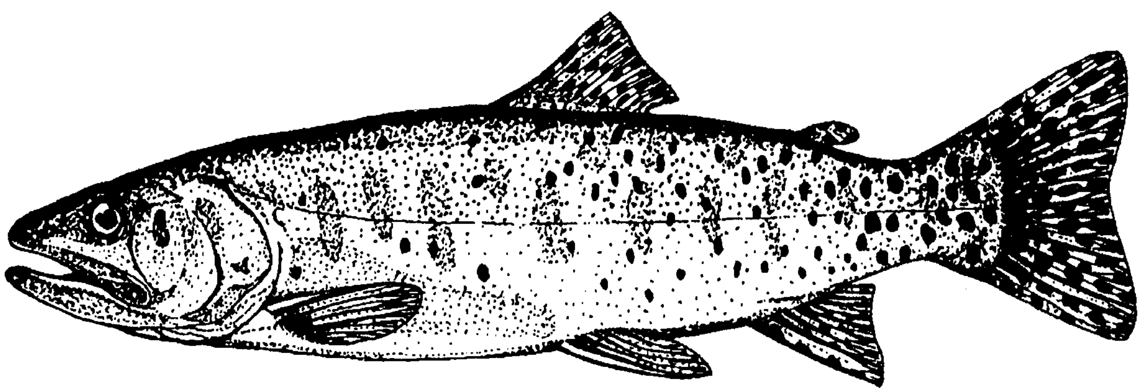
GREAT BASIN NATIONAL PARK

EAST SIDE FISHERIES

MANAGEMENT PLAN

MARCH 2000



Bonneville Cutthroat Trout
(Oncorhynchus clarki utah)

U.S. Department of the Interior
National Park Service

GREAT BASIN NATIONAL PARK
EAST SIDE FISHERIES
MANAGEMENT PLAN

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I. INTRODUCTION

Great Basin National Park (GRBA) is located in east central Nevada and encompasses 77,082 acres of the South Snake Range. The park was created in 1986 to preserve for the benefit and inspiration of the people a representative segment of the Great Basin of the Western United States possessing outstanding resources and significant geological and scenic values.

Fisheries management in GRBA focuses on two main issues: restoration and maintenance of native aquatic ecosystems to include introduction of the Western Bonneville cutthroat trout back into its native range and recreational fishing for the visiting public.

The Bonneville cutthroat trout (BCT) (*Oncorhynchus clarki utah*) is the only trout native to east central Nevada and it has experienced major declines caused by natural and man-related changes. This subspecies is endemic to the Bonneville Basin and it was once a native species in the streams on the east side of the southern Snake Range, which is now mostly encompassed within GRBA. BCT were abundant throughout glacio-pluvial Lake Bonneville and GRBA is located at the edge of the Snake Valley arm of this former lake. The Snake Valley arm was connected to Lake Bonneville during maximum water elevations and streams on the east side of the southern Snake Range were confluent with this arm. When Lake Bonneville's water level dropped, the Snake Valley arm population of BCT became isolated from the rest of the basin (Behnke 1976). Thus, the Snake Valley population has been geographically isolated from the eastern Bonneville Basin for at least 8,000 years. Such reproductive isolation allowed sufficient time for considerable genetic divergence and scientists suggest this population should be considered a unique race or group (Behnke 1988, 1992; Shiozawa *et al.* 1993); which is called the Western BCT (USDA Forest Service 1996). The presence of this unique race, the Western BCT, should be of concern for protection of remaining relic populations throughout the basin (USDA Forest Service 1996). Loss of connectivity to sub-basins, nonnative fish introductions, habitat fragmentation, and decreases in Western BCT populations throughout the Basin continue to threaten its recovery and may even preclude its future survival.

In 1979, the Fish and Wildlife Service (FWS) was petitioned to review the status of BCT. The FWS announced a status review of the BCT and requested comments in 1980 (45 FR 19857, March 26, 1980). In 1982, the FWS classified the BCT as a category 2 candidate species (47 FR 58454, December 30, 1982) and in 1985 reclassified the BCT as a category 1 candidate species (50 FR 37958, September 18, 1985). The FWS published a warranted but precluded finding for BCT because of higher priority actions in 1988 (53 FR 25511, July 7 1988). In 1991, BCT was included as a category 2 candidate species in an Annual Notice of Review (56 FR 58804, November 21, 1991) and the FWS reclassified the BCT as a category 2 candidate species in 1994 (59 FR 58982,November 15, 1994). The FWS amended their candidate policy and removed categories in 1996 (61 FR 7457, February 28, 1996). As a result of this action, BCT lost its candidate status and became a species of concern. Species of concern have no status under the ESA. With the loss of candidate status the BCT also lost its warranted but precluded finding. In 1997, an interagency conservation agreement and strategy was implemented in Utah. The FWS received a new petition to the list the BCT as a threatened species in 1998. The FWS found that the petition presented substantial information indicating that listing this species as threatened under the ESA may be warranted, and a status review was initiated (63 FR 67640, December 8, 1998). A determination by the FWS is anticipated in September 1999. GRBA, the Humboldt-Toiyabe National Forest (HNF), Nevada Division of Wildlife (NDOW) and the FWS are currently developing an interagency conservation agreement and strategy for the management conservation of BCT in Nevada. In addition, a rangewide conservation agreement and strategy is being developed to coordinate conservation activities throughout the range of BCT. The commitment by NPS to reintroduce BCT to GRBA will help forestall its listing under the ESA.

NDOW developed an interagency BCT management plan in 1987 in cooperation with the USDA Forest Service (FS) and Bureau of Land Management (BLM), for management and restoration activities in the Snake Valley-Spring Valley sub-basins (Haskins 1987). Following the plan's Implementation Schedule, reintroduction efforts have begun, and have been relatively successful, on the HNF in the northern Snake Range. Several streams slated for restoration work in the State plan are located within GRBA and the State's implementation schedule has been revised to begin work on these streams in 2000. The Park's desire to restore Bonneville Cutthroat trout to GRBA was highlighted in 1998 when Secretary of the Department of Interior, Bruce Babbitt, signed a memorandum of understanding (MOU) between Trout Unlimited (TU) and GRBA to work cooperatively on restoring native fish.

II. WESTERN BONNEVILLE CUTTHROAT TROUT IN GRBA

There are an estimated 30 miles of historic but vacant Western BCT stream habitat within GRBA and 56.5 miles, some of which is occupied by Western BCT, on the HNF. This gives a total estimate of 81.5 miles of historical BCT habitat within the Snake Range in Nevada. Based on the estimate that historically 90 percent of these stream miles contained Western BCT, now 94 percent of the Western BCT populations have been extirpated (USDA Forest Service 1996). Only one Western BCT population on the HNF, in Hendrys Creek, is a remnant population while the remaining four HNF and one BLM populations are transplants from this remnant population and the Pine/Ridge Creek populations.

Pure Western BCT occupy one stream system outside of their historic range within GRBA. Pine and Ridge Creeks, on the west slope of Wheeler Peak, are considered as one system because they are artificially connected by an irrigation ditch below the park boundary. The streams have a combined length of approximately five miles, two miles of which support fish, on GRBA and HNF before entering a ditch that flows onto land managed by the BLM. No historic stocking records exist for this stream system and it is assumed that Western BCT became established in Pine and Ridge Creeks via the Osceola Ditch, which ran from Lehman Creek on the east side of GRBA, or were planted by early settlers. A 1984 stream survey found 413 Western BCT per mile in Pine Creek and 316 per mile in Ridge Creek. As required by NPS Natural Resource Management Guidelines NPS-77, only pure genetic stock (either from Pine and Ridge Creeks or from Hendrys Creek in the northern Snake Range) will be used for reintroduction into historic waters in GRBA. These populations are assumed to be genetically pure but no scienctific testing has been conducted. GRBA is currently working with a researcher from the University of Nevada, Reno to conduct BCT genetic sampling of these populations.

A. Threats to the Species

Habitat alterations following human settlement of the area and the indiscriminate and widespread stocking of nonnative salmonids (brook, brown, and rainbow trout) are believed to be the causes that led to the complete extirpation of Western BCT from historic park habitats. The presence of these nonnative fish continues to be a threat to efforts for recovery of BCT. Other potential threats within the park include cattle grazing, loss of beaver, recreational fishing incidental to fishing for nonnative trout and catastrophic events (fire, flood and drought).

Loss of beaver from streams within the park has severely reduced the amount of deep-water habitat and in some watersheds has potentially reduced water quality and quantity and the health of riparian conditions. Beaver and beaver dams were removed from the streams in the belief that they were reducing downstream water quantity therefore impacting water rights. While their historic presence has not been confirmed, old beaver sign can be found in most canyons that have perennial flows.

Action Items:

- Reintroduce BCT into as many streams in the GRBA as possible to reduce the effects of catastrophic events. This is necessary due to limited metapopulation potential in GRBA.

- Verify or disqualify the historic occurrence of beaver on lands administered by GRBA through the use of dendrochronology. Old beaver use sign occurs in most perennial watersheds within the park. Increment bore samples will be taken from old beaver stumps at various locations (Baker Creek, South Fork Big Wash, Lehman Creek, and Strawberry Creek) in the park. Increment bore samples will be taken from live old trees of similar species adjacent to the beaver stumps. These samples will be cross-dated to determine the date when beaver downed the tree. Also, a complete search of NDOW's and other historical records will be commenced to find if they have information on the historic occurrence of beaver. If determined to be a native but extirpated species, develop a plan to reintroduce beaver into selected park watersheds.

Domestic livestock has occurred in the Snake Range for over 100 years and continues in the park to this day. Grazing in the park is managed according to Allotment Management Plans with standards that allow 45 percent forage utilization. These forage utilization standards are assumed to have minimized grazing impacts to riparian areas and stream channels. Little effectiveness monitoring and quantitative analysis has been conducted to support this assumption. If grazing is to continue along the stream courses proposed for Western BCT reintroduction, an adaptive management strategy needs to be considered and intensified efforts will be needed to assure compliance with prescribed utilization standards and adverse impacts to the aquatic ecosystems eliminated.

Action Items:

- Increase the monitoring of the 45 percent forage utilization standard to assure compliance and minimal impacts to aquatic ecosystems. Establish permanent forage utilization monitoring sites within riparian areas. Increase visitation and clipping and weighing techniques. Assure compliance. Photo-document all sites pre-, during, and post-grazing to assess vegetative recovery. Minimize or eliminate impacts to stream banks. Minimize sediment input into streams.

- If grazing of domestic livestock continues in the park, implement an early season grazing April thru May) strategy along potential BCT streams. Avoid "hot season" grazing (June thru August) of these streams. Cattle are reluctant to disperse from riparian areas during the hot season. This intensifies resource damage to riparian and aquatic ecosystems.

- Based upon monitoring results, utilize adaptive management to adjust grazing standards to mitigate any adverse impacts.

B. Status of Western BCT in GRBA

In GRBA, the Western BCT is considered a sensitive or special status species warranting special management due to the following facts:

- The species was endemic to the park and local vicinity and is the only fish native to the park. (see Native vs. Nonnative section of this plan).

- The species has been extirpated from all of its assumed historic range in GRBA due to the introduction of nonnative salmonids and human-caused habitat alterations.

- The purpose of establishing GRBA was to preserve a representative segment of the Great Basin of the Western United States. The recovery and maintenance of viable populations of salmonids native to the Great Basin region is consistent with the park's enabling legislation.

- The species is the subject of political concern and unusual public interest, as demonstrated by two petitions submitted to the FWS for listing under the ESA. The first petition resulted in a warranted but precluded finding in 1988, which means the species "deserves" to be listed but was precluded by other listing actions. The second petition resulted in a finding that listing may be warranted and a status review was initated.

C. Native vs. Nonnative

There is some debate as to the historic occurrence of Western BCT in GRBA. After considering the following information, which is somewhat anecdotal, it is logical to assume that Western BCT were native to the eastside streams of GRBA.

As discussed in the introduction, BCT were native to the glacio-pluvial Lake Bonneville basin (La Rivers, 1962). A bay of Lake Bonneville extended southward into Snake Valley to the latitude of Great Basin National Park. While the lake was at this maximum level, streams on the eastern side of the southern Snake Range drained directly into the lake. It is assumed that BCT populations would have migrated throughout suitable habitat within the entire water system, including these streams. It is also assumed that as the Snake Valley arm dried up in the basin, the BCT escaped upward into the mountain streams, forming isolated disjunct populations. A remnant population of Western BCT in the northern Snake Range proves that this was the case in at least one stream and it is logical to assume that fish would have been present in other streams that had been confluent with the Snake Valley arm.

First Euro-American entry into Snake Valley occurred in 1855 when Mormon expeditions explored Snake Valley for a few weeks. They were traveling light, completing a quick reconnaissance of the area, so it is unlikely that they brought any fish with them. Their reports to church leaders state nothing about stocking fish. It is almost certain that they stocked no fish at this time.

A second Mormon expedition, entering north of the present-day Eskdale, returned to Snake Valley in 1858 and members remained for a few months before returning to southern Utah. They planted grain and built rough buildings along Snake Creek near present-day Garrison, Utah, and along the meadows of Lake Creek to the south, testing the suitability of the area for permanent settlement. Documentation of the expedition is sketchy and incomplete, but descriptions of preparations and travel out from settlements say nothing about bringing fish from Utah. Exploration route maps drawn by expedition members show they went north up the Snake Valley as far as Salt Marsh Lake.

