User's Guide

Rapid Assessment of the Functional Condition of Stream-Riparian Ecosystems in the American Southwest

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About This Guide

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. 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.

Cover Photograph: Calf Creek, Grand Staircase-Escalante National Monument. This is a recovering system that has 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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Introduction

1.0 Introduction

Stream-riparian zones are some of the most productive and important natural resources found on public and private lands. These ecosystems include the stream and the terrestrial habitat that extend outwards to the edge of the floodplain. They are highly valued as habitats for fish and wildlife, as a source of clean water 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. These assessment methods can be used to detect components that are not functioning well or may be at risk in the future, prioritize management strategies and/or possible restoration activities if problems are discovered, objectively monitor any future changes within the system, and document the success of restoration programs or management actions. An effective assessment protocol must include consideration of the interactions among stream, fluvial wetland, and riparian habitats, as well as the potential impacts of upstream and adjacent upland areas.

The Rapid Stream-Riparian Assessment (RSRA) utilizes a primarily qualitative 1 - 5 rating assessment scale 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 floodplain 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). 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.

Table 1: RSRA Indicator Variables

	Indicator	Category and Variable	Justification For Inclusion In RSRA Assessment
Water Quality	**1**	Algal growth	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	**2**	Channel shading and solar exposure	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	**3**	Floodplain connection and inundation frequency	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	**4**	Vertical bank stability	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	**5**	Hydraulic habitat diversity	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	**6**	Riparian area soil integrity	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	**7**	Beaver activity	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.

Table 1: RSRA Indicator Variables

Fish/Aquatic Habitat	Qualifier	Loss of perennial flows	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).
	8	Riffle-pool distribution	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.
	9	Underbank cover	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.
	10	Cobble embeddedness	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.
	11	Diversity of aquatic invertebrates	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.
	12	Large woody debris	The amount, composition, distribution and condition of large woody debris in the stream channel and along the banks provides important fish habitat for nursery cover, feeding, and protective cover. Streams with adequate large woody debris generally have greater habitat diversity, a natural meandering shape and greater resistance against high water events.
	13	Overbank cover and terrestrial invertebrate habitat	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.

Table 1: RSRA Indicator Variables

Riparian vegetation	14	Plant community cover and structural diversity	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.
	15 and 16	Dominant shrub and tree demography (recruitment and age distribution)	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.
	17 and 18	Mammalian herbivory impacts on ground cover	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.
	19	Non-native herbaceous and woody plant cover	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.
	20	Mammalian herbivory impacts on shrubs and small trees	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	21,22, and 23	Riparian shrub and tree canopy cover and connectivity	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 overbank flow.
	24	Fluvial habitat diversity	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.

Introduction

1.1 Indicator Selection

Four principles guided selection of the RSRA variables. First, we focus on indicators that measure the ability of the system to provide specific ecological functions that are critical to the long-term maintenance of a healthy stream-riparian ecosystem and provide ecological resilience to stresses caused by climate change. Many of these functions are also ecological services that are important to human communities, such as producing clean water or preventing flooding, and are subject to local, state, or federal regulations. We included indicators that can 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 provide important habitat for fish and other aquatic species and their presence indicates that the bank is well vegetated, and there is sufficient root mass to allow the development of the hourglass shape channel cross-section typical of most healthy streams. This would suggest that the fluvial processes of erosion and deposition along that stretch of the reach are in relative equilibrium.

Second, we focus on variables that could be measured rapidly, do not require specialized equipment, or training. The protocol can be conducted not only by specialists, but conservationists, agency personnel, landowners, and other interested laypersons with some training. Detailed methods have been developed for many of the indicators included in this protocol. However, because these protocols often require considerable time and expensive equipment, their use will often limit other kinds of information that can be collected. Our goal was to obtain an overall picture of the functioning of the system within a 2 to 3 hour survey period. Should it be found that any of the individual components of the reach are problematic or non-functional, more specialized methods can then be used 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 a hypothesized future state or successional trend. 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 use this approach because stream-riparian systems are highly dynamic and often subject to disturbances (e.g., large flooding) that will alter successional trends and make predictions of future conditions highly problematic. By evaluating only current conditions, this protocol can be used as a 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 set of parameters, reevaluating the system using the identical protocol in subsequent years offers the ability to measure the effectiveness of management or restoration actions and to undertake corrections if the actions are not producing the desired changes. Adaptive management of restoration projects and land use guidelines is critical to their success and can be difficult if the evaluation and monitoring measures are based primarily upon the expectations of future, rather than current, condition.

Fourth, and for similar reasons, we use a quantitative approach to score variables and measure ecosystem health. Many current assessments are based upon dichotomous categories, such as "functional/non-functional," or "yes/no," and can be subjective and difficult to repeat from one year to the next, or when conducted by different observers. 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 restoration efforts might be necessary. We used a combination of a review of existing assessment and monitoring protocols, extensive external peer-review, and our own individual research experiences to create a five point rating scale for the current functionality of 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.

1.2 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 bedrock canyons will never develop the same number of meanders and floodplain 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.

1.3 Geographic Application

The RSRA was developed specifically in reference to perennial and intermittent or small and medium sized stream reaches in the Colorado Plateau and adjacent areas of the American Southwest. It applies most directly to low and mid-gradient watercourses, and is most useful in the lower and mid-elevation watersheds. Large streams and rivers, those at high elevations in mountain regions with high gradients, are often subject to conditions that are not fully considered or may not be adequately described by this protocol. With slight modification, the RSRA should be applicable to other parts of the American West and arid and semi-arid regions of the world.

2.0 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.
E. Score the results of the protocol in the field and record any additional observatoins that may be helpful in interpreting the results and its application.

We recommend that the protocol be conducted by a team of two or three people and each member read this User's Guide and become familiar with the RSRA Field Worksheet and Score Sheet (Appendix 1) before beginning the field surveys.

2.1 Identify the Study Reach

Reaches are segments of streams or rivers that share similar characteristics of gradient, channel substrate, landform, geology, and vegetation, and can be relatively short or extend for many miles. Different stream 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 each different reach. The study reach itself for each survey should be approximately 1 kilometer (km) in length (Figure 1), although in some cases the actual stream reach may be less than 1 km, in which the case the stream reach and the study reach will be identical. When possible, the study reach should include at least three to four stream meanders. The location of the study reach should be representative of the range of conditions found in that particular stream reach and should not be chosen to illustrate particularly good (or bad) conditions that would bias the scores given to the entire stream.

2.2 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.

Conducting the Assessment

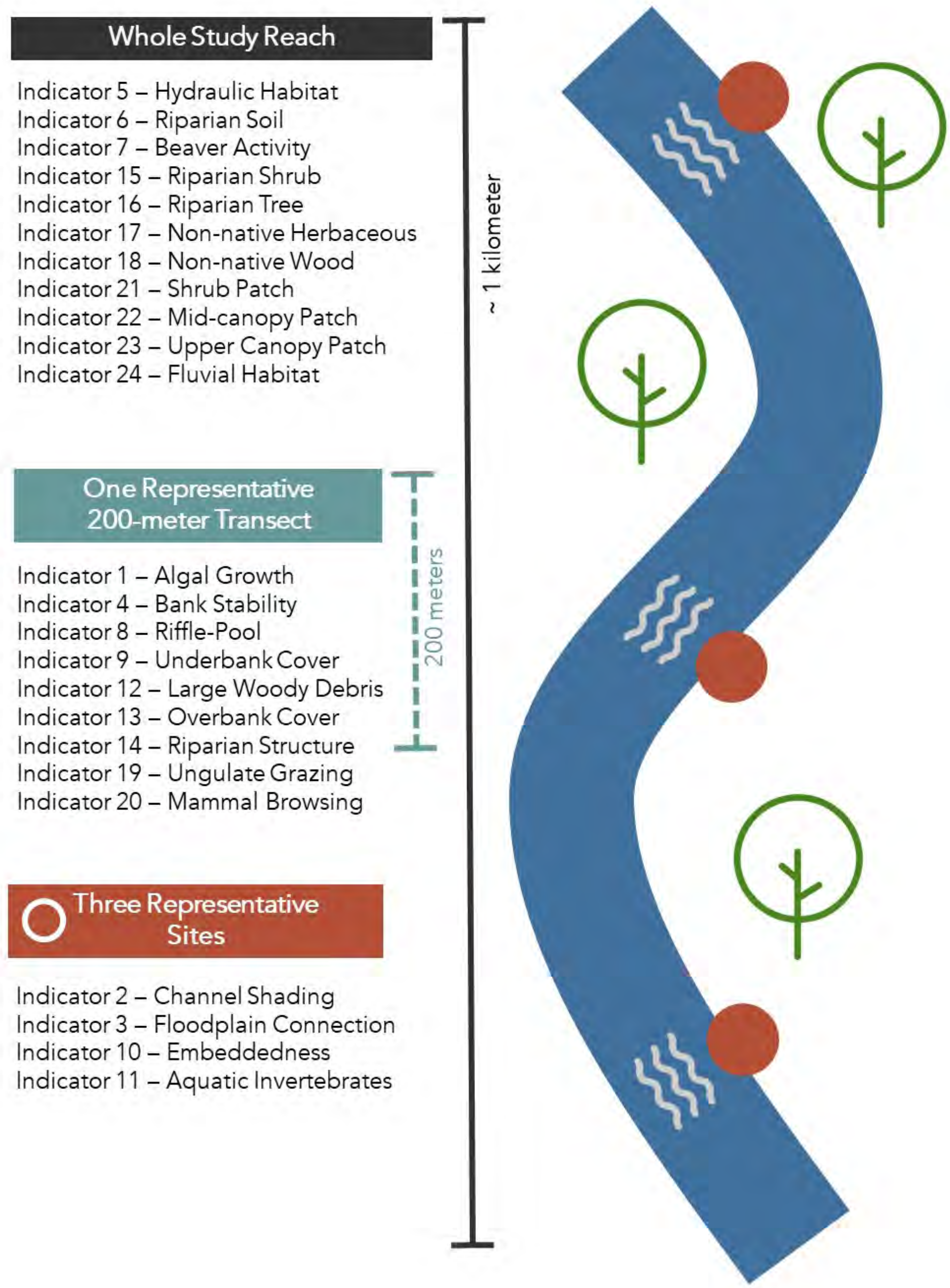

Figure 1: In each study reach, indicator data is collected from within one of three sample areas: the whole study reach (approximately 1 km), a 200 m transect, and three representative riffle sites.

