Building Resilience: Lessons from a Decade on Comanche Creek, Valle Vidal, New Mexico

by Avery C. Anderson, Tamara Gadzia and Courtney White

The mission of the Quivira Coalition is "to build resilience by fostering ecological, economic and social health on western landscapes through education, innovation, collaboration, and progressive public and private land stewardship." In ecology, "resilience" refers to the capacity of a system to absorb a shock or perturbation, such as a forest fire, large flood event or prolonged drought, while maintaining its integrity, i.e., not crossing a threshold into a new ecological state. It has a social parallel as well — bankruptcy, for instance, can cause a household or business to cross an economic threshold into an unsustainable state. Building resilience means restoring, maintaining or expanding the ability of an individual, family, community or component of an ecosystem to stay healthy and handle change constructively.

Since 2001, the Quivira Coalition has directed a public lands riparian restoration project within the 27,430-acre (43 square-miles) Comanche Creek watershed which lies in the heart of the 100,000-acre Valle Vidal Unit of Carson National Forest in north-central New Mexico. Our goal has been to build long-term resilience and restore habitat for the Rio Grande cutthroat trout (RGCT). In this article, we attempt to answer two questions: Are we succeeding? And what lessons have we learned that might help others? The quick answer to both questions is twofold:

- we've had good success at building ecological resilience into the Comanche Creek landscape, which means we have a great deal to share about methodology, implementation and monitoring; and
- there have been more challenges on the social and economic side of restoring degraded riparian systems to health than we expected, with some sobering implications for the long-term capacity of these systems to remain resilient.

Our restoration work appears to have successfully rebuilt resilience, evidenced by the system's capacity to withstand documented flood events and continuing drought that otherwise might have further degraded ecological health. This success is largely a result of a trial-and-error process that required constant adjustments to the fieldwork based on data collected as part of our ongoing monitoring program, observations made by experienced practitioners of restoration ecology, and dialogue between project partners as on-the-ground circumstances evolved over time. This process improved the effectiveness of the restoration work which, in turn, increased the resilience of the system.

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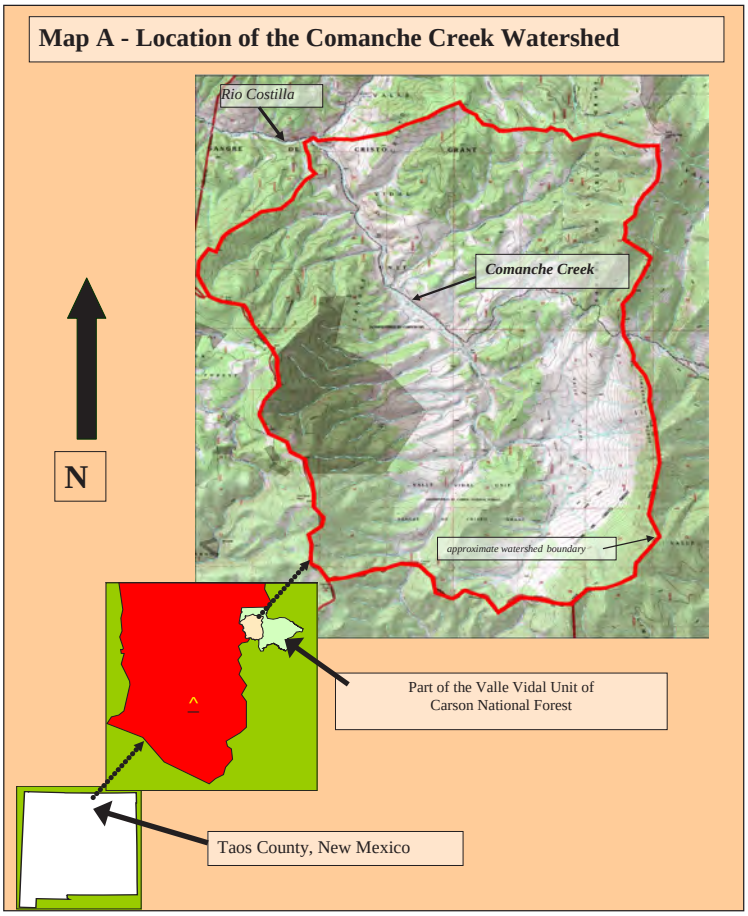
At the same time, we have learned that ecology cannot be isolated from social and economic factors. Profit, collaboration, sustained funding, bureaucratic processes and personal relationships are as much a part of building resilience on the land as any best management practice. The constant ebb and flow of all these dynamic components is both the beauty and the bane of trying to answer the question: Are we succeeding? The beauty lies in the complex and adaptive nature of the work; the bane is trying to separate what works specifically at a location and what works generally anywhere.

