
Community-Based Ecological Monitoring

A Rapid Appraisal Approach

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Continuous natural resources monitoring is greatly needed so that public agencies can make timely, cost-effective, and scientifically credible land management decisions and local communities can anticipate the effects of proposed changes in land use. This article discusses how participatory, community-based, rapid appraisal methods can be used to monitor riparian health and educate the public, providing a practical solution to the need for community-level knowledge of natural systems while complementing more detailed analyses by professional scientists.

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In the extensive landscapes of the western United States, natural resources monitoring is greatly needed so that public agencies can make timely land management decisions, regional bodies can make effective growth management choices, and local communities can anticipate the effects of proposed changes in land use. This requires frequent assessments and continuous public awareness of changes in the condition of the land. Gundersen (1999) points to the need for more timely awareness of changes in ecosystem health so that meaningful action can be taken to arrest the erosion of ecological resilience. Thomas (1999) argues for greater transparency in bio-regional assessment and resulting policies in order to mobilize greater public support for interventions promoting environmental stability.

Monitoring techniques should be adaptable to different scales, including the "ecological site" and the "ecological landscape" (Allen, 1994). This has been difficult to achieve because while monitoring must be timely, cost-effective, and scientifically credible, existing practices depend too heavily on time-consuming, expensive, and overly detailed analysis (Holechek et al., 1998). A new approach is needed that enables nonspecialist volunteers to measure ecosystem health over time so that land uses can be adjusted to support long-term viability.

Riparian ecosystem structure and function respond to both abiotic and biotic forces, and our monitoring approach focuses on 12 indicators of the health of these forces, ranging from hydrologic discharge to macroinvertebrate family diversity. Each criterion is evaluated on a scale of 1 to 4, with 4 the healthiest and 1 the least healthy. The approach is based upon systematic sampling by volunteers in more than 20 communities since 1993. This article describes the application of our approach to a watershed near Santa Fe, New Mexico, where local high school students have monitored riparian health for 5 years. The assessment of riparian health described here is considered one of the "rapid appraisal methods" in that it takes a trained person

less than an hour to complete. Once trained, a person can train others in turn. The method can be taught to volunteer monitors in two hours, making it possible to complete several surveys in a day. The only equipment required is a tape measure, insect screening, and a wrist-watch. For most appraisal teams, this requires an out-of-pocket expenditure of less than \$15.

Evaluating Riparian Ecosystems

There are no generally accepted criteria for evaluating and comparing the health of riparian ecosystems. Riparian "health" is defined here as a set of environmental conditions that result in the long-term sustainability of the riparian habitat. The quality of the riparian habitat refers to how well it supplies the physical, chemical, and biological needs of the organisms living there (Miller, 1990). In an ecosystem view of the restoration of the riparian system of the Kissimmee River, Dahm (1995) associates "health" with the degree of "connectivity and interactions between the abiotic and biotic variables of the river and floodplain" (p. 26).

In the past, appraisals emphasized either broad surveys at high levels of generalization or expensive and time-consuming in-depth fieldwork, the deficiencies of which led Chambers (1991) and others to explore alternative appraisal techniques. Observing that traditional scientific investigations are often derived from the scientist's *a priori* attitude toward the subject matter and an assumption that local informants possess knowledge needed to further the research, Chambers notes that "knowledge can also be generated by more participatory approaches, in which investigation and analysis are carried out more by rural people themselves, in which they 'own' the information, and in which they articulate their priorities" (p. 527). The outcome has been a virtual family of participatory methods, including Participatory Action Research, Participatory Rural Appraisal, and Participation and Learning Methods, among others (Slocum et al., 1995). The determination of suitable data, the composition of qualified survey teams, and the satisfaction of quality assurance and quality control criteria are key to making rapid appraisal both useful and acceptable.

One of the challenges presented by rapid appraisal approaches is defining what constitutes essential information. Steiner (1991), Sargent et al. (1991), and Marsh (1998), though coming from different perspectives, all agree on an ecosystemic approach to integrating geomorphology, soils, water, vegetation, and land use, to which Brown (1995) and Sauer (1998) add wildlife and wildlife habitat. Even where it is possible to agree upon the categories of environmental information needed, it is often unclear how rural areas with limited resources and

pressing needs to understand the changing health of the natural systems can acquire both the information and the analytical capability to use it.

Hildebrand's (1976) rapid survey method applied in farming systems research uses interdisciplinary teams whose members are methodically rotated and reassigned to offset biases, so that a database of empirical observations is formed. His method called *sondeo* (Spanish for "sounding") has given rise to a number of other methods used in Africa (Kabutha et al., 1993), Asia (Chambers, 1991), Europe (Day et al., 1998), and North America (Harker & Natter, 1995). It is not a very large step from formally trained researchers constructing an integrated analysis of farming systems in consultation with local residents to trained local residents themselves collecting and interpreting that information. Using local residents this way makes the analysis more robust and more cost-effective. Small communities may be able to afford this approach, especially where they can form an alliance with a cadre of trained research scientists—an alliance that should logically include graduate students and even highly motivated secondary school pupils from the community itself.

