

# A Rapid Stream-Riparian Assessment Protocol and its Utility in the Grand Staircase Region, Utah

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## ABSTRACT

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We developed an improved rapid stream-riparian ecological health assessment protocol for the stream-riparian ecosystems of the Grand Staircase-Escalante National Monument and similar places in the American Southwest. This Rapid Stream-Riparian Assessment Protocol (RSRA <http://biology.unm.edu/stacey/RUG-cover.pdf>) efficiently evaluates the current ecological health of streams and adjacent riparian areas. The method uses a series of simple but biologically based indicators to measure how much the stream system differs from what would be expected under unaltered (reference) conditions. It incorporates a simple scoring system that can be repeated in different locations and at various times by different people. This method therefore provides the opportunity to develop a regional database that will not only rank the conditions of stream-riparian systems, but also will allow monitoring of stream responses to restoration efforts. We report on citizen-based stream monitoring activities using the RSRA protocol in adjacent watersheds on the Colorado Plateau. These methods are relevant to other watersheds in and around Grand Staircase-Escalante National Monument.

**Keywords:** citizen-based actions, Colorado Plateau, ecosystem assessment protocols, environmental management, monitoring, multi-disciplinary, riparian, streams

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## Introduction

Stream-riparian ecosystems, including stream channels, stream margins, fluvial marshes, and terrace meadows, are among the most productive, biologically diverse, and threatened habitats in the American Southwest (Johnson et al. 1985, Knopf et al. 1988, Ohmart et al. 1988, Johnson 1991). These stream-riparian habitats consist of areas that are “inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and which, under normal circumstances...support, a prevalence of vegetation typically adapted for life in saturated soil conditions” (U.S. Department of the Interior 1992). They are influenced by various hydrogeologic and geomorphic processes that result from the water-

shed’s historic and contemporary flow patterns, flood disturbance regimes, sediment transport, adjacent upland conditions, and local and regional land management practices (Hupp 1988, Gregory et al. 1991, Malanson 1993, Mitsch and Gosselink 1993, Auble et al. 1994, Leopold 1994). As in most arid and semi-arid environments, riparian habitats in the American Southwest support diverse assemblages of distinctive species that are not found in the surrounding uplands. In addition, many upland wildlife species are dependent upon riparian habitats for water, nesting or breeding habitat, and thermal cover during the hotter times of the day (Stacey 1995). Healthy riparian ecosystems are also critical for maintaining overall water quality within the watershed, erosion control, and downstream flood prevention (Gregory et al. 1991).

Despite their great ecological importance and value to human communities, land management activities such as poorly managed grazing, flow regulation and diversion, and channelization have substantially compromised the ecological integrity of many stream, wetland, and riparian ecosystems in the Southwest and throughout North America (Fleischner 1994, Dale et al. 2000). Estimates of riparian habitat loss range from 40 percent to 90 percent among the southwestern states (Dahl 1990), and riparian habitats are considered to be one of this region's most endangered ecosystems (Noss et al. 1995). Although southwestern stream ecosystems have been greatly altered, these systems are highly resilient, and are likely to respond positively and often quickly to improved management practices (e.g., Phillips 1998). As a result, their restoration has become a central focus in both the public and private sectors. Federal agencies, such as the Bureau of Land Management (BLM), Bureau of Reclamation (BR) and the United States Forest Service (USFS), which together control most of the riparian habitat in the Southwest, are under Congressional mandate to manage public lands both for multiple use and long-term ecological sustainability (Federal Land Policy and Management Act of 1976). For example, the Department of the Interior, which oversees the majority of the middle and low elevation federal lands in the Southwest, has adopted a riparian and wetland management policy which establishes an agency goal to: "restore and maintain riparian-wetland areas...and to achieve an advanced ecological status, except where resource management objectives...require an earlier successional stage, thus providing the widest variety of habitat diversity for wildlife, fish, and watershed protection" (U.S. Department of the Interior, USDI, 1991). This policy was adopted in 1991 after DOI determined that only 15 percent of riparian areas in the lower 48 states under USDI management were meeting riparian management objectives (USDI 1991). Most other federal and state agencies, and many private organizations and individuals, have established similar goals or programs for the lands they manage.

