# SOUTH PLATTE RIVER RESTORATION

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The purpose of this symposium is to discuss "Using Ecological Restoration to Meet Clean Water Act Goals." During this symposium, we have discovered a whole gambit of ideas on ecological restoration. As I have listened, learned, and communicated, two themes have become readily apparent. Each restoration opportunity is unique and some principles that apply to one watershed absolutely do not apply to another.

Numerous restoration case histories have been presented. Demonstration projects have illustrated what has been done and many restoration strategies have been enumerated. An eye-catching poster by EPA and TERRENE (EPA/TERRENE Institute, 1994) summarized the steps involved in ecological restoration:

1. Protect what you have.
2. Prevent further degradation.
3. Restore natural sediment and water regime.
4. Restore natural channel geometry and morphology.
5. Restore riparian communities.
6. Restore native plants and animals.

These steps sound good but, with the exception of the first two, they cannot be followed and indeed are not being followed in the ecological restoration of the South Platte River.

## We Cannot Restore the South Platte River

The idea that we "cannot restore" the South Platte River or any other component of the environment to what it was in the past is not a new one. Aldo Leopold recognized this in 1927 when he wrote:

> It seems academic to talk about maintaining [restoring] the balance of nature [ecosystem]. The balance of nature in any strict sense has been upset long ago, and there is no such thing to maintain. The only option we have is to create a new balance objectively determined for each area in accordance with the intended use of that area . . ." (Leopold, 1947)

Leopold's words were somewhat ignored in the Clean Water Act of 1972, which identifies as the primary objective [Section 101(a)] to restore and maintain the chemical, physical, and biological integrity of our nation's waters. We have improved our nation's waters but we still have, and will continue to have, problems restoring them. Leopold recognized over sixty years ago that once the "balance of nature," or the ecosystem, had been upset, there was no turning back. We cannot make an antique new, and we cannot restore a river. We cannot rewrite the past, and we cannot balance or right an upset that has happened. The only option we have, according to the words of Leopold, is "to create a new balance objectively determined for each area in accordance with the intended use of that area." The ecological restoration steps listed on the EPA/TERRENE Institute poster cannot, and should not, be attempted nationwide . . . and especially not on the South Platte River near Denver. The "balance of nature" Leopold spoke of was long ago upset on the South Platte River and can no longer be maintained or restored. The costs to both society and the ecosystem would be too great.

**We Can Restore or Maintain Ecosystem Health**

Recently, Robert Steedman wrote that as resource managers work to protect or restore ecosystem health, "they are designing new ecosystems" (Steedman, 1994). On the South Platte River, we cannot restore biological integrity as "the product of evolutionary and biogeographical processes with little or no human influence" (Karr, 1995), but we can attempt to manage ecosystem health or "design a new ecosystem to be the preferred state of a site modified by human activity" (Steedman, 1994). This is what restoration on the South Platte River is attempting to accomplish.

## Past Ecological Health - A Basis

The first step in restoration (or management for ecological health) of the South Platte River ecosystem was a review of its "medical" history and a description of its historical condition. This medical history and condition of the river was not good. The river has been ridiculed, cursed, and derided by man throughout history.

Theodore Talbot, a trainee on Fremont's second expedition in 1824, wrote of the river's quality, "Here the buffalo come to drink and stand during the heat of the day, adding their own excrement to the already putrescent waters. This compound, warmed for weeks by the blazing sun, makes a drink palatable to one suffering from intense thirst" (Talbot, 1844). Stephan A. Long led an expedition up the South Platte River in 1820 and described the area as "the Great American Desert, an area uninhabitable by people depending upon agriculture" (Benson, 1988). Colonel McClure's description of the South Platte River during the early summer run-off period in 1867 was, "The river rolls its turbid waters through the Platte Valley and makes no sign of life along its borders. It is shallow, wide, and muddy and broken by innumerable islands, treacherous and apparently useless. It doesn't even shirt its own banks with shrubs or timber" (McClure, 1867). In 1846, Francis Parkman described the South Platte River near Denver as "nothing but a dry bed of sand, into which the water had sank and disappeared" (Parkman, 1846). The South Platte River historically was "a raging torrent one moment and a dry bed of sand the next" (Silkenson, 1992). The name of the river comes from the French, and means "dull" or "shallow." Early settlers described the river as "too thin to plow, too thick to drink, a mile wide and an inch deep."

