

10. Scud, Order Amphipoda
11. Alderfly Larva, Order Megaloptera
12. Fishfly Larva, Order Megaloptera
13. Damselfly, Order Odonata
14. Watersnipe Fly Larva, Order Megaloptera
15. Crane Fly, Order Diptera
16. Beetle Larva, Order Coleoptera
17. Dragon Fly, Order Odonata
18. Clam/Mussel, Class Bivalvia

### Pollution Tolerant Organisms

19. Aquatic Worm, Class Oligochaeta
20. Midge Fly Larva, Order Diptera
21. Blackfly Larva, Order Diptera
22. Leech, Order Hirudinea
23. Pouch Snail and Pond Snails, Order Pulmonata
24. Other Snails, Order Pulmonata



## Appendix 2: Rapid Stream-Riparian Assessment Score Sheet rev March 2006

Stream \_\_\_\_\_ Watershed \_\_\_\_\_ Reach \_\_\_\_\_

Survey Date \_\_\_\_\_ Time \_\_\_\_\_ Weather \_\_\_\_\_

Background information available? \_\_\_\_ Observers \_\_\_\_\_

Contact Info: Address \_\_\_\_\_ Phone \_\_\_\_\_ Email \_\_\_\_\_

Reach (UTM) Start \_\_\_\_\_ N \_\_\_\_\_ E Length Suveyed \_\_\_\_\_  
Stop \_\_\_\_\_ N \_\_\_\_\_ E

UTM zone \_\_\_\_\_

Stream Transect Start \_\_\_\_\_ N \_\_\_\_\_ E  
Upstream or Down? \_\_\_\_ USGS Quad Map Name: \_\_\_\_\_

Veg. Transect Upstream or Down? \_\_\_\_

Reference Photos #1 \_\_\_\_\_ N \_\_\_\_\_ E  
#2 \_\_\_\_\_ N \_\_\_\_\_ E Reach Elevation \_\_\_\_\_

OVERALL RATING: \_\_\_\_\_ CONDITION \_\_\_\_\_

Previous Ratings: DATE \_\_\_\_\_ Overall Score \_\_\_\_\_ Current Trend \_\_\_\_\_

Individual Previous Scores WQ \_\_\_\_ HG \_\_\_\_ F/AH \_\_\_\_ RV \_\_\_\_ TWH \_\_\_\_

Score (1-5 or N/A)	Indicator Number	Indicator	Scoring Definitions and Directions Scores of 5 indicate that the indicator is close to the potential of the geologically and biologically similar reference reach, and/or what would be expected to be found in a healthy ecosystem, a reference reach without anthropogenic disturbance. Scores of 1 indicate riparian or stream components that are not functioning properly. Use N/A if the indicator is not relevant or appropriate for this particular reach.	Notes on measurement methods
<b>WATER QUALITY</b>				
	<b>1</b>	<b>Algal Growth</b>	1 = >50% of stream bottom covered by filamentous algae 2 = 26-50% of bottom covered by filamentous algae 3 = 11-25% of bottom covered by filamentous algae 4 = 1-10% of bottom covered by filamentous algae 5 = no filamentous algae on stream bottom	Use ocular tube and field worksheet to score 0.5m from bank every 2m in 200m in-stream transect. Do not count the single cell algae on the surface of rocks.
	<b>2</b>	<b>Channel Shading, Solar Exposure</b>	1 = stream channel completely unshaded 2 = slight shading 3 = moderate shading 4 = substantial shading 5 = shading is geomorphically consistent	Look up and down stream in three different representative points in the overall stream reach. Look for geomorphic consistency.
<b>Water quality mean score:</b>		<b>Notes:</b>		

