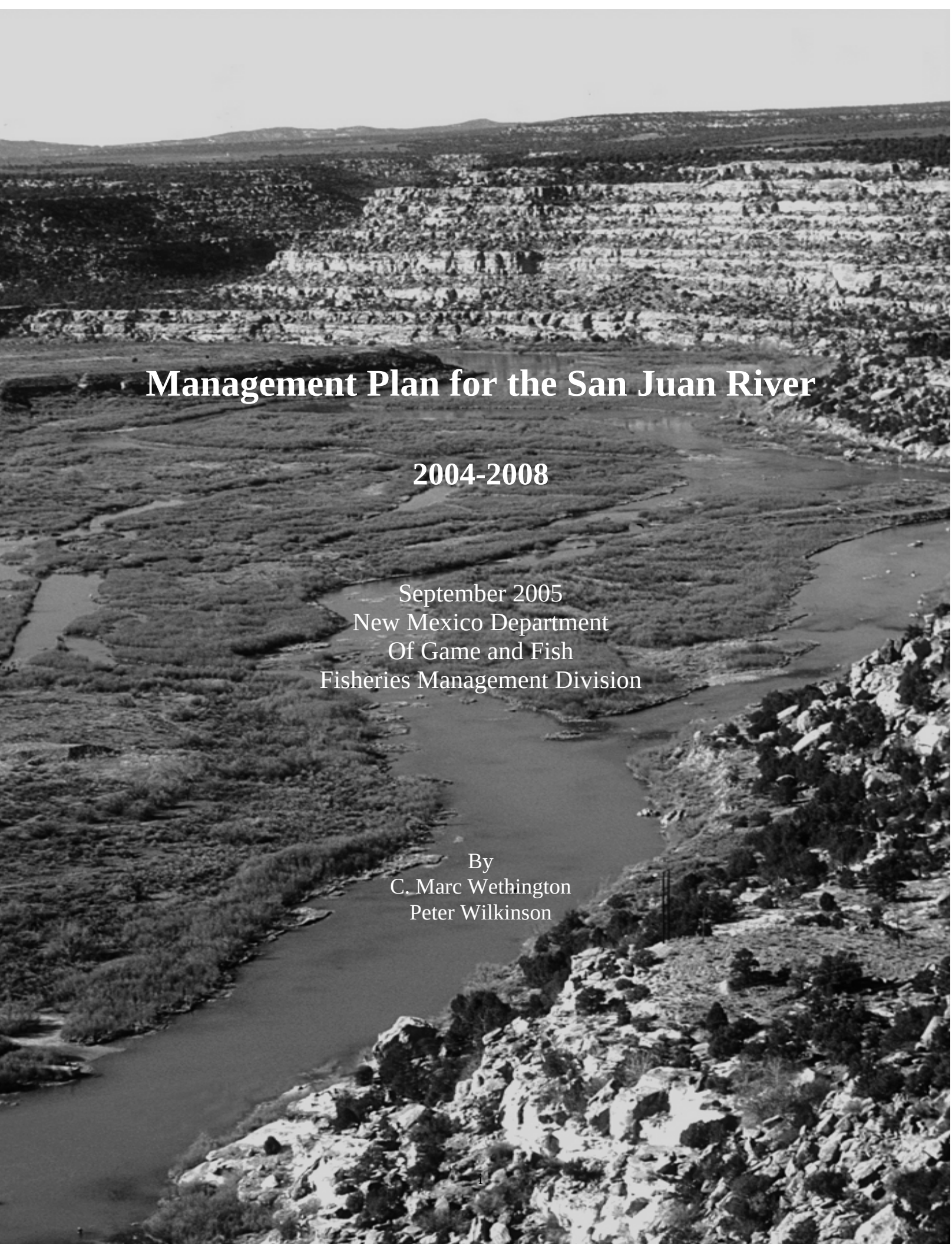

Management Plan for the San Juan River

2004-2008

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New Mexico Department
Of Game and Fish
Fisheries Management Division

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Executive Summary

Anglers from around the world travel to northwestern New Mexico specifically to fish the Special Trout Water of the San Juan River, downstream of Navajo Dam. The abundance of large rainbow trout in the fishery attracts thousands of anglers who spend an average of 217,000 angler hours per year on the river. With its international reputation and angler success, the San Juan River is without a doubt the finest trout fishery in New Mexico.

Many complex issues are involved in maintaining the world-class fishing experience currently available in the Special Trout Water of the San Juan River. Recent years have seen unprecedented changes in water releases from Navajo Dam. These flow alterations are intended to improve river conditions for Colorado pikeminnow (*Ptychocheilus lucius*) and razorback sucker (*Xyrauchen texanus*), both federally listed endangered species. Concomitant with these changes in the operation of Navajo Dam are planned future water withdrawals that will occur as part of continued water development in the basin. New Mexico Department of Game and Fish (NMDGF) seeks to define management strategies that will maintain the world-class trout fishery in the San Juan River during reoperation of Navajo Dam and expanded water development in the basin. The purpose of these new strategies is to identify informational needs critical to the scientific and social management that supports the long-term maintenance of this fishery.

Currently the US Bureau of Reclamation is developing an Environmental Impact Statement (EIS) for the reoperation (change in prior dam operations) of Navajo Reservoir to implement the flow recommendations developed by the San Juan River Biology Committee. These flow recommendations are designed to improve conditions for endangered fish downstream and allow future water development projects. There are two primary changes associated with reoperation of Navajo Dam, high spring releases (5000 cubic feet/second) to mimic natural spring runoff and lower base flows (250 cubic feet/second) to allow for additional water storage and to manage aquatic habitat downstream of the Animas River confluence. The reduction in base flow from 500 cfs to 250 cfs will reduce trout habitat by an estimated 34 percent in the Special Trout Water, increasing the need for management strategies to support long-term maintenance of the San Juan River trout fishery.

The NMDGF is developing strategies to better understand the dynamics of the fishery while working to maintain the “World-Class” fishing experience it’s known for. Stream habitat modifications along with riparian improvements are being developed to mitigate reduced flows, increase habitat, and improve the aquatic and terrestrial environment. Long-term studies have been developed to better evaluate stocking strategies, population densities, growth rates, natural reproduction, flow modifications, angler use, and many more aspects of this dynamic fishery.

The NMDGF will use this document as a tool to offer guidance for future management actions and to provide agencies, sportsmen’s groups, conservation organizations, and interested individuals an opportunity to participate in management of the San Juan River fishery in New Mexico.

There are three sections in this planning document. The first section is the Background and Situation Analysis. The second section is the Management Strategy Section that describes where we are, where we want to go, and how we will get there. The third section is the Action and Operational Plans that will provide guidance to program implementation.

TABLE OF CONTENTS

Acknowledgements

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Anglers enjoying late afternoon fishing on the San Juan River

Background and Situation Analysis Section

The headwaters of the San Juan River are located in the San Juan Mountains in southwestern Colorado. Among the headwater streams are the San Juan, Animas, Los Pinos, Piedra, and Navajo rivers. The San Juan Mountains are composed chiefly of Tertiary age rocks (Iorns et al. 1965) and soils of the San Juan River Basin have been principally developed by weathering of the underlying rocks. As a result of the arid climate, the soils are poorly developed and retain many of the geochemical characteristics of the parent rocks (Abell 1994).