What follows is a brief review of this long-running project. We provide some background, discuss goals and objectives, detail the work to date, and attempt to answer the question: Are we building resilience? At the end of this essay, we summarize our experience and take a stab at some lessons learned.



Comanche Creek: Background and Challenges

Throughout history, human actions have impacted riverine and wetland ecosystem functions and services. These impacts, including reduced vegetative cover, poorly constructed roads, livestock trailing, dams, mining, etc., have markedly increased during the age of European exploration and significantly accelerated since the advent of the Industrial Revolution. Due in large part to these impacts, riverine systems in the American Southwest and around the world are undergoing an epoch of channel down-cutting characterized by the loss of floodplain access, reduced sinuosity, accelerated rates of streambed and bank erosion, reduced bank water storage, radical fluctuations between flooding and no flow events, loss of wetlands and wetland habitats, and declines in wildlife and fish species diversity and abundance.

In addition, our current understanding of the local effects of climate change include a significant increase in the severity and intensity of precipitation events, increased stream water temperatures, and earlier snowpack run-off; all of which will increase stress on and put at risk riverine, riparian, and wetland systems. If this ecosystem decline is not addressed in a proactive manner there is the sobering probability that the associated ecological functions and services that all humans depend on will suffer continued degradation as well.

The challenges facing the Valle Vidal Unit of the Carson National Forest are not unlike the challenges pressing down on the rest of the Southwest. Comanche Creek is typical of areas that have experienced adverse historical impacts, including poor timber management, livestock overgrazing and mineral extraction.

These activities have created numerous inadequately constructed and maintained roads, depleted vegetation in riparian zones and raw stream banks — all of which increase erosion rates and amplify the sediment load within the watershed.

Over the last few decades, populations of Rio Grande cutthroat trout across the region have been reduced to 10 percent of their historic range. This is the result of a variety of factors, including competition from non-native trout species, habitat degradation and loss, surface water diversion and depletion, stream fragmentation, and isolation. All of these factors threaten the viability of the RGCT as a species. The Comanche Creek watershed has been identified by the New Mexico Department of Game and Fish as a potential refuge for these threatened fish. In response, the U.S. Forest Service has engaged a variety of collaborators to enhance existing trout habitat and restore degraded parts of the larger Comanche Creek ecosystem.

In addition to historical pressure on the Comanche Creek watershed, there are also ongoing impacts as a result of elk and cattle grazing. There is a substantial elk herd in the Valle Vidal and, although elk are native herbivores, their largely unregulated numbers and grazing behavior have impacted the rate of recovery of woody species along the streambanks. Recognizing this challenge, in the 1990s the Forest Service built a 62.5-acre elk exclosure in a meadow along Comanche Creek in order to protect streamside vegetation. However, because the entrance gate was lower than the fence and the structure was not properly maintained, it proved to be an ineffective deterrent to roaming elk. As a consequence, a decision was made to shift to mini exclosures (less than one-half acre in size) built to protect populations of willows and other woody plants along the creek. These structures have been more effective.

The management of cattle grazing in the Comanche Creek watershed has also proven to be a challenge. When the Forest Service acquired the Valle Vidal back in the early 1980s, they decided that the cattle would be managed by a herder who would stay with the animals all summer. The Valle Vidal Unit comprises eight pastures and Comanche Creek resides within two of these. All cattle were to be rotated through the pastures one-by-one during the course of the grazing season (May–October), with one pasture at rest each year. The herder was to keep the cattle together in a bunch within these pastures and keep them moving so they wouldn't overgraze.

This was the theory. The reality in our experience has been different. The Valle Vidal Grazing Association, the permittee on the

Large exclosure showing gate and fence, September 2005. Questa Ranger District and volunteers are in the process of decommissioning this structure.

Thriving willows and other riparian species in mini-exclosure, July 2008.

