STATUS REVIEW FOR BONNEVILLE CUTTHROAT TROUT (Oncorhynchus clarki utah)

United States Department of the Interior
U.S. Fish and Wildlife Service
Regions 1 and 6
Portland, Oregon and Denver, Colorado

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I. EXECUTIVE SUMMARY

a. Summary of Contents

We have compiled and analyzed to the extent possible the most recent and best scientific and commercial data available on BCT to complete the status review. This information included published and unpublished reports, manuscripts, books and data, comments, memorandums, letters, phone communications, email correspondence, and personal informational gathered at meetings. In addition, persons who are considered species experts on BCT were provided opportunity to comment on the data used in this report to ensure it was the most accurate and updated information available and that it was interpreted accurately.

Based on this analysis, the overall the status of BCT has improved in every GU since the 1970s when researchers began to investigate the status of BCT for the purpose of its long-term conservation. Currently, BCT occupy a total of 1,372 kilometers (852 miles) of stream habitat and 28,352 hectares (70,059 acres) of lake habitat with a total of 291 populations. Remaining potential exists to discover BCT populations in streams which have not been recently surveyed or explored. This potential is greatest in the Bear River and Northern GU which contain extensive natural water systems that remain uninvestigated. Viable, self-sustaining BCT populations occur within all five GUs, including remnant populations in each of these areas. Almost every major drainage within the five GUs supports pure BCT populations, either remnant or reintroduced. Furthermore, unsurveyed streams exist which may reveal additional remnant BCT populations as yet unidentified.

Although the numbers of extant BCT stocks are likely much lower than the historical number of populations, the known BCT populations have increased by an order of magnitude or more in the past 3 decades. Based on information from early accounts of pioneer settlement and early descriptions of land-use and wildlife management, a noted decline in BCT populations occurred between 1850 and 1950. This decline was due to devastating impacts from land-use activities such as extensive water development, overharvest of fish through commercial industry, nonnative salmonid introductions, tie-hacking of timber, and improper livestock grazing. Although many of those threats have not been entirely eliminated, the devastating disregard for land and wildlife no longer occurs to the extent that it did between 1850 and 1950. In addition, most BCT populations are located on lands publicly owned and managed by the USFS, NPS, and BLM. Public ownership provides some element of protection from development and guarantees public review of major activities which may adversely affect wildlife through compliance with the National Environmental Policy Act and various agency regulations.

The improved status of BCT in the past 30 years can be attributed to—increased sampling effort, improved technology for identification of pure populations (both biochemical-genetic and meristic), population expansion efforts (transplants and brood source development) that have resulted in establishment of additional BCT populations, and improved habitat and flow conditions in some streams. Because current management plans are ongoing and describe BCT conservation activities for future decades, it is likely that additional BCT populations will be

identified, additional reintroduced BCT populations will become established, and stream habitat and flow conditions will continue to be improved. Thus, the status of BCT will probably stabilize as surveys are completed and conservation activities are completed.

b. Status Review Team

A biological review team consisting of U.S. Fish and Wildlife Service biologists from Region 6, headquartered in Denver, Colorado and Region 1, headquartered in Portland, Oregon was established to prepare the status review for the Bonneville cutthroat trout and make appropriate recommendations in response to the Service's positive 90-day finding (63 FR 67640) on the petition to list the Bonneville cutthroat trout, received on February 26, 1998. Biological review team members included: Yvette Converse, Fish and Wildlife Biologist, and Jessica Gourley, Fish and Wildlife Biologist, Utah Ecological Services Field Office, Salt Lake City, Utah; Janet Mizzi, Senior Staff Biologist, Northern Ecosystems, Regional Office, Denver, Colorado; as well as team review from Mark Maley, Fish and Wildlife biologist in the Nevada Field Office, and staff from Idaho and Wyoming Field Offices.

c. Acknowledgments

The status review team of the Service would like to acknowledge the following agencies and institutions for providing information on the background, status and conservation activities for Bonneville cutthroat trout: US Forest Service (the Bridger-Teton, Caribou, Dixie, Fishlake, Humboldt-Toiyabe, and Wasatch-Cache National Forests), the Bureau of Land Management in Utah, Nevada, Idaho and Wyoming, the National Park Service of Great Basin National Park, the Confederated Tribes of the Goshute Reservation, Utah Division of Wildlife, Wyoming Game and Fish Department, Idaho Department of Fish and Game and Nevada Division of Wildlife, and local chapters of Trout Unlimited.

The status review team would also like to thank several researchers from local universities who reviewed and provided technical assistance on aspects of this document. Dr. Robert Hilderbrand, previously of Utah State University, assisted in development of the database template and provided technical advise and comment on ecology, habitat and population dynamics as well as maps of the Bonneville Basin. Warren Colyer of Utah State University also provided technical information and review of ecological information. Dr. Dennis Shiozawa of Brigham Young University and Dr. Robert Behnke of Colorado State University provided valuable expert peer review of this report in its draft form.

Many of the regional and local fisheries biologists, managers and interested professionals have provided information for and reviewed portions of this document in draft. Specifically, the following individuals assisted in the data compilation and review of this report: Louis Berg, Paul Burnett, Pete Cavalli, Jim Capurso, Paul Chase, Jennifer Coons, Scott Covington, Paul Cowley, Neal Darby, Mike Donahoo, Buck Douglass, Don Duff, John Henderson, Dale Hepworth, Geof Hogander, Milton Hooper, Dave Irving, Abbey Josie, Ann Keysor, Pat Koelsch, Mark Maley, Kurt Nelson, Bryce Nielson, Mike Ottenbacher, Vernon Phinney, Ron Remmick, Steve Schucht, Dick Scully, Hilda Sexauer, Kent Sorenson, Charlie Thompson, Paul Thompson, Jim Whelan,

Don Wiley, Todd Williams, and Larry Zeigenfuss.

II. GLOSSARY OF TERMS AND ABBREVIATIONS

The following terms and abbreviations are used throughout this document.

a. Agencies and Institutions:

AFS	American Fisheries Society
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
Goshute Tribe	Confederated Tribes of the Goshute Reservation
DFC	Desert Fishes Council
IDFG	Idaho Fish and Game
NDOW	Nevada Division of Wildlife
NPS	National Park Service
Service	US Fish and Wildlife Service
TU	Trout Unlimited
UDWR	Utah Division of Wildlife Resources
USFS	US Forest Service
WGF	Wyoming Game and Fish Department

b. Species:

BCT	Bonneville cutthroat trout
BKT	Brook trout
BNT	Brown trout
CCT	Colorado River cutthroat trout
LKT	Lake trout
RBT	Rainbow trout
YCT	Yellowstone cutthroat trout

c. Terms:

CA	Conservation Agreement
CS	Conservation Strategy
Act	Endangered Species Act of 1973, as amended
GU	Geographic Unit

d. Definitions: These definitions are intended for the purposes of this status review and may or may not reflect definitions used elsewhere.

Conservation Action - any activity that results in better information, improved conditions or perceivable benefits to the long-term protection, conservation and persistence of Bonneville cutthroat trout (BCT).

Conservation Population - a population managed for the primary purpose of sustaining the existence of the subspecies Bonneville cutthroat trout.

Hybridization - the resultant genetic introgression of nonnative salmonid genetic material into a native BCT genetic stock. This includes introgression with other cutthroat subspecies.

Introduction - Release of BCT into historically unoccupied sites.

Management Population - a population that is recognized as BCT for its ecological and phenotypic characteristics but that may be primarily managed for purposes other than sustaining the existence of BCT, such as for nonnative sportfishing.

Metapopulation - a collection of localized populations that is physically and genetically interconnected through the natural movement and successful reproduction of an occasional migrant from one population into a neighboring population. Because genetic interchange is difficult to document, for purposes of this document, a metapopulation refers to more than one population between which there is no physical barrier to fish movement. Connected populations not only provide genetic interchange but also provide demographic redundancy such that fish from one population are capable of recolonizing or supplementing numbers in a connected population where environmental impacts or catastrophic events have potential to suppress numbers or eliminate a population.

Nonnative - a fish that is outside of its native range.

Population - a geographically, genetically or ecologically distinct group of fish that regularly and freely intermix resulting in successful reproduction and recruitment of young fish to new generations.

Pure - the exact description of pure BCT has shifted as new technology and information has been acquired over the past 50 years. References to ‘pure’ BCT from 30 years ago was based primarily on physical identification. More recently, genetic characteristics are used to evaluate purity. Criteria are developed on which managers rate purity in the absence of having all information. For purposes of this review, pure BCT are those populations designated as pure according to each State’s criterion for purity.

Reintroduction - transplanting or stocking of BCT into historically occupied sites for purposes of starting a new population.

Remnant population- any population that has naturally persisted and currently occurs within its historically occupied stream or locale. Remnant populations do not include populations that have been introduced or reintroduced through transplanting or stocking.

Transplant - removal of BCT individuals from a population in the wild and subsequent release of these individuals into other waters.

III. INTRODUCTION

a. Purpose of the status review

The purpose of this status review is to assemble the best scientific or commercial data available on the status of Bonneville cutthroat trout *(Oncorhynchus clarki utah)* (BCT) within its known historic range in Utah, Idaho, Nevada and Wyoming. Based on this status review, the U.S. Fish and Wildlife Service (Service) makes a determination as to whether BCT is warranted for federal listing as threatened or endangered under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). The following types of information relating to BCT were specifically solicited from the public and from local, state and Federal agencies to thoroughly address this review:

- genetic variability and purity of the various subpopulations of BCT
- population status and trends
- management policies and conservation plans affecting BCT
- threats to the species, including those identified in the petition

b. Endangered Species Act requirements

This section describes more specifically, the Act and Service policy and guidelines that are used to assemble and evaluate this information. To evaluate the merit of this review, it is important to understand the intent of the Act, why species are listed under the Act, and what definitions and criteria are used to make determinations on the status of a species.

b.i. Listing regulations and guidelines

Section 4 of the Act and implementing regulations (50 CFR 424) describe the process whereby a species, subspecies, or population segments thereof, can be added to the list of threatened and endangered species. There are three methods by which a species can be added to the list. The Act allows that any interested person, under section 553 (e) of Title 5, United States Code, can petition the Service to add a species, or to remove a species from, the list of threatened and endangered species. When a petition is received by the Service, the Service shall make a finding within 90 days after receiving the petition to the maximum extent practicable, as to whether the petition presents substantial scientific or commercial information indicating the petitioned action may be warranted. This finding is to be based on all information available to the Service at the time the finding is made.

If a petition is found to be not substantial, notification is made to the petitioners and the process ends. If a petition is found to present substantial information as described above, the Service shall promptly commence a review of the status of the species. Subsequently, within 12 months after receiving a petition that is found to be substantial, the Service shall issue a 12-month finding on whether the petitioned action is warranted, not warranted, or warranted but precluded by other higher priority listing actions. If the action is found to be warranted, the finding may be published in the form of a proposed rule. The Service would then have one year to finalize the listing action for the species.

A second way that a species may be added to the list of endangered and threatened species is for the Service, recognizing that the species is imperiled, to place the species on its candidate list. By doing so, the Service is recognizing that the species warrants listing, but that an immediate listing is precluded by other higher priority actions. When listing of such species is no longer precluded by other actions, the Service would complete a proposed rule to list the species, followed by a final rule within one year.

The final way that a species may be added to the endangered and threatened species lists is by an emergency listing. Species are considered for emergency listing when the immediacy of a threat is so great to a significant proportion of the total population that the routine listing process is not sufficient to prevent large losses that may result in extinction. Expected losses to the species or its habitat during the time required for the normal listing process that could risk continued existence of the species are grounds for an emergency rule. An emergency rule may be published at any time. Upon publication, the rule becomes effective immediately and is applicable for a period of 240 days. This affords the species the protection of the Act while the normal rule-making procedures are followed. Because an emergency rule is only in effect for 240 days, a proposed rule to list the species followed by a final rule, must be completed within the 240 day time-frame or the provisions of the emergency rule expire.

According to the Act and implementing regulations (40 CFR 424.11), a species shall be listed or reclassified, if, based on the best scientific or commercial data available, after conducting a review of the species status, the species is found to be endangered or threatened because of any one or a combination of the following factors:

1) The present or threatened destruction , modification or curtailment of its of its habitat or range;
2) Overutilization for commercial, recreational, scientific, or educational purposes;
3) Disease or predation;
4) The inadequacy of existing regulatory mechanisms;
5) Other natural or manmade factors affecting its continued existence.

An endangered species is defined as any species which is in danger of extinction throughout all or a significant portion of its range. A threatened species is defined as any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Because no two species possess identical ecology and life history, and the response by a species to the above factors vary, the effect of the threat posed by the above factors also varies by species. This necessitates that the overall assessment in determining endangered or threatened status for individual species remain somewhat subjective. However, the definitions of both endangered and threatened, as provided in the Act, provide a baseline for a listing conclusion.

While the status assessment may include some subjectivity, guidance has been developed to assist the Service in making a determination. In evaluating the status of a species, section

4(b)(1)(A) of the Act requires that the Service must take into account those efforts, if any, being made by any State or foreign nation, or any political subdivision of a State or foreign nation, to protect such species. The Service, as provided by policy (59 FR 34270), requires independent peer review of any pertinent scientific or commercial data and assumptions relating to the taxonomy, population models, and supportive biological and ecological information for species under consideration for listing. To ensure that any information used by the Service to support a listing activity is reliable, credible, and represents the best scientific and commercial information available, biologists are required, by policy (59 FR 34271), to gather, impartially evaluate, and document their evaluation of all scientific and other information for the quality of the biological, ecological and other information. Lastly, the Service is required by policy (59 FR 34270) to use the expertise of and solicit information from State wildlife agencies in preparing proposed and final listing rules.

b.ii. Intercross policy

Throughout the range of BCT, hybridization between BCT and nonnative salmonids is known to occur. This is true for most inland cutthroat trout subspecies. In the extreme situation, hybridization or introgression can alter the genetically based, physical traits that make BCT different from other trout species or subspecies (Allendorf and Leary 1988) to the extent that BCT traits can be completely eliminated from the gene pool. However, the degree of genetic introgression that can and does occur before the unique characteristics of BCT are masked (no longer physically visible) or swamped (diluted such that BCT traits are effectively lost) is unknown.

Advances in scientific philosophy in the field of wildlife genetics in the past 30 years have shifted earlier concepts of speciation and hybridization such that delineations and functions of species are not considered as rigid as they once were. Molecular genetic studies on both listed and unlisted species indicate that natural matings and genetic exchange between related species may be more common events than previously believed (61 FR 4710).

In the case of BCT, some natural hybridization may have occurred in locations of overlapping or adjacent ranges of closely related subspecies of cutthroat, such as between BCT, Yellowstone cutthroat trout (YCT) and Colorado River cutthroat trout (CCT). However, excessive stocking of nonnative salmonid species, particularly rainbow trout (RBT) and YCT, into BCT occupied streams has artificially increased the potential for and incidence of hybridization beyond what may occur naturally. Such widespread stocking began more than 100 years ago for purposes of maintaining or even increasing fish productivity in streams. Subsequently, the societal popularity of angling has lead to strong public support for continued stocking within state fisheries programs. The history of extensive stocking was a primary factor contributing to rising concern in the 1960s and 1970s that pure BCT populations were likely quite rare given the potential for hybridization (Popov and Low 1950; Cope 1955; Holden et al. 1974).

Current genetic technology (acquired in the past 20) years has provided more accurate information about the levels of genetic introgression of cutthroat subspecies. It is now possible

to analyze populations for presence of nonnative salmonid genetic material. Results of genetic surveys indicate that despite more than 100 years of nonnative salmonid stocking, many BCT populations retain relatively high levels of native BCT genetic material.

Wildlife managers are now faced with difficult decisions about which populations retain BCT genetic and phenotypic information worth conserving and which warrant restoration. The difficulty with regard to understanding effects of hybridization on the long-term persistence of BCT lies in determining the level of ecologically and genetically valuable "purity" (presence of untainted BCT genetic material and physical traits) that is necessary to ensure persistence of the subspecies in a natural evolutionary trajectory. For example, two individual BCT may appear similar, but one may have more rainbow trout (RBT) genetic material which would then get passed to its offspring. The level of this hybridization can vary within and among populations as well. Should such a population be conserved as BCT or managed as RBT and possibly eliminated? Managing hybrid populations of BCT could lead to an eventual loss of BCT traits altogether if the environmental conditions are more suitable for RBT. Alternatively, removing this population could eliminate important local BCT genetic information. The same situation is true for hybridization between BCT and other subspecies of cutthroat trout, such as YCT.

In addition to this problem, there are multiple techniques available to make such determinations, and there is no objective way to determine which technique is most effective for evaluating purity. Confounding this problem are limitations of genetic techniques which sometimes cannot differentiate between subspecies such as BCT and YCT which have a relatively recent biogeographic relationship.

Wildlife managers have struggled with this dilemma by making use of genetic technology and risk assessment on hybridization impacts. In the past 10 years, many resource management agencies have adopted criteria to make determinations on purity. Most criteria include a mix of morphometric or phenotypic and genetic information. Some criteria include nonnative stocking records as well. Although the purity issue is widely debated among academic professionals and resource managers, no consensus exists on what level of hybridization constitutes an acceptable loss or how hybridization should be measured to ensure that the natural genetic integrity of the species is retained in the wild.

To deal with this as well as other related intercross issues for a variety of species, the Service and National Marine Fisheries Service (Services) published a Proposed Policy on the Treatment of Intercross and Intercross Progeny (the Issue of Hybridization) in the Federal Register in 1996 (61 FR 4710). This proposed policy has not been finalized but has been adopted by the agencies as interim guidance. The policy is intended to allow the Services to aid in the recovery of listed species (under the definition of "species" under the Act, this includes any species, subspecies, or distinct population segment of fish, wildlife or plants that meets the definition of endangered or threatened) by protecting and conserving intercross progeny where intercross individuals contribute to the persistence of the listed parent, eliminating intercross progeny if their presence interferes with conservation efforts for a listed species, and fostering intercrossing when this

would preserve remaining genetic material of a listed species.

The policy proposes that within the scope of a listing for a specific taxon, "where intercross progeny are produced as a result of a cross between an individual of a listed taxon and an individual of a taxon that is not listed, the Services believe the responsibility to conserve endangered and threatened species under the Act extends to those intercross progeny if (1) the progeny share the traits that characterize the taxon of the listed parent, and (2) the progeny more closely resemble the listed parents taxon than an entity intermediate between it and the other known or suspected non-listed parent stock. The best biological information available, including morphometric, ecological, behavioral, genetic, phylogenetic, and/or biochemical data, can be used in this determination".

Although this proposed policy is intended to address the management and recovery of species already designated as threatened or endangered under the Act, the policy is also relevant to introgressed stocks (i.e., intercross progeny) of BCT for the purposes of this status review and future management of the species. The policy connotes importance or value (i.e., ecological or evolutionary) to wild intercross progeny of petitioned species that look and function ecologically like their non-introgressed ancestors and contemporaries. Therefore, for the purposes of this status review, fish populations that State, Tribal, and Federal agency fisheries managers designate as BCT through their purity classification that meet the intercross policy guidelines, even though the precise genetic composition of the population cannot be readily acquired, are assumed to represent this subspecies unless specific physical, genetic or behavioral information indicates otherwise.

c. Limitations of the status review

As previously discussed, extensive stocking of nonnative salmonids has historically occurred into many waters throughout the range of BCT. While in some cases stocking records are complete, in other cases unintentional or even intentional stocking events were not well documented. In addition, success of stockings was not commonly recorded. This lack of information has led to uncertainties as to the presence and purity of BCT, as well as to the degree of hybridization, competition or predation from nonnatives in many historical BCT streams. Although stocking records can indicate where nonnatives are likely to occur, there is no known relationship between records of stocking, actual stocking and actual current nonnative fish presence. Therefore, this status review depends on recent site surveys to document nonnative fish presence.

Furthermore, while involved State wildlife agencies have ongoing efforts to obtain presence, and, where applicable, status, ecology, and purity information for historically suitable bodies of water, this analysis is not comprehensive or complete throughout the range of BCT and by nature must be updated regularly to remain accurate. Most land management agencies have processes in place to evaluate habitat conditions, yet it is virtually impossible to survey habitat comprehensively given funding and personnel resources, and this information must also be updated regularly to remain accurate. Therefore, this status review is limited to known populations of BCT and known habitat conditions, though additional populations may exist.

Thus, while there may be error in assessing the total number of populations of BCT, it is anticipated that this review errs on the conservative side, because only known populations of BCT are reported while the fish community in many drainages remains unknown. Additionally, the majority of information available is for relatively accessible populations in larger systems compared to inaccessible, headwater reaches. It is these inaccessible, headwater reaches that are more likely to retain BCT pristine in genetic purity and habitat condition. Although not considered to offset the level of existing threats on known populations, these unsurveyed areas are a consideration as to the overall status of BCT.

d. Chronology of Federal activity on BCT

1979 The American Fisheries Society (AFS) and the Desert Fishes Council (DFC) petition the Service to list BCT as threatened.
1980 45 FR 19857 Notice of review of BCT status and solicitation for information.
1982 47 FR 58454 Category II Candidate Species
1984 49 FR 2485 'Warranted but Precluded' for petitioned action.
1984 Status Review completed by the Service's Utah Field Office.
1985 50 FR 37958 Category I Candidate Species
1987 52 FR 24312 'Warranted but Precluded' for petitioned action.
1988 53 FR 25511 'Warranted but Precluded' for petitioned action.
1991 56 FR 58804 Category II Candidate Species
1992 The DFC and the Utah Wilderness Association petition the Service to list BCT as threatened. Service determines no new information provided in petition.
1994 59 FR 58982 Category II Candidate Species
1994 Conservation Agreement signed between the Service in Region 1 and the Caribou National Forest for BCT in the Thomas Fork drainage in Idaho.
1996 61 FR 7596 Removal from Candidate Status with policy change eliminating lists for Category II and III species.
1996 61 FR 48500 Notice of availability of draft Conservation Agreement for the BCT
1997 Conservation Agreement and Strategy signed by the Service, the Utah Division of Wildlife Resources (UDWR), Bureau of Reclamation (BOR), U.S. Forest Service (USFS), Bureau of Land Management (BLM), Confederated Tribes of the Goshute, Utah Reclamation Mitigation and Conservation Commission.
1998 The Biodiversity Legal Foundation petitions the Service to list BCT as threatened, with critical habitat in February.
1998 63 FR 67640 Positive 90-day finding for February petition to List BCT as threatened.
1999 64 FR 2167 Reopening of comment period on the 90-day finding for a petition to list BCT as threatened.
2000 The Service signs the Range-wide Conservation Agreement and Strategy for Bonneville Cutthroat Trout.

e. Federal status and petition history of BCT

In the mid to late 1970s, professional fisheries societies became alarmed by reports from the professional and academic community that few 'pure' populations of BCT remained in existence

(Tanner 1936; Cope 1955; Sigler and Miller 1963, Holden et al 1974, Behnke 1976, Hickman 1978). These reports prompted fish advocacy groups to investigate the status of BCT. After receiving a petition to list BCT in 1979, the Service conducted a status review of BCT (USFWS 1984). In 1984, the Service concluded that BCT was 'warranted but precluded' for listing by other higher priority activities.

In 1992, the Service was again petitioned to list BCT as threatened. Although the Service determined that this petition provided no new information, the Service initiated a status review for which a 1993 report was drafted but never finalized. One recommendation of the draft report was that the States enter into Conservation Agreements with other federal, state and local land and wildlife agencies. Such agreements were intended to provide a conservation plan which all involved agencies agreed to implement in concert.