The river flows south from Colorado into New Mexico, where the watercourse turns west and enters Lake Powell in Utah and the Colorado River. Navajo Dam was constructed in 1962 near the community of Archuleta, New Mexico, forming Navajo Reservoir and is part of the Colorado River Storage Project (CRSP). Prior to the construction of Navajo Dam, the San Juan River near Archuleta was a relatively warm, fluctuating, silt-laden river that supported a native fish community comprised of Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), flannelmouth sucker (*Catostomus latipinnis*), bluehead sucker (*Catostomus discobolus*), roundtail chub (*Gila robusta*), mottled sculpin (*Cottus bairdi*) and speckled dace (*Rhinichthys osculus*). Construction of the dam and subsequent filling of Navajo Reservoir provided a sediment collection basin and a cold, hypolimnetic release from the reservoir. The tailwater formed immediately below the dam changed the character of the river to a coldwater, cobble-bottomed stream that supports salmonids and a large crop of aquatic insects.

NMDGF has managed the tailwater section immediately below the reservoir as Special Trout Water since 1966. Through a series of regulation changes implemented by NMDGF, the San Juan River tailwater fishery has developed into one of the most popular trout fishing destinations in the western United States. Angler use of this fishery tripled during the period from 1987 to 1996, documenting the popularity of this tailwater trout fishery. Approximately 80 percent of these anglers fish the stream sections within the 4-mile area of the Special Trout Water located immediately below Navajo Dam.

San Juan River Trout Waters

The current management area for trout starts at the base of Navajo Dam and extends downstream17 miles to the U.S. Highway 64 bridge at Blanco, New Mexico. The upper 4 miles of the tailwater immediately below Navajo Dam is managed as Special Trout Water and will be the focus of this management plan. This section is divided into two management units, each having different fishing regulations. The first 0.25-mile section is managed with a catch-and-release fishing regulation with a tackle restriction of artificial flies and lures having a single, barbless hook. The next 3.75-mile reach has the same tackle restriction, but allows a daily bag limit of one trout with a minimum size limit of 20 inches.

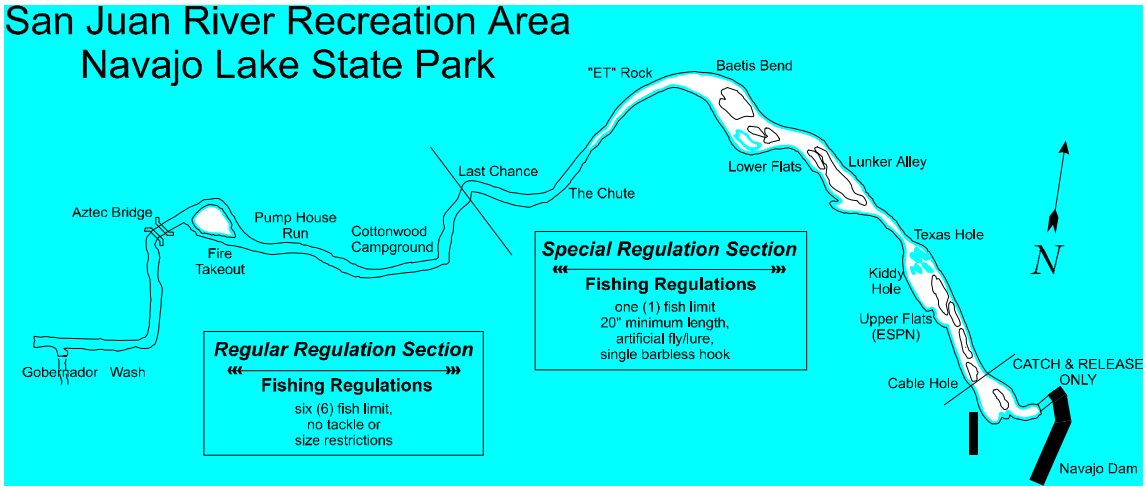


Figure 1. San Juan River Recreation Area

Immediately below the Special Trout Water section, statewide trout regulations apply. This section extends downstream approximately 3.3 miles, from the end of the Special Trout Water section to the confluence of the San Juan River and Gobernador Arroyo. In this section there are no tackle or size restrictions, and the bag limit is five trout per day. Together, the upper two sections of regulated waters (7.3 miles) provide suitable habitat for the survival and growth of trout and offer an excellent recreational fishery to the public.

The third reach, the Lower River, begins at the confluence of the San Juan River and Gobernador Arroyo and extends downstream approximately 10 miles to the U.S. Highway 64 Bridge at Blanco, New Mexico. The quality of trout habitat in this reach has improved with the higher spring releases from the dam that started in the early 1990's. These higher spring flows from Navajo Dam (5,000 cubic feet/second) simulate the natural hydrologic pattern and fluvial processes of the river basin, resulting in improved habitat that supports trout populations in the managed tailwater section.

Regular Regulation Water lies downstream from the Special Trout Water

Natural History

Rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), both non-native to the San Juan River, comprise the trout fishery and the management focus in the Special Trout Water. Both species have been stocked for years and flourish in the river below the dam. Brown trout were last stocked in 1997 and are now managed as a self-sustaining population.

Rainbow trout:

Rainbow trout are a well-known sport fish in the United States and around the world. It is a popular species with anglers because of its spectacular leaping and fighting ability. The species includes a freshwater strain, called rainbow or redband trout, and an anadromous strain referred to as steelhead.

The native range of rainbow trout are watersheds in the western United States, including the Pacific Rim from Mexico to Alaska, and extending to the eastern coast of Asia. In most cases, rainbow trout are not native east of the Continental Divide (Willers 1981).

Through extensive hatchery stockings, rainbow trout are now found in all provinces of Canada, the majority of the states within the United States, and on all continents, except Antarctica (Willers 1981). Most of the rainbow trout distributed worldwide are from stocks of coastal rainbow trout (*Oncorhynchus mykiss irideus*) (Behnke 1992).

A nice San Juan River rainbow trout

Rainbow trout usually begin spawning at 2-4 years of age. The age of sexual maturity can vary greatly depending on environment, size, and genetics (Behnke 1992). Rainbow trout that have good instream habitat and productive food sources will usually have a large body size at an early age, and therefore spawn earlier than a fish that inhabits a less productive aquatic environment. Mature females produce 1,200 to 3,200 eggs per kilogram of body weight.

Rainbow trout spawning typically begins during late winter and spring (December-April). Actual spawning times vary greatly among regions and are dependent on temperature and level of stream flow. Along with temperature and water flow, photoperiod also activates spawning behavior in rainbow trout (Willers 1981). Rainbow trout usually migrate upstream in the spring to spawn when water temperatures are between 5-15 C. However, fall spawning does occur (Mac Crimmon and Gots 1972). In freshwater river populations, spawning fish usually move from the feeding territories of a large river or stream into a smaller, coldwater tributary (Moyle and Cech 1996).

The female constructs a gravel nest, or "redd", in riffles within the gravels forming the stream bottom. The female digs the redd with her tail, depositing the gravel at one end. The finished redd can range in size from one half to three times the length of the female fish. It takes anywhere from several hours to several days to complete the redd. When finished, the female arches her body so that her head is elevated and the area of her vent is snug with the riverbed (Willers 1981). The eggs are released from her body and fall into the crevices between the gravel. The male simultaneously deposits milt into the bed. After fertilization, the female quickly buries the eggs with gravel (Moyle and Cech 1996). After the completion of spawning, the male and female will guard the nest for a short period of time.

Rainbow trout are tolerant of a wide range of water quality conditions, including temperature ranges from 0-28.3 C (Embody 1934) and pH tolerant of 5.8-9.6. Optimal conditions for growth are 13.0-21.0 C, slightly alkaline waters (pH of 7.0-8.0), dissolved oxygen concentrations greater than or equal to 7.0 ppm.