Valle Vidal, was not an active participant in the restoration process on Comanche Creek. Often cattle were observed in multiple pastures simultaneously. Additionally, our monitoring revealed a number of "hot spots" in side drainages caused by cattle trampling. If unaddressed, these areas could potentially adversely impact restoration efforts. We reported these "hot spots"' to the U.S. Forest Service, the supervisory agency. We will continue our efforts to involve the permitted livestock association in future restoration efforts in concert with the Forest Service.

A Collaborative Effort

In 2001, New Mexico Trout, a nonprofit conservation organization, approached the Quivira Coalition for assistance in their efforts to improve the survival chances of the native Rio Grande cutthroat trout, New Mexico's state fish, in Comanche Creek.

For the past 10 years, Quivira has worked collaboratively with a diverse team called the Comanche Creek Working Group to plan and implement projects that benefit the Rio Grande cutthroat trout in Comanche Creek. Over the years, Comanche Creek Working Group partners have included the Quivira Coalition; U.S. Forest Service (the Carson National Forest and the Questa Ranger District); New Mexico Department of Game and Fish (NMG&F); New Mexico Environment Department–Surface Water Quality Bureau; New Mexico Trout; Trout Unlimited, Truchas Chapter; Albuquerque Wildlife Federation; Philmont Scout Ranch and the Boy Scouts of America; Vermejo Park Ranch; Patagonia; the Taos Soil and Water Conservation District; Rocky Mountain Youth Conservation Corps; Valle Vidal Grazing Association; and various private companies and specialists, including Rangeland Hands, Inc.; Zeedyk Ecological Consulting; Resource Management Services; Dryland Solutions, Inc.; Blue Earth Ecological Consulting; and Keystone Restoration Ecology, Inc.

Documenting headcuts and gully formation on the upper reach of Springwagon Creek, a tributary of Comanche Creek, September 2005. This tributary exhibits "hot spots" due to trampling by cattle.

The goal of this long-term project has been to fully implement a restoration plan for the greater Comanche Creek watershed. This effort includes:

- returning stable stream dynamics to the main stem of Comanche Creek and tributaries;
- restore and maintain the integrity of the Comanche Creek watershed for the survivability, adaptability and health of RGCT and other native species in the creek, thereby positively impacting the species' ability to survive anthropomorphic challenges such as global climate change; and
- provide New Mexico residents/volunteers with hands-on educational opportunities that directly relate to maintaining the resilience and function of riparian ecosystem services by demonstrating sound, effective restoration theory and practices.

The innovative restoration methodology that Quivira employs was developed by Bill Zeedyk, a pioneering watershed restoration specialist. His techniques use native materials (e.g., river rock and cedar posts) to re-establish native riverine and riparian habitat, reinstate natural river length and sinuosity, reduce erosion, address the causes of increased water temperature, and add wetland acreage to riverine systems. Zeedyk's

methods work because they address the root causes of what ails a creek—the effects of poorly constructed and maintained roads, over-grazing, mineral/timber extraction, etc.—and Quivira's implementation of his techniques has been proven to effect positive change over the long-term.

In the beginning, we didn't use the word "resilience" to describe our goals. The "shock" or perturbation had already happened to the system, and heavily so, which meant our objective was to speed the watershed's recovery to a state of health so the RGCT could enjoy a productive home again. Eventually, however, we realized that the RGCT faced a significant new threat: climate change. This challenge includes a likely reduction in the abundance of clear, cold water that trout require for survival, rising water temperatures, increased incidence of diseases and parasites, decreased abundance of insect food sources, decreased dissolved oxygen levels, increased demand for water by human populations, increased potential of flooding, and increased fragmentation of habitat. Taken together, all of these stressors pointed to the need to talk about resilience. It didn't change the best management practices being implemented, but it did redefine what success meant.

Our experience has taught us that on-the-ground restoration solutions include:

- in-stream structures that stabilize streambank erosion, increase streambank water storage capacity, and improve riparian zone vegetative cover and diversity;
- restoration activities in tributaries that reduce erosion, stabilize headcuts, re-wet meadows and improve hydrological cycles;
- mitigation or elimination of "bad" roads and road-related features, such as poorly placed culverts, that increase sediment erosion into the creek;
- encouragement of the growth of bank-side native plants (to shade the water for the fish);
- management of the impacts of herbivory;
- annual maintenance and modification of structures as needed; and
- annual monitoring and assessment of progress.

Accomplishments

The project began in 2001 with a riparian, rangeland and cultural assessment of the watershed followed by the development of a plan for restoration work. We obtained National Environmental Protection Act (NEPA) clearance and 404/401 permits from the US Army Corps of Engineers and the New Mexico

Documenting the condition of road drainage structures and their contribution to sediment supply in Comanche Creek, June 2005.

