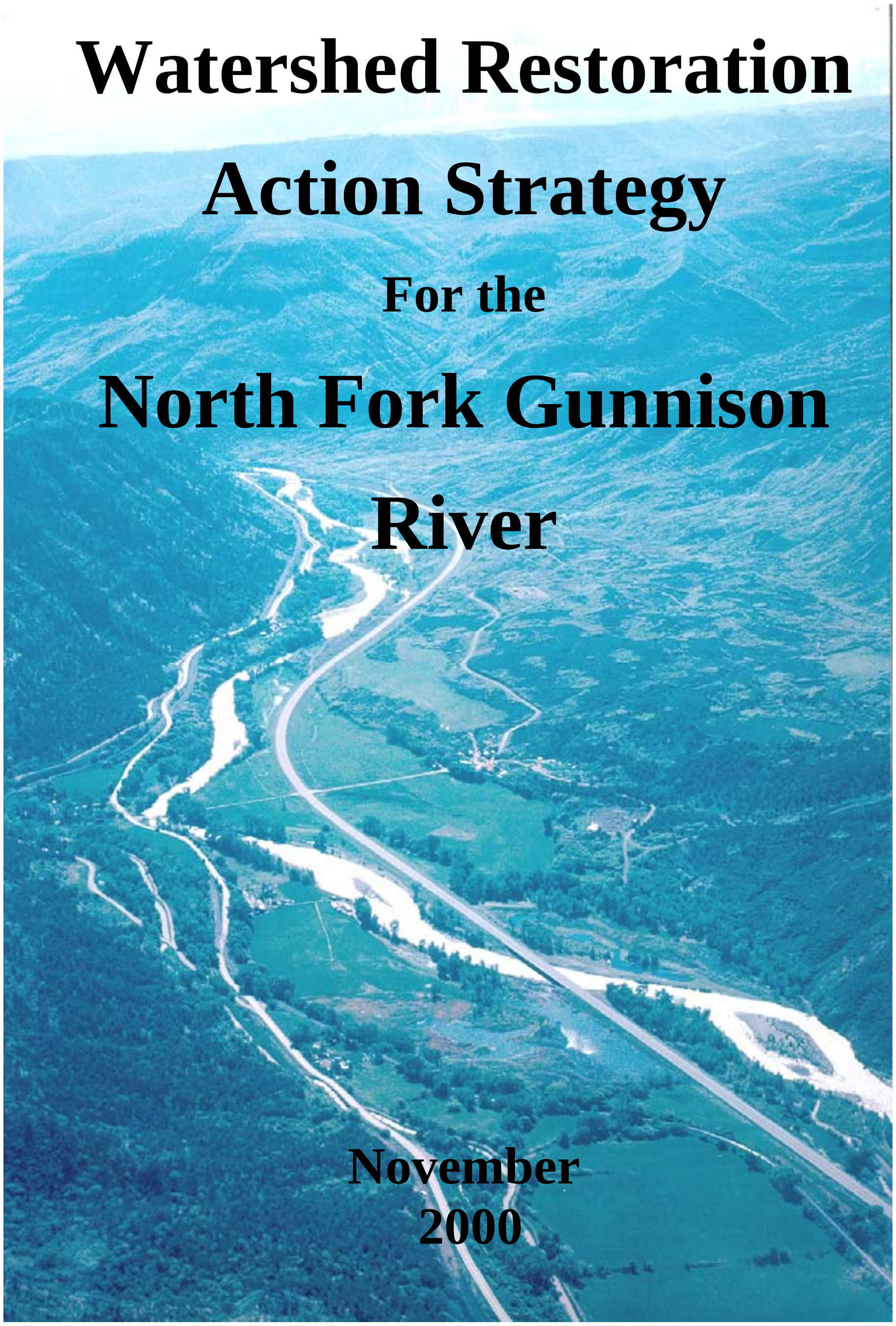
Watershed Restoration

Action Strategy

For the

North Fork Gunnison

River



November
2000

Prepared by:

North
Fork
River
Improvement
Association

ACKNOWLEDGMENTS

This work was supported by a grant to the North Fork River Improvement Association by the Environmental Protection Agency through incremental funds of Section 319 of the Clean Water Act and in cooperation with the Water Quality Control Division of the Colorado Department of Public Health and Environment. Dan Beley, Lower Colorado Watershed Coordinator for the Water Quality Control Division acted as the project coordinator for the Colorado Department of Public Health and Environment. Jeffory Crane was the project coordinator for the North Fork River Improvement Association and primary author of this document.

Several people contributed to the success of this project. Larry MacDonnell of Stewardship Initiatives was instrumental in developing the initial format of the document and coordinating initial public meetings and technical advisory committees. Daniela Howell, a professional facilitator trained in the Holistic Resource Management methods, facilitated our public meetings and her fee was paid by Delta County. Robert Molacek provided a considerable amount of watershed data and developed all the GIS maps. Alison Macalady re-formatted and edited the final versions of this document.

Our technical advisory committee was made up of many representatives from several organizations and government agencies. Special thanks to:
Carl Zimmerman - Colorado Soil Conservation Board
Jack Warren, Mike DiLuzio, Ed Neilson, & Tom Weber – Natural Resources Conservation Service
Tina Laidlaw, Deborah Lebow, Dawn Tesorero, Kim Larson, Marcella Hutchinson – Environmental Protection Agency
Paul Von Guerard – US Geological Survey
Randy Snyder – US Army Corps of Engineers
Mike Baker & John Ozga – US Bureau of Reclamation
John Almy & David Bradford – US Forest Service
Gary Weiner – National Park Service, RTCA
David Cooper - Colorado State University
Rick Kruger – US Fish & Wildlife Service
David Merritt – Colorado River Water Conservation District
Brian Hyde & John Van Sciver – Colorado Water Conservation Board

Most importantly we’d like to thank the landowners and members of this special community for all of their important input into this process.

NORTH FORK WATERSHED ACTION PLAN

TABLE OF CONTENTS

Chapter 1: Background and Introduction

<u>Statement of the Problem</u>

When Anglo settlers first arrived in the North Fork Valley in the early 1880's, they encountered a river with many meanders, dense riparian vegetation, and heavy spring floods that early reports say "covered the bottomlands from bluff to bluff." They also found extremely fertile river valley soils - a direct result of the periodic flooding. The valley immediately began producing some of the finest agricultural products in Colorado, and a strong agricultural community began to develop.

In order to expand and protect the burgenoning economy, settlers inadvertently changed the river's dynamics. They cleared more native bank vegetation for farming, straightened the river channel to increase the acreage available for tilling, and constructed ditches and diversion to take water from the river to irrigate crops. They also built dikes along the river to prevent flooding of the new developments.

Periodic floods still escaped the banks of the river, sometimes wreaking widespread damage to property and threatening human safety. A campaign to rein in the river ensued. Riparian landowners attempted to protect their lands by building hardened structures along their banks. With the advent of the bulldozer, efforts to straighten and deepen the channel intensified. Mining the abundant supplies of gravel from the river bottom became an important business and also lowered the base elevation of the channel as a perceived benefit.

Despite these efforts, today's river is anything but stable. In its ongoing quest to find some kind of new equilibrium between the energy of its water and its sediment load, the river has braided its channel into multiple parts and raised its bottom elevation in some locations, and has scoured deep below its banks in others. Scouring has been detrimental to bridge abutments, diversion structures, and adjacent property. Changes in the elevation of the channel bottom have caused the river to change course, threatening private property, county roads, irrigation facilities, and other diversion structures.

Numerous studies have shown that historic channelization is the primary cause of the river's instability. What began as a well-intentioned means to protect agricultural land from spring flooding and to expand crop production in the floodplain eventually cut the river off from its floodplain, increased stress and erosion on the riverbanks, and caused the following:

- Reduced riparian and wetland ecosystem function.
- Loss of riparian habitat.
- Property loss including prime agricultural land.
- Destruction of the fisheries.
- Damage to and relocation of existing irrigation diversions.

- Bridge scour.
- Reduction of bedload transport.
- Decreased late season flows.
- Increase in flood damage.
- Reduced water quality.
- Invasion of noxious weeds.

Specific ongoing activities in and along the river have compounded these problems. In-stream gravel mining increases riverbed scour and riverbank erosion. River instability forces irrigation companies to re-build diversion structures almost every year, increasing the number of times bulldozers must enter the river and push up new gravel dikes. Intensive grazing and other development continue to encroach into the floodplain, reducing or removing the native vegetation that helps to protect banks against erosion. Although many landowners have changed their land management practices within riparian zones, several parcels along the river are still in poor condition.

North Fork River Improvement Association

Landowners established the North Fork River Improvement Association (NFRIA) in 1996 as a means to improve the health of the North Fork of the Gunnison River. NFRIA takes a community-directed, solution-focused, grassroots approach to watershed organization and river rehabilitation. The mission of this group is *to meet current and future demands for traditional uses of the river while improving stream stability, riparian habitat, and ecosystem function*. It is designed to empower the community as an alternative to traditional “top-down” government regulatory approaches to river restoration. Our goal is to solicit community input from all stakeholders and government agencies involved with the river, build consensus, and develop collaborative solutions to the common problems of this stream system, such as those outlined above.

NFRIA has successfully brought together riverfront landowners, farmers and ranchers, environmentalists, irrigation companies, recreationalists, in-stream gravel mining companies, and concerned members of the community. The group enthusiastically faces the social, political, and technical challenges before them and looks forward to developing collaborative efforts between all stakeholders and government agencies to ask better questions, find substantive answers, and ultimately promote positive action.

Purpose of the Watershed Action Plan

NFRIA is now embarked on an ambitious effort to develop an action plan for improving the health of the North Fork watershed. In September 1999, we received a Clean Water Act Section 319 grant to begin this work. The grant totaled $22,500 and is administered by the Colorado Department of Public Health and Environment.

The action plan laid out in this report will serve as NFRIA's road map and guide book as we set our river-restoration course in the foreseeable future. At a goal-setting meeting in mid-September, the community reaffirmed its interest in creating a more stable river channel and a healthier river corridor. It also reaffirmed its strong desire that stream restoration activities take place in a manner that supports the valley's economy and that strengthens the community. The action plan reflects the community's vision of river management, and will help guide us in our efforts to create a river environment that is both ecologically functional and economically beneficial.

There are several components to this initial action plan. The first is a summary of currently available watershed data - Chapter 2 of this report compiles information that addresses the river's hydrology, riparian vegetation, channel processes, and water quality. It will be the scientific basis for all future studies and restoration efforts undertaken by NFRIA and/or the broader community. Chapter 4 describes NFRIA's first attempt at on-the-ground river restoration, and will serve as an initial template for similar efforts to come.

The primary product of the plan, though, is a set of actions proposed for improving the function and vitality of the stream corridor. It includes a community-driven strategy for prioritizing them, and a generalized timetable for their implementation (chapters 4 and 5). The plan also describes how current and future watershed actions will be monitored and evaluated.

Though NFRIA has developed a specific set of recommendations and actions for river improvement, this document is designed to be a living action plan that can change with the demographics and vision of the community. NFRIA is developing a decision-making framework that will guide the action plan accordingly.

A technical working group has been instituted to support development of the action plan. This group, which meets monthly, consists of river experts and representatives of federal, state, and local resources agencies. Working group members are contributing their time to help with such matters as information gathering, technical review, and identification of sources of assistance.

All planning meetings are open to the public. We expect to hold at least one special meeting to discuss the initial draft of the plan, which is to be completed by April 2000.

Chapter 2: The North Fork Valley and Watershed

Before we can develop a plan to create a healthier North Fork River, it's important for us to understand the conditions of today's river system. The following chapter is a compilation of baseline river information. It provides a snapshot of the watershed at the present point in time, thereby illuminating many of the problems present on today's river.

Description of the North Fork Valley

The North Fork of the Gunnison River (North Fork) watershed is located in western Colorado's Gunnison and Delta counties (Figure 2-1). The North Fork flows through the towns of Paonia and Hotchkiss before converging with the main stem of the Gunnison River north of the Black Canyon of the Gunnison National Park approximately 8.5 miles west of Hotchkiss. The headwaters begin at the confluence of Anthracite Creek and Muddy Creek in the Gunnison National Forest at an approximate elevation of 6200 feet. The river flows 33 miles in a southwesterly direction through a valley of multiple river terraces that run parallel to the river. These terraces make up a broad, highly dissected valley with a gentle to moderate down-valley slope. The valley is flanked by Grand Mesa on the north and west and the West Elk Wilderness area on the east and south. The North Fork watershed drains approximately 986 square miles.

Geology and soils

The North Fork drainage is located on the western edge of the Rocky Mountain uplift. The geology of the watershed is a complex mix of sedimentary formations, primarily Mancos shale, Mesaverde and Wasatch formations that were uplifted by the Rocky Mountain orogeny and then intruded by a variety of igneous materials. This mountain building process created an extremely varied landscape – a mountain region dominated by igneous cone-shaped peaks rising above mesas, ridges, basins and benches formed from sedimentary materials. These sedimentary materials are geologically young and loosely consolidated, causing a high erosivity and producing naturally high sediment loads in the river.

Little Muddy Creek, for example, has an unusually high sediment load. Since there is no livestock grazing, timber sales, coal mining or gas well development in the Little Muddy Basin, most of the sediment is probably a result of natural geologic erosion. The creek flows through the Wasatch formations on the south side of Spruce Mountain. The Wasatch is the same type of formation as those found in Bryce Canyon National Park and is highly erosive. Alluvial terraces and floodplains, the predominant depositional landform in the basin, also contribute to the river's high bedload and sediment supply.

The soils along the river valley are deep and moderately deep, nearly level to steep, well-drained gravelly loam and stony loam that formed in outwash alluvium derived from igneous rock.

Vegetation and climate

The native vegetation in the lower portion of the watershed is classified as northern desert scrub, and consists primarily of juniper, sagebrush, western wheatgrass, muttongrass, fourwing saltbush and bitterbrush. Aspen, spruce, and pinyon woodlands dominate the upper watershed.

The climate of the area is semi-arid with an abundance of sunshine and frequent wind. The prevailing direction of air movement is from the west. The primary sources of moisture are the Pacific Ocean and the Gulf of Mexico. Mean temperatures range from 25.8 degrees Fahrenheit in January to 72.8 degrees Fahrenheit in July (Table 2-1). The growing season is usually upwards of 120 days. Average precipitation for the year is 14.8 inches with an average snowfall of 44 inches.

TABLE 2-1
Summary of Climate Data

Paonia Station (1957-1997)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature (°F)													
Average Daily Maximum	38.8	45.5	53.9	63.1	73.5	83.9	89.6	87.4	78.7	67.4	52.0	41.6	64.6
Average Daily Minimum	12.7	19.8	26.9	33.3	41.5	49.6	55.9	54.7	46.6	36.4	25.7	16.6	35.0
Precipitation (inches)													
Average	1.10	1.13	1.47	1.24	1.34	0.80	1.05	1.20	1.46	1.61	1.35	1.30	14.82
Maximum	2.88	3.26	3.81	3.11	3.68	3.30	2.34	2.63	3.81	3.61	3.40	3.73	23.75
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.09	0.00	0.00	0.00	7.33
Snowfall (inches)													
Average	11.8	7.8	6.1	2.0	0.2	0.0	0.0	0.0	0.0	0.8	3.8	11.1	44.0
Maximum	42.7	23.3	24.0	18.0	6.5	0.0	0.0	0.0	1.0	8.0	16.5	39.5	74.9
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Colorado Climate Center 1999

Land ownership and use

Federally managed public lands make up a total of 73.7% of the 597,941-acre watershed. The remaining 26.3% is primarily private land located in the lower portions of the watershed (Figure 2-4). Approximately 94% of both public and private lands are forest and undeveloped wildlife habitat. Another 4% are mostly developed agricultural lands.

Though only a small fraction of the entire basin is developed, the lower southwestern portion of the watershed is dominated by private agricultural lands (Figure 2-2), which make up over 80% of all privately owned lands in the basin (Figure 2-3). Of the private agricultural lands, 15,605 acres are irrigated, 1,103 acres are orchards, 5,102 acres are non-irrigated meadow/hay land, and 95,431 acres are dry grazing land. Agricultural use consists primarily of cattle and sheep ranches, cropland, and fruit orchards. Major crops grown in the area include alfalfa, oats, grass hay, corn, and small grains. Fruit crops include apples, pears, peaches, cherries, plums, apricots, and grapes.

The North Fork of the Gunnison River watershed contains 397,956 acres of National Forest lands. This is approximately 63.1% of the watershed. The Gunnison National Forest manages the majority of these public lands. An additional 23,000 acres are located on the Grand Mesa National Forest. Most forestlands are in the upper regions of the watershed, and the majority of the acreage is considered sensitive to very sensitive to disturbance due to the basin's geology and slope. The forests' rich fish and wildlife resources supplement the general economy with tourism and outdoor recreation.

Activities on the forests that can affect watershed health include livestock grazing, timber harvesting, coal mining, natural gas development, and recreation (including vehicle travel on and off the forests' approximately 200 miles of roads). These forest uses should be regulated to minimize any negative effect on watershed conditions. Currently, no major watershed problems are attributed to management activities on the National Forests.