Low dissolved oxygen concentrations of 1.5-2.0 ppm are tolerated for short periods, although the incipient lethal level for adults and juveniles is approximately 3.0 ppm (Raleigh et al. 1984). Adult rainbow trout avoid permanent residence in waters that have temperatures above 18 C (May 1973), although upper incipient lethal temperature for adult rainbow trout is 25.0 C (Raleigh et al. 1984).

The diet of rainbow trout is typically made up of insects, though larger individuals do feed on small fish. They are highly territorial in streams and will aggressively defend a feeding area. In moving water, rainbow trout feed primarily on drifting organisms. In lakes, benthic invertebrates and zooplankton are preferred food sources. Small fish are a component in the diet of larger rainbow trout, especially those that occupy still water.

Disease has become an issue in the life history of rainbow trout. Whirling disease (*Myxobolos cerebralis*) is a microorganism that attacks immature rainbow trout and results in clinical symptoms that are life threatening. Microscopic spores of whirling disease are found on river and stream bottoms. Tubifex worms living in fine sediments on the stream bottom ingest the spores and serve as an intermediate host for the disease. Inside the digestive tract of the worm, spores change form and become a triactinomyxon (TAM). The TAM is later released from the tubifex worm into the water and is transported in the water column until contacting a trout. The TAM penetrates the skin of the trout and releases sporoplasms that enter the fish's nervous system. Sporoplasms move through the nervous system to the head, gill arches and into the skeleton. Clinical symptoms in infected fish are skeletal deformities, black tails, and whirling swimming behavior. Heavily infected fish may eventually die and decompose, releasing mature spores into the water column to continue the life cycle of the disease.

Brown Trout:

Brown trout are a well-known sport fish in the United States and throughout the world. It is a popular species with anglers for its good fighting ability and its selective feeding behavior. The species has two life histories, a freshwater strain, known as brown trout, and an anadromous strain often called sea trout.

The native distribution of brown trout is in Eurasia where the species is common. Eastern distribution of the species extends into Asia, and the southern limits extend to the Atlas Mountains of North Africa (Elliott 1994). The brown trout has been introduced into approximately 24 countries outside Europe, including the United States. Most of these introductions were carried out in the late 1800's and the first half of the 20th century, before disease and biological risks associated with the introduction of exotic species were recognized or well understood.

Brown trout become sexually mature in the third to fifth years of life (Raleigh et al. 1986). Spawning typically occurs in streams or rocky shoals in lakes during late fall and early winter. Spawning migrations are initiated by decreasing day length, increased late fall water flows, or decreases in water temperature to below 9 C (Stuart 1953, 1957; Raleigh et al. 1986). Redds are excavated by the female, usually in the gravel at the head of riffle areas or the tail of pools, at a depth of about 8 cm (Frost and Brown 1967). Homing instinct is highly developed and spawning adults will return to the stream of their origin.

In streams, young brown trout feed principally on aquatic and terrestrial invertebrates; larger individuals (those at least 25 cm total length) feed principally on benthic invertebrates and small fish. Young brown

trout in lakes feed on zooplankton and benthic invertebrates. Brown trout feed most actively during twilight periods.

Brown trout can survive a range of water conditions. The upper incipient lethal temperature for adults is approximately 27 C; optimal temperature for growth and survival is 12 C to 19 C (Raleigh et al. 1986). Optimal dissolved oxygen levels appear to be at least 9 ppm at temperatures less than or equal to 10 C, and at least 12 ppm at temperatures greater than 10 C (Raleigh et al. 1986). Incipient lethal dissolved oxygen concentration for adults is approximately 3 ppm (Burdick et al. 1954; Doudoroff and Shumway 1970). Brown trout tolerate a range in pH of 5.0-9.5 (Raleigh et al. 1986), although optimal growth occurs at a pH of 6.8-7.8 (Heacox 1974).

Brown trout are increasingly common in the Special Trout Water

Rainbow and Brown Trout Habitat Requirements:

Brown trout and rainbow trout have similar habitat needs. The first essential habitat type is spawning habitat. Most cool-water streams or rivers provide adequate spawning conditions for both species. The spawning habitat must have sufficient substrate materials that provide enough gravel for the construction of redds. The size of the gravel must not be too fine, or oxygen transport to the eggs will be limited. Water velocities must be appropriate to support successful spawning. Rapid water flows will carry the gravel off the redd, sending eggs downstream. Water velocities that are too slow will not provide adequate oxygen, therefore suffocating the eggs.

The second necessary habitat type is rearing areas for juvenile fish. Rearing habitats must have adequate cover to guard juveniles from predation. Good rearing areas will have low to moderate water velocities. Young fish are not yet strong enough to resist high water velocities for extended periods of time. Adequate food sources are also a requirement of good rearing habitat. When all of these conditions are met, survival of juvenile fish increases and they exhibit significant growth.
The third essential habitat type supports adult trout. Fish usually move into these areas during the second year of life. Adult habitat requires water depths of 0.3 meters or greater and is located where rapid flows

contact slower moving water. The complexities of current types allow the fish to rest in calm water and search for food and cover in the faster water. The protective cover in these areas often includes boulders, logs, vegetation, and undercut stream banks.

The fourth necessary habitat type supports trout in the river during the winter. Over-wintering habitat consists of deep, low velocity pools, overhanging vegetation from streambanks, submerged aquatic vegetation, logjams, and boulders. All are essential components for avoiding predators and providing resting cover when water temperatures decrease, metabolism slows, and ice formation begins.

Aquatic Insect Community:

The aquatic insect community in the San Juan River Special Trout Water is typical of many tailwater environments. The community consists of a low diversity of insect taxa with a high standing crop (number of organisms/m^2) (Ward 1974). Monitoring aquatic insects on the San Juan River has documented numbers exceeding 100,000 insects/m^2. Monitoring has documented that insect populations fluctuate seasonally and are also influenced by alterations in discharge levels from Navajo Dam (DuBey 1996).

Consistent cold-water (6.0 to 6.5 C) releases from Navajo Dam reduces the number of taxa immediately below the dam. Missing from this section of river are several taxa of aquatic insects commonly found in unregulated rivers. These include mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), and caddisflies (*Trichoptera*). These taxa require seasonal temperature changes for egg development. Dipterans, commonly known as black flies and midges, are capable of completing their life cycles in the thermally consistent conditions of the upper tailwater (Lehmkuhl 1972; Petts 1984; and Ward 1978). Moving downstream from the dam, water temperatures begin to fluctuate and increases in insect diversity occur. This condition becomes increasingly apparent in the lower portion of the Special Trout Water.

Historical Perspective of the San Juan Basin

The San Juan River Basin covers a surface area of 24,945 square miles and the distance from its headwaters in Colorado to the river's end at Lake Powell is 355 miles. The basin's climatic zones range from high-elevation alpine forests to low-elevation arid plateaus dominated by sagebrush communities. There are approximately 224 miles of river from Navajo Dam to Piute Farms Marina at the junction of Lake Powell. Of the remaining river, 54 miles are within the inundated high-water area of Lake Powell and 77 miles are upstream of Navajo Dam.