In 1994, the Service signed a Conservation Agreement with the Caribou National Forest and the Idaho Cattleman's Association to improve grazing and restore and protect the native BCT stock in the Thomas Fork drainage of the Bear River system in Idaho. Also, in 1994, the State of Utah initiated a Conservation Agreement with the Service, FS, BLM, BOR, URMCC and the Confederated Tribes of the Goshute Reservation (Goshute Tribe). This Conservation Agreement and the accompanying Conservation Strategy (CS) were signed in 1997 after three years of development and revision.

One action identified in the 1997 Conservation Agreement was development of a range-wide agreement. In 1998, the State of Utah took the lead in conjunction with the Service in developing a range-wide Conservation Agreement and Strategy that would describe threats and actions to remove threats for BCT across its range in 4 States. This Agreement was finalized and signed in 2000 (UDWR, 2000).

On February 26, 1998, the Service received a petition, dated February 5, 1998, from the Biodiversity Legal Foundation requesting that the Service list the Bonneville cutthroat trout, *Oncorhynchus clarki utah*, as threatened in United States river and lake ecosystems where it presently continues to exist and to designate its occupied habitat as critical habitat within a reasonable period of time following the listing.

On December 8, 1998, the Service published a 90-day finding for the BCT petition in the Federal Register (63 FR 67640). The Service found that the petition presented substantial information indicating that listing this species may be warranted. At that time, the Service initiated a review of the species' status within its historic range. While considerable information was provided to the Service concerning recent and ongoing efforts to conserve and remove threats to BCT throughout its range prior to the Service making its 90-day finding, the Federal Register announcement solicited any additional data, comments, and suggestions from the public, other concerned governmental agencies, the scientific community, industry or any other interested parties concerning the status of the BCT throughout its range.

The comment period for submission of additional information originally expired on January 7, 1999. However, this comment period was reopened on January 13, 1999 (64 FR 2167) and extended to February 12, 1999. Voluminous comments were received, evaluated and are incorporated, where appropriate, into this review. As this status review was being compiled, information was updated and reviewed where possible to ensure it reflects the most accurate information available.

IV. EVALUATION METHODS

a. Agency jurisdiction

Management of BCT is the responsibility of the individual States, Tribal governments and of the National Park Service (NPS) and the Service within national parks and refuges where the species is present. Authority for management of its habitat lies with Federal land management agencies (BLM and USFS), State land management agencies, Tribal governments, and private landowners. An exception to these agency jurisdictional standards, is that the NPS is responsible for both the management of the species and management of its habitat in the Great Basin National Park. Figure 1 is a map of the Bonneville Basin and the entire BCT range.

a.i. Federal jurisdiction

Federal agencies with jurisdiction over lands containing BCT populations include the BLM, the USFS, US Fish and Wildlife Service Wildlife Refuge System and the NPS. BLM lands are managed by BLM state offices in Wyoming, Idaho, Utah, and Nevada. BCT populations occur within portions of the following National Forest lands: Targhee-Caribou and Bridger-Teton, Wasatch-Cache, Uinta, Manti-LaSal, Fishlake, Dixie, and Humboldt-Toiyabe National Forests. Refuges within the range of BCT include the Cokeville Meadows National Wildlife Refuge, on the Bear River drainage in southwestern Wyoming, the Bear River Migratory Bird Refuge in the Bear River drainage in northern Utah, and the Fish Springs National Wildlife Refuge on the east side of the Deep Creek Mountains in western Utah. Great Basin National Park located in eastern Nevada is the only National Park managing streams for BCT.

a.ii Tribal jurisdiction

BCT are native to lands under the stewardship of the Confederated Tribes of the Goshute Reservation (Goshute Tribe). The Goshute Reservation is located primarily along the west slope of the Deep Creek Mountain range on the border of western Utah and eastern Nevada. On reservation lands, the tribe retains management of both the land and the wildlife. The Goshute Tribe manages the BCT fisheries with assistance from the Service.

a.iii. State jurisdiction

BCT are native to four states: Idaho, Nevada, Utah and Wyoming. Most of the range (greater than 90%) is within the State of Utah including the following counties: Rich, Box Elder, Weber, Morgan, Davis, Summit, Salt Lake, Wasatch, Utah, Juab, San Pete, Millard, Sevier, Beaver, Piute, Garfield, Iron, and Washington. In Wyoming, BCT occur in Uinta, Sweetwater, Lincoln and Sublette counties. In Idaho, BCT occur in Bannock, Bear Lake, Caribou, Franklin and Oneida counties. In Nevada, BCT occur in White Pine County.

a.iv. Local or private jurisdiction

Historic and current range of BCT includes private lands, particularly in northern Utah and the Bear River drainage. Land use under private ownership may support activities such as urban and residential development, farming and agriculture, recreation, mining, ranching, and power generation or other miscellaneous land use activities. However, management of fish and

wildlife, including BCT, remains with the respective State governments. Several private land-owners are involved in BCT conservation activities through cooperative efforts with Federal, Tribal, and State agencies.

b. Source of Information

Information sources used in this review include:

1) all comments received by the Service prior to and as a result of the 90-day substantial petition finding request for comments;
2) a comprehensive review of the published scientific literature;
3) unpublished agency reports and literature;
4) land management and agency management, planning and decision documents, plans or strategies; and
5) personal communications with pertinent academic and professional fisheries experts, State and Federal agency wildlife managers, and known groups or individuals with specific relevant knowledge of the status of BCT and its habitat.

Most information received in response to the Service's Federal Register notice and request for information was provided by State wildlife and Federal land management agencies, although private citizens and other entities, such as Trout Unlimited, also provided information.

c. Geographic Organization

Bonneville cutthroat trout is thought to have historically occupied most water bodies with appropriate habitat conditions within the Bonneville Basin (Behnke 1992). The Bonneville Basin extends from the deserts and mountains of southern Utah and eastern Nevada north into the southeastern portion of Idaho and southwestern portion of Wyoming. Since the desiccation of ancient Lake Bonneville nearly 10,000 years ago, the climate in the Bonneville Basin has remained relatively arid. Habitat with suitable conditions for cutthroat trout, such as adequate flow and temperature regimes, range from higher elevations (approximately 8000 to 11,000 feet above mean sea level) in small mountain streams and lakes within coniferous and deciduous forests and meadows to lower elevation (approximately 3000 to 5000 feet above mean sea level) alluvial desert river systems with sage-steppe grasslands and herbaceous riparian communities. Suitable habitat within BCT range is logically broken into 5 natural geographically and hydrologically distinct areas henceforth referred to as Geographic Units (GU). GUs are described in detail in Section VI. Status Summary by Geographic Unit. These GUs are generally categorized as:

1) Bear Lake - includes Bear Lake and several small streams draining into Bear Lake within Idaho and Utah (Figure 2),

2) Bear River - includes the upper Bear River draining the northwestern portion of the Uinta Mountains, the Thomas Fork watershed, the Cub River watershed, the Logan and Little Bear rivers watershed, the Malad River watershed and others

(Figure 3).

3) Northern Bonneville - includes the Weber, Ogden and Jordan rivers (Great Salt Lake) watershed and the Provo and Spanish Fork rivers (Utah Lake) watersheds (Figure 4).

4) Western Bonneville - includes small streams draining both the east and west slopes of the Deep Creek Mountain range on the border of Utah and Nevada as well as Wheeler Peak (Great Basin National Park) and Mt. Mariah Wilderness (Humboldt-Toiyabe National Forest) draining from the east slopes of the Snake Mountain range of southeastern Nevada, and the Snake and Steptoe valleys (Figure 5).

5) Southern Bonneville - includes Mt. Dutton and the Tusher Mountains in the Beaver and Sevier River drainages and northwestern portions of the Virgin River draining from the Pine Valley Mountains north of St. George, Utah (Figure 6).

d. Data Organization

Because BCT span four states with varying geographic and climatic conditions and because land use and subsequent threats differ across the range, the status review team wanted to ensure the same level of analysis was applied to each area. Therefore, a database template was designed to allow examination and compilation of a set of standard information on BCT, its habitat, threats and conservation actions across the range. This information was used to compliment the more detailed and/or specific comments the Service received on conditions within individual streams or drainages among the geographic areas.

First, data from all comments, documents, reports, publications and other information was incorporated into the database. Secondly, to ensure the accuracy and comprehensiveness of the data, the status review team contacted local biologists, land managers and other academic or professional technical experts to fill in data gaps where possible. Third, specific comments were incorporated where applicable. Finally, the data by geographic area was reviewed in draft by area biologists, managers and species experts to assess accuracy and completeness.

e. Assessing Purity of BCT Populations

In the early 1900s, confusion regarding the physical description of pure BCT arose because of the extinction of BCT from the type locality in Utah Lake in the 1930s and other confusing accounts. Early taxonomic distinctions were based solely on physical descriptions (Tanner and Hayes 1933; Behnke 1992). Reports of extinct BCT from some well known locations and knowledge of widespread stocking of RBT and YCT lead some experts to speculate that BCT was extinct in its pure form (Tanner 1936; Cope 1955; Sigler and Miller 1963; Holden et al 1974). Such speculation became widely accepted because there was no accurate and accepted criterion of what defined pure BCT.

In assessing levels of hybridization among species or subspecies, known 'pure' or unhybridized samples must be available. In the case of BCT, some of the earliest speculation and reports on purity are based on inter-drainage or inter-basin phenotypic differences. However, this kind of information can be misleading where phenotypic differences do not reflect genetic differences or speciation. It was not until the 1960s and 1970s when a few BCT populations were found in extremely isolated or pristine conditions where introductions of nonnative species had not occurred that wildlife managers felt with certainty that the BCT were pure and began to develop a standard for BCT purity. In the 1970s, Dr. Robert Behnke became the renowned expert on cutthroat trout identification and purity. Through his efforts and those of his students, criteria were developed by which some level of purity could be assessed. Soon after, genetic technology was applied to the question of purity.

Two main issues developed related to purity of BCT. The first is how to discern purity. The second is what level of purity warrants protection or conservation. Criteria and protocols to address these two separate, but related issues continue to evolve over the past three decades and into the present as technological advances and new information became available on what constitutes pure BCT. With shifts in understanding of the importance of local genetic adaptions, it became important to identify a critical level or range of hybridization or a conservation criterion by which important populations could be identified and protected. With such a criterion, managers hoped to ensure that important BCT genetic information was not dismissed or eradicated because of low levels of hybridization or speculative data.

In addition, various genetic techniques or combinations of techniques have evolved and continue to change. In the 1970s, allozyme studies (protein electrophoresis) were applied to wildlife issues and since have become widely applied to fish management. This technique examines a diversity of proteins assumed to represent genetic diversity among species. This approach is still considered useful because of the extensive knowledge base upon which comparisons can be made. However, allozyme studies are relatively conservative because of slow mutation rates which results in insufficient variability to detect some levels of genetic differentiation. Also, early allozyme analyses required large quantities of tissue from lethal sampling which was problematic for small populations or declining species. With the development of polymerase chain reaction (PCR) techniques in the early 1980s, genetic material in small tissue samples could be amplified for analysis and more genetic material good be processed.

Mitochondrial DNA (mtDNA) became popularly used in the 1980s and 90s because it is useful for identifying relatively recent taxonomic divergence episodes and for defining phylogeny. Yet, conclusions of hybridization drawn from mtDNA have been criticized because mtDNA is inherited only from the maternal parent. This trait may provide misleading results if one gender breeds preferentially or more readily with other species or subspecies.

In recent years, nuclear DNA markers have been developed for use with different techniques. Nuclear DNA is inherited from both parents. Different genetic analyses provide information on different levels of genetic variation, some of which are useful for interpretation of hybridization

and some of which are not. Some techniques may be too sensitive to variation; others may not be sensitive enough. With each new technology, a new set of standards must be developed to evaluate and compare past and new information. Therefore, the analyses of purity can become stifled by varying efficiency, effectiveness and application of different techniques in addition to the laboratory and field costs associated with complete genetic analysis.

In addition to genetic information, stocking records and biogeographic knowledge has been and continues to be used to assess the likelihood that a particular population is hybridized. Although stocking records are not always complete or accurate, they provide some information on what species have been introduced into a drainage. However, stocking records can be misleading as well, either because they are incomplete or inaccurate or because stocking of nonnative salmonids has not necessarily resulted in hybridized BCT. As previously stated, it was originally assumed that where RBT or other cutthroat subspecies such as YCT were stocked, BCT were hybridized. However, with the development of recent technology in genetic analyses, it has become apparent that many BCT populations have coexisted with extremely low or no levels of RBT hybridization. This can happen where stocked fish are harvested before they reproduce or where they do not successfully reproduce or establish wild populations. Recent genetic technology has proven valuable in identifying new pure populations that were previously suspected of being hybridized and yet no new technology has led to information that has eliminated populations previously identified as pure. Therefore, new technology has proven older techniques conservative in estimating purity.

Overall, managers have used all of these techniques as well as other information that they receive to make the best possible professional judgement as to the purity of a given population and its distribution within a given system. Distribution is described based on natural and artificial barriers, representative sampling and biological and ecological knowledge of the fish and its habitat needs. In an effort to ensure a standard assessment of purity and how BCT is managed, the state wildlife agencies in Utah, Wyoming, Idaho and Nevada have worked together to describe protocols and criteria for evaluating purity and managing BCT for conservation. Currently this document is considered a position paper and is being finalized by the State of Utah (UDWR 2000). Procedures identified within the document represent a combination of management strategies and review of academic and species experts to ensure that the process is based on the best available information and sound biology.

V. ECOLOGY

a. Biogeography and taxonomy

Cutthroat trout (*Oncorhynchus clarki)* have the widest distribution of any western trout species, ranging from southern Alaska to northern California and inland in the Columbia River, Missouri River, Colorado River, Southern Rocky Mountains, and the Great Basin drainages. This species comprises fourteen subspecies according to Behnke (1992), including the Bonneville cutthroat trout (*Oncorhynchus clarki utah*). The BCT is native to the Bonneville basin in Idaho, Nevada, Utah and Wyoming. The Bonneville basin covers approximately 132,650 km^2 within the Great Basin and once contained the largest of the Great Basin's ancient pluvial lakes, Lake Bonneville. At its maximum size, Lake Bonneville extended over 51,840 km^2 and had a depth of over 300 m (Snyder et al. 1964).

It is assumed, for the purposes of this review, as well as by the scientific community, that the BCT historically occupied all suitable habitats within the Pleistocene Lake Bonneville basin, which included portions of Idaho, Nevada, Utah and Wyoming. Lake Bonneville during the Pleistocene time is compared to the modern Lake Michigan including its diverse fish assemblages of top carnivores, planktivores, sculpins, minnows and suckers (Smith et al. 1968). Behnke (1992) suggests that the dessication of ancient Lake Bonneville about 8,000 years ago fragmented the BCT into remaining streams and lakes throughout the basin, resulting in several slightly differentiated groups of BCT: the Bear River basin, Bonneville basin proper including the Wasatch Mountain and Sevier River drainages, and the Snake Valley, an arm of ancient Lake Bonneville which was isolated during an earlier dessication event. There is general consensus among the scientific community that all three groups represent the BCT subspecies. The Service, likewise, recognizes these three groups as the BCT subspecies. Therefore, for the purposes of this review and the petition finding, all three groups are considered Bonneville cutthroat trout and are included in the following review.

Researchers have not reached consensus on the evolutionary history of BCT. BCT is thought to have originally evolved from the Yellowstone cutthroat subspecies, one of the three main evolutionary branches of cutthroat trout. Behnke (1979, 1992) postulated that cutthroat trout may have gained access to the Bonneville Basin at multiple times when Lake Bonneville reached varying elevations during past geologic events. Thus, some natural evolutionary differences may be evident among drainages in the Bonneville Basin that became geographically isolated at different geologic time periods.

Loudenslager and Gall (1980) discuss the ancestry of BCT. They theorized that Colorado River cutthroat trout and BCT are closely related and share a common ancestor but that Bear River BCT represent a subsequent invasion of YCT into the Bonneville Basin. Therefore, the Bear River BCT might be more closely associated with a subgroup of the Yellowstone cutthroat subspecies compared to other BCT in the Bonneville Basin. Limited mitochondrial DNA (mtDNA) analysis of BCT by Williams and Shiozawa (1989) supported the idea of diverse origins or multiple, independent mtDNA mutations in the basin. Later, Shiozawa et al. (1993) categorized BCT within Utah into three types different from Behnke (1992). The subgroups

were: (1) the Bear River type, (2) the Southern Bonneville type (from the Virgin River drainage), and (3) the main Bonneville Basin type. Shiozawa found that analysis of restriction fragment length polymorphisms (RFLPs) in mtDNA of Bear River BCT indicate this group is more closely related to YCT than to other BCT which further supports Loudenslager and Gall (1980).

Using protein electrophoresis, Wydoski et al. (1976) discovered a unique characteristic in BCT from the Snake Valley area, providing evidence of some genetic divergence within that group. In addition, Martin et al. (1985) determined that Bear River cutthroat trout were distinct from all other BCT using protein electrophoresis which further confirmed the similarities between the Bear River type BCT and Yellowstone cutthroat trout. Yet experts continue to place Bear River cutthroat in the BCT subspecies.

Because of the diverse nature of the BCT subspecies, more research is required before phylogeny and intraspecific relationships can be comprehensively interpreted (See review in Schmidt *et al*. 1995). Behnke and Zarn (1976) advise that the various existing types should be considered unique and should not be genetically mixed among types because much of the evolutionary history of this subspecies remains unknown. Based on current knowledge all types of cutthroat within the Bonneville Basin are considered BCT, however management agencies respect the divergence between drainages and as a general rule, do not transfer fish between these groups.

b. Morphometrics

BCT generally have large, evenly distributed spots, but there is a high degree of intra-basin variation. BCT tend to develop large pronounced spots that are more evenly distributed on the sides of the body rather than concentrated posteriorly as in the Yellowstone subspecies. Coloration in BCT is generally dull compared to other cutthroat subspecies; however coloration can vary depending on environmental conditions and local genetic composition. Vertebrae typically number 62-63, slightly higher than in other subspecies. Scales in lateral series average 150-170. Pyloric caeca number between 25-55 with a mean of 35, except in the Bear River drainage, which typicaly average more than 40 caeca. BCT average between 16-21 gill rakers, with a mean of 18-19, except the Snake Valley type which have 18-24 (mean, 20-22). Another important characteristic of all cutthroat subspecies is the presence of basibranchial teeth which are absent in rainbow trout (Behnke 1992). Numbers of basibranchial teeth provide information about subspecies derivation and relatedness. The Snake Valley type have profuse basibranchial teeth, averaging 20-28, while most other BCT average 5-10 (Behnke 1992).

c. Life history

i. Life strategy

Life strategies exhibited by BCT include stream resident, fluvial, adfluvial and lacustrine forms. The life strategy that a particular BCT population exhibits likely depends on a combination of environmental conditions and genetic plasticity of inherited traits. Very little information is available to suggest the extent of plasticity and what environmental characteristics may cue a successful shift in life strategy. Most information is based on the success or failure of transplants of various life forms among different aquatic ecosystems. Furthermore, evidence suggests that

BCT populations within a single stream can comprise multiple life history strategies (resident, fluvial, adfluvial), and that individuals may use mainstem rivers to move between and among drainages where they are not fragmented by water diversions or barriers (Kershner et al 1997).

ii. Reproduction

May et al. (1978) found that male BCT sexually matured at age 2 while females matured at 3 years of age. However, Bear Lake BCT were reported to mature much later, with adults normally beginning to mature at 5 years of age but not spawning until age 10 (Neilson and Lentsch 1988). Both the age at maturity and the annual timing of spawning vary geographically with elevation, temperature and life history strategy (Behnke 1992; Kershner 1995). Lake resident trout may begin spawning at two years and usually continue throughout their lives, while adfluvial individuals may not spawn for several years (e.g. Kershner 1995). Annual spawning of BCT usually occurs during the spring and early summer at higher elevations (Behnke 1992) at temperatures ranging from 4-10 ^{o}C (May et al. 1978).

May et al. (1978) reported BCT spawning in Birch Creek, Utah beginning in May and continuing into June. BCT in Bear Lake began spawning in late April and completed spawning in June (Nielson and Lentsch 1988). The wild broodstock at Manning Meadow Reservoir (9,500 ft. elevation) spawn from late June to early July (Hepworth and Ottenbacher 1995). In Lake Alice, Wyoming, fish were predicted to spawn from late May until mid-June (Binns 1981).

Little information is available on specific habitat requirements of BCT. Typical of most trout, BCT are thought to require relatively cool, well oxygenated water and the presence of clean, well sorted gravels with minimal fine sediments for successful spawning. However, BCT have also been found to survive and be fairly robust in what is considered marginal salmonid habitat conditions (e.g. turbid water, fine sediments, warmer temperatures, poor structural habitat) (R. Hilderbrand and W. Colyer, pers.comm.). This may be because BCT have evolved in a desert environment where climate can cause fluctuations in water and sediment regimes and environmental condition (Behnke 1992).

Although some BCT populations have been found to persist in these conditions, overall, BCT are thought to grow and survive better given typical salmonid habitat conditions of clearer, cooler water with complex instream habitat conditions. Kershner (USFS, pers.comm.) found substrate size to be proportional to body size. For example, large adfluvial BCT typically spawn in large gravels or cobbles, while smaller, stream resident BCT spawn over coarse sand or small gravels.

Fecundity of BCT is typically 1800-2000 eggs per kilogram of body weight (Behnke 1992). In Birch Creek, a 147mm female produced 99 eggs, a 158mm female produced 60 eggs and a 176 mm female produced 176 eggs (May et al. 1978). Whereas in Raymond Creek, Wyoming 3 females ranging from 124 to 246 mm averaged 165 eggs (Binns 1981). Evidence suggests fecundity of lake-dwelling BCT is greater. Fecundity of females in Lake Alice averaged 474 eggs/female (Binns 1981), while females in Manning Meadow, Utah, averaged 994 eggs/female (D. Hepworth, Utah Division of Wildlife Resources, unpubl. data). Incubation times for wild

BCT have not been verified but may be approximated from other wild cutthroat trout such as Yellowstone which average 310 degree-days (the sum of mean daily temperatures above 0°C) (Gresswell and Varley 1988). For hatchery-incubated eggs from Manning Meadow Reservoir, degree-days to hatching varied from 329-345 (D. Hepworth, Utah Division of Wildlife Resources, unpubl. data). Platts (1957) suggested eggs hatch and fry begin to emerge approximately 45 days after spawning, depending on temperature.

Larvae typically emerge in mid-to-late summer, depending on spawning times. Once emerged, larvae or fry, as they are commonly called, are poor swimmers and typically migrate to stream margins. Adfluvial BCT spend 1 or 2 years in streams before migrating to the Lake (Nielson and Lentsch 1988).

iii. Growth

Growth of resident BCT is highly dependent on stream productivity. In general, growth of trout tends to be slower in high elevation headwater drainages than in lacustrine environments but this likely depends on temperatures and food base. In Birch Creek, Utah, age 1 fish averaged 84 mm, age 2 fish averaged 119 mm, age 3 fish averaged 158 mm, and age 4 fish averaged 197 mm in length (May et al. 1978). Growth in two Wyoming streams was faster and age 4 fish averaged 282-320 mm in length (Binns 1981). In contrast, BCT in Bear Lake grow to an average size of 560 mm and 2 kg (Nielson and Lentsch 1988). Historic accounts of BCT in Utah Lake suggest fish may have reached a meter in length (Notes from Yarrow and Henshaw in 1872 as described by Tanner 1936). Platts (1957) reported that some BCT taken from Utah Lake a century ago attained weights of over 25 pounds.

iv. Feeding

Little is known about feeding habits of BCT. In general, BCT trout are insectivorous, especially in stream habitats. Both terrestrial and aquatic insects appear to be important to their diet (May et al. 1978; Binns 1981). In Birch Creek, May et al. (1978) reported BCT diets were diverse in summer, while in the fall in Trout Creek, Utah, their diet consisted primarily of terrestrial insects. Dipterans and debris were the dominant food items for immature trout while terrestrial insects were the dominant prey for mature individuals. It is possible that a shift from insectivory to piscivory occurs when BCT reach approximately 350 to 400 mm in length (Young 1995). Alternatively, BCT may display more plasticity in feeding habits depending on the system or specific population characteristics. Little information has been collected on BCT to understand the extent of ontogenetic feeding shifts of BCT. Platts (1957) suggested that cutthroat do not need to feed on fish to attain large sizes but will do so where insects are not abundant.