Monitoring the condition and effectiveness of a post vane bank stabilization structure on the middle reach of Comanche Creek, August 2011.

Before treatment, this one cutbank along Comanche Creek was contributing 110 to 120 cubic yards of sediment per year, September 2004.

This section of the creek was treated by realigning the channel to the opposite side of the willow stand. Now the willow stand acts as a buffer between the creek and the eroding bank, August 2011.

Environment Department for each of the grants awarded. Our baseline monitoring protocols call for rangeland health assessments, Rosgen Level II geomorphology surveys, riparian vegetation surveys and yearly documentation of established photo monitoring points.

Over the course of the last decade, volunteers (approximately 750 contributing some 15,000 person hours), staff and restoration specialists accomplished the following:

- installed 50 mini enclosures for herbivores for the purpose of protecting vulnerable streambank vegetation, including willows, cottonwoods, alder and riparian grasses/rushes/sedges;
- re-aligned one overextended meander to protect a 15-foot tall eroding terrace (estimating that this simple modification to the stream position would reduce the sediment contribution to the stream by 230 cubic tons per year);
- re-vegetated the better part of three miles of eroding stream banks with hundreds of locally-sourced willow cuttings;
- installed 208 in-stream structures at strategic locations to shift the strongest part of the stream's flow away from eroding streambanks
- stabilized the channel bed using several cross-vane structures and one hardened low-water-road-crossing;
- controlled sediment sources from upland eroding side gullies using 172 one rock dams, Zuni Bowls and head-cut control structures;
- conducted an extensive road survey, and as a result, repaired more than 10 miles of forest road with treatments that included closures, natural contours, stream crossings, rolling dip cross drains, waterbars, culvert removal, culvert plugs, and raised culvert inlets; and
- re-seeded disturbed areas, or when in the riparian corridor, planted with sedge.

Fish barrier where Comanche Creek crosses Forest Road 1950.

In tandem with our habitat restoration work, the New Mexico Department of Game & Fish installed a fish barrier along Comanche Creek in 2006. The intent of the fish barrier was to isolate the native RGCT from other non-native trout species that can genetically

out-compete their native counterparts. After installing the fish barrier, the NMDG&F spent two years removing all non-native fish from this upstream creek barrier, thus achieving a significant milestone in the recovery process for the RGCT in Comanche Creek.

Evidence of Resilience

Over the past 10 years, the Quivira Coalition has kept detailed records of the observed changes along Comanche Creek and its tributaries. Results serve not only as testament to the effectiveness of our work, but also have guided our subsequent activities. Quantitative and qualitative monitoring over the past 10 years has shown that restoration treatments on seven miles of Comanche Creek have had a net gain effect.

From an ecological perspective, we have had tremendous success. To begin with, the impressive scale of this project —10 years, a 43 square-mile watershed, hundreds of volunteers, more than 200 in-stream structures, 50 small grazing exclosures, 83 road improvement structures, and several wet meadows restored— demonstrates the effectiveness of involving members from different communities over an extended period of time in a united restoration effort. We have documented:

- dramatic recovery of wet meadow systems;
- the resurgence of wetland vegetation at bank full width along the stream which provides essential habitat for RGCT by shading the creek and keeping the water cool;
- cleaner/clearer/cooler in-stream flow;
- healed head-cuts;
- reduced contribution of sediment from poorly drained gravel/dirt roads;
- narrowed channel width and deepened channel depth with raised streambed elevation in some locations; and
- increased diversity and quantity of stream bank vegetation.

Volunteers repairing exclosure fencing, August 2011.

A headcut in Holman Meadow was healed using a log and fabric step falls structure, July 2010.

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The restoration treatments and their effects have been recorded by geomorphologic and vegetation monitoring, photo-documentation, and a yearly survey by stream restoration practitioners. Among other tests, the ability of the Comanche Creek system to withstand the crushing force of the 2005 and 2010 spring flood events (two 50-year floods in a single decade) and the effects of the ongoing drought is the ultimate testament to the resilience that has been built into the system.