Ecological monitoring should consider the cultural context (i.e., the value of natural resources to local residents) and local knowledge of the landscape in addition to biological factors. There is often a rich vernacular understanding of the immediate natural environment, but public agencies are usually not prepared to include less formalized and anecdotal knowledge in their decision making because it is hard to combine with the formal scientific protocols governing quality assurance and quality control. Consequently, potentially valuable data is overlooked. The integration of vernacular knowledge and applied analytical techniques is often missing, and combined with restricted local control over the resources themselves, the capacity of people to effect desirable change is thereby weakened.

Monitoring information must be suitable for technical specialists, decision makers, and nonspecialist local residents. Consequently, the scientific information collected must be of a sort that can be summarized both as an indicator of overall environmental health and as useful material for local political authorities. This entails the establishment of quality assurance project plans (QAPPs), which provide an accepted standard for the collection and evaluation of environmental data. The scientific validity of data monitored by volunteers has been increasingly accepted by governmental environmental agencies (Dates, 1998).

The community-based rapid appraisal approach we describe here grew out of our involvement in the New Mexico Watershed Watch. Initiated in 1993, the New

Mexico Watershed Watch is a high school watershed monitoring program that links community-based monitoring in 20 watersheds by student residents with the rigor of a science-based rapid appraisal approach to ecological monitoring. The program provides teachers with instruction on methods of water quality analysis, riparian habitat evaluation, and watershed planning. It also emphasizes local water quality as a function of an entire watershed.

In the Watershed Watch program, watersheds are viewed holistically, and land use impacts on water quality are emphasized. The following water quality parameters are sampled monthly: turbidity, temperature, pH, conductivity, nutrients (nitrate and total phosphorus), and metals (copper, zinc, aluminum, and lead; Fleming & Schrader, 1998). Issues of interest to the 20 communities motivate the choice of monitoring activities. Evaluation of riparian habitats is central to the program. Its method is described in the following section.

Riparian Habitat Evaluation Method

Several authors, such as Barbour and Stribling (1991) and Jacobi et al. (1995), have suggested criteria for evaluating the health of riparian habitats in the western United States. Although their criteria are heavily oriented toward stream habitats for fish, indices have been adapted for a wider range of organism classes, including birds and other wildlife (Fleming & Schrader, 1998). A riparian environment that is healthy for fish and birds is considered healthy for a wide range of organisms (Chiras, 1998; Dahm, 1995). Table 1 describes 12 criteria, beginning with streamflow necessary to support a healthy aquatic habitat. Each criterion is evaluated on a scale of 1 to 4, with 4 the healthiest and 1 the least healthy. The scores for the 12 criteria are summed and divided by 12, resulting in a composite score that provides a ranking of riparian health for the reach evaluated.

Streamflow

The ability of a stream to produce and maintain a stable streambed environment is indicated by the flow (Ball, 1982). For an optimum aquatic environment, several authors conclude that a streamflow of at least 0.05 cubic meters per second (cms), equivalent to 2 cubic feet per second (cfs), is necessary to support a high-quality, cold-water fishery (Barbour & Stribling, 1991; Oswood & Barber, 1982). If less than 0.01 cms are flowing, the habitat is considered poor (Barbour & Stribling, 1991). Streamflow is measured quickly and inexpensively by timing the number of seconds a floating object takes to travel 10 meters in the stream, resulting in the velocity (m/sec). The

cross-sectional area of the stream reach (m^2) is multiplied by the velocity to obtain streamflow (m^3/sec).

Streambed Geology: Composition

Streambed composition is critical for the maintenance of necessary void spaces in the substrate for macroinvertebrate habitat, which need a continuous flow of water, oxygen, and food sources (Frissell et al., 1986). Stream reaches are evaluated by walking in a zig-zag pattern, stopping every two steps to determine the size of material in front of the evaluator's boot (Potyondy & Hardy, 1994). If more than 50% of this material is composed of gravel, cobble, and boulder categories, the habitat is considered optimal (Barbour & Stribling, 1991). At least 20 samples should be chosen in each reach and a range of grain size percentages calculated. If more than 50% of the substrate is sand size or smaller, the habitat is considered poor. Even though this evaluation is somewhat coarse, an estimate of the percentage of fine material is considered a valuable indicator of upstream watershed disturbance (Frissell et al., 1986).

Streambed Geology: Embeddedness

Embeddedness measures how much of the surface area of larger substrate particles are surrounded by fine sediment (sand, silt, and clay; Platts et al., 1983). The evaluation is conducted by walking in a randomly chosen zig-zag pattern in the stream channel and picking up streambed material at each step of a 10-step transect. This criterion allows an evaluation of the substrate as a habitat for benthic (living in the streambed) macroinvertebrates and fish spawning (Barbour & Stribling, 1991). Heavy silting is an indication of upstream watershed disturbance and is known to cause a reduction in insect diversity and population (Minshall, 1984).