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.

2.3 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 below). 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.

2.3.1 Background Information to Help Interpret the 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 or whether the stream was historically perennial. 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 (e.g., upstream mine tailings, water treatment facilities, 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 if there have been alterations in the upland portions of the watershed that might impact the stream (e.g., timber harvests that may increase 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 (1994).
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.

Fish/Aquatic Habitat

1. (required) Perennial Flow (Fish / Aquatic Habitat 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 subbasin?
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

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

1. (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.

Figure 2: A biologist provides background information to a team of surveyors during the site visit. *Credit: Wild Utah Project.*

2.4 Conduct the RSRA Field Assessment

2.4.1 Required Field Gear

- Copies of RSRA Score Sheet and Field Worksheets (Appendix 1), clipboards, pencils, or waterproof pens.
- 50 meter (m) or 100 m tape to measure transects.
- 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.
- Camera (digital cameras that automatically record the time and date are best for taking reference photos).
- Flagging to mark the end of transects.
- Ocular tube. A "layperson's version" can easily be constructed with an toilet tissue cardboard roll or 15 centimeter (cm, 2 inches [in]) long and 5 cm (2 in) diameter PVC pipe with a crosshair made of threads across one end.
- Global Positioning System (GPS) unit to obtain accurate locations for return visits to the study reach.
- An inexpensive laser level, tripod as small as 15 cm (6 in) high to hold the level.
- Tape measure (2-3 m in length) for measuring historic floodplain to current bankfull ratios.
- Straight stick such as adjustable hiking stick (also called trekking pole) or a 5 cm (2 in) PVC pipe at length of 2 m or more is a cost-effective option.
- An adjustable marker such as a velcro strap to mark the location of the laser light on the vertical stick used in bankfull measurements.
- Field guides for plants of the region, including exotic species (optional).
- Calculator for determining scores.
- Hand lens for identifying stream macroinvertebrates (optional).

2.4.2 Reference Photographs

Reference photos provide an important visual record of the conditions of the reach during the survey period. At a minimum, two reference photos should be taken. The first should be made at the beginning (upstream) end of the survey reach, looking downstream, and the second at the end (downstream) of the reach, looking upstream. These two photos will become part of the permanent survey record, and can be stored along with the survey forms in a centralized database (Figure 3).

Figure 3: Reference photo at the downstream end of a survey reach, looking upstream. Note that the necessary information has been added to the photograph.

Additional photos, especially at the beginning and end of the survey reach, may be taken as appropriate and are frequently helpful. For each reference photo, the following information from the score sheet should be added to the photograph itself when returned from the field:

- Stream or river name, state, stream reach name, date, and elevation;
- Which end of the reach is recorded in the photo (upstream or downstream), and
- UTM coordinates of where the photo was taken.

Using digital cameras and simple photo editing programs, this information can easily be added to the photograph and will provide a permanent label for the photo.

2.4.3 Timing

The best time to visit the reference and study reaches is between late spring (usually after peak spring runoff) and early fall, when riparian vegetation is fully developed and 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 midday are used for one of the indicators.

2.4.4 Establishment of Transects

Some data will be collected from the entire approximately 1 km study reach and additional data along two 200 m sample transects located in the stream channel and on the adjacent bank(s). The team should first do a "walk through" of 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 walk through. During the walk, look for a representative location to establish the 200 m transects for detailed measurements of certain variables. You will collect data from two different but adjacent transects along the same 200 m section of the reach: an in-stream transect and a riparian zone transect (see below for details). The location of the transects should be representative as much as possible of the range of conditions found along the entire 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 m either upstream or downstream, and follow the center of the channel when making measurements. If there are several channels, follow the main channel in the stream. 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 200 m along the outside edge of the channel that marks the beginning of the riparian zone. This transect will usually be on the first terrace, along the outside edge of the bankfull level of channel or the edge of the channel if the stream is dry (see

Figure 2). Make sure that the bank of the main channel is followed. Do not include islands in the riparian transect. Also, do not include bridges, dams, reservoirs or other similar structures in the transect or in the entire study reach if possible. Because the channel and the terraces may follow slightly different paths, the ending points of the riparian zone and in-stream 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 200 m sample transects, and reach 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 200 m in-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. Including a human figure in the photograph can also be helpful for scale.

Figure 4: A measuring tape is used to plot the 200 m transect within the study reach.
Credit: Wild Utah Project.

2.4.5 Scoring - General Considerations

The 1 to 5 point range of scoring values assigned to each indicator on the RSRA Score Sheet either involves specific values for that indicator, or 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 or do not exist in the particular reach being assessed. The Field Worksheet in Appendix 1 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.

Each indicator is measured and the data recorded in the worksheet, 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 200 m riparian transect up on the bank, while another team member who is more familiar with fluvial morphology and aquatic habitats can take measurements along the 200 m in-stream transect.

The Overall Comments section at the end of the score sheet should be used to discuss the general conditions of the stream, as well as any extreme or unexpected conditions that are observed during the survey. These comments can be a very useful verbal summary of the most important findings of the assessment

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 in Appendix 1. 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.

2.4.6 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 first page of the score sheet. The overall score for the surveyed stream reach is then obtained by calculating the mean of the five category mean scores and recorded on the first page of the Score Sheet.

An overall mean score of 1 to 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 to 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 to 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. Thus, by examining the condition of a number of different ecological processes or conditions in each of five categories, the protocol can provide specific guidance as to which areas any future actions may be directed to be most useful and productive to the overall health of the stream-riparian ecosystem.

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.

When your survey is completed, consider sharing this with others by placing it on the web. You can upload your survey, review other completed surveys, and download completed surveys from other locales.

Figure 5: A team of surveyors tallies the score on the Score Sheet. *Credit: Wild Utah Project.*

3.0 *Indicator Scoring*

The pages in this next section provide 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 (Appendix 1) organizes the variables according to the physical areas of observations, resulting in a different order.

Figure 6: Functioning stream and riparian habitats support diverse bird species such as this yellow warbler. *Credit: Janice Gardner.*

Indicator Scoring

Assessment Indicators		page
Water Quality		
1.	Algal Growth	pg 21
2.	Channel Shading and Solar Exposure	pg 22
Hydrogeomorphology		
3.	Floodplain Connection and Inundation	pg 23
4.	Vertical Bank Stability	pg 25
5.	Hydraulic Habitat Diversity	pg 26
6.	Riparian Area Soil Integrity	pg 27
7.	Beaver Activity	pg 28
Fish/Aquatic Habitat		
8.	Riffle-Pool Systems: Number and Distribution	pg 29
9.	Underbank Cover	pg 30
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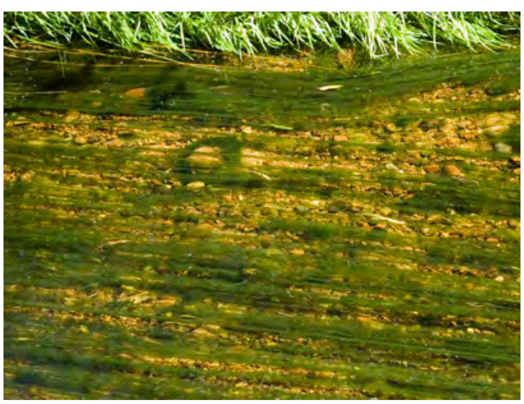
Indicator 1. Algal Growth.

Starting at the downsteam end of the 200 m in-stream transect, walk in the channel 1 m from the water's edge and, using the ocular tube, every 2 m record the presence or absence of filamentous algae. If the reach is less than 2 m wide, walk up the middle of the channel. 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 the total number of data collection points (which should be close to 100) along the transect. See examples in Figures 7 and 8.

Single-celled algal growth is typical in many undisturbed streams in the American Southwest, and should not be counted while measuring Indicator 1.



Figures 7 and 8: Algal Growth (Indicator 1). Strands of filamentous algae in a stream. The extensive growth of algae in this reach is due to nutrient loading from upstream sources of pollution. If an entire transect resembles this figure, it should receive a score of 1. *Credit: Kim Howes and 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 that would occur at midday. If appropriate, these may be the same sites used for measurements of cobble embeddedness, aquatic macroinvertebrate diversity, and floodplain connection and inundation. 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 midday is best). See examples in Figures 9 and 10.

Figure 9: Channel Shading and Solar Exposure (Indicator 2). A creek 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 figure, it would receive a score of 5. *Credit: Peter Stacey.*

Figure 10: Channel Shading and Solar Exposure (Indicator 2). 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. If the entire study reach resembles this figure, it would receive a score of 1. *Credit: Peter Stacey.*

Indicator 3. Floodplain Connection and Inundation.

The likelihood that the stream will be able to escape its bank and flow over the floodplain during typical high flow events can be measured by the ratio of the height between the channel bottom and the historic terrace (prior to entrenchment that indicates the boundary of the historic floodplain itself) and the distance between the channel bottom and its first bank (current bankfull location; see Figures 11 and 12).

At the three representative sites, use a laser level (or a survey instrument if available) to measure the distance between the deepest part of the bottom of the channel (thalwag) and current bankfull level (see Figure 12). The bankfull level is the highest level the water reaches during typical maximum flows, ususally during spring runoff. Then measure the distance or height of the beginning or closest part of the historic floodplain to the channel bottom. Next, divide the historic floodplain depth by current bankfull depth. Repeat these measurements at two additional representative locations along the reach. Take the average of the three values to calculate 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.