The earliest written reference to the presence of trout on the eastside of the Snake Range is as follows: Lieutenant George Wheeler, U.S. Army Corps of Engineers, led a reconnaissance and mapping expedition through eastern Nevada in 1869. In his report, he described the streams of the region as follows "A large number of the creeks are formed from the melting of the snows, which, among the higher ranges, feed a continuous stream for all seasons of the year. Others have their source in mountain springs of pure and limpid water. With hardly any exception the character of the water is very pure…It is very rare that one finds fish in any of these mountain streams. A few small trout were found to the eastward of the Snake Range." (Wheeler 1875:54). Wheeler wrote that his party camped on Snake Creek (1875:72) but the latitude and longitude provided in his report plot out to either Lehman Creek or Baker Creek, west of the present site of Baker, Nevada, and several miles north of Snake Creek.

The first Euro-American settlers made permanent homes in Snake Valley starting in 1868-1869. A report by settlers of fish in Lehman Creek was located: Laura Lehman Mellenbruch, born in 1871 to Absalom and Olive Lehman, was raised at Lehman Ranch (now known as Rowland Ranch), until she was nearly 10 years old. The ranch was located along Lehman Creek, below the mouth of the canyon, at an elevation of 6,200 feet. In an autobiographical sketch written in the 1940's, she related the following story about trout in Lehman Creek in the 1870s: "Mountain trout abounded in our streams and Frank and I had a novel way of catching them. Father had built a water wheel outside the milk house with which he churned the butter, 40 pounds at a time. The water would fall over the wheel, run through the calf pasture, and on down the valley. Father put a screen in the stream at the end of the pasture, so the fish had to stay there. In places the banks had washed from under the grass and it would hang down into the water. Behind this the fish would stay. Whenever my mother wanted fish for a meal she would say 'Run out and get 6 or 8,' or as many as she wanted. We would get a bucket and chase to the calf pasture, lie flat on the bank, draw our fingers into a fist, then sticking our thumb straight out, thrust it under the overhanging sod. When a fish tried to swallow our thumb, we just pressed it tight against the forefinger and pulled out our fish. It only took a few minutes to get the number we wanted." (Mellenbruch 1943) In 1881 Laura Mellenbruch moved to Ohio with her mother and brother, where she spent the rest of her childhood. It is unlikely that she confused the vivid and detailed memory described above with later events in Ohio.

Considering these references, we deduce that thousands of years ago, BCT migrated into streams on the east side of the southern Snake Range from the Snake Valley arm of Lake Bonneville. Earliest records of expeditions to this area do not contain any reference to stocking or moving of fish and due to the nature of these expeditions, it is prudent to assume that these early explorers did not bring any fish with them. Thus when Lieutenant Wheeler led his expedition to this area and found fish in the streams in 1869 they were most likely BCT.

In addition to the historic references cited above, recent planning documents have included assumptions that Western BCT are native to the east side of the southern Snake Range. An NDOW project proposal for the reintroduction of BCT, dated December 14, 1990, seeks cooperation with the National Park Service (NPS) in the introduction of BCT into Strawberry Creek which NDOW considered historic but vacant habitat. In the 1987 NDOW Bonneville Management Plan, Haskins states "(i)n Nevada, the historic range included the extreme eastern border areas of the State, including the east slopes of the Snake and Goshute, the Pilot Peak and the thousand Springs Creek drainage."

Great Basin's General Management Plan and accompanying Environmental Impact Statement states: "The Bonneville cutthroat trout is the only native trout in the streams of the park; it once inhabited all of the major streams on the park's eastern side. Because these streams have been disturbed by human actions, pure strains of Bonneville cutthroat trout no longer exist in the park's historic range."

III. PROPOSED MANAGEMENT ACTIONS

A. Western Bonneville Cutthroat Trout Reintroduction

1. Overview

Expansion of the current range of the Western BCT is necessary to reduce the possibility of extinction. This can be accomplished by translocating Western BCT into streams that are historic habitat but currently vacant or by renovating streams within the historic range that currently contain nonnative salmonids. GRBA proposes to initiate a multi-year process that reestablishes Western BCT into historic habitats within the park. GRBA has an estimated 25 miles of suitable fish habitat, a figure based upon 1980 fish surveys conducted by NDOW. Stream surveys conducted by T. C. Franz in 1953 found "native cutthroats" and nonnative trout much higher in the watersheds than the 1980 survey. It is therefore likely that the number of suitable stream miles in GRBA is significantly higher than the assumed 25 miles. GRBA proposes to eradicate nonnative salmonids from selected streams and to reintroduce pure native Western BCT into approximately 18 miles of stream, establishing 6 separate populations during the initial 10-year reintroduction plan. Due to the small closed watersheds that lack connectivity to other watersheds (limited metapopulation potential) within the Great Basin, enough populations must be established to prevent the loss of all populations due to man-caused and natural events such as fire, flood, and drought.

Considering recovery in the Snake Valley sub-basins, the Western BCT currently occupies only 1.5 percent of its historic habitat. As an example of Western BCT recovery needs, an estimated 102 stream miles (25 miles on GRBA, 47 miles on National Forest, 27 miles on BLM, and 2.5 on other lands) are estimated to be needed for viable Western BCT population recovery based on historical and current stream information. GRBA has the opportunity to provide 24 percent of the stream miles needed for recovery.

The entire 18 miles of proposed stream renovation and BCT reintroduction would take approximately 6 to 10 years to fully implement, but it has been divided into several individual stream reintroduction actions of shorter duration.

Action items:

- Survey selected stream ecosystems proposed for Western BCT reintroduction to document baseline conditions. Search for vulnerable native aquatic species that might be impacted by reintroduction efforts. Develop mitigation measures to minimize or eliminate these potential adverse effects.

- Through the Environmental Assessment (EA) process, consider impacts of the proposed plan and develop alternatives that minimize effects, and implement NPS-77 Resource Management Guidelines.

- If the EA indicates that the proposed reestablishment can proceed without significant impacts, eradicate nonnative trout populations from target streams and monitor to ensure that the eradication is complete.

- Introduce Western BCT from native genetic Snake Range stock found in Pine and Ridge creeks in GRBA or Hendrys Creek on the HNF. Two methods are proposed: 1) hard plants of adult fish and, 2) the placement of instream incubators.

- Establish protocols for maintaining healthy genetically viable BCT populations in streams that are selectedas donors. Protocols should follow the "American Fisheries Society Guideline for Introductions of Threatened and Endangeres Fishes."

2. Objectives

The objectives are to:

- Reestablish viable populations of Western BCT in GRBA. Establish enough separate populations so that natural or man caused events (fire, flood, and drought) does not lead to loss of all reintroduced populations within the park;

- Implement GRBA's enabling legislation and General Management Plan as they relate to native species and the Western BCT;

- Implement NPS-77 Natural Resource Management Guidelines as they relate to the management of native species, sensitive or special status species, and nonnative species;

- Assist with the conservation of a native species extirpated from GRBA and that has been petitioned for listing under the ESA. Establish enough separate populations so survival of the species is secured and maintained;

- Develop a conservation population or protected refugium population of BCT in the South Fork of Big Wash;

- Over time evaluate and develop the sport fishery potential of this unique species for the enjoyment of current and future generations. Implement the special 4(d) rule under the ESA that allows recreational fishing of a threatened species if ESA listing does occur. Work with FWS to develop fishing regulations.

3. Authority for Action

Western BCT are considered a native species to the east-side drainages of GRBA. NPS-77 Natural Resources Management Guidelines defines a native species as those animal species that occur, have occurred, or may occur in a park as a result of natural processes. Species that have moved into park environments directly or indirectly as a result of human activities are not considered native, except in cases where human activities accelerated native animal movements that would have occurred without human influence. NPS-77 Natural Resources Management Guidelines concerning the management of native species state:

> The National Park Service will seek to perpetuate the native animal life as part of the natural ecosystem of parks. (4:5)
>
> National Park Service will strive to restore native species to parks wherever all the following criteria can be met: Adequate habitat to support the species [at a viable population level] either exists or can reasonably be restored ..... The species does not ... pose a serious threat to [humans] .... The restored population most nearly approximates the extirpated subspecies or race .... The species disappeared ... as a direct or indirect result of human-induced change .... (4:10)
>
> The [restoration] of native ... animals will be accomplished using organisms taken from populations as closely related genetically and ecologically as possible to the park populations. (4:10)

The brook, brown, and rainbow trout stocked in park waters prior to park designation are considered nonnative species. The presence of these species has helped in the extirpation of Western BCT from their historic range within the park. In addition, these species have had unknown but potentially adverse impacts on other native aquatic life forms, such as amphibians and fresh water mollusks.

NPS-77 Natural Resources Management Guidelines concerning the management of exotic fish states:

> "Exotic fish pose a particular problem because their effects and their spread cannot be readily observed. Exotic fish may deplete or extirpate native invertebrates or fish by competition and/or predation and can affect the genetic integrity of native fish through interbreeding. The introduction of fish to fish-free waters can be devastating to natural aquatic ecosystems. Originally fish-free aquatic ecosystems can be so altered by fish

> introductions that they cannot recover once fish are removed. Complete and permanent removal of all fish in a water body is very difficult except in closed systems such as small lakes where toxins may be used, repeatedly if necessary, to kill the last survivors. Rotenone, antimycin, and other general pesticides can offer a potential control measure, under certain circumstances."

Bonneville cutthroat trout reintroduction is addressed in the GRBA General Management Plan. It states that:

> "The Park Service, in cooperation with the Nevada Department of Wildlife, would reestablish Bonneville cutthroat trout into selected streams on the east side of the park. Eastside streams would be selected on the basis of habitat suitability and the relative difficulty of removing existing nonnative fish species. Any competing nonnative fish species present in the streams selected for reintroduction would have to be eliminated to assure survival of the reintroduced trout and to protect the genetic integrity of the population. Special fishing regulations might be necessary to protect Bonneville cutthroat during and after their reestablishment. These regulations would be developed in cooperation with the Nevada Department of Wildlife. In addition, the impacts of grazing activities in the watershed would be carefully monitored to ensure that the fish would not be jeopardized.
>
> The Park Service would not permit stocking of nonnative fish species in the waters of the park. However, existing fish species remaining from past stocking activities would not be eliminated, except in streams selected for the reintroduction of Bonneville cutthroat trout."

4. Life History Information

BCT generally range in size from 2 to 9 inches long with lake populations reaching 30 inches. The back is yellow-brown to steel-gray with the sides lighter and the belly yellow to off-white (USDA 1991). A bright red stripe (or "cutthroat" mark) is present under each side of the lower jaw. The coloring of BCT is relatively subdued compared to other cutthroat trout, although some populations display bright reddish-orange spawning colors. BCT are sexually mature during the second year for males and the third year for females, although the age at maturity and the annual timing of spawning vary geographically with elevation, temperature, and life history strategy (Behnke 1992; Kershner 1995; May *et al.* 1978 in Lentsch *et al.* 1997). BCT living in lakes may begin spawning at two years and usually continue spawning through their lives, while individuals in rivers and streams can go for several years without spawning (Kershner 1995). Annual spawning of BCT usually occurs during the spring and early summer at higher elevations (Behnke 1992) at temperatures ranging from 4-10ºC (May *et al.* 1978). Little information exists regarding the fecundity of wild BCT (Lentsch 1997), but in general, trout fecundity is between 1,800 to 2,000 eggs per kilogram of body weight (Behnke 1992). Other wild cutthroat trout average 30 days of incubation (Gresswell and Varley 1988). Reproductive rates of BCT depend greatly on stream productivity and habitat conditions (Lentsch 1997).

Optimal cutthroat trout habitat in streams is characterized by clear and cool water, a silt-free rocky substrate in the riffle-run area, approximately a 1:1 pool-riffle ratio with areas of slow and deep water, well-vegetated stream banks, abundant instream cover, and relatively stable water flow, temperatures, and stream banks (Hickman and Raleigh 1982 in Jacobs and Flora 1994). More specifically, Hickman and Raleigh (1982) identified optimal cutthroat trout habitat as characterized by:

- Clear, cold water with an average maximum summer temperature of less than 22ºC (72ºF).
- An approximate 1:1 pool-riffle ratio.
- Well-vegetated, stable stream banks.
- 25 percent or more of stream area providing cover.
- Relatively stable water flow regime, less than 50 percent fluctuation from average annual daily flow.
- Relatively stable summer temperature regime, averaging about 13ºC (55ºF) with variations of about 4ºC (9ºF).
- A relatively silt-free rocky substrate in riffle-run areas.

5. Potential Reintroduction Resources

The streams to be considered for restoration efforts include: 1) Strawberry Creek; 2) Mill Creek; 3) Snake Creek; 4) South Fork of Big Wash; 5) Upper Lehman Creek; and 6) South Fork Baker Creek. The following are brief stream descriptions. The information is mostly qualitative in nature and shows the need for more quantitative analyses. The information was gathered from Frantz (1953); Frissell and Liss (1993); Greene and Mann (1997); Haskins (1987, 1988, and 1990); and Pfaff (1990-1996). Much of the stream characteristic information comes from Frantz (1953), which he collected in the fall of 1952. According to USGS discharge data from gaging stations on Baker and Lehman Creeks, 1952 recorded the highest discharge of any year between 1947 to 1993. Thus, reported estimates of size and discharge of the streams may be higher than average.

a. Strawberry Creek

Strawberry Creek originates at an elevation of approximately 9,600 feet and descends steeply through dense overhead cover, receiving water from small springs and seepages. Its upper reaches are intermittent. At 8,440 feet, it passes by the mouth of Windy Canyon, receiving water from an intermittent tributary, and enters the less steep foothill region. At 7,940 feet, it receives substantial flow from perennial Blue Canyon Creek. Strawberry Creek crosses the park boundary at 6,800 feet, then runs across HNF for about 0.25 mile. The stream enters BLM land at 6,720 feet where it exits Strawberry Creek Canyon and begins to traverse the bajada. It runs through a series of active beaver ponds at this point and in most years become intermittent. At 6,068 feet, he stream channel runs through a culvert under Highway 6/50. Shortly thereafter, at 6,000 feet, it is diverted for use on private agricultural lands. When the water is not diverted, it empties into Weaver Creek. The lower 1.4 miles of the stream may be dry during years of low precipitation. The stream is approximately 6.4 miles in length with 3.9 miles in the park, 0.25 miles on HNF, 1.25 miles on BLM and 1.0 mile on private land.