The Bureau of Land Management (BLM) manages an additional 59,744 acres of public land, or 10.6% of the watershed. BLM's acreage is mostly scattered in isolated parcels sandwiched between National Forest and private lands.

The BLM also regulates a large deposit of low-sulfur coal found in the Mesaverde Formation near the towns of Paonia and Somerset. The deposit was first exploited when the railroad was extended to the Somerset in 1890. Since then, mining has become an integral part of the valley's economy. Production at three area mines has increased dramatically in the past few years, in part because of changes in the federal Clean Air Act. The newer regulations have increased the demand for cleaner, low-sulfur coal.

Demography

Delta County's population grew by approximately 27-percent during the last decade (Table 2-2). Though growth in the North Fork Valley is concentrated in and around the major towns of Paonia and Hotchkiss and Crawford, subdivision and change of use from agriculture to residential on the valley's mesas is expanding rapidly. Currently, there are no planning or zoning laws that regulate growth and development in Delta County. New change-of-use regulations are now under review by the community and may be approved shortly.

TABLE 2-2
Population Estimates

Jurisdiction	1980	1990	1998	% Change 1980 – 1990	% Change 1990 – 1998
Delta County	21,225	20,980	26,791	-1.2%	27.7%
City of Delta	3,931	3,654	6,253	-7.0%	71.1%
Town of Hotchkiss	849	744	920	-12.4%	23.7%
Town of Paonia	1,425	1,403	1,779	-1.5%	26.3%

Source: Colorado Department of Local Affairs 2000

Valley history after Anglo resettlement

The Ute Indians were the earliest known residents of the North Fork region, but a treaty in 1880 moved the tribe out of the valley and into northeastern Utah. The area was opened to resettlement on September 1, 1881. Early Indian and Anglo accounts indicate that the valley was heavily vegetated and often flooded. The May 21, 1884 edition of the *Delta Chief* newspaper cites Indian reports of a flood that "covered the bottomlands from bluff to bluff" about 22 or 23 years earlier. Claudia King, a Paonia librarian, recalls accounts of Utes moving to higher ground near Erickson Spring on Anthracite Creek during spring floods in the valley.

Early reports indicate that the valley was covered with beaver ponds. Paul Stephens, a long time resident of Paonia, says he recalls hearing accounts of how the town was built right on top of the ponds. Several recent excavations have confirmed the existence of these ponds.

The Wade family established one of the first ranches in the valley near Paonia in 1882. Esra Wade, one of the first Wade settlers, writes that in 1882, "the larger part of the valley was covered with cottonwood timber, willows, buffalo brush, skunk brush, sage brush, and others too numerous to mention. On the outskirts of this timber on each side of the river grew large sagebrush. It was so thick in some places one could hardly penetrate it on foot. The river was very crooked and lessened its fall, therefore did not cut its banks, but spread over a large portion of the valley during high water time, and deposited sand and rich soil from the high country, making the valley soil, in places, very rich. Later on the ranchers began cutting these curves in the river and then the trouble began. Instead of getting it straightened out, it cut out across acres of good land. This had to be done, however, because the valley could not have been cultivated had it not been done."

Wade's manuscript also describes how the first fruit trees were transported from Gunnison City over Black Mesa to the North Fork. The trees and other crops were irrigated from a ditch diverted from Minnesota Creek, and the first harvest was excellent. There are reports of wonderful farming conditions - mammoth squashes over 100 pounds, potatoes so long that they were carried like firewood, and no insects.

The May 21 and 28, 1884 editions of the *Delta Chief* reported on details of a large spring flood. Some settlers were forced up to high ground, and farmers worried that they would not be able to plant their crops because of the floodwaters. Every bridge in the county washed out, with the exception of the railroad bridges and 2 or 3 small crossings over Tongue and Surface Creeks. On May 13, 1884 the county commissioners ordered the north bridge of the Gunnison to be lengthened by 20 feet in order to make room for rising floodwaters. Interestingly, there was no mention of property loss due to bank erosion.

The community grew quickly in the late 1880's and 1890's in part because of the valley's expanding fruit and livestock industries, and the discovery of coal. As more farmers moved into the valley, the fertile river bottomland between Paonia and Hotchkiss became prime real estate. Point bars along the inside of meander bends were the most coveted because they were the most fertile land and the easiest to irrigate. Horse drawn plows and fire were used to clear the land. Houses and orchards then replaced the dense native riparian vegetation. Crop production was good, and flood damage apparently was manageable until the flood of 1912.

The flood of 1912 caused extensive damage to both the agricultural communities along the river and the river itself. The May 23, 1912 edition of the *Paonia Booster* reports that floodwaters washed away acres of orchards and fields. Despite the efforts of hundreds of men and teams of horses, the river repeatedly changed course and washed away homes and businesses. In one case a man was forced to tear down his barn in order to save the material. Efforts were made to contain the North Fork's floods by straightening the channel, sometimes by using dynamite. The *Booster* reports similar efforts on many of the tributaries. There are several reports of the river recapturing an old channel in locations where the river had been straightened, cutting off farms and homes. Many bridges were washed away including a few of the big railroad bridges. The *Booster* reports that giant cottonwood trees were, "mowed down as if they were nothing."

Interviews with long-time residents of the valley corroborate early 20th century newspaper accounts of the river and its floods. Most residents say that the river bottom elevation was much higher than it is today. Correspondingly, the water table was much shallower, and root cellars were out of the question. Today, many homeowners have dry basements. Many long-time residents also recall deep water in the river's pools where they would swim even in the summer time.

What "old-timers" remember most is the flood damage that occurred during spring runoff. Acres of orchards and good farm ground were lost overnight. Landowners did anything and everything in their power to protect their property. Each year they would add more car bodies, large boulders, cabled cottonwood trees, or whatever they could find to stabilize their banks. Given these conditions and the knowledge of the day, channelization of the river made the most sense. It was considered to be the best defense against flood damage, and it was strongly encouraged by agencies such as the Army Corps of Engineers and the Soil Conservation Service. In reality, these practices only diverted river flows, which generally causes more flooding damage to downstream property owners.

Until the end of World War II, the river channelization and bank armoring efforts were undertaken manually and with teams of horses. In about 1947, Delta County purchased a surplus bulldozer from the Army. This single purchase intensified the annual campaigns to construct a straight, trapezoidal channel with high dikes, especially between the towns of Paonia and Hotchkiss. The bulldozing continued until 1980 and caused the channel to lower substantially. Today's river reflects the attempts to confine floodwaters in a straightened channel. Present river uses, such as in-stream gravel mining and the construction of annual gravel dams for irrigation diversions, continue to impact channel stability and riparian function.

Present hydrologic conditions and water use

Stream hydrology

The North Fork of the Gunnison River is a 4^{th} order perennial stream channel that drains approximately 986 square miles in the upper Colorado River watershed. The North Fork is a major tributary of the Gunnison River. The river begins at the confluence of Anthracite and Muddy Creeks. The primary tributaries include Muddy Creek, Anthracite Creek, Coal Creek, Hubbard Creek, Terror Creek, Minnesota Creek and Leroux Creek. There are over 80 smaller creeks that flow into these major tributaries or into the North Fork River itself. The North Fork joins the mainstem of the Gunnison River approximately 8.5 miles downstream from the Town of Hotchkiss. The USGS hydrologic unit code is 14020004.

River flows

Flows in the North Fork are highly variable depending on the season. Flows increase from approximately 100 to 300 cfs in late summer and winter to anywhere between 2000 to 9000 cfs during peak runoff. The highest peak flow on record is 9220 cfs, recorded in 1984 at the USGS gage in Somerset. The mean annual high water runoff is approximately 3200 cfs.

Average flows are highest during the spring snowmelt runoff months of May and June (Figure 2-5). Major flooding also occurs during spring runoff months when rapid melting snow is sometimes augmented by rain. Snowmelt flooding is characterized by moderate peak flows, large volume of runoff, and long flow duration. Flooding from rainfall is characterized by high peak flows of moderate duration.

The U.S. Geological Survey (USGS) collects river flow data along the North Fork of the Gunnison River and its tributaries. Table 2-3 lists the agency's various stream flow gauging stations within the North Fork watershed. The primary gauging station for the river is near the town of Somerset. Table 2-4 and Figure 2-5 summarize average monthly data from this station.

TABLE 2-3
Active USGS Gauging Stations

Station	Station No.	Gauge Type	Location	Drainage Area (sq.mi.)	Period of Record	Maximum Flow (cfs)
Paonia Reservoir	09131495	Stage recorder	16 miles east of Paonia	246	12/61 to current	Not applicable
North Fork Gunnison River near Somerset	09132500	Streamflow, Water Quality	2.3 miles east of Somerset	526	10/33 to current	9,220 5/24/84
Minnesota Creek near Paonia	09134000	Streamflow	6 miles up from mouth	41.3	4/36 to 9/47 10/85 to current	359 5/28/93
North Fork Gunnison River below Leroux Creek[1]	09135950	Streamflow	0.7 mi. down from Leroux Creek	922	7/97 to current	1,390 7/1/98

[1] Seasonal records only (July through October).
Source: USGS 1998

TABLE 2-4
Average Monthly Flows (cfs)

Month	Gauging Station – North Fork River near Somerset
January	66
February	71
March	155
April	733
May	1,951
June	1,508
July	462
August	200
September	152
October	121
November	94
December	77
Annual	467
Bankfull discharge[1]	2,847
Average annual runoff	338,400 acre-feet

[1]Discharge corresponding to incipient flooding or when discharge fills the channel to the top of its banks and water begins to overflow onto the floodplain.
Source: USGS, 1998

Table 2-5
Historical Peak Flows

Flow (cfs)	Date	Flow (cfs)	Date
9,220	May 24, 1984	6,580	May 20, 1973
8,610	May 27, 1993	6,450	May 13, 1928
8,590	May 12, 1932	5,850	May 16, 1944
7,860	June 4, 1957	5,850	May 13, 1941
7,310	May 15, 1929	5,760	May 27, 1985
6,720	May 28, 1979	5,660	June 17, 1995
6,580	May 31, 1983		

Source: USGS 1999

Flooding

Historical flood records date back to 1928 (Table 2-5). The Federal Emergency Management Agency (FEMA) uses this and other data to estimate the flood frequency of the river (Table 2-6). The estimated 100-year flood flow (1-percent chance it will occur in any given year) on the North Fork near Somerset is 9,200 cfs (FEMA 1983). Flood frequencies are subject to large uncertainties and should be treated conservatively.

TABLE 2-6
Summary of Flow Frequencies

Location	10-year[1]	50-year[2]	100-year[3]	500-year[4]
North Fork near Somerset	5,600	8,000	9,200	11,300
North Fork below confluence with Leroux Creek	8,100	11,300	12,800	15,700

[1]10-percent chance in any given year, [2]2-percent chance in any given year, [3]1-percent chance in any given year, [4]0.2-percent chance in any given year.
Source: FEMA 1983

Delta County recently completed a study to identify deficiencies in flood hazard maps (Buckhorn Geotech 1999). The study prioritizes flood information needs based on three (3) criteria: land use, development potential, and existing flood information. High need areas are residential and/or commercial areas, areas currently developed, and areas where no flood studies have been performed. Low need areas include public lands, land with low development potential, areas already covered by a detailed FEMA flood study. The lower two (2) miles of Minnesota Creek, the North Fork, and Cottonwood Creek (tributary to the North Fork) were identified as high to very high need areas for additional flood hazard information.

Paonia Reservoir

The Bureau of Reclamation completed the construction of Paonia Dam and Reservoir, located on Muddy Creek just above the confluence with Anthracite

Creek, in January 1962. The reservoir's primary purpose is to store irrigation water for the Fire Mountain Canal and Reservoir Company, the Leroux Creek Water Users Association, and the Ragged Mountain Water Users Association. Flood control is listed as a supplemental benefit, and the Bureau of Reclamation estimates that the dam has already prevented $212,000 in flood damages. An Analysis of stream gage data on the North Fork since 1934 indicates very little difference in flood peaks or duration between pre and post dam eras. In fact, the two largest floods on record have occurred following the dam construction. However, it's difficult to determine if the dam reduced the peak flows and duration of those record post-reservoir floods.

Reservoir sedimentation was considered as part of USBR's Paonia reservoir planning process. The Bureau collected basic sedimentation data for the reservoir in 1949, 1952, and 1953, and compiled the information in a report dated October 1956. The study predicted sediment deposition in Paonia Reservoir averaging about 100 acre-feet per year. A re-survey of the reservoir in 1987 indicates that the deposition exceeds the initial estimate by nearly 40 acre-feet per year. However, this number also includes sediment generated by a massive landslide near Ragged Mountain in 1986.

The reservoir was originally constructed for a total storage of 20,950 acre-feet. This can be divided into three zones:

- Dead storage below the sill of the outlet structure (below elev. 6358').
- Inactive storage, or the storage necessary to create sufficient head to deliver water (between elev. 6358' and 6362').
- Active storage, or water that is available for delivery (between elev. 6362' and 6447.5') (Table 2-7).

The reservoir's active storage capacity is 16,527 acre-feet. A total of 14,650 acre-feet are currently allocated. 8,100 acre-feet are allocated to the Fire Mountain Canal and Reservoir Company, 4,550 acre-feet to the Leroux Creek Water Users Association, and 2000 acre-feet to the Ragged Mountain Water Users Association.

In 1987, total storage was reduced to approximately 17,461 acre-feet, a reduction of 3,489 acre-feet in 25 years (Table 2-7). There has not been another capacity survey since 1987, but assuming that the Bureau's conservative estimate of sedimentation rate (100 a.f/yr.) is close to correct, today's total storage is probably about 16,261 acre-feet, leaving only 1,877 total acre-feet above the allocated amount. Only a new survey can determine how much the current sedimentation in Paonia Reservoir has reduced the active storage zone.

Water diversion and use

There are nine (9) existing irrigation diversions along the river between Somerset and Hotchkiss. They deliver water to thousands of acres of agricultural land throughout the valley. Most of the irrigation water is returned to the river, either through direct tributaries and wastewater channels or indirectly through groundwater recharge. In late summer, however, some sections of the river are left with almost no water. At certain points, such as through the town of Paonia, the river is almost completely diverted into irrigation ditches and metered at headgates further down the ditch channel. The excess water is returned to the river channel downstream, but the temporary short-circuiting of the river channel can be detrimental to fish and wildlife.

Table 2-7

Paonia Reservoir Elevation/Capacity Comparison

Elevation (ft)	As-Built Capacity (ac-ft)	1987 Capacity (ac-ft)	Capacity Difference (ac-ft)
6329	798	1	797
6340	1280	184	1096
6350	1860	462	1398
6360	2620	843	1777
6370	3640	1346	2294
6380	4890	2071	2819
6390	6390	3253	3137
6400	8170	4877	3293
6410	10300	6896	3404
6420	12740	9319	3421
6430	15500	12053	3447
6440	18520	15052	3468
6450	21790	18298	3492
6460	25360	21821	3539

In 1987, dead storage was 558 AF (below elev. 6358'), inactive storage was 176 AF (between elev. 6358' and 6362'), active and joint use was 16527 AF (between 6362' and 6447.5').
Source: USBR 1988

Table 2-8 lists the primary water users in the study area and Figure 2-6 displays their locations. Along the North Fork, water is used primarily for irrigation and stock. A small portion is reserved for minimal streamflow, commercial fishery production, and domestic uses.

<u>Domestic Water Use and Source Water Protection</u>

Water for domestic use is derived primarily from groundwater (Table 2-9). The most important exception is the town of Hotchkiss, which diverts surface water from Leroux Creek.

Currently, there is no comprehensive monitoring of source water in the North Fork watershed. However, the Colorado Department of Public Health and Environment is working to create source-water protection plans in watersheds throughout the state. The plans will identify all domestic source-water diversions and develop strategies to protect them.

TABLE 2-8
Primary Water Users in Study Area[1]

ID[2]	Name	Type	Use	Decree
3416	Paonia Reservoir	Reservoir	Irrigation, Stock	21,000 AF
2347	North Fork River	Other	Min. streamflow	60.0 cfs
1133	Fire Mountain Canal	Ditch	Irrigation	219.0 cfs
1206	Steward Ditch	Ditch	Irrigation	77.9 cfs
2681	Steward Ditch	Ditch	Stock	5.0 cfs
1185	Farmers Ditch	Ditch	Irrigation	32.1 cfs
1189	Paonia Ditch	Ditch	Irrigation	32.3 cfs
1183	Monitor Ditch	Ditch	Irrigation Stock, Domestic	8.25 cfs 2.0 cfs
1195	Shepard/Wilmont Ditch	Ditch	Irrigation Stock, Domestic	12.6 cfs 3.5 cfs
1196	Short Ditch	Ditch	Irrigation, Stock, Domestic	43.5 cfs 1.0 cfs
1213	Vandeford Ditch	Ditch	Irrigation	14.5 cfs
1197	Smith/McKnight Ditch	Ditch	Irrigation	10.3 cfs
1727	Myles McMillan Ditch	Ditch	Fishery	8.0 cfs
928	J.W. Cline Ditch	Ditch	Fishery	8.0 cfs

[1]Water users along the North Fork and Gunnison Rivers with total decreed amounts greater than 5 cfs or 100 acre-feet. [2]State Engineer's Office water rights identification number. Source: CDWR 1998.