In Bear Lake, BCT experience a diet shift as the fish mature. Trout less than 250 mm primarily ate aquatic and terrestrial insects (Wurtsbaugh and Hawkins 1990). Of the aquatic insects, over 90 percent were chironomid pupae. Later in the summer, terrestrial insects became the primary food source, with 92 percent of the diet in August consisting of ants. Intermediate sized fish (250-350 mm) consumed mostly Bear Lake sculpin during the winter and spring, and fish, aquatic chironomids and terrestrial insects during summer and fall. Chironomid pupae and ants

and homopterans were the most frequest aquatic and terrestrial items, respectively, in the diet. At 225 mm fish in Bear Lake became piscivorous, primarily preying on Bear Lake sculpin until they reached 300 mm in length. At this time, they switched to other fish prey items. BCT longer than 350 mm preyed almost exclusively on fish, preferring Bear Lake cisco in the winter. In Mantua Reservoir BCT favored the abundant fathead minnow (Benhke 1992).

v. Nonnative Interactions

BCT may or may not persist when nonnative trout are stocked into BCT waters. The actual mechanism which dictates the survivorship of BCT in the presence of nonnatives is unknown but the recent discovery that numerous BCT populations have persisted for decades in the presence of RBT, YCT, and other nonnatives suggests BCT is not always displaced by nonnatives as previously thought. However, BCT can hybridize with rainbow trout and Yellowstone cutthroats in some situations and be displaced by the superior competitor, brook trout (BKT). The degree of hybridization appears to vary with the persistence of the stocked fish and also with habitat conditions as does the level of competition with BKT.

Benhke (1992) reported that BCT native to the Bear River drainage adapted to the harsh and fluctuating environments of desert basin streams, remaining the dominant trout today in many streams where nonnative trout were introduced. This seems to be a fairly unique trait of BCT compared to other cutthroat subspecies. There is still no specific rationale as to why BCT would persist better than other desert cutthroat subspecies, yet something in its unique genetic composition seems to allow BCT to persist where other cutthroat subspecies have been found to be displaced.

For example, Bear Lake BCT, probably due to the unique environmental conditions in which they developed, have resisted hybridization with and replacement by nonnative trout. Yellowstone cutthroat trout, Yellowstone cutthroat x rainbow trout hybrids and rainbow trout were consistently stocked into Bear Lake for decades. Benhke (1992) examined specimens from Bear Lake and compared these to museum specimens from the lake and with cutthroat trout from the Bear River drainage and found no evidence of hybridization among their taxonomic characters. Nielson and Lentsch (1988) similarly reported that, after examining 52 Bear Lake specimens electrophoretically, no rainbow trout alleles were observed in any fish.

Since the early 90's, many additional remnant BCT populations have been found in streams that had been stocked with RBT or YCT (Utah Division of Wildlife Resources, unpublished data). These BCT populations were assumed to be lost through hybridization until recent surveys found BCT present. Results of these surveys suggest BCT have retained much of their natural genetic integrity despite intensive nonnative stocking efforts.

Introduced BKT have been stocked, legally and illegally, into some BCT waters. BCT do not hybridize with BKT, but BKT are thought to acquire resources better and reproduce and recruit more efficiently than BCT. The specific mechanism of how BKT displace BCT is unknown but greater fecundity, earlier maturity and tolerance of higher densities gives BKT an advantage over

the native BCT (Fausch 1989; Griffith 1988). The extent of threat to BCT from BKT varies depending on environmental conditions of the stream. Although not considered the greatest threat to the persistence of BCT, competition from introduced BKT can and has displaced native BCT populations.

vi. Habitat requirements

Trout, regardless of their evolutionary history, require 4 types of habitat during various stages of their life history: spawning habitat, nursery or rearing habitat, adult habitat and overwintering habitat. Spawning gravels are required for spawning success and can be a limiting factor in high gradient streams where the current carries off suitable spawning gravel (Behnke 1992). Conversely, an even greater concern may be accumulation of fine sediments into interstitial spaces of spawning gravels which prevents egg incubation and reduces larval survival. Such fines can become dominant in the sediments when poor land-use practices alter flow regimes, remove riparian vegetation, and/or degrade overall watershed conditions. These human-induced activities can aggravate already fragile soils and geology in vulnerable desert climates.

Little information is available on specific habitat requirements for BCT; however, there is a wealth of information on salmonid habitat conditions in general which appear to generally represent those of BCT (Binns and Eiserman 1979; Pennak and Van Gerpen 1947, Scarnecchia and Bergersen 1987). For example, well oxygenated water, cooler temperatures in general and a complexity of instream habitat structure such as large woody debris and overhanging banks are considered good trout habitat conditions. For various species, subspecies and local forms, adaptations and tolerance of these conditions varies.

It was previously thought that with the exception of two lacustrine systems, Bear Lake (Utah and Idaho) and Alice Lake (Wyoming) BCT were historically found in cool headwater streams throughout the Bonneville basin. However, more recent research, status and genetic surveys reveal BCT populations are found at high, moderate and low elevations (within the range of elevations in the Bonneville Basin) in small headwater streams, such as those of the north slope of the western Uintas, to larger mainstem rivers, such as the Thomas Fork of the Bear River (unpublished data, UDWR; W. Colyer, pers.comm.).

Modern human influences (habitat changes, nonnative introductions) have relegated cutthroat subspecies to what has been viewed in recent decades as ‘cutthroat’ habitat (Platts 1957), pristine or inaccessible areas which are also the more high-gradient, headwater reaches. For this reason, cutthroat has become associated with these systems. However, historically, these high-gradient systems may have actually been less desirable as they are often food, temperature and flow limited compared to lower elevation streams in their natural state (W. Colyer, pers.comm.).

vii. Population dynamics

Existing studies of population dynamics of BCT are relatively recent and still ongoing (R. Hilderbrand, pers.comm.). Metapopulation dynamics of other salmonid species have been examined in the past decade (Reiman and McIntyr 1995) and are considered generally applicable

to most salmonid species and subspecies, such as BCT. More specific population studies on BCT by Hilderbrand and Kershner (2000) suggest a relationship for the minimum stream length necessary to sustain a population of adequate size and density while minimizing risks of extinction from demographic considerations. Hilderbrand (2000) also suggests strategies for stabilizing small, isolated populations through transfer of individuals from other populations. The number of individuals stocked and frequency of stocking into such a population should depend on the available habitat and population characteristics of the supplemented population. Studies such as these allow managers to restore populations with greater chance of long-term success which will contribute to the overall persistence of the subspecies.

VI. STATUS SUMMARY

a. Background Status of BCT: 1850 to 1993

This section contains a review of information on the past status and distribution of BCT as well as past threats on BCT populations and/or habitat and any past conservation actions as reported in historic letters, accounts, reports, documents and BCT status assessments. Information is examined from the mid-1800s, the approximate time of pioneer settlement of the Bonneville Basin, up to 1993, the year the last status review of BCT was conducted (USFWS 1993).

i. Status and distribution

The status and distribution of BCT before the mid-1800s after which written records of western livelihood were commonly reported, can only be assumed through infrequent wildlife notes taken from occasional surveys and explorations and/or anecdotal accounts from Native American communities, early explorers and non-indigenous settlers. Behnke (1988) and Trotter and Bisson (1988) review the history of cutthroat trout in general with reference to the earliest accounts of western exploration. Hickman (1978) reviews more current local accounts of BCT in Utah during the mid- to late-1800s. Suckley (1874) provided the first scientific description of BCT based on collections from Utah Lake, Utah, made in the late 1850s.

In general, historic accounts reference abundant trout, successful angling ventures and/or other qualitative descriptions (see discussion in Trotter and Bisson 1988; Cope and Yarrow 1875, Rawley 1985). No specific or comprehensive information on BCT status or distribution in the Bonneville Basin is available before or during the time of pioneer settlement. For purposes of this review, it is therefore assumed that BCT occupied all suitable stream, river and lake habitat before the influence of pioneer settlement within the Bonneville Basin. Suitable habitat would include those water bodies with adequate flow, temperature, food and space to provide for successful reproduction and recruitment of all life stages of BCT.

BCT likely had access to all existing perennial waters during the highest levels of ancient Lake Bonneville approximately 10,000 years ago (Behnke 1992). Yet there may be some waters of the Bonneville Basin that were naturally fishless at the time of pioneer settlement either because gradient or habitat were never suitable or because climatic caused hydrologic changes fragmented populations over time such that they became locally extinct. The later is particularly applicable in more arid regions of the Bonneville Basin such as the west and southern deserts. Such extinctions could have occurred from catastrophic events such as floods, fires or droughts or could have been the result of natural genetic and demographic instability of small, isolated populations. It is important to note, that although there may have been naturally fishless streams in the Bonneville Basin, some of these have been stocked with nonnative RBT or YCT in the past 150 years (Popov and Low 1950; Cope 1955; Holden et al. 1997; D. Hepworth, pers. comm.).

The exact status and trend of BCT over the past 150 years is further clouded by limited data and professional speculation where information was sparse. The identification of ‘pure’ populations

of BCT in the Bonneville Basin has been hindered by the extinction of BCT from the type locality, Utah Lake in the 1930s, and further aggravated by the absence of an adequate description and the single, misleading illustration published by Jordan in 1891 (Tanner and Hayes 1933; Behnke 1992). Because it was difficult to phenotypically identify a pure BCT based on the type locality description and because it was known that nonnative salmonids had been stocked for decades across the Bonneville Basin, most experts speculated that 'pure' BCT were likely extinct throughout their range (Tanner 1936; Cope 1955; Sigler and Miller 1963; Holden et al 1974). Although it was clear BCT had become locally extinct among certain water bodies like Utah and Panquitch lakes and the main Jordan and lower Bear rivers, there had been little or no survey and abundance data collected before the 1980s to determine the status or distribution of BCT in more remote stream bodies such as high mountain streams and lakes or smaller, less accessible tributaries of larger river systems. Furthermore, it was assumed that individuals from mixed populations of BCT and RBT were hybridized to the extent that they no longer represented BCT as a subspecies (Cope 1955, Sigler and Miller 1963, Holden et al 1974).

By the mid-1970s, emphasis was placed on finding 'pure' relict populations of BCT which led to the discovery of several pure populations of BCT (Hickman 1978). New genetics technology of the period allowed researchers to compare BCT with RBT and YCT and to determine hybridization levels and/or genetic relatedness of subspecies of cutthroat trout and other salmonids.

Hickman (1978) identified 15 BCT populations that he considered 'pure' according to his technique based on systematic analysis of physical characteristics (Table 1). It is unclear from this document how many total population samples were examined in this dataset.

Table 1. 1978 summary of information on pure populations of *O. c. utah* modified from Appendix B. Hickman (1978).

Stream	**Origin**	**Density**	**Threats**
Hendry's Cr., NV (Snake Valley, White Pine Co.)	Remnant	400 in 8 km	Poor habitat - drought in 1977 led to 50% mortality
Hampton Cr., NV (Snake Valley, White Pine Co.)	Introduced from Pine Cr. 1953	300 in 4.8 km	Poor habitat - drought in 1977 led to 50% mortality
Pine Cr., NV (Spring Valley, White Pine Co.)	Canal from Lehman Cr.	200 in 2.4 km	Water development for irrigation; limited stream size
Goshute Cr., NV (Steptoe Valley, White Pine Co.)	Introduced from Pine Cr. 1960	500 / 1.6 km in 6.4 km	Grazing, flooding, and drought
Water Canyon Cr., NV (White Pine Co.)	Introduced from Goshute Cr. 1977	41 in 6.4 km	Grazing, flooding, and drought

Clear Cr., NV (White Pine Co.)	Introduced from Goshute Cr. 1977	20 in 1.6 km	Grazing, flooding, limited stream size
Raymond Cr. WY (Thomas Fk, Lincoln Co.)	Remnant	300 - 800 in 4.8 km	Grazing, mining, non-native trout
Giraffe Cr. WY (Thomas Fk, Lincoln Co.)	Remnant	300 - 600 in headwaters	Grazing, mining, non-native trout
Lake Alice, WY (Smith Fk., Lincoln Co.)	Remnant	293.4 ha	Unknown.
Trout Cr., UT (Snake Valley, Juab Co.)	Remnant	800 in 2.4	Mining and nonnative salmonids.
Water Canyon Cr., UT (Virgin R., Washington Co.)	Unknown (transplant or remnant out of basin)	200 in 0.8 km	Grazing, non-native trout, limited stream size.
Reservoir Cyn. Cr., UT (Virgin R. Washington Co.)	Unknown (transplant or remnant out of basin)	500 in 3.2 km	Grazing, non-native trout, limited stream size.
Birch Cr., UT (Sevier R., Beaver Co.)	Remnant	200 / 1.6 km in 8 km	Grazing, poor habitat conditions, drought in 1977 led to 35% mortality.
Sam Stowe Cr., UT (Sevier R., Beaver Co.)	Introduced from Birch Cr. in 1977	50 - 100 in 2.4 km	Limited stream size.
No. Fk. Deaf Smith, UT (Jordan River, Salt Lake Co.)	Remnant	less than 1.6 km of habitat	Limited stream size, urban water development.

Additional surveys conducted in the mid-1980s indicated that additional BCT populations existed and sometimes persisted where nonnative RBT, YCT, BKT and brown trout (BNT) were stocked. By the time of the 1984 status report, several additional pure populations were added to the list (Pine Creek, Beaver Co., UT; Carter Creek, Summit Co., UT; Coal and Coantag Creeks, Lincoln Co., WY).

By the early 1990s, BCT management began to focus on status surveys and genetic testing to more accurately assess BCT status and the extent of hybridization present among populations. A second status review conducted by the Service in 1993, reported 48 populations of BCT throughout the Bonneville Basin (USFWS 1993). Because this report was never finalized, the information can only be assumed to be cursory; however, the report sheds light on the trend of BCT status and conservation during this time period.

The 1993 draft status report described the following populations by state. In Idaho, 4 populations were identified in Preuss, Giraffe and Dry Creeks in the Thomas Fork of the Bear River and in Bear Lake, Idaho. In Nevada, 5 populations were described with remnant populations in Hampton and Hendry's creeks and with introduced, out-of-basin populations in Pine, Ridge, Willard and Goshute creeks. Utah was noted as having 29 native or reintroduced populations of BCT in 6 different drainages: Bear Lake/Bear River (Bear Lake, Carter, Meadow, McKenzie and Sugarpine Creeks), Weber River (Moffitt Creek), Jordan River (North Fork Deaf Smith Canyon, Red Butte Creek), Sevier River (Birch, Pine, Sam Stowe, Deep, Pig, Spirit, Horse, Briggs, North Fork North Creek), Virgin River (Water Canyon, Reservoir Canyon, Leap, Leeds, South Ash, Mill and Harmon Creeks), and Snake Valley (Trout and Birch Creek). Several stream names are not listed for Utah possibly because they are small tributaries of other listed streams or information was incorrectly reported. Wyoming was noted as having 10 native or reintroduced populations of BCT: Water Canyon, Upper Giraffe, Raymond and Upper Coal Creeks in the Thomas Fork Drainage of the Bear River; Sawmill, Coal (Howland), Porcupine, Coantag and Hobble Creeks in the Smiths Fork Drainage of the Bear River; and Lake Alice also in the Smiths Fork Drainage.

ii. Past Activities that Threatened the Long-Term Persistence of BCT

Pioneer settlement and substantial human population growth in the years following pioneer settlement of Utah and the Bonneville Basin in 1847 led to devastating environmental impacts, particularly from over-harvest of fish and wildlife, stream de-watering, tie-hacking, and over-grazing (Peterson and Speth 1980; see discussion in Hickman 1978). These kinds of activities are speculated to have resulted in a catastrophic decline of BCT from the late 1800s through the early to middle 1900s in the more populated areas of the Bonneville Basin.

The devastating disregard for land condition and wildlife left many drainages in poor, degraded conditions with continuing poor land-use. In recent decades, concern shifted to focus on the cumulative and interacting effects of wildlife management and multiple land-use activities imposed on BCT, where its status was tenuous or unknown after an extended period of catastrophic decline.

<u>Fish Harvesting and Angling for Sustenance</u>

In the Bonneville Basin, pioneer settlement acutely impacted BCT populations, as desert streams, rivers and lakes were exploited for the resources they offered struggling pioneers. Fresh fish from local rivers and specifically the excellent trout fishery noted in Utah Lake near Provo, Utah, provided a major source of sustenance to the growing community (Yarrow 1874; Tanner 1936; Cope 1955). Early exploitation of BCT led to their extirpation in Utah Lake. This foretelling account from 1872, conveys the concern over commercial harvest on the condition of the Utah Lake fishery only 25 years after the Salt Lake Valley was settled:

> "In comparison with the other fishes of Utah, the Lake Trout (BCT) is undoubtedly the most numerous and easily captured; how long, however, this condition of affairs will last it is impossible to say, the supply having greatly diminished during the past few years,

> owing to the reckless methods of fishing and increase in the number of fisherman; moreover, a larger demand is now made for this fish, owing to the increase in the number of settlers. The decrease in yield may be roughly estimated at about one-third, but this percentage is slowly but surely increasing."
>
> "No steps have as yet been taken to increase the supply of this valuable fish by artificial means, the yield still being large enough to meet the wants of the settlers and miners; but, in the course of a few years, artificial propagation must be resorted to, for although certain laws have been passed regulating the size of the meshes of nets, no attention is paid to them by some greedy individuals, who think only of filling their own pockets at the expense of future generations." (Yarrow 1874; also see Tanner 1936).

It is important to note that the recommended solution to the noted decline was artificial propagation and not conservation management. Based on the need to establish a trout hatchery in Salt Lake City as early as the 1870s, the pioneer community recognized that the existing fishery would not support long-term harvest at the rate it was experiencing and that a facility for artificial propagation was necessary (Stone 1874).

Other indications of early decline of BCT are the passing of laws to protect native trout passed within the Territory of Utah and additional laws that limited seining with certain mesh sizes and at certain times of year in the Jordan River to protect reproduction and recruitment of native cutthroat trout or requiring fish passage at water diversions (Utah Territorial Legislation of 1853-1876). The lack of emphasis on protection in new legislation after 1875 suggests that hatchery production became the main solution to restoring a declining fishery.

The dominant commercial fishing industry of the 1800s and early 1900s focused on Utah Lake, but Bear Lake and Panquitch Lake were also heavily impacted by commercial fishing (see discussion in Hickman, 1978). Although documentation is best for the condition of Utah Lake. Particularly vivid is the chronology of decline in commercial harvest as reported by Mr. Peter Madsen, a commercial fisherman, that one haul in 1864 weighed from 1600 to 1700 kg compared to the same haul in 1872 which averaged approximately 200 kg (Cope and Yarrow, 1875; notes of Yarrow and Henshaw in 1872 as described by Tanner 1936). In 1889, a seine haul of 45 kg was considered good (Jordan 1891(a) as described by Tanner 1936, and Sigler and Miller 1963). This account describes the BCT population crash that took place in Utah Lake in the late 1800s due to commercial harvest.

By the 1930s, BCT was essentially extinct in Utah Lake and other popular fishing areas and in later decades, speculated to be extinct in its pure form throughout most of the Bonneville Basin due in part to over-harvest by commercial and private fishing (Tanner 1936, Hatton 1939, Cope 1955; Sigler and Miller 1963; see discussion in Hickman 1978).

<u>Nonnative fish introductions and stocking</u>

Early in pioneer history, nonnative salmonids were widely introduced in an effort to supplement

or restore the food supply not satisfied by the depauperate native fishery (Popov and Low 1950). BKT were introduced into waters in Utah as early as 1875, RBT in 1883 and BNT possibly as early as 1895 (Popov and Low 1950; Sigler and Miller 1963). It is unknown exactly when nonnative cutthroat were introduced; Ravenel (1900) documents that 11,000 adults and yearling cutthroat trout were sent to John H. Sharp, Fish and Game Warden in Salt Lake City in 1899. This delivery may have included several subspecies, including YCT (Sigler and Miller 1963). The earliest stocking records indicate large numbers of young fish were stocked for decades into accessible waters in an effort to restore or sustain a high quality fishery (Holden et al. 1997). After 1900, nonnative introductions and stocking focused more on satisfying angler interests as the human population became less reliant on local food sources and recreational angling became more popular (Popov and Low 1950; Holden et al. 1997).

Cope (1955) reports that in 1915, nearly 2 million cutthroat and over 7 million other trout were planted in Utah waters alone in the Bonneville Basin. Of the cutthroat stocked in 1915, 100,000 were from out of Utah; the remainder were collected from Bear Lake and other productive cutthroat populations and stocked into less productive or exploited systems. From 1915 to 1952, over 100 million cutthroat were planted comprising about one-third of the total stocking effort in Utah. Approximately 45% were imported from out of Utah, being almost exclusively from Yellowstone Lake (Cope 1955 as reported from Biennial reports of the Utah State Fish and Game Commission 1915-1952). Comprehensive stocking records for the Bonneville Basin in Nevada, Idaho and Wyoming at the turn of the century are not readily available as most of these peripheral areas of the Bonneville Basin are remote and inaccessible. However, there are suggestions of settlers moving fish among drainages in remote areas like the Snake Valley and the Pine Valley Mountains in the mid- to late-1800s (Miller and Alcorn 1946; Popov and Low 1950; Behnke 1992). It is assumed that fish transplanting among and across drainages without oversight, consent or record-keeping was common in remote pioneer settlements.

Although many nonnative species have been stocked throughout Utah, salmonid species, particularly RBT, YCT and BKT, comprise the greatest threat to BCT. RBT were regularly stocked into most cold, clear-water stream systems and impoundments throughout the Bonneville Basin (Duff 1988; Holden 1997). It is important to note that RBT were commonly stocked at accessible sites and were not always successful at establishing wild populations (those that naturally reproduce and recruit in the wild). As a result, annual stocking was necessary to maintain a sustainable fishery. Heavy annual stocking has taken place in some streams for more than a century. In the past 30 years, stocking has been modified to prevent stocking nonnative salmonids into waters with known pure populations of BCT in Utah (Holden et al. 1997).

Because of the nearby source of fry, YCT were readily available for stocking. YCT and other subspecies of cutthroat trout were stocked into streams to supplement the declining native fishery. In some cases, (e.g. Bear Lake) substantial records exist to document the annual stocking of YCT and other species. Experts hypothesize that the lacustrine form of YCT were not readily established into streams in which they were stocked and as a result, YCT has not prevailed over the native BCT. At this point, genetic information is not sufficient to clearly

discern YCT from the form of BCT in the Bear River drainage because of their recent evolutionary divergence, yet most experts agree that stocked YCT from Yellowstone Lake have not genetically altered the native BCT stock in streams in the northern Bonneville Basin, and some morphological characteristics remain distinctive between BCT and YCT which can be used determine hybridization where it is suspected (D. Shiozawa, pers.comm., Behnke 1992).