Navajo Dam is located at latitude N 36° 48'28", longitude W 107° 36'31" in San Juan County, New Mexico. The dam is an earth and rock-fill structure with a vertical spillway height of 365 feet from the upstream toe at an elevation of 5,720 feet. Storage of water in Navajo Reservoir began in June of 1962 (USGS 1990) and the reservoir has a capacity of 1,708,600 acre-feet (Stone et al. 1983). The reservoir has a calculated dead storage (non-dischargeable) of about 500,000 acre-feet. Navajo Reservoir extends 35 miles up the San Juan River into Colorado, 5 miles up the Piedra River, and 13 miles up the Los Pinos River (Woodbury 1961). The drainage area above Navajo Dam is approximately 3,230 square miles (USGS 1990).

The major tributaries to the San Juan River above Navajo Dam are the Navajo, Piedra, and Los Pinos Rivers. Both the Navajo and Piedra Rivers are free flowing, while the Los Pinos is dammed for agricultural purposes. The Animas River is the major tributary below the Navajo Dam; it joins the San Juan River downstream approximately 44 miles below Navajo Dam and is free flowing. Precipitation in the San Juan Mountains is the principal source of the surface water in the San Juan River drainage (Iorns et. al. 1965).

Navajo Dam and the beginning of the San Juan River Special Trout Water

Upstream from Navajo Dam, extensive hydromodifications have occurred in the San Juan Basin. In 1971, the high-water diversion Azotea Tunnel was completed to transport water across the Continental Divide into the Rio Grande Basin. It was built on the Blanco River, a San Juan River tributary. When operating at full capacity, the Azotea Tunnel can divert 100,000 acre-feet of water a year (Stone et al. 1983). Municipal water withdrawals occur at Pagosa Springs, Colorado. Water diversion for irrigation in the upper San Juan Basin totals approximately 11,000 acre-feet annually (USGS 1990). The Los Pinos River is impounded upstream from the community of Bayfield, Colorado, forming Vallecito Reservoir, with 129,700 acre feet of storage used for agricultural purposes.

Navajo Dam was constructed to provide water storage for the Navajo Indian Irrigation Project (NIIP). The project was designed to irrigate 110,000 acres of land on and adjacent to the Navajo Indian Reservation. Nearly a third of the reservoir's storage capacity (508,000 acre-feet) has been allocated for NIIP. Approximately 200,000 acre-feet per year of the full amount authorized under NIIP is being diverted at this time.

Secondary purposes of the impoundment are flood control, river regulation, de-silting, recreation (USGS 1990), and hydroelectric power generation (Holden et al. 1980). Water released from the lower levels of the reservoir provides a cold flow of water that supports the trout fishery below Navajo Dam.

Research flows have been implemented to simulate a natural hydrograph below Navajo Dam since 1992 and are a departure from past (1973-1991) operational practices. Starting in 1963 after completion of the Navajo Dam, operations emphasized maintaining stable flows and maximizing reservoir storage. Two key factors involved in the 1992 operational change of Navajo Dam were the Endangered Species Act and continued water development in the San Juan Basin. Releases from Navajo Dam since 1992 involve peak spring releases of up to 5,000 cfs, followed by lower releases ranging from 250 cfs to more than 500 cfs during the remainder of the year. Flows less than 500 cfs reduce habitat quantity, crowd fish, and diminish water quality and food resources in the Special Trout Water (Summer Low Flow Test Report-BR 2002).

Habitat Trends

Prior to construction of Navajo Dam, the San Juan River was typical of most southwestern rivers in the United States characterized by large spring snowmelt peak flows, low summer and winter base flows, and high-magnitude short-duration summer and fall storm events. It was a relatively warm, fluctuating, high sediment loaded river that supported a native fish community.

The completion of Navajo Dam and the subsequent dam operation altered the natural hydrograph of the San Juan River below the dam. The reservoir provided a sediment collection basin and a cold, deep-water release from the reservoir. The tailwater changed the character of the river to a coldwater, cobble-substrate stream channel that supports large standing crops of aquatic insects and salmonids. Base flows were substantially elevated and became relatively constant, while peak spring flows were significantly lower from 1962-1991, compared with pre-dam flow data. The 1962-1991 conditions were all favorable for the flourishing trout fishery.

In 1992, modifications of flow release patterns were made to provide a more-natural hydrograph for native fish species downstream. Large peak spring releases and lower base flows were intended to improve conditions for native fish. Spring releases also had some benefits to the tailwater habitat by increasing sediment transport, which provided cleaner substrate and improved conditions for some aquatic insects and spawning conditions for trout. Brown trout numbers increased after flow modifications began in 1992. The success of rainbow trout spawning and contribution to the fishery is currently unknown, but studies have been proposed to address these questions. High releases also may have some negative impacts on the stream channel and aquatic community by increasing the transport of gravel and cobble that are not being replaced from upstream sources, potentially resulting in a reduction in insect and fish habitats.

Base flows from 1992 to the present have typically been 500 cfs. In the near future, these flows are expected to drop to 250 cfs and river conditions will reduce trout habitat by as much as 34 percent in the Special Trout Water. A 34 percent reduction in trout habitat will concentrate fish into the remaining wetted channel, resulting in crowding and increased stress on the fishery. High angler pressure will compound these conditions and may further stress the fishery. Reduction in flows also will reduce habitat available for aquatic insects.

Population Trends

The fish population in the Special Trout Water has remained fairly constant from 1993-2003 as measured by angler catch rates and annual population surveys conducted by NMDGF. Data from catch rate and collection surveys help monitor numbers and size of fish in the Special Trout Water. Angler catch rates have been stable and quite high, averaging 1.12 fish/hr over the past 10 years, reflecting a very large fish population (Wethington 2002). Annual electrofishing surveys during the same period of time have consistently reported high catch rates, also reflecting a large fish population.

Fishing guide helping a client

Several population estimate and growth studies on the Special Trout Water have been conducted with only limited success. Tagging studies were attempted in the Special Trout Water, Regular Regulation, and the Lower River. In the Special Trout Water, visual implant tags were used from 1993-1995. This study was designed to evaluate growth, movement, and population densities. In the lower two sections, Floy tags were used with the same objectives. The lack of recaptures from year to year did not allow for valid conclusions. The tagging studies were discontinued after 1995. Additional information is still needed.

Several attempts to conduct trout population estimates were made from 1992-1995 with varying success. The first attempts were made in 1992 and 1993. These efforts lacked adequate recaptures for a valid population estimate (NMDGF 1992 and 1993). In 1995, another attempt was made and the data showed that fish densities vary dramatically, depending on habitat type. Densities, however, remain high

throughout the Special Trout Water. Confidence intervals were wide due to the small number of recaptures. From this study, it is apparent that densities of trout were very high during this period. More survey passes would be required to increase estimate accuracy; however, this activity could be harmful to the fishery.

The average size of fish in the Special Trout Water declined in the early 1990's and has remained relatively constant in recent years. In the Special Trout Water, from 1991 to 2001, length and weight data were collected for all trout species, along with observations related to fish health and injuries from fishing hooks. The mean length of rainbow trout and proportion greater than 18 inches in the Special Trout Water has fluctuated since flow changes (high spring releases and lower base flows) began in 1992. The mean length in 1992 was 16.8 inches and 51% of the fish were greater than 18 inches total length. These numbers steadily declined from 1993 to 1995. Results from 1996 indicated the first year that an increase was recorded in the mean length since 1990-91. Mean length increased again in 1997, the first year since 1992 that mean length exceeded 15.5 inches (Table 1).

Possible explanations for the decline in the average size of rainbow trout in the Special Trout Water include over-harvesting of large fish, increasing angler densities, flow modifications, diminished food resources, and increasing fish densities.

