BIG COTTONWOOD CREEK
Stream Survey Report

United States Department of Agriculture
Wasatch-Cache National Forest
Salt Lake Ranger District

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

TABLE PAGE

FIGURE PAGE

INTRODUCTION

In the summer of 1999 a fish habitat inventory was conducted on Big Cottonwood Creek. These stream sections are located in Big Cottonwood Creek in Salt Lake County, Utah. Big Cottonwood Creek is a tributary of the Jordan River on the Wasatch-Cache National Forest. The R1/R4 (Northern/Intermountain Regions) Fish and Fish Habitat Standard Inventory (Overton et al. 1997) was performed July-September 1999 by Kate Schwager and Tammy Smith. The purpose of the survey was to assess fish habitat and abundance in Big Cottonwood Creek.

PROJECT AREA

Big Cottonwood Creek is a 1st order stream at the headwaters of Big Cottonwood Canyon and becomes a 2nd to 3rd order stream as it flows through the canyon. The creek flows from around 9600 feet at the headwaters to around 4250 feet when it reaches the confluence with the Jordan River. The stream flows in a northwest direction as it leaves the headwaters near Brighton and then travels southwest about half way down canyon near Reynolds Gulch. At the base of the canyon the stream leaves the Wasatch-Cache National Forest and a portion of the flow enters the Big Cottonwood Treatment Plant to provide municipal drinking water. At this point the stream again flows northwest until the confluence with the Jordan River around the Taylorsville-Murray area.

The source waters at the top of the canyon begin near the Brighton Ski Resort and flow from Silver Lake, Twin Lakes Reservoir, Lake Mary, Lake Martha, Lake Catherine, and Dog Lake. Additionally precipitation and many tributaries along the canyon contribute to Big Cottonwood Creek's water volume. Brighton receives over 50 inches of precipitation annually, most in the form of snow. 400 inches of total annual snowfall are measured. The average water yield of Big Cottonwood Creek is 52,864 acre-feet, which is the highest water yield of any Wasatch Front canyon stream in Salt Lake County. This canyon is a protected watershed area under strict management controls since it is a major source of drinking water for Salt Lake City. No dogs or horses are allowed. The water quality provides an excellent source for drinking water. There were no exceedences of state drinking water standards in 1999. (Utah Department of Wildlife Resources as cited in: USDA Forest Service 1999)

The Utah Department of Wildlife Resources has identified Big Cottonwood Creek as a Class II Fishery. This classifies the area as "a moderate to large productive stream with high aesthetic value where fishing and other recreational uses should be the primary consideration". It was determined to be an especially important water body due to its capacity to provide a strong resident trout fishery close to a metropolitan area. (Utah Department of Wildlife Resources as cited in: USDA Forest Service 1999)

Big Cottonwood Canyon and the surrounding Wasatch-Cache National Forest have a long history of resource use and development. As Salt Lake City grew through the mid 1800's to early 1900's tremendous demands were placed on natural resources through population growth, mining, railroading, and manufacturing. The canyons were stripped of timber, forage, and minerals by 1900. A serious impact was the timber industry's sawmills. The first mills were built in the lower portion of Big Cottonwood Canyon by 1850 and in the next decade the mills moved up the canyon. Today the canyon continues to be impacted through recreational demands and urban pressure. (Peterson et al. 1980)

Outdoor activities in the canyon include fishing, seasonal hunting, camping, hiking, picnicking, sightseeing, biking, rock climbing, skiing, and snowboarding. The National Forest land in the canyon is intermixed with private land. The private land contains many homes, some of which are right alongside Big Cottonwood Creek. Two large ski resorts are also located in the canyon. All of these activities further influence this ecosystem.

Big Cottonwood Creek from the Big Cottonwood Treatment Plant to Brighton can be divided into 17 reaches. From July 27, 1999 to September 15, 1999 a complete survey was performed on reaches 2, 3, 8, and 9, while a general survey was performed on reaches 1, 4, 5, 6, 7, and 11. Both reaches 10 and 12 were completed in the 1997 survey and will not be discussed in detail in this paper.