Another salmonid which poses a potential problem for BCT is BKT because of their ability to out-compete native BCT in some systems. Although it is not specifically stated, BKT were likely introduced into Utah from the eastern United States to improve the fishery yield and perhaps because BKT was a familiar species to pioneers emigrating west. Research has and continues to be conducted to determine the specific mechanism whereby BKT outcompete native cutthroat trout (acquisition of food or habitat, reproduction) (Cummings 1987, DeStago and Rahel 1994, Griffith 1972, Griffith 1988, Fausch 1989, DeStaso and Rahel 1994); however there is no definitive mechanism identified at this point. In fact, BKT do not displace BCT in all systems as illustrated by co-existing BCT and BKT populations, but BKT seem to do better under certain conditions. Managers have long recognized that BKT can displace BCT but the extent to which BKT threatens the long-term persistence of BCT is difficult to ascertain.

Little is known about the overall affects of BNT on BCT. Although BNT are not stocked as commonly as RBT or BKT, they have established wild populations more readily than RBT. In particular, BNT seem to do well in marginal cutthroat trout habitat. They are known as voracious predators and grow to large sizes; however it is difficult to ascertain the extent to which BNT threaten the long-term persistence of BCT. Although BNT occur in some waters with and native to BCT, habitat and flow in these systems are generally altered such that BCT do not appear to thrive so it is difficult to determine the extent that the presence of BNT affects BCT persistence compared to that of the altered habitat condition. BNT has been one of the most important hatchery-reared fish and has been extensively stocked into Utah waters throughout the past 100 years. Popov and Low (1950) report that in 1947 and 1948, nearly 6 million brown trout were planted in public waters. With a shift in recent decades in stocking policies and with the deftness of BNT to establish wild populations, BNT stocking has decreased in the past decade. From 1991-1995, only 4 lakes and 55 streams or rivers in Utah were stocked with BNT (Holden et al. 1997).

Many other nonnative sportfish, such as largemouth bass and green sunfish, have been stocked at different times throughout the Bonneville Basin but are mainly restricted to or derived from artificial impoundments. In addition, these species are not considered cold-water species and not expected to compete well in cooler, fluvial systems. Therefore, other nonnative fish are not thought to have substantially contributed to the decline of BCT except perhaps in popular fishing impoundments where BCT may have occurred. Carp and other nonnative fish introduced a century ago, may have contributed to the decline of BCT in Utah Lake but BCT demise in that system is generally attributed to over-harvest by commercial industry (Cope and Yarrow 1975; Tanner 1936).

Water Development

From the time pioneers settled the Bonneville Basin, dams and canals were built, water was diverted, certain stream reaches were dewatered and other water bodies were made inaccessible to fish. Geographically, the water systems most impacted from water diversions and depletions are those feeding human populated areas such as the Weber and Provo river drainages that emerge along the Wasatch Front in the Salt Lake Valley and major agricultural centers like the Bear River Valley where the Bear River is the main source of water for irrigation. In these larger systems, high mountain lakes were dammed to increase storage capacity and control water outlet, and elaborate canal systems were constructed to feed communities along the river system. Small, mountain streams were commonly diverted as they reach the valley floor where ranches and communities became established throughout the Bonneville Basin. Larger-scale water impoundments were established to secure municipal water sources in more urban areas.

Direct effects of water diversions and depletions on BCT occur where reaches are dewatered or made inaccessible by instream barriers. Secondary effects of water development may include higher water temperatures in summer months because of lower water volume and diminished riparian condition and altered instream and shoreline habitat, all of which can contribute to an altered macroinvertebrate food base (Clancy 1988).

Rates of habitat loss through water diversions and depletions were likely heaviest for the decades immediately after pioneer settlement, in the late 1800s, throughout the Bonneville Basin near locations of population growth. As the pioneer population grew, local water districts formed to pool resources and protect the water interests of local communities. Within the more organized water districts, larger and more efficient projects were constructed that severely impacted fish in stream and river systems. In the early to mid-1900s, the BOR became a leading federal agency in developing water for the growing western municipal and agricultural needs (Kendrick, 1984).

Most major dams and diversions have been constructed in the Weber, Ogden, Provo and Spanish Fork drainages, the most developed part of the Bonneville Basin. Other urban and agricultural centers have also experienced extensive water development, such as the Bear River, Logan, Little Bear, and Sevier river systems. The overall impact of water development projects on BCT is nearly impossible to determine but has no doubt been a large factor in the demise of native fish populations.

Grazing

Livestock (sheep and cattle) grazing has permanently altered the vegetational communities of the Bonneville Basin (Cottam 1947). Contrary to what is evident in the current-day vast expanses of the Bonneville Basin that are covered with sagebrush and pinyon-juniper forests, historical accounts suggest hard-wood (including sagebrush and pinyon-juniper) was scarce in the valley floors of the Bonneville Basin. Instead, valleys were covered with extensive grasslands similar to that of the plains. Livestock grazing in the first 50 years after pioneer settlement is considered the main land-use activity that has led to a shift in the vegetational community type to the current conditions (Cottom 1947).

In addition to shifting vegetation types, livestock grazing also caused problems for watershed and stream health. By the 1850s, Utah was considered important grazing country, particularly for cattle (Peterson and Speth 1980). Cattle numbers increased from 200,000 in 1870 to more than 356,000 head in 1895 as ranching became a dominant livelihood in western culture. Cattle numbers reached a high in the 1920s of more than 500,000 head in Utah. Sheep numbers began to increase dramatically after 1890 from one million head in 1895 to a high of 3,818,000 at the turn of the century (Peterson and Speth 1980).

Livestock grazing became an acute problem for watershed health in the late 1880s through 1930s when grazing, particularly sheep grazing, was so extensive and ill-managed that widespread watershed damage occurred throughout more used areas of the Bonneville Basin. In fact, at the turn of the century, sheep were crowding cattle out of many areas (Peterson and Speth 1980). In the Wasatch Mountains east of Salt Lake City, Utah, over-grazing of sheep denuded mountain meadows, some to the extent that watersheds experienced massive soil loss, land-slides and severe erosional damage. In addition to resident sheep, Utah was at a geographical 'crossroads of the west' where hundreds of sheep were trailed to and from neighboring states (Peterson and Speth 1980).

Overgrazing by sheep can be particularly damaging to overall watershed conditions. Sheep have been known to graze vegetation down to dirt and 'grub' away at grass roots thereby damaging the soil mantel, which acts to hold water for plant uptake (Peterson and Speth 1980). The extensive watershed damage typical of over-grazing sheep in the early 20th century led to massive soil erosion, land slides and flooding during heavy precipitation (Cottam 1947). Such events can completely eliminate local fish populations and undoubtedly affected local populations of BCT. For streams already fragmented from diversions or dewatering, such events could have led to local extirpation of BCT where no connected populations were available to recolonize streams after a catastrophic flood.

Although cattle grazing can affect watershed conditions as well, the greater concern for cattle grazing stems from direct stream impacts where cattle are permitted to dwell in or are trailed through stream channels and riparian areas. Without adequate management, cattle can trample and destroy instream habitat and stream banks. They forage on lush riparian vegetation, which leads to degraded stream conditions and changes in channel morphology. Trampling destroys undercut banks resulting in wider and shallower channel morphology. Where this occurs, BCT can be impacted by increased water temperatures, loss of habitat complexity, altered macroinvertebrate food-base and increased deposition of fine sediment (Belsky et al. 1999, Platts 1991, Rinne 1999).

Other ungulates (elk and deer) may also pose a threat when their numbers increase such that they overpopulate the land. Cottom (1947) documents deer over-populating and overgrazing areas of the Wasatch Mountains well into the 1940s. He attributes the overpopulation of wild ungulates to several concurrent activities: 1) control or extermination of natural predators such as wolves and bear, 2) hunting regulations for 'buck only' hunts and 3) deer and elk preserves which

attracted and concentrated large numbers of wild ungulates on already over-grazed. Some comments received in response to this status investigation describe current conditions of overgrazing of elk in the Bear River drainage; these specific comments are described in the section on current status of BCT within the discussion of threats for the appropriate stream in the Bear River drainage.

Timber Harvesting

Timber harvesting has resulted in direct and indirect effects on BCT. Similar to water development and grazing, the greatest impacts from timber harvesting occurred from 1850 to 1950. Although timber harvesting still occurs on National Forest Lands and very limited private lands in the Bonneville Basin, timber harvesting standards have substantially improved, particularly regarding protection of streams and watershed condition. This is not to say that timber harvest has not continued to have detrimental impacts on streams and watersheds but rather to suggest that the catastrophic destruction that occurred in the first 100 years of pioneer settlement no longer occurs.

Historically, the most devastating direct impacts from timber harvest occurred from a technique of transporting harvested timber called 'tie-hacking'. This technique was used to transport large quantities of railroad ties to downstream sites where timber could be easily transported overland via railroads or sold to nearby communities or industry. Tie-hacking involved construction of splash-dams to create a water volume sufficient to transport timber downstream through the stream channel. Spring flooding season was a common time to move ties downstream. Many rivers were manually cleared of instream obstacles and, the river was channelized where possible to maximize efficient delivery of timber. Timber was stacked along the stream's edge until the time to transport. Tie-hacking severely damaged stream channels and altered substrate composition as well as likely eliminating or greatly impairing resident fish populations and degrading riparian conditions.

In more recent decades, indirect effects of timber harvesting on BCT include road building and deforestation. Road building is known to add fine sediment to streams where roads cross or follow stream channels. These fine sediments can fill interstitial spaces important for successful spawning and survival of eggs and larval fish as well as altering the macro-invertebrate food base (Williams and Mundie 1978). Deforestation can also add sediment input into streams where riparian buffers are not implemented. Loss of trees also increases water volume draining into stream channels which can alter flow and sediment regimes or exacerbate catastrophic flooding during extreme precipitation events.

Within the Bonneville Basin, timber harvesting is fairly limited compared to other areas of the inland west, mainly because the arid climate is not conducive to extensive, lush forests. However, these same climatic factors result in more vulnerable watershed conditions within the existing forests of the Bonneville Basin.

iii. Past Actions to Protect BCT

Early management of BCT focused on maintaining or increasing yield of fish for harvest, particularly as it was noted that local fisheries were in decline due to over-harvest or poor harvest techniques. Based on the information examined for this review, the first conservation action to preserve or protect BCT was legislation enacted through Utah Territorial Law passed in 1853 which provided jurisdiction to counties over their fisheries resources and were intended to 'prevent the needless destruction of fish.' (Annual Sessions of the Legislative Assembly of the Territory of Utah; Rawley 1985). This law does not provide specific information but is thought to be in response to over-harvest by local communities and indiscriminate fishing techniques. Laws followed in subsequent years with more specific restrictions, regulations and penalties. In 1862, a law was passed which set limits on the traps blocking free migration of fish and requiring licenses for trapping. From 1874 to 1876, laws were passed to protect native trout in the Jordan River presumably using nursery habitat before recruiting into the Utah Lake population, limiting fishing to hook and line only, and requiring fish passage be constructed on all water diversions (Annual Sessions of the Legislative Assembly of the Territory of Utah 1855 -1874).

Despite this legislation, the fishery in Utah Lake was in serious decline by the 1870s. Artificial propagation began to provide a steady supply of fish to be stocked into streams by 1874, and emphasis shifted from conservation to production. The hatchery system in Utah that developed from the late 1800s through the 1900s, as managed through State and Federal wildlife agencies provided RBT and other salmonids to stock throughout the Bonneville Basin with no emphasis on BCT. At the time, very few acknowledged value in native species. The value of a species was measured by its potential as food and sport. Management of BCT was incidental to management of a sustainable fishery that emphasized nonnative species.

As fishing interest shifted from sustenance to recreational, likely with the advent of household electricity and modern refrigeration in the early 1900s, fishing license sales continued to increase and stocking increased throughout Utah. By the 1930s to the 1960s, sport fishing and nonnative stocking to sustain sport fisheries had become extremely popular. Although State and Federal wildlife agencies began to recognize the value of native fish populations, little emphasis was placed on restoring or protecting these populations because funds were directed at maintaining popular sport fisheries. Hence, management and conservation actions for BCT were relatively minimal through the 1980s.

b. Current Status of BCT: 1994-2000

In the following sections, the geography, land-ownership and background of specific GUs are described. Also, the status and distribution of BCT populations and their habitat is outlined. Habitat is described as 'potential' and 'occupied', based on all information collected and summarized in the database for this status review, including personal communication with land and wildlife managers. Because of the extent of alteration of some water bodies, it is not feasible for purposes of this review, to quantify historical stream miles and surface acres. Therefore, if a stretch of stream has been permanently dewatered or diverted into a canal, that section is not included in estimates of habitat unless some potential exists to restore this area.

Activities that threaten BCT or its habitat are summarized within each GU and categorized by the five listing factors of the Act. These listing factors are:

1) The present or threatened destruction , modification or curtailment of its of its habitat or range;
2) Overutilization for commercial, recreational, scientific, or educational purposes;
3) Disease or predation;
4) The inadequacy of existing regulatory mechanisms;
5) Other natural or manmade factors affecting its continued existence.

Specific conservation actions implemented to protect BCT are also summarized for each GU. In general, conservation actions fall into the following general categories:

1) Research: determine BCT population demographic and life history characteristics
2) Population and Genetic Investigations: assess status and distribution of BCT and determine purity of BCT populations
3) Population expansion: increase or restore range through introductions or reintroduction
4) Habitat Restoration: identify requirements and protect and/or enhance habitat
5) Nonnative control: control or remove nonnatives
6) Disease control: control spread of disease
7) Regulation: enforce wildlife and land-use regulations that protect BCT
8) Socio-political: educate public and reduce conflicts over BCT management

c. Status summary by geographic unit

Bear Lake Geographic Unit

Description of Geographic Unit

Bear Lake is a natural lake that is at least 100,000 years old (Robertson 1978). Bisected by the Utah-Idaho border, it is located at an elevation of 1.1 km (0.7 mi) and has a surface area of 28,200ha (69,683 ac). Vegetation surrounding the lake is dominated by sagebrush communities with the tributaries reaching up into aspen and subalpine fir/spruce forests. Historically, Bear Lake was an oligotrophic, nitrogen limited, terminal lake isolated from other major drainages. However, the nearby Bear River was artificially diverted into Bear Lake via a shallow marsh area (Dingle Marsh) in 1917 for irrigation water storage (Nielson and Lentsch 1988). This input of Bear River water has elevated nutrient levels in portions of the lake resulting in increased productivity overall (B. Nielson, pers. comm.). Indeed, the Bear River now represents the largest inflow source to Bear Lake. Natural tributaries to Bear Lake comprise 6 relatively small perennial streams draining surrounding mountains.

Approximately 70% of the Bear Lake Geographic Unit (BLGU) is under private ownership with the remaining 30% owned by the states of Utah or Idaho primarily as parks and recreation areas.

Similarly, the land adjacent to tributaries are primarily under private ownership (~65%) with the remainder as BLM (~15%) and USFS (~10%) lands. Management of BCT in this unit is primarily the responsibility of the UDWR and IDFG. However, the BLM and USFS take an active role in both land use and BCT management. Figure 2 shows the Bear Lake GU.

Background

Before human settlement, BCT are believed to have been common in Bear Lake as reported by local indigenous communities, early settlers in the area and a commercial fishing industry (McConnell et al. 1957). Settlers moving into the Bear Lake valley significantly diminished cutthroat trout populations through water development (tributary diversions) for irrigation and a commercial fishing industry. Additional stresses on the population included the collection of millions of eggs for stocking into other waters and the introduction of rainbow, lake and other cutthroat trout. These changes caused a decline in the status of BCT in Bear Lake through the 1900s. Bear Lake first came under intensive fisheries management and study in 1952 with the first Dingell-Johnson project in the country (John Neuhold, personal communication). In 1974, UDWR and IDFG initiated a Federal Aid in Fish Restoration Project in an effort to enhance BCT in Bear Lake. Monitoring was implemented and life-history and genetic studies have been conducted over the past 2 decades to determine the status of the BCT in Bear Lake.

Although BCT are assumed to have been present in all ephemeral tributaries to Bear Lake, very little documentation exists regarding the historic status or trend of BCT in tributaries of Bear Lake. By the 1980's, BCT were known to remain in some Bear Lake tributaries but their status (purity, viability, ecology) was virtually unknown.

In the Bear Lake system, most adult BCT move from the lake to tributaries to spawn, after which, the adults return to Bear Lake where they primarily reside. The main activity impacting BCT in tributaries historically (1850-1950) has been diversion of water out of tributaries for use in irrigating agricultural lands. While this threat still remains to some extent, it has been gradually diminishing, particularly in recent years because shifts in land-use are moving away from agricultural use to more recreational use (B. Nielson, pers. comm.). In addition, UDWR and IDFG have been working with local farming communities to improve stream conditions and restore flows where opportunity exists (R. Scully, pers. comm.).

Shifts in the level of Bear Lake from pumping water from and to the Bear River via a canal constructed almost 100 years ago can affect success of reproduction in tributaries. When lake level is low, mouths of tributaries may become impassable to fish either entering or leaving tributaries.

Population Status of Bear Lake and Tributaries

Status of Bear Lake and each tributary is summarized separately but conclusions apply to the entire system.

Table 2. Waters containing BCT in the Bear Lake drainage with total occupied stream length in

km (mi) or *surface area* of water body in *hectares (surface acres)* (SL/*SA*), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	**SL/*SA***	**LH**	**CS**	**DN** (#/m^2)	**PS**
Bear Lake	*28,328 (70,000)*	adfluvial	CP	*	remnant population
Swan Creek	3.2 (2.0)	spawning	MP	*	remnant population
Big Spring Creek	3.2-4.8 (2.0-3.0)	spawning/nursery	MP	*	remnant population
North Eden Creek [a]	15.2 (9.5)	stream resident	CP	*	remnant population
Laketown Creek [a]	19.2 (12.0)	stream resident	CP	*	reintroduction (North Eden Creek 1996)
St. Charles Creek	unknown	spawning	MP	1.8	remnant population

[a] = isolated population
* = estimate not available
CP = Conservation Population
MP = Management Population

Bear Lake

BCT in Bear Lake are currently considered abundant and managed as conservation populations. Although no recent data exists, the number of BCT in Bear Lake is estimated at approximately 100,000 fish based on earlier data and present stocking rates (B. Nielson pers. comm.). Recruitment of BCT in Bear Lake includes all life stages and habitat appears to include all requirements to complete the BCT life cycle. The lake resident BCT, which constitutes approximately 95% of all BCT in the Bear Lake GU, spends most of its life cycle in the lake (B. Nielson pers. comm.). This form is mainly piscivorous as an adult and can be large-bodied and long lived compared to other forms (Nielson and Lentsch 1988). Adfluvial BCT typically ascend tributary streams from late April to June to spawn and then return to the lake immediately after spawning. Offspring hatched in tributaries are noted to sometimes remain in the tributary 'nursery habitat' for up to two years but eventually return to Bear Lake for the remainder of its life cycle (Nielson and Lentsch 1988).

Once in the lake, BCT inhabit shoreline and open-water zones occupying deeper zones during warmer summer months. BCT feed on terrestrial insects, drifting invertebrates, and other fish and their eggs, mainly other endemic species like Bear Lake sculpin, Bonneville ciscoes, recently stocked BCT, and whitefish. Diet of BCT in Bear Lake appears to shift to piscivory as they grow. For example, 20% of BCT averaging 250 mm were piscivorous whereas 95% of BCT over 550 mm consumed fish (Nielson and Lentsch 1988).

Considered a conservation population by UDWR, cutthroat in Bear Lake are actually thought to be more abundant today than historically based on increased catch rates between the 1950's and 1990's (B. Nielson pers. comm.). Greater lake productivity and intensive fisheries management including, egg trapping in tributaries, rearing of young outside of Bear Lake, and strict angling

regulations on Bear Lake, has allowed a larger, sustainable fishery in Bear Lake, within which BCT has become a valued native species (Bryce Nielson pers. comm).

Trapping and rearing of young BCT and then restocking Bear Lake is necessary because tributary flow does not commonly sustain habitat to ensure young fish survival and growth followed by successful migration into Bear Lake. Currently, natural reproduction is supplemented with some artificial rearing in an effort to balance angling needs with that needed for the long-term persistence of BCT. Eggs taken from tributaries are hatched and reared at Mantua Reservoir in Box Elder County to age 2 when they are returned to Bear Lake. Wild eggs are collected from Swan Creek by hatchery personnel from Mantua Hatchery where they are hatched to young fish. These young fish are then shipped to Fountain Green and Glenwood hatcheries where warmer water temperatures improve growth rates. If sufficient numbers of wild eggs from Swan Creek are not collected, stocking quotas for Bear Lake are supplemented with BCT from a separate captive brood stock at Mantua Hatchery. Fish are reared for one year at Mantua Hatchery and stocked into Bear Lake as advanced fingerlings. All fish reared from wild eggs are then restocked into the Bear Lake. No egg collection takes place in any other lake tributaries where wild reproduction opportunities are being enhanced.

St. Charles Creek

St. Charles Creek is located in Idaho on the northwest corner of Bear Lake. This first order stream provides about 23.3 km (14.5 miles) of aquatic habitat and is made up of approximately 68% USFS, 25% private, and 7% BLM land. In a unique geomorphology, probably reminiscent of its natural marsh condition, St. Charles Creek naturally forks at the downstream end into Big and Little Creeks. An adfluvial population of BCT use Little Creek exclusively for spawning. This creek provides prime spawning habitat for the Bear Lake cutthroat population and success of spawning and egg viability can be high in this system. However, the stream resident BCT in upper portions of St. Charles Creek is considered a management population due to presence of wild RBT and BKT and emphasis on sportfishing. BCT from this stream are awaiting genetic analysis. Preliminary phenotypic evaluations indicate there is no hybridization with RBT despite their established residency. The results of genetic analysis and restoration potential could alter future management of this stream for BCT.

Swan Creek

Swan Creek is located in Utah on the western side of Bear Lake. BCT occupy about 3.2 km (2.0 mi) of this stream which is all of estimated suitable aquatic habitat. Swan Creek is composed of approximately 65% private, 15% BLM, and 10% USFS. This stream is the most undeveloped of Bear Lake tributaries. Swan Creek provides spawning habitat, but no resident or nursery habitat. Spawning habitat is considered high quality and recruitment of young BCT into Bear Lake is noted as good with BCT emigrating from Swan Creek to Bear Lake after hatching. Genetic and meristic results indicate limited hybridization has occurred between BCT and resident RBT in Swan Creek. Eggs are harvested from Swan Creek as part of supplemental stocking efforts into Bear Lake in an effort to reduce natural mortality.

Big Spring Creek

Big Spring creek is located at the southern end of Bear Lake. BCT are known to occupy 3.2-4.8 km (2.0-3.0 mi) of the stream which is all of the habitat considered suitable for BCT. Although this is only about half of the total stream length of Big Spring Creek, the remaining portion of the stream is a naturally low gradient, wetland reach that is not utilized by BCT aside from a migratory corridor. It is primarily (85%) under private ownership with some (15%) Utah State Park property at its confluence with Bear lake. The creek originates in the developed streams in Round Valley and is extensively diverted for irrigation. The upper 8 km flow through extensive wetland complexes and contains no spawning habitat. While less than 10% of the stream, all of which is located on State property, has suitable spawning habitat, the stream provides considerable nursery habitat for BCT.

North Eden Creek

North Eden Creek is located on the eastern side of Bear Lake in Utah. This second order stream provides approximately 16.1 km (10 miles) of aquatic habitat consisting of 50% private and 50% State land. This stream is routed into a ditch in its lower section before it enters Bear Lake. North Eden Creek is the only known strong stream resident population of BCT in the Bear Lake unit. This population is managed as a conservation population by the state of Utah. Fragmentation from Bear Lake BCT is a potential threat to this populations as fish passage may be hampered by the section routed through the ditch near Bear Lake; however the resident BCT above the ditch have persisted.