Valley Segment Classification – Three stream types are found within Great Basin National Park, according to Frissell and Liss (1993). Strawberry is the type that occurs in valley floors whose landforms are extensively shaped by alluvial processes. Quartzite and granite that weather into gravel- and sand-sized particles that are easily transported by fluvial processes dominate the geology. Sediment-rich channels have developed extensive alluvial fans and floodplains on wide valley floors. The typical sequence of valley segments is alluviated canyon, alluvial valley, alluvial fan-influenced valley complex, and alluvial fan delta. Scattered terrace-bound valleys, alluviated canyons, and bajada-filled canyons sometimes occur at lower elevations as well, depending on geologic structure of the slopes. Snake Creek and Big Wash are also examples of this stream type.

Fish Habitat – See Table 1. Strawberry Creek runs for approximately 3.9 miles within the park. In Haskins (1987), it was estimated that it flows between 1.5-2.0 cfs during non-runoff periods and Frantz (1953) estimated discharge at 1.5 cfs in October 1952. A survey in 1952 found 3.5 miles of confirmed fish habitat. No data are available for the length of fish habitat in the 1.4-mile Blue Canyon Creek. The lower 0.5-mile or more of Blue Canyon Creek could be year-round fish habitat. Surveys need to be completed to access the contribution of this stream to BCT reintroduction efforts. Including tributaries, there are approximately 5 miles of perennially flowing water in the Strawberry Creek system within the park. Spawning gravel was limited to small pockets of slow water. The upper and central elevations had good to excellent spawning sites, but spawning sites at the lower elevation are considered fair. Water quality sampling resulted in an average spring/early summer pH of 7.62, electrical conductivity of 72.6 µS/cm @ 25ºC, and temperature of 6ºC, with a range from 3 to 9ºC. The average fall pH was 7.73, average electrical conductivity was 109.2 µS/cm @ 25ºC, and average temperature was 4ºC, with a range from 2 to 6ºC (Table 2). The lower 1.4 miles of stream has an average gradient of 7 percent and a mid-elevation gradient of 8 to 10 percent. The upper elevation stream gradient averages greater than 10 percent.

The following information on pools was taken from Frantz (1953). At the upper elevations the pools are of the “pothole” type, narrow and just a little deeper than the average depth of the stream. In 1952, the average stream width was 4’2” and average stream depth was 3.2”. Pools at the middle elevations were often narrow and deeper than the average depth of the stream. Oblong plunge pools were present under some of the undercut banks. The middle section of the stream contains favorable over-wintering trout habitat. Old beaver use sign is quite common. Loss of beaver from this system has decreased the quality and quantity of deep-water fish habitat. At the lower elevations, there were a fair number of potholes; the quality will range from good to extremely poor (dry) depending on the water volume. Pool to riffle ratios were moderate at 40:60.

Streamside vegetation ranges from sagebrush and pinyon-juniper at the lower elevations to a mixture of aspen and white fir at the upper elevations. Water birch, willow, and rose provide close cover at varying densities from the upper to lower elevations. Overhead cover along the middle and upper elevations is dense and composed of aspen, white fir, Douglas-fir, water birch, willow, and aspen. About 70 percent stream shading was afforded by willow, rose, water birch, and grasses. Coarse woody debris in the stream offers good cover at middle and upper elevations; however, it is scant at lower elevations. Undercut banks are present along most of the stream, but susceptibility to erosion was low because of the stabilizing root mass.

The Strawberry Creek road is a major negative influence on the functionality of the stream. The functionality of approximately 1.25 miles of stream is being negatively altered by the encroachment of the road. The road has generated excessive sedimentation into the riparian area and in places has hemmed in the stream, acting as an unstable streambank. The remainder of Strawberry Creek, as well as the streams coming out of Windy and Blue Canyons and off of Bald

Mountain, are classified as Aa stream types, are relatively unimpacted, and are in Proper Functioning Condition. Domestic livestock grazing has occurred along Strawberry Creek for over a century, but no major adverse effects to the stream due to grazing have been recently documented. Several undeveloped campsites are situated along the stream and road, but it has not yet been determined what if any adverse effect they are having on the stream.

Action Items:

- Work with the park Maintenance Division to eliminate adverse effects of the Strawberry Creek road on aquatic resources. Prevent barriers to fish passage by redesigning upper road crossing culverts. Assess and correct road maintenance practices that result in sedimentation of the stream.

- Assess and redesign unplanned dispersed campsite developments to minimize adverse effects to the aquatic resources.

Stocking History – Available records indicate that rainbow trout were stocked in Strawberry Creek from 1919 to 1971. The number planted per year averaged 1,181 and ranged from 573 in 1952 to 2,000 in 1940. The average size of fish in each stocked group ranged from four to nine inches. Some stocking took place between 1953 and 1971 however data are incomplete.

Results of Surveys - A stream survey in 1952 recovered cutthroat trout (subspecies not identified) at the upper elevations, brook trout at the middle elevations, and rainbow trout at the lower and middle elevations. Brook and rainbow trout were recovered on BLM land, at a station located somewhere between 6,000 and 6,720 feet in 1984. An electroshocking survey was conducted in 1989 and rainbow and brook trout were found at lower elevations. Rainbow trout and apparent cutthroat/rainbow hybrids were found just below the second road crossing at 7,920 feet in elevation. The last fish were found approximately 0.25 miles above the third road crossing at the 8,400-foot elevation. This population of BCT is considered hybridized because of the concurrent presence of rainbow trout.

b. Mill Creek

Mill Creek has often been overlooked as a fishery and there is little data pertaining to this stream. It is a relatively low discharge stream, with no significant roads or trails adjacent to the stream, although the Osceola Ditch crosses it at 8,221 feet. Seasonal variations in discharge appear to be less then any other perennial stream in GRBA. It has never flooded and does not dry up within the park boundary. Mill Creek originates at 9,200 feet and runs for approximately 1.8 miles within the park, descending steeply through dense forest. A small tributary at 8,200 feet feeds it. At 7,560 feet, it crosses the park boundary onto HNF. At 7,220 feet it enters onto private lands and collects in a pool that is fed by a small tributary from the north. From there it descends 120 feet into another pool, then continues downward and back onto to lands administered by the HNF. At 6,610 feet, Mill Creek becomes intermittent and crosses from HNF to BLM land and enters alluvial fan outwash.

Valley Segment Classification - No quantitative data are available. Geology of this basin is quartzite and similar to Lehman Creek.

Fish Habitat – See Table 1. A survey in 1952 found 1.0 mile of confirmed fish habitat. No data are available for the length of potential fish habitat, quality or existence of spawning areas, amount or type of cover, gradient, discharge, pool-to-riffle ratios, or stocking history. Most of the stream is associated with a narrow riparian zone. Negative impacts due to grazing were determined to be minor in 1997. The entire stream was determined to be in Proper Functioning Condition. Water quality sampling found an average spring/early summer pH of 7.53, electrical conductivity of 58.5 µS/cm @ 25ºC, and temperature of 12ºC, with a range from 8 to 14ºC. The average fall pH was 7.49, average electrical conductivity was 60.7 µS/cm @ 25ºC, and average temperature was 3ºC, with a range from 1 to 3ºC (Table 2).

Results of Surveys - In 1994 a survey of Mill Creek found fish expressing cutthroat characteristics, fish that appeared to be influenced by rainbow, and those which were clearly rainbow trout. This population appears to be similar to other populations in the Snake Range that probably contained pure BCT at one time, but had nonnative trout stocked onto them, and should be considered hybridized (Haskins 1990). There are no stocking records for the stream.

c. Snake Creek

The Snake Creek System is composed of North, Middle, and South Forks of Snake Creek and is one of the larger, more complex systems proposed for BCT reintroduction efforts in GRBA. We plan to reintroduce Western BCT into Snake Creek above the barrier of the artificial pipeline diversion, which is discussed in further detail below.

The North Fork of Snake Creek originates in steep, densely forested terrain from a spring at 9,280 feet (upper elevations). As it descends through the forest, this fork is fed by small springs and seeps. At 8,800 feet, the gradient decreases and continues doing so as the elevation decreases. The Middle Fork joins the North Fork at 8,620 feet. At 8,520 feet, Snake Creek passes by Shoshone Campground, a primitive camping area, and then parallels a maintained gravel road and numerous primitive campsites. At 8,100 feet (middle elevations) Snake Creek is directed under the road through culverts, and is immediately joined by the outflow of the South Fork.

An artificial diversion diverts the entire stream flow into and through a buried pipe from 7,610 feet to 6,760 feet, a distance of almost three miles. During periods of low flow the pipeline contains all of the Snake Creek flow, forming a barrier to fish migration. During periods of high flow the long vertical drop at the overflow structure at the inlet to the pipeline provides a barrier to upstream movement of fish. We will consider Snake Creek for reintroduction of Western BCT only above this diversion. Thus, what if anything is left of stream below the pipeline inlet will not be considered in this report except for the following brief description. The diversion was installed by the water user in the community of Garrison, UT in cooperation with the HNF. The belief was that water was lost due to the karst geology of Snake Creek and the pipeline would prevent this loss. No dye testing has ever been conducted to substantiate this claim. The legal point of diversion for the Snake Creek water right is located in Utah. This could become an issue if the BCT is listed under the ESA and Snake Creek is included in a Critical Habitat designation. Testing should be conducted to substantiate the need for and effectiveness of this pipeline. Recovery of this three miles of trout habitat would greatly enhance both BCT recovery efforts and recreational fishing opportunities in GRBA. In addition to the loss of fish habitat, the pipeline has adversely affected the entire aquatic ecosystem. Riparian area vegetation is also showing downward trending signs due to then loss of water.

A short tributary arising from Tilford Spring could contribute to the flow of Snake Creek at 7,160 feet but is diverted directly into the pipeline. At 6,760 feet the pipeline empties into the Snake Creek stream channel. The stream crosses the park boundary at 6,190 feet, then enters HNF. It exits the canyon and HNF at 5,940 feet, entering the higher slopes of Snake Valley bajada (lower elevations). Shortly thereafter it passes a Nevada State Fish Rearing Station. Just below the Rearing Station, 0.9-mile-long Spring Creek joins Snake Creek at 5,870 feet. The stream enters Millard County, Utah at 5,352 feet and the entire flow is diverted for private irrigation systems just west of Garrison, Utah. The total length of the stream is 15 miles.

The Middle Fork of Snake Creek originates at the outlet of Johnson Lake at 10,800 feet. Shortly below this outlet the stream disappears, with several intermittent channels continuing on. At approximately 9,640 feet, to the northwest of Dead Lake, an apparent perennial spring source flows into the Middle Fork, from which point the stream can be classified as perennial. It flows south of Dead Lake, with no outflow from this lake, increasing in velocity as it passes through a deeply cut ravine, and eventually joining with the North Fork at 8,620 feet. The total length of this fork is 3 miles. In 1952, the average stream width was 3 feet and the average stream depth was 3 inches.

The perennial portion of the South Fork of Snake Creek originates at a spring at approximately 8,800 feet. Its flow is augmented by contributions from seepage areas and a small tributary located to the southwest until, at 8,100 feet, this fork joins Snake Creek. The approximate length of the South Fork is 2 miles and in 1952, the average width was 4 feet 11 inches, and the average depth was 3.6 inches.

Valley Segment Classification – See Section IV.4.a. Strawberry Creek.

Fish Habitat – See Table 1. The total length of Snake Creek within GRBA, including all forks, is 10.16 miles with 8.16 above ground and 5.35 miles of confirmed fish habitat. No data is available for total length of estimated suitable fish habitat.

Rock and rubble are present along the entire streambed length of Snake Creek. The upper and middle elevations contain sand and gravel bed substrate as well. At the middle elevations, silt is prominent in some areas, particularly along bank margins. Spawning sites are numerous and of good quality at the upper and middle elevations. Small spawning areas are numerous along the entire stream length. The South Fork streambed is composed mainly of large rocks, with a few areas of gravel and sand.

Numerous good quality pools are present at the upper elevations, although most of them are not very wide. Pool quality in the middle elevation ranges from fair to good. Adequate, although not numerous, riffle areas are present along the entire length of the stream. No pool-to-riffle ratios have been calculated for any portion of Snake Creek. Estimated discharge in September 1952 was 5.2 cfs. The pools in the 0.25-mile stretch of the Middle Fork below the outlet of Johnson Lake are too small to support fish. From the mill site to where this fork becomes intermittent, pools are good and relatively numerous considering the width of the stream. Many of the pools in this section are wider and deeper than the average width and depth of the stream.

This section could conceivably support small to mid-sized trout. Below the area of the three springs the pools are of excellent quality—large and deep and follow in a series for 0.25 miles. Below this, the pools range from fair to excellent. Riffles are poor along the series of small pools. Riffles along other stretches of the stream are few. In the South Fork, upper elevation pools are numerous and of fair quality. Most are narrow and shallow and are located below a series of boulders. The lower elevation pools are also numerous and of higher quality than those at the upper elevations. They are wide and deep, providing satisfactory cover for trout. Riffle areas are infrequently encountered at the upper elevations, and somewhat more numerous at lower elevations.

Overhead tree cover is excellent in the upper elevations with aspens, white fir, Douglas-fir Englemann spruce dominating. At middle elevations, willow, water birch, and cottonwoods are numerous, while at lower elevation; willows, rose and sagebrush are dominant. Other common plants along the stream bank are squawbush, rabbit brush, rose, pinyon, and juniper. Undercut banks, large rocks, coarse woody debris, and other vegetative debris provide good shelter particularly at the middle and upper elevations.