## HYDROGEOMORPHOLOGY (STREAM FORM)

	<b>3</b>	<b>Floodplain Connection and Inundation</b>	1 = >1.7 bankfull / depth ratio 2 = >1.5 - 1.7 bankfull / depth ratio 3 = >1.4 - 1.5 bankfull / depth ratio 4 = >1.3 - 1.4 bankfull / depth ratio 5 = 1.0 - 1.3 bankfull / depth ratio	Use field worksheet and measure ratios at three representative locations in the overall stream reach.
	<b>4</b>	<b>Vertical Bank Stability</b>	1 = >90% of channel banks are vertically unstable 2 = 61 - 90% of banks are unstable 3 = 31 - 60% of banks are unstable 4 = 5 - 30% of banks are unstable 5 = <5% of banks are unstable	Estimate along both banks of 200m in-stream transect. Do not include rock or cliff faces.
	<b>5</b>	<b>Hydraulic Habitat Diversity</b>	1 = no diversity (variability) of stream form features 2 = low diversity 3 = moderate diversity 4 = moderately high diversity 5 = high diversity, geomorphically consistent	Check in overall walk through. Examples include runs, pools, cobble or boulder debris fans, off-river side channels, backwaters, sand-floored runs, etc.
	<b>6</b>	<b>Riparian Area Soil Integrity</b>	1 = >25% of surface riparian soil surface disturbed 2 = 16 - 25% disturbed 3 = 6 - 15% disturbed 4 = 1 - 5% disturbed 5 = <1% disturbed	Check in overall walk through. Look for unnatural surface disturbances in the flood plain from such things as vehicles, foot travel, and ungulate activity.
	<b>7</b>	<b>Beaver Activity</b>	1 = beavers not now present but were historically 2 = no beaver dams, few signs of activity in last year 3 = conspicuous recent activity but no dams 4 = beaver dams on some of the stream 5 = beaver activity and dams dominate stream	Check in overall walk through. Beaver sign includes tracks, drags, digging marks, cut stems, burrows, dams, and caches active within past season.
<b>Hydrogeomorphology mean score:</b>   		<b>Notes:</b>   		

## FISH/AQUATIC HABITAT

**Qualifier:** If the stream is no longer perennial, but used to be a fishery, the mean score entered for this section is a score of "1." (It is no longer functioning as fish/aquatic habitat>)

	<b>8</b>	<b>Pool Distribution</b>	1 = no pool habitat in 200m stream transect 2 = one to several pools 3 = limited to moderate pool and riffle distribution in reach 4 = moderate to abundant pool and riffle distribution 5 = pools abundant (>50% of transect has pools connected by riffles)	Check along 200m in-stream transect. Look for geomorphic consistency (e.g. high gradient streams will have more pools than low gradient streams).
	<b>9</b>	<b>Underbank Cover</b>	1 = no underbank cover in 200m stream transect 2 = <10% transect has underbank cover 3 = 10 - 25% of transect has underbank cover 4 = 26 - 50% of transect has underbank cover 5 = >50% of transect has underbank cover	Check along both banks of 200m in-stream transect. Undercut must be at least 15cm (6 in) into the streambank.
	<b>10</b>	<b>Cobble Embeddedness</b>	1 = average of >50% of rock volume is imbedded in fine silt 2 = 41 - 50% of rock imbedded 3 = 26 - 40% of rock imbedded 4 = 20 - 25% of rock imbedded 5 = <20% of rock imbedded	Determine the percent embeddedness of a sample of 6 rocks 3-8" in diameter from riffles in each of three different random points along the overall stream reach.
	<b>11</b>	<b>Aquatic Macro-invertebrate Diversity</b>	1 = no aquatic (benthic) macroinvertebrates found 2 = 1 macroinvertebrate order present 3 = 2 macroinvertebrate orders present 4 = 3 macroinvertebrate orders present 5 = 4 or more orders present	Examine 5 rocks 15cm (6") or larger at the same sites used for Indicator 10. Use Appendix 2 or other guide to identify macroinvertebrate orders.
	<b>12</b>	<b>Large Woody Debris</b>	1 = no large woody debris (LWD) in transect 2 = <3 LWD pieces in transect 3 = 3 - 5 LWD pieces in transect 4 = 6 - 10 LWD pieces in transect 5 = >10 LWD pieces in transect	Count woody debris pieces larger than 15cm (6") in diameter and 1m (3 ft) long or longer in the channel in the 200m in-stream transect
	<b>13</b>	<b>Overbank Cover and Terrestrial Invertebrate Habitat</b>	1 = no grass, shrubs, trees overhang water 2 = <10% of bank has grass, trees, shrubs that overhang the water 3 = 10 - 25% of bank has overhanging veg. 4 = 26 - 50% of bank has overhanging veg. 5 = >50% of bank has overhanging veg.	Check along both banks of 200m in-stream transect. Look for geomorphic consistency. Do not include rocks or cliff faces.