In response to the Safe Drinking Water Act amendments of 1986 and 1996, the State of Colorado has developed both a Wellhead Protection (WHP) program and a Source Water Assessment and Protection (SWAP) program to aid in the protection of public drinking water supplies. Under both programs, participation by the public water suppliers (PWS) is voluntary. Under the WHP program, approximately 200 Public Water Sources have voluntarily started local programs. The degree of completion of each program varies.

As a result of SWAP, each state is now ultimately responsible for seeing that source-water assessments are completed for all public water sources (ground water and surface water based). Selected wellhead protection activities will essentially be assumed under SWAP program. The information from SWAP and WHP will be made available to the general public for review once the assessments are completed and compiled for an individual process, as it will help identify likely point and non-point sources of contamination within the watershed.

Within a given watershed, the State of Colorado will utilize contractors to complete source water assessments for each public water supplier. The State and their contractors will try to work with each PWS to delineate the source water area, inventory potential sources of contamination within the defined source water areas, and evaluate the susceptibility of the drinking water supply to the potential sources of contamination identified. Throughout the process, public water sources will be encouraged to comment and provide input into the development of the assessments.

TABLE 2-9
Domestic Water Sources in the Study Area[1]

Water System ID[2]	Name	County	Population Served	Primary Water Source Type
CO0115152	Bone Mesa Water District	Delta	300	Groundwater
CO0115168	Cathedral Water	Delta	250	Groundwater
CO0115352	Town of Hotchkiss	Delta	2000	Surface water
CO0115467	Lazear Domestic Water	Delta	178	Groundwater
CO0115601	Town of Paonia	Delta	2200	Groundwater
CO0115601	Pitkin Mesa Pipeline Co.	Delta	435	Groundwater
CO0115671	Redwood Arms Motel & Trailer Camp	Delta	100	Groundwater
CO0115685	Rogers Mesa Domestic Water	Delta	840	Purchased Surface water
CO0115725	Sunshine Mesa Domestic Water	Delta	100	Groundwater
CO0215200	Bowie Mine #1/Bowie Mine #2	Delta	180	Groundwater UDI/Surface water
CO0215202	Bowie Mine #2	Delta	65	Surface water
CO0215538	Mad Dog Water	Delta	47	Groundwater UDI Surface water
CO0181289*	McClure CG – G.Mesa	Delta	11	Groundwater
CO0126718	Somerset Water District	Gunnison	90	Groundwater
CO0326503	McClure Campground	Gunnison	26	Groundwater
CO0226160	Camp ID-RA-HA-JE West	Gunnison	46	Groundwater
CO022689	Crystal Meadows	Gunnison	30	Groundwater
CO0226838	Mountain Coal Co., LLC-West Elk Mine	Gunnison	76	Surface water
CO0326502	Erickson Springs CG	Gunnison	26	Groundwater

[1]Compiled from EPA's Envirofacts Warehouse, Safe Drinking Water database, 2000. Listing may not be complete. [2]EPA Safe Drinking Water identification code. [3]Groundwater under direct influence of surface water.

public water sources and local citizens also will be encouraged to participate in collecting, reviewing and/or commenting on the available information assembled for their SWAP assessment. For those public water sources which have started and/or completed assessments of their drinking water supply under the WHP program, the State will review and finish the assessments, as necessary, to meet SWAP requirements. In addition, a susceptibility analysis, which evaluates and ranks how vulnerable the public water source is to the potential contaminant sources identified, must be part of the SWAP assessment, as this element was not included in the original WHP requirements. The State will begin work on SWAP assessments in late 2000 and must be complete assessments for all public water sources by 2003 (Karst 2000).

Riparian Vegetation

Riparian vegetation influences the physical character and stability of the North Fork River. It also provides habitat for a great diversity of wildlife. Historical descriptions of the riparian vegetation (see above) indicate a major change in the type and density of the riparian vegetation since the early part of the 20th century. Development along the river has altered the composition and vigor of the vegetation. Changes in vegetation qualities, such as rooting depths, rooting densities, and species composition, have changed the river’s physical integrity. Less vegetation means the river is less shaded, water temperatures are increased, and physical protection from bank erosion is decreased. Loss of certain types of vegetation has decreased insect habitat and the contribution of woody detritus to the channel. Both water quality and the aesthetic character of the river have also changed as a result of changes in riparian vegetation.

A number of studies describe and inventory the existing riparian vegetation along the North Fork River. The following summarizes the information available from three recent studies:

Colorado Natural Heritage Program’s Riparian Vegetation Survey (CNHP 2000)

The Colorado Natural Heritage Program reviewed riparian sites along the North Fork of the Gunnison River corridor in order to identify areas with unique or significant riparian vegetation and to prioritize the sites’ relative value for conservation.

Potential riparian conservation locations were first identified using aerial photographs. Large riparian areas that appeared to have hydrologic connection, little human modifications, and natural vegetation were delineated on the aerial photographs and tag-marked for site surveys. Of the 16 high-potential areas identified in the photographs, 6 are located along the North Fork (Figure 2-7). One site was not visited due to its inaccessibility. It was consequently dropped from the study.

Site visits clarified each parcel's location, size, condition, landscape context and vegetative communities. In order to compare the sites and prioritize them for future conservation efforts, relative ranks of A through D were assigned to each site. A represents an excellent location, D represents a poor location (Table 2-10).

TABLE 2-10
CNHP Riparian Vegetation Quality Rankings

Survey Location[1]	Vegetation Communities Observed	Vegetation Ranking
11	Fremont cottonwood, narrowleaf cottonwood, Russian olive, tamarisk, Siberian elm, rubber rabbit bush, coyote willow	C
12	Non-native weedy species	D
13	Fremont cottonwood, narrowleaf cottonwood, coyote willow, Russian olive, tamarisk, box elder, skunk bush, silver buffaloberry, river hawthorn, river birch,	C
14	Not surveyed[2]	
15	Narrowleaf cottonwood, silver buffaloberry, Fremont cottonwood, skunk bush, red cedar, box elder	A
16	Fremont/narrowleaf cottonwood, coyote willow, silver buffaloberry, thin leaf alder, strap leaf willow	C

[1]See Figure 2-7 for surveyed locations, [2]Sites identified from aerial photographs but not surveyed because they were inaccessible.
Source CNHP 2000

The following is a list of the primary findings of the CNHP report:

- Heavy competition for resources has resulted in the deterioration of riparian corridor function in the Upper Gunnison basin. Much of this dysfunction is the result of non-native species introduction, regulation and diversion of river flows, and land use conversion.
- In the North Fork, historical land use conversions and water diversions have been the primary factors affecting riparian vegetation.
- Despite the overall decline in riparian vegetation, several locations have retained important components of a natural riparian community. These sites would require some restoration in order to be returned to their natural state.
- Any conservation or restoration effort should include a site management plan that defines objectives and management practices. The plan should include a weed management plan and a site-specific evaluation of hydrologic conditions. This will ensure establishment and maintenance of native riparian vegetation.

<u>North Fork of the Gunnison Vegetation Inventory (NRCS 1997)</u>
In 1997, the Natural Resources Conservation Service conducted an inventory of riparian vegetation along the North Fork. Sixteen river miles between Terror

Creek and the Old Chipeta Fish Hatchery were inventoried in order to obtain baseline information on the North Fork's present vegetative composition. The study also identified reference reaches, and assessed the ability of current vegetation to stabilize streambanks.

Vegetation was inventoried at 11 cross-sections along the river following transects both perpendicular and parallel to the channel. The sites correspond to those studied in NFRIA's recent river morphological assessment (Crane 1997). The study was conducted according to the USFS Integrated Riparian Guide for the Intermountain Region for level 3 inventories (USFS 1992).

The data collected at each site was used to determine plant community types, plant succession statuses, and relative streambank stability ratings. Locations of and results from inventoried sites are shown in Table 2-11 and Figure 2-7. The plant ecology at sites 2 and 6 were classified as late seral, and both sites had a good streambank stability rating. Because of these qualities, site 6 was chosen as a reference area that shows the vegetative potential for other sites. Appendix B of the NRCS report provides the vegetation composition and other data for site 6.

TABLE 2-11
Riparian Vegetation Summary for NRCS Surveyed Sites

Site ID	Cross-section Ecological Status	Greenline Ecological Status	Greenline Bank Stability Rating
0	Early seral	Early seral	Moderate
1	Late seral	Very early seral	Moderate
2	Late seral	Late seral	Good
3	Early seral	Early seral	Moderate
4	Mid seral	Mid seral	Moderate
5	Mid seral	Early/Mid seral	Moderate
6	Late seral	Late seral	Good
7	Late seral	Early seral	Poor/moderate
8	Early seral	Early seral	Moderate
9	Early seral	Early seral	Moderate
10	Early seral	Early seral	Moderate
11	Late seral	Very early seral	Poor

[1]See Figure 2-7 for surveyed locations.
Source: NRCS 1997

Overall, the inventoried areas display adequate seed and root sources for colonization. However, colonization is only successful when favorable sediment and hydrologic conditions are present. In most cases, entrenchment of the stream channel prevents fine sediment from depositing in the floodplain, inhibiting the establishment of vegetation.

River Survey of West-Central Colorado (Dexter 1998)
In 1998, the Bureau of Land Management (BLM) inventoried bird species along rivers in western Colorado. Over 242 river miles were surveyed in west central Colorado, including the North Fork downstream from Hotchkiss. The study's specific goal was to identify habitat for the exceedingly rare Yellow-billed Cuckoo. As part of this effort, field personnel collected riparian vegetation data.

Specific plant communities (identified by key species) were coded into six categories based on their abundance. Cottonwood, willow, emergents, desert shrub, tamarisk, and Russian olive were ranked from category 1 to category 6. Categories are described below:

Category 0 — no plants observed.

Category 1 — very limited numbers of the plants.

Category 2 — a few scattered, mostly immature plants.

Category 3 — plants observed, but not dominant and in fragmented patches.

Category 4 — plants observed, but not dominant and less fragmented.

Category 5 — plant species found in over 50% of the riparian zone.

Category 6 — plant species found in 75% of the riparian zone.

Based on this categorization, it appears that the healthiest riparian vegetation along the North Fork is located from Hotchkiss downstream to the old Chipeta fish hatchery. The riparian area along the river downstream from the hatchery to the confluence of the North Fork and the Gunnison rivers has been invaded by knapweed and thistle, making the area inhospitable to native plants and their obligates. Riparian areas upstream of Hotchkiss were not surveyed.

Wetlands

Wetlands are those areas inundated or saturated by surface or ground water at a frequency and duration that supports vegetation adapted for life in saturated soils. Wetlands generally include swamps, marshes, bogs, and similar areas. Figure 2-8 depicts wetlands inventoried by the U.S. Fish and Wildlife Service (USFWS) along the North Fork. The USFWS study was conducted as part of the National Wetland Inventory (NWI), which delineates wetlands based on reflection conditions on aerial photographs shot during specific years and season. Detailed field evaluations may result in revisions to wetlands boundaries on NWI maps.

Wetlands on the NWI maps are classified based on their vegetation, visible hydrology, and geography, and in accordance with the *Classification of Wetlands and Deep Water Habitats of the United States* (USFWS 1979). Wetlands are either *riverine, lacustrine,* or *palustrine* systems. Generally, a riverine wetland system includes all wetlands and deep-water habitats within a channel of continuously moving water. Lacustrine wetlands are larger than 20 acres, in a topographic depression or a dammed river channel, and lack trees, shrubs, persistent emergents, emergent mosses, and lichens. Palustrine wetlands include all non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and all wetlands in tidal areas where salinity is below 0.5 percent. Riverine and palustrine systems are most prominent along the North Fork.

River Channel Characteristics

In 1997, NFRIA conducted a preliminary assessment of morphological characteristics along the North Fork (Crane 1997). The purpose of this study was to determine causes for river degradation by examining historical uses and investigating morphological characteristics of the river channel. The dimensions, pattern, and profile of the North Fork were measured at 12 cross-sections from Terror Creek downstream to the Old Chipeta Fish Hatchery. The data was analyzed to determine causes, rates, magnitudes, and directions of river adjustments, as well as to develop recommendations to decrease excessive erosion. Each cross section is re-surveyed annually to verify the river process relationships inferred from the initial analysis.

NFRIA used the Rosgen stream classification system to characterize the North Fork at each cross section. Stream classification systems are frequently used in river studies because they can help to predict a river's behavior and determine its stable form. Most classification systems break rivers down into stream segments with consistent and reproducible characteristics. Measurements of physical attributes are used to place each segment into a stream type category, each with a certain geography, morphology and behavior.

Several stream classification methodologies have been developed, but the Rosgen method has gained the most popularity in recent years (Rosgen 1996). Rosgen utilizes a hierarchy system to describe stream segments at different levels of detail (Figure 2-9). Classifications on the four assessment levels vary from broad geomorphic portraits to very detailed characterizations designed to establish empirical morphologic relationships and to predict stream responses. Table 2-12 and Figure 2-10 describe the Rosgen stream classification system and provide an understanding of the river channel characteristics that exist within the study area. The primary Rosgen stream types existing today along the North Fork are C3 and D3.

At the beginning of the North Fork (at the confluence of the Muddy and Anthracite creeks), the channel falls primarily is a stable C3 stream type and has a healthy riparian buffer. At the Farmer's Ditch diversion just downstream of Terror Creek, the channel evolves into an entrenched F3 type where agricultural land development on one side and road construction on the other side has pinched the river into a constricted channel.

TABLE 2-12
General Rosgen Stream Type Descriptions

Stream	General Description	ER[1]	W/D[2]	Sinuosity	Slope	Landform/Soils/Features
Aa+	Very steep, deeply entrenched, debris transport, torrent streams.	<1.4	<12	1.0 to 1.1	>10	Very high relief, erosional, bedrock or depositional features; debris flow potential. Deeply entrenched streams, vertical steps with deep scour pools; waterfalls
A	Steep, entrenched, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.	<1.4	<12	1.0 to 1.2	0.04 to 0.10	High relief. Erosional or depositional and bedrock forms. An entrenched and confined stream with cascading reaches. Frequently spaced, deep pools in associated step/pool bed morphology.
B	Moderately entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools. Very stable plan and profile, stable banks.	1.4 to 2.2	>12	>1.2	0.02 to 0.039	Moderate relief, colluvial deposition, and/or structural. Moderate entrenchment and width/depth ratio. Narrow, gently sloping valleys. Rapids predominate with scour pools.
C	Low gradient, meandering, point-bar, riffle/pool, alluvial channels with broad, well-defined floodplains.	>2.2	>12	>1.4	<0.02	Broad valleys with terraces, in association with floodplains, alluvial soils. Slightly entrenched with well-defined meandering channels. Riffle/pool bed morphology.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks.	N/A	>40	N/A	<0.04	Broad valleys with alluvium, steeper fans. Glacial debris and depositional features. Active lateral adjustment, with abundance of sediment supply. Convergence/divergence bed features, aggradational processes, and high bedload and bank erosion.

DA	Multiple channels, narrow and deep with extensive, well-vegetated floodplains and associated wetlands. Very gentle relief and highly variable sinuosities and width/depth ratios. Very stable streambanks.	>2.2	Highly variable	Highly variable	<0.005	Broad, low-gradient valleys with fine alluvium and or lacustrine soils. Multiple channel geologic control creating fine deposition with well-vegetated bars that are laterally stable with broad wetland floodplains. Very low bedload, high wash sediment loads.
E	Low gradient, meandering riffle/pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander width ratios.	>2.2	<12	>1.5	<0.02	Broad valley/meadows. Alluvial materials with floodplains. Highly sinuous with stable, well-vegetated banks. Riffle/pool morphology with very low width/depth ratios.
F	Entrenched meandering riffle/pool channel on low gradients with high width/depth ratio.	<1.4	>12	>1.4	<0.02	Entrenched in highly weathered material. Gentle gradients, with a high width/depth ratio. Meandering, laterally unstable with high bank erosion rates. Riffle/pool morphology.
G	Entrenched "gully" step/pool and low width/depth ratio on moderate gradients.	<1.4	<12	>1.2	0.02 to 0.039	Gullies step/pool morphology with moderate slopes and low width/depth ratio. Narrow valleys or deeply incised in alluvial or colluvial materials, i.e., fans or deltas. Unstable with high bank erosion rates.

[1]Entrenchment ratio – measures the degree the river channel is incised in the valley floor.
[2]Width/depth ratio – ratio of bankfull surface width to mean bankfull depth.
Source: Rosgen 1996

The river from Black Bridge to beyond the Town of Paonia cascades from an F3 to a B3c to an unstable C3. A series of channelization operations and several encroachments into the floodplain probably caused the change of stream type and reduced riparian function. Between Paonia and Hotchkiss the valley opens up into a series of terraces and mesas and reduces its slope. At this point, the river begins an abrupt transition from excessive channel scour to extreme deposition. The channel changes from a C3 to a braided D3 stream type. Just above Hotchkiss, recent channelization near an existing in-stream gravel mine constricts the river back into an unstable C3. From the Town of Hotchkiss to approximately 3 miles west of town, it alternates between a D3 and an unstable C3 stream type with numerous indications of previous channel alterations. Shortly beyond the old Chipeta Fish Hatchery the river enters another canyon and the channel returns primarily to a stable C3 stream type with improved riparian and aquatic habitat.