From the headwaters of Snake Creek to the pipeline outlet at 6,760 feet, a distance of 5.8 miles, the average gradient is 6.9 percent. Upper elevations of the Middle Fork have an average gradient of 12 percent. In the steep ravine below Dead Lake, for a distance of about 0.3 miles, the gradient is 25 percent. In all other areas the gradient is more moderate and averages between 8 to 15 percent. There is no data available on the gradient of the South Fork. Water quality sampling results show an average spring/early summer pH of 7.81, electrical conductivity of 86.2 µS/cm @ 25ºC, and temperature of 7ºC, with a range from 4 to 11ºC. The average fall pH was 7.77, average electrical conductivity was 94.1 µS/cm @ 25ºC, and average temperature was 3ºC, with a range from 2 to 5ºC (Table 2).

Table 1. Stream lengths and characteristics on east side of southern Snake Range within GRBA. Confirmed and potential fish habitat estimates are from NDOW's 1990 survey (Haskins 1990) when available; otherwise from Frantz* (1953) or in the case of S. Fork of Big Wash, from Greene and Mann (1997). All other estimates are from Frantz (1953). nd = no data available

STREAM	Tot. Length (miles)	Confirmed Fish Habitat (miles)	Potential Fish Habitat (miles)	Avg. width (inches)	Avg. depth (inches)	Avg. Gradient	Discharge (cfs)	Pool:riffle Ratio
Strawberry	5.31	3.5*	nd	50	3.2	7-10%	1.5	40:60
Mill	1.83	1.0*	nd	nd	nd	nd	nd	Nd
Snake	10.16	5.35	nd	73	5.7	7-25%	5.2	Nd
Big Wash	4.25	0.0	3.0	57	3.1	6%	1.9	Nd

S. Fk. Baker	2.72	2.22	2.62	52	3.2	11%	1.8	Nd
Baker	6.66	3.24	5.95	89	5.2	9-12%	5.2	Nd
Lehman	6.49	4.74	6.49	78	4.9	7-11%	5.7	Nd
TOTALS:	**34.42**	**20.05**						

Table 2. Average pH, electrical conductivity, and temperature for selected east-side GRBA streams and lakes for spring/summer 1993, 1995, and 1996; and fall 1991-1995 (except temperature which is from 1993-1995) (Pfaff 1990 – 1996). Snake Creek averages were calculated only from the 3 sampling stations above the diversion. nd = no data available.

STREAM/LAKE	SPRING/SUMMER			FALL		
	pH	Conductivity (μS/cm @ 25ºC)	Temp. (ºC)	pH	Conductivity (μS/cm @ 25ºC)	Temp. (ºC)
Strawberry Creek	7.62	72.6	6	7.73	109.2	4
Mill Creek	7.53	58.5	12	7.49	60.7	3
Snake Creek	7.81	86.2	7	7.77	94.1	3
S. Fork Big Wash	8.12	359.7	8	8.23	329.5	6
S. Fork Baker Creek	nd	nd	nd	nd	nd	nd
Baker Creek	7.28	30.3	7	7.32	35.6	3
Lehman Creek	7.45	34.5	8	7.42	39.5	4
Baker Lake	6.58	11.5	5	7.54	16.2	4
Johnson Lake	6.63	20.5	4	7.60	34.7	5

Two man-made structures are having potentially significant impacts on Snake Creek. One is the dirt road that hems in the stream along several reaches and is especially problematic along about 4 miles of stream. The other structure is the water diversion: at the point of diversion, a dramatic change in streambank vegetation occurs. There is a change from mesic riparian species above the diversion to xeric species below with the pinyon-juniper woodland community rapidly encroaching on the stream. Most of Snake Creek was determined to be in Proper Functioning Condition, except for 3.75 miles, which are downward trending due to the combination of the road and the diversion. Grazing occurs along Snake Creek, but was not determined to be having a recent adverse effect on the stream. However, no effectiveness monitoring has been conducted to assess the effects of the new grazing allotment management plan.

Action Items:

- Work with the park Maintenance Division to eliminate adverse effects of the Snake Creek road on aquatic resources.

- Assess and redesign unplanned dispersed campsite developments to minimize adverse effects to the aquatic resources.

- Seek technical assistance from U.S. Geologic Resources and NPS Geologic Resource division to assess the impacts of the pipeline diversion. Initiate dye studies to verify actual loss of water and recovery down stream

- Work with and involve water user in Garrison, Utah to facilitate studies.

- Work with and involve water user in Garrison, Utah to restore minimum instream flow.

Stocking History - Between 1925 and 1986, Snake Creek was stocked with black spotted (Lahontan cutthroat), rainbow, and brook trout. Existing records indicate that black spotted trout were stocked during four years, brook trout during five years, and rainbow trout during 59 years. No records have been located to show when brown trout were planted. Yellowstone cutthroat trout were stocked in the Middle Fork in 1951 and brook trout in 1953 and 1957. Yellowstone cutthroat trout were planted in the South Fork in 1951, cutthroat trout in 1952, and brook trout in 1953 and 1957.

Results of Surveys - A stream survey in 1952 found rainbow, brown, and brook trout at the middle and upper elevations of Snake Creek. In 1960 rainbow and brook trout, as well as sculpin were found at the lower elevations. In the 1984 survey brook and rainbow trout were recovered from the upper elevations, and brown and rainbow trout from the middle elevations. In 1990 brook trout were encountered at the middle and upper elevations, and rainbow trout were found below the pipeline diversion. In the Middle Fork, fish were noted in 1984, but no electroshocking or identification was done. In 1954, four rainbow trout were recovered from 150 feet of the South Fork.

d. South Fork of Big Wash

The South Fork of Big Wash stems from a large spring on a south-facing slope at an elevation of about 8,420 feet. This flows through a deep gorge acquiring additional water from seepage areas and one larger spring at a lower elevation for approximately 0.5 mile. Approximately 0.6 miles within the gorge are surface flow is lost due to the geologic nature (limestone) of the channel for At 7,880 feet the stream resurfaces and continues down the canyon for approximately 2.0 miles. The majority of the gorge gains from several springs along the northern wall of the canyon, and is perennial, as indicated by the dense woody riparian vegetation. This flow, though fairly strong for a period, eventually dies to a trickle near the 7170-foot elevation near the mouth of the gorge. Below the gorge, the channel is dry and there is a shift to drier vegetative species (white fir and juniper) with large debris and sediment dams present. A spring at about 6,950 feet in elevation creates a perennial flow of water, as evidenced by a shift in vegetation back to dense riparian species. At 6,860 feet, the stream flows out of GRBA and onto HNF and shortly afterward, at 6,760 feet, onto private land. At 6,720 feet, South Fork joins the dry North Fork of Big Wash and then flows through a series of narrow fields in a wide canyon. Toward the upper end of this wide canyon, additional water flows into the stream from several springs and seepage areas. Beyond this point the stream flows through a wide ravine cut into the bajada. At an elevation of 5,560 feet, the stream enters Millard County, Utah, and empties into Pruess Lake at 5,380 feet.

Valley Segment Classification – See Section IV.4.a. Strawberry Creek.

Fish Habitat – See Table 1. The South Fork has a total length of approximately 4.25 miles within GRBA and in 1952 had an average stream width of 4 feet 9 inches and a stream depth of 3.1 inches. The South Fork of Big Wash has approximately 2.5 miles of outstanding fish habitat and 0.5 mile of marginal fish habitat. Big Wash is 9.5 miles in length with 7.5 miles in Nevada and 2.0 miles in Utah. The South Fork could be naturally fishless, although reports confirm that fish were in Big Wash in the 1950's. In 1952 a local rancher living next to Big Wash claimed that there had never been any fish in the South Fork, although Big Wash had fish. A flood down the South Fork of Big Wash occurred in 1952 and the same rancher reported that his irrigated field were littered with cutthroat trout. This flood could have extirpated all fish within this system. Due to the extremely remote and rugged nature of this system, little aquatic analysis has been conducted. Further research into its possible fishless nature is required prior to any Western BCT reintroduction efforts.

The average velocity of the stream in 1952 was 1.6 feet per second and the volume flow was 1.9 cfs. Pools are numerous and of excellent quality, wide and deep. No pool-to-riffle ratios have been calculated. The stream bed is composed of rocks, rubble, and gravel, although some sand and mud are present.

The upper elevations of the stream are surrounded by dense stands of aspens, white fir, ponderosa pine, Douglas-fir, rocky mountain maple and dogwood. Cottonwood, dogwood and rose are dominant at the lower elevations. Other common vegetation along the stream is chokecherry, willow, water birch, juniper, pinyon pine, squaw bush, and raspberry. Close cover was created along the stream by overhanging dogwood, rose, and chokecherry. Undercut banks are present along many sections of stream. The walls of the gorge are 400 feet or more in height and add shade to the stream most of the day.

Spawning conditions are good along many sections of stream. Aquatic invertebrate abundance was fair to good. Waterfalls at the park boundary on the South Fork would serve as impassable barriers to the upward migration of fish. The average gradient was 6 percent. The stream was determined to be in Proper Functioning Condition. Domestic livestock grazing has not officially occurred on South Fork of Big Wash since 1990 although cattle have been found along the stream in recent years. This unauthorized trespass cattle grazing is infrequent and grazing is not considered to be having adverse impacts on the stream. Water quality sampling resulted in an average spring/early summer pH of 8.12, electrical conductivity of 359.7 µS/cm @ 25ºC, and temperature of 8ºC, with no variation. The average fall pH was 8.23, average electrical conductivity was 329.5 µS/cm @ 25ºC, and average temperature was 6ºC, with a range from 4 to 7ºC (Table 2).

Stocking History – No stocking records have been found.

Fish Survey Results - No fish were found from one sample site near the park boundary on South Fork of Big Wash in 1952 although brook trout were found in Big Wash about 1 mile below the confluence of North and South Fork.

Action Item

- Initiate research into the possible fishless nature of the South Fork of Big Wash prior to any Western BCT efforts.

e. South Fork Baker Creek

South Fork arises from a large basin that is created by the combined flow of several small springs at an elevation of about 9,880 feet. It descends at a moderate to steep gradient through dense forests to Lions meadow at 8,880 feet where it divides into two channels for the length of the long, almost level meadow, reuniting at the lower end (8,840 feet). Near the point of confluence with Baker Creek, Timber Creek flows into South Fork, and the combined flow empties into Baker Creek at 8,040 feet.

Valley Segment Classification - Baker Creek is classified as the type that has an extensive history of alpine glaciation and coarse-grained debris flows all the way to the basin floor. Geology is dominated by quartzite and granitic rocks that yield hard, boulder-sized and cobble-sized clasts on weathering. Valley segments grade from bedrock canyons, incised moraine-filled valleys in headwater areas to leveed outwash valleys in downstream areas, finally splaying onto extensive alluvial fan deltas. Lehman Creek was also placed in this category.

Fish Habitat – See Table 1. The South Fork of Baker Creek has 2.3 miles of confirmed fish habitat (1952, 1990) with an estimated 2.6 of potential fish habitat (1952). Both combined and split channels are found. Bank stability is good at upper elevations and lower elevations and fair at middle elevations. Cattle grazing is having significant impact on the meadow areas of South Fork Baker Creek. Damage due to over utilization of forage, heavy hoof action and lack of compliance monitoring is especially apparent on banks of spring channels and steep slopes above the stream.

The streambed of the upper and middle elevations is composed of small rock and gravel, with some sand present. At the lower elevations (below the lower end of the meadow), the streambed is very rocky. There is some gravel and sand present, particularly near the Baker Creek South Fork confluence. The upper elevations have numerous spawning areas, many of exceptional quality. The middle and lower elevations have satisfactory spawning areas. Pools and riffles are numerous along the entire length of the stream, and are of fair quality. The majority of the pools are small potholes interspersed with a few deep and narrow ones. Riffle areas are of good abundance and quality at the upper and middle elevations. The lower elevations have fewer riffle areas, mostly along bank margins. No pool-to-riffle ratios have been calculated.

Except in those areas impacted by cattle grazing, overhead cover is good along the entire length of the stream, afforded by dense stands of aspens, white fir, Englemen spruce, Douglas-fir, willow and rose. There are no trees in the meadow and intensive cattle grazing removes all cover that might be afforded by grasses. At the uppermost elevations, undercut banks and coarse woody debris offer some cover in areas. At the middle and lower elevations, coarse woody debris, large rocks and undercut banks present satisfactory cover.

The gradient is moderate to steep throughout the stream's length, except in the meadow where it is very slight. The average gradient is 10.7 percent. No water quality data have been collected from South Fork Baker, but data have been collected from the main channel of Baker Creek (Table 2). In 1952 the average width was 4 feet 4 inches, average depth was 3.2 inches, and approximate discharge was 1.8 cfs.

Stocking History - See the section under Baker Creek for information regarding stocking and survey results in the main channel of Baker Creek

Results of Surveys – Rainbow trout were found during a survey in 1952. A 1990 survey recovered brook and rainbow trout and one hybrid cutthroat trout. No fish were found in stations above the meadow although suitable habitat exists

6. Interdependent and Interrelated Effects of Reintroduction

NPS-77 Natural Resources Management Guidelines concerning the management of native species states:

> "The National Park Service will seek to perpetuate the native animal life as part of the natural ecosystem of parks. (4:5)
>
> The National Park Service will strive to protect the full range of genetic types (genotypes) native to plant and animal populations in the parks by perpetuating natural evolutionary processes and minimizing human interference with evolving genetic diversity. (4:10)"

Currently, no information is available concerning amphibians in GRBA. The worldwide decline of amphibian health and population numbers is of international concern. The use of fish toxins could have a significant adverse effect on native amphibians if not designed to minimize or eliminate these potential adverse effects. There is thus a compelling need to initiate an investigation about this faunal component, in order to better protect and conserve it. In order to meet NPS-77 guidelines, surveys are essential to develop a species list to best protect known amphibians from the effects of antimycin and/or rotenone. Using life history information will help plan stream treatments to have the least impact to the most species. Absence, however, is extremely difficult to determine: "the absence of evidence is not the evidence of absence" (Anon). A faunal list of amphibians is a management tool, and can be used to protect them through knowledge of their life histories and habitat use.