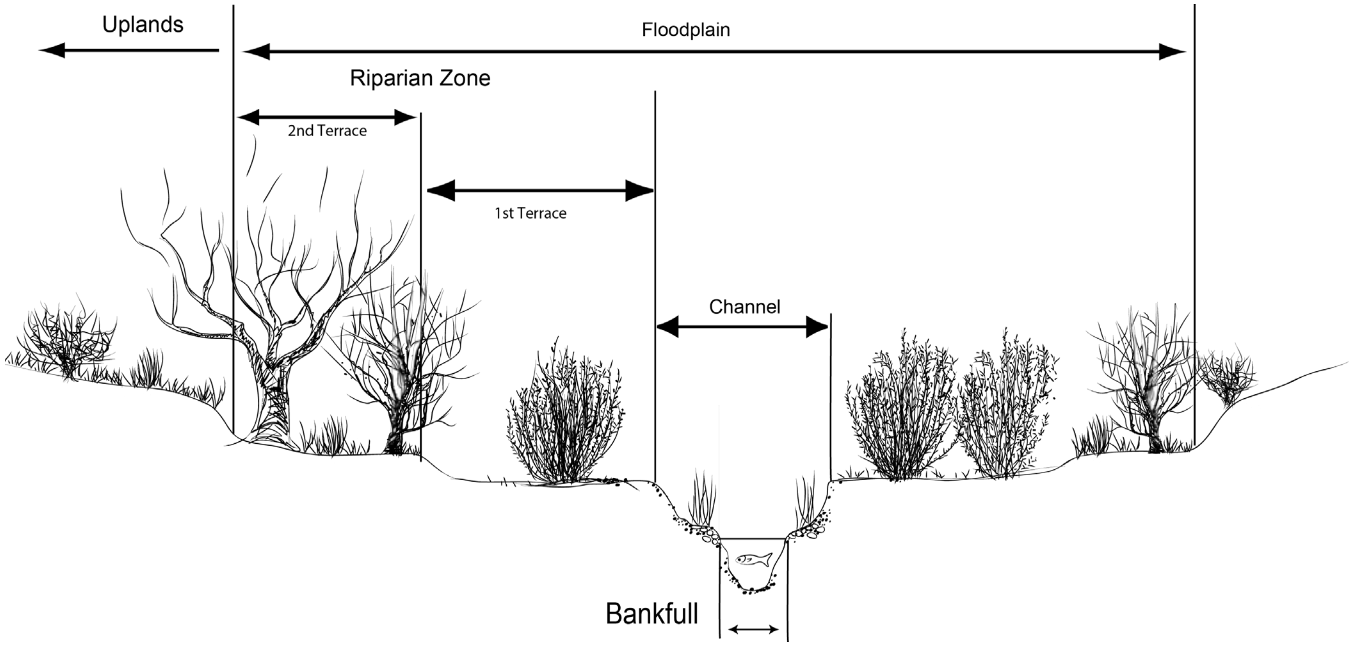


Figure 11: Idealized cross section of a downcut stream and associated floodplain in the American Southwest. Areas of the floodplain outside of the scour zone are flooded only during rare and high flow events. In entrenched streams, the second terrace represents the pre-entrenched floodplain. The edge of the first terrace close to the stream channel marks the inside edge of the riparian zone as used in this protocol, and the riparian transect should be put there. *Credit: Heidi Snell.*

The easiest way to make these measurements is to first place the laser level on a rock on the stream bank. Make sure it is level. Place the walking stick at the deepest part of the channel and shine the laser light on the stick. Mark where the light hits the stick (A). Next, move to the current bankfull location and again mark where the light hits the stick (B). Finally, mark the stick when placed at the edge of the historic floodplain terrace (C). The distance between A and B is the bankfull height while the distance between A and C is the historic floodplain height.

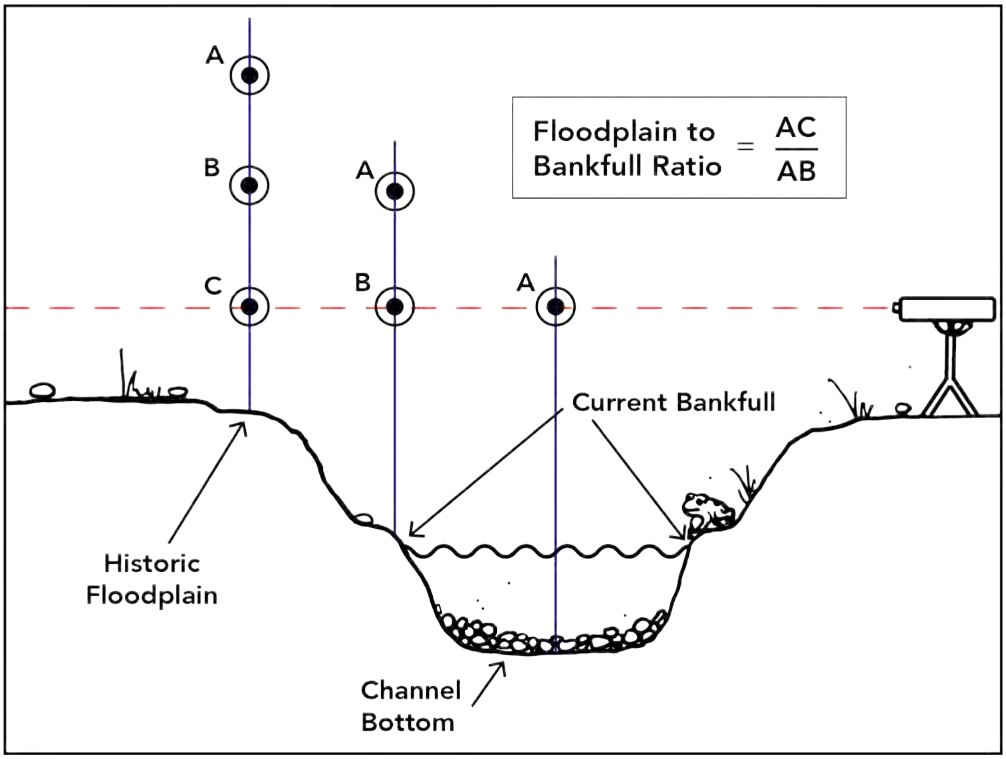


Figure 12: Floodplain Connection and Inundation (Indicator 3). Method used to measure the ratio between the height above the bottom of the channel to the historic (pre-entrenched) terrace on the floodplain and the height of the current bankfull level. Credit: *Sarah Woodbury.*

Indicator 4. Vertical Bank Stability.

Within the 200 m in-stream transect, estimate the length of the channel bank where there are actively-eroding, near-vertical cut banks. Indicator 4 requires counting the meters of bank on both sides of the transect that are stable and unstable. In fine soils, the "sloughing off" of the banks into the channel and deposition of sediments into the stream will be obvious. Include both sides of the stream. Estimate the total amount of vertical cut banks on each side of the 200 m in-stream transect, and divide by 400 m to arrive at the percent cut banks. If the total distance of both banks with stable banks is 80 m, the percent of vertical banks would be 20% (80 m divided by 400 m total). See examples in Figures 13 and 14.

Figure 13: Vertical Bank Stability (Indicator 4). A section of river with almost all of the eastern bank as bare soil and 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. *Credit: Peter Stacey.*

Figure 14: Vertical Bank Stability (Indicator 4). An example where the bank is unstable and actively "sloughing off." This reach was being heavily utilized by cattle. Credit: *Carrell Foxx.*

Indicator 5. Hydraulic Habitat Diversity.

Count the number of distinctive hydraulic channel features that would provide unique habitats that are observed in the overall reach walk-through. Look for riffles, scour pools, cobble or boulder debris fans, flowing side channels, backwaters, sand-floored runs, or other features that can provide different habitats for fish and other aquatic organisms. Figure 15 gives an example of reaches with different levels of hydraulic feature diversity.

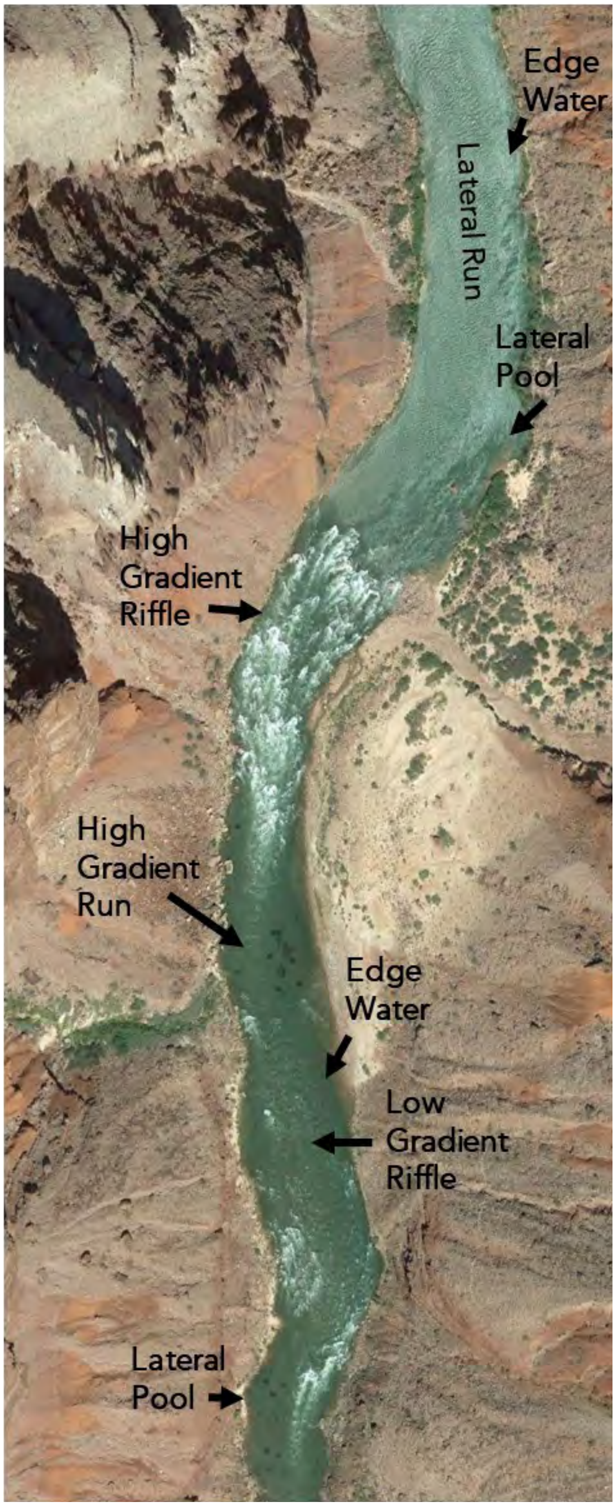


Figure 15: Examples of reaches with different levels of hydraulic habitat diversity (Indicator 5). Note that the number of different hydraulic habitats tends to increase with the number of meanders. *Credit: Google Earth.*

Indicator 6. Riparian Area Soil Integrity.