Width/Depth Ratio

The ratio of bankfull channel width (the width at the top of the bank determined by its extent when full of water, usually once a year) to mid-channel depth is optimal for fish and aquatic insect habitat if less than 7:1 (Rosgen, 1994). A very wide and shallow stream with a width/depth ratio of more than 25:1 is considered poor habitat for fish and the macroinvertebrate food supply on which they depend (Ball, 1982; Gibson, 1994). A tape measure and meter stick are used to measure the width and depth of the channel.

Bank Stability

Upper bank stability is considered excellent if less than 10% of the bank area is vertical and unvegetated, while stability is rated poor if more than 50% is in an un-

TABLE 1. Riparian health indices applied to the Upper Tesuque Watershed.

Criterion	Condition score			
	4 Excellent	3 Good	2 Fair	1 Poor
Streamflow (m ³ /sec)	>0.05	0.03–0.05	0.01–0.03	<0.01
Streambed geology: Composition (proportion of rock material = boulders, cobbles, and gravel)	>50%	25–50%	10–25%	<10%
Streambed geology: Embeddedness (proportion of rock material below streambed surface)	<25%	25–50%	50–75%	>75%
Width/depth ratio (ratio of bankfull channel width to mid-channel depth)	<7:1	8–15:1	15–25:1	>25:1
Bank stability (area w/o vertical, unvegetated banks)	>90%	70–90%	50–70%	<50%
Riffle/pool ratio (ratio of distance between riffles to stream width)	<7:1	7–15:1	15–25:1	>25:1
Buffer width (vegetation coverage adjacent to channel)	>18m	12–18m	6–12m	<6m
Vegetation: Species diversity (number of species w/in riparian zone)	>10	5–10	3–5	<3
Vegetation: Structural diversity (number of height classes)	3	2	1	1 sparse
Vegetation: Cover (proportion of riparian area covered)	>90%	70–90%	50–70%	<50%
Canopy shading (mix of sun and shade)	Mixed sun/shade	Sparse canopy	Mostly sun or shade	No shade
Aquatic insects (presence of selected macroinvertebrates)	Stoneflies, mayflies, and caddisflies	Mayflies and caddisflies	Mayflies or caddisflies	Only midges or leeches

stable and eroding condition (Barbour & Stribling, 1991). Streams with unstable banks often have degraded instream habitat for fish and aquatic insects (Plafkin et al., 1989). The steeper the bank, the greater the likelihood for erosion and loss of soil into the stream, because steep banks are less likely to hold vegetation cover (Ball, 1982). The evaluator looks upstream and downstream from the reach to estimate the percentage of visible bank length that is not vegetated and actively eroding.

Riffle/Pool Ratio

If the ratio of distance between riffles (areas of turbulence) to stream width is between 5:1 and 7:1, heterogeneity for aquatic insects and fish is optimal, while a ratio of more than 25:1 is considered a poor habitat (Frissell et al., 1986). Since benthic communities thrive as a result of integrated environmental factors (substrate, food availability, current, etc.) and species have preferences for alternative substrate types, it follows that maximum variability in streambed morphology should

support higher species diversity (Barbour & Stribling, 1991). Upstream land use activities can profoundly change riffle/pool relationships, as well as human-caused changes in flood and low-flow discharge (Frissell et al., 1986). The evaluator uses a tape measure to gauge the average distance between riffles and the average width of the channel along the extent of the reach.

Buffer Width

Vegetated buffer strips are effective in filtering pollutants such as sediment and nutrients from streams, and several authors consider 18 meters of buffer width to be sufficient for many riparian situations (Schueler, 1987). Where riparian areas have very steep slopes and/or runoff with high levels of agricultural fertilizer, a buffer of more than 18 meters may be necessary. This parameter rates the entire riparian buffer zone on the side of the stream nearest to a disruption (road, housing development, row crop), and if the average vegetated width is less than 6 meters, it is considered poor (Barbour & Strib-

ling, 1991). A tape measure is used to gauge the width of the least buffered side of the stream reach.

These conclusions are more conservative than those reached by researchers studying southeastern riparian forests, who found that "substantial nitrate removal has been observed in the first 5 to 10 meters of riparian forest" (Lowrance et al., 2000, p. 215). However, Lowrance et al. found that phosphorus and ammonium removal was minimal. Guidelines published by the Natural Resources Conservation Service (1995) recommend a 3-zone riparian buffer system of trees, shrubs, and herbaceous vegetation at least 23 meters wide, which is consistent with the 18-meter buffer width suggested in New Mexico for an "excellent" buffer width rating.

Vegetation: Species Diversity, Structural Diversity, and Cover

Species diversity is evaluated by counting the different species of vegetation that occur in the riparian zone. The presence of 10 or more species is considered optimal, while fewer than 3 species is considered poor. The concept of species evenness, or relative density of each plant species in the riparian zone, is not considered here, but could be included in future method refinements. Structural diversity is estimated by the presence of a mix of grasses and forbs, shrubs, and trees; the presence of all three of the canopy height classes is considered excellent, whereas the sparse presence of only one height class is considered poor. Vegetation cover, expressed as a percentage, is estimated by randomly choosing a transect direction to walk and noting at every other step either vegetation cover or bare soil. Ninety percent vegetation cover is considered adequate for erosion control, while less than 50% is considered poor (Brooks et al., 1996; Fleming, 1998).