The historical health of the South Platte River was summarized in Michener's book, Centennial (1974):

> And finally there is the river, a sad, bewildered nothing of a river. It carries no great amount of water, and when it has some, it is uncertain where it wants to take it. No ship can navigate it, nor even canoe it with reasonable assurance. It is the butt of more jokes than any other river on earth, and the greatest joke is to call it a river at all. It's a sand bottom, a wandering afterthought, a useless irrigation, a frustration, and when you've said all that, it suddenly rises up, aprils out to a mile wide, engulfs your crops and lays waste your farms.

Although Michener may have used poetic license in his description of the health of the South Platte River, his description is backed by historical record.

Urban communities of the arid West developed along the banks of this "nothing" of a river in order to make use of its precious water resources. Farming developed along its naked banks, and the inconsistent water supply was used to grow commodities to feed the developing populations. Even after settlement, periodic floods moved the river's channel back and forth across its broad flood plain, wreaking havoc with the communities that had developed along its banks. These periodic floods moved the river far from where irrigation headgates had been first established, which continually frustrated the farmers.

The flora and fauna of the South Platte River was also ridiculed. The riparian corridor was nonexistent. The extremes of flow and lack of rainfall of the river corridor lend credibility to the descriptions that maintained the river did not "shirt its own banks," "made no sign of life along its banks," and was "nothing but a barren wasteland." It is likely that the South Platte River historically supported a very poor, highly tolerant fish fauna consistent with intermittent flows. In 1891, only 12 fish species in the South Platte River had been identified (Jordan 1891). Even historically, the river did not exhibit a picture of ecosystem health that would be palatable by today's standards.

With the advent of irrigation in the 19th century, changes came to the riparian corridor. Many shrubs, forbes, and trees not historically found on the high prairie became established on the once-denuded banks. The "new" riparian habitat was a function of more constant flows, invading species, and subsurface irrigation return water.

Further development in the watershed and the establishment of irrigation reservoirs expanded the once-ephemeral dry alluvium and shallow hyporheic zones of the river. Transmountain diversions of water from watersheds across the Continental Divide were originally made by gold miners to provide water to the miners' sluices. Later, more diversions were made to assure an adequate irrigation and water supply for the growing population along the front range. The once flashy, ephemeral, "nothing" of a river became a hardworking resource. Continuous flooding along the river banks required the establishment of additional reservoirs for flood control, irrigation, and even recreation during the 20th century.

The natural (historical) sediment and water regime, channel geometry and morphology, non-existent riparian communities, and depauperate plant and animal communities within the South Platte River's watershed are not the type of ecosystem health desired today by over half of Colorado's human population living near the river banks. The historical condition of ecosystem health also cannot be accepted today by resource managers, regulators, or by established water policy.

In the arid West, like it or not, all aquatic ecosystems are managed. The Discharge Permit System manages quality and the Water Rights System manages quantity. Both systems regulate all policy decisions on aquatic ecosystem health and both recognize the South Platte River cannot be "as it used to be," the natural, flashy, sediment-laden "nothing" of a river it once was. Therefore, in order to restore or maintain ecological health on the South Platte River, decisions must be based on what the river presently is.

## Present Ecosystem Health and Restoration Inventory

The second step in restoring and/or managing ecosystem health on the South Platte River was to give it a present-day "physical" by looking at what the greatest influences on the current ecosystem health was and how the river could be maintained, improved, or restored.

In order to accomplish this, the Metro Wastewater Reclamation District financed a series of studies on the South Platte River to identify as many of the attributes of ecosystem health as possible. The Metro District undertook these studies since the District's discharge makes up 90 percent of the present-day river's flow for over 90 percent of the year. To conduct this "physical" identifying the present-day ecosystem health of the South Platte River, many specialists on rivers in the arid West were brought together. Each specialist brought a different perspective of the river's health. Studies were prescribed and tests undertaken by these specialists to inventory the present health of the river.