During the overall reach walkthrough, estimate the extent of soil disturbance in the riparian zone 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 Figures 16 and 17.

Figure 16: Riparian Area Soil Integrity (Indicator 6). Photo of riparian area soil disturbed by off-road vehicles. *Credit: Liz Thomas.*

Figure 17: Riparian Area Soil Integrity (Indicator 6). A section of riparian area with soil that has been extensively disturbed on one side of the fence by ungulate activity. Whenever possible, the source of any soil disturbance found in the reach should be noted. *Credit: Jim Catlin.*

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. If beavers are no longer present but were historically, then score this indicator as 1.

Certain streams do not allow beavers to construct a dam because of geomorphic factors. This also should be considered when assessing evidence of beaver activity. If it is known for certain that beaver were never in the reach, then score this "N/A."

Figure 18: One of the more apparent signs of beaver is dams or lodges (Indicator 7). This photo shows a small beaver dam located on 50-Mile Canyon in Glen Canyon National Recreation Area. *Credit: Janice Gardner.*

Figure 19: Beaver tracks are characterized by the zig-zag dragging pattern of their tails (Indicator 7).

Figure 20: Signs of beaver are often detected on living or loose branches (Indicator 7). This branch shows signs of a beaver foraging on the cambium layer under the bark. The beaver cut this branch loose from a living shrub, as seen in the chew marks on the end of the branch.

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 (otherwise "N/A"). See Section 2.3.1 for more details. Once you have determined how the qualifier applies, continue on to the next section.**

Indicator 8. Riffle-Pool Systems: Number and Distribution.

In a stream that is in dynamic equilibrium, stretches of fast-moving and relatively shallow water with obvious bubbles (riffles) will usually alternate with sections that are deeper and slower moving (pools; see Figure 21). Fish use pools to hide and rest, and riffles to lay their eggs. Note and record the number of pool and riffle units within the 200 m in-stream transect. For the purpose of this indicator, riffles need to have a cobble bottom. 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.

Figure 21: Riffle-pool (Indicator 8). An example of a riffle-pool system. The number of riffle-pools will be counted from within the 200 m in-stream transect. *Credit: Janice Gardner.*

Indictor 9. Underbank Cover.

Underbank cover as used here is that amount of bank that has at least a 15 cm (6 in) horizontal distance from the edge of the bank underwater into the undercut (Figure 22). 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 15 cm (6 in), and should be counted. Estimate the total amount of underbank cover (undercut) along each bank of the 200 m in-stream transect, and divide by 400 m to arrive at the percent undercover bank. If the total distance of both banks with undercut is 80 m, the percent underbank cover would be 20% (80 m divided by 400 m total).

Figure 22: For Indicator 9, underbank cover must be at least 15 cm (6 in) deep. *Credit: Sarah Woodbury.*

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 8 cm to 20 cm (3 in to 8 in) 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 23). 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 the average of the rocks measured at each of the three sites to determine the final score.

Figure 23: Cobble Embeddedness (Indicator 10). A clear line on this rock delineates the lower portion of the rock that was embedded in the stream substrate. The observer recorded this rock as being 45% embedded in the stream substrate. *Credit: Janice Gardner*

Indicator 11. Aquatic Macroinvertebrate Diversity.

Sampling for aquatic invertebrates should be done at the same locations in riffle areas where embeddedness (Indicator 10) is recorded. Pick up and, preferably using a hand lens, observe the organisms on six rocks greater than 15 cm (6 in) in diameter in each of the three riffle areas.

Identify aquatic invertebrates to the Order only (e.g., stonefly larvae, mayfly larvae, caddisfly larvae, beetles, etc.) using the illustrations in Appendix 2 or a suitable field guide. List the Orders found on the Worksheet. Note the presence of crawfish on the Worksheet, but for this protocol, do not include them in the final tally of the total number of orders found in the samples to determine the final score. This is because crawfish are often introduced (non-native) in many streams in the West, and their presence in such situations can be an indicator of other conditions in the stream that are problematic.

Figure 24: Riffle Beetle, Order Coleoptera, described further in Appendix 2. Illustration of adult and larva. *Credit: Sarah Woodbury*

Indicator 12. Large Woody Debris.

This is defined as wood that is not rooted and at least partially in the water or located in the active stream channel and that is at least 15 cm (6 in) in diameter and 1 m (3 ft) in length. Large woody debris not only provides cover habitat for fish, but also has an important effect on creating channel complexity. Record the number of large woody debris pieces observed within the 200 m in-stream transects.

Figures 25 and 26: Both photos illustrate pieces of large woody debris located in the active stream channel (Indicator 12). To be considered large woody debris, pieces of wood must be at least 15 cm (6 in) in diameter and approximately 1 m (3.3 feet) in length. *Credit: Janice Gardner*

Indicator 13. Overbank Cover and Terrestrial Invertebrate Habitat.

Insects that drop into the stream from overhanging vegetation (see Figures 27, 28, and 29) are a key source of food and nutrients for fish and other aquatic life. Visually estimate the distance along both banks of the 200 m in-stream transect where there is vegetation (including forbs, grass, shrubs and trees) hanging over any part of the channel. Similar to Indicators 4 and 9, use the same technique for calculating this measurement as a percentage value.

Figure 27: Section of Calf Creek, Utah, with dense vegetation overhanging almost all of both sides of the stream channel. If the entire in-stream transect resembles this photo, it should receive a score of 5. *Credit: Peter Stacey.*

Figure 28: In this section of the Paria River, Arizona, less than 10% of the banks of the stream channel have overhanging vegetation. If the entire in-stream transect resembles this photo, it should receive a score of 2. *Credit: Peter Stacey.*

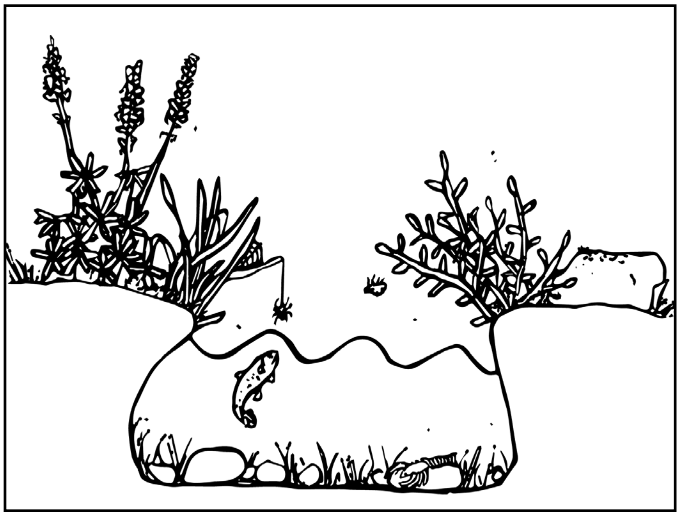


Figure 29: Overhanging vegetation provides organic input to streams. This includes terrestrial invertebrates and insects that drop into streams and are then eaten by fish. *Credit: Sarah Woodbury.*

Indicator 14. Riparian Zone Plant Community Structure and Cover.

The presence or absence of vegetation cover observed in each of the four structural layers (i.e., ground, shrub, middle canopy, and upper canopy; see Figure 30) should be recorded for the riparian transect. In this protocol, the ground cover layer is the vertical zone that includes both living grass and other herbaceous vegetation, woody plants, and dead vegetative matter up to a height of 1 m above the ground. Shrub cover is woody perennial vegetation occurring from 1 m up to 4 m above the ground. Middle canopy vegetation is large shrub and small tree cover 4 m to 10 m above the ground. Upper canopy vegetation is tree cover greater than 10 m above the ground. The same species (e.g., cottonwoods) may have individuals in different structural layers (shrub, middle or upper canopy), depending on the particular age of the plant. Also, one individual plant (i.e., the same cottonwood tree) can generate cover "hits" in multiple canopy layers.

Using an ocular crosshair tube and the Field Worksheet, walk along the transect and, every 2 m, 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 crosshairs in each structural layer: ground cover layer, shrub layer, middle canopy layer, and upper canopy layer (Figure 30). The line-of-sight through the ocular tube should mimic whether or not a ray of light originating directly overhead would strike any vegetation as it passes through each layer.

If the line-of-sight falls upon a rock, score "N/A" (not applicable) for the ground cover layer, since a plant cannot grow there. If the ground cover layer is a rock, there can be "hits" in the canopy layers above the ground. Use the number of "hits" through the ocular tube for cover in each layer (out of what should be about 100 samples along the 200 m transect) to determine percent cover for that layer. Average the percent cover 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.