**Fish/Aquatic Habitat mean score:**

**Notes:**

## RIPARIAN VEGETATION

	<b>14</b>	<b>Lower Riparian Zone Plant Community Structure and Cover</b>	<p>1 = &lt;5% average plant cover in lower riparian zone (LRZ)</p> <p>2 = 5 - 25% average plant cover in LRZ</p> <p>3 = 26 - 50% average plant cover in LRZ</p> <p>4 = 51 - 80% average plant cover in LRZ</p> <p>5 = &gt;80% average plant cover in LRZ</p>	Use the field worksheet and ocular tube to determine the cover for the ground, shrub, midcanopy and tall canopy layers along 200m transect in the lower riparian zone. Look for geomorphic consistency.
	<b>15</b>	<b>Upper Riparian Zone Plant Community Structure and Cover</b>	<p>1 = &lt;5% average plant cover in upper riparian zone (URZ)</p> <p>2 = 5 - 25% average plant cover in URZ</p> <p>3 = 26 - 50% average plant cover in URZ</p> <p>4 = 51 - 80% average plant cover in URZ</p> <p>5 = &gt;80% average plant cover in URZ</p>	Use the field worksheet and ocular tube to determine the cover for ground, shrub, midcanopy and tall canopy layers along the 200m transect in the upper riparian zone. Look for geomorphic consistency.
	<b>16</b>	<b>Shrub Demography and Recruitment</b>	<p>1 = no native shrubs present in study reach</p> <p>2 = one age class present</p> <p>3 = two classes present, one class with seedlings or young shrubs</p> <p>4 = three age classes present</p> <p>5 = all age classes present</p>	Determine during the overall walk through the number of age classes (seedlings, saplings, mature, standing dead) for the dominant (most common) native shrub species.
	<b>17</b>	<b>Tree Demography and Recruitment</b>	<p>1 = no native tree present in study reach</p> <p>2 = one age class present</p> <p>3 = two classes present, one class with seedlings or saplings</p> <p>4 = three age classes present</p> <p>5 = all age classes present</p>	Determine during the overall walk through the number of age classes (seedlings, saplings, mature, standing dead) for the dominant (most common) deciduous native tree species.
	<b>18</b>	<b>Non-native Herbaceous Plant Species</b>	<p>1 = &gt;50% of herbaceous plant cover are not native species</p> <p>2 = 26 - 50% herbaceous not native</p> <p>3 = 11 - 25% herbaceous not native</p> <p>4 = 5 - 10% herbaceous not native</p> <p>5 = &lt;5% of herbaceous cover not native</p>	Estimate on the overall walk through.
	<b>19</b>	<b>Non-native Woody Plant Species</b>	<p>1 = &gt;50% of woody plant cover are not native species</p> <p>2 = 26 - 50% of woody cover not native</p> <p>3 = 11 - 25% of woody cover not native</p> <p>4 = 5 - 10% of woody cover not native</p> <p>5 = &lt;5% of woody cover not native</p>	Estimate on the overall walk through.
	<b>20</b>	<b>Mammal Herbivory (Grazing) Impacts on Ground Cover</b>	<p>1 = &gt;50% of plants impacted by grazing, signs of ungulates common (scat, trampling and trails)</p> <p>2 = 26 - 50% of plants impacted, ungulate use signs are common</p> <p>3 = 11 - 25% of plants impacted</p> <p>4 = 5 - 10% of plants impacted</p> <p>5 = &lt;5% of plants impacted</p>	Use the field worksheet and ocular tube to determine the number of "hits" showing herbivory on the ground covering plants (grasses and forbs) on the LRZ and URZ 200m transect. Use average of the two transects to score.