Laketown Creek

Laketown Creek is located at the southern end of Bear Lake in Utah. BCT are known to occupy approximately 15.2 km (9.5 mi) of stream which constitutes nearly all of the estimated suitable habitat. The stream consists of 40% private and 60% BLM lands. Laketown Creek has been diverted for irrigation and culinary uses and is dewatered and flows subterranean before it can connect with Big Spring Creek. Laketown Creek currently contains a transplanted population of BCT moved into this stream from North Eden Creek in 1996 as a part of expansion efforts. This stream resident population, although recently established, is managed as a conservation population by the state of Utah. Genetic and meristic information indicate that these BCT from North Eden Creek are pure BCT.

<u>Activities Threatening Long-Term Persistence of BCT</u>

A. The Present or Threatened Destruction, Modification, or Curtailment of the Species' Habitat or Range.

Altered flow regimes and lake levels due to water diversions in tributaries is the primary threat to the BCT in Bear Lake and its tributaries. Irrigation diversions and canals on tributaries have eliminated spawning habitat for some populations of adfluvial BCT. In addition, the upper 21 feet of Bear Lake is used for irrigation water storage. The Bear River Compact provides for local water use that can lead to drawdowns of lake level. During severe lake level draw-downs, availability of littoral zone habitat with adequate shoreline vegetation essential to juvenile BCT is limited and access to tributaries is impeded as tributary inflows become disconnected from Bear Lake. This drawdown can also isolate tributaries from Bear Lake preventing fish from

moving into or out of tributaries.

Grazing has also had an acute impact on BCT in the BLGU, particularly on tributary habitat. Poor livestock management has resulted in degraded stream habitat in localized, heavily grazed areas. Some timber harvest occurs in higher elevation forested reaches on occasion. Although not an acute problem, road crossings for timber is known to cause some local problems in higher elevation streams where deposits of fine sediments accumulate in stream substrates important to BCT feeding and spawning.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

The threat of over-harvesting from angling pressure is not acute at this time mainly because of intensive fisheries management. While overutilization is not currently considered a threat in the BLGU, it should be considered a factor affecting BCT in future conservation efforts. At this point in time, catch rates of BCT have been reported as stable despite increased angling (Nielson and Lentsch 1988).

C. Disease or Predation

The limited presence of BRN, BKT, and RBT throughout the region suggests that predation by nonnative fish on BCT is a potential threat as expansion and enhancement efforts for BCT continue and BCT densities continue to increase. In most restoration efforts, nonnatives are removed or restricted to limit any potential negative interactions.

D. Inadequacy of Existing Regulatory Mechanisms

There have been no acute regulatory inadequacies identified in existing federal, state, or local regulatory mechanisms that affect BCT in the BLGU. However, protection of BCT depends on the continued appropriation of funding and commitment of the local management or regulatory agencies to fulfill their responsibilities in managing land and wildlife uses.

E. Other Natural or Manmade Mechanisms

The presence of nonnative fish species have the potential to negatively impact BCT in Bear Lake. Nonnative species include primarily lake trout (LKT) in the lake with RBT and BKT in the tributaries. Competition with these nonnative species, primarily LKT and BKT, is suspected to occur. Although hybridization has not been a significant problem to date, the presence of RBT in many spawning tributaries means the potential is there despite LKT and BKT having been in the system for nearly 100 years. LKT are currently stocked into the lake every three years. BKT were stocked in the past and have established wild populations in some tributaries. YCT were intensively stocked into Bear Lake for many years in the early 1900s in an effort to supplement the declining native fishery.

Flooding, fire and other natural threats although possible are not considered major threats to BCT in the Bear Lake drainage. Fragmentation of habitat caused by drought exacerbated by human water development locally threatens several tributaries with limited flow.

Conservation Actions to Protect BCT

Amelioration of threats to, and restoration and enhancement of BCT populations is a priority for Federal and state managers in this region. Effective management of BCT has been conducted via the implementation of various water, land-use and fishery management programs, policies, and actions. In addition, current state and Federal laws, policies, and regulations prevent indiscriminate actions to destroy BCT habitat. Such regulatory mechanisms did not exist when catastrophic BCT declines occurred from the 1850s to the 1950s.

A. Research, Range expansion, Nonnative Control, Regulation

Bear Lake has been a focus of local BCT conservation efforts for more than 25 years. Actions include ongoing population and habitat surveys, and life history studies to monitor and understand BCT in Bear Lake. These actions provide information that guide decision making and management alternatives for protection of BCT. Populations have been enhanced by the annual stocking of 30,000 pounds of Bonneville cutthroat trout into the lake in order to balance fishing pressure and naturally low lake productivity with conservation of a native species. Range expansion into Fish Haven Canyon Creek which includes 11.3 km (7 mi) of suitable stream habitat is currently under investigation. A fish propagation program that includes egg taking for brood stock development and rearing of young fish outside of Bear Lake has proven successful and provides an element of security against catastrophic loss in Bear Lake. Disease certification has also been in place in conjunction with brood stock development to ensure that parasites or other diseases not native to Bear Lake are not inadvertently introduced.

The prevention of further expansion of nonnative salmonids is a primary objective for managers in the BLGU. Accordingly, the involved agencies have initiated specific management policies to meet this objective. Current UDWR policy excludes stocking of nonnative fishes in streams with transplanted or remnant populations of BCT (Lentsch et al.1997). As of the year 2000, all RBT stocking in the state of Idaho will use exclusively sterile individuals to prevent further risk of BCT hybridization (D. Scully pers. comm.). Furthermore, the feasibility of RBT and BKT eradication, along with the suspension of stocking, is being assessed for tributaries on an individual basis. A successful and productive egg taking operation is also in place as a part of fish production operations for the unit.

B. Habitat Restoration

Habitat restoration, primarily in the form of regulating water development and improving hydrologic function, is currently a priority for Bear Lake managers. Regulation of local water via minimum instream flows agreements, diversion screening, and restrictions on new development have helped in restoring hydrologic function in tributaries as well. Grazing restrictions, riparian enclosures, and sometimes complete removal of livestock have been implemented in an effort to minimize stream habitat degradation. Working with private land owners to manage irrigation diversions, maintain minimum flows in tributaries and improve grazing has lead to restoration of spawning habitat in St. Charles and Big Spring Creeks. Additionally, an agreement with PacifiCorp and other downstream water users for minimum lake level requirements should minimize drawdown problems and increase connectivity between the lake and tributary streams

(B. Nielson, pers. comm., Lentsch et al. 1997).

Conclusion

In summary, the Bear Lake GU contains one lake population which uses three tributaries for spawning and nursery habitat and two stream resident populations totaling 28, 328 ha (70,000 sa) of lake habitat and 61.8 km (38.4 mi) of stream habitat. Bear Lake and its tributaries and encompassing drainages are currently in better condition than 30 years ago, and BCT are possibly more abundant than they were historically because of an aggressive fisheries management program. Threats to the species still exist; however the management trend is towards protection of existing BCT populations and restoration of BCT into many historical streams. Conservation plans have been developed and actions are being implemented to continue restoration and protection of BCT in the BLGU. Overall, it appears that human activities are being balanced with environmental needs to reduce conflict thereby ensuring better long-term success of conservation actions. It is expected that the status of BCT, if managed under the existing momentum for BCT conservation and stream restoration, will continue to improve, particularly in tributaries.

Recommendations:

Based on this summary, the Service recommends the following to further promote BCT in the Bear Lake GU:

1) Management actions on Bear Lake should continue to protect native BCT stock and supplement it with brood stock and artificial rearing to compensate for angling pressure.

2) Increased implementation and enforcement of grazing regulations to prevent acute impacts from grazing in streams and along riparian areas. Although regulations have been developed, some are not adequately enforced to protect BCT in certain drainages. Habitat restoration should focus on restoration of minimum flows in tributaries to ensure available flow during spawning periods and adequate flow for natural recruitment of young BCT. Tributaries should be examined for opportunities to improve habitat condition so that resident BCT can be established or enhanced where possible.

3) Nonnative species should be eliminated where possible to promote BCT but can be balanced through angling harvest and put-and-take fishing in streams that receive high angling pressure.

4) Land management agencies (USFS and BLM) should regulate activity in upper watersheds to maintain good riparian conditions in upper portions of the streams, including implementation of land-use activities that are conducive to good water quality and healthy stream conditions.

Bear River Geographic Unit

Description of Geographic Unit

The Bear River Geographic Unit (BRGU) encompasses the extreme northeast corner of the Bonneville Basin spanning across the northeast corner of Utah, the southwest corner of

Wyoming, and the southeast corner of Idaho. The principal water in this GU is the Bear River which has a large drainage covering 8250 km^2 and comprising many watersheds ranging from high mountain lakes and streams with alpine forests to low elevation sagebrush and grassland prairie. The Bear River has its headwaters in Utah in a high elevation, alpine region of the northeastern Uinta Mountains where smaller headwater drainages come together to form the mainstem. The Bear then flows north into the southwest corner of Wyoming. Near the town of Evanston, Wyoming, the Bear turns west and enters Utah in the most northeast corner of the state. It then meanders north and east through a small portion of Wyoming and into Idaho looping around the north end of Bear Lake. At this point the Bear is partially diverted via an artificial canal to Bear Lake joining these two historically separate drainages. The Bear then heads further north in Idaho before looping back south and entering Utah. Lower Bear River refers to portions of the river near and downstream of Bear Lake. Flowing around the north end of the Wellsville Mountains in Utah and paralleling them on their west, the Bear River empties into the Great Salt Lake through the Bear River Migratory Bird Refuge.

The BRGU ranges in elevation from 5,000 to approximately 11,000 feet. The natural vegetational community is characterized by sagebrush communities at lower elevations, and aspen and subalpine fir/spruce communities at higher elevations. Riparian areas are generally dominated by willows or mountain maples and gambel oak (Lentsch et al. 1997). Stream gradient ranges from extremely high alpine streams to low gradient meadow meanders. Lower elevation areas have extensive agricultural and urban development whereas inaccessible high elevation areas tend to be more pristine. Streams hydrology in this GU is characterized by high spring runoff peaks during snowmelt and low to intermittent fall and winter base flows.

Approximately 42% of this unit is under private ownership. The remaining land is publically owned by the USFS (~38%), BLM (~15%), and state (~5%). Management of BCT in this unit is primarily by UDWR, WGF, IDFG and USFS. The BLM also takes an active role in both land use and BCT management.

Background

Historic references noted trout as common in the Bear River drainage (see discussion in May et al. 1978). The Bear River from Wyoming to Utah was used during the early 1800s by trappers and explorers as a natural travel corridor and likely was influenced by human traffic long before the main Bonneville Basin in Utah. From as early as the 1840s, the Bear River drainage underwent a period of excessive human-induced changes to river systems and aquatic habitats including water diversions, overharvest of fish, livestock grazing, agricultural production of lands, and introduction of nonnative salmonids (Cottum 1947, May et al. 1978). By the 1980's, most experts speculated BCT populations in the BRGU were either eliminated through hybridization with RBT or nonnative cutthroat trout or competitively displaced by introduced BKT. In addition, portions of the watershed and some streams were in a degraded condition after decades of timber harvest in the Uinta Mountains from the 1850s through the 1950s and due to impacts from large tracts of agricultural lands and livestock grazing in the Bear River valley.

Although portions of this GU continue to suffer from significant human-induced impacts, primarily urbanization and agriculture, the mountain climate results in greater rainfall and larger stream systems as compared to some more arid areas of the Bonneville Basin. As a result, the BRGU retains high potential for recovery of BCT including maintenance and possible discovery of new remnant populations in the more remote and undeveloped drainages. Despite the intensity of human impacts in some areas, the BRGU has retained many naturally functioning water systems.

Population Status

UTAH (Bear River Headwater Drainages)

Hayden Fork Drainage

Table 3. Waters containing BCT in the Hayden Fork drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Bear River, Hayden Fork (2)	29.8 (18.5)	stream resident, fluvial	CP	52 (32)	remnant population
Teal Lake Creek (1)	1.6 (1)	stream resident, fluvial	potential CP	26 (16)	remnant population
Whiskey Creek (1)	3.2 (2)	stream resident, fluvial	potential CP	*	remnant population
Gold Hill Creek (1)	1.6 (1)	stream resident, fluvial	CP	*	remnant population

* = estimate not available
CP = Conservation Population

The Hayden Fork drainage contains about 36.2 km (22.5 mi) of suitable stream habitat with BCT found throughout all reaches (100%). These are remnant BCT with stream resident and/or fluvial life strategies. Based on recent surveys, BCT are considered common in abundance and recruitment appears to be fair to good. Streams in the Hayden Fork drainage are part of a larger Bear River metapopulation and are potentially connected to 30 to 40 other BCT populations throughout the Bear River and its tributaries. Some historic stocking of nonnative fishes has occurred in this drainage, and BKT are still stocked into high elevation lakes in the drainage. Both Whiskey and Teal Lake Creeks still contain RBT. Despite the occurrence of RBT in these streams and to a lesser extent in the mainstem Hayden Fork, genetic analyses to date have not indicated any hybridization with native BCT in this drainage. There continues to be debate among local biologists, managers and geneticists as to the level of hybridization that may have occurred where YCT were stocked in the past into waters native to BCT. However, BCT populations in the Hayden Fork drainage are considered remnant and are managed as conservation populations where genetic and meristic analyses are complete. Pending the completion of surveys of Whiskey and Teal Lake Creeks, these BCT may be considered conservation populations if results indicate genetic purity.

Bear River, Stillwater Fork Drainage

Table 4. Waters containing BCT in the Stillwater Fork, Bear River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Bear River, Stillwater Fork- Section 1 (2-3)	19 (12)	stream resident, fluvial	CP	803 (499)	remnant population
Bear River, Stillwater Fork- Section 2 (2)		stream resident, fluvial	CP	26-595 (16-370)	remnant population
West Basin Creek (1)	3.2 (2)	stream resident, fluvial	CP	*	remnant population
Ostler Fork Creek (1)	5.6 (3.5)	stream resident, fluvial	CP	103-388 (64-241)	remnant population
Main Fork Creek (1)	6.4 (4)	stream resident, fluvial	CP	336-518 (209-322)	remnant population

* = estimate not available
CP = Conservation Population

The Stillwater Fork of the Bear River drainage contains about 32.6 km (21.5 mi) of suitable stream habitat with BCT thought to occupy all reaches (100%). BCT in this drainage are considered to be remnant populations and exhibit both stream resident and fluvial life histories. Current surveys indicate that BCT are abundant and appear to be successfully recruiting. Streams in the Stillwater Fork drainage are part of a larger Bear River metapopulation and are potentially connected to 30 to 40 other BCT populations throughout the Bear River and its tributaries. Past records indicate some stocking that included BKT and YCT. RBT are currently stocked on a limited basis in Section 1 of Stillwater Fork. Genetic and meristic analyses indicate that BCT in the Stillwater Fork drainage are pure. Streams in the Stillwater Fork drainage are managed as conservation populations

Bear River, East Fork Drainage

Table 5. Waters containing BCT in the East Fork Bear River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Bear River, East Fork (2)	16.1 (10)	stream resident, fluvial	CP	*	remnant population
Bear River, Right Hand East Fork- Sections 1-2 (1)	8.0 (5)	stream resident, fluvial	CP	*	remnant population
Bear River, Left Hand East Fork- Section 8 (1)	7.2 (4.5)	stream resident, fluvial	CP	*	remnant population
Boundary Creek [a] (1)	1.6 (1)	stream resident, fluvial	CP	156 (97)	remnant population

[a] = isolated population

* = estimate not available
CP = Conservation Population

The East Fork is the next drainage to enter the Bear River after the Stillwater Fork. This drainage contains approximately 33.0 km (20.5 mi) of suitable stream habitat with BCT suspected to occupy all suitable areas (100%) based on limited sampling and management history. BCT in this drainage are remnant populations exhibiting both stream resident and fluvial life strategies. BCT range from rare to common in abundance, and based on current sampling, all populations are noted to have successful recruitment. Streams within this drainage are fairly well connected with the Right Hand Fork, Boundary Creek, and the mainstem East Fork Bear River providing habitat for more than 5 individual populations. The Left Hand Fork, however, is isolated from all other populations due to a natural waterfall. Although both RBT and BKT have been commonly stocked throughout the drainage over the past decades, genetic and meristic analysis shows that BCT are pure except for BCT in the mainstem East Fork Bear which show slight hybridization with RBT.

Bear River, West Fork Drainage

Table 6. Waters containing BCT in the West Fork Bear River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Bear River, West Fork (2-3)	14 (8.7)	stream resident, fluvial	MP	77-1709 (48-1062)	remnant population
Meadow Creek (1)	4.8 (3)	stream resident, fluvial	MP	*	remnant population
Mill City Creek (1-2)	12.9 (8)	stream resident, fluvial	MP	259 (161)	remnant population
Deer Creek (1-2)	12.9 (8)	stream resident, fluvial	MP	*	remnant population

* = estimate not available
MP =Management Population

The West Fork drainage of the Bear River contains about 44.6 km (27.7 mi) of suitable stream habitat with BCT suspected to occupy all reaches (100%). BCT populations are considered remnant and both stream resident and fluvial life strategies are present within the drainage. Based on recent sampling, BCT are considered abundant and recruitment is believed to be successful. Connectivity of this drainage is relatively good with each population being connected to at least 6 other populations. Currently stocking of RBT occurs throughout the West Fork drainage. Although genetic analyses have not been conducted, local managers have found no visual evidence of hybridization of BCT with nonnative salmonids. These BCT are treated as management populations due to the emphasis on maintaining RBT for angling.

Mill Creek Drainage

Table 7. Waters containing BCT in the Mill Creek, Bear River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Mill Creek (3)	20.1(12.5)	fluvial	CP	129-290 (80-290)	remnant population
Mill Creek, North Fork (1)	4.8 (3)	fluvial	CP	208-335 (129-208)	remnant population
Lost Dog Creek (1)	2.3 (1.4)	fluvial	CP	*	remnant population
McKenzie Creek (2)	8.0 (5)	fluvial	CP	*	remnant population
Christmas Tree Creek (1)	1.6 (1)	fluvial	CP	*	remnant population
Carter Creek (1)	4.0 (2.5)	fluvial	CP	*	remnant population
Deadman Creek (1)	4.8 (3)	fluvial	CP	*	remnant population

* = estimate not available
CP = Conservation Population

Mill Creek drainage contains about 45.7 km (28.4 mi) of suitable stream habitat with BCT found throughout all areas (100%). BCT populations in this drainage are considered to be remnant and exhibit fluvial life strategies. Based on recent sampling, BCT are considered common in abundance and are noted as having successful recruitment. Streams within this drainage are well connected providing habitat for more than 7 individual populations. Past stocking of RBT has occurred throughout the drainage although recent surveys indicate that nonnatives fishes are currently absent from the drainage. Genetic and meristic analysis shows that BCT are pure and BCT are managed as conservation populations.

Woodruff Creek Drainage

Table 8. Waters containing BCT in the Woodruff Creek drainage with total occupied stream length in km (mi) or *surface area* of water body in *hectares (acres)* (SL/*SA*), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SM/*SA*	LH	CS	DN	PS
Woodruff Creek, above Woodruff Reservoir (3)	43.4 (27)	adfluvial	CP	*	remnant population
Big Spring Fork Creek (1)	4.5 (2.8)	adfluvial	CP	52 (32)	remnant population
Wheeler Creek (1)	7.2 (4.5)	adfluvial	CP	*	remnant population
Sugar Pine Creek (2)	8.0 (5.0)	adfluvial	CP	*	remnant population
Woodruff Reservoir	*102 (41.3)*	adfluvial	CP	*	remnant population

Woodruff Creek, below Woodruff Reservoir (3)	8.0 (5.0)	fluvial	MP	*	remnant population
Birch Creek (1)	11.2 (7.0)	stream resident	MP	*	remnant population
Birch Creek, below reservoir (1)	4.8 (3.0)	stream resident, fluvial, adfluvial	MP	*	remnant population
Walton Canyon Creek (1)	11.2 (7.0)	stream resident	MP	*	remnant population

* = estimate not available
CP = Conservation Population
MP = Management Population

Woodruff Creek drainage contains about 98.7 km (61.3 mi) of suitable stream habitat and 41.3 hectares (102 acres) of impounded water with BCT believed to occupy all areas within the drainage (100%). Woodruff Reservoir acts as a barrier to fish passage with BCT above and below having different population characteristics. Below Woodruff Reservoir, both stream resident and fluvial life strategies are present. Abundance overall is considered rare, because RBT commonly outnumber BCT in this lower reach. This portion of the drainage was substantially stocked with nonnative fishes in the past. Today, RBT is only stocked in a small reservoir located on Birch Creek. Although genetic and meristic analyses have not been conducted, moderate to substantial hybridization is visible in BCT occupying streams below Woodruff Reservoir. BCT below Woodruff Reservoir are considered management populations because of this hybridization with a management focus on maintaining RBT for angling.

Above Woodruff Reservoir, BCT with adfluvial, fluvial, and stream resident life histories are present. Based on status surveys, BCT are considered abundant and are recruiting successfully. Over the past 100 years, incidental stocking of YCT occurred in the drainage above Woodruff Reservoir. However genetic and meristic evaluations suggest that BCT remain pure in this area. The streams in the drainage above Woodruff Reservoir are well connected with no movement barriers. BCT populations above Woodruff Reservoir are currently managed as conservation populations

Deseret Ranch

Table 9. Waters containing BCT on the Deseret L&L Ranch lands with total occupied stream length in km (mi) or *surface area* of water body in *hectares (acres)* (SL/*SA*), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	**SL/*SA***	**LH**	**CS**	**DN**	**PS**
Meecham Creek [a] (1)	9.7 (6.0)	stream resident	CP	*	reintroduction (Sugar Pine Creek)
Dip Reservoir [a]	*0.8 (2.0)*	lacustrine	MP	*	reintroduction (Sugar Pine Creek)

[a] = isolated population
* = estimate not available

CP = Conservation Population

Currently isolated from the Bear River, Meecham Creek and Dip Reservoir are located just south of the Woodruff Creek drainage. Located on the privately owned Deseret L&L Ranch property, Meecham Creek provides about 9.7 km (6 mi) and Dip Reservoir about 0.8 hectares (2 acres) of aquatic habitat. Meecham Creek is an isolated stream that went dry in the early 1990s due to drought conditions. BCT from Sugar Pine Creek were subsequently transplanted into the stream. The current BCT populations consists of stream resident fish, considered common in abundance, that are showing signs of successful recruitment. Nonnative salmonids are absent from Meecham Creek and genetic and meristic analysis from this stream indicate no influence of hybridization in BCT. Meechum Creek is managed for pure BCT and is treated as a conservation population. Dip Reservoir currently contains an introduced population of BCT that are considered abundant. However, habitat condition and reservoir operations limit use of this reservoir by BCT.

Big Creek Drainage

Table 10. Waters containing BCT in the Big Creek drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Big Creek [a] (1-2)	29.0 (18.0)	stream resident	potential CP	*	remnant population

[a] = isolated population
* = estimate not available
CP = Conservation Population

Big Creek is an isolated stream that feeds into the Bear River located just north of the Woodruff Creek drainage. Based on current survey information, BCT are found throughout 100% of the 29.0 km (18.0 mi) of suitable stream habitat; however their purity is as yet unassessed. Presently, RBT are stocked into upper Big Creek. Potential restoration including suspension of stocking, eradication of RBT, and subsequent transplant of BCT is planned. Restoration activities are contingent on pending surveys indicating the genetic purity of the BCT. This population exhibits a stream resident life strategy. BCT are considered of common abundance in Big Creek and they appear to be successfully recruiting based on cursory sampling. Hybridization has not been detected through physical examination; however, genetic and meristic analyses have not been conducted on these fish. Big Creek is currently a management population with potential plans to restore a conservation population contingent on genetic and meristic analysis.