The environmental inventory was taken not necessarily to determine what was wrong with the South Platte River (after all, historically, the river's health was considered a problem by resource managers for both water quality and quantity), but rather how the river could be improved. The environmental inventory on the South Platte River was conducted under the direction of a working team of experts, or STAT (Scientific and Technical Advisory Team).

Each member of this team was uniquely familiar with some aspect of the South Platte River's environmental health or represented an agency with a direct concern for the health of the river. Although all of the resource "doctors" on STAT had preconceived diagnoses on the South Platte River's health, they agreed on conducting a series of studies to provide a scientific basis and a more holistic diagnosis of the river. This inventory of ecosystem health could then be used to ascertain the best approach to improvement of the South Platte River.

These studies examined fish populations, flows, habitat, benthos, ducks, microbes, sediment, spawning, time of travel, water quality, nutrients, toxicity, hydrology, aeration, oxygen, carbon, biological demands and cycling, groundwater, infiltration, respiration, metals, temperature, ammonia, dissolved gasses, channel width, depth and profile, temperature, wind speed, and climate. The data collected by these studies were brought together in a series of reports (Camp Dresser & McKee, Inc., 1994) and incorporated into a model. Alternatives to improve the river's health were then evaluated.

During this evaluation, all of the watershed stakeholders were brought into the discussion and review process. Stakeholders included the irrigators, dischargers, flood control regulators, parks personnel, and the STAT diagnosticians. This process was not unlike bringing in "the family" to discuss the diagnosis and treatment of a patient with a perceived health problem. The input of all stakeholders was necessary to make decisions concerning the South Platte River's restoration or ecosystem health. The personal knowledge of one stakeholder could change or affect the diagnoses of others, just as the knowledge a close relative might have about a patient's health could modify treatment.

## Diagnosis and Prescription

The third, and never-ending, step in managing the ecological health of the South Platte River was to come up with a diagnosis of existing problems, and then follow up the diagnosis with a "prescription" of alternative treatments to improve the ecosystem health. The diagnosis and prescription phase is ongoing. Symptoms of degraded water quality, flora, and fauna were reviewed. Historical data and results of present studies were compared to distinguish both degradation and improvements. Water quality and biological communities were compared with other arid, high-plains rivers. Toxicity tests were conducted to determine if the symptoms of

poor ecosystem health were actually causing a detrimental effect. When all the data were reviewed, several characteristics of the ecosystem became very obvious:

- The biotic community (fish) is not unlike other high-plains streams.
- The river is effluent dominated.
- Habitat is restrictive for most fish species.
- Nutrients are high.
- Instream flows are a function of the Metro District's discharge.
- Groundwaters coming into the stream is higher in nutrients than surface waters in the stream.
- The predominant influence (most of the year) on water quality and quantity is the Metro District.
- Oxygen depletion exceeds re-aeration in man-made slack water regions.
- The river provides an excellent habitat for the overwintering duck population.
- Summertime irrigation diversions deplete water as quickly as it accrues.
- The channel is no longer a mile wide.
- The depth averages over one inch.
- A large percentage of the water does not come from the South Platte River basin.
- Groundwater gain accounts for nearly all late-summer flow 26 miles downstream.
- Many people use the urban-corridor bike trails and access points along the river.
- The riparian corridor is diminishing.
- The river, although highly regulated, is still subject to extreme flows that are confined to a narrow channel and destroy habitat.
- River depth and flow are usually a function of the Metro District's discharge and may vary daily from less than 100 to over 300 cfs (cubic feet per second).
- Flows in the South Platte River are no longer ephemeral.
- Most of the water of the South Platte River which flows north out of Denver comes from the sewers, connectors, and trunk lines that supply the Metro District. This effluent receives treatment by the District and the discharge water becomes the South Platte River.
- Diversion of high-ammonia effluent from the river has not improved but decreased the water quality.
- Most effects of the Metro District's discharge cannot be distinguished 30 miles downstream.
- Minimum dissolved oxygen at higher elevation is a function of time and percent saturation, as well as concentration.