Assessment of condition of riparian ecosystems on large land management units, such as those administered by the BLM and USFS,

requires a standardized method for determining the current health or functional status of selected stream or river reaches. This is necessary in order to distinguish stream-riparian habitats that are functioning in accord with management program goals from those that require active or passive management. Standardized assessment protocols can help prioritize which reaches and watersheds need the most immediate attention when resources are limited. Standardized assessment protocols also can be used to monitor management and restoration progress through trend analysis.

Many different protocols have been developed to directly or indirectly assess the condition of riparian and associated riverine ecosystems (see examples listed in Stevens et al 2005). Most focus on a particular component or process within the overall system (e.g, channel geomorphology, steamside or greenline vegetation and bank stability, flow regime patterns, aquatic habitat quality, channel morphology, water quality and aquatic invertebrate community composition). While such protocols have helped guide land management decisions, their usefulness has been limited by: 1) their presumption that the component under study is the best "umbrella" to encompass overall ecosystem functionality (e.g., areas rated high in water quality and aquatic invertebrate diversity may not provide suitable terrestrial wildlife habitat, and visa versa); 2) an overly narrow focus; 3) reliance on specialized equipment; and 4) overly time-consuming measurements.

One of the most widely used rapid assessment methods for riparian habitat evaluation at the present time is Proper Functioning Condition (PFC) Assessment, an assessment protocol developed by the U.S. National Riparian Service Team for the BLM. The PFC protocol (USDI 1992, 1993, 1994, 1998) defines proper ecological function primarily in terms of geomorphic processes, and provides a qualitative method to determine the current status of a particular reach. This methodology subsequently has been adopted by other federal agencies charged with managing riparian habitats (e.g., the U.S. Forest Service: Winward 2000). Potential inefficiencies and drawbacks of this method are discussed in Stevens et al. (2005). Geomorphic function is an important but by no means the sole

criterion of riparian ecosystem health, and effective assessment should include an efficient, multidisciplinary approach as is described above.

A different approach to riparian habitat evaluation is to examine a broader array of variables that encompass the entire ecosystem. Each variable then serves as an indicator for one or more important components or processes. By focusing on simple yet appropriate measurements and avoiding the use of specialized equipment, these protocols can be completed in a relatively short time and applied to many different reaches in a wide area, a critical requirement for large-scale survey programs. They also can usually be performed by almost any interested individual who has been properly trained and whose work is overseen by an expert. Thus, with proper training, these protocols can become a widely-used and effective riparian ecosystem assessment and monitoring approach, and is an approach useful for educational purposes and generating citizen involvement in land management issues as well (e.g., Fleming and Henkel 2001).

## Rapid Stream-Riparian Assessment (RSRA) Protocol

The Rapid Stream-Riparian Assessment (RSRA) protocol was developed by a team of scientists with extensive research and applied experience in the Southwest over the past six years, and is designed to measure the health or functioning condition of riverine and associated river habitats (Table 1). Our goal has been to integrate an efficient, multidisciplinary suite of protocols, while at the same time keeping the method simple enough that it can be completed in the field by trained individuals in a relatively short length of time (3 hours or less). The method is an outgrowth of our work in riparian habitats, including many in the Grand Staircase (Stevens et al. 2005), five seasons of field testing in various watersheds in the Southwest, and independent review of the protocol by numerous academic scientists, agency personnel, environmental activists and concerned citizens. RSRA was designed for use in low and middle elevation reaches of streams in the Southwest where

steep ecological gradients create abrupt changes in vegetation between moist riparian soils and upland xeric soil assemblages. However, RSRA is conceptually robust and, with minor adjustments, it should be applicable for use in many other places, such as montane sites or more mesic areas.

RSRA involves quantitative measurements to develop a qualitative assessment of an individual stream-riparian reach. It focuses upon five functional categories of stream-riparian ecosystem characteristics: 1) water quality, 2) stream channel and floodplain morphology, 3) habitat availability and quality for native fish and other aquatic species, 4) vegetation structure and composition (including non-native species), and 5) suitability as habitat for terrestrial wildlife, including threatened or endangered species. Within each of these categories, RSRA evaluates 2-8 variables that reflect overall function and health of the stream-riparian ecosystem.