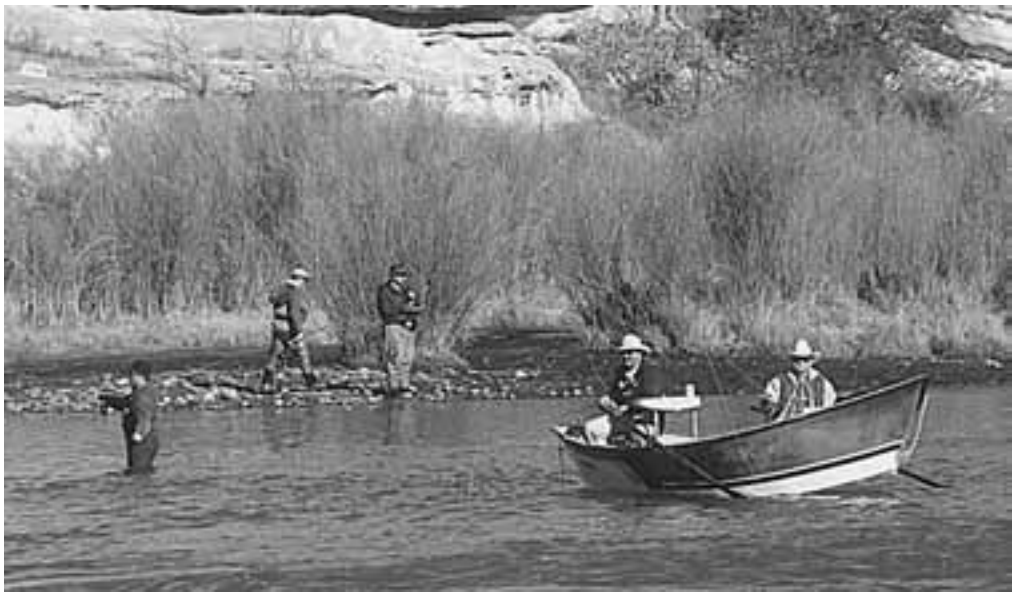
Heavy fishing pressure exists in some reaches

Creel data collected (2,100 plus angler interviews/year) shows that less than one percent of anglers harvest fish in the Special Trout Water, which would not contribute to the decline in average size of fish.

Angler pressure on the 4 miles of Special Trout Water is one of the highest of any trout fishery in North America. This level of pressure may contribute to the decline in the average size of fish. In 1999, 243,842 angler hours were estimated in the Special Trout Water, with an average catch rate of 1.12 fish/hr. This pressure would result in approximately 273,000 fish being landed, and a much larger number would represent the number of fish actually hooked by anglers. Approximately 90 percent of all fish captured during surveys have signs of at least one incident of hooking. The stresses associated with angler pressure may contribute to the decline in fish size.

Flow changes since 1992 altered habitat and may have reduced the average size of fish by flushing older, larger fish downstream, out of the Special Trout Water. No direct evidence has been documented, but older, less healthy fish may not be able to sustain their position in the river during peak releases.

Food resources in the Special Trout Water fluctuated seasonally and reduction in aquatic insect densities occurred during the 1996-1997 low-flow study. However, no direct evidence has been related to the condition and/or growth of rainbow trout due to lack of food sources.



A busy day in Texas Hole

High fish densities can affect the growth rates and size of adult rainbow trout in a given population. The Special Trout Water has maintained high fish densities for many years. Catch rates and survey data suggest population numbers have been relatively stable and density has not influenced the overall size of rainbow trout within this section.

The percentage of brown trout in the Special Trout Water has increased from approximately 5 percent to almost 30 percent during the past five years. This increase is probably due to improved spawning conditions resulting from the high spring releases that improve spawning habitats for browns.

In the Regular Regulation section, the number of fish collected and the mean length were considerably lower than in the Special Trout Water. This section of the river represents a “put-and-take” fishery, where most rainbow trout are probably harvested within two weeks of stocking. The brown trout in this section are from natural reproduction, but it is assumed that when they reach a length of 8 inches or greater they are also harvested at a high rate.

Table 1. Rainbow trout mean total length and percent of fish greater than 18 inches in the San Juan River Special Trout Water.

Year	Mean Total Length	Percent greater than 18 in
1992	16.8 in	51%
1993	15.2 in	36%
1994	13.4 in	22%
1995	12.4 in	11%
1996	15.1 in	14%
1997	15.8 in	16%
1998	15.1 in	16%
1999	15.3 in	23%
2000	14.3 in	19%
2001	14.6 in	18%

Anglers utilize the Lower River less because most of this section flows through private property and is less accessible. Stocking in this section occurs only at the lower end, where public access to the Hammond Wildlife Area is available. Natural reproduction of brown trout occurs in this reach. This section is primarily a brown trout fishery due to increased natural reproduction and the limited stocking of rainbow trout in this reach (Table 2). The number of native fish (flannelmouth sucker, bluehead sucker, and mottled sculpin) collected in this reach has dropped significantly since 1992, when 61 percent of the fish collected were native fish. In 1997, less than 1 percent of the fish collected were native. High coldwater discharges (greater than 3000 cfs) that were initiated during the reoperation of Navajo Reservoir in the spring of 1992 may have displaced the native fish populations downstream.

Table 2. Total number of fish collected by reach on the San Juan River, 1993-1997.

	REACH # 1				REACH # 2				REACH # 3			
	No. Fish		% Species		No. Fish		% Species		No. Fish		% Species	
Year	RB	BR	RB	BR	RB	BR	RB	BR	RB	BR	RB	BR
1993	571	35	94%	6%	184	58	76%	24%	NA	NA	NA	NA
1994	499	19	96%	4%	329	77	81%	19%	NA	NA	NA	NA
1995	496	29	94%	6%	287	124	70%	30%	553	624	47%	53%
1996	806	52	94%	6%	158	158	50%	50%	352	748	32%	68%
1997	653	37	95%	5%	306	95	76%	24%	248	805	24%	76%
1998	581	56	91%	9%	198	115	63%	37%	226	943	19%	81%
1999	420	71	86%	14%	127	127	50 %	50%	206	452	31%	69%
2000	222	75	76%	24%	61	123	33%	67%	51	321	14%	86%
2001	202	83	71%	29%	46	287	14%	86%	46	399	11%	89%

RB = Rainbow Trout, BR = Brown Trout

Use and Demand Trends

Starting in 1966, the NMDGF has managed the upper section of the tailwater as a special regulation trout fishery. Through a series of regulation changes designed to improve the quality of the fishery, the San Juan River trout fishery has developed into a highly visited trout fishery that is the destination of anglers from throughout the country.

Angler use in the Special Trout Water has remained high from 1990 to 2001, with a record high 243,842 angler hours recorded in 1999. Catch rates in the Special Trout Water have remained high during the past five years (1998-2002), with an average of 1.12 fish/hour or 273,000 fish landed annually. Harvest rates in the Special Trout Water are extremely low because most anglers practice catch-and-release fishing. Less than 1 percent of all the anglers surveyed had harvested a fish, but the high demands on the fishery are still apparent with approximately 90 percent of the fish collected in surveys showing signs of hooking scars in the Special Trout Water.

The San Juan River provides excellent fishing opportunities in numerous back channels.

Fewer anglers fish the river during the periods of high releases (5,000 cfs) due to increased difficulty in wading, reduced access to the stream, and the perception by anglers that high flows cause fish to stop feeding. Total angler use over the past five-year period (1997-2001) (Table 3) showed a 5-year average of 217,000 angler hours annually over the period.