UTAH (Lower Bear River Drainages)

Logan River Drainage

Table 11. Waters containing BCT in the Logan River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Logan River, (1-3)	22.5 (14.0)	stream resident, fluvial	CP	12.9-3523 (8-2189)	remnant population
Peterson Hollow Creek (1)	4.8 (3.0)	stream resident, fluvial	CP	288 (179)	remnant population
Beaver Creek (1-2)	10.5 (6.5)	stream resident, fluvial	CP	316-2356 (380-1464)	remnant population
Stump Hollow Creek (1)	3.2 (2.0)	stream resident, fluvial	CP	103 (64)	remnant population
White Pine Creek (1)	8.9 (5.5)	stream resident, fluvial	CP	346-1313 (215-816)	remnant population
Bunchgrass Creek (1)	8.0 (5.0)	stream resident, fluvial	CP	163-388 (101-241)	remnant population
Tony Grove Creek (1)	9.7 (6.0)	stream resident, fluvial	CP	109-520 (68-323)	remnant population
Little Bear Creek (1)	3.2 (2.0)	stream resident, fluvial	CP	103-1252 (64-778)	remnant population
Theurer Hollow Creek (1)	2.4 (1.5)	stream resident, fluvial	CP	821 (510)	remnant population
West Hodges Creek (1)	4.8 (3.0)	stream resident, fluvial	CP	206 (128)	remnant population
Twin Creek (1)	4.8 (3.0)	stream resident, fluvial	CP	233-871 (145-541)	remnant population
Bear Hollow Creek (1)	5.6 (3.5)	stream resident, fluvial	CP	356-415 (221-258)	remnant population
Temple Fork Creek (2)	9.7 (6.0)	stream resident, fluvial	CP	378-502 (235-312)	remnant population
Spawn Creek (1)	5.6 (3.5)	stream resident, fluvial	CP	90-163 (56-101)	remnant population
Chicken Creek (1)	4.8 (3.0)	stream resident, fluvial	CP	220 (137)	remnant population
Cottonwood Creek (1)	10.5 (6.5)	stream resident, fluvial	CP	45-373 (28-232)	remnant population
Wood Camp Creek (1)	3.2 (2.0)	stream resident, fluvial	CP	32-77 (20-48)	remnant population
Right Fork Logan River (1-2)	5.6 (3.5)	stream resident, fluvial	CP	51-117 (32-73)	remnant population
Spring Hollow Creek (1)	3.2 (2.0)	stream resident, fluvial	CP	127 (79.0)	remnant population
Wind Caves Trail (1)	1.6 (1.0)	stream resident, fluvial	CP	32.0 (20.0)	remnant population
White Canyon Creek (1)	4.8 (3.0)	stream resident, fluvial	CP	*	remnant population
Hodge Nibley Creek (1)	0.8 (0.5)	stream resident, fluvial	CP	*	remnant population
Corral Hollow (1)	1.6 (1.0)	stream resident, fluvial	CP	*	remnant population

Boss Canyon (1)	1.6 (1.0)	stream resident, fluvial	CP	*	remnant population
Little Bear, East Fork above Porcupine Res. (2)	19.3 (12.0)	stream resident, fluvial	CP	*	remnant population

[b] = Includes the lower Twin Bridge and Wood Camp sections of the Logan River
[c] = Includes the Chokecherry and Spring Hollow sections of the Logan River
* = estimate not available
CP = Conservation Population

The Logan River drainage drains into the Little Bear River not far upstream from where the Little Bear River joins the Bear River in northern Cache Valley, Utah. The drainage contains about 160.7 km (100 mi) of suitable stream habitat with BCT documented in 19.8 km (12.3 mi) (12.3%) with more occupied area being identified as surveys are completed. Local biologists and managers suspect BCT are found throughout the entire drainage but have not completed surveys. Intensive surveys initiated in 1999 found BCT to occur throughout the drainage where surveys were conducted (Cowley 2000, Thompson 2000). The documented area are likely to further increase as on-going status surveys continue to document BCT in additional stream reaches that are currently unsurveyed. This drainage is thought to represent one of the strongest and largest metapopulations within the natural range of BCT with over 20 connected populations (Thompson 2000).

BCT are currently considered common to abundant in most of these streams. Smaller streams tend to contain lower densities, and BCT abundance is low in some very small streams. Densities range from 8 to 2189 fish per mile, and recruitment has been documented as being successful in most streams. Specific habitat problems primarily from localized sedimentation near road crossings, recreational trails, and livestock grazing may reduce recruitment in some areas. Phenotypic evaluation of BCT by local managers indicates little or no hybridization with RBT, and managers considered the BCT to represent remnant populations that naturally evolved in the system (Cowley 2000, Thompson 2000). However, genetic analyses are in progress to verify this determination. Although BCT migrate through and range within local nonnative salmonid populations, nonnative populations are contained below barriers in certain sections of the drainage. Where the Logan River drops into the valley floor, diversions, dams, agriculture and rural and urban development have altered the river so that little potential exists for restoring viable BCT populations into the valley reaches of the river; therefore BCT occur mainly in the canyon streams. Most streams in the drainage are considered conservation populations.

Blacksmith Fork Drainage

Table 12. Waters containing BCT in the Blacksmith Fork River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Blacksmith Fork River (2-3)	19.2 (12.0)	stream resident, fluvial	HP	*	remnant population

headwater tributaries (1)	19.2 (12.0)	stream resident, fluvial	potential CP	*	remnant population
Sheep Creek (2)	11.3 (7.0)	stream resident, fluvial	potential CP	*	remnant population
Mill Creek (1)	8.0 (5.0)	stream resident, fluvial	potential CP	*	remnant population
Curtis Creek (1)	12.9 (8.0)	stream resident, fluvial	potential CP	467 (290)	remnant population
Rock Creek (1)	8.0-11.3 (5.0-7.0)	stream resident, fluvial	potential CP	370 (230)	remnant population
Blacksmith Fork River, Left Hand Fork (Saddle Creek)[a] (1)	20.8 (13.0)	stream resident	MP	*	remnant population

[a] = isolated population
* = estimate not available
CP = Conservation Population
MP = Management Population
HP = Hybrid Population

The Blacksmith Fork River drainage joins the Logan River just west of Providence, Utah in southern Cache Valley before the Logan River reaches the Little Bear River. BCT are known to occupy about 72.0-75.2 km (45.0-47.0 mi) which is nearly all of the estimated available stream habitat in the basin. BCT are considered common in most streams, have a stream resident or fluvial life strategy, and are successfully recruiting based on recent sampling. Although considered remnant BCT, many populations in this drainage are considered management populations until further analysis provides information on the extent of hybridization between BCT and RBT. Stocking of RBT and BKT occurred as several discrete incidents in the past decade and is currently discontinued. If BCT populations in this drainage are determined to be pure based on genetic and meristic analysis, these populations will be designated as conservation populations. BCT in this drainage would represent a relatively large metapopulation in this drainage if they are determined pure, because connectivity within the canyon reaches of the Blacksmith Fork River is relatively good maintained. Where the Blacksmith Fork River drops into the valley floor, diversions, dams, agriculture and rural and urban development have altered the river so that little potential exists for restoring viable BCT populations into the valley reaches of the river.

WYOMING

Bear River Drainage

Table 13. Waters containing BCT in the Bear River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	**SL**	**LH**	**CS**	**DN**	**PS**
Twin Creek (3)	8.0 (5 .0)	stream resident, fluvial	CP	80.5 (50.0)	remnant population

Rock Creek (2)	16.1 (10.0)	stream resident, fluvial	CP	322 (200)	remnant population
Watercress Canyon Creek (1)	3.2 (2.0)	stream resident, fluvial	CP	80.5 (50.0)	remnant population
Seaweed Creek (1)	4.8 (3.0)	stream resident, fluvial	CP	80.5 (50.0)	remnant population

* = estimate not available
CP = Conservation Population

These streams are separate tributaries to the mainstem Bear River near where it enters Wyoming. BCT are known to occupy approximately 32.2 km (20.0 mi) which is all of the estimated suitable stream habitat in this basin. These are considered remnant BCT populations with both stream resident and fluvial life strategies exhibited. BCT in Rock Creek are considered common in abundance, and are recruiting successfully based on recent sampling. BCT in Twin, Watercress Canyon, and Seaweed Creeks, are more rare, and recruitment appears to be limited due to small stream size and low late summer flows. Overall, connectivity amongst these stream is good with each stream being connected to 2 to 4 other streams through the Bear River thereby providing some genetic exchange and stability against catastrophic loss. Stocking in the drainage has been limited to past, undocumented introductions of BKT into Rock Creek. Nonnative fishes are currently absent from these streams except Rock Creek based on recent sampling. These BCT populations have not been genetically tested so their purity status is unknown. They are currently assumed pure and managed as conservation populations until genetic and meristic analysis is complete and suggests otherwise.

Smith's Fork Drainage

Table 14. Waters containing BCT in the Smith's Fork drainage with total occupied stream length in km (mi) or *surface area* of water body in *hectares (acres)* (SL/*SA*), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	**SL/*SA***	**LH**	**CS**	**DN**	**PS**
Smith's Fork River (3)	56.3 (35.0)	stream resident, fluvial	CP	684 (425)	remnant population
Coal (Howland) Creek (1)	4.8 (3.0)	stream resident, fluvial	CP	692 (430)	remnant population
Sawmill Creek (1)	1.6 (1.0)	stream resident, fluvial	CP	185 (115)	remnant population
Hobble Creek (2-3)	25.7 (16.0)	stream resident, fluvial	CP	595 (370)	remnant population
Contag Creek (2)	16.9 (10.5)	stream resident, fluvial	CP	*	remnant population
Sam's Creek (1)	2.4 (1.5)	stream resident, fluvial	CP	*	remnant population
Lake Alice	*93.5 (231)*	adfluvial, lacustrine	CP	*	remnant population
Porcupine Creek (1)	8.4 (5.2)	stream resident, fluvial	CP	748 (465)	remnant population
Trespass Creek (1)	4.0 (2.5)	stream resident, fluvial	CP	885 (550)	remnant population

Trail Creek (1)	1.6 (1.0)	stream resident, fluvial	CP	*	remnant population
Smith's Fork, North Fork (1)	6.4 (4.0)	stream resident, fluvial	CP	290 (180)	remnant population
Lander Creek, and North Fork (1)	3.2 (2.0)	stream resident, fluvial	CP	*	remnant population
Poker Hollow Creek (2)	6.4 (4.0)	stream resident, fluvial	CP	*	remnant population

* = estimate not available
CP = Conservation Population

The Smith's Fork drains into the Bear River in Wyoming. BCT are known to occupy approximately 34.7 km (85.7 mi) which is all of the estimated of suitable stream habitat in this basin. In addition, BCT are found in Lake Alice which is 93.5 ha (231 ac). The BCT in this drainage, including Lake Alice, are considered to be remnant populations. BCT exhibit resident or fluvial life strategies except for adfluvial and lacustrine forms in Lake Alice. Recent surveys indicate that BCT are common to abundant in all waters and are successfully recruiting. The drainage is relatively well connected with each stream being connected to 2 to 5 other BCT populations. Although currently discontinued, substantial stocking of YCT into the Smith's Fork River and Lake Alice occurred over the past century. Recent surveys indicate that BNT and a few isolated BRT populations have persisted in the mainstem Smith's Fork although there are no indications that their low densities threaten BCT. Recent genetic and meristic analyses have determined BCT throughout the Smith's Fork drainage to be pure and they are managed as conservation populations.

Thomas Fork River Drainage

Table 15. Waters containing BCT in the Thomas Fork River drainage with total occupied stream length in km (miles)(SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	**SL**	**LH**	**CS**	**DN**	**PS**
Thomas Fork River (3)	2.5 (1.5)	stream resident, fluvial	CP	209 (130)	remnant population
Giraffe Creek (1-2)	16.1 (10.0)	stream resident, fluvial	CP	563 (350)	remnant population
Robinson Creek (1)	8.0 (5.0)	stream resident, fluvial	CP	*	remnant population
Salt Creek (2)	18.5 (11.5)	stream resident, fluvial	CP	740 (460)	remnant population
Water Canyon Creek (1)	5.6 (3.5)	stream resident, fluvial	CP	700 (435)	remnant population
Little White Creek (1)	4.8 (3.0)	stream resident, fluvial	CP	483 (300)	remnant population
Packstring Creek (1)	3.2 (2.0)	stream resident	CP	241 (150)	remnant population
Dipper Creek (1)	3.2 (2.0)	stream resident, fluvial	CP	*	remnant population
Huff Creek (1)	5.6 (3.5)	stream resident, fluvial	CP	394 (245)	remnant population
Little Muddy Creek (1)	9.6 (6.0)	stream resident, fluvial	CP	*	remnant population
Coal Creek (2)	17.7 (11.0)	stream resident, fluvial	CP	643 (400)	remnant population

Raymond Creek [a] (2)	16.9 (10.5)	stream resident, fluvial	CP	643 (400)	remnant population

[a] = isolated population
* = estimate not available
CP = Conservation Population

The Thomas Fork drainage, begins in southwestern Wyoming, then flows west and south into Idaho where it joins Bear River. BCT are known to occupy 111.8 km (69.5 mi) which is nearly all of the estimated suitable stream miles in this drainage. BCT populations are considered remnant and both stream resident and fluvial life strategies are exhibited. Recent sampling indicates that BCT are common in abundance and recruitment appears to be good. Although this drainage is somewhat fragmented primarily due to poor habitat conditions in the Coal Creek drainage and highway crossings on 2 first order streams, streams with BCT are connected to at least 3 other populations. Although some historical stocking of BKT, RBT, and YCT occurred in Salt and Raymond Creeks, and in the mainstem Thomas Fork River, recent surveys indicate that nonnatives are currently absent from the drainage. Genetic and meristic analyses indicates that BCT identified in the Thomas Fork drainage are pure. Streams in the Thomas Fork drainage are managed as conservation populations.

IDAHO

Thomas Fork Drainage

Table 16. Waters containing BCT in the Thomas Fork drainage with total occupied stream length in km (miles) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per square meter, and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN (per 100m^2)	PS
Thomas Fork River (3)	44.4 (27.6)	stream resident, fluvial	CP	*	remnant population
Preuss Creek (2)	19.8 (12.3)	stream resident, fluvial	CP	3.2-11.1	remnant population
Beaver Creek (2)	13.7 (8.5)	stream resident, fluvial	CP	*	remnant population
Dry Creek (2)	14.0 (8.7)	stream resident, fluvial	CP	11.2-24.8	remnant population
Giraffe Creek (2)	14.8 (9.2)	stream resident, fluvial	CP	5.0-17.3	remnant population

* = estimate not available
CP = Conservation Population

From it's headwaters in Wyoming, the Thomas Fork drainage then flows into Idaho where it contains about 106 km (66.3 mi) of estimated suitable stream habitat before joins the Bear River. BCT are known to occupy nearly all of this drainage. Except for Bischoff Canyon Creek for which the status of BCT is unknown, surveys indicate that occupied streams contain remnant BCT that are common to abundant and exhibit a stream resident or fluvial life strategy. Recruitment is thought to be good, where BCT are present, based on the presence of self-sustaining BCT populations. Connectivity is good amongst these streams with each being connected to two or more populations. Minor historical stocking of nonnative RBT and BNT is

documented throughout this drainage, however, recent surveys indicate that nonnative species are currently not found in the drainage. Although genetic analyses have not been performed, meristic analyses have found no evidence of hybridization between BCT and nonnative salmonids. All streams in the Idaho portion of the Thomas fork drainage, except for Bischoff Canyon Creek, are managed as conservation populations.

Montpelier Creek Drainage

Table 17. Waters containing BCT in the Montpelier Creek drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per square meter, and population status (PS).

Stream/Tributary (stream order)	**SL**	**LH**	**CS**	**DN**	**PS**
Montpelier Creek [ar] (2)	12.9 (8.0)	stream resident	MP	*	remnant population
Little Beaver Creek [ar] (1)	5.8 (3.6)	stream resident	MP	*	remnant population
Whiskey Creek [a] (1)	4.8 (3.0)	stream resident	MP	*	remnant population
Snowslide Canyon Creek [ar] (1)	3.1 (1.9)	stream resident	MP	*	remnant population
Lower Montpelier Creek [br] (3) (Including Home Canyon, Telephone Draw, Twin Spring Creeks) (all 1)	19.3 (12.0)	stream resident	MP	*	remnant population

[ar] = above Montpelier Reservoir
[br] = below Montpelier Reservoir
* = estimate not available
MP = Management Population

Montpelier Creek, draining off the Pruess Range into the Bear River, contains approximately 45.9 km (28.5 mi) of estimated suitable stream habitat with BCT found throughout. Montpelier Reservoir, which contains a limited stocked BCT population, acts as a partial barrier to passage with fish prevented from moving downstream while they are able to move upstream. Current surveys indicate that BCT in streams above Montpelier Reservoir are common in abundance, exhibit a stream resident life strategy, and show fair to good recruitment. BCT in streams below the reservoir are known as present based on recent sampling, but little information is available on their population status. They are thought to exhibit a stream resident life strategy with somewhat limited recruitment due to habitat loss from water diversions and road construction. Aside from the reservoir, BCT populations above and below are well connected. Although RBT are present, there is currently no stocking of nonnative fish into streams above Montpelier Reservoir. Historic nonnative stocking into the upper drainage was documented but the range and extent of stocking is not known. Current substantial stocking of RBT is ongoing in the lower Montpelier Creek streams to sustain angling interests. Genetic and meristic analyses are underway to determine the purity status of BCT populations above and below the reservoir. Because of the presence of and management focus on RBT, BCT populations in the Montpelier Creek drainage are considered management populations at this time.

Ovid River Drainage

Table 18. Waters containing BCT in the Ovid River drainage with total occupied stream length in km (miles) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per square meter, and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN (per 100m^2)	PS
Ovid Creek (2)	23.3 (14.5)	unknown	MP	*	remnant population
Mill Creek (1-2)	17.4 (10.8)	stream resident	CP	*	remnant population
North Creek (2)	22.2 (13.8)	stream resident	CP	0.73-5.1	remnant population

* = estimate not available
CP = Conservation Population

The Ovid Creek drainage, from the Bear River Range, is next to enter the Bear River. This drainage contains about 62.9 km (39.1 mi) of estimated suitable stream habitat with BCT found throughout. Although information on distribution in this stream is limited, BCT are suspected to be present throughout Ovid Creek. All three stream consist of remnant BCT populations. Recent surveys indicate that BCT in North and Mill Creeks exhibit a stream resident life strategy and are considered common in abundance. These populations are also believed to have good recruitment based on the presence of viable BCT populations. Due to a naturally variable water supply, the only remaining connected streams within this drainage are North and Mill Creeks during good water years. Although RBT have been stocked in the past, information on the range and extent of stocking was not available. Genetic analysis has not been conducted BCT from these populations. Local biologists have not detected morphological signs of hybridization. Due to minimal information on BCT in Ovid Creek, this population is not managed for conservation of BCT; however, North and Mill Creeks are considered conservation populations.

Georgetown Canyon Creek Drainage

Table 19. Waters containing BCT in the Georgetown Canyon Creek drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per square meter, and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Georgetown Canyon Creek[a]	23.7 (14.7)	stream resident	MP	*	remnant population
Georgetown Canyon Creek, Left Hand Fork	10.0 (6.2)	stream resident	MP	*	remnant population

[a] = isolated population
* = estimate not available
MP = Management Population

The Georgetown Canyon Creek drainage, from the Aspen Range, contains approximately 33.7 km (20.9 mi) of estimated suitable stream habitat, with BCT in all reaches (100%). IDFG considers these BCT to be rare to common in abundance and suspects that they exhibit a stream resident life strategy, although IDFG believes more current surveys are required to validate this

information. Based on the presence of sustainable BCT populations, recruitment is thought to be occurring, however the extent of recruitment is unknown. Dewatering and instream water diversion structures in the lower reaches of the mainstem Georgetown Canyon Creek functionally disconnect this stream from the main Bear River. Although this stream remains connected to the Left Hand Fork, this system is susceptible to genetic and/or catastrophic loss, because habitat is limited and populations are isolated from other populations of BCT. Historic stocking of nonnative BKT and RBT has been documented throughout this drainage but the range and extent of stocking is not known. Some limited meristic analyses have been conducted, but results were inconclusive as to the purity of BCT in this drainage. Genetic analyses have not been conducted on BCT from this drainage. Although both Georgetown Canyon and Left Hand Fork are considered remnant BCT populations, management focus on an RBT fishery and considers these BCT as management populations.

West Slope Nounan Valley Drainage

Table 20. Waters containing BCT in the west slope Nounan Valley drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per square meter, and population status (PS).

Stream/Tributary (order)	SM	LH	CS	DN	PS
Eightmile Creek (2)	16.1 (10.0)	stream resident, fluvial	MP	*	remnant population
Pearl Creek (1)	4.8 (3.0)	stream resident, fluvial	CP	*	remnant population
Skinner Creek (1)	9.7 (6.0)	unknown	CP	*	remnant population
Co-op Creek (1)	9.7 (6.0)	stream resident, fluvial	CP	*	remnant population
Stauffer Creek (1-2)	12.9 (8.0)	unknown	CP	*	remnant population
Beaver Creek (1)	4.0 (2.5)	unknown	CP	*	remnant population

* = estimate not available
CP = Conservation Population
MP = Management Population

Flowing through the Nounan Valley, several streams enter the main Bear River. This drainage contains about 67.1 km (41.7 mi) of estimated suitable stream habitat with BCT found throughout. Although these streams are tributaries to the Bear River, they are diverted at the forest boundary and commonly do not reach the mainstem of the Bear River depending on water year. These BCT populations are considered remnant with BCT common in abundance in the streams where they occur. Based on surveys, BCT populations in Pearl and Co-op Creeks are known to recruit. Little information is available on the other streams; however it is assumed that recruitment is occurring based on the presence of viable BCT populations. Although each stream in this drainage is connected to the mainstem Bear River, severe habitat degradation in the lower sections from water diversions and grazing functionally disconnects them from the Bear and isolates BCT populations. Historic stocking of nonnative BKT and RBT was documented in this drainage but the range and extent of stocking is not known. Currently, RBT are found in

Eightmile Creek and BKT are found in Eightmile and Pearl Creeks. Some hybridization with RBT has been detected in Skinner, Stauffer, and Beaver Creeks in genetic analysis of BCT from these streams. Eightmile Creek is considered a management populations emphasizing RBT and BKT fisheries. The remainder of the streams in this drainage are managed as conservation populations to protect the remaining BCT stock.

Cottonwood Creek Drainage

Table 21. Waters containing BCT in the Cottonwood Valley drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per square meter, and population status (PS).