## RIPARIAN VEGETATION, CONTINUED

	<b>21</b>	<b>Mammal Herbivory (Browsing) Impacts on Shrubs and Small Trees</b>	1 = >50% of plants (shrubs and trees) impacted 2 = 26 - 50% of plants impacted 3 = 11 - 25% of plants impacted 4 = 5 - 10% of plants impacted 5 = <5% of plants impacted	Using the same transects as for Indicator 20, estimate the percentage of shrubs and small trees that have branch tips that have been clipped or eaten by large mammals.
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**Riparian Vegetation,  
mean score:**

Notes:

## TERRESTRIAL WILDLIFE HABITAT

	<b>22</b>	<b>Shrub Patch Density</b>	1 = no shrub patches in stream reach 2 = few, isolated shrub patches 3 = isolated patches 4 = few large open areas between large patches 5 = almost continuous dense shrub cover	In overall walk through, examine patches and clusters of shrubs (<4m tall) and openings between those clusters. Look for geomorphic consistency.
	<b>23</b>	<b>Mid-Canopy Patch Density</b>	1 = no mid-canopy shrub or tree patches in reach 2 = few isolated small patches in mid canopy 3 = isolated patches 4 = few large open areas between large patches 5 = almost continuous dense mid-canopy cover	In overall walkthrough, examine clusters of mid-canopy large shrubs and trees (4-10m tall) and openings between those clusters. Look for geomorphic consistency.
	<b>24</b>	<b>Upper Canopy Patch Density and Connectivity</b>	1 = no large trees present in reach 2 = 1 - 25% of upper canopy patches connected 3 = 26-50% of upper canopy patches connected 4 = 51-75% of upper canopy patches connected 5 = >75% of upper canopy patches connected	In overall walk through, examine clusters of upper canopy trees (>10m tall) and openings between those clusters. Look for geomorphic consistency.
	<b>25</b>	<b>Fluvial Habitat Diversity</b>	1 = no other fluvial habitat besides the stream channel 2 = one other type of fluvial habitat present 3 = two other types present 4 = three other types present 5 = four or more other types present	Examine during overall walk through. Fluvial habitat types include flood-plain ponds, oxbows, side channels, sand bars, wet meadows, beaver ponds, and stable cutbanks.

**Terrestrial Wildlife  
Habitat, mean score:**

Notes:

## Final Score - Rapid Stream Riparian Assessment

### Mean Scores:

Water Quality:

Hydro-geomorphology:

Fish/Aquatic Habitat:

Riparian Vegetation:

Wildlife Habitat:

**Overall Score:**

Overall Comments:

Attach field worksheets (including the human impact worksheet) to this score sheet

### **Appendix 3: Rapid Stream Riparian Assessment Field Worksheet**

The worksheet that follows is used in the field to collect the data that are then used to calculate the scores for the indicators in the Rapid Stream Riparian Assessment. This completed worksheet should be attached to the RSRA Score Sheet and kept as part of the permanent record.

The worksheet is organized into physical areas of observation (study reach or individual transects). A GPS unit should be used to record the ends of the stream reach, individual transects, and other sample locations. This will allow other observers to return to the exact same location in future years and collect the same data. This will allow anyone to determine whether there have been any changes in the indicators over the intervening period (positive or negative).

The record for photographs also should include information that will allow others in the future to revisit the same site and take a similar photograph. This information includes the GPS location and the direction that the photograph was taken. Try to frame your picture to show both the ground and surrounding topography.

In some cases, the indicator assessment method calls for the User to count the number of observations that, for example, show the presence of filamentous algae. An efficient way to tally the data for these indicators is the “five strike” method where each count gets a vertical mark and the fifth then crosses through the other four to make five. This is continued in groups of five, and makes totaling the count easier.

Updated 7 April 2006

## Rapid Stream Riparian Assessment Field Worksheet

revised 7 April 2006

Stream reach identification: \_\_\_\_\_ Date: \_\_\_\_\_

### Whole Study Reach Transect

Begin by recording the GPS locations of the ends of the study reach on the Score Sheet, and take reference photos at both ends of the study stream reach transect. Data for the following indicators are gathered on the whole reach transect:

**Indicator 5** (Hydraulic Habitat diversity), **Indicator 6** (Riparian Area Soil Integrity)  
**Indicator 7** (Beaver, Signs of activity), **Indicator 16** (Native Shrub Demography),  
**Indicator 17** (Native Tree Demography), **Indicator 18** (Non-Native Herbaceous species),  
**Indicator 19** (Non-Native Woody Plant Species), **Indicator 22** (Shrub Patch Density),  
**Indicator 23** (Mid-Canopy Patch Density), **Indicator 24** (Upper Canopy Patch Density), and  
**Indicator 25** (Fluvial Habitat Diversity).