METHODS

General Information

The 1999 Big Cottonwood Creek Fish Habitat Inventory was conducted using the R1/R4 (Northern/Intermountain Regions) Fish and Fish Habitat Standard Inventory Procedures Handbook. (Overton et al. 1997) This handbook was designed for fisheries biologists working for the Forest Service, U.S. Department of Agriculture in order to assess the effects of National Forest management activities on fish and fish habitat. The standardized data collected through this procedure can help identify factors limiting fish populations and future extinction risks.

There is a basic four-step process to this inventory procedure that includes: preinventory, inventory, postinventory, and data entry and reporting. In the preinventory stage, survey reaches are delineated based on flow changes from: tributaries, channel type, and substantial gradient changes. These reach breaks are then recorded on 7.5 minute topographic maps. Header forms are completed to give an overall description of each reach. The inventory phase is where a two-person crew consisting of an Observer and a Recorder performs the field inventory. During this stage the stream habitat and sample fish population data is collected. The postinventory process involves proofreading, organizing, and labeling data and photos. Data entry and reporting are completed through a fish habitat input program called FBASE. This computer program takes raw data figures and calculates summary reports that can be used to analyze the data effectively. (Overton et al. 1997)

Survey Details

The four reaches (2, 3, 8, and 9), where the complete R1/R4 survey was performed in 1999, were classified into different habitat classes based on discharge measurements and then further specified into habitat groups and habitat types. Fast water habitats have a velocity greater than 0.3 m per second, while slow water habitats generally have a velocity less the 0.3 m per second. Fast water habitats can be either turbulent or non-turbulent. Turbulent water types include: cascades (CAS), step runs (SRN), high grade riffles (HJR), and low grade riffles (LGR). Non-turbulent water types include runs (RUN) and glides (GLD). Slow water habitats or pools are broken into dammed and scour habitat groups and then further classified into various habitat types based on their positions and formative features. Dammed pools can either be in the main (M) or backwater (B) position in the stream and can have formative features such as: large woody debris (LWD), boulders (B), artificial (man caused)(A), beavers (V), landslides (L), and other (O). Scour pools can be in several positions in the stream channel such as: lateral scour (L), mid-scour (M), plunge (P), or underscour (U). The formative features that characterize scours include: large woody debris (LWD), boulder (B), artificial (A), bedrock (R), tributary (T), culvert (C), meander (M), beaver (V), and other (O). One other habitat type is the step pool complex (STP); it is characterized by a series of three or more step-like mid-scour pools separated by short sections of turbulent water. For example a typical habitat unit labeled as DMV would be interpreted as a dammed pool formed by beavers in the main channel of the stream. (Overton et al. 1997)

Habitat unit variables were collected for each new habitat unit surveyed along the reaches. The data collected varied based on the reach type, channel unit, and the habitat type. Every habitat unit had several standard variables measured such as: length, width, average wetted width and depth, bank length, bank stability, bank undercut, channel shape, LWD counts, and riparian community types. In fast water habitats the number of pocket pools and the average maximum depth of the pocket pools was recorded. In slow water habitats the maximum depth and crest depth of the pools was measured as well as the number of pools over 1 m. Substrate composition was analyzed about every 15-30 habitat units (every page) in low grade riffles and scour pool tails in the main stream channel from bankfull stage to bankfull stage. The percentage of each substrate class (fines, small gravel, small cobble, cobble, small boulder, boulder, and bedrock) was visually estimated and recorded. Water and air temperatures and the time they were measured were also recorded every page, or at least 3 times daily, and above and below tributaries. All large woody debris that was in the bankfull channel was classified as either single ($\geq$ 3m. length or $\geq$ two-thirds the wetted width of the stream and $\geq$ 0.1 m. in diameter one-third of the way up the base), aggregates ($\geq$ two clumped pieces of LWD; all qualifying pieces are counted), brush piles, or rootwads. The riparian classes were used to identify the vegetative structures surrounding the stream bed and consisted of: grassland/forb (GF), shrub/seedling (SS), sapling/pole (SP), small trees (ST), large trees (LT), and mature trees (MT). (Overton et al. 1997)

Fish population sampling was performed by either one or two snorkelers depending on the width of the habitat unit. Larger habitat units were divided in half and the observers would move at the same speed adjacent to each other and only count the fish that passed between their shoulder outward to the bank. In narrower habitat units one snorkeler counted all the fish from bank to bank as they floated down the center of the stream or swam upstream. Fish were counted by species and size or age classes. Snorkeling surveys were conducted at every 10^{th} slow water habitat and at a few non-turbulent fast water habitats. (Overton et al. 1997)