A literature review (Pfaff 1996) developed a list of amphibians potentially occurring in GRBA. Some of the suspected species are themselves former candidate species for listing under the ESA.

The following summarizes those amphibians suspected to occur in GRBA:

- Tiger Salamander (Ambystoma tigrinum) *Distribution*: Expected to occur in or near GRBA (Pfaff 1996); however, absent from most of Great Basin (Stebbins 1985). Ranges from sea level to 12,000 feet in Rocky Mountains.

- Great Basin Spadefoot Toad (Scaphiopus intermontanus) *Distribution*: Occurs throughout most of Nevada and in the Great Basin (Stebbins 1985); expected to occur in or near GRBA. One specimen collected 2 miles west of Baker, Nevada; specimen located in Nevada State Museum. Up to 9,200 feet.

- Western Toad (<u>Bufo</u> <u>boreas</u> <u>boreas</u>) *Distribution*: Occurs throughout most of Nevada. Reportedly collected in White Pine Co., but not near GRBA. Sea level to >11,800 feet.

- Woodhouse Toad (<u>Bufo</u> <u>woodhousei</u> <u>woodhousei</u>) *Distribution*: Expected to occur in or near the Park. Atlantic Coast to southeastern Washington, western Utah, and southeastern California. To 8,500 feet.

- Pacific Treefrog (<u>Hyla</u> <u>regilla</u>) *Distribution*: Occurs in most counties in Nevada. From British Columbia to tip of Baja California, east to western Montana and eastern Nevada. Sea level to 11,600 feet.

- Western Leopard Frog (<u>Rana</u> <u>pipiens</u> <u>brachycephala</u>) *Distribution*: Occurs in northern two-thirds of Nevada. Expected to occur in or near GRBA. Specimens have been collected in Spring Valley at Shoshone (reposited in California Academy of Sciences) and Cleveland Ranch (reposited at University of California Museum of Vertebrate Zoology).

- Northern Leopard Frog (<u>Rana</u> <u>pipiens</u>) *Distribution*: Most of Nevada. Occurs from sea level to 11,000 feet. Identified in Shoshone Ponds within Spring Valley in 1997.

- Spotted Frog (<u>Rana</u> <u>luteiventris</u>) (Banta (1965) lists <u>R</u>. <u>pretiosa</u> <u>luteiventris</u>, the Nevada Spotted Frog, as inhabiting the streams and meadows within the Humboldt River Valley). If the spotted frog occurs in GRBA, it is more likely to be <u>R</u>. <u>luteiventris</u>, the Columbia spotted frog, than <u>R</u>. <u>pretiosa</u>, the Oregon spotted frog (Olson, personal communication). *Distribution*: A U.S. Fish and Wildlife Service candidate taxon. Possibly occurs in or near GRBA. Populations occur in northern and central Nevada (Stebbins 1985) and (USDA Forest Service 1994). Sea level to 10,000 feet.

Action Item:

- Survey selected streams for the presence of amphibians prior to any renovation treatments. Utilize the methodology found in the "Great Basin National Park Aquatic Monitoring Protocols" handbook. Investigate life histories of those species found. Design stream treatment and other mitigation measures to minimize or eliminate any adverse impacts to these species.

In 1998 the NPS, NF, U.S. Geological Survey, The Nature Conservancy, and BLM entered into an MOU with the FWS to manage for the conservation and recovery of Great Basin spring snails. Spring snails are gilled, which makes them dependent upon dissolved oxygen, and thus, vulnerable to adverse impacts from chemical renovation treatments. These species are endemic to individual springs and watersheds in the Great Basin (Hershler 1998). The 1998 MOU represents an effort to preclude the need to list Great Basin spring snails as a threatened species under the ESA. The MOU states that the NPS will manage lands for the conservation of spring snails and their associated habitats and develop protocols and methodologies for their restoration and conservation. GRBA must inventory streams identified for chemical renovation prior to treatment so that any potential effects can be mitigated. GRBA has met part of the MOU's intent by working with the FWS in developing survey protocols contained in the GRBA Aquatic Monitoring Protocols (1999).

Other mollusk's species could be negatively impacted from chemical stream renovation treatments and unfortunately, very little information is available about mollusks in GRBA. Dr. William Pratt of the University of Nevada Museum of Natural History has conducted limited springsnail work in GRBA and supplied the following list of true aquatic snails that could be impacted: 1) *Helisoma newberryi,* 2*) Vorticifex effusus,* 3) *Plannorbella spp.,* 4) *Gyraulus spp.,* 5) *Stanicola spp.,* 6) *Physella spp.,* and, 7) *Physella virgata* (Pratt, personal comm. 1998). As a first step in conservation of these species, GRBA personnel will collect macro invertebrates to include fresh water mollusks just prior to treatment, hold and release after treatment to facilitate their recovery or place them in side seeps, spring or above the treatment area.

Action Items:

- Survey selected streams for the presence of mollusks prior to any renovation treatments. Utilize the methodology found in the "Great Basin National Park Aquatic Monitoring Protocols" handbook. Investigate life histories of those species found. Design stream treatment and other mitigation measures to minimize or eliminate any adverse impacts to these species.

- Just prior to chemical renovation treatments, collect and hold macroinvertebrates in a suitable tank to allow persistence or place them in side seeps, spring or above the treatment area. If held, release several days post-treatment to facilitate system recovery.

There is no documentation of other nonsalmonid native fish species in the waters of GRBA. Sculpins have been found below the park boundary in Snake Creek. There is the potential for sculpins to occur in park streams. Steam renovation treatments would have an adverse effect to nonsalmonid native fish species.

Action Items:

- Survey selected streams for the presence of nonsalmonid native fish prior to any renovation treatments. Utilize the methodology found in the "Great Basin National Park Aquatic Monitoring Protocols" handbook. Investigate life histories of those species found. Design stream treatment and other mitigation measures to minimize or eliminate any adverse impacts to these species.

- If found, just prior to chemical renovation treatments, collect and hold in a suitable tank to allow and release several days post-treatment to facilitate system recovery.

7. Methodology

a. Pretreatment Surveys

In conjunction with the development of this plan, a companion document titled "Great Basin National Park Aquatic Monitoring Protocols" was completed. This effort was completed cooperatively with Great Smoky Mountains National Park, Western Washington Office of the

FWS, Regional Ecosystem Office Survey and Management Specialists, the National Aquatic Monitoring Center, and numerous university researchers. The protocols include surveys for fresh water mollusks, amphibians, fish, macroinvertebrates, and water quality analyses. The protocol handbook was designed to meet the intent of NPS-77 Resource Management Guidelines and allows field technicians to implement the numerous techniques at each of selected monitoring sites within selected watersheds. It is assumed that by the end of year three, a comprehensive faunal list for amphibians, mollusks, and macroinvertebrates will be completed and life histories explored. This will allow data extrapolation and renovation treatments that are designed to have little to no adverse effects on nontarget species.

Monitoring sites will be selected to encompass the array of habitats available to trout. The number of sites per stream will be dependent upon stream size and length. Locations of sites will be recorded using GPS and reference photo points taken with a digital camera to build a GIS database. These sites will be come permenant monitoring locations used for all future monitoring efforts.

b. Chemical Renovation

The objective of chemical renovation is to eradicate all fish present within a stream system to allow for the introduction of a more favorable species, in this case Western BCT. Traps, nets, and electrofishing have all been tried to renovate streams, but experience shows limited success (USDA Forest Service 1986). The use of toxicants is currently the most effective means to eliminate nonnative salmonids from a restoration stream (Berger *et al*. 1969, Gilgerhus *et al*. 1969, Rhine and Turner 1991). Piscicides are routinely used in fishery management for the control of undesirable species, as well as for the management of out-of-balance fish populations. In particular, rotenone and antimycin A can be used effectively to manipulate fish populations. Stream treatments will be repeated until no nonnative salmonids are found during effectiveness monitoring. Prior to treatment, GRBA must develop an Integrated Pest Management Plan with an integrated approach. As part of this integrated approach, GRBA plans on trying both chemicals in different streams and conducting a comparative analysis that assesses the effects to target and nontarget aquatic resources. Adaptive management will then be used to refine renovation techniques.

Rotenone has been the principal agent used for controlling undesirable fish populations. It is an Environmental Protection Agency (EPA) registered fish toxicant in the United States and it acts by inhibiting cellular respiration. It seldom persists in the environment longer than two weeks and can be rapidly detoxified with potassium permanganate drip stations, if desired. It has several advantages that make it valuable for fish population control, the most important being its low toxicity to mammals, birds, and reptiles. Some disadvantages are that it is toxic to aquatic invertebrates, relatively costly, fish can sense its presence, and it is somewhat ineffective in colder waters. NDOW and HNF are successfully using rotenone to remove nonnative salmonids from streams in the northern Snake Range as part of their BCT reintroduction efforts.

Antimycin A is an antibiotic isolated from a fungus-like bacterium and is an EPA registered fish toxicant in the United States. Antimycin A is nonpersistent in the environment and can be detoxified immediately with potassium permanganate, which is harmless in the environment. Antimycin A is formulated in a sandgrain carrier designed to release the toxicant in the first 5 to

15 feet of water. Its advantages are its effectiveness at low dosages, no toxicity to mammals, effectiveness in cold waters, less toxic than rotenone to aquatic macroinvertebrates, and its species specificity at different dosages. Fish killed with antimycin A do not pose any health hazards to man or wildlife. The principal advantage of antimycin A, in contrast to rotenone, is that fish do not sense its presence (Lennon *et al.* 1970). Because of the low dose requirements, it is also easier to transport to remote treatment sites as opposed to rotenone. A disadvantage is that it is less effective in alkaline waters.

The recommended concentrations of rotenone and antimycin are generally safe for nontarget organisms. Although most fish toxicants are also toxic to aquatic invertebrates, the effect is temporary; usually the populations rapidly rebuild to pretreatment levels (Lennon 1971; Schnick 1974a, 1974b). All use of chemicals for stream renovation at GRBA will be coordinated and conducted in cooperation with NDOW.

Due to the private lands just below the park boundary in Mill Creek, more aggressive work will be required to completely eliminate any changes in water quality from stream renovation. While electrofishing has not been effective in the past, aggressive efforts will be made to remove nonnative salmonids from this system prior to the use of piscicides. Potassium permanganate drip stations will be install at and above the park boundary to assure complete detoxification if piscicides are needed.

Remoteness and other factors may complicate the disposal of nonnative trout collected from these streams. The preferred method will be to leave some fish along the banks for nutrient cycling and removing the majority to be buried off-site.

Action Item:

- Conduct a comparative analysis that assesses the effects to target and nontarget aquatic resource of rotenone and antimycin A by using both chemicals in different streams. Rotenone will be used in Strawberry Creek and antimycin A in Mill Creek. Repeat pre and post treatment surveys and assess effects. Adaptive management will then be used to refine renovation techniques.

c. Barrier Construction

Renovated reaches of streams must be protected from upstream migration of nonnative salmonids. Most selected stream reaches have natural barriers. Fish barriers will need to be constructed on at least two or three streams proposed for reintroduction. These sites could include Mill Creek just above the private lands and the South Fork Baker Creek above the confluence with Baker Creek and Snake Creek at the diversion. Barrier design will be tailored to the conditions at the site, use natural materials, and have minimal visual effects.

d. Fish Transportation

Methods used to transport Western BCT hard plants and instream incubator stock will be totally dependent on access and remoteness of the site. Truck transfer will be the preferred method for reintroducing larger older fish. Sites with road access will utilize a truck mounted aerator tank. Remote sites with trails will use backpack tanks to move Western BCT. Fingerlings will be placed in small four- to five-gallon plastic tanks that fit a pack frame, oxygenated, and possibly iced-down. Helicopters, if they can be arranged, could be a more effected method. Helicopter could transfer materials needed for the establishment of instream incubators along the South Fork of Big Wash. No helicopter landings will be authorized within the park backcountry. All equipment and supplies will be sling-loaded to prescribed sites.

8. Establishing a Translocated Population

Replication of populations of Western BCT and expansion of present distribution is not simply a matter of translocating Western BCT into a renovated or barren stream. Factors affecting population persistence (e.g., drought, fire, and flood) mandate monitoring of translocated populations to determine population status and to assess changes in habitat conditions. Droughts can cause varying degrees of reduced stream flow that result in a contraction of available habitat and a reduction in habitat suitability. The extreme effect is interrupted to total cessation of surface flow. Riffle areas may become desiccated, reducing macroinvertebrate food production and spawning areas. Reduced pool depth and volume increases the vulnerability of Western BCT to predators, increases water temperature and associated levels of stress, and intensifies intraspecific competition. Flood events can cause channel scouring, habitat alteration, year class failure, and displacement and/or complete loss of Western BCT from a system. High intensity fire can result in increased water temperature, decreased stream shading, increased soil erosion, increased runoff, and increased peak flow. These natural events are usually not independent of each other. These natural events can result in the localized extinction of species within a system. Recovery of a system after these events may vary from several years (Novak 1988) to more than 20 years (Roby 1989). Lack of watershed connectivity and downstream populations of Western BCT compound these issues in the Great Basin.

a. Post-Treatment

The following monitoring is proposed along all treated streams. Monitoring will be conducted in years one, two, and three post-renovation treatment.