Canopy Shading

Shading provided by a vegetative canopy is important in reducing summer water temperatures and as a mediating factor in the solar energy available for photosynthetic activity and plant growth (Barbour & Stribling, 1991; Platts et al., 1983). Diversity of shade conditions is considered by Barbour and Stribling (1991) to be optimal, with different areas of a stream reach receiving direct sunlight, complete shade, and filtered light. The evaluator estimates the percentage of sun and shade by looking upstream and downstream from the middle of the stream reach.

Aquatic Insects

Abundance and diversity of species of aquatic macroinvertebrates are important indicators of the long-term health of a watershed (Jacobi et al., 1995). Insects re-

main in streams during transitory periods of flood, drought, turbidity, and heavy metal inflow. Benthic insects are affected by chemical pollution and physical changes such as temperature, pH, streamflow, and sediment resulting from upstream land use activities. The presence or absence, as well as the relative numbers, of species less tolerant to watershed disturbances are important indicators of riparian health (Fleming & Schrader, 1998; Jacobi et al., 1995).

Stoneflies (*Plecoptera*) are generally the insects most sensitive to human impacts, such as sewage pollution (Jacobi et al., 1995). The absence of stoneflies may indicate phosphorus or nitrogen in higher than natural concentrations. Usually stoneflies are a smaller percentage of the insects (10–20%) and are often the first to disappear with increased human impacts (Gibson, 1994). Mayflies (*Ephemeroptera*) are also sensitive to watershed disturbances, but can be 20–40% of the total number, and may be the next order to disappear in a stressed watershed. If an insect collection is dominated by midges or worms, the watershed and stream are probably highly degraded (Jacobi et al., 1995). The presence of different families and percentages of each family are indicators of the health of the watershed (Fleming & Schrader, 1998).

A 1-meter-wide screen with openings of approximately 1 millimeter (mosquito-net size) is used to collect insects from the stream. The screen is attached to wooden stakes and is held in the stream for 3 minutes while a second evaluator disturbs upstream bedload material so that aquatic insects will be captured on the screen. The screen is taken out of the stream and the insects removed with tweezers and put in an open container for evaluation.

Data collected by Watershed Watch students and watershed plans developed with help from graduate planning students and faculty are used by state and federal agencies in the management of land and water resources on a watershed basis. For example, the New Mexico Game and Fish Department uses water quality and macroinvertebrate data to evaluate conditions and choose sites for the reintroduction of native cutthroat trout (McCarter, 1999). The National Park Service used the riparian health index to evaluate critical habitats in the formulation and implementation of a riparian restoration project in the Glorieta Creek watershed (Pecos National Monument, 1998).

Application of the Approach in a New Mexico Watershed

As one example, the method was applied by two high schools participating in the Watershed Watch program to a watershed in the Santa Fe National Forest, 15 miles

northeast of Santa Fe, New Mexico, which has an area of 1.1 square miles and ranges in elevation from 9,800 to 11,100 feet (see Figure 1). The Tesuque watershed was chosen for this analysis because it was evaluated annually for the longest period (5 years) of the 20 watersheds presently evaluated in the Watershed Watch program. The watershed is in a relatively undeveloped condition, with one road used only for hiking, ski touring, and maintenance of telecommunications antennae.

The consistency of the method was evaluated through a comparison of surveys carried out by students from the Santa Fe Indian School and the Santa Fe Preparatory School from 1995 to 1999 (see Table 2). Ratings for the 12 criteria are summed and divided by 12 to obtain a composite score for the site (sample site #1; see Figure 1). While the ecological health of the watershed did not appear to change over time, a new set of students was taught the method annually and carried out the surveys in September of each year. The range in values is small (3.58 to 3.83), indicating that different sets of students obtained similar results. All values are in the higher end of the "excellent" category. Because of the small sample size, a formal statistical evaluation is not appropriate.

Results

Scores for five of the criteria did not change during the 5 years that different sets of trained students moni-

tored riparian health at the same site. Students rated streamflow, streambed composition, bank stability, buffer width, and vegetation structural diversity as "excellent" for each year. The consistency in ratings for these criteria seems to be due to objectivity in measurement techniques and little natural variability at the site. For example, streamflow in this perennial stream is always greater than 2 cubic feet per second, sufficient for a viable fishery, and the measurement method is quantitatively reproducible and objective. Similarly, width of vegetation buffer is easily measured and is consistent at the site.

In contrast, scores for the other seven criteria varied between "good" and "excellent." These criteria (embeddedness, width/depth ratio, riffle/pool ratio, vegetation species diversity, vegetation cover, canopy shading, and aquatic insects) have combinations of natural variability and measurement techniques that result in small differences in ratings by different groups of trained students. The degree of streambed embeddedness was rated "good" in three years and "excellent" in two years. While the determination of percent embeddedness is highly reproducible, randomness in selecting the transect location produces somewhat different results.