RESULTS

Reach 2

Reach two started at the Stairs Power Plant Flume, elevation 5760 ft. and ended at the base of the Storm Mountain Diversion Dam. The total reach length was 1309.3 m. (Table 5) and contained a total of 53 habitat units (22 fast and 31 slow) (Table 1). The slow water: fast water velocity by count was 1:0.71 (Table 1) and by surface area was 1:0.56 (Table 3). Reach 2 was a confined channel with reach type A and a map gradient of 1.9%. Field gradients were not taken in the 1999 study because of faulty equipment. The average flow was not taken due to very low water conditions. The Granite Power Plant was not working so the Stairs Plant was releasing more water than usual. The average habitat width was 5.4 m. (Table 7) and the average habitat depth was 0.27 m. (Table 8). The habitats were composed of 30.8% riffles, 4.9% runs/glides, and 64.3% pools (Tables 11 and 12). The total number of pocket pools was 141 and there were 35 per 100 m. with an average depth of 0.38 m. Reach 2 encompassed a total of 38.1 pools/mile with 18.4 large pools/mile. The stream banks were 78% stable overall with 1.2% undercut (Table 13). The dominant substrate was 25% cobble and surface fines were 6.7% (Figure 1). The total number of pieces of LWD per mile was 132.7 with a total of 62 single pieces (4.7/100 m.), 20 aggregates (1.5/m.), and 26 root wads (2/100 m.) (Table 14). Reach 2 had a dominant riparian class of Small Trees (Table 14). Rainbow, brook, and brown trout species were present in this reach (Figures 5, 6, and 7) and there was 0% overhead cover in snorkel areas.

Reach 3

Reach three started above the Storm Mountain Diversion Dam, elevation 5816 ft. and ended at the Mill B South Fork Bridge. The total reach length was 1,738.8 m. (Table 5) and contained a total of 56 habitat units (30 fast and 26 slow) (Table 1). The slow water: fast water velocity by count was 1:1.15 (Table 1) and by surface area was 1:3.38 (Table 3). Reach 3 was a confined channel with reach type A and a map gradient of 5.3%. The flow was 2.15 m^3/s above the Big Cottonwood Creek bridge above Storm Mountain. The average habitat width was 8.0 m (Table 7) and the average habitat depth was 0.35 m. (Table 8). The habitats were composed of 62.1% riffles, 2% runs/glides, and 24.5% pools (Tables 11 and 12). The total number of pocket pools was 343 and there were 26.8 per 100 m. with an average depth of 0.46 m. Reach 3 encompassed a total of 24.1 pools/mile with 17.6 large pools/mile. The stream banks were 83.2% stable overall with 11.3% undercut (Table 13). The dominant substrate was 25% small cobble and surface fines were 11.3% (Figure 2). The total number of pieces of LWD per mile was 92.5 with a total of 65 single pieces (3.7/100m), 14 aggregates (0.8/100 m.), and 21 root wads (1.3/100 m.) (Table 14). Reach 3 had a dominant riparian class of Large Trees (Table 14). Rainbow, brook, and brown trout species were present in this reach (Figures 5, 6, and 7) and there was 14.9% overhead cover in snorkel areas.

Reach 8

Reach eight started 2 m. below the Mill B South Fork confluence, elevation 7080 ft. and ended 10 m. downstream of the Jordan Pines Campground Bridge. The total reach length was 1,4601.0 m. (Table 5) and contained a total of 102 habitat units (51 fast and 51 slow) (Table 1). The slow water: fast water velocity by count was 1:1 (Table 1) and by surface area was 1:1.93 (Table 3). Reach 8 was a confined channel with reach type A and a map gradient of 4.3%. The average flow was 1.55 m^3/s and was taken above and below the Mill B South Fork confluence. The average habitat width was 5.7 m. (Table 7) and the average habitat depth was 0.26 m. (Table 8). The habitats were composed of 61.8% riffles, 8.7% runs/glides, and 29.5% pools (Tables 11 and 12). The total number of pocket pools was 332 and there were 36.8 per 100 m with an average depth of 0.38 m. Reach 8 encompassed a total of 77.1 pools/mile. The stream banks were 87.4% stable overall with 7.5% undercut (Table 13). The dominant substrate was 24.9% small cobble and surface fines were 13.4% (Figure 3). The total number of pieces of LWD per mile was 563.8 with a total of 95 single pieces (6.5/100 m.), 38 aggregates (2.6/100 m.), and 23 root wads (1.6/100 m.) (Table 14). Reach 8 had a dominant riparian class of Shrub/Seedling (Table 14). Rainbow, brook, and brown trout species were present in this reach (Figures 5, 6, and 7) and there was 20.8% overhead cover in snorkel areas.