Stream/Tributary (order)	SL	LH	CS	DN	PS
Cottonwood Creek [a] (3)	38.0 (23.6)	stream resident	CP	*	remnant population
Shingle Creek (1)	10.1 (6.3)	stream resident	CP	*	remnant population

[a] = isolated population
* = estimate not available
CP = Conservation Population

As the Bear River makes a turn to the south, Cottonwood Creek enters from the Portneuf Range to the west. This drainage contains 48.1 km (29.9 mi) of estimated suitable stream habitat with BCT in all streams (100%). Recent surveys indicate that these remnant BCT populations exhibit a stream resident life-strategy and are considered common in abundance. Dewatering and instream water diversion structures in the lower reaches Cottonwood Creek functionally disconnect this stream from the main Bear River. Although Cottonwood Creek is fed by Shingle Creek, this system is susceptible to genetic and/or catastrophic loss because of its isolation from the main Bear River. Some stocking of nonnative RBT and BKT is reported to have occurred in this drainage; however, recent surveys indicate that these species are currently absent. Genetic and meristic analyses indicate BCT are slightly hybridized with RBT. Yet BCT in this drainage are considered conservation populations so that the remaining BCT can be protected and preserved.

Mink River Drainage

Table 22. Waters containing BCT in the Cub River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per square meter, and population status (PS).

Stream/Tributary (stream order)	SM	LH	CS	DN (per $100m^2$)	PS
Mink Creek	8.8 (5.5)	stream resident	CP	*	remnant population
Birch Creek	4.8 (3.0)	stream resident	CP	5	remnant population

Mink Creek drains from the west slope of the Bear River Range and joins the Bear River approximately 4 miles upstream of Riverdale, Idaho. This drainage contains about 12.8 km (8.5 mi) of estimated suitable habitat with BCT found throughout. The upper portion of Mink and all

of Birch Creek consist of BCT while remainder of the Mink Creek drainage is dominated by nonnative trout species. Although part of the larger Mink River drainage, Birch Creek is typically isolated from the rest of the system due to diversions in its lower reaches. Populations consist of remnant BCT and surveys indicate that individuals are generally common to abundant. Recruitment is thought to be good based on the presence of multiple age classes. Records are unavailable and the historic stocking of nonnative trout or BCT is not known. Nonnatives are currently absent from the Birch Creek and genetic and meristic analyses indicates that these are pure BCT. Genetic and meristic information on BCT in Mink Creek is presently unavailable. Both streams managed as a conservation populations.

Cub River Drainage

Table 23. Waters containing BCT in the Cub River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per square meter, and population status (PS).

Stream/Tributary (stream order)	SM	LH	CS	DN	PS
Cub Creek (2)	34.8 (21.6)	stream resident, fluvial	CP	*	remnant population
Sugar Creek (1)	10.9 (6.8)	stream resident, fluvial	CP	*	remnant population
Maple Creek (1)	16.1 (10.0)	stream resident, fluvial	CP	*	remnant population

CP = Conservation Population
* = estimate not available

Although the confluence of the Cub River with the Bear River is in Utah just south of the Idaho-Utah border, approximately 61.8 km (38.4 mi) of estimated suitable stream habitat is located in Idaho and BCT are found throughout this drainage (100%). Populations consist of remnant BCT and recent surveys indicate that these BCT are stream residents, common in abundance. The presence of all life-stages suggests good recruitment. All populations are connected within this drainage allowing genetic exchange between populations and stability from catastrophic loss. Diversions at the forest boundary often isolate the streams in this drainage from the main Bear River. Although RBT have been stocked in the past, information on the range and extent of stocking is not known. Recent genetic and meristic analyses determined BCT in both Sugar and Maple Creeks to be pure. RBT are present in the main Cub River and genetic and meristic analyses show some slight hybridization between BCT and RBT in this population. BCT in this drainage are managed as conservation populations in an effort to protect and preserve the natural BCT stock.

Activities Threatening Long Term Persistence of BCT

A. The Present or Threatened Destruction, Modification, or Curtailment of the Species' Habitat or Range.

Habitat degradation from multiple sources is a considerable threat to BCT populations throughout the BRGU. Livestock grazing has been identified as one primary reason for habitat degradation in the region. Improper livestock grazing has led to moderate to severe localized impacts on stream habitat and riparian areas throughout the unit. Indirectly, excessive fine

sediment, resulting from of poor upland watershed condition, affects water quality and instream habitat. More direct damage includes decreased bank stability and loss or destruction of riparian area. Local ranchers in the Cokeville, Wyoming, region indicate that wild ungulate grazing (specifically elk) may be as much or more of a problem than livestock grazing. These ranchers contend that unlike private livestock which is closely monitored, wild ungulate populations are not adequately managed by state wildlife agencies.

Road building is a continuing problem as well within this unit and has exacerbated problems of sedimentation, bank instability, and loss of riparian area. Habitat damage from historic timber harvest has affected the long-term channel stability, substrate and morphology in some streams, particularly in the mountainous areas where large timber stands were historically harvested for railroad and development. In particular, extreme stream channel alterations due to tie-hacking are still apparent in localized areas of the East Fork of the Bear River.

In addition, water development (diversions and dams), used primarily for agriculture in the lower Bear River valley, has irreversibly changed individual stream processes and hydrologic conditions. The same is true for more urban areas such as in the drainages in Cache Valley near Logan, Utah, which have been extensively developed for agricultural and municipal water use. Instream water diversion structures that dewater stream reaches, culverts and other barriers to fish movement fragment or reduce available habitat and stream miles occupied for BCT in some drainages. In the Cache Valley, most major drainages are diverted and dispersed throughout the valleys. Where this occurs, BCT are commonly restricted to upper watersheds within canyons.

Although many of these streams receive extensive recreational traffic (hikers, anglers, camping, horseback riding, ATVs) which can result in instream and riparian damage or indirect effects to water quality and hydrology where the activity is not adequately controlled, impacts from these activities tend to be localized to close proximity of the activity rather than affecting overall watershed conditions. Habitat degradation, such as increased sedimentation from high-use trails, has occurred in localized reaches of streams in the headwaters of the Bear River that are part of a popular recreation area. Although more popular areas are commonly governed through extensive land-use regulation administered by the USFS or BLM, cumulative impacts to habitat remain a concern for BCT populations in these high-traffic areas (i.e. Logan Canyon).

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Although overutilization likely contributed to the historic decline of BCT in this area, it is currently not considered a threat to the persistence of BCT in the BRGU. Some populations, however, have the potential to be impacted by localized intense fishing pressure, particularly near urban centers such as BCT in Logan Canyon, Utah.

C. Disease or Predation

Whirling disease was recently discovered in the Logan River and has the potential to affect the nearby Blacksmith Fork populations as fish migrate between the two drainages. Although a significant risk, it has not yet manifested itself detrimentally on BCT populations. In some

areas, BCT, by nature of their life-strategy, are not likely to be affected by whirling disease. Because whirling disease attacks the cartilage present in young fish, adult fish have not been found to be susceptible to the detrimental affects. Therefore, if BCT exhibit a fluvial life stage, migrating into inaccessible headwater reaches to spawn, young BCT are not exposed to the spores that cause whirling disease present in lower reaches where hatchery fish have been stocked. It will take some time and research to understand the full potential of whirling disease on BCT.

Whirling disease has often been introduced through stocking of infected hatchery fish or through transportation of spores on animals or equipment. The potential threat of this disease spreading to other drainages is greatly reduced by established procedures and protocols that are in place that require disease certification for transplanting live fish.

The potential for predation does not currently pose a significant threat to BCT in the BRGU because most BCT populations managed for conservation are isolated from streams that contain nonnative fish, such as BNT, known as predators of BCT.

D. Inadequacy of Existing Regulatory Mechanisms

There are no evident inadequacies in existing federal, state, or local regulatory mechanisms that can be considered a threat to the long-term persistence of BCT in the Bear River drainages. Most agencies retain appropriate authority and have adequate regulations to protect land and watershed conditions and wildlife. However, protection of BCT depends on the continued appropriation of funding and time of the local management or regulatory agencies to fulfill their responsibilities and commitments through adequate regulatory authority. For example, it is the responsibility of USFS and BLM to ensure that grazing regulations are appropriately applied and followed where grazing permits are issued on public lands. Because of personnel and funding constraints, it may be difficult, at times, for these agencies to monitor all grazing activities. In many cases, agencies must rely on the grazing permittee to uphold grazing regulations and adequately manage their livestock. In addition, these regulations are not in place on private lands.

E. Other Natural or Manmade Mechanisms

As a result of extensive past stocking and to some extent current stocking, nonnative fishes including BNT, BKT, YCT, and RBT have become established in some streams within the BRGU. While competition between nonnative salmonids and BCT likely affect overall population condition in some areas, hybridization between RBT and BCT is a greater threat to BCT where these species coexist. Hybridization occurs to varying degrees in some drainages throughout the region. However, BCT and RBT coexist in some drainages without hybridization. It is not clear why hybridization may or may not occur. Overall, the Service considers that if nonnative and/or hybrid fishes are allowed to further mix throughout the BRGU there is the potential to lose pure strain BCT.

Hybridization remains one of the main threats to the persistence of BCT in the BRGU. Although current trends in State stocking procedures to eliminate stocking of RBT into known pure BCT

populations, to reduce RBT stocking, and/or to stock sterile RBT have lessened the severity of this threat overall, there are still many opportunities to further reduce this threat through removal of RBT or discontinued stocking of RBT. Expanding of BCT into State hatchery systems would provide substantial numbers of BCT that could be used for stocking in many waters.

In addition, more popular and accessible angling areas, such as areas of the Logan and Blacksmith Fork rivers, are managed for nonnative RBT, BKT and BNT to ensure a sustainable sport fishery. Because conservation of BCT may require segregating these nonnative populations from conservation populations of BCT, management of sport fishing populations may limit BCT to more inaccessible, headwater portions of the watershed, thereby reducing overall habitat availability.

Conservation Actions

A. Research

Life history and population dynamics studies on BCT, particularly in the Thomas Fork drainage, have been ongoing for several years. Also, Utah State University has also been developing a population viability model that could be an important tool in the management of BCT in this region.

Research on BCT in Wyoming has been ongoing for several years. The University of Wyoming is currently managing two studies on BCT in the Thomas Fork Drainage, Wyoming. A three year study is evaluating BCT movement throughout the drainage. A second study is examining the effects of various habitat parameters on the movement and survival of BCT in the drainage. Additionally, WGF has ongoing life history studies in several streams in Wyoming to better understand the ecology of BCT populations that will enable them to improve their management of this species.

B. Population and Genetic Investigations:

Population surveys have been completed or are in progress on numerous of BCT waters in the BRGU. Additionally, a primary focus of the UDWR and Wasatch-Cache National Forest is to survey previously unexamined streams which could lead to the identification of additional remnant populations.

Genetic surveys to determine or confirm the purity status of BCT in the BRGU are either ongoing or have been completed for a significant portion of these streams. Not all genetic analyses are complete however, because of time constraints. Currently, genetics analysis is being contracted to Allendorf and Leary genetics laboratory at the University of Missouri. These results have been and will be used to guide management for this unit including key reintroduction and range expansion efforts.

C. Range Expansion

Although reintroduction of BCT has not been as extensive in the BRGU as in other regions, BCT population expansion has been and continues to be a priority for managers. IDFG has focused on

expansion primarily through stocking BCT in Battle, Eightmile, Pearl, Cottonwood, Left Fork Gorgetown Canyon, and Trout Creeks completed. Eradication of nonnative fishes from selected streams in Utah, including the Wind Caves Trail Creek and Right Hand Fork of the Logan River, with subsequent reintroductions of BCT scheduled.

B. Habitat Restoration

Habitat restoration has also been the primary focus for BCT management in the BRGU. Habitat surveys in known BCT waters are ongoing in areas with identified problems. Due to the extensive impacts of grazing in this unit, much of the habitat restoration has focused restructuring of grazing practices. For example, Allotment Management Plan's (AMP), riparian fencing or complete removal of livestock has been implemented in some areas where grazing has been identified as a problem to BCT. Wyoming has been particularly active addressing this issue and has implemented rotational grazing plans and off-stream water sources in addition to riparian fencing to reduce impacts on stream habitat. Idaho and Utah have focused on riparian fencing and AMP restructuring to address their grazing problems.

The Smith's Fork Grazing Association, an organization of local livestock grazing permittees, provided information for this status review on efforts of their association in cooperation with local land-management agencies to improve habitat conditions on private and public lands. The group retains the services of a private range consultant and since 1996 has been involved with BLM, WGF, TU and other interested parties in developing a cooperative management planning effort (CRM) for grazing. Their conservation efforts to date include grazing rotations, seasonal resting of riparian areas, and fencing off of sensitive habitat to assist in rotational grazing. Protocols for seasonal use limits and stream-side vegetational stubble height have been established and required for all permittees. In addition, permittees have hired additional riders to ensure appropriate herding and distribution of cattle, including a range boss and four full time riders.

Exclosures have been built by BLM and WGF on Huff Creek and Coal Creek. Special management to improve riparian and instream habitat is underway on Raymond Creek which contains an important BCT population. Erosion control structures have also been constructed on Raymond Creek to stop and reverse the erosional process. One of the full time riders camped in Raymond Basin for the entire grazing season to ensure cattle did not move into the stream or riparian areas. Under the CRM, no livestock grazing is allowed below the forks of the canyon in Raymond Basin and there is minimal spring use above the forks. Monitoring data on grazing and resource conditions is being collected each year to evaluate and guide management activities. Data from the 1998 and 1999 end-of-grazing season riparian monitoring data collected by BLM showed significant improvements in streamside vegetation, particularly in Raymond Canyon. Prescribed burns are planned to improve upland watershed conditions (Smith's Fork Grazing Allotment, in litt).

The Caribou National Forest has been particularly active in BCT habitat protection and improvement in the BRGU. The Forest has modified grazing practices and taken necessary

permit actions to ensure aquatic resources are protected, not only in watersheds containing Bonneville cutthroat trout, but in all watersheds. The Forest entered into a Conservation Agreement in the Thomas Fork of the Bear River on the Montpelier-Elk Valley allotment to benefit Bonneville cutthroat trout. The agreement was signed in 1994. The intent and purpose was to protect aquatic habitat in Pruess, Dry and Giraffe Creeks. Since 1994, the Forest has spent about $20,000 for 14 new or reconstructed water developments; built 10.25 miles of new fence at a cost of $35,000; constructed 5 livestock exclosure fences at a cost of $12,000. In addition to the CA, the Forest has spent considerable time and effort in allotment administration throughout the Forest. Over the past 8 years, livestock have been reduced on several allotments in an attempt to better meet utilization standards and bring permitees into compliance with their existing permits. Many allotment plans have been updated and 83 (out of 140) are on a 15 year schedule for updates. These measures have resulted in improved habitat conditions and protection of riparian and stream habitat for important BCT populations.

The Caribou National Forest has also made considerable efforts to minimize impacts to aquatic resources resulting from timber harvest activities. Every phase of the process is carefully scrutinized and evaluated, from planning to implementation, to post-harvest reviews. Full interdisciplinary teams containing hydrologists, biologists, soil scientists, engineers, and foresters are assembled for every project. An example of the extensive efforts that the Caribou National Forest has undertaken to protect BCT associated with a timber sale occurred at Bailey Creek. This timber sale was specifically referenced in the Petition to list Bonneville cutthroat trout as lacking in quality, content and integrity. A watershed analysis was completed in association with this project. This analysis was completed using the 6-step process outlined in the Ecosystem Analysis at the watershed scale- Federal Guide for Watershed Analysis, revised in 1995 and referenced in INFISH interim direction. In analyzing the alternatives for this project, a thorough analysis of each alternative was conducted which included several intensity levels of mitigation and protection for each alternative. The preferred alternative included the most intensive level of protection for aquatic resources including Best Management Practices, INFISH and protection measures suggested by the Idaho Department of Environmental Quality. The analysis concluded no adverse impacts would occur to any streams within the sale area, and no measurable impacts would occur to downstream areas. Ultimately, the project was delayed due to issues associated with roadless areas. This example, however, demonstrates the commitment of the forest to adhere to protective measures concerning timber harvest and Bonneville cutthroat trout protection.

Habitat improvement has also come in the form of regulation of development. The primary focus here has been regulation or restructuring of planned or existing roads and recreational uses. The Caribou National Forest has been active in this type of habitat improvement. In the past, many roads in the Forest were located in areas that caused damage to the ecosystem. It is the Forest's policy to relocate or repair these less-than-acceptable roads where opportunities exist. Many miles of roads have been relocated or repaired over the last decade. The result has been a net reduction in miles of roads that impact aquatic resources. High usage of this area has also resulted alteration or closure of roads, restrictions of off-road vehicle use, and alteration or

removal of recreational trails and campgrounds. This type of regulation has been of particular importance in the Logan River drainage in Utah and in localized areas in Idaho including the Lower Montpelier Creek and Cub Creek drainages.

Additional work has included a partnership between the NRCS and some landowners on the Thomas Fork of the Bear River to improve habitat by planting riparian vegetation and constructing and maintaining livestock exclosure in sensitive riparian areas. Additionally, the Service recently (mid-1990s) purchased land including nearly 3.75 miles of the lower Thomas Fork of the Bear River. Livestock grazing has been removed from these stream miles. Additionally, a new landowner recently purchased land immediately down stream from the Service property that contains the lower 0.5 miles of the Thomas Fork and an additional four to six miles on the north side of the Bear River downstream from the mouth of the Thomas Fork. This landowner has constructed fences on his property to keep livestock out of the riparian areas.

The Wasatch-Cache National Forest has been active in identifying populations of BCT, improving habitat conditions, and providing increased habitat protection over the past 8 years. Approximately 95% of the streams within the within the Bear River drainage on the Forest have been surveyed and fish tissues samples collected for genetic analysis. Basin-wide habitat surveys have been conducted in an effort to better identify habitat needs and improvements that could be made to better secure BCT populations. The Temple Fork Road has been relocated, at a cost of $700,000, to move traffic and recreational visitors away from the stream. Other roads in the Forest have been altered to minimize sedimentation in adjacent streams. A timber sale originally proposed for the Little Bear River Drainage has been predominately relocated to a fishless drainage outside of the Logan River drainage. Little other timber sales have occurred on the Forest. New pit toilets have been installed in replacement of older toilets that had potential to leak into the mainstem Logan River. Over 100 recreational camping sites have been altered to minimize impacts on riparian vegetation. Grazing issues have also been a priority for the Forest. A Forest-wide rangeland health EIS was completed in 1996 and incorporated improvement standards into all allotment management plans. Approximately 3 miles of range enclosure fences have been installed in the Sugar Pine drainage. In addition, in 1998, the Forest began voluntary compliance with the INFISH. This provided Forest-wide direction for the protection of aquatic resources.

E. Regulation

Current UDWR policy excludes stocking of nonnative fishes in streams with transplanted or remnant populations of BCT in Utah as identified through genetic and meristic analysis (Lentsch et al.1997). As of the year 2000, all RBT stocking in the state of Idaho will use exclusively sterile individuals to prevent further risk of BCT hybridization (D. Scully pers. comm.). WGF also discontinued stocking of all nonnative fishes in 1976 to all waters within the Thomas Fork and Smith's Fork Drainages (R. Remmick pers. comm.). Additionally, since 1982, WGF has had restrictive angling regulations within these streams to protect BCT recruitment.

Conclusion

The status of BCT in this unit has been gradually improving over the past 20 years. Currently, more than 1182 km (734 mi) of stream habitat and 0.8 ha of reservoir is occupied by approximately 124 populations of BCT. In the 1980's, many of these populations were either unknown or thought to be completely lost to hybridization. In addition to discovering new remnant BCT, recent surveys have also determined that hybridization was not as severe as previously thought in many of these populations. Further surveys are scheduled and may potentially locate even more remnant BCT in this unit and continued genetics analyses to determine purity.

Active management of BCT is a continued priority for natural resource managers in the BRGU. Although threats including poor grazing habits, development and road building, whirling disease and nonnative trout species still remain, aggressive restoration and protection activities for BCT are ongoing and have reduced impacts of these threats. These efforts have focused on research of BCT life history and population dynamics, comprehensive population and genetic surveys, habitat improvement, and BCT range expansion. In particular, regulation of grazing via restructuring AMP's and riparian fencing has been a primary focus for habitat improvement throughout the unit. In addition, the modification of and in some areas complete discontinuation of stocking of nonnative trouts by Utah, Idaho, and Wyoming in BCT range is a key factor in the restoration and protection of this species. Conservation plans and actions have been developed and are being implemented by all three states for the continued restoration and protection of BCT in this region. It is expected that the status of BCT, if managed at the continued level of conservation, will continue to improve.

Recommendations

Based on this summary, the Service recommends the following to further promote BCT in the Bear River GU:

1) Increased implementation and enforcement of grazing regulations to prevent acute impacts from grazing in streams and along riparian areas. Although regulations have been developed, information provided in association with this status review suggest some of these regulations are not adequately enforced to protect BCT in certain streams.

2) Consider using BCT for stocking rather than RBT or other nonnative salmonids into appropriate stream reaches. By stocking BCT, UDWR, WGF and IDFG can promote the sportfish and native species value of BCT while further reducing known threats. This action would be most appropriate where nonnative salmonid stocking continues in waters that are connected to areas occupied by pure BCT populations.

3) Conduct further population, habitat and genetic surveys in both unstudied areas or known BCT drainages requiring further study (ie. Logan Canyon) so that a more comprehensive assessment of BCT among these drainages exists.

4) Managers in this unit have expressed that further research on habitat and resource conflicts and on effects of hybridization between BCT and RBT would be very useful. This information may be useful to BCT conservation throughout BCT range.

Northern Bonneville Geographic Unit

Description of Geographic Unit

The Northern Geographic Unit (NGU) encompasses the north-eastern portion of the main Bonneville Basin and drains the west slope of the Wasatch Mountains. This GU includes all drainages of the Great Salt Lake from the Weber River drainage in the north to the Spanish Fork drainage to the south. This area comprises 5 major river basins: the Weber and Ogden drainages which drain the northern Wasatch mountains directly into the Great Salt Lake to the west; the Provo and Spanish Fork rivers which drain the southern Wasatch Mountains westward into Utah Lake; and the Jordan River which flows from Utah Lake northward, collecting a number of smaller river systems (City Creek, Red Butte, Emigration, Parleys, Big and Little Cottonwood creeks) from the central Wasatch Mountain through the Salt Lake Valley, and terminates in the Great Salt Lake. The Great Salt Lake has no outlet; it is a closed basin.

The NGU ranges in elevation from approximately 5,000 to10,000 feet. The natural vegetational community is characterized by sagebrush and grasslands at lower elevations, and aspen and subalpine fir/spruce communities at higher elevations. Riparian areas are generally dominated by willows or mountain maples and gambel oak. Stream gradient ranges from extremely high alpine streams to low gradient meadow meanders. Lower elevation areas have extensive agricultural and urban development whereas inaccessible high elevation areas tend to be more pristine. Habitat condition is highly variable among drainages and streams (Lentsch et al. 1997). Nearly all potential and occupied habitat for BCT is within the canyon or mountain meadow reaches of these streams. Lowland reaches in urban and residential centers have been diverted, piped and channelized and no longer appear to provide adequate habitat for viable resident populations of BCT. There are a few streams which retain some semblance of their natural flow and habitat in valley reaches through parks and occasional stream channel; however, these reaches are effectively disconnected from higher elevation reaches where native BCT occur.

Current land ownership in the NGU is roughly estimated to be 60% private, 35% USFS, and 5% State of Utah. Management of BCT populations in the NGU is the responsibility of UDWR; however, federal agencies, in particular the Wasatch-Cache and Uinta National Forests, work cooperatively with UDWR to manage BCT populations and their habitat.