- Post-treatment monitoring will utilize the sampling sites designated for pre-treatment monitoring. Sampling of benthic and mollusks populations will be conducted at this time to document changes and recovery in this segment of the aquatic community as a result of rotenone or antimycin treatments. Mill Creek will be treated with antimycin and Strawberry Creek with rotenone. A comparative analysis will be conducted to assess the differences in impacts to these two aquatic systems and decisions on what chemical to use in the rest of the streams will be based on the results of this analysis.

- Electrofishing surveys will be conducted each year to assess the effectiveness of the treatment and to assure complete nonnative salmonid removal prior to any BCT reintroduction. Systematic stations will be established at the pre-treatment sites 0.25 mile reaches will be surveyed. Backpack electrofishing techniques utilizing a three-pass protocol will be used.

- Amphibian monitoring will be conducted within each treated watershed following the "Great Basin National Park Aquatic Monitoring Protocols".

b. Post-Reintroduction

The following monitoring is proposed along all treated streams and will be conducted in years one and three post-BCT reintroduction.

- Post-Reintroduction monitoring will utilize the sampling sites designated for pre-treatment monitoring.

- Fish population sampling will be conducted at a minimum of once per sampling year, during the same period each sampling year; to document changes in population structure and reproduction. Backpack electrofishing techniques will be used to sample along the 100-meter transect. One unit will be utilized and a three-pass protocol will be used. Trout will be counted and measured for total length (mm) and weight (grams). Total bio mass of fish will be calculated. Age class will be estimated and documented for each fish.

- Sampling of benthic populations will be conducted to document changes in this segment of the community and changes in food habits.

- Redd counts will be conducted during the spawning season in years 3 and 5 to assess reproduction efforts..

- Computerized GIS databases will be developed and used for basic data analyses.

- A summary report will be prepared and submitted to the superintendent at the completion of each monitoring cycle to assess the effectiveness of the reintroduction efforts.

c. Validation Monitoring

In order to validate the objective of reestablishing viable populations of Western BCT in GRBA, validation monitoring will be completed in years 2 and 4-post reintroduction for hard plants of adults and in years 3 and 5 for instream incubators. The following monitoring is proposed:

- Validation monitoring will utilize the sampling sites designated for pre-treatment monitoring.

- Pre-treatment backpack electrofishing techniques will be used to sample along the 100-meter transect. A three-pass protocol will be used. All nonnative trout will be collected, weighed and measured. Total biomass (g/msq), age class, size class, and density will be calculated for the currently viable nonnative trout population within the stream reach.

- Post-reintroduction backpack electrofishing techniques will be used to sample along the same 100-meter transect. A one-pass protocol will be used. All BCT trout will be collected, weighed, and measured. Total biomass (g/msq), age class, size class, and density will be calculated for the reintroduced trout population within the stream reach. Extreme care will be taken to minimize sampling mortality. Any mortalities will be preserved and curated at the GRBA museum.

- The attainment of viability will be made when the Western BCT population total biomass, age class, size class, and density matches that of the pretreatment viable nonnative trout population within the stream reach.

9. Partners

This effort involves several State and Federal Agencies and private partners. To date the following have pledged their cooperation and assistance:

- NDOW will work cooperatively with GRBA during the nonnative salmonid removal and Western BCT trout reintroduction phase of the projects. They will apply the chemical treatments and assist with the capture, movement, and release of Western BCT.

- HNF will work cooperatively on Western BCT reintroduction along Strawberry and Mill Creeks due to shared administration.

- FS/TU Partnership Coordinator will assist in reintroduction and technical assistance as requested.

- FWS, Reno Offices will supply technical assistance as requested.

- National Aquatic Monitoring Center will work cooperatively in benthic sampling and analysis.

- BLM, Ely Resource Area, will assist as requested. The BLM and other Federal agencies listed above, as well as TU, are all members with GRBA on the Bonneville Trout Recovery and Reintroduction Team.

- TU, Southern Nevada Chapter is currently working cooperatively with GRBA on this effort. A TU Embrace-a-Stream Grant proposal was funded in 1999 and new proposals will be submitted yearly to help with the costs of fish collection, lab and genetic analysis, stocking, and instream incubators.

- A $10,000 grant from the Nevada Biodiversity Initiative has been requested. This grant is anticipated and future requests will be solicited.

- Additional partners will be sought throughout this project. The National Fish and Wildlife Foundation has already expressed an interest.

We anticipate receiving approximately $63,416 in grants and volunteer labor throughout the initial 4-year project.

10. Personnel, Budget, and Activity Plans

a. ONPS Base Funding

The following GRBA Resource Management Staff positions will supervise the project, coordinate implementation and work with partners, and conduct analyses for the reintroduction efforts through ONPS base funding:

- GS-401-12, Resources Management Branch Chief will assist in planning and overseeing project implementation for 20 PP over the initial four-year project request @$1,900/PP = $38,000

- GS-401-11 Wildlife/Fisheries Biologist will manage and supervise the project, supervise and conduct the inventories and monitoring, coordinate interagency and special interest participation, direct and conduct data analyses, prepare annual progress reports, direct and conduct reintroduction efforts, and write up results and findings for 60 PP, over the initial four-year project @$1,750/PP = $105,000

  GRBA-ONPS Base Contribution = $143,000

b. NPS Regional and National Resource Funding Request

A GS-408-9 term Aquatic Ecologist will be hired in year 2 to work on data analyses, development of adaptive management alternatives, assess impacts and effectiveness of mitigation measures, conduct effectiveness monitoring, maintain and update GIS database, develop draft journal articles, and supervise, direct, and conduct ecological analyses. Three seasonal GS-404-5 Biological Science Technicians and a Student Conservation Association (SCA) volunteer will gather field data, conduct data analyses, and assist with monitoring and reintroduction efforts.

Year 1 (1999) – Activities will include: pretreatment surveying for macroinvertebrates, water quality, mollusks, fish, and amphibians along Strawberry and Mill Creeks; initial electrofishing assessment on South Fork Big Wash; development of environmental compliance analyses and documentation; GIS database development; development and publication of an informative BCT brochure; and if survey results do not prohibit action, treatment of Strawberry Creek.

Personnel	
1 GS-11 Biologist 4pp@$ 1,728.00 =	$ 6,912.00
2 GS-05 Bio. Sci. Techs. 10 pp@$ 1,664.00/pp =	$16,664.00
1 SCA on a 12wk Contract =	$ 2,900.00
Personnel Subtotals	$26,124.00
Support	
GSA vehicle rental	$ 2,500.00
Housing rental subsidy for SCA and GS-5 Bio. techs	$ 2,650.00
Sampling supplies ie. Film/Nets/H2O Chem.etc.	$ 1,000.00
Backpack Electroshocker	$ 4,950.00
Lab Analysis (Macros/Mollusks)	$ 1,000.00
Renovation Chemicals	$ 550.00
Support Subtotals	$12,650.00
Year 1 Project Totals	**$39,126.00**

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Year 2 (2000) – Activities will include: pretreatment surveying for macroinvertebrates, water quality, mollusks, fish, and amphibians along Snake and South Fork of Big Wash Creeks;

further pretreatment surveying along Mill Creek; post-treatment monitoring of Strawberry Creek to determine effectiveness of treatment and to assess the impacts to macroinvertebrates, mollusks, fish, and amphibians as a result of rotenone treatment (adaptive management will be used to minimize effects to other streams); if no nonnative salmonids found, release Bonneville trout in Strawberry; if nonnative salmonids found, re-treat system; installation of streamside incubators on South Fork Big Wash if year one surveys allow; update GIS database; preparation of progress reports; if initial surveys allow, planning and treatment of Mill Creek for the removal of nonnative salmonids.

Personnel

1 GS-09 Term Aquatic Ecologist 22pp@$ 1,528.00/pp =	$33,616.00
3 GS-05 Bio. Sci. Techs. 10 pp@$ 2,496.00/pp =	$24,960.00
1 SCA on a 12wk Contract =	$ 2,900.00
Personnel Subtotals	$61,476.00

Support

GSA vehicle rental	$ 2,500.00
Housing rental subsidy for SCA and GS-5 Bio. Techs.	$ 3,500.00
Sampling supplies ie. Film/Nets/H2O Chem.etc.	$ 500.00
GIS Work Center/Supplies	$ 3,500.00
BCT Collection/Stocking	$ 2,300.00
Mill Creek Barrier	$ 1,250.00
Instream Incubators	$ 625.00
Lab Analysis (Macros/Mollusks)	$ 2,000.00
Renovation Chemicals	$ 550.00
Support Subtotals	$16,725.00

Year 2 Project Totals	**$78,201.00**

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Year 3 (2001) – Activities will include: pretreatment surveying for macroinvertebrates, water quality, mollusks, fish, and amphibians along Lehman and South Fork Baker Creek; post-reintroduction monitoring and instream incubator maintenance and restocking on South Fork Big Wash Creek; post-treatment monitoring of Mill Creek to determine effectiveness of treatment and to assess the impacts to macroinvertebrates, mollusks, fish, and amphibians as a result of antimycin treatment (adaptive management will be used to minimize effects to other streams); if no nonnative salmonids found, release BCT in Mill Creek; if nonnative salmonids found, re-treat Mill; post-treatment and post-reintroduction monitoring of Strawberry Creek; update GIS database; installation of a fish barrier along Snake Creek; preparation of progress reports; preparation of draft articles to scientific journals from project findings; nonnative salmonid removal planning and treatment of Snake Creek based upon adaptive management analyses.

Personnel

1 GS-09 Term Aquatic Ecologist 22pp@$ 1,570.00/pp =	$34,540.00
3 GS-05 Bio. Sci. Techs. 10pp@$ 2,570.00/pp =	$25,700.00
1 SCA on a 12wk Contract =	$ 3,100.00
Personnel Subtotals	$63,340.00

Support

GSA vehicle rental	$ 2,500.00
Housing rental subsidy for SCA and GS-5 Bio. Techs.	$ 3,500.00
Biological sampling supplies	$ 500.00
Lab Analysis (Macros/Mollusks)	$ 1,500.00
BCT Collection/Stocking	$ 2,300.00
Renovation Chemicals	$ 750.00
Support Subtotals	$11,050.00

Year 3 Project Totals **$74,390.00**

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Year 4 (2002) – Activities will include: further pretreatment surveying for macroinvertebrates, mollusks, water quality, fish, and amphibians along South Fork Baker Creek; post-reintroduction monitoring and instream incubator maintenance and restocking on South Fork of Big Wash Creek; post-treatment monitoring of Snake Creek to determine effectiveness of treatments and to assess the impacts of treatment to macroinvertebrates, mollusks, fish, and amphibians (adaptive management will be used to minimize effects to other streams); if no nonnative salmonids found in Snake Creek, release Bonneville trout, if nonnative salmonids found, re-treat system; post-treatment and validation monitoring of Strawberry Creek; post-reintroduction monitoring of Mill Creek; update GIS database; preparation of progress reports; submissions of articles to scientific journals from project findings; planning and treatment of Lehman for the removal of nonnative salmonids based upon adaptive management analyses.

Personnel

1 GS-09 Term Aquatic Ecologist 22pp@$ 1,600.00/pp =	$35,200.00
3 GS-05 Bio. Sci. Techs. 10 pp@$ 2,647.00/pp =	$26,470.00
Personnel Subtotals	$61,670.00

Support

GSA vehicle rental	$ 2,500.00
Housing rental subsidy for GS-5 Bio. techs	$ 2,500.00
Biological sampling supplies	$ 250.00
Lab Analysis (Macros)	$ 1,000.00
BCT Collection/Stocking	$ 2,300.00
Renovation Chemicals	$ 750.00
Support Subtotals	$ 9,300.00

Year 4 Project Totals **$70,970.00**

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4-YEAR PROJECT TOTALS:

Funding needs may vary based upon the ability to receive grants. Economics is based on not receiving all grants to reflect actual project needs. Receiving all grants will reduce NPS requests.

4-year NPS NRPP funding needs = $262,687.00

GRBA ONPS base funding = $143,000.00

Anticipated Grants and Volunteer Labor = $ 63,416.00

c. Tentative Ten Year Timeline*:

	Strawberry Creek	Mill Creek	S. Fork Big Wash	Snake Creek	Lehman Creek	S. Fork Baker Creek
1999	PS CT	PS	PS			
2000	PT BCT	PS CT	PS BCT	PS		
2001	PT PR	PT BCT	PR BCT	PS CT	PS	
2002	PT V	PT PR	PR BCT	PT BCT	PS CT	PS
2003	PR	PT V	PR	PT PR	PT BCT	CT
2004	V	PR	PR	PT V	PT PR	PT BCT
2005		V	PR V	PR	PT V	PT PR
2006			PR	V	PR	PT V
2007			V		V	PR
2008						V

PS = pre-treatment survey
CT = chemical renovation treatment
PT = post-treatment monitoring
BCT = BCT reintroduction
PR = post-reintroduction monitoring
V = validation monitoring

* Moving to the next step on the timeline is totally dependent on the results of previous surveys and monitoring, and successful chemical treatment, so this timeline will be very flexible. Also, the timeline will change depending on if we use streamside incubators or hard plants. This timeline is based on using hard plants of adult BCT, except in South Fork of Big Wash.

11. Products

Products are based upon a best case scenario, meaning all treatments are successful.

Year 1 - Pretreatment surveying along Strawberry Creek, Mill Creek, and South Fork of Big Wash. Development of a programmatic environmental compliance documentation. Database development. Development and publication of an informative BCT brochure. Potential chemical renovation treatment of Strawberry Creek for the removal of nonnative salmonids.

Year 2 - Pretreatment surveying along Mill and Snake Creeks and potentially South Fork of Big Wash. Post-treatment monitoring along Strawberry Creek. If nonnative salmonids are found, re-treat the system. If nonnatives are not found after careful and complete surveys in the spring and fall, introduce adult Western BCT through hard plants into Strawberry. Database update. Potential chemical renovation of Mill Creek for the removal of nonnative salmonids. Potential introduction of BCT into South Fork of Big Wash using streamside incubators. Progress reports written.