Reach 9

Reach nine started at the Jordan Pines Campground Bridge, elevation 7260 ft. and ended at the west end of the Spruces Campground Bridge, elevation 7360 ft. The total reach length was 1642.6 (Table 5) and contained a total of 91 habitat units (34 fast and 57 slow) (Table 1). The slow water: fast water velocity by count was 1:0.6 (Table 1) and the slow water: fast water by surface area was 1:1.23 (Table 3). Reach 9 was a moderately confined channel with reach type B and a map gradient of 2.0%. The average flow was 0.74 m^3/s and was taken above the Days Fork confluence. The average habitat width was 5.5 m. (Table 7) and the average habitat depth was 0.25 m. (Table 8). The habitats were composed of 38% riffles, 12.8% runs/glides, and 49.2% pools (Tables 11 and 12). The total number of pocket pools was 124 and there were 19.9 per 100 m with an average depth of 0.31 m. Reach 9 encompassed a total of 63.7 pools/mile. The stream banks were 76.7% stable overall with 32.1% undercut (Table 13). The dominant substrate was 27.1% small cobble and surface fines were 15% (Figure 4). The total number of pieces of LWD per mile was 308.6 with a total of 57 single pieces (3.5/100 m.), 18 aggregates (1.1/100m.), and 21 root wads (1.3/100 m.) (Table 14). Reach 9 had a dominant riparian class of Shrub/Seedling (Table 14). Rainbow, brook, and brown trout species were present in this reach (Figures 5, 6, and 7) and there was 13.6% overhead cover in snorkel areas.

DISCUSSION

Big Cottonwood Creek, as mentioned earlier in this paper, has been identified as a Class II Fishery with high aesthetic value and great importance due to its capacity to provide a strong resident trout fishery close to a metropolitan area. (USDA Forest Service 1999) Although resource use and development have been impacting the canyon since the 1800's and continues today, Big Cottonwood Canyon and its waters reflect an overall healthy ecosystem and a productive riparian community in the Wasatch-Cache National Forest.

In the User's Guide to Fish Habitat: Descriptions that Represent Natural Conditions in the Salmon River Basin, Idaho (Overton et al. 1995), natural condition descriptors of stream channel characteristics are listed. These figures can be compared to the 1999 Big Cottonwood Creek data along with statistics taken from the Inland Native Fish Strategy Environmental Assessment (INFISH, USDA Forest Service 1995). INFISH lists quantitative summary features used to describe good habitat for western anadromous and non-anadromous streams. It is important to note a few main differences between Natural Condition Descriptors and INFISH. The Natural Condition Descriptors explain what is representative in the field currently, but not necessarily the most optimal conditions. INFISH, however, describes desired future conditions for riparian zones to be achieved over time. Another main difference between these two stream descriptors is that INFISH does not account for channel type and topography in its estimates.

Big Cottonwood Creek's pools per mile were comparable to the natural condition descriptors. Reaches 2 and 3 with average wetted widths of 16.2 ft. (5.4 m.) and 24.0 ft. (8.0 m.), respectively, were within the standard error range of pools per mile. Reach 2 had 38.1 pools/mile as compared to 39.02 pools/mile in the natural condition descriptors and reach 3 had 24.1 pools/mile as compared to 22.66 pools/mile. Both reaches 8 and 9 had much higher pools/mile than the natural condition descriptors. Reach 8 with a wetted width of 17.1 ft. (5.7 m.) had 77.1 pools/mile as compared to 39.02 pools/mile in the natural condition descriptors. Reach 9 with a wetted width of 16.5 ft. (5.5 m.) had 63.7 pools/mile as compared to 39.02 pools/mile in the natural condition descriptors. The increased pools/mile in reaches 8 and 9 could be due to factors such as: high amounts of large woody debris, the presence of several large beaver dams, and the meandering habitat often seen in these areas. As for the INFISH statistics, reaches 2, 8, and 9 with wetted widths of 10-20 ft. should have had 96-56 pools/mile and reach 3 with a wetted width of 20-25 ft. should have had 56-47 pools/mile. Both reaches 2 and 3 fell short of the INFISH desirable characteristics for pools/mile.