Aerial photos taken along the North Fork reveal the presence of historic river oxbows in areas that are now used for agriculture. The meander belt-widths of these old oxbows range from several hundred to a couple of thousand feet across, and have a radii of curvature similar to some that still exist on the river today. The presence of these meanders implies that there has been a substantial decrease in the river's sinuosity since Anglo settlement. The decrease in sinuosity translates into an increase in the average slope of the channel, which in turn has increased the river's velocity, bank shear stress, and erosion potential.

Historical knowledge of the river, combined with knowledge of the river's present channel characteristics (described above), suggests that the most probable stable form of the North Fork in the study area is a C3. As a stable C3 river, the North Fork would have increased sinuosity, an expanded floodplain, and improved composition, density and vigor of riparian vegetation.

After NFRIA collected data on the North Fork, we compared them with an extensive catalog of river morphology data compiled by David Rosgen and other local hydrologists. The goal was to understand the study reach on the North Fork in the context of other similar but stable river reaches in nearby watersheds. The comparison allowed us to quantify and classify the extent of the disturbances on the North Fork. Table 2-13 lists some of the data collected on the North Fork and compares it with the similar measurements made on other, stable C3 stream types.

The cross sections within the study reach on the North Fork vary considerably and contain different stream types at different locations. However, in general the entrenchment ratio and the pebble counts fall within the average range of stable C3 streams while the width/depth ratio, the sinuosity, and the slope have been substantially altered. Sinuosity, width/depth ratio and river slope, then, are the primary morphological variables in need of adjustment on the river.

No one type of disturbance is responsible for the existing condition of the North Fork. However, the various types of disturbances found throughout this study reach have one common denominator – they all promote(d) channelization of the river. Channelization creates a cycle of river instability, and so what began as a means to develop more riverfront land evolved into efforts to protect that land from the destructive erosive characteristics that resulted from the initial channelization. Irrigation diversions, road construction, and gravel mining also continue to channelize the river.

One of the primary consequences of channelization is the decrease or elimination of sinuosity from the river pattern. Once a river has been channelized it immediately responds by attempting to restore its meanders by building point bars and eroding banks. This process is evident throughout the study reach of the North Fork. Banks that lack their native vegetation are even more prone to erosion.

Table 2-13

Channel Characteristics of the North Fork and Other C3 Stream Types

Channel Characteristic	North Fork Study Reach	Other Stable Streams
Entrenchment ratio (ft./ft.)[1]	1.45 - 5.35 averages 2.91	2.3 –4.9 70% between 2.3 and 3.14; average 2.90
Width / Depth ratio (ft./ft.)[2]	30 – 315 averages 119	10.3 – 90.0 80% between 10.3 and 36.7 average 33.2
Sinuosity (ft./ft.)[3]	1.01 – 1.63 averages 1.23	1.2 – 2.1 40% between 1.3 and 1.5 average 1.4
Slope (ft./ft.)[4]	0.0035 – 0.0116 averages 0.0060	0.0002 – 0.0128 80% between 0.0002 and 0.0044 average 0.0037
D50 Range Pebble Count (mm)[5]	45 – 180 average 111	52 – 173 58% between 52 and 92 average 106.5

[1] Entrenchment ratio measures the degree the river channel is incised in the valley floor, [2] Width/depth ratio – ratio of bankfull surface width to mean bankfull depth, [3]Sinousity is stream segment's length over the length of the valley, [4]Slope is measurement of the water surface's gradient at bankfull flow, [5]D50 range pebble count is a measurement of the average size of the river bottom's substrate.
Sources: Crane 1997, Rosgen 1996.

NFRIA made the following recommendations based on its field evaluations and morphological data analyses. Implementation would help restore the North Fork to its stable, functional configuration.

- Create customized grazing plans for livestock producers along the North Fork. This would promote the maintenance of vigorous riparian vegetation.
- Modify in-stream gravel mining operations by conducting the following activities:

  -Develop monitoring programs that track the extent of mining-related degradation to the channel.

  -Perform bedload analyses and sediment budgets of the river above and below gravel excavation areas to quantify gravel extraction volumes.

-Establish grade control structures to prevent headcuts and channel scouring from migrating outside mining permit boundaries.

-Replace check dams along the river that do not allow transport of bedload.

-Develop alternative methods of mining that allow harvesting of gravel from the river at a rate the river supplies.

-Mine the floodplain instead of the river channel.

- Improve irrigation diversions so that they effectively divert water, but also maintain channel stability, allow bedload transport and safe passage for boaters. These improvements would increase diversion efficiency, bolster instream flows and enhance fish habitat.
- Incorporate the knowledge of stable stream dimensions, patterns and profiles into channel realignments and restoration projects.
- Develop conditions to promote establishment of additional riparian vegetation.
- Improve floodplain management by conducting the following activities:

-Restore the historic capacity of the river and its floodplain. This would help accommodate floodwaters and promote the removal or relocation of existing levees.

-Increase wetland and riparian forest habitat within the widened floodplain.

-Improve streambank stability through bioengineering techniques instead of riprap.

-If necessary, strengthen and reconstruct existing flood-control structures to protect existing high-value floodplain uses, such as high value agricultural lands and existing residential and commercial buildings.

-Re-assess Paonia Reservoir to ensure efficient, reliable, and prudent use of its storage capacity.

-Revise floodplain mapping to accurately portray limits of potential flooding.

-Discourage new developments within floodplains, wetlands and tributary floodplains.

-Ensure that new buildings in floodplains are designed and constructed to resist flood damage.

-Educate the community on the risks of living, working, or farming in flood-prone areas.

-Provide assistance to those who are willing to relocate out of a floodplain.

-Use acquisition and easement programs to restore historical wetlands and floodplain acreage.

- Implement a program that educates the public on river channel cause and effect relationships, the costs and benefits of natural river stabilization techniques. Inform riverfront landowners as to what they can do individually to enhance the river's condition.

Water Quality

The Water Quality Control Division (WQCD) of the Colorado Department of Public Health and Environment (CDPHE) is responsible for protecting water quality and implementing Federal and State water quality control programs in Colorado. One of WQCD's primary regulatory responsibilities is to implement the stream use classifications and numeric standards established by the Water Quality Control Commission (WQCC).

In Colorado, all surface waters except ditches and other manmade conveyance structures can be classified according to their presently suitable beneficial uses (and also presently intended suitable uses). Table 2-14 describes existing surface water classifications. Each surface water classification has associated water quality standards. Water quality standards are narrative and/or numeric restrictions applied to state surface waters to protect one or more beneficial use. For example, a stream segment classified as aquatic life class 1 shall maintain a dissolved oxygen concentration of 6.0 milligrams per liter. Stream segment classifications are displayed in Table 2-14. Table 2-15 shows use classifications for stream segments in the North Fork watershed.

When data shows no evidence of exceeding water quality standards, a segment is said to be "fully supporting" its designated uses. Segments are designated as "impaired" if they are not meeting standards. The CDPHE identifies impaired water bodies based on an evaluation of biological, chemical, or physical data that demonstrate numeric or narrative standards violations, use impairment, or declining trends in water quality or biotic communities.

If stream segments are impaired, they are placed on the Clean Water Act Section 303(d) list, which sets and prioritizes water quality improvement goals. There are several stream segments in the North Fork watershed that are impaired. Leroux, Jay, Terror, Hubbard, and Minnesota creeks exceed water quality standards for selenium from the U.S. Forest Service boundary down to the North Fork (CDPHE 1998).

TABLE 2-14
Surface Water Classification

Primary Class	Subcategory	Description
Recreation	Class 1 Primary Contact	Surface waters suitable or intended to become suitable for recreational activities in or on the water when ingestion of small quantities of water is likely.
Recreation	Class 2 Secondary Contact	Surface waters suitable or intended to become suitable for recreational uses on or about the water, which are not included in the primary contact subcategory, including but not limited to fishing and other streamside or lakeside recreation.
Agriculture		Surface waters suitable or intended to become suitable for irrigation of crops usually grown in Colorado and which are not hazardous as water for livestock.
Aquatic Life	Class 1 Cold Water	Surface waters that (1) currently are capable of sustaining a wide variety of cold water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions.
Aquatic Life	Class 1 Warm Water	Surface waters that (1) currently are capable of sustaining a wide variety of warm water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions.
Aquatic Life	Class 2 Cold & Warm Water	Surface waters that are not capable of sustaining a wide variety of cold or warm water biota, including sensitive species, due to physical habitat, water flows or levels, or uncorrectable water quality conditions that result in substantial impairment of the abundance and diversity of species.
Domestic Water Supply		Surface waters suitable or intended to become suitable for potable water supplies. After receiving standard treatment, these waters will meet Colorado drinking water regulations and any revisions, amendments, or supplements thereto.
Wetlands		Do not apply to constructed wetlands. Compensatory wetlands shall have the classifications of the stream segment in which they are located. Created wetlands shall be initially unclassified, and shall be subject only to narrative standards. Tributary wetlands shall be considered tributaries of the surface water segment to which they are most directly connected and shall be subject to interim classifications. Wetland functions that may warrant site-specific protection include ground water recharge of discharge, flood flow alteration, sediment stabilization, sediment or other pollutant retention, nutrient removal or transformation, biological diversity or uniqueness, wildlife diversity or abundance, aquatic life diversity or abundance, and recreation.

Qualifiers may be appended to any classification to indicate special considerations.
Source: CDPHE 1999.

The WQCD also identifies stream segments where water quality is suspect. Typically, these stream segments do not meet the credible data criteria that would qualify them for a 303(d) listing. Instead, they are placed on a monitoring and evaluation list that preserves and acknowledges suspicions, and over time, addresses the water quality uncertainty. The North Fork from Paonia Reservoir to the Black Bridge (4175 Driver) has been placed on the monitoring and evaluation list for manganese, selenium, ammonia and fecal coliform.

Several reports have been written by other resource agencies related to specific water quality issues. These studies are summarized in Table 2-16 and cited in the reference section of this report.

TABLE 2-15
North Fork Stream Segment Classifications

Stream Segment Description	Classification
1) All tributaries to North Fork including all lakes, reservoirs, and wetlands within the West Elk and Ragged Wilderness Areas	Aq Life Cold 1 Recreation 1 Water Supply Agriculture
2) Mainstem of North Fork from the outlet of Paonia Reservoir to Black Bridge (4175 Drive)	Aq Life Cold 1 Recreation 1 Water Supply Agriculture
3) Mainstem of North Fork from Black Bridge (4175 Drive) to confluence with Gunnison River	Aq Life Cold 1 Recreation 2 Agriculture
4) All tributaries to North Fork including all lakes, reservoirs, and wetlands from the source of Muddy Creek to a point immediately below the confluence with Coal Creek; all tributaries to North Fork including all lakes, reservoirs, and wetlands, including Grand Mesa Lakes which are on national forest lands, except specific listing in Segments 1 and 7.	Aq Life Cold 1 Recreation 1 Water Supply Agriculture
5) Mainstems of Hubbard Creek, Terror Creek, Minnesota Creek, and Leroux Creek from their boundary with national forest land to their confluences with the North Fork; mainstem of Jay Creek from its source to its confluence with the North Fork; mainstem of West Roatcap Creek from its source to its confluence with Roatcap Creek	Aq Life Cold 1 Recreation 1 Water Supply Agriculture
6) All tributaries to the North Fork including lakes, reservoirs, and wetlands which are not on national forest lands, except for specific listings in Segments 4,5, and 7.	Aq Life Warm 1 Recreation 2 Water Supply Agriculture
7) Paonia Reservoir	Aq Life Cold 1 Recreation 1 Water Supply Agriculture

Source: CDPHE 1999

TABLE 2-16
Summary of Water Quality Reports

Report	Stream Segment	Water Quality Parameter	Primary Conclusions
Detailed Study of Selenium and Other Constituents in Water Bottom Sediment, Soil, Alfalfa, and Biota Associated with Irrigation Drainage in the Uncompahgre Project Area and in the Grand Valley, West-Central Colorado, 1991-93 (USGS 1996)	North Fork, Gunnison Uncompahgre Colorado	Selenium	• Selenium concentrations for soils derived from Mancos Shale were 10 to 13 times greater than the geometric mean for soils in the Western United States. • The highest concentrations of dissolved selenium were in ground water from wells in alluvium overlying Mancos Shale. • About 64% of the samples from the Gunnison River exceeded EPA's aquatic life water quality criterion of 5 μg/L. • The eastern side of the Uncompahgre Irrigation Project is the primary source of selenium loading from the Uncompahgre Irrigation Project. • Selenium concentrations exceeded 5 μg/L in almost all surface-water samples collected from the eastern side of the Uncompahgre Irrigation Project during non-irrigation season. • The largest selenium concentrations in surface water in the Uncompahgre Irrigation Project were in Loutsenhizer Arroyo Basin and in the area between Garnet Canal and Peach Valley Arroyo. • Most of the selenium concentrations in bottom sediment samples exceeded the level of concern for fish and wildlife. • 71% of the fish samples from the Gunnison and North Fork Rivers exceeded selenium guidelines for whole-body fish. • The biggest bioaccumulation factors of selenium in the study area were from water to biota. • Selenium probably is not a human health concern in the study area.
Effects of a Coal Mine Discharge on the Upper North Fork of the Gunnison River: Assessment of Aquatic Impairment (Hoffmeister 1996)	Upper North Fork	Invert.	• The impact of the Somerset mine discharge on the upper North Fork is not significant. • Invertebrate indices that incorporate tolerance/intolerance factors are the most effective (as opposed to measurement of diversity alone). • The Hilschoff index indicates that the upper North Fork's biota was impacted before coal mining. • The overall quality of the stream agrees with the current class III rating of the river. While local physical habitats are good to excellent by EPA standards and the stream is productive, the effects of long-term, low level impacts from highways, railroads, reservoirs, and coal mining are suspected to have lowered the overall aquatic health of the stream.
Effects of a Landslide Complex on Sediment Discharges and Loads in the Muddy Creek Drainage Basin and	Muddy Creek	Sediment	• On average, an estimated of 470 tons of sediment are delivered daily to Paonia Reservoir. • Paonia Reservoir trapped an estimated 90% and 83% of Muddy Creek's sediment during two measured time periods.

Deposition into Paonia Reservoir, West-Central Colorado, 1986-87 (USGS 1991)			• Before the onset of a large landslide above the dam, 2,100 acre-feet of storage had already been lost in Paonia Reservoir due to sediment deposition. • Total sediment load to Paonia Reservoir increased by an estimated 210 tons per day right after the landslide.
Surface Water Quality Characteristics in the Upper North Fork Gunnison River Basin, Colorado (USGS 1987)	North Fork, tributaries above Paonia	Dissolved-solids, Trace elements, Sediment	• Dissolved-solids concentration and specific-conductance values were low for the study area. • The North Fork showed the largest mean suspended sediment discharges. • The study appeared to have relatively large total-iron concentrations compared to other measured trace elements. • Mean suspended-sediment concentration and mean total trace-element concentrations decreased by an average of 67% between inflow and outflow of Paonia Reservoir.

Town of Somerset Sewage Disposal Issues

One of the water quality concerns on the North Fork today involves sewage treatment in the town of Somerset. The following summarizes the issues related to this problem:

Prior to 1993, the town of Somerset had no central system for handling its sewage. Typical handling of sewage included direct discharge into the North Fork, discharge to the river via 55-gallon drums, etc. Very few leach fields existed.

In the late 1980s, the Colorado Water Quality Control Division (WQCD) and the Colorado Department of Local Affairs (DOLA) looked into funding a central treatment system for the town to resolve the unsanitary conditions. It was determined at that time that a collection system and central treatment system were not feasible. The average price of a home in Somerset at that time was between $20,000 and $30,000, and the cost for this type of system would have run at least $30,000 per home.

The decision was to sewer as much of the town as possible, and work at improving the individual systems in the remaining portion of the town. A site approval for the system was signed in 1992, and DOLA awarded a grant to Somerset to pay for this “temporary” resolution to the problem. This turned out to include a central system for most of the western half of the town. The sewage was collected and transmitted to a central Individual Sewage Disposal System (ISDS) with a leach field. In this system, about one half of Somerset’s 50 homes are connected to the central system, and the other half are on the ISDS.

According to CDPHE, the central system is somewhat effective, but is not a permanent fix to the problem. ISDS systems on the east side of town have been improved, but there is still room for further improvement. Gunnison County has been working with residents in the eastern portion of town to improve conditions there.

However, there have been reports from the public of strong sewage odors near the river, and of existing pipes draining to the river from the east end of town. There are also reports of other problems with the system, including central system failure, and horses and cows grazing on the leach field.

Feasibility issues today are not dramatically different than they were in 1992. It is still very expensive to fix this problem, given the limited number of homes that a central system would serve. The WQCD has been in discussions recently with Gunnison County concerning this issue (Beley 2000).

Oxbow and West Elk mines have indicated a willingness to actively participate in a solution to the problem. NFRIA will work with all interested parties to develop a collaborative solution to the problem.