Lowest angler activity occurred during peak flows, while the highest occurred from July through October with some monthly estimates exceeding 40,000 angler hours. Angler activity has been monitored since the early 1970's and it steadily increased until the mid-1990's and has been relatively constant thereafter. Angler use is partitioned by regulation reach (i.e., Special Trout Water and Regular Regulation). From 1995-2001 more than 75 percent of the angler use has been in the Special Trout Water.

Also, the number of out-of-state anglers utilizing the Special Trout Water is increasing; approximately 60 percent of angler use came from nonresidents (Table 4).

Table 3. Estimated angler hours and days for the San Juan River 1992-2001.
(STW/hr) Special Trout Water angler hours, (STW/days) Special Trout Water angler days, (RR/hrs) Regular Regulation water angler hours, (RR/days) Regular Regulation water angler days

Year	STW/hrs	STW/days	RR/hrs	RR/days	Total/hrs	Total/days
1992	102,672	20,534				
1993	99,279	19,855				
1994	137,738	27,547				
1995	160,909	32,181	47,910	11,977	208,819	44,158
1996	238,140	47,628	54,211	13,553	292,351	61,181
1997	213,324	42,664	54,985	13,746	268,309	56,410
1998	222,172	44,434	47,218	11,805	269,390	56,239
1999	243,842	48,768	46,737	11,684	290,579	60,452
2000	216,668	43,333	34,668	8,667	251,336	52,000
2001	175,053	35,010	36,051	9,013	211,110	44,023

Table 4. Estimated angler origin for the San Juan River 1997-2001: (SJC) San Juan County, (NM) New Mexico not including SJC, (OS) outside the state of NM.

	Special Trout Water				Regular Regulation			
	SJC	NM	OS	% OS	SJC	NM	OS	%OS
1997	120	249	607	62%	329	154	52	8%
1998	225	468	1007	59%	693	427	133	11%
1999	267	422	934	57%	751	378	260	18%
2000	181	488	1190	64%	659	392	122	10%
2001	88	303	752	65%	437	270	75	10%

In 1990 an angler survey was conducted to determine angler perceptions of the overall quality of the angling experience on the Special Trout Water of the San Juan River. Approximately 78% of anglers surveyed rated their most recent fishing trip good or very good, but most anglers surveyed felt the number of 20 inch or larger fish had declined. The major suggestions and/or complaints were the lack of law enforcement, too many guides, increase in water flows, and an increased angler use in the Special Regulation Water (Ahlm 1990).

Past Management Practices

Past management was directed at stocking and monitoring the fishery. The NMDGF first stocked trout into the San Juan River in the mid-1960s. Shortly after the initial trout stockings, the fishery flourished and the NMDGF initiated special regulations.

Stocking in recent years consisted of releasing 80,000 3-inch rainbow trout fingerlings annually. These stocking levels have met the high angler expectations of the San Juan River and provided one of the highest catch-rates of any fishery in the United States. Annual surveys were conducted to monitor average size, catch-per-unit effort, trout movements, and the overall health of the fishery. Angler surveys monitored angler numbers and catch-rates. Numerous studies were conducted to evaluate fish movement, food resources, population numbers, and many other aspects of the fishery (Ahlm 1991-1994, Wethington 1995-2002).

In 2001, a new tagging study was developed to address many of the frequently asked management questions about the San Juan River. This study provides a proposed plan for a 10- to 15-year research study on the San Juan River trout fishery. The study plan is designed to yield information about critical aspects of the fishery and how it responds to alterations in discharge levels from Navajo Dam. The objectives of the study plan are to:

- Estimate survival rates from one age class to the next.
- Estimate in-stream reproductive contribution to the rainbow trout population.
- Estimate population size.
- Evaluate success of selected strains of rainbow trout.
- Model the fishery using the information obtained.

Whirling disease was detected in 1999 in the Special Trout Water. All fish collected in the survey tested positive and had high numbers of spores. The effects of whirling disease on the stocked fingerlings prior to the verification are not known. Changes in stocking procedures were initiated after verification of whirling disease. The NMDGF began stocking larger fish (greater than 4 inches) in the Special Trout Water to avoid any possible detrimental affects of whirling disease. At this time it appears that NMDGF has been able to manage around the negative affects of whirling disease in the San Juan River by stocking larger fish that are not susceptible to the clinical conditions of the disease and historically stocking large numbers of smaller fish.

Habitat Assessment

Status:

The Special Trout Water is primarily a wide, shallow and braided channel, comprised of riffles and runs with a cobble bottom. The Bureau of Reclamation (BR) has conducted habitat mapping to measure usable adult rainbow trout habitat in the Special Trout Water. The trout habitat mapping utilized the stream model called Instream Flow Incremental Methodology, which was developed by the U.S. Fish and Wildlife Service. This methodology uses a series of mathematical, empirical, and conceptual models to quantify habitat availability under different stream flows. Changes in available habitat with respect to stream flow and the habitat requirements of trout are described using a Physical Habitat Simulation System (Bovee 1986).

These studies showed trout habitat in the Special Trout Water was maximized from a discharge ranging from 1,000-2,000 cfs. A base flow of 500 cfs is estimated to provide approximately 1.7 million square ft of useable trout habitat in the Special Trout Water (Valdez unpublished 2002). Any reduction in flows

will reduce trout habitat. Additional information will be available in the Environmental Impact Statement for the Reoperation of Navajo Dam from the BR in late 2004.

Projections:

Reoperation of Navajo Dam will allow continued development of water in the San Juan Basin along with providing water for endangered species. This reoperation will require reduced flows out of Navajo Reservoir. The reduction in base flows from 500 cfs to 250 cfs will decrease coldwater trout habitat. During these projected low-flow periods, an estimated 34 percent reduction in trout habitat will occur in the Special Trout Water (Valdez unpublished 2002). The loss of useable trout habitat from the base of Navajo Dam to the Texas Hole is estimated to be 280,000 square feet. The loss in useable trout habitat from the Texas Hole to the end of the Special Trout Water is estimated to be 284,000 square feet. The total loss of trout habitat in the Special Trout Water is estimated to be 564,000 square feet.

The insect community will be affected by proposed decreases in discharge from Navajo Reservoir. Several short-term studies have evaluated the potential impacts to the insect community during and after flows have been reduced from 500 cfs to 250 cfs. Low-flow studies conducted in January 1996 and November 1996 to March 1997 showed reductions in aquatic insect populations. The January 1996 two-week study showed reductions ranging from 29-74 percent for specific taxa (DuBey 1996). The November 1996 to March 1997 study showed a reduction of 36 percent in insect densities (BR 1998). Reduction in insect densities could negatively influence the trout fishery by reducing the food base that supports the high trout density.

Supply and Demand Assessment

Supply:

The number of trout in the Special Trout Water ranges between 75,000 to 85,000 fish. NMDGF has actively stocked the Special Trout Water to maintain a high density of fish throughout this section of the river. These densities have provided excellent catch rates from 1992-2001.

Future stocking of the Special Trout Water section of the San Juan River will include approximately 60,000 4”-5” fingerlings annually. Specific strains of rainbow trout will be selected that have genetic traits to meet the demands of a trophy trout fishery. When selecting a specific strain of rainbow trout for the Special Trout Water, the criteria will include growth rate, food conversion, time of spawning, catchability, survival, and habitat needs. Rainbow trout have a capacity to meet a variety of management objectives. Selecting the correct strain will help provide a fishery that meets the desires of the angling public. Another consideration includes obtaining fish from a disease-free source. All fish stocked in New Mexico waters must receive a negative test result for whirling disease within the past two months prior to stocking and must be from a certified disease-free facility.