Habitat percentages by area (Table 12) are a supplementary way to analyze pool habitat through pool: riffle ratios. By using the adjusted percent of habitat area (m^2) found in Table 12, the following pool: riffle ratios were calculated for reaches 2, 3, 8, and 9: 1:0.48, 1:2.3, 1:1.8, and 1.1:1, respectively. The Habitat Suitability Index Models suggest a pool: riffle ratio of 1:1 for optimal fish habitat conditions or at least 40-60% pool habitat. (Hickman and Raleigh 1982). Reach 9 had the most ideal conditions with 53% pools and 47% riffles. Reach 2 had almost twice as many pools than riffles with 68% pools and 32% riffles. Both reaches 3 and 8 had fewer than 50% pool habitat with only 30% and 36%, respectively.

Large Woody Debris (LWD) is another stream channel characteristic analyzed by the User's Guide to Fish Habit (Overton et al. 1995) and INFISH (USDA Forest Service 1995). Reaches 2, 3, 8, and 9 had 132.7 LWD/mile, 92.5 LWD/mile, 563.8 LWD/mile, and 308.6 LWD/mile, respectively. Reach 2 was below the natural condition descriptor of 189.80 LWD/mile for its wetted width, while reach 3 was within the standard of error range of 100.58 LWD/mile. Both reaches 8 and 9 were above the natural condition descriptor of 189.80 LWD/mile. The increased woody debris in reaches 8 and 9 may be caused by high amounts of log jams and beaver dams recorded in this area. INFISH lists the desirable LWD in forested systems as >20 pieces/mile (>12 inch diameter; >35 foot length). It is difficult to compare this characteristic to the 1999 Big Cottonwood Creek data because the LWD diameters and lengths were not recorded, however with the high amounts of LWD recorded in the reaches it seems that they would fall within the desirable characteristics. On a side note it is interesting to point out that reaches within Big Cottonwood Creek near the road had considerably less woody debris than those reaches that were more out of sight. It appears that those areas that were more easily accessible were heavily deforested in the 1800-1900's and continue to be stripped of trees for snow plowing purposes today.

A stream bed's width per depth ratio references it's ability to be a stable ecosystem by maintaining optimal temperatures in the summer and winter, providing deep pools and therefore better fish habitat. A low width per depth ratio is ideal in productive riparian areas. Big Cottonwood's width/depth ratio was calculated by dividing the reaches average wetted width by the average depth (Table 7 and Table 8). Reaches 2, 3, 8, and 9 had width/depth ratios of: 20, 23, 22, and 22, respectively. According to the classification key for natural rivers in Applied River Morphology (Rosgen 1996) all four Big Cottonwood reaches surveyed in 1999 would fall under stream type B and should therefore have a width/depth ratio of >12 which correlates with the field data found. The natural condition descriptor lists a width/depth between 4 and 22 as occurring most often. (Overton et al. 1995) However, in relation to the width/depth ratio of ≤10 in INFISH (USDA Forest Service 1995), all four reaches are below the objective value. There are significant influences to the stream channel within Big Cottonwood Canyon that would cause this undesirable elevated width/depth ratio. The mine activity of the 1800-1900's forced large amounts of tailings and sediment into the stream. Additional manipulations to the stream bed were caused by the construction and development of the canyon road, saw mills and mines, picnic and campground areas, residential houses, and the 2 ski resorts. Present and future management concerns should address the further riparian damage of winter road maintenance and additional recreation and residential site expansion.