Year 3 – Pretreatment surveying along South Fork Baker, Lehman, and Snake Creeks. Post-treatment monitoring along Strawberry and Mill Creeks. If nonnatives are not found after careful and complete surveys in the spring and fall, introduce adult Western BCT through hard plants into Mill Creek (and Strawberry, if not done in Year 2). Post-reintroduction monitoring of Strawberry and South Fork of Big Wash Creeks. Database update. Installation of a fish barrier along Snake Creek. Potential chemical renovation of upper Snake Creek for the removal of nonnative salmonids. Progress reports and scientific articles written.

Year 4 - Pretreatment surveying along South Fork Baker Creek. Post-reintroduction monitoring and streamside incubator maintenance and restocking on South Fork of Big Wash Creek. Post-treatment monitoring on Strawberry, Mill, and Snake Creeks. Post-reintroduction monitoring on Mill Creek. Adaptive management will be used to minimize effects to other streams. Post-treatment monitoring on Snake Creek. If nonnatives are not found after careful and complete surveys in the spring and fall, introduce adult Western BCT through hard plants into Snake Creek. Validation monitoring on Strawberry Creek. Database update. Planning and treatment of Lehman for the removal of nonnative salmonids based upon adaptive management analyses. Progress reports and scientific articles written.

B. Recreational Fisheries Management

1. Objectives

Baker Creek and Lehman Creek contain healthy self-reproducing populations of nonnative brook, brown, and rainbow trout. These systems are within the historic range of the Western BCT, but are extremely complex with numerous tributaries. It would be difficult, but not impossible, to eradicate all nonnative salmonids. These systems are highly valued by locals and visitors to GRBA for recreational fishing opportunities due to their abundance of fish. During the 10-year life of this plan, only that portion of Lehman Creek above the fish block at the Osceola ditch inlet diversion point and the South Fork of Baker Creek will be analyzed for potential Western BCT restoration activities. Increasing the knowledge of fishing and the accessibility to Baker and Lehman Creeks by building small trails and parking areas will be considered.

Action Items:

- Recognize aquatic resource and fishery programs as interpretive "themes" and include them as a program area in Annual Statements for Interpretation developed by the park.

- Develop an interpretive brochure that describes the recreational fishing opportunities at GRBA.

- Encourage park interpretive staff to be well informed about all aspects of fishing and fishery management in order to give accurate information to the visiting public.

- Develop programs to introduce children to fishing and fishing ethics through activities such as the Junior Ranger program.

- Promote recreational fisheries as renewable resources by encouraging non-consumptive methods such as catch and release.

The management of nonnative species for recreational angling has created much discussion in the NPS. NPS policy has been clarified in an effort to address this issue, particularly where there is demand to manage for a non-native sport fish population and no feasible method exists to remove nonnative species. NPS-77 states:

> "The current policy for fisheries management within natural, cultural, and park development zones emphasizes the restoration and preservation of natural assemblages of native species. However, in some instances, stocking done decades ago, possibly predating the establishment of the park, has introduced species, which have become well established and ecologically balanced within their aquatic community. Often these are highly desirable species to the recreational fishing visitor, and there is strong local support for managing them. Designating as special use zones all water bodies where these species occur is usually not practical. Under such circumstances within natural, cultural, and Park development zones, management actions that encourage the survival of a fishery for an exotic species, such as limits on catch, may be permitted, but only if both of the following criteria apply, in accordance with the general NPS policy on exotics:
>
> a. there are no practical means of eliminating the exotic from the natural aquatic habitat; and
>
> b. the species has a limited impact on native fish and non-fish species and has not greatly altered the natural ecological functioning of the aquatic community.
>
> If a superintendent declares, for a specific water body, that such management of an exotic species of fish will be permitted in accordance with the above criteria, he/she must clearly state that intent within the park's Statement for Management, Resource Management Plan, and other such public documents. Such declaration will not override consideration for and perpetuation of other native species within the park, in accord with NPS management Policies and in compliance with the National Environmental Policy Act and other pertinent legislation. The policy will not preclude using future technologies to eliminate the exotic species in favor of truly native populations.

> Recreational angling is a consumptive use activity that has been allowed in national park units since Yellowstone was established. Approximately one-third of all NPS units support substantial recreational fishery activities; this sport is widely accepted as one of the ways visitors enjoy national parks. Management policies for fishery resources were intended to provide common objectives for natural, cultural and development zones in parks. However, differences in interpretation led to some confusion about the intent of these policies. To alleviate this problem, NPS-77, in part, was drafted to clarify fishery management policies and management requirements on issues such as " ... exotic species, stocking, commercial harvest, traditional use, fisheries restoration versus enhancement, and maintenance of genetic integrity."

NPS Management Policies (8:4) states that:

> "Recreational fishing will be allowed in parks where it is authorized by federal law or where it is not specifically prohibited and does not interfere with the functions of natural aquatic ecosystem or riparian zones. Where fishing is allowed, it will be conducted in accordance with applicable federal laws and treaty rights and state laws and regulations. However, the National Park Service may restrict fishing activities whenever necessary to achieve management objectives outlined in a park's resource management plan."

The GRBA General Management Plan states:

> "The Park Service would not permit stocking of nonnative fish species in the waters of the park. However, existing fish species remaining from past stocking activities would not be eliminated, except in streams selected for the reintroduction of Bonneville cutthroat trout."

2. Recreational Fisheries Resources

a. Baker Creek System

Baker Creek is the largest watershed system in the park, consisting of Baker Creek, North and South Forks of Baker Creek, Pole Canyon and Timber Creek. The headwaters of Baker Creek arise from a spring below Baker Lake at an approximate elevation of 10,670 feet. North Fork Baker Creek starts at 10,940 feet and joins Baker Creek at 9,320 feet, covering a distance of 1.97 miles. Just below this confluence, a spring augments the flow of Baker Creek. In times of high water, such as the spring melt, overflow from Baker Lake meets with Baker Creek at 10,000 feet. South Fork Baker Creek, 2.72 miles long, originates at 9,800 feet and feeds Baker Creek at 8,040 feet. Timber Creek arises at 9,190 feet and joins South Fork Baker Creek just upstream of its confluence with Baker Creek, covering 1.32 miles. Pole Canyon Creek arises from a spring at 8,260 feet, covers approximately 2.56 miles, and unites with Baker Creek at 6,880 feet. Baker Creek crosses the park boundary at 6,760 feet and is diverted into a man-made channel at 6,560 feet. A small portion of the total flow continues down the old channel and eventually seeps away, while most of the flow empties from the diversion into Lehman Creek at approximately 6,200 feet. South Fork Baker Creek is described in a separate section of this plan. North Fork, Pole Canyon, and Timber Creeks have not been surveyed in any detail.

Valley Segment Classification – See Section IV.4. e. South Fork Baker Creek.

Fish Habitat – See Table 1. Baker Creek runs for 6.66 miles within the park. A survey in 1952 found 5.94 miles of confirmed fish habitat. Research in 1990 indicated 3.24 miles of confirmed fish habitat, with 5.95 miles of potential habitat. Timber Creek does not appear to have enough water to support fish on an annual basis, however it may supply habitat during years or seasons of high precipitation. Although Pole Canyon Creek is also low volume, numerous small brook trout have been observed in recent years as far up as 1.5 miles from its confluence with Baker Creek. Pole Canyon Creek appears to have a larger volume of water than Timber Creek and may be suitable habitat for fish, although it does not appear to be capable of supporting fish in the winter. Baker, South Fork Baker, Timber and Pole together have 9.78 miles of confirmed fish habitat. No estimate of potential fish habitat is available. Baker and South Fork Baker combined have 5.46 miles of confirmed and 8.57 miles of potential fish habitat, according to Haskins (1990).

Pools and riffles are numerous along the entire length of the stream. There are many deep and wide pools at upper elevations, with deep and narrow ones at the bases of short falls. At the middle elevations, there are numerous pools of high quality being deep and narrow. At the lower elevations, most of the pools are potholes of poor structure, with a few deep ones present. Riffles are common along the bank margins at the upper elevations and decrease as the elevation decreases. Old beaver sign is quite common along the stream above the Grey Cliffs area. Loss of beaver from this system has decreased the quality and quantity of deep-water fish habitat. No pool to riffle ratios have been calculated. A USGS gaging station was operated on Baker Creek, near the narrows, from 1947 to 1997. Between 1947 and 1993, the maximum discharge was measured at 90.5 cfs in June 1952; the minimum was 0.28 cfs in January 1993; and mean monthly discharges range from 1.53 to 37.10 cfs.

Overhead cover is good along most of the stream, although there are a few sections in the lower elevations that lack this cover. Mixed spruce-firs with willows and aspens are the dominant forms of bank vegetation at the upper elevations, with water birch and rose dominant along middle elevations. Willow is predominant along the lower elevations, as well as chokecherry, cottonwoods, water birch, rose, sagebrush, and rabbitbrush. Undercut banks are numerous, particularly at lower and middle elevations. At the upper and middle elevations, logs and limbs in the stream provide good cover in many spots, as do large boulders.

From 7,000 to 8,000 feet (Grey Cliffs to Baker Creek trailhead), a distance of 2.9 miles, the average gradient is 8.8 percent. From 8,400 feet to 10,040 (Dieshman cabin), a distance of 5.0 miles, the gradient averages 11.9. Water quality sampling resulted in an average spring/early summer pH of 7.28, electrical conductivity of 30.3 µS/cm @ 25ºC, and temperature of 7ºC, with a range from 3 to 11ºC. The average fall pH was 7.32, average electrical conductivity was 35.6 µS/cm @ 25ºC, and average temperature was 3ºC, with a range from 2 to 5ºC (Table 2).

Livestock grazing has had significant impacts on several wet meadow and riparian areas of Baker Creek. Damage due to over utilization of forage and heavy hoof action was especially apparent on banks of spring channels and steep slopes above the stream. Action is necessary to prevent damage from cattle grazing to these sights and start the recovery process. All other areas of Baker Creek were classified as Proper Functioning Condition.

Stocking History - Baker Creek was stocked between 1924 and 1986. Black spotted trout (Lahontan cutthroat trout), rainbow trout, and "steelhead" were first stocked in 1924 and brook trout in 1925. Over the years, cutthroat, rainbow, brook and brown trout were repeatedly planted. Rainbow trout were the most commonly stocked fish. For instance, between 1977 and 1986, almost 30,000 rainbow trout were planted. Cutthroats were last stocked in 1951. South Fork Baker Creek was stocked with cutthroat trout in 1951 and rainbow trout in 1952.

Results of Surveys - A stream survey in 1952 found cutthroat (subspecies not specified) and rainbow trout. In 1990 rainbow, brown and brook trout were encountered at middle and lower elevations. No fish were encountered in the upper elevations, although the authors opined that suitable trout habitat existed in stretches. It was claimed that 44 large "native" cutthroat were caught in one day in Baker Creek by George Baker and another party. The year was not reported except that it was "many years ago" (previous to 1952).

Action Items:

Baker Creek currently contains healthy self-reproducing populations of nonnative salmonids. This stream is a very popular fishery and receives moderate use by recreational anglers. Access to most of Baker Creek would be considered poor due to a lack of trails along the most productive lower elevation fishery. We plan to improve angler access to Baker Creek by developing low impact trails.

- Trail 1 – Baker Creek Interpretative Trail. A 0.5-mile trail would be constructed between the Pole Canyon Picnic area and Grey Cliff campground. Trail would be signed as Angler Access Trail.

- Trail 2 – Grey Cliffs Campground/Baker Campground Trail. A 1.25-mile trail would be developed between these two campgrounds. An old overgrown trail exists and would be used. Some minor vegetative clearing, tread development and rerouting would be required to minimize impacts to riparian areas. Trail would be signed as Angler Access with mileage given between points at the start in each campground. A small wooden bridge would be constructed to allow stream crossing to access the Baker Campground access point.

- Trail 3 – Baker Campground/Baker Trailhead Trail. A 1.25-mile trail would be developed between the campground and the trailhead. Approximately one mile of this trail is an old road. Development of ¼ mile of trail would be required. Trail would be signed with name and Angler Access with mileage given between points.

b. Lehman Creek

Lehman Creek originates at about 10,150 feet in elevation, above a large meadow where several short tributaries that receive their water from ground sources combine. The stream runs through the meadow then plunges downward over a long gradient fall. At the foot of the gradient, a short south tributary empties into Lehman Creek. The stream continues through a narrow canyon, obtaining additional flow from numerous seepage areas and short spring tributaries. Lehman Creek crosses the park boundary at 6,560 feet, flows across private land for about 2 miles, and at 5,960 feet enters BLM land and a man-made ditch where the water is diverted for irrigation of private lands. Three developed park campgrounds are located in the riparian corridor of Lehman Creek.

Valley Segment Classification – See Section IV.4. e. South Fork Baker Creek.

Fish Habitat – See Table 1. Lehman Creek runs for 6.49 miles within the park. A survey in 1952 found 6.38 miles of confirmed fish habitat. Research in 1990 indicated 4.74 miles of confirmed fish habitat, with 6.49 miles of potential habitat. No data is available for the length of fish habitat in the 0.43-mile long upper tributary. A potential fish block resulting from a small waterfall occurs at the Osceola ditch inlet.

At the upper elevations the stream substrate is composed of rocks and gravel with some sand present. At the middle elevations, rock and small boulders make up the substrate; some gravel and sand is present. Lower elevations substrate is composed of rocks, with moderate amounts of gravel present, or both gravel and rubble present in large amounts. Spawning areas are present at the upper and middle elevations, and lacking at lower elevations.