Fisheries

A 1999 Bureau of Land Management study describes the North Fork fisheries as follows: Game fish species in the North Fork include rainbow trout, brown trout, cutthroat trout, and brook trout. Rainbow, brown, and cutthroat trout were stocked in the North Fork from 1973 through 1995. Rainbow trout and brown trout are usually the most abundant game fish species, however, low to average numbers of trout were collected during a survey conducted by the Colorado Division of Wildlife. Other game fish species, such as northern pike and green sunfish, occur sporadically and in low numbers. (They were stocked in Paonia Reservoir in xx and have since migrated to other hospitable areas.) Native species collected in the North Fork include roundtail chub, bluehead sucker, flannelmouth sucker, speckled dace, longnose dace, and mottled sculpin.

The flannelmouth and bluehead suckers are found in a variety of channel habitats, including riffles, pools, runs, and backwater areas in larger streams and rivers. These species generally choose channels with minimal vegetation, moderate to high turbidities, and high spring flows. Channel depths range from about 1 to 6 feet, with substrates consisting of rocks, gravel, or mud.

Roundtail chub inhabit pools, eddies, runs, and riffles in medium to large rivers. Adults prefer pools associated with undercut banks and other types of cover, while young fish inhabit shallower water with lower flows. All age groups prefer cobble-rubble, sand-cobble, or sand-gravel substrates. Runs and riffles are used primarily during feeding periods.

Habitat and water quality conditions in the North Fork could support bigger trout populations. The general types of habitat present in the North Fork below Hubbard and Terror creeks include a mixture of long runs and smaller riffles and pools. In wider sections of the river, the channel is braided with islands and side-channels. Fish cover is provided mainly by in-stream substrate and other structures. Factors that limit the quality of aquatic habitat include low summer flows due to irrigation diversions, return irrigation flows, siltation, general lack of cover, and disturbance by livestock.

Table 2-17 lists the occurrence of fish species in various streams in the North Fork watershed.

Table 2-17
Fish Species Occurrence in Selected Streams Segments

Common Name	Status	Trib 1	Trib2	North Fork
Trout				
Cutthroat trout	Game fish			√
Rainbow trout	Game fish			√
Brown trout	Game fish			√
Brook trout	Game fish			√
Pike				
Northern pile	Game fish			√
Carp/Minnows				
Humpback chub	Federally endangered, Colorado endangered			
Roundtail chub	Colorado special concern, BLM special concern			√
Red shiner	Introduced nongame			
Carp	Introduced nongame			
Sand shiner	Introduced nongame			
Flathead minnow	Introduced nongame			
Colorado pikeminnow	Federally endangered, Colorado endangered			
Longnose dace	Native nongame			√
Razorback sucker	Native nongame			√
Suckers				
White sucker	Introduced nongame			√
Bluehead sucker	Colorado special concern, BLM special concern			√
Flannelmouth sucker	Colorado special concern, BLM special concern			√
Razorback sucker	Federally endangered, Colorado endangered			
Catfishes				
Black bullhead	Game fish			
Channel catfish	Game fish			
Sunfishes				
Green sunfish	Game fish			√
Smallmouth bass	Game fish			
Largemouth bass	Game fish			
Sculpins	Native nongame			√

Source: BLM 1999

Wildlife

Riparian zones are the most species-diverse wildlife habitats in Colorado, providing some or all of the habitat requirements for about 75% of the state's wildlife. Wildlife habitat within riparian areas varies depending on plant species composition, woodland and shrubland structural characteristics, climate, geologic substrate, surface water regime, adjacent upland habitat type, and level of past and present disturbance. Consequently, different areas support a unique assemblage of wildlife species.

The diverse riparian and canyon habitats of the North Fork support a wide range of wildlife species. Over 200 species of vertebrate wildlife that are present as yearlong residents, summer breeders, or winter residents. Riparian habitats are essential for many species such as frogs and toads, beaver, muskrat, waterfowl, and wading birds.

In the arid landscape surrounding the North Fork, riparian zones provide the most significant stands of forest and heavy brush. These areas provide crucial breeding and resting habitat for hawks, eagles, and owls, as well as foraging areas for carnivores and omnivores such as coyote, red fox, striped and spotted skunks, and long-tailed weasels. With few exceptions, riparian areas of the North Fork support a far greater biomass of rodents, shrews, rabbits, and songbirds than surrounding arid landscapes.

Many more species, particularly birds and bats, use the area during passage migration. Many more species of invertebrates also occur and are important to the organization of ecological communities.

Species of Concern

The seven wildlife species listed in the Table 2-18 occur as residents or migrants of the North Fork's riparian zones. Northern leopard frogs are widespread in Colorado, but population declines in many areas have been attributed to river diversions, wetland degradation, and predation by introduced bullfrogs and predatory fish (Hammerson 1999). Small populations of leopard frogs occur along the North Fork and along principal tributaries.

Populations of American peregrine falcons seriously declined throughout North America due to widespread use of the pesticide DDT. Peregrine populations have partly recovered following a continental ban on DDT and extensive recovery work. American peregrine falcons were removed from federally threatened status in 1999, although the species is still considered sensitive. Peregrine falcons nest on ledges of tall vertical cliffs of river canyons and other rock faces. At least one recent nest site is known near Crawford. Peregrine falcons' prey — swifts, swallows, doves, and waterfowl — all depend heavily on aquatic or riparian habitats for foraging, nesting, or roosting. Riparian areas are especially important in attracting the spring migrant birds that are peregrine's prey during the early nesting season.

TABLE 2-18
Wildlife Species of Concern

Common Name (*Scientific Name)*	**Status**
Northern leopard frog (*Rana pipiens)*	Colorado species of concern
Peregrine falcon (*Falco peregrinus anatum)*	Colorado species of concern
Whooping crane (*Grus americana tabida)*	Federally endangered Colorado endangered
Southwestern willow flycatcher (*Empidonax traillii extimus)*	Federally endangered Colorado endangered
Bald eagle (*Haliaeetus leucocephalus)*	Federally threatened Colorado threatened
Sandhill crane (*Grus canadensis)*	Colorado species of concern
River otter (*Lutra canadensis)*	Colorado endangered

Whooping cranes are very rare spring and fall migrants in the study area, accompanying flocks of more common greater sandhill cranes on their long migratory flights between breeding areas in Idaho and Montana and wintering areas in New Mexico. Migration stopover habitat is critical for the federally endangered whooping cranes and state sensitive sandhill cranes, which need to rest and replenish vital energy reserves. Fruitgrowers Reservoir near Eckert, a few miles from the North Fork, is a significant stopover point for several thousand cranes each spring and fall. River-associated wetlands and floodplain agricultural fields in the study area also provide occasional stopover points for migrating cranes, which can forage and rest in fields sheltered from excessive human disturbance.

Willow flycatchers are neotropical migrant songbirds that breed in dense willow clumps or similar riparian vegetation throughout much of North America. The southwestern subspecies has experienced severe declines in recent decades due to degradation of riparian habitat and increased nest parasitism by brown-headed cowbirds, which thrive in rural agricultural areas. Most of the subspecies' known breeding sites are along the Gunnison River west of Delta. In recent years, one to several pairs nested each year in the Escalante State Wildlife Area's dense thickets of willow, tamarisk, Russian olive, and cottonwood.

More than a thousand bald eagles winter in the lower river valleys of Colorado (Andrews 1992). They arrive by late November from breeding areas in the northern Rocky Mountains and usually stay through late March or early April. About 100 bald eagles winter above Paonia downstream to Grand Junction. Major concentrations occur on the North Fork below Hotchkiss. Bald eagles prefer wide valleys with well-developed cottonwood stands (Figure 2-11). They roost in tall trees that occur primarily in extensive groves of mature cottonwoods. During daylight hours, Bald eagles forage widely for carrion, fish, and waterfowl.

Bald eagles also nest in Colorado in very low numbers in summer, using large stick platform nests constructed in tall trees. Nesting numbers are gradually increasing in Colorado as continental populations continue to build. Nesting habitat is common where riparian stands of cottonwoods occur in areas free from human disturbance.

River otters were once widespread in most Colorado rivers, but by the early 1900s otters had been extirpated from the state. Unregulated trapping, water depletions, and decimation of fish populations all contributed to the declines. A reintroduction effort in the 1970s restored river otters to the Gunnison River above the confluence with the North Fork. Otters have since colonized downstream. However, otters are still relatively uncommon throughout the watershed, and they probably reach their greatest density in the Gunnison River from the North Fork confluence downstream to Escalante Creek. River otters require diverse and abundant prey and densely vegetated riverbanks habitat for denning. They are wide-ranging carnivores that eat fish, crayfish, and other small aquatic animals. They dig dens in earth riverbanks, sometimes utilizing old beaver dens or other natural tunnels.

<u>Game Species</u>

Big game species in the project area include mule deer, elk, black bear, and mountain lion. Riparian zones provide essential hiding and thermal cover, browse, and drinking water for deer in all seasons. Deer density is greatest in wide valleys where the riparian strand is widest, and where the cottonwood woodland is well developed and mixed in with extensive understory shrubbery and irrigated agricultural lands. Optimum habitat quality is reached when good vegetation characteristics coincide with areas where deer experience minimum disturbance from human developments and dogs.

Large numbers of deer summering at higher elevations join the resident deer in the valleys during the winter. They migrate down to the valleys to escape deep snows and to find forage. Critical mule deer winter range (areas where greatest numbers of deer concentrate during winter weather) exists along the North Fork from Hotchkiss to the Gunnison River confluence (Figure 2-12). Wintering deer rely primarily on upland shrubs for browse, but they find hiding and thermal cover in riparian vegetation. In early spring, deer browse more heavily in riparian areas, which are often the first to green up and grow higher quality food. This first source of nutritional food is especially important for pregnant females: Current Colorado Division of Wildlife (CDOW) research on the Uncompahgre Plateau suggests that spring season nutritional deficiencies may be the leading factor in Uncompahgre Plateau mule deer declines (Watkins 2000).

Elk are winter residents of the North Fork Valley. They summer in mountain forests and migrate to the valleys from about late November to April. The extent and timing of migration varies from year to year depending on the severity of winter conditions. The entire North Fork valley is considered elk wintering range, and elk severe winter range and migration corridors occur above Somerset

(Figure 2-12). The wintering elk primarily occupy upland slopes, but they make some use of riparian zones for hiding and thermal cover, foraging, and drinking water. Like mule deer, elk prefer riparian areas with extensive cottonwood woodlands and shrub lands adjacent to agricultural fields.

Black bears and mountain lions occur widely throughout the North Fork watershed. Black bears are highly opportunistic omnivores, roaming widely to find seasonally shifting food resources and hibernating in winter to avoid food scarcity (Beck 1991). Bears do not permanently occupy the North Fork or Lower Gunnison riparian zones, but frequently wander there from adjacent uplands, searching for berry crops, rodents, or carrion.

Mountain lions also roam very large home ranges, often moving with herds of deer, their primary prey in this region. Mountain lions occur throughout the riparian zones in all seasons. In addition to providing forage, riparian areas provide important cover and travel corridors for bears and lions attempting to move through the settled valleys.

Riparian zones provide critical waterfowl nesting habitat in grassy and brushy sites up to one half mile from open water (Boyle 1998). Canada geese and mallards nest along the rivers, reaching their greatest density in the wider valleys. Common mergansers are nearly as wide spread, favoring canyons and upper reaches of rivers more than dabbling ducks and geese. Cinnamon teal and green-winged teal are less common breeders in the same valleys. Geese often favor mid-channel island nest sites to avoid predation on their more conspicuous nests (Winn 1998). In winter, the Gunnison Valley also provides one of the principal waterfowl wintering areas in western Colorado (Figure 2-11). Perhaps a thousand Canada geese and a few thousand dabbling ducks of several species winter on the river and in associated marshes, finding cover in open water and feeding in agricultural fields and grassy riparian areas. Optimum winter habitat combines slow flowing or standing open water with nearby agricultural fields and dense riparian vegetation free from excessive human disturbance.

Chukars inhabit arid canyon slopes and dry brushy bottoms along the Gunnison River above the Orchard City area and in the canyons below Roubideau Creek (Figure 2-13). Chukars forage in upland desert shrub lands but also seek forage and cover in tall greasewood or saltbush stands occurring in silty bottoms adjacent to riparian zones (Dexter 1998a). Chukars require daily water in summer and often visit riparian areas to drink.

Ring-necked pheasants are common in riparian areas from near Paonia to Roubideau Creek (Figure 2-13), especially in riverside marshes and where riparian areas with heavy shrub cover lie adjacent to irrigated farmland. Riparian areas provide pheasants with year round forage and cover for nesting and escaping predators or rough weather (Kuenning 1998). Riparian areas and wetland margins are especially critical in winter when agricultural lands are largely bare.

Gambel's quail are common in the riparian zones of the North Fork from Paonia downstream (Levad 1998). These introduced quail occupy heavy brush along rivers and streams, favoring skunkbrush thickets and tall greasewood stands.

<u>Other Significant Wildlife and Habitat Features</u>
The North Fork valley provides other benefits for wildlife. Great blue herons are resident in the valleys, breeding in communal nesting colonies in tall cottonwood groves. Nest sites require freedom from human disturbance and proximity to feeding areas along rivers and larger reservoirs. Breeding colonies occur on the North Fork near Hotchkiss (Figure 2-11). The colonies occupy extensive stands of mature cottonwoods well isolated from excessive human disturbance.

Significant off-river wetlands occur within the North Fork valley bottom. These include developed and undeveloped ponds and channel sloughs surrounded by marshes of emergent plants (plants growing in standing water), such as cattail and bulrush. These wetlands, rare in the otherwise arid valleys of western Colorado, provide critical habitat for obligate wetland wildlife species such as amphibians, waterfowl, rails, herons, and songbirds, such as marsh wrens and common yellowthroats.

The North Fork flows through agricultural or urban areas where natural wildlife habitats have been heavily altered or eliminated by human land uses. In these areas, the remaining linear strands of relatively natural riparian vegetation provide important connections between patches of remnant habitat. This facilitate movement of animals reduces the negative effects of human-caused habitat fragmentation on wildlife survival. The importance of riparian areas as wildlife corridors will increase as human growth further fragments and alters animal habitats (and especially habitat used by larger, wide-ranging animals such as mountain lion and bear) in the valleys.

Avian species richness, expressed as the number of avian species present per mile of riparian habitat, reveals areas of high bird species diversity. When avian species richness is high, it suggests that the area has a great diversity of bird habitat type, good vegetation development and complex vegetative structure. A recent avian survey downstream from Hotchkiss (Dexter 1998b) found the highest avian species richness along the North Fork for several miles below Hotchkiss, where riparian cottonwood forests are most extensive (Figure 2-11). The survey found up to 41 bird species per mile in these areas, compared to as few as six species per mile in areas where riparian vegetation is much less developed. The riparian forests downstream from Hotchkiss are large, spatially patchy, and contain high levels of vertical integration with a diverse mix of shrub species and understory plants and a range of tree age classes including old trees and snags.

Chapter summary

This chapter identified and described most of the water quality problems in the North Fork watershed. The following is a summary of these issues, how they affect specific aspects of water quality, their potential causes, and suggestions that have been made to improve conditions.

Problem: The river is structurally unstable.

Causes:

- Historic channelization.
- Use of temporary irrigation diversions.
- In-stream gravel mining.
- Poor grazing practices.

Impacts to water quality:

- Increased erosion of valuable agricultural lands and other riverside property.
- Increased levels of sediment in the river.
- Continued loss of riparian vegetation.
- Entrenchment of the river, which reduces the ability of the river to deposit silt on the floodplain and thereby impedes recruitment of new riparian vegetation and decreases the ability of the floodplain to dissipate flood energy.
- Lowered alluvial ground water table.

Potential solutions:

- Increase the river's sinuosity through channel restoration projects.
- Re-connect the river with its floodplain through river channel restoration projects.
- Construct permanent irrigation diversions.
- Reform in-stream gravel mining practices.
- Reform grazing practices.
- Encourage re-establishment of native woody vegetation.

Problem: In-stream flows, especially near the town of Paonia, are low to intermittent during the summer.

Causes:

- Inefficient diversion of irrigation water.

Impacts to water quality:

- Loss of habitat for aquatic life.
- Increased water temperature in certain stream segments

Potential Solutions:

- Replace irrigation diversions to increase in-stream flows by diverting only the decreed amount and keeping the rest in the stream.
- Promote water conservation by reforming Colorado water law.

Problem: Paonia Reservoir is filling with sediment.

Causes:

- Natural sediment influxes to the upper watershed.

- ❖ Landslides near the reservoir.

Impacts to the watershed:

- ❖ Shrinking storage capacity for irrigation and flood control.

Potential Solutions:

- ❖ Study Paonia Reservoir and it's effects on sediment regimes downstream.
- ❖ Develop a sediment reduction plan for the reservoir.
- ❖ Decrease sediment input at the source.

Problem: Flood damage in the valley has increased.

Causes:

- ❖ Channelization of the river has cut the river off from its floodplain.
- ❖ Development in the floodplain.
- ❖ Destruction of riparian vegetation and wetlands.

Impacts to water quality:

- ❖ Increased bank erosion and loss of property.
- ❖ Increased taxpayer expense for flood control and flood damage.
- ❖ Increased fine sediment loads in the river downstream.