Other influences to the width per depth ratio are the percent surface fines in the stream bed substrate composition and the percent stream bank stability. Reaches 2, 3, 8, and 9 had surface fine percents (Figures 1-4) of: 6.7%, 11.3%, 13.4%, and 15.0%, respectively. The natural condition descriptor (Overton et al. 1995) of 10-20% surface fines occurred most frequently. The Habitat Suitability Index Models (Hickman and Raleigh 1982) states the optimal spawning gravel for trout species is ≤5% fines, while ≥30% fines will cause low survival of embryos and emerging yolk-sac fry. All four reaches are above the optimal percent fines, but are well below the amount to cause mortality. It is important to note, however, the distinction between percent surface fines and percent fines. Surface fines are estimated by only looking at the fines at the top of the substrate, while fines are estimated within a column of material. Therefore, these surface fines estimates may be underestimated when comparing to fines estimates. Reaches 2, 3, 8, and 9 had stable bank percentages (Table 13) as follows: 78%, 83%, 87.5%, and 76.5%. This data was found by averaging the % stable bank left and the % stable bank right. The natural condition descriptor (Overton et al. 1995) was 93-100% bank stability, which suggests that the banks are somewhat degraded in Big Cottonwood Creek. INFISH (USDA Forest Service 1995) recommends >80% bank stability, which reaches 3 and 8 comply with and reaches 2 and 9 come very close to attaining. These figures may indicate that the stream bed has begun to recover from some of the land disturbing activities of the past and present.

In stream temperatures in Big Cottonwood Creek ranged from 6ºC to 13ºC (43ºF to 55ºF) during the survey. The most frequently observed natural condition descriptor temperature was 8ºC (46ºF) (Overton et al. 1995), while INFISH (USDA Forest Service 1995) lists a maximum temperature of <68ºF (20ºC) in compliance with state water quality standards. According to The Habitat Suitability Index Models (Hickman and Raleigh et al. 1982, 1984, 1986) the optimal temperature range for trout species is as follows: 12-15ºC (54-59ºF) for cutthroat, 12-18ºC (54-64ºF) for rainbow, 11-16ºC (52-61ºF) for brook, and 12-19ºC (54-66ºF) for brown. The survey data indicates that the water temperatures were within the range for the natural condition descriptor and INFISH, while stream temperatures may have been on the low end for the HIS models.

Big Cottonwood Creek snorkeling surveys indicated trout species in all four reaches. Rainbow trout (*Salmo gairdneri*) (Figure 5), brook trout (*Salvelinus fontinalis*) (Figure 6), and brown trout (*Salmo trutta*) (Figure 7) were all found in reaches 2, 3, 8, and 9. Bonneville cutthroat trout (*Salmo clarki utah*), the only trout native to the drainage, was not found in any of the four reaches surveyed in Big Cottonwood Creek in 1999. In the 1994 Big Cottonwood Creek Survey, only brook trout and hatchery stocked rainbow trout were found close to the Solitude Ski Resort above Reach 9. (USDA Forest Service 1999) In the 1997 Big Cottonwood Creek Survey, hatchery stocked rainbow trout, brook trout, and brown trout were all located in the stream. (USDA Forest Service 1999) Historically, however, the waters of Big Cottonwood Creek supported a healthy cutthroat trout population. In 1889 a fish hatchery began operation 1.5 miles east of Murray, UT. Fish eggs were obtained from native Bonneville cutthroat trout from Big Cottonwood Creek. (Sigler et al. 1987) This historic presence of the native trout leads one to question why Big Cottonwood Creek is not supporting a cutthroat population today? It is difficult to pinpoint one distinct answer to this question for it is more likely a combination of factors. As explained earlier in this paper, there have been significant influences to this riparian ecosystem over the years such as: mining and timber harvesting, which have resulted in sediment inputs and habitat loss. Couple these impacts with the current issues of road sediment, ski area and residential expansion, campground use, and over fishing. There is also the possibility of one single incident such as a chemical spill at the mines in the 1800-1900's that could have wiped out the entire population instantaneously. Another issue that further complicates matters is the stocking of non-native fish species by The Utah Department of Wildlife Resources. Currently UDWR stocks Twin Lakes with 2,500 cutthroat trout every other year, Lake Mary and Lake Catherine with 2,500 brook trout every other year, Silver Lake with 1,500 brook trout and 12,000 rainbow trout every year, and below Silver Lake with 12,500 rainbow trout every year. (USDA Forest Service 1999) The lake stocking is not as much of a concern due to all the downstream fish barriers preventing successful fish migration from the lakes to Big Cottonwood Creek, however the rainbow trout stocking below Silver Lake could be impairing the other trout populations. It would be beneficial to reintroduce the native Bonneville cutthroat trout to Big Cottonwood Creek in place of the stocked rainbow trout; creating a more natural and diverse riparian system.