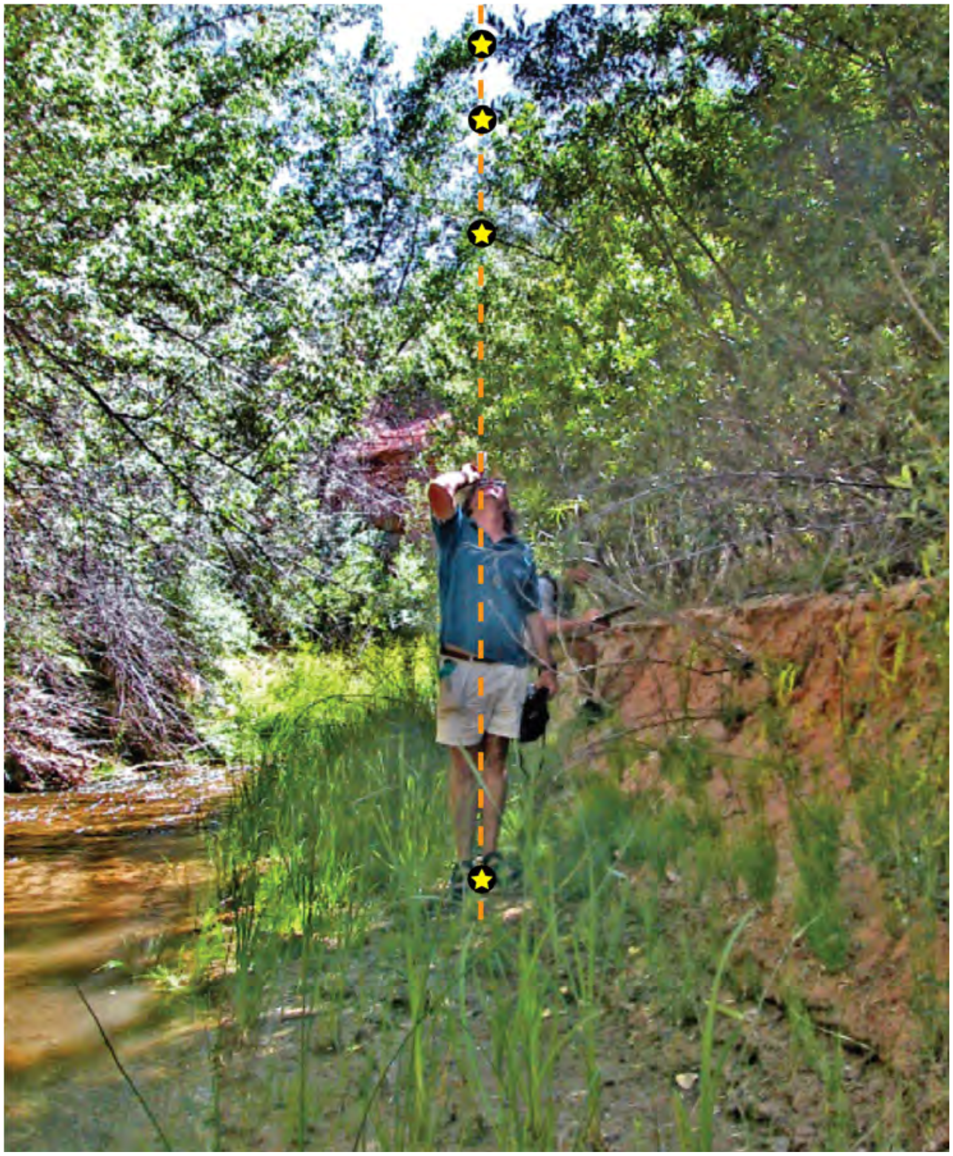


Figure 30: Method of using an ocular tube to measure cover in each of the four structural layers (ground, shrub, middle canopy, and upper canopy) used in Indicator 14. Note that multiple "hits" in one structural layer is scored as a single "yes" on the Worksheet. *Credit: Allison Jones.*

Indicator 15 and 16. Native Shrub and Tree Demography and Recruitment.

The distribution of age classes (i.e., seedlings, saplings, mature, and snags; see Figure 31 of the dominant native riparian species in the riparian zone) should be determined during the initial study reach walk-through. As used here, the dominant species is the one that provides the most vegetative cover throughout the floodplain, and not necessarily the one that has the most individuals. The observer also should comment on unexpected demographic conditions, such as the absence of particular age classes of expected dominant species, like willows and cottonwoods in the American Southwest.

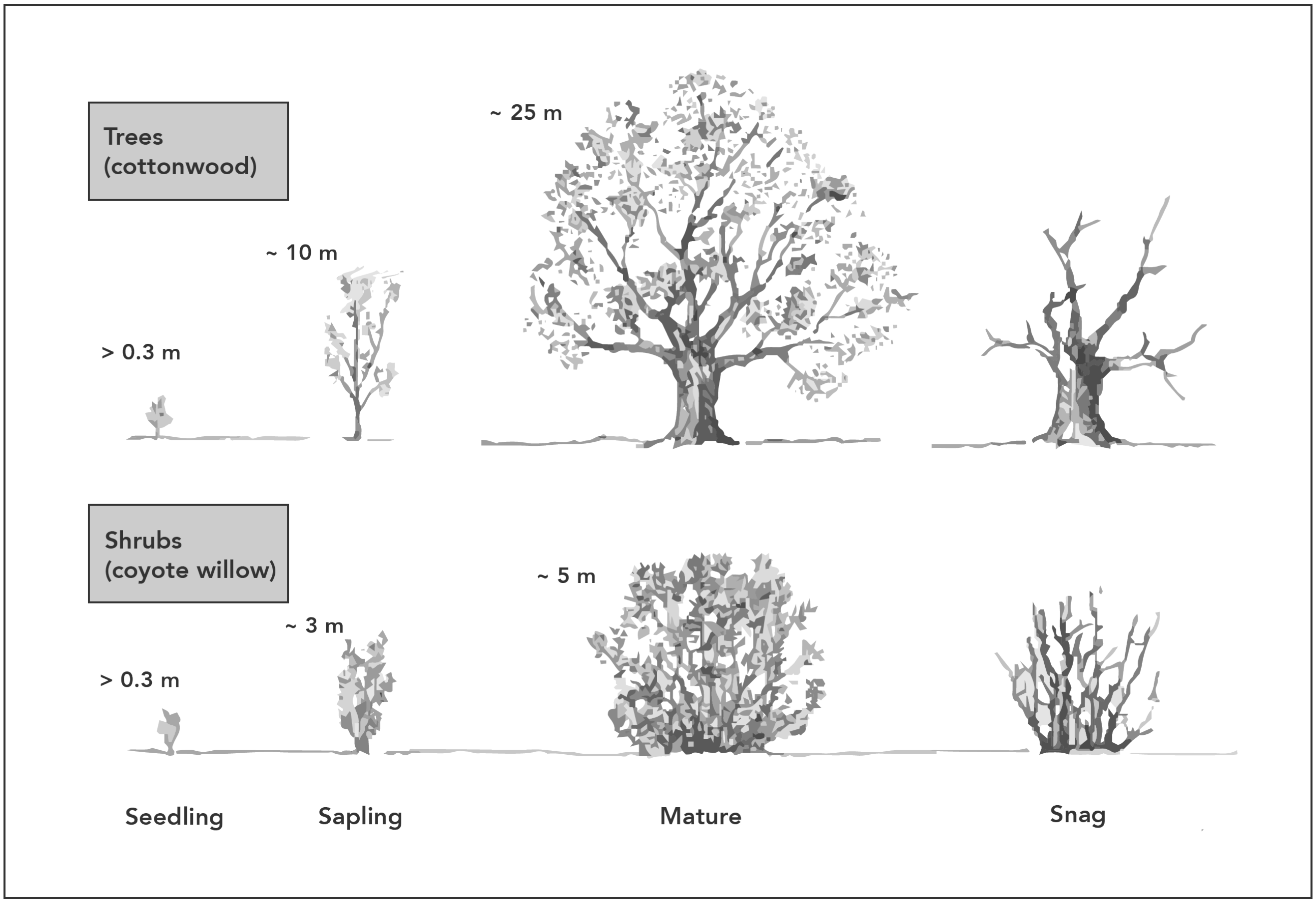


Figure 31: Age classes of shrubs and trees used for Indicators 15 and 16. Cottonwoods (*Populus* spp.) and willows (*Salix* spp.) are typical dominant native tree and shrub species in the American Southwest. Other taxa may be the expected dominant species in other regions or in special situations. *Credit: Heidi Snell & Sarah Woodbury*

Indicators 17 and 18. Non-Native Herbaceous and Woody Plant Species Cover.

During the initial study reach walkthrough, visually estimate the percentage of cover provided by non-native shrub, tree, and herbaceous plant species relative to that provided by native species. Background information on exotic or non-native plants that have been observed in the local watershed can be extremely useful 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 entire floodplain for this estimate. Do not consider bare ground and litter cover when making this estimate. See the examples in Figures 32 and 33.

Figure 32: Non-native Herbaceous Plant Species Cover (Indicator 17). The herbaceous cover in the 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. If the study reach resembled this photo, it would receive a score of 1 for Indicator 17. Credit: *Peter Stacey.*

Figure 33: Non-native Woody Plant Species (Indicator 18). 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 18, non-native woody plant species. C*redit: Peter Stacey.*

Indicator 19. Mammalian Herbivory (Grazing) on Ground Cover.

This assessment can be performed simultaneously with the assessment of vegetation cover (Indicator 14), while using the ocular tube method described above. While recording the number of positive and negative cover hits for each structural layer on the riparian zone transect, also record each time you see evidence of mammalian herbivore impacts on grasses and herbaceous ground cover.

Include both native and non-native grasses and herbaceous plants for this measure, but do not include woody plants. Use the number of "hits" to estimate percent ground cover vegetation that has been grazed by herbivores such as where a grass blade has been clipped off. 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 (e.g., deer and elk) and non-native (e.g., livestock) species. Use "N/A" for locations where there is no possibility of ground cover (e.g., rock).