Potential solutions:

- ❖ Promote rehabilitation of the floodplain, where possible.
- ❖ Discourage more development in the floodplain.
- ❖ Reform land use regulations in the floodplain.
- ❖ Encourage conservation or re-establishment of native riparian vegetation and wetlands.
- ❖ Protect existing developments by maintaining strategic flood-control structures.
- ❖ Revise outdated FEMA flood maps.
- ❖ Educate people about living in the floodplain.
- ❖ Enhance flood control capacity of Paonia reservoir.

Problem: Riparian vegetation has declined in acreage and vigor.

Causes:

- ❖ Development of the floodplain.
- ❖ Introduction of non-native species
- ❖ Entrenchment of the river.

Impacts to water quality:

- ❖ Loss of important wildlife habitat.
- ❖ Increased bank erosion.
- ❖ Increased sedimentation inputs into the river.

Potential solutions:

- ❖ Promote conservation of remnant healthy patches of riparian vegetation and wetlands.
- ❖ Include efforts to establish native vegetation in restoration projects.
- ❖ Stop instability of the river channel so that riparian areas are not washed away or left isolated above the water table.
- ❖ Restore connection between the river and its floodplain to encourage recruitment of native vegetation in the floodplain.

- ❖ Encourage better agricultural and grazing practices in riparian corridors

Problem: Aquatic and terrestrial wildlife have lost habitat in the river corridor.
Causes:
- ❖ Development in the floodplain.
- ❖ Invasion of weeds and non-native species.
- ❖ Decreased overall water quality.
- ❖ Structural instability of the river channel.

Potential solutions:
- ❖ Conserve remnant riparian habitat through acquisition or conservation easements.
- ❖ Improve river and floodplain function.
- ❖ Improve land-use practice.
- ❖ Restore segments of the river channel.

Problem: Some stream segments are on the evaluation and monitoring list for fecal coliform.
Causes:
- ❖ Poor wastewater management.

Impacts to water quality:
- ❖ Decreased recreational potential.
- ❖ Health hazards.

Potential solutions:
- ❖ Improve waste management for the towns of Paonia and Somerset.

Problem: Some stream segments are impaired for selenium.
Causes:
- ❖ Concentration of selenium through irrigation and leaching of selenium-bearing soils.

Impacts to water quality:
- ❖ Decreased water quality in the North Fork and downstream in the Gunnison and Colorado Rivers.
- ❖ Health of aquatic and riparian wildlife is impeded.

Potential solutions:
- ❖ Improve irrigation practices.
- ❖ Improve riparian vegetation.
- ❖ Identify plants that enhance selenium uptake.
- ❖ Construct and maintain wetlands in the floodplain.

Problem: Some stream segments are being monitored for high levels of ammonia.
Causes:
- ❖ Agricultural runoff.

Impacts to water quality:
- Impairs aquatic life.

Potential solutions:
- Encourage development of wetlands and riparian vegetation.
- Encourage good agricultural practices.

Problem: The North Fork is recognized as a major contributor of salt to the Colorado River system.

Causes:
- Irrigation runoff.

Impacts to water quality:
- Threatens endangered Colorado River basin fishes.

Potential solutions:
- Line ditches.
- Pipe irrigation waters.
- Construct wetlands.

Problem: Public access to the river is limited.

Causes:
- Private landowners are concerned with vandalism and privacy.

Impacts to water quality:
- Decreased water quality awareness.
- Limited recreational potential.
- Decreased public concern about the river.

Potential solutions:
- Work with landowners, the cities and the county to increase access.

Chapter 3: The Community's Vision

As a grassroots, community-driven organization, NFRIA is committed to involving the public in all aspects of watershed restoration. Therefore, we solicited the advice and input of the river stakeholders as we developed this restoration action plan. Chapter 3 summarizes the results of numerous community meetings. Based on the outcome of these discussions, NFRIA developed an initial framework for choosing and prioritizing future projects. The framework is included at the end of the chapter.

NFRIA's public involvement history

The first public meeting designed to gauge public sentiment about the river was held in February 1996. It was well attended, primarily by landowners and water users, and facilitated by Carl Zimmerman of the Colorado Soil Conservation Board. It was a working session designed to determine the community's perception of the North Fork's problems. By the end of the meeting, it was apparent that bank erosion, land loss, and the unpredictability of the river were the highest priority problems for the community. Other problems identified included: damage to irrigation facilities, gravel mining in the river, loss of fish and wildlife habitat, no access to the river, weed infestation, and the river's poor appearance.

Several public meetings were held after that and eventually a non-profit, grassroots, local watershed organization (NFRIA) was formed with an elected Board of Directors, articles of incorporation, and by-laws. One of NFRIA's first tasks was to hire a consultant to perform an assessment of the condition of the river and to develop recommendations for its repair. The Board obtained a grant from the EPA and the Colorado Soil Conservation Board, and the study commenced in January 1997. The results of the study were published in September of that year and made available to the community. The response to the series of recommendations was mixed but generally favorable. Most concerns centered on the issue of property rights and protection of water rights.

In March of 1998, a survey was sent out to all landowners and water users along the North Fork, again to petition the community as to the perceived problems along the river. The response was the same as the previous year, and the majority of those surveyed reiterated that they wanted to see on-the-ground restoration work done and not another study. Work then began on developing a funding strategy to construct the demonstration project (see Chapter 4). Throughout 1997 and 1998 several other public meetings were held in order to stay in touch with the community. The same general positions were again reiterated.

Community vision for the Watershed Action Plan

In November 1998, NFRIA applied for funds from the Clean Water Act's section 319 program to help with the first demonstration project. The Colorado

Department of Public Health and Environmental and the EPA denied us primarily because members of the review board suggested that a complete watershed assessment be performed before restoration occur. However, early in 1999 the Dept of Health offered to fund a watershed action plan with incremental 319 funds. The process of petitioning the community for direction and consensus was then re-energized.

On September 14 1999, NFRIA hosted a community workshop in Hotchkiss to review goals previously identified by its membership and also to work on involving the public directly in the creation of the action plan. During this meeting, which was facilitated by Daniella Howell, several questions were posed to the participants. They were first asked to identify what they regarded as the "problem" that needed to be addressed in the action plan. Then, they were asked about the scope of the plan should be, watershed decision-makers (who has veto power), key players, and sources of assistance.

Presented here is a summary of comments generated in response to these questions.

Part 1. STATE THE PROBLEM (or set of problems). Ms. Howell asked the participants "what is the problem that NFRIA's efforts should be trying to address," and, "is there a problem in the first place?"

We displayed a set of concerns that NFRIA had already expressed in various documents and meetings. Participants added, refined and expanded this set of concerns. The outcome of this brainstorming session follows:

-The river presents substantial siltation; - it is polluted with sediment; - poor channel stability; - bank erosion; - poor water quality; - poor wildlife habitat; - loss of fish habitat; loss of riparian area; - property loss; - negative effect for interest groups that utilize resources in and around the river; - lack of reliable irrigation water; - security of Paonia dam: is it stable?; - loss of beauty and aesthetics; - pressure of growth (development in flood plain and total corridor extending sewer); - not enough water in the river; - design of water rights (use it or lose it); - lack of river management plan; - mismanagement of upper areas affect people down lower; - agricultural run-off; - pollution for lack of waste treatment from Somerset; - specific actions taken by landowners and agencies in the past to protect/improve/use the river; - potential outside and non-desired intervention from agencies and interest groups (including grantors).

Part 2. SET THE GOAL. After river concerns were identified, work was done in groups to generate potential goals for the action plan. The questions for the groups were:

1) How do you want the river and watershed and environment in general to be in the long term?

2) How do you want the relationships among yourselves and with NFRIA to be / and your community at large?
3) How do you want to see the economy of this community and your activity in particular in the long term? And how do YOU want to be perceived by others in the long term?

Every member of the group answered each question, and answers were captured as said on a flip chart. The outcome of this exercise follows:

Question 1: *(how tos and specific desired "things" are placed between brackets) We want to see a nice, slow moving, meandering, clean, unencumbered river with grass and trees ; we want stream stability, a better contained river that does not change its course; a watershed that presents effective ecosystem processes; healthy, usable and sustainable river environments and riparian areas with healthy habitat for wildlife (i.e. ducks and birds sanctuary; fish) and high biological diversity; clear, pure and (abundant) water in the river/ water quality is maintained; with (fish you can eat and the Lochness Monster in it!!); we want the environment to be developed for less erosion and better overall conditions; we want to see a more responsible and conservative use of irrigation water and good irrigation systems and reliable irrigation structures in place; irrigation water diversion systems are maintained; (we want a series of ponds in high water); stable banks and an established bed/predictable channel, with the ability to flood and recede to original; we want to be able to live by the river (although this is contrary to reality); we want the river to have aesthetically pleasing environments and great scenic views and be a fun, beautiful and safe water way; we want the river to provide a wide diversity of uses (including kayak courses) and have (a little more) public access; we want to see more responsible gravel mining activities in future permit areas.*

Question 2: *We want to see the least amount of Government intervention possible; we want to meet current and future demand for traditional uses; we want to see open, honest, polite and respectful participation; caring and personal relationships; equitable and democratic communication; we want to be considerate of all consequences of our decisions for the river and others; free flow of information; we want to see us acting like a community and show we are forward thinking/focused, optimistic, hopeful, and progressive people, who can communicate and cooperate until we decide what's best for the majority; we can find solutions to challenges; we have appreciation for the past and consider historic values; we want organized communications and relations with community; we want to work for everyone's mutual benefits; NFRIA and all river users need to keep community outreach and education concerning existing resource users is important; NFRIA keeps on asking for and getting community's input; we encourage wise stewardship of rivers; we want community participation and active involvement; we want to voice planning and zoning concerns for community; we want to maintain and improve our quality of life; (NFRIA should be made up by land owners and water users); we want cooperation and* *agreements between water users and gravel companies, etc. to mitigate injury to irrigation water diversion (without eliminating gravel companies); we want to be (more) ecologically minded and socially responsible; our quality of life is most important.*

Question 3: *The area is able to sustain an economically viable community with irrigation water, mining as an income producer and also gravel companies, etc.; farming, ranching and agricultural lifestyle in general is preserved; the economy is stable, diverse, prosperous, thriving and environmentally conscious; we all appreciate recreational opportunities (such as trails everywhere possible without interfering, instead coexisting with agriculture); sustainable agriculture, mining and main street economy; we want to grow wisely by growing slowly; (middle class with few rich and few poor); local ownership and entrepreneurship (we need to shop locally); plenty of opportunities for younger generations (more things for kids to do); community resources are available and properly used.*

Question 4: *We need to protect water rights; improve water management; (develop upland water (wells/springs)); include all interests in decision-making; have continued meetings and hard-nosed planning; continued willingness to talk to others; we need problem solving efforts like this meeting; we need to spread the news; we need to treat our neighbor as we would like to be treated; we need to compromise, revise, use good science and more education and research to increase our understanding of what's going on, such as riparian management; use the holistic perspective and team work; we need to agree to disagree and be respectful of others; we need to add value to our existing resources; we need money and resources; political support; (negative publicity to keep some groups out); we need to understand the obligations required by funding sources; we need as little as possible; we want the government to be us, as opposed to grantors, funding agencies, on board members only, etc.; control over the river stays in community; members working together to develop strategy plans.*

A proposed decision-making framework

A large number of perspectives and objectives were obtained during the brainstorming sessions. The following is an effort to shape the sentiment of these comments into broad questions that NFRIA can pose to the community before developing future objectives for the watershed action plan. In order for NFRIA to take on a certain project, it would need to pass scrutiny under these questions (and the more specific considerations listed under the questions).

1. **Does the proposed action contribute to long-term, sustainable rehabilitation of the North Fork River and its adjacent corridor?**
    - Will it improve stream channel stability and predictability?
    - Will it reduce land loss?
    - Will it reduce soil erosion?

- Will it improve water quality?
- Will it improve the fishery?
- Will it improve riparian and wetland habitat?

2. **Does the proposed action contribute to maintaining a diverse and stable local economy?**
   - Is it compatible with the needs of irrigated agriculture and ranching?
   - Is it compatible with continued mining?
   - Is it compatible with other important economic activities such as recreation?

3. **Does the proposed action contribute to strengthening the community?**
   - Is it based on local decision-making?
   - Is it based on active citizen involvement?
   - Is it based on open and respectful communication?
   - Does it create unnecessary conflict?

4. **Is the proposed action based on the best available information and science?**

5. **Does the proposed action contribute to maintaining and improving our quality of life?**
   - Will our community be better off because of taking this action, now and in the long term?

Other factors suggested for inclusion in the decision-making framework are:

1. A process for prioritization of actions. What factors will be considered and with what weights of importance?
2. A matrix portraying the primary objectives of the action plan against the specific actions proposed to accomplish those objectives. What are the primary objectives?
3. A preliminary timetable. What activities should be accomplished early in the process? Which can come later?
4. A monitoring and evaluation plan. How do we assess the effectiveness of our activities? What indicators should be monitored? How do make changes, if necessary, in response to problems identified by our monitoring?

Chapter 4: Goals and Objectives

Chapter 3 illustrates the North Fork community's desire to maintain many of the traditional uses of the valley's land and streams. It's also clear that the community is increasingly aware of the importance of a healthy natural environment. Not only is the watershed a valuable and essential source of water needed for agricultural and domestic uses, it is a living system that provides much of the quality of life valued by those who live in and near the watershed. We appreciate the presence of wildlife. We enjoy our riparian cottonwood forests. We value clean water. We like to spend our free time fishing, swimming, boating, or hiking.

Within this context, there many things that can be done to improve the quality of the natural ecosystems of the watershed. This chapter spells out goals, objectives and actions that need to be implemented in order to improve the North Fork's water quality. It is a reflection of the sentiments expressed in Chapter 3. Actions proposed by other groups and agencies in the watershed are also listed. This chapter, then, is the meat of the Watershed Action Plan, and is intended to provide an initial roadmap by which NFRIA can plot a course of action for achieving community goals and objectives related to the North Fork stream corridor.

Goal 1: Improve ecosystem function and reduce the amount of valuable land lost to excessive streambank erosion.

Human activities over the years have greatly altered the manner in which the North Fork performs as a river system. Important values such as good water quality, a productive fishery, recreation, and natural beauty have been lost. Actions are needed to help return basic functionality to the river system, including restoring the active floodplain where possible.

River channel instability causes loss of lands and improvements within and adjacent to the river. At risk are such things as homes, buildings, irrigation diversion structures, roads, bridges, and water treatment facilities. Actions are needed to devise ways to protect and maintain essential human investments within the stream corridor in a manner that does not cause harm to others or to the river system itself.

Objective 1: Understand the factors that lead to instability and unpredictability of the river channel.

River systems are complex and dynamic. The North Fork has not yet adjusted to changes imposed on its natural operation. Research, analysis, and monitoring are required to understand those factors most critical to enabling the river to function in a healthier, more stable manner.

Action	Responsible Organization	Timeline	Funding Sources
Watershed Assessments	NFRIA, USFS DSCD	Completed 9/97 2/99 & 6/00	EPA,CSSCB, USFS, USBR
Paonia Reservoir sediment study	NFRIA, USBR CSU, CWCB	Completed by 2005	CWCB, USBR
Municipal wastewater treatment-Somerset	CDPHE, local governments	Completed by 2002	EPA, CDPHE Coal mines
Channel monitoring	NFRIA	On-going	CRWCD, USGS NFRIA
Watershed mapping	NFRIA	Completed by 2004	NFRIA, CWCB foundations

Desired outcome: A publicly accessible watershed database.
A science-based watershed improvement technology.

Objective 2: Develop community education and outreach.

The North Fork of the Gunnison is fundamentally important to the both the community and economy of the North Fork valley. Any actions taken that affect the North Fork need to be determined locally, with the full and active involvement of interested members of the community.

Action	Responsible Organization	Timeline	Funding Sources
NFRIA membership drives	NFRIA	On-going	NFRIA
Newsletters	NFRIA	On-going	NFRIA
Workshops	NFRIA	On-going	EPA, CSSCB
Display exhibits at community events	NFRIA	On-going	NFRIA
Presentations at local schools and civic groups	NFRIA	On-going	NFRIA
Develop web site	NFRIA	On-going	NFRIA, 319
Public meetings	NFRIA	Monthly	NFRIA
River Awareness Float	NFRIA	Annually	NFRIA, local groups

Desired outcome: Voluntary change individual land use practices.
Increased citizen participation.
Increased awareness of floodplain function.

Objective 3: Construct floodplain rehabilitation projects.

Channel instability, caused primarily by channelization of the river, has resulted in the loss of hundreds of acres of prime agricultural land. Property loss was the initial reason for the establishment of NFRIA, and bank stabilization remains the top priority for landowners along the river. Education of basic stream dynamics, voluntarily preventing further encroachment into the floodplain, establishment of riparian buffers, improved grazing practices, and assessments of the morphological condition of the river have done much to reverse well-intentioned but misguided practices along the river. However, awareness does little to repair the decades of damage. It is true that the river needs time to heal but it will not be left to its own devices until the threat of property loss does not loom so ominously. There are ways to protect private property and still allow the river plenty of room to move and meander through a well-vegetated floodplain. The removal of dikes, the construction of a geometrically well-balanced channel, the initial stabilization of high-risk outside bends, and the revegetation of an expanded floodplain will all improve the health of the river while also providing some level of comfort to previously traumatized landowners.