**Indicator 5:** Hydraulic Habitat Diversity (number of different stream features).

Check each type of hydraulic (stream) features providing aquatic habitat.

- ☐ edge water
- ☐ low velocity riffle
- ☐ high velocity riffle
- ☐ lateral pool
- ☐ high gradient riffle
- ☐ low gradient riffle
- ☐ scour pool
- ☐ cobble/boulder debris fans
- ☐ side channels
- ☐ backwaters
- ☐ sand-floored runs
- ☐ other (type \_\_\_\_\_)

Total number of different feature types: \_\_\_\_\_

**Indicator 6:** Riparian Area Soil Integrity.

Notes \_\_\_\_\_ Percent soil area disturbed \_\_\_\_\_

**Indicator 7:** Beaver Activity.

(Signs of beaver activity include tracks, drags, digging marks, cut stems, burrows, dams, and caches).

Signs observed \_\_\_\_\_

**Indicator 16:** Native Shrub Demography and recruitment.

Circle age classes present: seedling, immature, mature, old dead clumps.

Notes \_\_\_\_\_



**Indicator 17:** Native Tree Demography and Recruitment.

Circle age classes present: seedling, immature, mature, snags.

Notes \_\_\_\_\_

**Indicator 18:** Non-Native Herbaceous Plant Species Cover.

(grasses and forbs, as percentage of total grass and forb cover).

Percent of non-native herbaceous plants \_\_\_\_\_

Notes \_\_\_\_\_

**Indicator 19:** Non-Native Woody Plant Cover.

(shrubs and trees, as percentage of total shrub and tree cover).

Percent of non-native woody plant cover \_\_\_\_\_

Notes \_\_\_\_\_

**Indicator 22:** Shrub Patch Density.

Notes \_\_\_\_\_

**Indicator 23:** Mid-canopy Patch Density.

Notes \_\_\_\_\_

**Indicator 24:** Upper Canopy Patch Density.

Notes \_\_\_\_\_

**Indicator 25:** Fluvial Habitat Diversity.

Check each type of geophysical feature providing riparian habitat:

- ☐ flood-plain ponds
- ☐ oxbows
- ☐ side channels
- ☐ sandbars
- ☐ wet meadows
- ☐ marsh
- ☐ stable cutbanks
- ☐ beaver pond
- ☐ others (name \_\_\_\_\_)

Total number of fluvial habitat types \_\_\_\_\_

### Three Representative Reach Sites

Data for the following indicators are collected at three different and representative sites along the study reach. The locations used for each indicator may be the same or different as appropriate.

**Indicator 2:** Channel Shading and Solar Exposure.  
(percent of stream surface shaded at mid-day).

Observation Site 1: Percent stream shaded \_\_\_\_\_ %  
(Optional GPS) UTM N \_\_\_\_\_ E \_\_\_\_\_

Observation Site 2: Percent stream shaded \_\_\_\_\_ %  
(Optional GPS) UTM N \_\_\_\_\_ E \_\_\_\_\_

Observation site 3: Percent stream shaded: \_\_\_\_\_ %  
(Optional GPS) UTM N \_\_\_\_\_ E \_\_\_\_\_

Average of three observation sites \_\_\_\_\_ % Time recorded \_\_\_\_\_

**Indicator 3:** Floodplain Connection and Inundation.  
(data are taken at three representative sites).

Site 1: Value for channel bottom \_\_\_\_\_ Bankfull \_\_\_\_\_ 1st Terrace \_\_\_\_\_  
Bankfull depth \_\_\_\_\_ Floodplain height \_\_\_\_\_  
Ratio of floodplain/bankfull \_\_\_\_\_ Score from Figure 3 \_\_\_\_\_  
(Optional Site GPS) UTM N \_\_\_\_\_ E \_\_\_\_\_  
(Optional) Photo ID \_\_\_\_\_ Direction \_\_\_\_\_

Site 2: Value for channel bottom \_\_\_\_\_ Bankfull \_\_\_\_\_ 1st Terrace \_\_\_\_\_  
Bankfull depth \_\_\_\_\_ Floodplain height \_\_\_\_\_  
Ratio of floodplain/bankfull \_\_\_\_\_ Score from Figure 3 \_\_\_\_\_  
(Optional Site GPS) UTM N \_\_\_\_\_ E \_\_\_\_\_  
(Optional) Photo ID \_\_\_\_\_ Direction \_\_\_\_\_