The ratio of bankfull width to depth was rated "excellent" in two years and "good" in three years by different students. Determination of this parameter requires judgment in choosing a representative cross-section and estimating the location and height of the annual flood

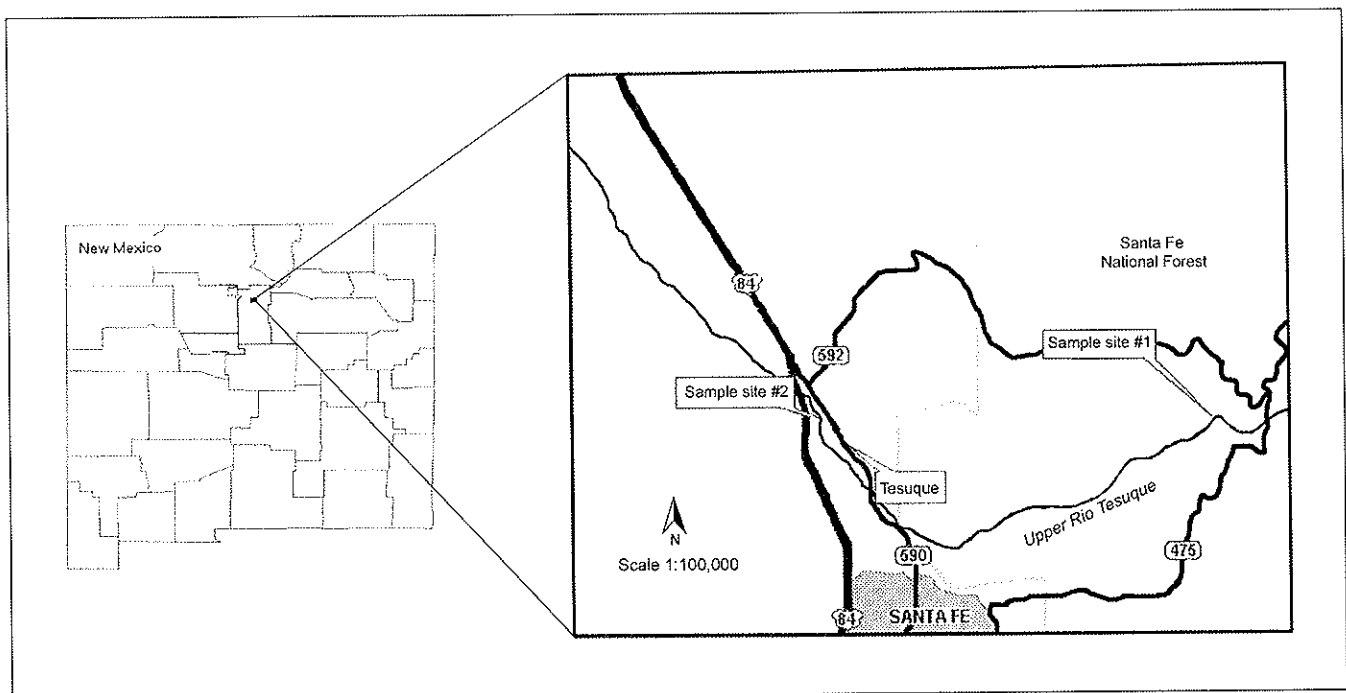


FIGURE 1. Study site location in the Upper Tesuque Watershed.