Action	**Responsible Organization**	**Timeline**	**Funding Sources**
Prioritize reaches for restoration	NFRIA	Completed by 2002	NFRIA
Develop landowner & funding coalitions	NFRIA	On-going	NFRIA
Rehabilitate 12 miles of river corridor	NFRIA	Completed by 2010	Agencies, foundations, corporations, NFRIA
Monitor projects	NFRIA	On-going	NFRIA, CRWCD, USGS

Desired outcome: Improved streambank stability.
Enhanced deposition of sediment on floodplain.
Improved terrestrial and aquatic wildlife habitat.
Decreased flood damage.
Improved water quality.

Objective 4: Protect environmentally sensitive and recently restored areas.

Action	**Responsible Organization**	**Timeline**	**Funding Sources**
Educate community	NFRIA	On-going	NFRIA, CSSCB
Encourage conservation of lands through easements	Three Rivers Land Trust	On-going	GOCO, CDOW
Research potential for land acquisitions	NFRIA	On-going	CDOW

Desired outcome: Long term preservation of the North Fork's unique river environments.

Objective 5: Reduce impacts of gravel mining.

NFRIA has spent a considerable amount of time and effort to understand the impacts of in-stream gravel mining. As water flows into excavated pits in the channel, erosion occurs at the upstream edge. These 'knick-points' begin to propagate and erode further and further upstream. The upstream migration of erosion is called headcutting, and in some cases it causes damage to adjacent property owners outside of the permit boundaries. The deposition of moving gravel into an excavated pit in the river may also cause channel scour immediately downstream of the mining operation. This 'hungry-water' effect happens when the gravel material moving on or near the streambed is removed, and river attempts to regain its bedload by scouring the channel immediately downstream. These impacts typical of in-stream gravel mining and also lead to the loss of riparian vegetation and function.

NFRIA is also keenly aware of the increasing demand for gravel in the community. Therefore, it is the policy of this organization to work closely with these companies to develop solutions to mitigate these impacts.

Action	**Responsible Organization**	**Timeline**	**Funding Sources**
Encourage gravel mines to mine out of the river channel.	NFRIA	On-going	NFRIA, foundations
Revise land use regulations	Delta County	Completed by 2001	Delta County
Construct grade-control structures to mitigate off-site mining impacts	NFRIA	Completed by 2010	Agencies, foundations corporations, NFRIA
Implement monitoring programs	NFRIA, DMG	On-going	NFRIA, DMG
Develop sediment budget	NFRIA	Completed by 2010	319, CSSCB, CRWCD, USGS

Desired outcome: Decreased off-site mining damage to private property and riparian habitat.
Improved water quality.

Objective 6: Improve irrigation diversions.

Agriculture is the mainstay of the economy in the North Fork and the supply of irrigation water is crucial to its development and success. The extreme instability of the channel along portions of the North Fork has caused severe damage to many important irrigation diversions. The practice of using bulldozers to construct annual gravel diversion dams has created a perpetuating cycle of channel instability that continues to lower the base elevation of the river and eventually requires moving the diversion point further upstream or lowering the ditch. The cost of constructing a permanent diversion that eliminates the need for bulldozers is generally prohibitive to the most ditch companies in the valley. NFRIA has successfully funded, designed and constructed a permanent diversion for the Smith-McKnight Ditch in Hotchkiss as part of a demonstration project (see Chapter 4). More of these types of structures can easily be constructed along the North Fork at other diversions. The following is a list of the major ditch diversions currently in need of reconstruction to improve both efficiency and habitat:

- Stewart Ditch
- Paonia Ditch
- Monitor Ditch
- Short Ditch
- Sheppard-Wilmot Ditch
- Vandiford Ditch

There are other diversions along the North Fork but the rehabilitation of these 6 diversions is the top priorities. The removal of abandoned irrigation diversions must also occur to prevent further destabilization of the river channel and remove unnecessary dangers to the public.

Action	**Responsible Organization**	**Timeline**	**Funding Sources**
Construct new head gates at diversion points	NFRIA	Completed by 2010	CRWCD, CSSCB, ditch companies
Construct low-head rock diversion structures	NFRIA	Completed by 2010	CRWCD, CSSCB, ditch companies

Desired outcome: Conservation of water resources.
Increased in-stream flows.
Elimination of bulldozers in the stream channel.

<u>Objective 7: Improve flood management within the North Fork Valley</u>

Floods are part of the dynamic nature of healthy rivers. It was the annual floods that created the rich soils that produced the prime agricultural land of the North Forth Valley. However, it was the floods that also made it so difficult for the early settlers to maintain their farms near the source of irrigation water. At that time, the only known recourse available to those farmers was to channelize the river. It was a well-meaning effort to develop the resource and contain the river.

What was not well understood at the time were the consequences of eliminating the floodplain from the river. The channelized river no longer had the opportunity to deposit its rich silt or to dissipate energy through a well-vegetated floodplain. Instead, slope and velocity increased dramatically, subsequently increasing bank erosion and property loss. Channelization created a never-ending cycle of continued and increasing maintenance.

For political, economic, and environmental reasons, the traditional approach of building levees and channelizing rivers is simply no longer viable. We are beginning to see that we must follow the river's lead and store floods on their floodplains. The implementation of the following actions will minimize the loss of life and property, save taxpayers dollars, and protect and restore important and valued natural environments.

Action	Responsible Organization	Timeline	Funding Sources
Revise floodplain mapping	Delta County	Completed by 2012	FEMA
Reform land use regulations in the floodplain	Delta County	On-going	Delta County Gunnison County
Educate the community	NFRIA	On-going	EPA, FEMA
Provide relocation assistance	FEMA	On-going	FEMA
Purchase conservation easements	Three Rivers Land Trust	On-going	GOCO, CDOW
Rehabilitate and expand the floodplain	NFRIA	Completed by 2010	319, foundations NFWF, CSSCB
Expand capacity of Paonia Reservoir	USBR	Completed by 2020	USBR, CWCB
Manage road-building and clear cutting in upper watershed	USFS	On-going	USFS
Develop SWAPs	USFS, CDPHE	Completed by 2003	CDPHE

Goal 2: Improve water quality

Objective 1: Encourage development of riparian buffers and new wetlands.

The Colorado Riparian Association refers to riparian zones as "the thin green line" because in an arid place like Colorado, they harbor the greatest abundance of vegetation and wildlife habitat despite their relatively small dimensions. Riparian areas represent only 3% of western Colorado's arid landscape, yet more than 90% of all western wildlife species depend on them. Riparian zones also provide valuable flood detention and energy dissipation benefits whenever streams overflow their banks. They can capture sediments and pollutants running off upland areas into streams and rivers, thus improving water quality. Their vegetation can stabilize banks and reduce erosion. Riparian zones along the North Fork vary widely in type, condition and degree of use. Such zones, including wetlands, are exceptionally important biologically when in a healthy, functioning condition. The following are actions that will improve the number and quality of riparian acres along the North Fork.

Action	**Responsible Organization**	**Timeline**	**Funding Sources**
Educate community	NFRIA	On-going	NFRIA, CSSCB
Promote government conservation programs	NRCS	On-going	NRCS, landowners
Construct new wetlands	NFRIA	Completed by 2010	CDOW, conservation & sport groups
Acquire conservation easements	Three Rivers Land Trust	On-going	GOCO, CDOW

Desired outcome: A minimum 50' riparian buffer between the normal high water mark and adjacent lands along the North Fork.
A 20% increase in wetlands along the North Fork.

Objective 2: Reduce pollution from municipal wastewater.

Sewage discharge into the river at Somerset has been identified as a water quality problem for the North Fork. NFRIA will work with CDPHE and Gunnison County to develop and implement a plan to treat wastewater from Somerset.

High ammonia levels at Paonia and Hotchkiss have resulted in the planning and construction of two new wastewater treatment facilities in both towns. The facility in Hotchkiss was completed in 1999 and the facility in Paonia is scheduled for construction in 2001. CDPHE classifies the reach of the North Fork from Paonia to the confluence of the mainstem the as Class 2 recreational use—a use that does not support human body contact such as swimming. NFRIA has documented many instances of swimming and boating in this section of the river and is working with CDPHE to change the classification.

Action	**Responsible Organization**	**Timeline**	**Funding Sources**
Construct new wastewater treatment facility for Paonia	Town of Paonia	Completed by 2002	Paonia, EPA
Construct wastewater treatment facility in Somerset	CDPHE	Completed by 2005	EPA, Gunnison County, coal mines

Desired outcome: Reduction in ammonia and fecal coliform levels.
Increased recreational potential.

Objective 3: Monitor water quality in the North Fork and create a source water protection plan.

A more comprehensive and systematic sampling program is needed for the North Fork and its tributaries, as well as for domestic water supplies. NFRIA wants to help establish and maintain such a program. One option is to work with the local schools and a large number of volunteers from the community to develop a community monitoring system. The River Watch program from the CDPHE was previously used at Paonia and Hotchkiss High Schools and may be brought back as one option. Karla Brown, a water quality specialist from Colorado State University Cooperative Extension, has expressed interest and tentatively agreed to help develop such a program. Funding is currently being sought from 319 to start this program.

Action	Responsible Organization	Timeline	Funding Sources
Develop WQ monitoring program	DSCD	Program in place by 2001	319, CSSCB, CSU
Identify sources and relative contributions	NFRIA	Completed by 2003	319, CDPHE, CSSCB
Develop TMDLs	CDPHE	2010	319, CDPHE
Develop SWAPs	CDPHE, local Public Water Sources	2000-2003	CDPHE

Desired outcome: Identification of water quality problems and their relative contribution to the overall health of the river. Identify possible sources of domestic water contamination.
Water quality database developed by community volunteers.

Objective 4: Reduce selenium in the tributaries of the North Fork.

Selenium concerns in the watershed are relatively new and are being addressed by the Gunnison Basin Selenium Task Force. As information becomes available, NFRIA will work with the task force to develop best management practices that will reduce selenium in the stream. The most likely course of action will be the development of new wetlands and enhanced riparian areas.

Action	Responsible Organization	Timeline	Funding Sources
Identify sources	Selenium Task Force	Completed by 2001	319, CDPHE, DSCD
Develop BMP's for selenium reduction	Selenium Task Force	Completed by 2004	319, CDPHE, CDOW USFWS, CSSCB
Develop TMDL	CDPHE, Selenium TF	2009	319, CDPHE

Desired outcome: Reduced selenium in the watershed.
Stream segments are removed from the 303(d) list.

Objective 5: Reduce sediment in the North Fork.

High sediment rates in the North Fork are primarily naturally occurring. Much of the river's load is thought to be from the Wasatch Formation high in the upper watershed's Muddy Basin. Historically, much of this sediment was deposited by the river on the floodplain between Paonia and Hotchkiss, where the valley opens up into a series of broad terraces. Paonia Reservoir now traps a considerable percentage of that sediment, but early in the runoff season the reservoir's gates remain wide open and the sediment from the Muddy Basin runs uninhibited through the reservoir and downstream to the main stem of the Gunnison River. Channelization of the river has effectively eliminated the river's ability to deposit this sediment on the floodplain and so it remains in the washload. A rehabilitation of the floodplain in the high priority area between Paonia and Hotchkiss can return that vital river function, regenerate new riparian growth in the floodplain and reduce the washload. The same rehabilitation can also stabilize highly erodible banks, further reducing sedimentation.

Action	**Responsible Organization**	**Timeline**	**Funding Sources**
Identify sources	NFRIA, CSU	Completed by 2003	319, DSCD, CSU CSSCB, CWCB
Construct floodplain rehabilitation projects	NFRIA	Completed by 2010	319, corporations, agencies, foundations

Desired outcome: Improved streambank stability.
Enhanced deposition of sediment on floodplain.
Improved terrestrial and aquatic habitat.

Objective 6: Reduce salinity to the lower Colorado River from the North Fork.

The North Fork of the Gunnison River is recognized in the Colorado Non-point Assessment Report as a major contributor of salt to the Colorado River system that includes prime habitat for endangered fish. The Delta field office of the Natural Resources Conservation Service is actively promoting cost-sharing programs to local farmers and ranchers to line irrigation ditches, improve irrigation methods, and increase riparian buffers in an effort to reduce salinity in the region. These programs also are simultaneously being used to help fund restoration efforts on the North Fork and draw increased landowner participation.

Action	Responsible Organization	Timeline	Funding Sources
Promote existing cost-sharing programs	NRCS	On-going	NRCS, landowners
Develop BMP's for salinity reduction	NRCS	On-going	NRCS

Desired outcome: Reduced salinity to the Colorado River.

Goal 3: Increase recreational potential

At present, the North Fork supports only limited in-stream recreational activity. Access is the biggest obstacle. Landowners are understandably not inclined to allow public access because of liability and vandalism. Some landowners do, however, allow access by permission. There are several isolated parcels owned by Delta County and the Towns of Paonia and Hotchkiss that also provide potential access. NFRIA intends to work with the appropriate entity to improve access by assisting local governments in securing funds and designing new facilities at existing public sites, and by identifying potential new sites. NFRIA will also work with individual landowners that voluntarily wish to provide access.

Again, efforts to restore functionality to the river will improve its usability for in-stream recreation. As the river regains a more distinctive channel with improved sinuosity and stable banks it will tend to narrow and deepen. Even with relatively low stream flows, a narrower and deeper channel may still be able to support boating and swimming uses.

Objective 1: Increase public access.

Action	Responsible Organization	Timeline	Funding Sources
Identify potential access locations	NFRIA	On-going	NFRIA
Utilize existing acquisition programs	Three Rivers Land Trust	On-going	CDOW
Purchase access easements	Three Rivers Land Trust	On-going	GOCO

Desired outcome: Additional public access.

Objective 2: Improve fisheries

The fishery potential in the North Fork and its tributaries is regarded as high. At present, however, much of the fishery is in poor condition. This is attributable to the highly altered aquatic environment caused by historic stream channelization and continued by ongoing water diversions that often dry up the channel during the summer irrigation season.

Building diversion structures similar the one for the Smith-McKnight ditch should help to reduce or eliminate the need for annual reconstruction of gravel dikes and should help irrigators leave more flow in the stream to support the fishery.

As meanders are either constructed or allowed to develop naturally by action of the unconstrained river, the channel is likely to narrow and deepen. More normal channel forms also are likely to reestablish themselves as the river is allowed to shape itself more freely. The pool-riffle combination favored by many fish species can also be constructed in appropriate locations. Healthier riparian areas are likely to provide greater vegetative cover along the streamside, helping to lower water temperatures in the summer low flow months.

The Colorado Division of Wildlife has expressed interest in working to improve the fishery of the North Fork. At present, however, CDOW is focusing its efforts elsewhere in the Gunnison Basin. NFRIA should continue to express its desire to have CDOW do a thorough evaluation of the existing fishery in the river, and should work with CDOW to develop and implement a plan for making improvements to the fishery. NFRIA will work to develop additional partnerships with groups such as Trout Unlimited and the FishAmerica Foundation.

Action	**Responsible Organization**	**Timeline**	**Funding Sources**
Perform fish habitat and population studies	CDOW	On-going	CDOW
Construct fish holding structures	NFRIA	Completed by 2010	CDOW, USFWS, NFWF
Fish stocking	CDOW	On-going	CDOW, CWHF

Desired outcome: Improved fisheries

Objective 3: Improve public safety on the river

Action	**Responsible Organization**	**Timeline**	**Funding Sources**
Remove abandoned irrigation structures	NFRIA	On-going	CWCB, foundations NFRIA
Reconstruct existing diversion structures	NFRIA	Completed by 2010	CWCB, 319, CDOW Foundations, NFRIA
Tree removal	NFRIA	On-going	NFRIA

Desired outcome: Safer recreational potential

Chapter 5: The North Fork River Demonstration Project

NFRIA's main approach to improving water quality in the North Fork watershed is to restore discreet segments of the river channel and floodplain. Though river restoration projects are not the only way the watershed's different water quality problems (summarized in Chapter 2) will be addressed, restoration projects make up the core of NFRIA's watershed restoration strategy. This is consistent with the concerns expressed by NFRIA's membership and the community at large (see Chapter 3). Improving river stability will not improve all of the water quality issues in the watershed, but it will address many of the more pressing issues. These include bank erosion, loss of property, flood control, wildlife habitat, loss of riparian vegetation, increased sedimentation, passive treatment of agricultural runoff, loss of wildlife habitat, loss of aquatic habitat, and in-stream flows.

This part of the action plan describes a restoration project that NFRIA has already completed. It illustrates NFRIA's first attempt at floodplain and river channel restoration. The North Fork River Demonstration Project will serve as a template for other future restoration projects.

Background

When NFRIA first proposed to construct a demonstration restoration project on the North Fork, a couple of technical advisors suggested that we first perform a more comprehensive evaluation of the entire watershed. Though research is a very important component of NFRIA's approach to restore the river, our Board felt that we needed on-the-ground, visible action to keep momentum for river improvement growing in the community. The Board wanted to construct a demonstration project that would show the community new and innovative technologies for floodplain rehabilitation.

Following the completion of our initial morphological assessment in 1997, then, NFRIA began a search for an appropriate place to test recommendations in the report. We investigated several sites, and eventually we found a contiguous group of willing landowners in the town of Hotchkiss. The most compelling reason for the selection of this particular site was its visibility to the public. Most of the project is clearly visible from one of two bridges that cross over the river in the 1 ½ mile project reach.