Site 3: Value for channel bottom \_\_\_\_\_ Bankfull \_\_\_\_\_ 1st Terrace \_\_\_\_\_  
Bankfull depth \_\_\_\_\_ Floodplain height \_\_\_\_\_  
Ratio of floodplain/bankfull \_\_\_\_\_ Score from Figure 3 \_\_\_\_\_  
(Optional Site GPS) UTM N \_\_\_\_\_ E \_\_\_\_\_  
(Optional) Photo ID \_\_\_\_\_ Direction \_\_\_\_\_

Indicator 3, average score for three sites \_\_\_\_\_

### Three Representative Instream Sites

**Collect the data for Indicators 10 and 11 at the same representative stream riffle locations**  
(these sites may be different than those used for the other indicators)

**Indicator 10:** Cobble Embeddedness (three representative riffles, observe six samples per site).

Riffle site 1: Rock embedded \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ Average \_\_\_\_  
(Optional GPS) UTM N. \_\_\_\_ E \_\_\_\_

Riffle site 2: Rock embedded \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ Average \_\_\_\_  
(Optional GPS) UTM N. \_\_\_\_ E \_\_\_\_

Riffle site 3: Rock embedded \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ Average \_\_\_\_  
(Optional GPS) UTM N. \_\_\_\_ E \_\_\_\_

Overall average embeddedness: \_\_\_\_

**Indicator 11:** Aquatic Invertebrates

(Examine at least 5 rocks at least six inches in diameter at each of the sites used to measure embeddedness. Use key for identification and the invertebrate orders found below).

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### **In-stream 200 meter transect**

Data for the following assessment indicators are collected on this transect:

**Indicator 1** (Algal Growth), **Indicator 4** (Vertical Bank Stability),  
**Indicator 8** (Pool Distribution), **Indicator 9** (Underbank Cover),  
**Indicator 12** (Large Woody Debris), and **Indicator 13** (Terrestrial Invertebrate Habitat,  
Overbank cover).

(Optional Photo) Identification \_\_\_\_\_ Photo direction \_\_\_\_\_

(Optional Photo) Location: UTM N \_\_\_\_\_ E \_\_\_\_\_

#### **Indicator 1: Algal Growth.**

(Count the number of samples with filamentous algae taken every 2 meters  
looking straight down with the ocular tube).

Count \_\_\_\_\_

Percent of total stops on transect that are "hits" for algae \_\_\_\_\_

#### **Indicator 4: Vertical Stability of Stream Banks.**

Meters unstable bank (both sides) \_\_\_\_\_

Total \_\_\_\_\_ Percent of transect \_\_\_\_\_

#### **Indicator 8: Pool Distribution.**

Number of pools \_\_\_\_\_ Number of riffles \_\_\_\_\_

Approximate percent of total transect with riffle/pool habitat \_\_\_\_\_

#### **Indicator 9: Underbank Cover.**

Meters of underbank cover (both sides) \_\_\_\_\_

Total \_\_\_\_\_ Percent of transect \_\_\_\_\_

#### **Indicator 12: Large Wood Debris.**

( > 6 inches in diameter and three feet long).

Pieces of large woody debris \_\_\_\_\_ Total \_\_\_\_\_

#### **Indicator 13: Overbank Cover and Terrestrial Invertebrate Habitat.**

Meters of vegetation hanging over bank (both sides) \_\_\_\_\_

Total \_\_\_\_\_ Percent of stream transect \_\_\_\_\_

## Lower Riparian Zone 200 meter transect

Data for the following indicators are collected on this transect:

**Indicator 14** (Lower Riparian Zone Plant Community Structure and Cover),

**Indicator 20** (Mammalian Herbivory, Grazing of Ground Cover), and

**Indicator 21** (Mammalian Browse of Shrubs).

**Indicator 14:** Lower Riparian Zone Plant Community Structure.

(every two meters observe directly up and down ground, shrub, and middle and tall canopy).