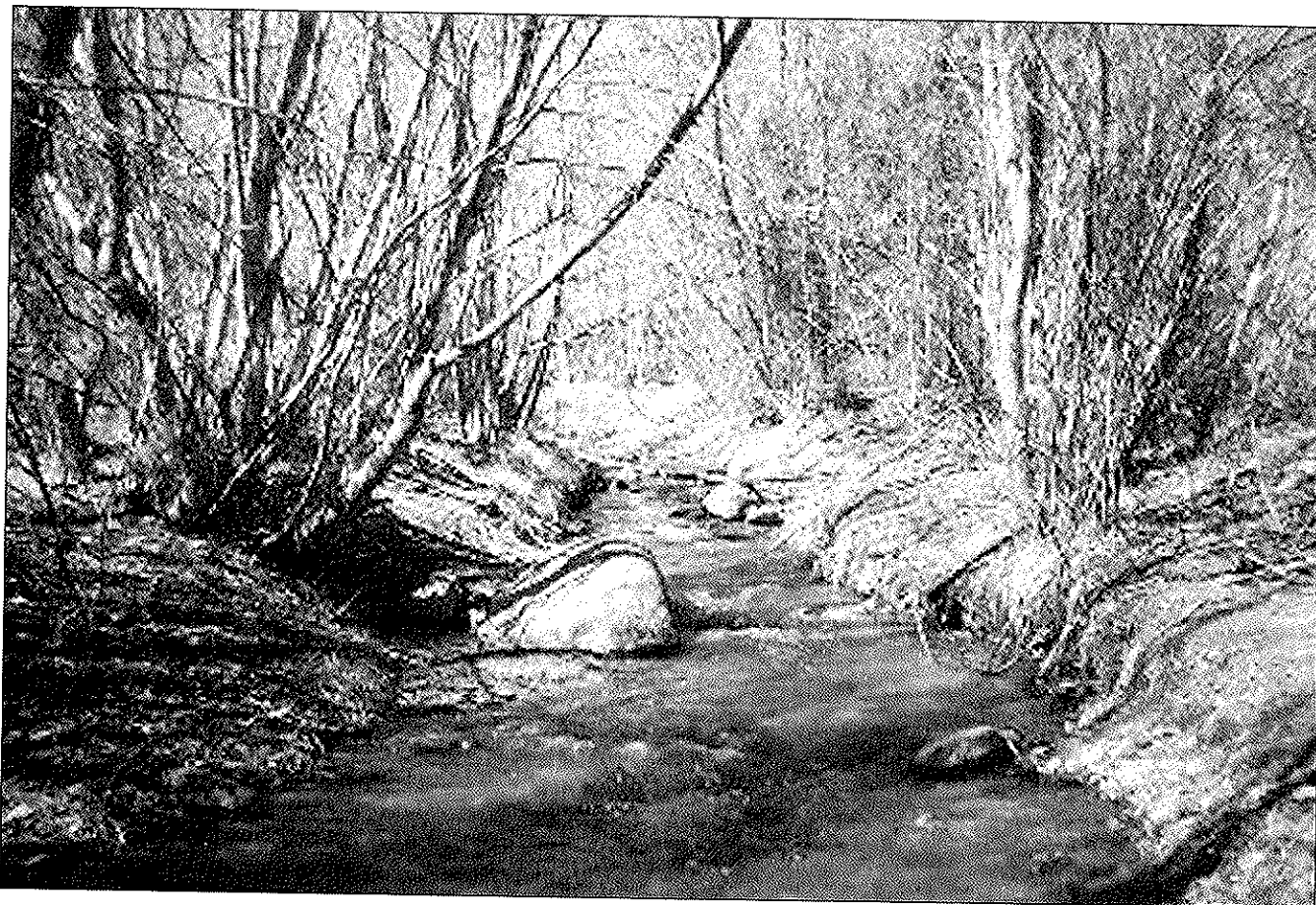


FIGURE 2. View of the streambed, Upper Tesuque Watershed.

TABLE 2. Riparian health in the Upper Tesuque Watershed, 1995-1999.

Criterion	Condition score*				
	1995	1996	1997	1998	1999
Streamflow	4	4	4	4	4
Streambed geology: Composition	4	4	4	4	4
Streambed geology: Embeddedness	3	4	3	3	4
Width/depth ratio	4	3	4	3	3
Bank stability	4	4	4	4	4
Riffle/pool ratio	4	4	3	4	3
Buffer width	4	4	4	4	4
Vegetation: Species diversity	4	4	3	3	3
Vegetation: Structural diversity	4	4	4	4	4
Vegetation: Cover	3	4	4	3	4
Canopy shading	3	4	3	3	3
Aquatic insects	4	3	4	4	4
TOTAL	45	46	44	43	44
Composite score (Σ values/12)	3.75	3.83	3.67	3.58	3.67

*4 = Excellent, 3 = Good, 2 = Fair, 1 = Poor

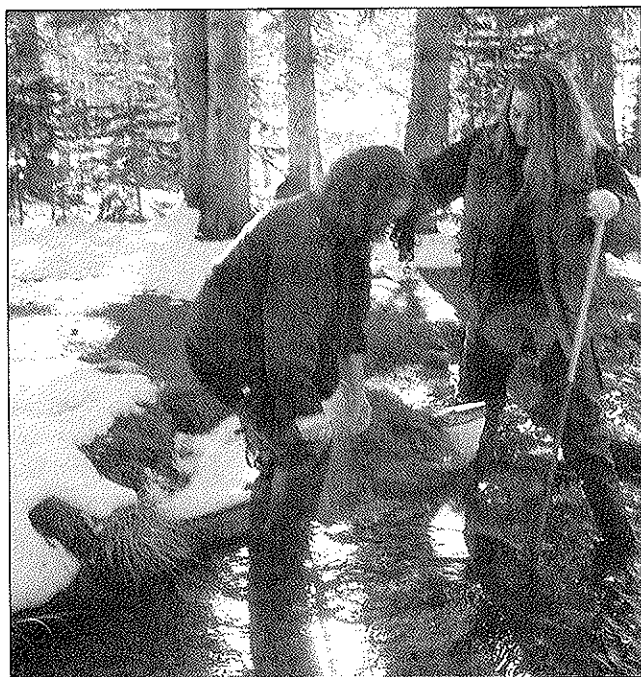


FIGURE 3. Students taking samples.

peak. This criterion is the most technically difficult to estimate and requires more training time than other criteria for consistent ratings.