Figure 34. Mammalian herbivory or grazing can be seen on this ground cover (Indicator 19. Note grazing by mammals is often from the top of the blade or leaf and can be both jagged or sharp. Looking for tracks and dropping can also help identify the herbivory as mammalian. Insect foraging often appears as small chew marks on the sides of grass blades or leaves; insect foraging is not included in this indicator. *Credit: Janice Gardner*

Indicator 20. Mammalian Herbivory (Browsing) on Shrubs and Trees.

Walk again along the riparian vegetation transect and count in a 1 m band on either side of the transect the number of shrubs and trees (including seedlings) whose branches or trunks show evidence of browsing (see Figures 35 and 36) such as clipped ends. Compare this to the number of plants that do not show signs of browsing. For this indicator, a single stem that has been clipped is considered to be evidence of browsing on the entire plant, and browsing on multiple stems of a single plant would be counted only once.

Herbivore impacts on shrubs and small trees should also be noted during the overall study reach walkthrough. Browsing can include that done by both native (e.g., deer and elk) and non-native (e.g., livestock) species. Browse can have occurred either within the current growing season or be older to qualify.

Figure 35: Sapling cottonwood that has been repeatedly browed for at least two growing seasons (Indicator 20). Almost every major stem of the plant has been "clipped" or browsed. This produces a heavy branching growth pattern. If browsing on more than 50% of the shrubs and small trees in the transect occurs as shown in this image, it would score a 1 for Indicator 20. *Credit: Peter Stacey.*

Figure 36: Closeup of river birch stems that have recently been browsed by mammals, likely deer. *Credit: Janice Gardner.*

Indicator 21. Shrub Density and Connectivity.

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 all woody perennial vegetation (including small trees) up to 4 m tall. The frequency and connectedness of patches of shrubs should be estimated during the overall study reach walkthrough. Include both native and non-native species for this score. See the example in Figure 37.

Figure 37: Shrub Patch Density (Indicator 21). A section of Grandstaff Canyon, near Moab, Utah has continuous shrub patches (all woody vegetation up to 4 m tall) composed of native willows and non-native tamarisk. If the shrub patch density in the study reach was continuous throughout, it would score 5 for shrub patch density. *Credit: Wild Utah Project.*

Indicator 22. Mid-Canopy Patch Density and Connectivity.

Middle canopy vegetation is large shrub and small tree cover 4 m to 10 m above the ground. As in Indicator 21, the frequency and connectedness of patches of mid-canopy trees should be estimated during the overall study reach walkthrough. Include both native and non-native species for this score. See the example in Figure 38.

Figure 38: Mid-canopy Patch Density (Indicator 22). A section of Calf Creek, near Escalante, Utah has a mid-canopy (woody vegetation 4 m to 10 m tall) composed of many different species of native shrubs and trees and is nearly continuous in this part of the reach. This area would provide excellent habitat for riparian wildlife that utilize the mid-canopy part of the vegetation. If the entire study reach resembled this photo, it would score 5 for mid-canopy patch density. *Credit: Peter Stacey.*

Indicator 23. Upper Canopy Tree Patch Density and 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, it is considered to be at least 10 m tall. Note the frequency and connectedness of upper canopy patches over the full study reach during the overall walkthrough. Include both native and non-native species for this score. See Figure 39.

Figure 39: Upper Canopy Patch Density (Indicator 23). 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 floodplain so that the canopy is only one to two trees wide. If the entire study reach resembled this photo, it would score 5. *Credit: Peter Stacey.*

Indicator 24. 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, oxbows, marshes, cut banks, sand bars, islands in the channel, etc. (see Figures 40 and 41). 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 floodplain; scores for this indicator should be scaled to what would be geomorphically possible within the specific study reach. Include the entire floodplain when scoring this indicator.

Figure 40: Fluvial Habitat Diversity (Indicator 24). Wet meadows, sand and gravel bars, and oxbows provide unique habitat for terrestrial wildlife. Other fluvial habitats include marshes, beaver ponds, stable cutbacks, and floodplain ponds. *Credit: Google Earth.*

Figure 41: Cutbanks provide unique habitat for some wildlife, such as the northern rough-winged swallow. *Credit: Janice Gardner.*

Definitions

Bankfull level. This is the level that a stream reaches during average peak runoffs or flows for an average year. This is the typical maximum height water reaches in the stream most years. 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 active channel and the lower floodplain that marks bankfull levels. The areas just below the bankfull level are often bare soil or contain aquatic and annual vegetation, while the areas above bankfull often contain perennial forbs, shrubs and trees. The highest level of sand or gravel bars within the channel itself may also be useful to indicate bankfull levels, since this is the highest level that sediments are deposited in the channel during peak (or bankfull) flows. In the American Southwest, peak annual stream flows often occur at the end of spring runoff (March and April), or in southern Arizona, during the monsoon season.

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).

Browse (Browsing). Mammalian herbivory is described in this protocol as browse of plants that have woody stems and trunks. While many kinds of wildlife consume plants, this protocol looks for characteristic browsing patterns typical of wild and domestic mammals including deer, elk, and livestock. These patterns include removal of buds, leaves, and stems of shrubs and trees.

Ephemeral. A stream that does not flow continuously throughout the year, but only in direct response to precipitation or during seasonal runoffs such as with snow melt in the spring. There may or may not be subsurface water flow year round in ephemeral streams. Intermittent streams, in contrast, may flow year round but dry up during the warmest season or during the afternoon on the hottest days. See also Perennial.

Floodplain level. The floodplain is usually a series of terraces above the bankfull level. The first terrace, or active floodplain, 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 floodplain 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 (e.g., rock, soil, etc.).

Fluvial Habitat. These habitat features include tributaries, oxbows, backwaters, and side channels that provide habitat for aquatic species. They include side springs, wet meadows, and floodplain ponds that provide habitat for amphibians. Additional fluvial habitat includes sandbars, marshes, and stable cutbanks, which can create habitat for a variety of wildlife.

Geomorphically inconsistent and consistent. The term "geomorphic" refers to the shape, structural characteristics, and geology of a stream channel and its adjacent banks and floodplain. 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., oxbows, sand bars, side channels) as would a same-sized stream running through an open area consisting of alluvial deposits and erodible soils. Therefore, scoring of field indicators must include consideration of the geomorphic context. This guide uses the phrase "geomorphically consistent" to compare stream channel structure and geologic characteristics that are consistent with the reference study reach characteristics. Lack of consistency 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.

Graze (Grazing). This refers to the consumption of grasses and forbs by mammals both wild and domestic.

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

Hydraulic habitat. This term refers to underwater habitats for fish and aquatic organisms that represent geomorphic diversity in the stream channel. Examples include riffles, edge waters, backwaters, lateral pools, scour pools, and stream run.

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

Intermittent streams. These streams dry up during some times of the year (although there may still be subsurface flows). Intermittent streams often will dry up during the warmest season or during the afternoon on the hottest days. Flow resumes at night when temperatures and surface evaporation declines. 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.

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.

Riffle and pool systems. Riffles are stretches of a stream that are both fast-moving and relatively shallow with a cobble bottom. Look for geomorphic consistency with a similar stream stretch in reference conditions. Riffles are often followed or preceded by pools. For this survey method, pools are slower bodies of water that are large enough to offer adequate habitat for native fish. The combination of pools and riffles is a key aquatic habitat feature needed for many aquatic animals.

Riparian Zone. There are a number of ways to define the riparian zone. As used here, this area consists of that area from the edge of bankfull to the outer extent of the stream's floodplain. The riparian zone is where plant growth is affected by surface or underground water flows from the stream. Plants in the riparian zone are able to grow with their roots in the water table (in fact, many require this). Many also require surface water flows in order to germinate from seeds. Outside the riparian zone, upland plants may not be able to reach the water table, and they do not require underground or surface water flows to grow or germinate.

Sinuosity. A measure of how much the stream channel meanders within the floodplain 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.

Terrace. This part of a riparian area that shows evidence of deposition and modification by inundation from flooding that occurs infrequently. Evidence of this kind of flooding includes the deposition of fine sediment, flotsam hanging from brush, log jams, flattened grass, and secondary channels formed by stream scour action.

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.

Appendix 1 Score Sheet & Worksheets

Rapid Stream-Riparian Assessment Score Sheet

Reach Name		Observers	
Stream		Email	
Watershed		Address	
Survey Date			
Survey Time		Phone	

Reach Location

Upstream UTM E UTM N		Downstream UTM E UTM N	
Elevation	m	Elevation	m
Photo ID		Photo ID	

Stream Transect Location

UTM E UTM N		Location of coordinate *Circle One*	Upstream Downstream

Scores	
Water Quality	
Hydrogeomorphology	
Aquatic Habitat	
Riparian Vegetation	
Terrestrial Habitat	
Overall	

Previous Scores (If available) Date:	
Water Quality	
Hydrogeomorphology	
Aquatic Habitat	
Riparian Vegetation	
Terrestrial Habitat	
Overall	

Overall Notes

Score[1]	Indicator	Scoring Definitions and Directions
Water Quality		
% = ___	1- Algal Growth	1 = greater than 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
% = ___	2 - Channel Shading, Solar Exposure	1 = stream channel completely unshaded (0%) 2 = slight shading (1 - 15%) 3 = moderate shading (16 - 30%) 4 = substantial shading (31 - 60%) 5 = Channel mostly shaded (greater than 60%)
	: Water Quality Mean Score	Notes:

[1] Scores range from 1 – 5. Use N/A if the indicator is not relevant or appropriate for this particular reach. Exclude indicators scored with "N/A" from the scoring.