The problems at the selected site were typical to those of the 16-mile reach studied in the morphological assessment. The Smith-McKnight Ditch diversion point is located at the upstream end of the project reach, and the principal means of diverting water here was similar to several other irrigation diversions in the valley: Shortly following the spring runoff the ditch company hired a bulldozer to scrape gravel from the bottom of the channel into a diversion dam. Every year the high water washed this temporary structure away, and every year it was rebuilt. The years of bulldozing caused substantial downcutting of the channel, and by 1998 the ditch was 4 feet above the bottom of the river. The ditch company did not have the financial resources to construct a permanent structure, and so the problem simply continued to expand.

Other problems at the demonstration site, such as excessive bank erosion, were the result of channelization. Dikes constructed at the edge of the active channel cut the river off from its floodplain, straightening the river and increasing its velocity. Channel degradation and aggradation occurred at opposite ends of the project. Sediment deposition and recruitment of new riparian vegetation was dramatically reduced. Fish and wildlife habitat was substantially compromised.

The specific objectives of the 1.5 mile demonstration project were to:

- Stabilize the river channel and reduce excessive bank erosion.
- Construct a permanent low-head irrigation diversion that delivers the full decree of water, conserves water, reduces maintenance, and at the same time allows for upstream migration of fish, safe passage of recreational boats, and improved habitat.
- Enhance, expand, and protect riparian and wetland areas and improve the capability of the floodplain. This minimizes flood damage, helps retain water, and enhances silt deposition.
- Demonstrate various stabilization and re-vegetation techniques and evaluate them for use in other parts of the watershed.
- Improve fish and wildlife habitat.
- Improve water quality by reducing the amount of sediment introduced into the river, increasing the amount of washload deposited in the floodplain, and filtering agricultural runoff.
- Educate the community and other watershed groups throughout the western US.

Methods

NFRIA used a variety of methods to achieve the goals and objectives of the project. After the site was chosen, we performed a detailed survey to determine actual dimensions, patterns, and profiles of the project site. We compared that data to data obtained from more stable sites on the North Fork in order to adjust the damaged reach to replicate healthy reaches of the river. We discovered that the demonstration reach should be re-designed to increase sinuosity, reduce slope, increase the bankfull channel depth, decrease the channel width, increase the effective area of the floodplain, and stabilize the banks along outside bends.

We drafted plans for a new channel that's depth was designed to allow the river to overtop its banks and flood safely within the new expanded floodplain. In order to better fish holding areas and reduce stream velocity, the design also incorporated natural riffle/pool sequencing found in stable reaches of the river.

The new channel geometry was only one component of the site's design. Large boulders were used to further reduce high shear stresses along vulnerable banks. We dug trenches 3 to 4 feet below the toe of vulnerable banks and filled them with some of the boulders, nearly to the height of the average high water mark. The boulders were then chinked and covered with river gravel. Several bundles of willows were simultaneously planted behind these boulders to further stabilize the soil and to provide shade and habitat for fish and wildlife species. Other boulders were used to construct energy-dissipating structures known as rock veins. Rock veins are lines of large boulders placed at 20-degree angles upstream from vulnerable banks. The veins deflect energy away from the shore and reduce the potential for erosion. The rest of the boulders were used placed in random clusters in the channel to provide holding pools for fish and play waves for kayaks.

A new irrigation diversion structure was the centerpiece of the project design. This new diversion has a concrete headgate structure at the diversion point with a pipe sized to pass the full decree of water, and a slide valve to further regulate or shut off flows to the ditch. Any water above the capacity of the pipe therefore remains in the river. Thus the practice of diverting nearly the whole river during low flows and returning the undecreed portion back to the river somewhere downstream of the diversion point was eliminated. The diversion structure itself consists of a low-head weir built with large boulders and buried a minimum of 5 feet below the bottom of the channel. The height of the weir above the bottom of the channel is minimized to create sufficient head or backwater to fill the ditch and still allow fish and boats to pass up and down stream. The structure is constructed in the shape of a ‘V’ pointing upstream to reduce stress on the banks and direct the flow of the river toward the center of the channel. The new headgate and diversion eliminate the need for bulldozers in the channel and allow for a natural healing of the riparian habitat surrounding the diversion point.

Another primary component of the project was the rehabilitation of the floodplain. When we designed the new channel we made every effort to protect mature stands of cottonwoods and willows. In places where we were forced to remove them, they were carefully excavated and later transplanted to other locations. We removed existing dikes and transformed old side channels into new wetlands and backwaters, planted with a diverse mix of nursery grown native wetland species. The project added 3 acres of new wetlands to the riparian area and substantially increased fish and waterfowl habitat. The wetlands also play an important role in dissipating energy during floods and filtering runoff back to the river.

Willow cuttings were planted to stabilize the new floodplain. Student volunteers and prison crew cut several hundred bundles of willows and planted them throughout the site. We planted in several different ways in order to test different bioengineering techniques. Some vertical bundles were planted against a 2:1 cut bank and then buried with soil. Others were planted behind large toe rocks so that they hung out over the river. Some of these bundles were pruned approximately 2 feet above the ground and others were not. Additional cuttings were used to create a brush mattress, which was then installed along one bank. The mattress was secured using horizontal facines staked at the toe of the bank.

Previous studies on the North Fork indicate that native vegetation will propagate and thrive naturally where silt is allowed to deposit. Therefore, willow cuttings were also used to construct live silt fences that trap sediment during high water. Live cottonwood stakes and poles were also planted throughout the project to supplement the willows.

We completed construction of the project ahead of schedule in February 2000.

Funding

NFRIA put together a large and diverse group of partners to fund the project. The following is the list of contributing partners:

1. National Fish & Wildlife Foundation – awarded $90,000
2. Colorado Smart Growth Regional Partnership Initiative – awarded $50,000
3. Resources for Community Collaboration – awarded $2,500
4. Colorado Soil Conservation Board – awarded $23,000
5. Colorado River Water Conservation District – awarded $15,000
6. Smith-McKnight Ditch Company – cost-shared $13,000
7. FishAmerica Foundation – awarded $5,000
8. General Service Foundation – awarded $10,000
9. National Park Service, Rivers & Trails Program – awarded $24,900
10. Maki Foundation – awarded $3,000
11. Colorado Dept of Transportation – awarded $72,240 in-kind rock donations
12. Delta County – awarded $15,100 in-kind rock hauling
13. Colorado Div of Wildlife – awarded $10,000 cash for revegetation and pledged $2,000 in-kind habitat evaluation study
14. Natural Resources Conservation Service – donated $5,000 in-kind
15. Army Corps of Engineers – donated $10,000 in-kind engineering services
16. Colorado Wildlife Heritage Foundation - $5,000 for fish stocking
17. Oxbow Mining Co. – donated $5,000 cash
18. Mary McCarney/landowner – donated $6,300 in cash for surveying
19. Webb Callicutt/Delta County Weed Coordinator – donated $930 in-kind weed control
20. Curry Construction – donated $3,000 in-kind equipment services
21. Sickles Construction – donated $9,200 worth if in-kind equipment services
22. Mesa State College – offered a 1-credit college course to students for streambank bioengineering that included 32 hours of in-field implementation of bioengineering techniques. 31 students participated – approximate value = $5,200
23. Local landowners along the project applied for and received financial assistance from the NRCS' EQIP program - a total of $25,582 was applied towards the demonstration project

In total, over $410,952 was raised for the project. Of that, $280,282 was actual cash and the remaining $130,670 was donated materials or services.

Lessons Learned
The project's first big test came during spring runoff in 2000. As expected, the new channel held up very well structurally. A short section of bank (approximately 100 feet long) had some minor erosion immediately downstream of the termination of a toe rock revetment. Additional rock was later installed to stabilize that section. However, runoff was only about 83% of average, with peak flows of approximately 2500 cfs in late April. By the end of May, which is typically the time of peak flow, the river had dropped to 1000 cfs.

The drought conditions in the summer of 2000 put the irrigation diversion to a real test. In July, the flow in the river dropped to approximately 20 cfs, and the decree for the Smith-McKnight ditch calls for 10 cfs. Because of the low flows, the ditch was only consistently receiving 8 cfs. In order to divert the extra 2 cfs to the ditch, a couple of large rocks were installed at the low flow head of the weir structure. The extra rocks installed did not raise the height of the structure or impede the upstream migration of fish. The ditch company now feels very confident that the structure will deliver the necessary water for many years to come.

At the onset of the project, we felt that the willows and other bioengineered stabilizations would be most likely to fail. Several factors are involved the success rate of bioengineering techniques, including the unknown initial health of willows at the time of cutting. An initial survey of the project's plantings in June indicated an approximate overall success rate of 70%. The willows that had the most stem to soil contact and that were pruned down had the greatest success rate. The overhanging willows did not do as well. Much of the soil on the brush mattress was washed away at high water and so they did not do very well, either. The live silt fences did very well. We expected that high water would wash some of them away but this did not happen. The ends of these willow fences were almost fully submerged during the spring, but they remained in place. When the water receded, a substantial deposit of silt and debris had been trapped. By July, the willows in the fences appeared to be thriving. The cottonwood stakes and poles had a similar initial success rate.

In order to measure and monitor the site's overall success, NFRIA established a partnership with the US Geological Survey and the Colorado River Water Conservation District. Together, we established sixteen permanent cross sections that will monitor the channel for bed and bank erosion rates, vegetation density and diversity, diversion structure integrity, and habitat improvement. The findings will be recorded and published by the USGS and NFRIA and used to improve subsequent projects.

Appendix 1 – EPA's Watershed Restoration Action Strategy (WRAS) requirements and where to find them in this report.

<u>WRAS requirements</u>

1. Identify measurable environmental and programmatic goals.

Chapter 4 (pages 49-59) outlines NFRIA's goals to improve water quality in the North Fork watershed. It includes a timeline for implementation of these goals.

2. Identify sources of water pollution and the relative contribution of sources.

Chapter 2 (pages 6-43) summarizes all the data available on the North Fork's water quality, including information on water pollution and its sources. Table 2-15 summarizes all river segments which are have identified water quality problems. Table 2-16 summarizes the results of published water quality studies on the North Fork.

3. Provide information on implementing restoration measures to achieve clean water and other natural resource goals.

Chapter 4 (pages 49-59) outlines objectives for improving water quality in the watershed. Restoration work on the river is NFRIA's prerogative, and specific restoration projects are listed under Goal 1, Objectives 3 and 4, Goal 2, Objective 1, and Goal 3, Objectives 1 and 2. Chapter 5 (pages 60-65) is a summary of NFRIA's previous restoration work.

4. Provide information and schedules for implementing needed restoration measures.

Chapter 4 (pages 49-59) includes proposed restoration projects as well as time-lines for their implementation.

5. Identify appropriate lead agencies to oversee implementation, maintenance, monitoring and evaluation.

Chapter 4 (pages 49-59) identifies lead agencies for various restoration activities within the watershed.

6. Provide information on developing and/or implementing total maximum daily loads for pollutants exceeding State water quality standards.

Chapter 4, Goal 2, Objectives 3 and 4 (page 56).

7. Provide information on implementing source water assessment and protection programs.

The CDPHE is currently developing Source Water Protection Plans (SWAPs) for watersheds throughout the state. The SWAP program is described in Chapter 2, under the Domestic Water Use and Source Water Protection heading, page 15. SWAP is also mentioned in Chapter 4, Goal 2, Objective 3, page 56.

8. Provide information on monitoring and evaluation to assess progress towards achieving environmental and programmatic goals.

NFRIA is currently monitoring and evaluating previous restoration projects. These monitoring efforts are described in Chapter 5 (pages 60-65). Future restoration projects will have similar monitoring. Plans for a community water-quality monitoring program is mentioned in Chapter 4, Goal 2, Objective 3, page 56.

9. Discuss funding plans to support the implementation and maintenance of needed restoration measures.

Chapter 4 (pages 49-59) lists possible funding sources for all of NFRIA's programmatic goals. Chapter 5 discusses NFRIA's previous restoration efforts and its funders (pages 61-65).

10. Provide information on cross-agency coordination to help implement the watershed restoration strategy.

Chapter 1, page 5 discusses NFRIA's Technical Advisory Group.

11. Provide information on process for public involvement.

Chapter 3 (pages 44-48) deals entirely with the public's involvement in identifying and prioritizing watershed improvement goals.

Works Cited

Andrews, R., Righter, R., 1992. Colorado Birds: A Reference to their Distribution and Habitat. Denver Museum of Natural History, Denver, CO.

Beley, D., 2000. Lower Colorado River Watershed Coordinator, CDPHE, WQCD, personal communication.

Buckhorn Geotech, 1999. Needs Assessment for Floodplain Map Revision, Delta County, Colorado, September, 1999.

CDPHE (Colorado Department of Public Health & Environment), 1998. Status of Water Quality in Colorado, 1998. CDPHE, Water Quality Control Division, December, 1998.

CDPHE (Colorado Department of Public Health & Environment), 1999a. CDPHE – Water Quality Control Commission, Regulation No. 31, The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31). Amended: January 11, 1999.

CDPHE (Colorado Department of Public Health & Environment), 1999b.

CDWR (Colorado Department of Water Resources), 1998. Printout of the water rights report, Division 4.

CNHP (Colorado Natural Heritage Program), 2000. Riparian Assessment of the North Fork Gunnison River and Lower Gunnison River. Prepared by the CNHP, Colorado State University, Fort Collins, Colorado. February, 2000.

Colorado Climate Center, 1999. http://ulysses.atmos.colostate.edu

Crane, J., 1997. Preliminary Assessment of the Morphological Characteristics of the North Fork of the Gunnison River. September, 1997.

EPA (Environmental Protection Agency), 2000. http://oaspub.epa.gov/enviro

Dexter, C., 1998. River Survey of West-Central Colorado for Yellow-billed Cuckoo and Riparian Weeds. December, 1998. Unpublished report, Bureau of Land Management, Grand Junction, Colorado.

FEMA (Federal Emergency Management Agency), 1983. Flood Insurance Study, Delta County, Colorado, Unincorporated Areas. FEMA, September 15, 1983.

Hammerson, G.A., 1999. Amphibians and Reptiles in Colorado, second edition. University Press of Colorado and Colorado Division of Wildlife, Denver, Colorado.

Hoffmeister, S., 1996. Effects of Coal Mine Discharge on the Upper North Fork of the Gunnison River: Assessment of Aquatic Impairment. Masters Thesis, Colorado School of Mines, Golden, Colorado.

Karst, G., 2000. CDPHE Source Water Protection Specialist, personal communication, October, 2000.

Kuenning, R., 1998. Ring-necked Pheasant, pages 134-135, Colorado Breeding Atlas. Colorado Bird Atlas Partnership and Colorado Division of Wildlife, Denver, Colorado. H.E. Kingery, Editor.

Levad, R., 1998. Gambel's Quail, pages 152-153, Colorado Breeding Bird Atlas. Colorado Bird Atlas Partnership and Colorado Division of Wildlife, Denver, Colorado. H.E. Kingery, Editor.

Molacek, R., 2000. Lower Gunnison River Conservation Lands Inventory, Final Report, June, 2000. Prepared for Delta Soil Conservation District, Delta, Colorado.

NRCS (Natural Resources Conservation Service), 1997. North Fork of the Gunnison River Vegetation Survey. Unpublished report prepared for the North Fork River Improvement Association. NRCS, Grand Junction Area Office, Colorado.

Rosgen, D., 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

USBR (U.S. Bureau of Reclamation), 1956. Sedimentation Study, Paonia Reservoir, Paonia Project. Western Colorado Area Office, Upper Colorado Region, Grand Junction, Colorado, October, 1956.

USBR (U.S. Bureau of Reclamation), 1988. Paonia Project, Paonia Reservoir, Colorado, Area and Capacity Tables. Western Colorado Area Office, Upper Colorado Region, Grand Junction, Colorado.

USFS (U.S. Forest Service), 1992. Integrated Riparian Guide for the Intermountain Region.

USFWS (U.S. Fish and Wildlife Service), 1979. Classification of Wetlands and Deepwater Habitats of the United States. December, 1979.

USGS (U.S. Geological Service), 1987. Surface Water Quality Characteristics in the Upper North Fork Gunnison River Basin, Colorado, J. Michael Norris. Water-resources investigations report 86-4152.

USGS (U.S. Geological Survey), 1991. Effects of a Landslide Complex on Sediment Discharges and Loads in the Muddy Creek Drainage Basin and Deposition into Paonia Reservoir, West-Central, Colorado, 1986-1987.

USGS (U.S. Geological Survey), 1996. Detailed Study of Selenium and other Constituents in Water Bottom Sediment, Soil, Alfalfa, and Biota Associated with Irrigation Drainage in the Uncompahgre Project Area and in the Grand Valley, West-Central Colorado, 1991-1993.

USGS (U.S. Geological Survey), 1998. Water Resources Data, Colorado, Water Year 1998, Volume 2, Colorado River Basin. Water-Data Report CO-98-2.

USGS (U.S. Geological Survey), 1999. http://nwis-colo.cr.usgs.gov/historic.html

Watkins, B., 2000. Terrestrial Wildlife Biologist, Colorado Division of Wildlife, Montrose, CO. Personal Communication as cited in Molacek, 2000.