Demand:

The Special Trout Water of the San Juan River is one of the most heavily fished trout rivers in the country. Angler use tripled from the 1980s to the 1990s when it reached a plateau, exceeding 200,000 angler hours a year. The estimate of fish in the Special Trout Water is 75,000 to 85,000 fish. Using creel

data, on average, an estimated 250,000 trout are landed each year meaning that many of the same fish are landed several times per year. With anglers handling 250,000 fish a year in a catch-and-release fishery, angler-induced mortality becomes a primary concern in the Special Trout Water.

Many anglers fish from guide boats in the Special Trout Water

Economic Impacts

The economic value of San Juan River fishing and associated expenditures is important for the surrounding area. Most of the fishing on the San Juan River takes place between Navajo Dam and the Hammond Diversion in the 4-mile section designated by the NMDGF as Special Trout Water.

An economic study identified expenditures made by resident recreation users in New Mexico State Parks (NMSP 1995). It showed that average resident users spent $85.81/day while visiting state parks. Expenditures for out-of-state anglers visiting the San Juan River Special Trout Water were estimated at $400.00 per day per person based on a study done in 1994 (Farmington Visitors Bureau 1999).

A more recent economic study was conducted by the Cooperative Extension Service at New Mexico State University to determine the value of the San Juan River to the state of New Mexico. Direct economic outputs for the Fishing Guides and Outfitter industry in San Juan County is estimated at $25 million (Ashcroft 2003). Further estimates of indirect and induced impacts and the total output for the fishing industry is estimated at over $38.6 million (Ashcroft 2003). Currently, the Bureau of Reclamation is developing economic analyses directed at determining the fishing and recreation expenditures as part of the EIS for the reoperation of Navajo Reservoir.

Special Considerations

After completion of Navajo Dam in 1962, criteria governing releases of water from Navajo Dam focused primarily on meeting irrigation needs, providing flood control, and maintaining a suitable recreation pool in Navajo Reservoir. During the last decade, the criteria and associated patterns for releasing water from the dam have changed. The purpose of modifying the operation of Navajo Dam and Reservoir was to implement the flow requirements of the Endangered Species Act.

Discharge patterns from Navajo Dam will comply with the guidance in the *Flow Recommendations for the San Juan River* (Holden, 1999). The *Flow Recommendations for the San Juan River* was developed by several different federal, state, tribal agencies, and private groups (Bureau of Indian Affairs, U.S. Fish and Wildlife Service, Bureau of Reclamation, Jicarilla Apache Tribe, Navajo Nation, Southern Ute Tribe, Colorado Division of Wildlife, NMDGF, water users in the basin, and Bureau of Land Management).

Aerial view illustrating different river channel types.

These recommendations will enable water development in the basin to proceed in compliance with Federal and State laws, interstate compacts, court decrees, and Indian trust responsibilities. To accomplish these, Navajo Dam and Reservoir would be operated to provide water releases designed to maintain and improve habitat for the razorback sucker and the Colorado pikeminnow, while maintaining the authorized purposes of Navajo Reservoir.

The U.S. Bureau of Reclamation is developing an EIS concerning the reoperation of Navajo Reservoir. The Draft Environmental Impact Statement (DEIS) was made available to the public in September 2002 and the completion date is planned for fall 2003. The DEIS evaluated seven alternatives. Most of the alternatives formulated for the evaluation are described in terms of flow rates representing minimum and

maximum limits in cubic feet per second in the range of release rates from Navajo Dam. The alternatives formulated are shown in table 5.

Table 5. List of Navajo Reservoir operations EIS alternatives

Title
No Action Alternative (Historical Operations)
250/5000 Alternative (Flow Recommendations)
500/5000 Alternative
250 Variable/5000 Alternative
250/6000 Alternative
500/6000 Alternative
Decommissioning/Breaching Navajo Dam Alternative

The range of alternatives developed for this DEIS was initially formulated and subsequently evaluated using hydrologic modeling and the following:

- Authorized purposes of the Navajo Unit
- Goals of the San Juan River Basin Recovery Implementation Program (SJRBRIP)
- The *Flow Recommendations for the San Juan River* (Holden, 1999)
- Public scoping meetings and informal public contacts
- Coordination with cooperating agencies and interagency consultations
- Flood control procedures for Navajo Dam established with the Corps of Engineers (Corps) to provide flood protection for areas along the San Juan River from the dam to Farmington, New Mexico
- Authorized and potential American Indian (Indian) and non-Indian water uses, including those pursuant to Indian water rights and Federal trust responsibilities to Tribes and Tribal nations, water contracts with the Secretary of the Interior for delivery of the Navajo Reservoir water supply, and compact apportionments
- Applicable water rights, laws, treaties, interstate compacts, court decrees, Indian trust responsibilities, and various rules, regulations, policies, and directives

Also taken into account in formulating the alternatives were such issues as water user concerns that high releases could wash out existing water diversion structures, while low releases might make it difficult to divert water. Other concerns centered on water quality, erosion, and minimizing adverse impacts of alternative dam operations on fish and wildlife, recreation, and hydropower generation benefits. The proposed alternatives follow:

The **No Action Alternative** would help maintain the downstream trout fishery and river rafting in the lower reaches of the San Juan River (Bluff, Utah to Lake Powell) by moderating flow fluctuations. This action would not meet the Flow Recommendations and would impact present and future water development projects in the San Juan Basin.

The **250 cfs base flow with a 5,000 cfs peak flow** was selected as the preferred alternative for future operations at Navajo Dam, as selected in the San Juan River report. This alternative is designed to mimic a natural hydrograph and to meet the Flow Recommendations for the San Juan River below Farmington. Some restriction on the periodicity of maximum and minimum releases may occur. Typically, the dam would have a release pattern to mimic the natural hydrograph in the San Juan River downstream of Farmington consisting of high spring flows followed by low-stable base flows during the non-runoff periods.

In this alternative, the spring release of 5,000 cfs is planned to meet the Flow Recommendations of the San Juan River report, while the summer, fall, and winter releases support a target flow in the San Juan River downstream of Farmington of 500 to 1,000 cfs for endangered fish habitat. This alternative also is designed to conserve water for spring releases and water development.

The summer, fall and winter flow targets would require releases from Navajo Dam to reach a low of 250 cfs. If high reservoir inflows from storm events occur during the summer and the reservoir volume is already high, water could be released in brief peaks in the fall and winter to avoid uncontrolled spills from the dam.

A **500/5,000 alternative** reduces potential impacts on downstream water users and recreation by maintaining higher minimum flows, but still provided a high spring peak. This action was eliminated because it did not fully meet the Flow Recommendations.

The **250-variable/5,000 alternative** was developed to minimize potential impacts on downstream water users and downstream recreation by maintaining higher minimum releases during certain critical times of the year than the 250/5,000 alternative. This alternative was eliminated because it did not allow for sufficient reservoir storage to meet the spring peak flow criteria in the Flow Recommendations.

The **250/6,000 alternative** was considered because it was discussed in the Flow Recommendations as a way of creating a greater spring peak in the San Juan River west of Farmington. It was eliminated because the Army Corps of Engineers and the Bureau of Reclamation determined 6,000 cfs releases were not feasible without major structural modifications to the dam's outlet works. In addition, safe-channel capacity in the reach from Navajo Dam to Farmington is 5,000 cfs, and releases of 6,000 cfs would reduce the active storage of the reservoir and impact release to the Navajo Indian Irrigation Project.

A **500/6,000 alternative** was considered a way to reduce impacts to water users and to recreation by providing higher minimum flows. It was eliminated for the same reasons as the 250/6,000 alternative and it did not fully meet the Flow Recommendations.