Groundcover count \_\_\_\_\_

Total positive hits \_\_\_\_\_ Percentage positive hits \_\_\_\_\_

Shrub count \_\_\_\_\_

Total positive hits \_\_\_\_\_ Percentage positive hits \_\_\_\_\_

Middle canopy \_\_\_\_\_

Total positive hits \_\_\_\_\_ Percentage positive hits \_\_\_\_\_

Upper canopy \_\_\_\_\_

Total positive hits \_\_\_\_\_ Percentage positive hits \_\_\_\_\_

Average percent cover (all four layers) \_\_\_\_\_

**Indicator 20 (part):** Ungulate Grazing in Lower Riparian Zone.

(Count grass and forb cover that show signs of grazing when performing observations for Indicator 14, LRZ Plant Community Structure and Cover).

Groundcover that has been grazed \_\_\_\_\_

Total positive hits \_\_\_\_\_ Percentage positive hits \_\_\_\_\_

**Indicator 21 (part):** Mammalian Browsing of Shrubs and small Trees in LRZ.

Percent of trees and shrubs showing clipped branches \_\_\_\_\_

Notes \_\_\_\_\_



## Upper Riparian Zone 200 meter transect

Data for the following indicators are collected on this transect:

**Indicator 15** (Upper Riparian Zone Plant Community Structure),

**Indicator 20** (Mammalian (wild and domestic livestock) Grazing of Ground Cover), and

**Indicator 21** (Mammal Browse of Shrubs).

**Indicator 15:** Upper Riparian Zone Plant Community Structure.

(every two meters observe directly up and down for groundcover, shrub, middle and tall canopy).

Groundcover count \_\_\_\_\_

Total positive hits \_\_\_\_\_ Percentage positive hits \_\_\_\_\_

Shrub count \_\_\_\_\_

Total positive hits \_\_\_\_\_ Percentage positive hits \_\_\_\_\_

Middle canopy \_\_\_\_\_

Total positive hits \_\_\_\_\_ Percentage positive hits \_\_\_\_\_

Upper canopy \_\_\_\_\_

Total positive hits \_\_\_\_\_ Percentage positive hits \_\_\_\_\_

Average percent cover (all four layers) \_\_\_\_\_

**Indicator 20 (part):** Ungulate Grazing in Upper Riparian Zone.

(Count grass and forb cover that show signs of grazing when performing observations for Indicator 15, URZ Plant Community Structure and Cover).

Groundcover that has been grazed \_\_\_\_\_

Total positive hits \_\_\_\_\_ Percentage positive hits \_\_\_\_\_ Average of LRZ, URZ \_\_\_\_\_

**Indicator 21 (part):** Ungulate Browsing of Shrubs and Small Trees in URZ.

Percent of trees and shrubs showing clipped branches \_\_\_\_\_

Average of LRZ, URZ \_\_\_\_\_

Notes \_\_\_\_\_

## Appendix 4: Human Impacts Worksheet

(Note: This information can be used to help interpret the scores recorded from a survey in the study reach during the assessment and suggest possible areas for future restoration, if necessary. This information does not influence the assessment score. If this optional worksheet is completed, attach it to the other worksheets for this stream reach.

To what extent does the current hydrograph of the stream match the likely historic and undisturbed hydrograph?

To what extent has the upland areas of the watershed been altered by human activity in a way that would impact the functioning of this reach (e.g. timber harvests, loss of plant cover, etc.)?

If the reach is grazed by livestock, is grazing use consistent with the current management plan (Allotment Management Plan) and appropriate for the watershed?

To what extent is the stream and adjacent areas free of road impacts, including bridges? How far from the channel are the impacts from the road?

To what extent has the channel geomorphology been affected by human activities (e.g., channelization, check dams, irrigation canals, etc.)?

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<sup>1</sup> Stevens, L.E., Stacey, P.B., Jones, A. L., Duff, D., Gourley, C., and J.C. Catlin. 2005. A protocol for rapid assessment of southwestern stream-riparian ecosystems. Proceedings of the Seventh Biennial Conference of Research on the Colorado Plateau titled *The Colorado Plateau II, Biophysical, Socioeconomic, and Cultural Research*. Charles van Riper III and David J. Mattsen Ed. pp 397-420. Tuscon, AZ: University of Arizona Press.