RSRA uses a quantitative approach to score field indicator variables. Qualitative assessment systems (e.g. PFC) often are based on dichotomous categories, such as “functional/non-functional”, or “yes/no”, which are subjective in interpretation and often difficult to interpret or replicate between site visits, particularly when conducted by different observers. In addition, dichotomous scoring systems do not provide sufficient description of altered ecological processes to indicate whether and which management activities are needed. We used a review of existing assessment and monitoring protocols, our own research experience, and extensive external peer-review to create a 5-point scale for each assessment variable on the checklist (Appendix 1). The maximum score (5 points) is given when that component or process is fully functioning 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 or dysfunctional, and incapable of delivering the contributions of that variable to the ecosystem.

Table 1 elucidates some of the principles that guided our selection of the specific variables that are included in the RSRA. For example, RSRA

Category and Variable	Justification for inclusion in RSRA Assessment
<b>Water Quality:</b> 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.
<b>Water Quality:</b> 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.
<b>Hydrogeomorphology:</b> 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.
<b>Hydrogeomorphology:</b> 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.
<b>Hydrogeomorphology:</b> 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.
<b>Hydrogeomorphology:</b> 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.
<b>Hydrogeomorphology:</b> 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.
<b>Fish/Aquatic Habitat Qualifier:</b> 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).
<b>Fish/Aquatic Habitat:</b> 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
<b>Fish/Aquatic Habitat:</b> 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.
<b>Fish/Aquatic Habitat:</b> 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.
<b>Fish/Aquatic Habitat:</b> Diversity of aquatic macro 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.
<b>Fish/Aquatic Habitat:</b> Large woody debris	The amount, composition, distribution and condition of large woody debris (LWD) in the stream channel and along the banks provides important fish habitat for nursery cover, feeding, and protective cover. Streams with adequate LWD generally have greater habitat diversity, a natural meandering shape and greater resistance against high water events.
<b>Fish/Aquatic Habitat:</b> 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.
<b>Riparian vegetation:</b> 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.
<b>Riparian vegetation:</b> 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.
<b>Riparian vegetation:</b> Non-native herbaceous and woody plant 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.
<b>Riparian vegetation:</b> Mammalian herbivory impacts on ground 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.
<b>Riparian vegetation:</b> 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.
<b>Terrestrial Wildlife Habitat:</b> 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 over-bank flow.
<b>Terrestrial Wildlife Habitat:</b> 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.

**Table 1.** Field indicators included in the RSRA, and justification for their inclusion. Reprinted from Stacey et al. 2006. Literature citations for justification are included in Stevens et al. (2005).

focuses on indicators that not only measure the ability of the system to provide specific functions (e.g., overbank cover that provides shelter and insect drop for fish and other aquatic species), but that also reflect other important ecological processes in the stream-riparian system (e.g., overbank cover also indicates that the channel is well-vegetated and functioning in erosion control during overbank flooding). Should any individual component of the reach be found to be particularly problematic or non-functional, more specialized methods can then be used during subsequent visits to collect additional quantitative information on that variable.

Another important feature of RSRA is that it only measures the current condition of the ecosystem, rather than guessing at an hypothesized future state or successional trend. For example, a particular fluvial geomorphology may lead to a particular potential natural community (e.g., USDI 1993); however, too many other factors come into play during the successional development of riparian vegetation. Stream-riparian systems are highly dynamic and often are subject to disturbances (e.g., large floods) that alter successional trends and make predictions of future conditions difficult. By focusing on current, rather than potential future conditions, RSRA can be used for monitoring and developing baseline conditions, which are useful to measuring future changes in the functional status of the system.