The ratio of riffles to pools was rated “good” in two years and “excellent” in three years. Variability in the ratings can be attributed to randomness in the choice of pool and riffle locations, in addition to variability in determining where riffle sequences begin and end. Vegetation species diversity was rated “good” for three years and “excellent” for two years. If students found more than 10 different species, they rated it “excellent,” while if the count was between 5 and 9, the riparian zone was rated “good.” Students were instructed to explore areas of their choice in the riparian zone, introducing a degree of randomness and explaining at least part of the variability. More inquisitive students tended to find more species, even though there was no requirement to identify them. Vegetation cover was rated “good” for two years and “excellent” for three years. Transect locations for this criterion are selected by a random procedure, and vegetation cover is not uniform. Natural variability in precipitation also impacts the percent of cover from year to year.

Canopy shading received ratings of “excellent” for four years and “good” for one year. There is some subjectivity involved in making a distinction between “mixed sun and shade” (excellent) and “sparse canopy with filtered light.” Aquatic insects were rated “excellent”

for four years and “good” one year. Stoneflies were not found one year, which can be attributed to a small sample collection of less than 100 insects.

During one year (1997), watershed professionals evaluated the method by conducting an independent survey of the site. Professionals included an aquatic ecologist, a hydrologist and a botanist, all educators at high schools or universities. They rated the site “excellent” with a composite score of 3.9, compared with a composite student score of 3.7 (Fleming & Schrader, 1998). It is therefore interesting to note that the ratings of these students were slightly more conservative than those of the professionals, lending further validation to the use of local residents in data collection.

To demonstrate the applicability of the method to other, less pristine sites, the Indian School surveyed the riparian health of the same river 12 miles downstream (sample site #2; see Figure 1) at an elevation of 6,400 in Tesuque Pueblo (Schrader & Fleming, 1997). Here the stream banks had little vegetation, and river sediments were mainly fine sand and silt. No aquatic insects were found, and most of the channel banks were actively eroding. Two riparian surveys carried out by students in 1997 rated the site as “fair” (scores were 2.3 and 2.4). This part of the watershed has been heavily impacted by roads, agriculture, and residential development.

Conclusions

The criteria for community-based ecological monitoring established at the beginning of this discussion in-

TABLE 3. Riparian health scores for the Upper Tesque Watershed, professionals vs. students, 1997.

Criterion	Professionals	Students
Streamflow	4	4
Streambed geology:	4	4
Composition		
Streambed geology:	4	3
Embeddedness		
Width/depth ratio	4	4
Bank stability	4	4
Riffle/pool ratio	4	3
Buffer width	4	4
Vegetation: Species diversity	4	3
Vegetation: Structural diversity	4	4
Vegetation: Cover	4	4
Canopy shading	3	3
Aquatic insects	4	4
Composite score (Σ values/12)	3.92	3.67

cluded timeliness, cost-effectiveness, reproducibility, and scientific credibility. The minimal costs and short time required for training local monitors are significant advantages for poor rural communities dependent upon scientific professionals who do not reside locally and are expensive to retain, if they are available. The survey method presented here can be used in several ways: (1) to establish the biological condition of the riparian monitoring, (2) to develop a framework for comparing several riparian areas within a larger watershed, and (3) to compare results of appraisals made by different evaluators at the same site over time.

The consistency of the method was evaluated through a comparison of surveys carried out by students from two schools at the same site between 1995 to 1999. While the ecological health of the watershed did not appear to change over time, a new set of students was taught the method annually and carried out the surveys in September of each year. The range in values is small (3.58 to 3.83), indicating that different sets of students obtained similar results.

While the operationalization of qualitative values (excellent/good/fair/poor) may vary depending upon local conditions, the appraisal technique is flexible enough to be modified appropriately. For example, where a stream is too small to support fish, the weighted importance of volume of flow can be reduced in the final calculations of overall quality. Regardless of the location, the numerical values assigned to each criterion remain as a record for time-series comparisons.

Making use of an integrated team approach, these skills can grow to include the central environmental elements identified by Steiner (1991), Sargent et al. (1991), and Marsh (1998). Scientific credibility in this case was confirmed by independent measurements taken by trained scientists and can be maintained both through the involvement of local science teachers and by periodic review of the findings by nonprofessionals and professionals. In this way, a collaborative approach between trained scientists and local nonspecialists can serve community purposes in a sound and affordable manner.

The iterative nature of this rapid appraisal technique allows an assessment of multiple sites to be grouped into a characterization of riparian habitat health for a larger landscape, as in the case of the Río de Chama or subareas in the New Mexico/Chihuahua border region. The analysis and integration of such landscape information can be incorporated in existing institutions within a matter of months, and can be brought before a broader public in a manner and at a level of expense that is supportable by small communities with limited financial resources.