From a social perspective, measurable results have come in the form of volunteers and collaborators. The usual route for the recovery of a "species of concern" like the Rio Grande

cutthroat trout is through regulation, litigation and confrontation—action which can be very divisive to affected communities. This project, in contrast, uses proactive collaboration and innovation to achieve species recovery by working to unite communities in the restoration effort, and we believe it is succeeding. In addition, more than 150 volunteers have contributed 2,400 hours over the last three field seasons at Comanche Creek. Volunteers are our lifeblood! They provide invaluable assistance in all aspects of the work in the Comanche Creek watershed, and in exchange, they benefit from the expert instruction provided by our watershed restoration specialists during Quivira's FREE summer workshops. We are actively increasing public awareness about the importance of being stewards of trout habitat, and simultaneously using volunteer enthusiasm and energy to get work done on the ground.

In addition to our volunteer base, the Comanche Creek watershed has the potential to become a major, long-term demonstration site for the U.S. Forest Service. They are committed to continuing this work, as are the New Mexico Department of Game & Fish, the New Mexico Environment Department and the U.S. Fish & Wildlife Service. Within the next 10-15 years, their goal is to restore RGCT to the entire Costilla River watershed, of which Comanche Creek is a major part.

Lastly, an important point about the financial resilience of the Comanche Creek project: A significant challenge that we have faced in our work at Comanche Creek relates to the expense associated with doing landscape-scale restoration projects and the corresponding monitoring and adaptive maintenance. Non-profit organizations like Quivira have an explicit obligation to educate the public. Long-running demonstration projects like Comanche Creek serve a critical role in our education program because we have partners we can count on, continuity in our tasks, investment from our volunteers, funding that we can leverage and

Eighty percent of mini-exclosures along Comanche Creek were damaged during the flood of 2005 and again in 2010 (June 2005). Construction, installation and location protocols were adapted to withstand future high water events.

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Assessing post van performance, July 2008.

demonstrated ecological success over many years. Simultaneously, however, each year we face the daunting challenge to raise the requisite funds to maintain/monitor our existing success and create the potential for expanded success within the 43 square-mile watershed.

As federal and state funding for restoration work continues to decline, possibly steeply in the next few years, the challenge of maintaining current levels of work will become more difficult. New funding strategies will need to be developed in order to build financial resilience on Comanche Creek.

Headcuts unzipping the La Belle wet meadow drainage of Comanche Creek, July 2008.

Cattle in the Comanche Creek riparian area, September 2006.

Lessons Learned

Constant Vigilance. There's an old saying that the price of democracy is constant vigilance. It is the same for building resilience, especially in degraded ecosystems. Restoration work needs constant monitoring, adjustment and maintenance. At some point, a creek or river or watershed will become healthy enough to "take over'" its own maintenance, but many systems have been so degraded over time that reaching this point will take decades to achieve. This assumes, of course, that no further degradation take place within the system. On Comanche Creek, for example, there is a small but persistent problem with cattle. Inadequate control of livestock grazing by the permittees and U.S. Forest Service in portions of the watershed, especially in side drainage wet meadows, has retarded the healing process and could theoretically undo much of the restoration work if allowed to continue or expand. This situation demonstrates the need for constant vigilance and pressure—one "thread" could unravel the whole tapestry.

Unfortunately, monitoring, adjustment and maintenance is expensive, labor-intensive and demanding of a long-term commitment on the part of the landowner, often making them difficult to achieve. Additionally, funding for this work is hard to find; many funding sources prefer to support "new" work as opposed to ongoing monitoring and maintenance of "old"work. On public land, this commitment is probably best met by the agency. On private land, it is probably best met as a cost of doing business, i.e., from the profits of an economic enterprise though grants could supplement portions of the work. One potential solution would be the development of an "ecosystem services" model that compensates landowners for their restoration work.

The Ecology is the Easy Part. We know how to fix creeks affordably and effectively, thanks to a great deal of trial-and-error by many people in many places over the years. What is much more difficult is managing the social and economic relationships that are necessary to build and maintain resilience in the long run. This is a truism, of course, but it does not lessen the challenges. For example, the bureaucratic gauntlet that must be run to direct restoration work on public lands these days, including the costly NEPA process (costly in time and money), requires considerable patience, persistence and good humor. Personnel changes, rising administrative requirements, shifts in agency priorities

and a confounding bureaucracy often pose significant obstacles to collaborative projects. Unfortunately, in our 10-year experience on Comanche Creek, these obstacles have grown, not shrunk, over time. The NEPA process in particular discourages proactive partnerships, especially in recent years as federal agencies have begun to shift their costs onto the partners.