Hydrogeomorphology		
Average = __	3 - Floodplain Connection and Inundation	1 = greater than 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
% = ___	4 - Vertical Bank Stability	1 = less than 10% of channel banks are vertically stable 2 = 10 – 39% of banks are vertically stable 3 = 40 - 69% of banks are vertically stable 4 = 70 – 95% of banks are vertically stable 5 = greater than 95% of banks are vertically stable
	5 - Hydraulic Habitat Diversity	1 = no diversity (variability) of stream form features 2 = low diversity, 2 habitat types present 3 = moderate diversity, 3 types present 4 = moderately high diversity, 4 types present 5 = high diversity, 5 or more present
% = ___	6 - Riparian Area Soil Integrity	1 = greater than 25% of riparian soil surface disturbed 2 = 16 - 25% disturbed 3 = 6 - 15% disturbed 4 = 1 - 5% disturbed 5 = less than 1% disturbed
	7 - Beaver Activity	1 = beavers not now present but were historically 2 = no dams, a few signs of activity but none within past year 3 = activity in past year but no dams 4 = beaver dams on some of the stream 5 = beaver activity and dams control stream
	: Hydro-geomorphology Mean Score	Notes:

Fish/Aquatic Habitat		
	8 - Riffle-Pool Distribution	1 = no riffle-pool habitat in transect 2 = one to several riffle-pool habitats in transect 3 = limited to moderate riffle-pool habitat distribution in transect 4 = moderate to abundant riffle-pool habitat distribution in transect 5 = riffle-pool habitat abundant (>50% of transect has riffle-pools)
% = ___	9 - Underbank Cover	1 = no underbank cover in 200m stream transect 2 = less than 10% transect has underbank cover 3 = 10 - 25% of transect has underbank cover 4 = 26 - 50% of transect has underbank cover 5 = greater than 50% of transect has underbank cover
% = ___	10 - Cobble Embeddedness	1 = greater than 50% of rock embedded in silt 2 = 41 - 50% of rock embedded in silt 3 = 26 - 40% of rock embedded in silt 4 = 20 - 25% of rock embedded in silt 5 = less than 20% of rock embedded in silt
	11 - Aquatic Macro-invertebrate Diversity	1 = 0 - 1 benthic macroinvertebrate orders present 2 = 2 macroinvertebrate orders present 3 = 3 macroinvertebrate orders present 4 = 4 macroinvertebrate orders present 5 = 5 or more orders present
	12 - Large Woody Debris	1 = no large woody debris (LWD) in transect 2 = less than 3 LWD pieces in transect 3 = 3 - 5 LWD pieces in transect 4 = 6 - 10 LWD pieces in transect 5 = greater than 10 LWD pieces in transect
% = ___	13 - Overbank Cover and Terrestrial Invertebrate Habitat	1 = no vegetation overhang water 2 = less than 10% of banks have vegetation that overhang the water 3 = 10 - 25% of banks have overhanging vegetation 4 = 26 - 50% of banks have overhanging vegetation 5 = greater than 50% of banks have overhanging vegetation
	: Fish/Aquatic Habitat Mean Score	Notes:

Riparian Vegetation		
	14 - Riparian Zone Plant Community Structure and Cover	*G=____% S= ____% MC=____% UC=____% Average*=____% 1 = less than 5% average plant cover in riparian zone 2 = 5 - 25% average plant cover 3 = 26 - 50% average plant cover 4 = 51 - 80% average plant cover 5 = greater than 80% average plant cover
	15 - Riparian Shrub Demography and Recruitment	1 = no native shrubs present in study reach 2 = one age class present 3 = two classes present. One of the classes must be seedlings or saplings. 4 = three age classes present 5 = all age classes present
	16 - Riparian Tree Demography and Recruitment	1 = no native trees present in study reach 2 = one age class present 3 = two classes present. One of the classes must be seedlings or saplings. 4 = three age classes present 5 = all age classes present
	17 - Non-native Herbaceous Plant Species	1 = greater than 50% non-native herbaceous plant species 2 = 26 - 50% non-native herbaceous plant species 3 = 11 - 25% non-native herbaceous plant species 4 = 5 - 10% non-native herbaceous plant species 5 = less than 5% non-native herbaceous plant species
	18 - Non-native Woody Plant Species	1 = greater than 50% non-native woody plant species 2 = 26 - 50% non-native woody plant species 3 = 11 - 25% non-native woody plant species 4 = 5 - 10% non-native woody plant species 5 = less than 5% non-native woody plant species
% = ___	19 - Mammalian Herbivory (Grazing) Impacts on Ground Cover	1 = greater than 50% of ground cover impacted by grazing 2 = 26 - 50% of ground cover impacted 3 = 11 - 25% of ground cover impacted 4 = 5 - 10% of ground cover impacted 5 = less than 5% of ground cover impacted
% = ___	20 - Mammalian Herbivory (Browsing) Impacts on Shrubs and Small Trees	1 = greater than 50% of shrubs and trees impacted by browsing 2 = 26 - 50% of shrubs and trees impacted 3 = 11 - 25% of shrubs and trees impacted 4 = 5 - 10% of shrubs and trees impacted 5 = less than 5% of shrubs and trees impacted
	: Riparian Habitat Mean Score	Notes:

Terrestrial Wildlife Habitat		
	21 - Riparian Shrub Patch Density	1 = no shrub patches in stream reach 2 = few, isolated small shrub patches 3 = more patches but still isolated 4 = few large open areas between large patches 5 = almost continuous dense shrub cover
	22 - Riparian Mid-Canopy Patch Density	1 = no mid-canopy shrub or tree patches in reach 2 = few isolated small patches in mid canopy 3 = more patches but still isolated 4 = few large open areas between large patches 5 = almost continuous dense mid-canopy cover
	23 – Riparian Upper Canopy Patch Density	1 = no upper-canopy trees present in reach 2 = few isolated small patches in upper canopy 3 = more patches but still isolated 4 = few large open areas between large patches 5 = almost continuous dense upper-canopy cover
	24 - Fluvial Habitat Diversity	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
	: Terrestrial Wildlife Habitat Mean Score	Notes:

Whole Study Reach

Begin by recording the GPS locations of the ends of the whole study reach on the Score Sheet. Take reference photos at both ends of the whole study reach.

Indicator 5: Hydraulic Habitat Diversity *Check hydraulic stream features providing important aquatic habitat*

☐ Edge water
☐ Lateral pool
☐ Scour pool
☐ Cobble/boulder debris fans
☐ Active, flowing side channels
☐ Backwaters
☐ Sand-floored runs
☐ High velocity riffle/run
☐ Low velocity riffle/run
☐Other________________________
☐Other________________________

Total Hydraulic Habitat Features: ___________

Indicator 24: Fluvial Habitat Diversity *Check geophysical features in the riparian zone that provide unique wildlife habitat*

☐ Flood-plain ponds
☐ Oxbows
☐ Large & isolated sand/gravel bars
☐ Wet meadows
☐ Marsh
☐ Stable cutbanks
☐ Beaver pond
☐ Other______________________
☐ Other______________________

Total Fluvial Habitat Features: ___________

Indicator 6: Riparian Area Soil Integrity

Percentage of soil area disturbed in whole study reach: ____________

Notes: ____

Indicator 7: Beaver Activity *Mark any signs of past or current beaver activity*

☐ Tracks
☐ Drags
☐ Digging marks
☐ Cut stems
☐ Burrows
☐ Dams
☐ Caches
☐ Other__________
☐ Other__________

Native Species Indicators	Dominant Species:	Age Classes Present (*Check all observed*):
Indicator 15: Native Riparian Shrub		☐ Seedling ☐ Mature ☐ Sapling ☐ Old, dead clumps
Indicator 16: Native Riparian Tree		☐ Seedling ☐ Mature ☐ Sapling ☐ Old, dead snags

Non-Native Cover Indicators	Percent (%) of Non-native Species
Indicator 17: Non-Native Herbaceous Grasses and forbs, as percentage of total Grasses and forbs cover.	
Indicator 18: Non-Native Woody Plant Shrubs and trees, as percentage of total shrub and tree cover.	

Riparian Patch Density Indicators	Density Scores (*Pick One*)				
	1 - No patches	2 - Few, isolated patches	3 - More patches, but still isolated	4 - Few large openings between large patches	5 - Almost continuous dense cover
Indicator 21: Shrub (less than 4 m)	☐	☐	☐	☐	☐
Indicator 22: Middle Canopy (4 – 10 m)	☐	☐	☐	☐	☐
Indicator 23: Upper Canopy (greater than 10 m)	☐	☐	☐	☐	☐

Reach Name ____________ Date ____________

Riparian Zone 200-meter Transect

Indicator 14: Riparian Zone Plant Community Structure and Cover & Indicator 19: Grazing on Ground Cover

Collect data for Indicator 14 and Indicator 19 every 2 m along one 200-m transect running 1 m from water's edge

Layer	Hits "Yes"	Hits "No"	Hits of "N/A' (i.e., rocks)	Scoring		
				Total Points (excluding any "N/A")	Total Hits "Yes"	(Total Hits "Yes" / Total Points) X 100
Ground Layer (0-1m)						% cover
IF ground layer is grass/herbaceous, is it grazed?						% grazed
Shrub Layer (1-4m)						% cover
Middle Canopy Layer (4-10m)						% cover
Upper Canopy Layer (>10m)						% cover

Indicator 20: Mammalian Herbivory (Browsing) on Woody Vegetation (i.e., any shrubs and trees)

Count along one 200-m transect running 1 m from water's edge.

	Total Browsed	Total NOT Browsed	Scoring		
			Total Woody Vegetation Individuals	Total Browsed	(Total Browsed / Total) X 100
Woody Vegetation					% browsed

Reach Name ____________ Date ____________

In-stream 200-meter Transect

Indicator 1: Algal Growth (tally ocular tube hits for filamentous algae at each point 1 m from water's edge). Collect data for this indicator every 2 m along one in-stream transect approximately 1 m from the bank.

Indicator 4: Vertical Bank Stability; Indicator 9: Underbank Cover; Indicator 13: Overbank Cover and Terrestrial Invertebrate Habitat Collect data on number of meters in each 2-m interval on both banks.