## RSRA in the Grand Staircase Region and Colorado Plateau

### *Previous Studies*

Stevens et al. (2005) describes some of the initial “beta testing” of RSRA in four different stream reaches in the Grand Staircase Escalante National Monument. The riparian sites examined included the Gulch, Deer Creek, Harris Wash and Cottonwood Creek. They reported that RSRA documented a much broader array of ecosystem condition issues and more detailed, quantitative information on site conditions than did the BLM’s PFC results for those same reaches. While part

of the reason for differences may have been the different make-up of survey teams, Stevens et al. (2005) also found substantial differences in the final site scores between the two approaches for those reaches. The PFC assessments conducted by the BLM concluded that three of the four sites (all but Harris Wash), were in proper functioning condition, whereas RSRA indicated that Harris Wash was dysfunctional, Cottonwood Creek and the Gulch were functioning at risk and in need of management attention, and only Deer Creek was functioning properly. These results were primarily driven by field indicators representing fish and terrestrial wildlife habitat, indicators that are under-emphasized in the BLM’s PFC approach.

One lesson learned from the development of the RSRA protocol was that a simplified version of the protocol was needed that could be easily taught to ranchers, landowners, teachers, conservation activists, agency personal and other interested stakeholders. We held a number of RSRA workshops in Utah and New Mexico with a variety of educated laypeople. These workshops provided feedback that resulted in a streamlined version of the protocol and an easy-to-follow Users Guide (Stacey et al. 2006, <http://biology.unm.edu/stacey/RUG-cover.pdf>).

### *On-going Work*

The RSRA is presently being used to assess the Mancos River watershed in southwest Colorado. In the summer of 2006, the Mancos Conservation District hired one of the authors (PBS) to survey the entire upper Mancos River using RSRA. Part of this program involved a local stakeholder workshop. County commissioners, Conservation District Staff, National Park Service (Mesa Verde) staff, landowners and other local residents convened in the field to learn about RSRA, how it was used to assess the current health and ecological status of the river, and how to interpret results to prioritize restoration activities. When the Conservation District held a presentation the following winter to share the results of the RSRA surveys, nearly half of the adult population in the town of Mancos turned up at the Community Center to hear about it. Results of the surveys, some of which indicated that the health of the river had declined as it descended in elevation and entered

agricultural lands, are provided in Stacey (2007). As a result of the surveys and the enthusiastic endorsement of the watershed communities for using RSRA as a planning and restoration tool, two landowners have offered their riverfront ranches for 2007 restoration demonstration projects.

The Mancos story shows us the utility of RSRA not only for quickly determining the ecological functionality of a river from headwaters to valley floor, but also as a management tool for prioritizing riparian restoration efforts. Therefore, RSRA also may be used as an effective teaching and communication tool because it provides concepts and assessment techniques that a group of stakeholders with mixed (and even contradictory) interests can understand and use to improve the management and restoration of stream-riparian ecosystems.

### *Future Applications*

We hope to repeat the Mancos story in 2008 in a locale much closer to the Grand Staircase region, the Fremont watershed. From its marshy headwaters at 11,000 feet on the Fishlake Plateau, the Fremont River flows south and east through U.S. Forest Service, private, Capitol Reef National Park, state, and Bureau of Land Management lands, flowing through canyonlands desert into the Dirty Devil River at 5,000 feet altitude, and thence into the Colorado River. This route drains a 1,970 square mile watershed. While private lands represent only 5 percent of the watershed area, they occupy approximately 40 percent of the Fremont River's banks.

The Fremont watershed provides an excellent opportunity to use RSRA to integrate public and private concerns and improve stream-riparian habitat management and restoration. An RSRA workshop for local stakeholders is the first step. Ecologists working with a local conservation group plan to systematically assess conditions and conservation/restoration opportunities along the Fremont River and key tributaries using RSRA. Discussions will be held with local residents, including private landowners who want to develop blue-ribbon fisheries and others who wish to purchase key conservation lands and/or establish conservation easements. Much discussion has taken place with

federal land managers, including those in Fishlake National Forest regarding the establishment and protection of key riparian reference areas for better understanding the potential functioning of this and other nearby watersheds. RSRA surveys will help identify the best riparian sites for establishment of those reference areas. Thus, RSRA promises to be an invaluable method for bringing diverse stakeholders together with a common language about their watersheds, assessing current conditions, and working toward common goals in river and riparian management.

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