To **decommission and breach Navajo Dam**, another alternative would largely meet the conditions of a natural hydrograph and increase habitat for native fish. Spring peaks would be provided on most years but low flows during the irrigation season would be substantially less than 500 cfs west of Farmington.

Therefore, this alternative does not meet the Flow Recommendations. This action also would impact all water development projects

All future management decisions in the basin must take into consideration the alterations in the proposed operation of Navajo Reservoir. Changes in releases from the dam will impact the quality and quantity of habitat for the trout and other aquatic organisms. Flow alterations also will affect the angler's ability to access the river during high flows and result in angler crowding during low flows.

Summary and Conclusions

The Special Trout Water of the San Juan River continues to be a destination fishery for anglers due to the high density of large trout. Angler use has averaged more than 217,000 hours/year in recent surveys. Catch rates, size of fish, quality of fish and the overall condition of the fishery remain high and continues to attract anglers.

The ability of the trout fishery to continue to support high angler use during the process of reoperation of Navajo Dam is unknown. Three short-term low flow tests have been conducted to address questions concerning the potential impacts from the proposed reoperation. All three tests indicate, as addressed in the Habitat Analysis Section of this report, that lower flows will significantly reduce the habitat and food supply available to trout in the San Juan River.

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Management and Strategy Section

GOAL:
Anglers continue to be satisfied with the world-class fishing experience on the San Juan River Special Trout Water.

OBJECTIVE:
At least 75 percent of anglers fishing the San Juan River Special Trout Water are satisfied that the quality of their angling experience rates as world-class in 2004-2008.

1. Issue: Public perceptions of the term "world-class" may differ and lead to varying expectations and satisfaction ratings.

1.1-Strategy: Establish the following objective parameters as criteria of "world-class" angling for the San Juan River Special Trout Water:

- An average catch-rate of not less than 1.0 fish per hour. (exceptional catch-rate)
- Five percent of the trout population exceeds 20 inches. (Good trophy potential)
- Fish appear vigorous, healthy, and provide a memorable angling experience. (Good fighting characteristics)
- Maintain a 75 percent or higher angler satisfaction rating for the Special Trout Water.

1.2-Strategy: Monitor catch-rates, percent of population over 20 inches, and fish quality to determine if "world-class" standards are being met.

2. Issue: River flows necessary to maintain a "world-class" fishery may be adversely affected by water developments.

2.1-Strategy: Evaluate impacts of flow modifications on the trout fishery.

3. Issue: Angler numbers on the Special Trout Waters have tripled since 1986. Resultant increased angler density may diminish aesthetic appeal and potentially decreases catch rates and fish size may fall below the criteria for a world-class angling experience.

3.1-Strategy: Monitor angler use and determine if, and to what extent, current angler densities are diminishing the aesthetic value of the Special Trout Waters angling experience.

3.2-Strategy: Monitor catch rates, fish size, and fish vigor and health, for compliance with our world-class criteria.

3.3-Strategy: Evaluate how changes in angler density are impacting the status of the fishery.

3.4-Strategy: Investigate the expansion of the Special Trout Water downstream to reduce angler densities.

3.5-Strategy: Work with New Mexico State Parks to improve access to areas under used by anglers.

3.6-Strategy: Investigate potential for limited-entry system.

4. Issue: The San Juan River trout fishery cannot naturally support the world-class parameters that have been established.

4.1-Strategy: Stock strains of fish that have the potential to support a world-class fishery and meet angler expectations.

4.2-Strategy: Evaluate current regulations in the Special Trout Waters. The first 0.25-mile below Navajo Dam is catch-and-release fishing and the next 3.5 miles have a daily bag limit of one trout with a minimum size limit of 20 inches. Both sections have tackle restrictions of artificial flies and lures having a single, barbless hook.

5. Issue: The reoperation of Navajo Dam to simulate natural flows (250-5,000 cfs) for endangered species downstream of the tailwater may adversely affect our ability to sustain the world-class fishery.

5.1-Strategy: Work with Bureau of Reclamation/U.S. Fish and Wildlife Service to develop methods to mitigate adverse impacts caused by planned flow strategies.

5.2-Strategy: Work with Bureau of Reclamation/U.S. Fish and Wildlife Service to implement instream habitat improvement measures that will sustain fish populations through low flow periods.

5.3-Strategy: Work with the angling public to develop strategies to maintain angler densities at levels consistent with world-class quality angling during times of low flow.

5.4-Strategy: Develop measures to monitor the health and sustainability of the fishery with respect to varying water levels and angler use.

6. Issue: Declines in the numbers of 20 inch and larger trout have diminished the angler's opportunity to catch trophy fish.

6.1-Strategy: Stock strains of rainbow trout that have the growth potential to reach and/or exceed 20 inches.

6.2-Strategy: Work with Bureau of Reclamation/NM State Parks to implement instream habitat improvement measures that will mitigate adverse flow conditions and angler pressure.

6.3-Strategy: Study relationships between fish size and population density.

6.4-Strategy: Evaluate how current fishing regulations affect the fishery.

7. Issue: Methods for data archiving and data analysis are needed to improve long-term management decisions.

7.1-Strategy: Build and maintain a database that will provide comprehensive data storage and analysis so effective management decisions can be made.

7.2-Strategy: Conduct annual data analysis to support Special Trout Water management decisions.

8. Issue: Storm-caused sediment deposits and suspensions in the Special Trout Water reduce aesthetic appeal, trout populations, insect food sources, and angling success.

8.1-Strategy: Work with state and federal land management agencies to develop land management activities to reduce sediment run-off.

8.2-Strategy: Work with Bureau of Reclamation/U.S. Fish and Wildlife Service and New Mexico State Parks to install in-stream structures that increase sediment transport.

9. Issue: Anglers who possess inadequate information about laws, regulations, proper handling of fish, and angling etiquette diminish the aesthetic quality of the experience for other users and can increase user conflicts and violation rates.

9.1-Strategy: Provide educational material to the public concerning laws, regulations, proper handling of fish, and angling etiquette. (Use public outreach, signs, brochures, etc).

9.2-Strategy: Work with local guides and outfitters to provide information to their clientele concerning regulations, the proper handling of fish, and angling etiquette.

9.3-Strategy: Work with New Mexico Game and Fish Northwest Area Conservation officers to provide an effective law enforcement presence on the San Juan River.

10. Issue: Diseased fish lack the vigor and health expected of fish in a world-class fishery.

10.1-Strategy: Culture and stock fish that are four inches or longer to avoid negative impacts of whirling disease.

10.2-Strategy: Investigate strains and/or species that show biological resistance to diseases.

11. Issue: Presence of whirling disease diminishes angler perceptions of the fishery's quality.

11.1-Strategy: Provide educational material to the public (public outreach, signs, brochures, meetings, etc).

11.2-Strategy: Work with local guides and outfitters to provide accurate information to their clientele about whirling disease to the public.

12. Issue: Riparian woody vegetation was dramatically altered during the construction of Navajo Dam. This reduced aesthetic appeal, important habitat for invertebrates, and in-stream nutrients.

12.1-Strategy: Work with New Mexico State Parks to plant native cottonwoods throughout the riparian area and implement measures to protect existing trees and newly planted trees from wildlife.

12.2-Strategy: Work with Bureau of Reclamation/U.S. Fish and Wildlife Service and New Mexico State Parks to develop methods and specific sites for removal of salt-cedar and Russian olive vegetation and replace it with native riparian species.