Indicator 8: Riffle-Pool Systems & Indicator 12: Large Woody Debris

Count number of riffle-pool complexes. Count partly/wholly submerged wood pieces greater than 15 cm (6 in) diameter and greater than 0.9 m (3 ft) long.

Indicator	Hits "Yes"	Hits "No"	Total Points	Total Hits "Yes"	(Total Hits "Yes" / Total Points) X 100
1. Algae "Hits"					% transect covered in algae
Indicator	**Positive**	**Negative**	**Total Meters**	**Total Meters "Positive"**	**(Total Meters "Positive" / Total Meters) X 100**
4. Vertical Bank Stability	m of stable banks	m of unstable banks			% stable banks
9. Underbank Cover	m with underbank cover	m lacking underbank cover			% undercut banks
13. Overbank Cover	m of bank with overbank cover	m of bank lacking overbank cover			% overbank cover

Indicator	Counts	Total Number
8. Riffle / Pool Complexes		
12. Pieces of Woody Debris		

Reach Name ____________ Date ____________

Three Representative Reach Sites

Data for the following indicators are collected at three representative sites along the study reach. The locations used for each indicator may be the same or different, as needed, and they do not need to be within the 200-m transect.

Sites *Optional* UTM Coordinates & Photo ID	Indicator 2: Channel Shading	Indicator 3: Floodplain Connection		
	% of stream shaded at mid-day	Current bankfull depth (AB)	Historic foodplain height (AC)	Floodplain / bankful ratio (AC / AB)
Site 1 Photo ID: UTM E: UTM N:	%			
Site 2 Photo ID: UTM E: UTM N:	%			
Site 3 Photo ID: UTM E: UTM N:	%			
Average % of 3 sites	%	**Average floodplain / bankful ratio of 3 sites**		

Representative Instream Riffle Sites

Collect data for these indicators at three representative stream riffle locations. These sites may be different or the same than those used for Indicators 2 and 3. Make sure these sites represent typical riffles in your reach.

Indicator 10: Cobble Embeddedness Indicate the degree to which each rock is covered by silt or sand in the substrate. *At each site, examine six cobbles 8-20 cm (3-8 in) in diameter for embeddness.*

Sites *Optional* UTM Coordinates & Photo ID	Indicator 10: Cobble Embeddedness						
	Rock 1	Rock 2	Rock 3	Rock 4	Rock 5	Rock 6	Average % of Rocks
Site 1 Photo ID: UTM E: UTM N:	%	%	%	%	%	%	%
Site 2 Photo ID: UTM E: UTM N:	%	%	%	%	%	%	%
Site 3 Photo ID: UTM E: UTM N:	%	%	%	%	%	%	%
Average % of 3 Sites							%

Indicator 11: Aquatic Macroinvertebrates *Examine six rocks at least 15 cm (6 in) in diameter at each site. Create a running list of macroinvertebrate orders found at all three sites, combined.* Note: Crayfish are not counted.

☐ Amphipoda (Scud)
☐ Coleoptera (Beetle, Water Penny)
☐ Diptera (True flies)
☐ Ephemeroptera (Mayfly)
☐ Isopoda (Sowbugs)
☐ Class Hirudinea (Leech)
☐ Megaloptera (Hellgrammite, dobsonfly)
☐ Odonata (Damselfly, dragonfly)
☐ Class Oligochaeta (Worm)
☐ Plecoptera (Stonefly)
☐ Pulmonata (Pouch/ pond snail)
☐ Trichoptera (Caddisfly)
☐ Turbellaraia (Flat worm)
☐ Prosobranchia (Gilled snail)
☐ Other: ___________________
☐ Other: ___________________
☐ Other: ___________________

Reach Name ____________ Date ____________

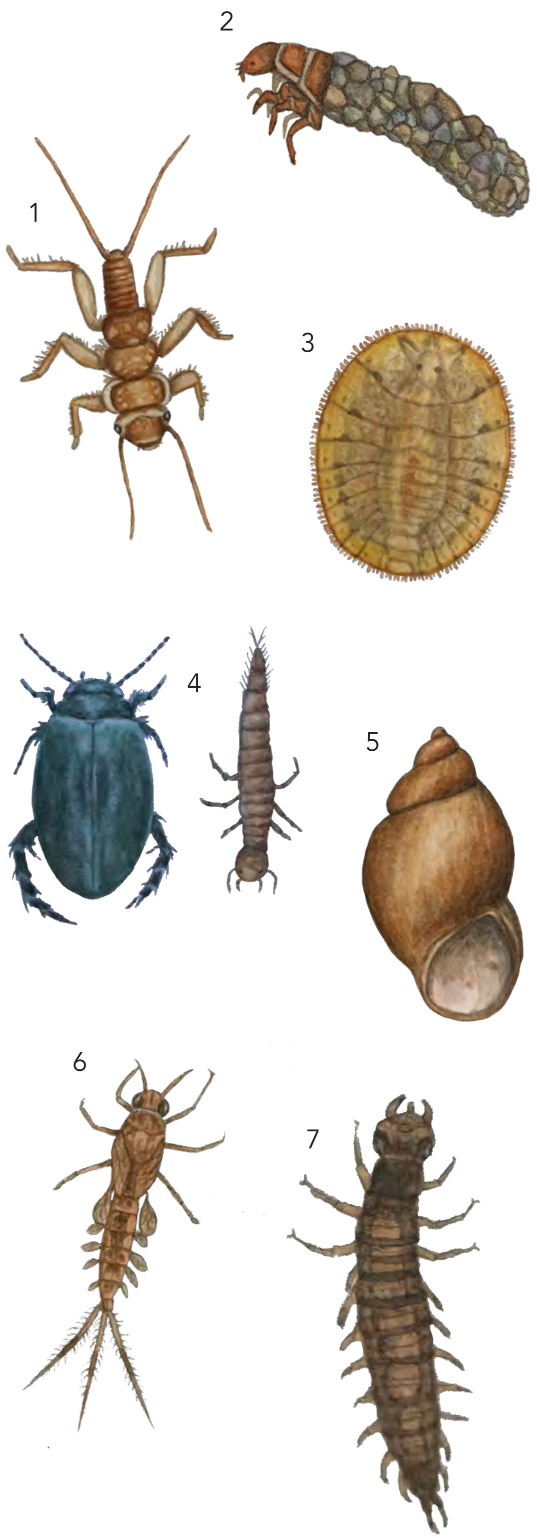
Human Impacts Worksheet

This information can be used to help interpret the scores received by 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, overgrazing, etc.)?
If the reach is used for livestock grazing and under a current annual management plan (AMP), is the actual level of grazing consistent with that outlined in the 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 road impacts?
To what extent has the channel geomorphology been affected by human activities (e.g., channelization, check dams, irrigation canals, etc.)?

Appendix 2 - Benthic Macroinvertebrates

Benthic Macroinvertebrate Species Orders
Used for Indicator 11



Pollution-Sensitive Organisms
Found in good-quality water

1. Stonefly, Order Plecoptera, 1/2 - 1 1/2"
6 legs with hooked tips, antennae, 2 hair-like tails, smooth (no gills) on lower half of body.

2. Cadisfly, Order Trichoptera, up to 1"
6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock or leaf case with its head sticking out. May have fluffy gill tufts on underside.

3. Water Penny, Order Coleoptera, 1/4"
Flat saucer-shaped body with raised bump on one side and 6 tiny legs and fluffly gills on the other side. Immature beetle.

4. Riffle Beetle, Order Coleoptera, 1/4"
Oval body covered with tiny hairs, 6 legs, antennae. Walks slowly underwater. Does not swim on surface. Adult and larva shown here.

5. Gilled Snail, Order Prosobranchia
Shell opening covered by thin plate called operculum. When opening is facing you, shell usually opens on right.

6. Mayfly, Order Ephemeroptera, 1/4 - 1"
Brown, moving, plate-like or feathery gills on sides of lower body, 6 large hooked legs, antennae, 2 or 3 long, hair-like tails. Tails may be webbed together.

7. Dobsonfly (Hellgrammite), Order Megaloptera, 3/4 - 4"
Dark-colored, 6 legs, large pinching jaws, 8 pairs of feelers on lower half of body with paired cotton-like gill tufts along underside, short antennae, 2 tails and 2 pairs of hooks at back end.

Somewhat Pollution-Tolerant Taxa

Can be found in good- or fair-quality water

8. Crayfish, Order Decapoda, up to 6”
2 large claws, 8 legs, resembles small lobster.

9. Sowbug, Order Isopoda, 1/4 - 3/4”
Gray oblong body wider than it is high, more than 6 legs, long antennae.

10. Scud, Order Amphipoda, 1/4”
White to gray, body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp.

11. Alderfly Larva, Order Megaloptera, 1”
Looks like small hellgrammite but has 1 long, thin, branched tail at back end (no hooks), no gill tufts underneath.

12. Fishfly Larva, Order Megaloptera, up to 1 1/2” long
Looks like small hellgrammite but often a lighter reddish-tan color, or with yellowish streaks, no gill tufts underneath.

13. Damselfly, Order Odonata, Suborder Zygoptera, 1/2 - 1”
Large eyes, 6 thin hooked legs, 43 broad, oar-shaped tails, positioned like a tripod, smooth (no gills) on sides of lower half of body.

14. Watersnipe Fly Larva, Order Diptera, 1/4 - 1”
Pale to green, tapered body, many caterpillar-like legs, conical head, feathery “horns” at back end.

15. Crane Fly, Order Diptera, 1/3 - 2”
Milky, green or light brown, plump caterpillar-like segmented body. 4 finger-like lobes at back end.

16. Beetle Larva, Order Coleoptera, 1/4 - 1”
Light-colored, 6 legs on upper half of body, feelers, antennae.

17. Dragon Fly, Order Odonata, Suborder Anisoptera, 1/2 - 2”
Large eyes, 6 hookedlegs, wide oval to round abdomen.

18. Clam/Mussel, Class Bivalvia

References

Acknowledgements:

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