On private land, relationships are just as crucial, though often for different reasons. Working with a single landowner or a family means the ecological work can happen faster and more efficiently, but it also means economic factors will likely come into play that could affect a project's ability to build resilience over time. Redirecting the profit motive away from short-term exploitation of a resource toward the long-term sustainability that is necessary to build resilience often involves an educational process that goes far beyond the nuts-and-bolts of riparian restoration. This process can be a serious challenge for partners if they are not prepared from the start to deal with educational and economic components of their collaboration.

Who Are You Trying to Please? Building resilience means answering the question: Who is your audience? Researchers and academics may require a high degree of quantification and data-processing as well as peer review before they consider an effort to have achieved success. Farmers and ranchers may be satisfied, on the other hand, with anecdotal or plain-to-their eye signs of success. Agencies in charge of wildlife, especially those involved with threatened or endangered species, may employ an entirely different set of metrics for evaluating resilience in a system. Similarly, a federal land agency, a regulating authority (such as the EPA), or a funder may have their own criteria for measuring success. Knowing who your "client" is at the start of a project may affect how one goes about building resilience and determining its success.

Tips for Success

- Create a detailed design and implementation plan. Pencil out the calendar, but expect that things will not always go as planned.
- Consider a time frame for implementation in relation to regional hydrology and climate. Implement when flow rates are low. Understand that natural events such as drought, floods, timing of snow, and forest closures can disrupt an implementation schedule.
- If the project is a collaborative endeavor or will have a volunteer component, work with people who are open to new ideas and have a personal commitment to the land.
- Create a budget that incorporates the time for acquiring funding and adequately reflects inflation over the entire length of the project. Remember, prices usually don't go down.
- Be aware of the local, state and federal regulations and required permits for working in a riverine system. If possible, bring regulators to the project site.
- Hire professional restoration specialists who have experience with a variety of riverine systems and an understanding of geomorphology, hydrology, soils and the local ecology.
- Livestock grazing of project areas must be managed. Consider creating a riparian pasture for a drought reserve or a dormant season only grazing pasture. Understand what the true dormant season months are for your location.
- Set up permanent photo points before the project begins to adequately reflect changes to the river system over time.
- Expect the river system to make ecological adjustments over time. These types of treatments nudge the natural progress of a river's ability to heal itself and so the system is not "fixed" overnight with these treatments.
- Monitoring for maintenance and effectiveness of the treatments. Review project after each major flow event and repair, maintain or adjust as needed.

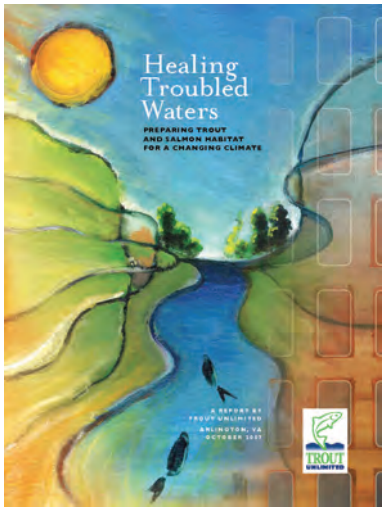
Conclusions

As the authors of a recent report by Trout Unlimited titled "Healing Troubled Waters" (TU October 2007) note, trout are a resilient species and have repeatedly adapted to fluctuations in climate and environmental conditions over their long evolutionary history – though current conditions are unprecedented. If given some help, trout should be able to withstand the modern challenges confronting them. To do so, the authors propose a strategy that emphasizes "restoring entire watersheds, not just individual streams," and a "sustained conservation and recovery effort." This strategy includes:

- restoring habitat health;
- restoring native fish populations;
- engaging diverse communities in a collaborative effort over a significant period of time; and
- monitoring and evaluating success.

This is what the Comanche Creek project has tried to accomplish, with success, and points the way for future work in the watershed.

There are basic benchmarks that can satisfy almost all interested parties while building resilience for the long-run. These involve basic ecological processes, such as improving the water, nutrient and mineral cycles; slowing or reversing sedimentation; growing grass; building soil; and improving plant vigor. These are the foundations of ecological resilience without which social, cultural and economic resilience is not possible. They're relatively easy to accomplish, as we have discovered, and relatively simple to measure. Building resilience means starting at the level of soil, grass, and water. From there, everything else will flow.



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