- Irrigation structures obstruct upstream migration of fish and divert larval fish.
- For the most part, downstream of Denver the SOUTH PLATTE RIVER IS A RESOURCE, *not a problem*, and restoration activities should not concentrate so much on controlling negative environmental impacts as creating positive ones.

This last point--the rallying cry for restoration--although obvious from both the discharger and user points of view, is the hardest one for the Western regulators of both water quantity and quality to understand. Western regulators of water quantity are not as concerned about negative or positive environmental effects as they are concerned about economic effects. Water in the arid West means money and often the best manager of water quantity is judged on resource utilization. Western regulators of water quality, on the other hand, are constrained by regulations which do not recognize the environmental benefits or attributes of an effluent-dominated stream in an arid ecosystem.

Designing and prescribing a program to restore or maintain environmental health on the South Platte River required an evaluation of alternatives that would provide the most cost-effective environmental benefits. The economics of restoration become the driving force when looking at restoring or maintaining the environmental health of any ecosystem--and the South Platte River is no exception. Evaluating the possibilities for using ecological restoration in concert with direct water quality improvements has the potential to provide the maximum benefits to the ecosystem.

In many cases in the wastewater treatment industry, monies spent for traditional treatment facilities have achieved minimal environmental improvement. This occurs simply because regulations and funding have been designed under a control strategy and not in a manner to achieve restoration. As employees of the public, as scientists, and as regulators, we must incorporate the economic factor into using ecological restoration to meet the Clean Water Act goals and assure funding of restoration activities.

The first steps in ecological restoration on the South Platte River were designed to increase dissolved oxygen levels downstream of the Metro District's central treatment plant. Historically, the approach to treating dissolved oxygen problems in a receiving water downstream of a point source has been to require further treatment before discharge by using a control strategy. In the case of the South Platte River, the Segment 15 Water Quality Model (an upgraded Lotus version of Qual II-E and the Colorado DO model) was used to evaluate treatment alternatives.

Using data collected during the environmental inventory, the model confirmed predictions that dissolved oxygen levels could be maintained by alternative, less expansive, means (a restoration strategy). The initial improvements involve restoring the natural re-aeration capacity of the river by modification of a downstream dam and the addition of an upstream "waterfall" complete with a boat and/or kayak chute. It is predicted that these instream improvements will increase dissolved oxygen levels in more than a mile of stream. The design benefits to aquatic life, water quality, and cost will be assessed upon completion of these improvements to determine if similar modifications should be made to the river.

Concurrently, the Metro District is continuing its efforts to evaluate other possible improvements which would increase the number and diversity of aquatic species in the South Platte River downstream of the District's central treatment plant. This is in spite of the fact that the river was historically ephemeral and had a low number of species. The improvements will be evaluated for benefits regarding mitigation of risks to aquatic species from a less stringent dissolved oxygen standard, as well as benefits to both ecosystem health and society. Benefits to aquatic life under evaluation include, but are not limited to:

- Increases to the number of diversity of fish species.
- Increases in biotic diversity.
- Enhancement of endangered species and/or threatened fish species.
- Additional improvement to water quality.

Secondary benefits to the ecosystem and society include, but are not limited to:

- Floodplain management and protection.
- Water supply augmentation.
- Enhancement of agricultural and municipal water rights management.
- Enhancement and/or addition of wetlands.
- Enhancement of recreational opportunities.
- Protection of open space.

Restoration activities to be evaluated include:

- Flow equalization of discharge; currently, diel flow fluctuations restrict spawning activities of nest-building fish.

- Modification of irrigation diversion structures to allow upstream migration of fish.
- Modification of irrigation intake structures to lessen losses of larval fish from the river during irrigation diversion.
- Development of fish nursery areas in side channel and wetlands.
- Physical habitat improvements creating a more varied local habitat in stream reaches.
- The use of features such as wetlands, gravel pits, and flood plains to improve water quality and enhance the urban corridor.