Pools are numerous at the upper elevations. In the fall of 1952, the average stream width of the stream was 78 inches, average stream depth was 4.9 inches, and approximate discharge was 5.7 cfs. A USGS gaging station was operated along Lehman Creek shortly above the current park boundary from 1947 to 1997. Maximum discharge was measured at 32.5 cfs in June 1952; minimum was 0.82 cfs in January 1954; and mean monthly discharges range from 1.21 to 16.40 cfs. Pools are less numerous at middle elevations, most are smaller potholes. At the lower elevations, pools are poor in number and quality; at the extreme lower elevations, there are almost no pools. Riffle areas appear frequently along marginal banks of the stream at all elevations.

Overhead cover is excellent at the middle and upper elevations, and along a few sections at lower elevations. However, most of the lower elevations experience no overhead cover. White firs, spruce, aspens, rose and mountain mahogany dominate the upper elevations, with grasses and other herbaceous vegetation present. Willows and water birch are numerous at middle elevations, with firs, aspens, rose, sagebrush, rabbitbrush, junipers, and pinyons. At lower elevations willow, sagebrush, rose, rabbitbrush are dominant with some cottonwoods present. Coarse woody debris was abundant along most of the stream except the extreme lower elevations. Rocks and boulders offer additional cover along some sections. Undercut banks are numerous at the upper and middle elevations, and nonexistent at the lower elevations.

From the park boundary to Upper Lehman Campground (7,840 feet), a distance of 3.3 miles, the gradient averages 7.0 percent. From Upper Lehman Campground to Wheeler Peak Campground (9,850 feet), a distance of 3.0 miles, the gradient averages 10.7 percent. Water quality sampling resulted in an average spring/early summer pH of 7.45, electrical conductivity of 34.5 µS/cm @ 25ºC, and temperature of 8ºC, with a range from 5 to 13ºC. The average fall pH was 7.42, average electrical conductivity was 39.5 µS/cm @ 25ºC, and average temperature was 4ºC, with a range from 1 to 7ºC (Table 2).

The entire system was determined to be in Proper Functioning Condition, according to the 1997 Riparian Assessment. Negative impacts by roads and trails are unnoticeable and impacts from cattle appeared to be of small extent. Channel switching was noticed in one area, which most likely occurred during flooding in 1995. Historically, there may have been a much broader floodplain associated with this stream and it appears the stream may have been anabranched.

Near the park boundary and along the lower portion of the Wheeler Peak Scenic Drive, there are noticeably broad, wide, flat areas with the appearance of having been wetter than at present.

Stocking History - Rainbow, steelhead, and black spotted (Lahontan cutthroat) trout were first planted in 1924. Brook trout were first stocked in 1925. Over the years numerous stocking episodes occurred with the stocking of rainbow trout the most common. No records have been found to indicate the stocking history of brown trout.

Results of Surveys - "Native cutthroat trout" were reported in 1938. A stream survey in 1952 found rainbow trout at all elevations. One each of brown and cutthroat trout were found below the confluence of Lehman and Baker Creeks. A survey completed in 1990 found brook trout at all elevations, and rainbow and brown trout at lower and middles elevations. No fish were encountered above 9,080 feet. The researchers concluded that the steep gradient and debris barriers impede upstream movement, although suitable fish habitat exists in stretches.

Action Items

Improve angler access to lower Lehman Creek by developing a low impact trail and a paved pull-off along the Wheeler Peak Scenic Drive.

- Pull off/Parking Area – For safety reasons, a small several car pull-off and parking area will be constructed 0.25 miles up the Wheeler Peak Scenic Drive. The site is currently a very small dirt pull-off with enough space for one vehicle. The pull-off will be enlarged for three vehicles and safe backing. The trail would be signed with name and Angler Access with mileage given between points at the starts. A small wooden bridge would be constructed to allow stream crossing to access Lower Lehman Creek trail and Picnic Area trail.

- Trail 1 – A 0.25-mile trail will be constructed from the visitor center picnic area to the Lower Lehman Creek trail. Some minor vegetative clearing, tread development and routing would be required. Trail would be signed with name and Angler Access with mileage given between points at the starts.

- Trail 2 – Lower Lehman Creek trail. A 1.25-mile trail will be constructed between the pull off/parking area and Lower Lehman Creek campground. Some minor vegetative clearing, tread development and routing would be required to minimize impacts to riparian areas. Trail would be signed with name and Angler Access with mileage given between points at the starts. A small wooden bridge would be constructed to allow stream crossing to access Lower Lehman Creek Campground.

- Trail 3 –Lower Lehman to Upper Lehman Campground Trail. A 0.50-mile trail would be developed between these two campgrounds. Portions of this trail exist but no maintenance has ever occurred. Some minor vegetative clearing, tread development and routing would be required to minimize impacts to riparian areas. Trail would be signed with name and Angler Access with mileage given between points at the starts.

All action items listed under Lehman and Baker Creeks require planning and design. No cost estimates are available at this time.

c. Baker Lake

Baker Lake is at an elevation of approximately 10,730 feet and is located between Pyramid and Baker Peaks in a deep, narrow cirque basin with the southwest edge against talus slopes. The lake is spring-fed and is the initial underground source of flow for Baker Creek. The lake is approximately 4 surface acres at its maximum and drops rapidly through the summer. The deepest section of the lake is approximately 14 feet deep, but in general the lake is about 3 foot deep.

Fish Habitat – The bottom of the lake in the shallow areas is made up of large and small rocks, which are the extension of the talus slopes. No suitable spawning areas were observed in 1952 and in 1988 NDOW personnel wrote, “it would appear that Baker Lake is lacking in spawning gravels”. Water quality sampling for spring/summers 1993, 1995, and 1996, resulted in an average pH of 6.58, average conductivity of 11.5 µS/cm @ 25ºC, and average temperature of 4.6ºC, with a range from 0 to 9ºC. The average fall (1991-1995) pH was 7.54, average electrical conductivity was 16.2 µS/cm @ 25ºC, and average temperature was 3.6ºC, with a range from 1 to 5ºC (Table 2).

Stocking History – Rainbow trout were planted in the lake in 1938 and 1952. Brook trout were planted in the early 1930’s. In 1985, 2,500 Lahontan cutthroat trout fry were stocked in the lake. Survey Results – In 1952 rainbow, brook, and cutthroat trout were found. In 1984 only brook trout were found, while in 1988 Lahontan cutthroat and brook trout were netted. In 1984 NDOW found the fish population in Baker Lake to be in difficulty. Low water years in the mid-1970’s, were thought to have resulted in conditions conducive to winter kill. Angler use during that same period was thought to be greater that the reproductive potential of the lake. After the introduction of Lahontan cutthroat in 1985 NDOW found that “Baker Lake has a fishable population of cutthroat trout” in 1988 (Haskins 1988).

d. Johnson Lake

Johnson Lake is found at approximately 10,800 feet in elevation and is situated in a small cirque basin 600 feet below and east of the dividing crest of the southern Snake Range with steep talus slopes extending upwards to the crest and north to Pyramid Peak. The main source of water for this lake comes from three small springs located on the talus slope to the west and south. A man-made dam at the eastern end of the lake is constructed of loose rocks and boulders. Johnson Lake is approximately 4 surface acres in size, with a perimeter of approximately 1,238 feet and a maximum depth of 20 feet. Old buildings and mining paraphernalia, remnants of a tungsten mine, are near the lake on the south and east sides.

Fish Habitat – Numerous boulders are prominent in the shallow water and silt and gravel are filling in many bottom areas. The gravels appear to be suitable for spawning. Grasses grow along the south and east sections of the shore, while the rest is bare rock. From data collected in spring/summers 1993, 1995, and 1996, average pH was 6.63, average electrical conductivity was 20.5 µS/cm @ 25ºC, and average temperature was 4ºC, with a range from 0 to 10ºC. During the fall of 1991-1995, average pH was 7.60, average electrical conductivity was 34.65 µS/cm @ 25ºC, and average temperature was 5ºC, with a range from 4 to 6ºC (Table 2).

Fish Stocking History – 840 fingerlings (species unidentified) were planted in 1952. NDOW cites introductions of brook, Lahontan cutthroat, and rainbow trout, with no date given for these transplants.

Survey Results – Brook and rainbow trout were found in a 1952 survey. In 1984 and 1988, brook trout were the only species netted in the lake. During these 1980's, surveys, NDOW found "a self-sustaining brook trout population capable of supporting the existing anglers use".

Johnson Lake would be an excellent candidate for the BCT reintroduction program. Fish surveys need to be completed and the potential for rainbow trout escapement assessed prior to treating and stocking BCT into Snake Creek. If the potential for escapement does exists, rainbow/cutthroat hybridization would occur eliminating the potential for a pure BCT population in Snake Creek.

IV. SUMMARY OF ACTION ITEMS

- Verify or disqualify the historic occurrence of beaver on lands administered by GRBA through the use of dendrochronology. Old beaver use sign occurs in most perennial watersheds within the park. Increment bore samples will be taken from old beaver stumps at various locations (Baker Creek, South Fork Big Wash, Lehman Creek, and Strawberry Creek) in the park. Increment bore samples will be taken from live old trees of similar species adjacent to the beaver stumps. These samples will be cross-dated to determine the date when beaver downed the tree. Also, a complete search of NDOW records will be commenced to find if they have information on the historic occurrence of beaver

- If grazing of domestic livestock continues in the park, implement an early season grazing April thru May) strategy along potential BCT streams. Avoid "hot season" grazing (June thru August) of these streams. Cattle are reluctant to disperse from riparian areas during the hot season. This intensifies resource damage to riparian and aquatic ecosystems.

- If determined to be a native but extirpated species, develop a plan to reintroduce beaver into selected park watersheds.

- Increase the monitoring efforts of the 45 percent forage utilization standard to assure compliance and minimal impacts to aquatic ecosystems. Establish permanent forage utilization monitoring sites within riparian areas. Increase visitation and clipping and weighting techniques. Assure compliance. Photo document all sites pre, during and post grazing to assess vegetative recovery. Minimize or eliminate impacts to stream banks. Minimize sediment input into streams.

- Based upon monitoring results, utilize adaptive management to adjust grazing standards to mitigate any adverse impacts.

- Survey selected stream ecosystems proposed for Western BCT reintroduction to document baseline conditions. Search for vulnerable native aquatic species that might be impacted by reintroduction efforts. Development mitigation measures to minimize or eliminate these potential adverse effects.

- Through the Environmental Assessment (EA) process, consider impacts of the proposed plan and develop alternatives that minimize effects, and implement NPS-77 Resource Management Guidelines.

- If the EA indicates that the proposed reestablishment can proceed without significant impacts, eradicate nonnative trout populations from target streams and monitor to ensure that the eradication is complete.

- Introduce Western BCT from native genetic Snake Range stock found in Pine and Ridge creeks in GRBA or Hendrys Creek on the HNF. Two methods are proposed: 1) hard plants of adult fish and, 2) the placement of instream incubators.

- Conduct effectiveness and validation monitoring until the new population(s) stabilizes.

- Work with Maintenance Division to eliminate adverse effects of the Strawberry Creek road on aquatic resources. Redesign upper road crossing culverts to prevent barriers to fish movement. Assess and correct road maintenance practices that result in sedimentation of the stream.

- Assess and redesign unplanned dispersed campsite developments to minimize adverse effects to the aquatic resources.

- Work with Maintenance Division to eliminate adverse effects of the Snake Creek road on aquatic resources.

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- Seek technical assistance from U.S. Geologic Resources and NPS Geologic Resource division to assess the impacts of the pipeline diversion. Initiate dry studies to verify actual loss of water and recovery down stream

- Work with and involve water user in Garrison, Utah to facilitate studies.

- Work with and involve water user in Garrison, Utah to restore minimum instream flow.

- Survey selected streams for the presence of amphibians. Utilize the methodology found in the "Great Basin National Park Aquatic Monitoring Protocols" handbook. Investigate life histories of those species found. Design stream treatment and other mitigation measures to minimize or eliminate any adverse impacts to these species.

- Survey selected streams for the presence of mollusks. Utilize the methodology found in the "Great Basin National Park Aquatic Monitoring Protocols" handbook. Investigate life histories of those species found. Design stream treatment and other mitigation measures to minimize or eliminate any adverse impacts to these species.

- Just prior to chemical renovation treatments, collect and hold macroinvertebrates in a suitable tank or place them in side seeps, spring or above the treatment areato allow persistence. Release several days post treatment to facilitate system recovery.

- Conduct a comparative analysis that assesses the effects to target and nontarget aquatic resource of rotenone and antimycin A by using both chemicals in different streams. Rotenone will be used in Strawberry Creek and antimycin A in Mill Creek. Repeat pre and post treatment surveys and assess effects. Adaptive management will then be used to refine renovation techniques.

- Recognize aquatic resource and fishery programs as interpretive "themes" and include them as a program area in Annual Statements for Interpretive developed by the park

- Develop an interpretive brochure that describes the recreational fishing opportunities at GRBA.

- Develop an interpretive brochure about the Western BCT and the re-establishment efforts here and elsewhere.

- Encourage park interpretive staff to be well informed about all aspects of fishing and fishery management in order to give accurate information to the visiting public.

- Develop programs to introduce children to fishing and fishing ethics through activities such as the Junior Ranger program.

- Promote recreational fisheries as renewable resources by encouraging non-consumptive methods such as catch and release.

- Trail 1 – Baker Creek Interpretative Trail. A 0.5-mile trail would be constructed between the Pole Canyon Picnic area and Grey Cliff campground. Trail would be signed as Angler Access Trail.

- Trail 2 – Grey Cliffs Campground/Baker Campground Trail. A 1.25-mile trail would be developed between these two campgrounds. An old overgrown trail exists and would be used. Some minor vegetative clearing, tread development and rerouting would be required to minimize impacts to riparian areas. Trail would be signed as Angler Access with mileage given between points at the start in each campground. A small wooden bridge would be constructed to allow stream crossing to access the Baker Campground access point.

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