PROJECT OPPPORTUNITIES

Throughout history rivers have been impacted with watershed activities that cause environmental stress and degrade water resource values. There is currently a rising interest in fish habitat improvement projects throughout the western U.S. that are focused on the maintenance of natural tendencies in river channel behavior. (Rosgen 1996) With today's growing population and watershed requirements, a balance needs to be created between consumptive uses of water resources and sustainable riparian systems.

Salt Lake City, Utah is a prime example of this theory. The population of Salt Lake valley is growing at a tremendous rate and so are the demands placed on watersheds and riparian systems such as Big Cottonwood Canyon. Salt Lake City is a unique metropolitan area with its close proximity to the Wasatch-Cache National Forest, therefore the management of Big Cottonwood Canyon and Big Cottonwood Creek must be designed to minimize the pressures of the city and the surrounding area.

According to Rosgen's applications table for management interpretations of various stream types (Rosgen 1996), Big Cottonwood Creek has a very low sensitivity to disturbance, sediment supply, and stream bank erosion potential. Additionally vegetation has a negligible influence to width to depth ratio stability and the system as a whole has an excellent recovery potential after causes of instabilities are corrected. (Rosgen 1996) This is useful information when considering future riparian improvement project opportunities.

Overall the main impacts to fish habitat quality observed in Big Cottonwood Creek were: sediment loading from the canyon road and areas of bank instability, bank slumping and erosion, and riparian vegetation degradation. Some of the most effected areas in the 4 surveyed reaches were the popular destination spots such as: Storm Mountain Picnic Area, Jordan Pines Campground, and Spruces Campground. Possible improvement projects could include: allowing fewer access points to the stream banks in affected areas, building of improved stream crossings, and riparian vegetation restoration. Additional management concerns are the rainbow trout stocking below Silver Lake, low instream flows in late summer through winter and the amount of water uptake by the Granite and Stairs Gulch Power and Treatment Plants, and the expansion of residential properties and ski area facilities. We need to carefully analyze our stocking policies and shift to the stocking of native Bonneville cutthroat trout as well as increase our instream flow requirements.

Rivers are the lifeblood of our civilization, we therefore need to carefully analyze the consequences of our actions and attempt to maintain ecologically sound riparian communities.

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APPENDIX

Information sheet for Big Cottonwood Creek, Wasatch-Cache National Forest.
Survey completed summer 1999.

Date Surveyed:	July 27, 1999 – August 15, 1999
County:	Salt Lake, Utah
Survey Length:	6,151.7 m.
Reach 2:	1,309.3 m. (Stairs Power Plant Flume - Storm Mountain Diversion Dam)
Reach 3:	1,738.8 m. (Storm Mountain Diversion Dam - Mill B South Fork Bridge)
Reach 8:	1,461.0 m. (Mill B South Fork confluence - 10 m. downstream of the Jordan Pines Campground Bridge)
Reach 9:	1,642.6 m. (Jordan Pines Campground Bridge - west end of the Spruces Campground Bridge)
Climate:	Mountainous climate with wide ranging temperatures. During the 1999 summer survey, air temperatures ranged from 10ºC - 22ºC (50ºF – 72ºF). Mean annual precipitation is 50 inches and from this 400 inches of total annual snowfall are measured. (USDA Forest Service 1999) Water temperatures ranged from 6ºC - 13ºC (43ºF – 55ºF) during the 1999 summer survey.
Elevation:	Headwaters 9600 feet Confluence with Jordan River 4250 feet
Riparian Vegetation:	Riparian vegetation includes: grasslands/forbs, shrubs/seedlings, saplings/poles, small trees, large trees, and mature trees.
Fish Species:	Rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), and brown trout (*Salmo trutta*)
Distribution:	Reach 2: rainbow trout, brook trout, and brown trout Reach 3: rainbow trout, brook trout, and brown trout Reach 8: rainbow trout, brook trout, and brown trout Reach 9: rainbow trout, brook trout, and brown trout
Management:	Summer recreation (sightseeing, hiking, picnicking, camping, rock climbing, biking, fishing, and seasonal hunting) Winter Recreation (skiing, and snowboarding)