These activities, although not actual restoration to the theoretical ecologist, do involve the science-based management of environmental design to improve ecosystem health and restore function to this river of the West.

## Ecological Health and Restoration Issues

Ecological restoration on the South Platte River is many things. Several of the most significant factors that stand out are:

**Ecological restoration on the South Platte River is designing ecosystem health to fit into an urban environment.** White Water Design (McLaughlin Water Engineers, 1993) includes multi-use recreational and flood control design, coupled with riparian habitat restoration and wetland design. Ecosystem restoration may involve grouted concrete habitats, cemented flood channels, and landscape features of an urban rather than natural environment.

**Ecological restoration on the South Platte River is recognition of the uniqueness of the ecological system.** The South Platte River may be a "water closet" watershed, but it is an invaluable resource in a high desert. Biking, bird-watching, jogging, rollerblading, and just watching the water flow by are activities that historically could have not taken place during the entire year on the South Platte River. Today, due to transmountain diversions, daily water usage by over a third of Colorado's population, and efficient advanced treatment by a restoration, resource, recycling, reclamation plant, the river flows downstream of the Metro District 365 days a year. Ecological restoration on the South Platte River is **recognition of a resource,** not a problem.

**Ecological restoration of the South Platte River is education.** It is education for resource managers and elementary school children. It is education for the Metro District Board members and regulators. It involves interaction and learning of scientific, ecological, and economic principles by all who are involved with the ecosystem health of the South Platte River.

**Ecological restoration of the South Platte River is recognition of the obvious.** We must recognize the obvious--**w**e cannot make the South Platte River something that it is not, e.g., a trout steam. The river is not cold enough since it is discharged from a "man-made spring" at 18° to 20°C for 365 days a year. Cold weather species will not inhabit the immediate vicinity of the discharge, but this discharge is much better for aquatic life than no discharge at all. To paraphrase Dr. Hynes (1970), "The more the conditions of a site differ from normal, the fewer the number of species and the greater the number of individuals of each species will occur there." We must apply common sense in our ecosystem evaluation.

**Ecological restoration of the South Platte River means working together.** It requires that all stakeholders must work together for mutual benefit. This must be a cooperative effort. This means compromising and "taking off the blinders" to view the ecosystem from a different perspective--restoration requires the development of a water ethic which looks at both societal and environmental benefits.

**Ecological restoration of the South Platte River is EXPENSIVE!** Improving ecological health is expensive, and so is health maintenance and preventative medicine. Current value for an aeration drop structure may run over $2 million. This is an expensive effort funded by the Metro District's ratepayers, even though the lower dissolved oxygen that it mitigates occurs due to previous gravel operations, and the loss of re-aeration ability due to a man-made structure. To modify channels, build wetlands, restore bank conditions, or even design waterfalls, costs money. Present water quality law does not encourage restoration activities. Grant funds are not provided for restoration to point-source dischargers through the Clean Water Act, as provided for nonpoint improvements and for lake restoration activities.

**Ecological restoration on the South Platte River is not true restoration to its original form.** It is not going back to natural sediment on water regime. It is not restoring the natural channel geometry and morphology. It is not restoring a "non-existent" riparian corridor, nor is it returning to the days of the buffalo wallow.

**Ecological restoration on the South Platte River takes time.** We cannot restore overnight an ecosystem that has been abused for centuries. We must be patient to view the results of our efforts.

We all get a warm "fuzzy" feeling when we put something back that we have taken; when we replace something that is missing; when our consciences are relieved because we have righted a past wrong; when we have stripped the last coat of paint on a priceless antique . . . when we can say to ourselves we have restored something valuable. Unlike the restoration of an antique, restoration of the South Platte River does not entail stripping away the layers of man-induced changes. Instead, restoration of the South Platte River involves designing and managing--not to make it what it used to be, but what we want it to become. The value of an antique is not in its original value but, as with any true resource, the value placed upon it by society.

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