The importance of community involvement in monitoring goes beyond its function as a form of local in-

volvement in visioning and consultation about land use. Since many rural and urban jurisdictions (and even federal land management agencies) lack adequate funding and personnel for timely monitoring, the health of our most vital natural resources must rely upon a new awareness by interested residents equipped with new skills and applied with greater frequency. In this sense, the "new" rapid assessment techniques represent something of a return to an earlier time when the intimate connections between agrarian people and their land provided a constant awareness of changes in the condition of natural systems. The difference is that the new approaches are more methodical and, when conducted frequently, are more useful in drawing attention to timely interventions. An intriguing area of inquiry is the degree to which these capacities can contribute to the popular management of natural resources in addition to the framing of policy governing their use.

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Annual Meetings

September 30–October 4

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION, Annual Meeting, Philadelphia, PA. Contact: APTA, 1201 New York Avenue NW, Washington, DC 20005; 202-898-4000; Fax: 202-898-4029; Email: <meeting@apta.com>; URL: <http://www.apta.com/meetings/annual/index.html>.

October 3–6

NATIONAL RECREATION AND PARK ASSOCIATION, Annual Congress and Exposition, Denver, CO. Contact: National Recreation and Park Association, 22377 Belmont Ridge Road, Ashburn, VA 20148; 703-858-0784; Fax: 703-858-0794; Email: <congress@nrpa.org>; URL: <http://activeparks.org/meetings/convention.cfm>.

October 10–13

AMERICAN SOCIETY OF CIVIL ENGINEERS, Annual Civil Engineering Convention and Exposition, "Engineers in a Changing World," Houston, TX. Contact: ASCE, 1801 Alexander Bell Drive, Reston, VA 20191-4400; 703-295-6300; Fax: 703-295-6222; URL: <http://www.asce.org/conferences/annual01>.

October 17–20

COUNCIL OF EDUCATIONAL FACILITY PLANNERS INTERNATIONAL, Annual International Conference, Denver, CO. Contact: CEFPI, 9180 East Desert Cove, Suite 104, Scottsdale, AZ 85260; 480-391-0840; Fax: 480-391-0940; Email: <cefpi@cefpi.org>; URL: <http://www.cefpi.org/>.

October 20–24

URBAN AND REGIONAL INFORMATION SYSTEMS ASSOCIATION, 2001 Annual Conference, Long Beach, CA. Contact: URISA, 1460 Renaissance Drive, Suite 305, Park Ridge, IL 60068; 847-824-6300; Fax: 847-824-6363; Email: <info@urisa.org>; URL: <http://www.urisa.org/annual.htm>.

October 24–26

NATIONAL ASSOCIATION OF INDUSTRIAL AND OFFICE PROPERTIES, Annual Conference and Marketplace, Chicago IL. Contact: Kathleen Turner, NAIOP, 2201 Cooperative Way, 3rd Floor, Herndon, VA 20191; 800-666-6780 ext.117; Fax: 703-904-7942; Email: <turner@naiop.org>; URL: <www.naiop.org>.

November 7–9

ENTERPRISE FOUNDATION, "Community: A Capital Idea," Annual Network Conference, Washington, DC. Contact: Enterprise Foundation, 10227 Wincopin Circle, Suite 500, Columbia, MD 21044; 410-772-2418; Email: <networkconference@enterprisefoundation.org>; URL: <http://www.enterprisefoundation.org>.

November 8–11

ASSOCIATION OF COLLEGIATE SCHOOLS OF PLANNING, 2001 Annual Conference, Cleveland, OH. Contact: ACSP, 1400 Village Square Boulevard No. 3, Tallahassee, FL 32312; 850-907-0092; Fax: 850-907-0093; URL: <http://www.uwm.edu/Org/acsp/events/conferences.html>.

November 21

REGIONAL STUDIES ASSOCIATION, 2001 Annual Conference: "Realising the Knowledge Economy," London, UK. Contact: Regional Studies Association, PO Box 2058, Seaford, BN25 4QU, UK; +44-0-1323-899698; Fax: +44-0-1323-899798; Email: <rsa@mailbox.ulcc.ac.uk>; URL: <http://www.regional-studies-association.ac.uk>.

January 13–17

TRANSPORTATION RESEARCH BOARD, 81st Annual Meeting, Washington, DC. Contact: Transportation Research Board, National Academy of Sciences/ National Research Council, 2101 Constitution Avenue NW, Washington, DC 20418; 202-334-2935; Fax: 202-334-2003; Email: <rallen@nas.edu>; URL: <http://www4.nationalacademies.org/trb/annual.nsf>.

Other Meetings of Interest

October 2–6

URBAN LAND INSTITUTE, Fall Meeting, Boston, MA. Contact: Urban Land Institute, 1025 Thomas Jefferson Street, NW, Suite 500 West, Washington, DC 20007; 202-624-7000; URL: <http://www.uli.org>.

April 21–24

SCENIC AMERICA and EDAAW, INC., "Scenic Summit: Action for America's Communities, Countryside, and Public Lands," Denver, CO. Contact: Scenic Summit, PO Box 3499, Boulder, CO; 303-494-1246; Email: <scenicsummit@atwoodcompany.com>; URL: <www.scenicsummit.org>.