Background

Historic occurrences of BCT in the NGU have been extensively documented. Detailed examples of BCT distribution and general abundance date to the late 1700's exist (Hickman 1978, Rawley 1985, Behnke 1992). Most historic accounts indicate abundant trout and salmon-like fish referred to by early explorers, settlers, and Native American tribes in waters including Utah Lake, the Weber River, and other streams in the NGU (Sigler and Sigler 1987, Cleland and Brooks 1983). BCT began a rapid decline soon after pioneer settlement of the NGU during a period of excessive wildlife exploitation, land-use and mis-use including water diversions, overharvest, livestock grazing, and introduction of nonnative trouts (Cleland and Brooks 1983, Cottum 1947, Popov and Low 1950, Hickman 1978). During the middle 1900s, emphasis was placed on sustaining fisheries for angling and little was known about the status and distribution of native BCT.

Although this GU represents the most human-populated and urbanized portion of the Bonneville Basin, the mountain climate results in greater rainfall and larger river systems in general compared to other areas of the Bonneville Basin. As such, the NGU retains the greatest potential to discover remnant BCT populations among more remote or less popular drainages particularly on private lands and undeveloped National Forest Lands. Although experiencing the greatest impacts of early pioneer settlement and having the closest proximity to urban areas, the NGU also retains the most complex water systems both in terms of their natural hydrologic regimes and in terms of the impacts of human development.

Complex land-use management issues arose over the past century and continue into present management. Originally, grazing, timber, water development, and other resource use issues caused local impacts complicated by the nearby urban needs. More recently, recreational uses conflict with each other as well as with continued urbanization, water development and wildlife and ecosystem management. Although the impacts of today do not equal the devastating land-use activities of the 1850s to 1950s, an increased human population has escalated the traffic and use of the lands and water systems in the NGU such that cumulative impacts can become equally severe.

There are extensive water systems in the NGU for which little information on the status of BCT was collected prior to the 1990's and some additional streams systems remain unsurveyed. It has long been suspected that many of these systems have been overtaken by nonnative salmonids (RBT, BKT, BNT) due to stocking for many years. However, BCT have recently been found to be present in some creeks or sub-drainages. The status of these and their purity is not yet assessed. Because of the extensive numbers of streams in the NGU, many smaller waters are, as yet, unsurveyed for BCT. For BCT populations in the NGU that have been more thoroughly investigated and genetically tested, results are indicating that BCT populations are pure where there are barriers to prevent movement of fish from larger river systems that have been stocked with nonnative salmonids.

As additional relatively unknown systems, such as Chalk Creek, are investigated and the local BCT are found to be pure, streams uninvaded by nonnative salmonids, and where major sport fisheries have not been established, the status of these systems is being changed from managing for sportfish (management population) to managing for the long-term persistence of BCT (conservation population)

Population Status

Ogden River Drainage

Table 24. Waters containing BCT in the Ogden River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Ogden River, South Fork (3)	unknown	unknown	ND	*	remnant population
Beaver Creek (2)	7.2 (4.5)	stream resident, fluvial	ND	435 (270)	remnant population

Wheeler Creek (2)	5.6 (3.5)	stream residents	CP	259 (161)	suspected remnant population
Dry Bread Creek[a] (1)	1.6 (1.0)	stream residents	MP	*	remnant population
Wheatgrass Creek[a] (1)	9.7 (6.0)	stream residents, poss. adfluvial	MP	906 (563)	remnant population, genetics results may change conservation status
Ogden River, Left Fork South Fork (2)	9.3 (5.8)	stream residents, poss. adfluvial	MP	1556 (967)	remnant population
Bear Canyon Creek (1)	4.0 (2.5)	stream residents	MP	*	remnant population, genetics results may change conservation status
Ogden River, Middle Fork (2)	16.1 (10.0)	stream residents	MP	*	pure BCT, hybrids, and wild RBT present
Geertsen Creek[a] (1)	5.6 (3.5)	stream residents	MP	*	remnant population
Ogden River, North Fork, Section 1 (1)	unknown	unknown	ND	*	status unknown
Ogden River, North Fork, Section 2 (1)	unknown	unknown	ND	*	status unknown
Broadmouth Creek (1)	2.4 (1.5)	unknown	MP	*	status unknown
Cobble Creek (1)	unknown	unknown	potential CP	*	status unknown
Wolf Creek (1)	3.2 (2.0)	stream residents	potential CP	*	status unknown
Cutler Creek (1)	4.0 (2.5)	unknown	MP	*	status unknown, hybrids present

[a] = isolated population
* = estimate not available
ND = Not Designated
CP = Conservation Population
MP = Management Population

In the Ogden River drainage, BCT are known to occupy 61.6 km (38.3 mi) which is approximately half of the estimated suitable stream miles in the basin. Presently, information is incomplete on several of the streams that potentially contain BCT. These streams are scheduled for survey in the future. Recent surveys of BCT indicate that they are common in abundance and that successful recruitment occurs. Connectivity among streams is good compared to other GUs but not as good as other areas of the NGU with most streams being connected to 1 to 3 other streams. Several streams including Wheatgrass, Broadmouth, and Dry Bread Creeks, and the Right Fork South Fork Ogden River are isolated from other portions of the drainage due to natural instream barriers or water diversions.

Although currently discontinued, historic stocking of nonnative YCT and RBT occurred to some extent in this drainage. Past UDWR records indicate that there was substantial stocking of YCT into Wheatgrass Creek. YCT, RBT and BCT hybrids currently exist in some streams or reaches of streams within this major drainage. Genetic and meristic testing in the drainage as a whole has been limited to date. Where potential BCT populations are tentatively identified, genetic analyses is scheduled. However numerous other strong BCT populations in this GU have been a priority for investigation to date. Two populations, Wheeler Creek and Left Fork South Fork

Ogden River, have been confirmed as pure BCT. Because of the presence of nonnative fishes, most of the Ogden River drainage streams are treated as management or nonnative populations. Wheeler Creek, however, is currently considered a conservation population. Additional conservation populations may be designated as more information on this drainage is acquired.

Lower Weber River Drainage

Table 25. Waters containing BCT in the Lower Weber River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Weber River, Sect. 4 (2)	16.1 (10.0)	stream resident, fluvial	MP	*	remnant population
Arbuckle Creek (1)	3.4 (2.1)	stream resident	CP	*	remnant population
Cottonwood Creek (1)	20.1 (12.5)	stream resident	CP	*	remnant population
Deep Creek (1)	4.8 (3.0)	stream resident	CP	*	remnant population
Deep Creek, North Fork (1)	6.4 (4.0)	stream resident	CP	*	remnant population
Line Creek (1)	6.4 (4.0)	stream resident	CP	*	remnant population
Smith Creek (1)	9.7 (6.0)	stream resident	CP	*	remnant population
Dalton Creek (1)	5.6 (3.5)	stream resident	CP	*	remnant population
Peterson Creek (1)	4.0 (2.5)	stream resident	CP	*	remnant population
Dry Creek (1)	14.5 (9.0)	stream resident	CP	*	remnant population
Gordon Creek (1)	8.4 (5.2)	stream resident	CP	*	remnant population
Strawberry Creek (1)	6.4 (4.0)	stream resident	CP	*	remnant population

* = estimate not available
CP = Conservation Population

In the lower Weber River drainage, BCT are known to occupy 89.3 km (55.8 mi) which is all of the estimated suitable stream habitat (100%). Based on recent surveys, BCT populations throughout this drainage are considered abundant and are noted to have successful recruitment. Connectivity among streams is relatively good with each populations being connected to at least 2 or more populations. Historic records indicate only limited incidental stocking of nonnative species. The fish community is considered relatively pristine with no nonnative salmonids present. A subsample of genetic analyses indicates that BCT in this drainage are pure. Due to the results of genetic and meristic analyses and the lack of nonnative species, these populations are thought to be remnant BCT and are managed as conservation populations for the long-term persistence of BCT.

East Canyon Creek (Weber River)

Table 26. Waters containing BCT in the East Canyon Creek drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT

density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Hardscrabble Creek (2)	15.8 (9.8)	stream resident	CP	*	remnant population
Farrel's Creek (1)	2.6 (1.6)	stream resident	CP	*	remnant population
Walton Creek (1)	3.2 (2.0)	stream resident	CP	*	remnant population
Shingle Mill Creek (1)	4.0 (2.5)	stream resident	CP	*	remnant population
Arthur Fork Creek (1)	4.8 (3.0)	stream resident	CP	*	remnant population
Threemile Canyon Creek (1)	2.4 (1.5)	nursery stream	potential CP	*	remnant population
Toll Canyon Creek (1)	4.8 (3.0)	nursery stream	CP	*	remnant population
Big Bear Hollow Creek (1)	4.0 (2.5)	stream resident	potential CP	*	remnant population
Deer Hollow Creek (1)	3.7 (2.3)	stream resident	potential CP	*	remnant population
Schuster Creek (1)	4.8 (3.0)	stream resident, fluvial	CP	*	remnant population
Little Dutch Creek (1)	3.2 (2.0)	stream resident	potential CP	*	remnant population
Sheep Canyon Creek (1)	6.6 (4.1)	stream resident	potential CP	*	remnant population
Sheep Canyon Creek, Right Fork (1)	4.3 (2.7)	stream resident	potential CP	*	remnant population

* = estimate not available
CP = Conservation Population

In the East Canyon Creek drainage, BCT are known to occupy 66.4 km (41.5 mi) which is nearly all of the estimated suitable stream miles in the basin. Recent surveys on some streams in this drainage indicate that BCT are stream resident forms, common in abundance. Recruitment is considered successful based on the presence of self-sustaining BCT populations. Connectivity is generally good among these streams with each being connected to 2 to 6 other populations. Limited historical stocking of nonnative species (BNT, RBT) was documented for this drainage but to date, no hybridization between BCT and RBT has been identified. Designated conservation populations have undergone genetic and meristic analyses to confirm their status as pure BCT. Potential conservation populations of BCT are suspected as pure based on preliminary phenotypic analysis and known BCT characteristics but are awaiting genetic and meristic confirmation of this status. Potential conservation populations have been scheduled for population and habitat surveys to further delineate the status and extent of the BCT in this drainage.

Lost Creek Drainage (Weber River)

Table 27. Waters containing BCT in the Lost Creek drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS

Lost Creek, Sect. 2 [ar] (2)	19.3 (12.0)	stream resident, fluvial	CP	*	remnant population
Lost Creek, Sect. 1 [ar] (2)	19.3 (12.0)	stream resident, fluvial	MP	*	remnant population
Blue Fork Creek [ar] (1)	17.7 (11.0)	stream resident, fluvial	CP	*	remnant population
Hornet Gulch Creek [ar] (1)	4.8 (3.0)	stream resident, fluvial	CP	*	remnant population
Killfoil Creek [ar] (1)	1.6 (1.0)	stream resident, fluvial	CP	*	remnant population
Hell Canyon Creek [br] (1)	9.7 (6.0)	stream resident, fluvial	potential CP	*	remnant population
Guildersleeve Creek [br] (1)	6.4 (4.0)	stream resident, fluvial	potential CP	*	remnant population
Pine Canyon Creek [br] (1)	3.2 (2.0)	stream resident, fluvial	CP	*	remnant population

[ar] = above Lost Creek Reservoir
[br] = below Lost Creek Reservoir
* = estimate not available
CP = Conservation Population

In the Lost Creek drainage, BCT are known to occupy 28.9 km (17.5 mi) which is approximately 35% of the estimated suitable stream habitat in the drainage and are suspected to occupy all of the drainage. This area includes Lost Creek Reservoir which contains only few BCT. Recent surveys indicate that BCT in are common in abundance in Hornet Gulch, Blue Fork, and Lost Creeks. The status of BCT in the remaining streams is unknown but population surveys are scheduled for these streams to determine BCT status. All populations are thought to exhibit a stream resident or fluvial life strategy and have good recruitment based on the presence of self-sustaining BCT populations. Connectivity is good for the drainage with each stream being connected to 4 other populations.

Records indicate only limited historical stocking of RBT and BNT has occurred in this drainage and nonnative salmonids have not been currently found in these streams. However, RBT are currently stocked into Lost Creek Reservoir and present a potential threat to this drainage. BCT populations designated as conservation populations have undergone genetic and meristic analyses and have been deemed to be primarily pure BCT with some potential influence by YCT which may have been stocked historically. These populations are managed as pure BCT despite some suggestions that they may be influenced by YCT hybridization. Populations currently identified as potential conservation populations are managed as pure BCT by local biologists and awaiting genetic and meristic confirmation of this status.

Echo Creek Drainage (Weber River)

Table 28. Waters containing BCT in the Echo Creek drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SM	LH	CS	DN	PS
Echo Creek (2-3)	26.6 (16.5)	stream resident, nursery	potential CP	*	remnant population
Rees Creek (1)	unknown	stream resident, nursery	potential CP	*	status unknown
Sawmill Creek (1)	4.8 (3.0)	stream resident, nursery	potential CP	*	remnant population

* = estimate not available
CP = Conservation Population

In the Echo Creek drainage, BCT are known to inhabit 31.2 km (19.5 mi) which is about 80% of the estimated suitable stream habitat in the drainage. Although little is known about the status of BCT in Rees Creek, recent surveys have determined BCT in Echo and Sawmill Creeks to be common, have good recruitment, and exhibit stream resident and/or fluvial life histories. Although historical stocking was documented as being very limited, both RBT and BNT are currently present in the mainstem Echo Creek. Although slight hybridization has been phenotypically noted by local biologists, these streams are treated as potential conservation populations until genetic analyses are complete. Managers are awaiting the outcome genetic analysis to make a final decision on the appropriate management of these streams.

Chalk Creek Drainage (Weber River)

Table 29. Waters containing BCT in the Chalk Creek drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Chalk Creek, Section 3 (1)	27.4 (17.0)	stream resident, fluvial	CP	724 (450)	remnant population
Basin Creek (1)	unknown	unknown	ND	*	status unknown
Unnamed tributary to Chalk Creek, Section 3 (1)	4.0 (2.5)	stream resident, nursery	CP	182 (113)	remnant population
Unnamed trib to Unnamed trib to Chalk Creek, Sect. 3 (1)	unknown	unknown	ND	*	remnant population
Chalk Creek, Section 2 (2)	26.6 (16.5)	stream resident, fluvial	CP	362 (225)	remnant population
Porcupine Creek (1)	unknown	unknown	ND	*	ND
Huff Creek (2)	unknown	stream resident	ND	*	remnant population
Chalk Creek, Section 1 (2)	6.4 (4.0)	stream resident	MP	*	remnant population
Chalk Creek, East Fork (1-2)	16.1 (10.0)	stream resident	CP	644 (400)	remnant population
2nd unnamed tributary to Chalk Creek, East Fork (1)	3.2 (2.0)	stream resident, nursery	CP	208 (129)	remnant population
3rd unnamed tributary to Chalk Creek, East Fork (2) (1)	1.6 (1.0)	stream resident, nursery	CP	*	remnant population

Middle Fork Creek (1)	8.9 (5.5)	stream resident, fluvial	CP	398 (247)	remnant population
Red Hole Creek (1)	1.6 (1.0)	nursery stream	CP	81 (50)	remnant population
Mill Fork Creek (1)	7.2 (4.5)	stream resident, fluvial	CP	370 (230)	remnant population
Unnamed tributary to Mill Fork Creek (1)	3.2 (2.0)	stream resident, fluvial	CP	467 (290)	remnant population
Chalk Creek, South Fork (2)	24.9 (15.5)	stream resident	CP	805 (500)	remnant population
Chalk Creek, Right Fork South Fork (2)	4.8 (3.0)	stream resident	CP	277 (172)	remnant population
Unnamed tributary to Chalk Creek, South Fork (1)	4.0 (2.5)	stream resident, fluvial	CP	208 (129)	remnant population
Fish Creek (1)	12.9 (8.0)	stream resident	CP	161 (100)	remnant population
Lodgepole Canyon Creek (1)	0.6 (0.4)	stream resident, fluvial	CP	338 (210)	remnant population
Elkhorn Canyon Creek (1)	9.7 (6.0)	stream resident, fluvial	CP	156 (97)	remnant population

* = estimate not available
ND = Not Designated
CP = Conservation Population
MP = Management Population

In the Chalk Creek drainage, BCT are known to occupy approximately 163.1 km (101.3mi) which is about 80% of the estimated suitable stream habitat in the basin. The extent and distribution of BCT in this drainage was relatively unknown until 1998-1999 when comprehensive surveys were conducted (Thompson 2000). This effort greatly expanded the known distribution of this BCT in the NGU by the identification of 17 previously unknown BCT populations. The Chalk Creek drainage is potentially the largest BCT metapopulation in Utah and possibly in the entire BCT range. Each stream is connected to as many as 15 other populations. These numbers are likely to increase as more streams in this drainage are surveyed this year. BCT are typically common to abundant in these streams with densities ranging from 50-500 fish per mile and recruitment is thought to be fair to good where BCT are found.

RBT are currently stocked in the lower main stem of Chalk Creek (Sect. 1) but a diversion barrier prevents migration into upstream reaches. There are records of limited historical stocking of nonnative fishes at points above the current location of the barrier, however, nonnatives are currently not found in the drainage above the barrier. Phenotypic evaluation of BCT by local managers indicate little or no hybridization with RBT in the drainage except for Chalk Creek (Sect. 1). Genetic and meristic analyses are in progress to verify this determination. Presently, most of these BCT populations are considered remnant and are managed as conservation populations.

Although this stream would not be considered remote (state road access and open streams), the diversion barrier and private land holdings may have protected native fish populations from stocked salmonids. It has been assumed for many years that nonnatives were prevalent

throughout this drainage. Chalk Creek is an example of why it is important to survey and examine BCT from each drainage despite stocking records or past assumptions. Erroneous information from past assumptions could imperil other pure BCT populations that have not been adequately surveyed or examined for status and purity. With new information on the pure status of BCT in this drainage, local managers have been coordinating with private land owners to implement riparian and instream habitat improvements and to alter land-use so that BCT are protected.

Beaver Creek Drainage (Weber River)

Table 30. Waters containing BCT in the Beaver Creek drainage with total available stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Beaver Creek, Sect. 2 (2)	10.5 (6.5)	stream resident, fluvial	CP	435 (270)	remnant population
Beaver Creek, Sect. 1 (2)	11.3 (7.0)	stream resident, fluvial	ND	*	status unknown
Shingle Creek (1)	10.5 (6.5)	stream resident, fluvial	CP	103 (64.0)	remnant population
Co-op Creek (1)	3.2 (2.0)	stream resident, fluvial	CP	116-156 (72-97)	remnant population
Yellowpine Creek (1)	6.4 (4.0)	stream resident, fluvial	CP	51.0 (32.0)	remnant population
Slate Creek (1)	4.8 (3.0)	stream resident, fluvial	CP	245 (152)	remnant population

ND= Not Designated
CP = Conservation Population

In the Beaver Creek drainage, BCT are known to inhabit 46.7 km (29.0 mi) which is approximately 75% of estimated suitable stream habitat in the basin. Current surveys indicate that the remnant BCT are common in these streams. BCT populations were found to exhibit a stream resident life strategy and have successful recruitment. Connectivity is considered good, because all streams are connected to as many as 5 other populations. Although not stocked into streams in this drainage, RBT are currently stocked into other streams in nearby, connected drainages which suggests RBT hybridization could be a potential threat to these remnant BCT populations. Phenotypic evaluation by local managers indicates that slight hybridization with RBT may be present, but this has not been confirmed by genetic analysis. Despite the presence of nonnative salmonids and potential hybrids, these BCT are currently managed as conservation populations. When results of genetic analyses are complete, managers will decide the value of these BCT to the overall persistence of the species, and specifically whether stream renovations and nonnative control are worthwhile in these streams or if status quo management will allow these BCT to persist at their current status.

Upper Weber River Drainage

Table 31. Waters containing BCT in the upper Weber River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT

density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Weber River, Section 12	11.3 (7)	stream resident, nursery	potential CP	*	status unknown
Weber River, Section 11	9.7 (6.0)	stream resident, nursery	potential CP	*	status unknown
Silver Creek (1)	10.5 (6.5)	stream resident, nursery	potential CP	*	status unknown
Weber River, Section 10	17.7 (11)	stream resident, nursery	potential CP	*	status unknown
Weber River, Middle Fork (2-3)	8.0 (5.0)	stream resident, nursery	potential CP	*	status unknown
Gardeners Fork Creek (1)	2.4 (1.5)	stream resident, nursery	potential CP	311 (193)	status unknown
Dry Fork Creek (1)	11.9 (7.4)	stream resident, nursery	potential CP	*	status unknown
Moffit Creek (1)	6.4 (4.0)	stream resident, nursery	potential CP	*	status unknown
Larabee Creek (1)	5.6 (3.5)	stream resident, nursery	potential CP	*	status unknown
Red Creek (1)	3.4 (2.1)	stream resident, nursery	potential CP	*	status unknown
Smith Morehouse Creek (2)	8.0 (5.0)	stream resident	CP	309 (192)	remnant population
Red Pine Creek (1)	4.0 (2.5)	stream resident	CP	336 (209)	remnant population
Box Canyon Creek (1)	4.8 (3.0)	stream resident	CP	595 (370)	remnant population
Stillman Creek (1)	2.4 (1.5)	stream resident, nursery	potential CP	*	status unknown
Bob Young Creek (1)	3.2 (2.0)	stream resident, nursery	potential CP	*	status unknown
Weber River, South Fork (1)	5.6 (3.5)	stream resident, nursery	potential CP	121-156 (75-97)	status unknown
Whites Creek (1)	6.4 (4.0)	stream resident, nursery	potential CP	*	status unknown

* = estimate not available
CP = Conservation Population

In the upper Weber River drainage, BCT are considered to occupy 117.3 km (77.3 mi) which is almost all of the estimated suitable stream habitat in the drainage. This drainage contains 3 streams (Smith Morehouse, Box Canyon, and Red Pine) with known remnant BCT populations

and additional streams for which little information is known. Recent surveys indicate that BCT in these populations are common in abundance in with densities averaging 257 fish per mile and have good recruitment. These BCT populations are thought to exhibit a stream resident life strategy with a few streams also providing specific nursery habitat. Little is known about the BCT in the remainder of the streams and surveys to delineate the population status those streams are scheduled for upcoming field seasons. Connectivity is good in the drainage with each stream being connected to as many as 10 other populations. Historic records indicate that only limited stocking of nonnative fishes occurred in this drainage. However, RBT are currently stocked in Smith-Morehouse Reservoir and escapement into tributary streams presents a threat to the BCT populations in that area. Although genetic and meristic analyses have not been conducted, phenotypic evaluation suggests slight hybridization is possible in these streams. Presently, only Smith-Morehouse, Box Canyon, and Red Pine Creeks are managed as conservation populations. However, most of the remaining streams in the drainage are considered potential conservation populations, the final status of which will be determined after scheduled surveys and genetic analyses are complete.

Jordan River Drainage

Table 32. Waters containing BCT in the upper Jordan River drainage with total occupied stream length in km (mi) or *surface area* of water body in *hectares (acres)* (SL/*SA*), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	**SL/*SA***	**LH**	**CS**	**DN**	**PS**
City Creek [a] (1)	8.0 (5.0)	stream resident	CP	457/313	remnant population
Red Butte Creek (1)	5.8 (3.6)	stream resident, adfluvial	CP	*	transplant (North Fork Deaf Smith)
Red Butte Reservoir	*20.2 (50.0)*	adfluvial	CP	*	transplant (North Fork Deaf Smith)
Emigration Canyon Creek [a] (1)	11.3 (7.0)	stream resident	CP	*	remnant population
Parley's Creek (2-3)	6.4 (4.0)	stream resident	CP	*	reintroduction (Mt. Dell Res.)
Lamb's Creek (1)	8.2 (5.1)	stream resident	CP	*	reintroduction (Mt. Dell Res.)
Mountain Dell Creek (1)	10.1 (6.3)	stream resident, adfluvial	CP	*	remnant population
Mountain Dell Creek, upper (1)		stream resident, adfluvial	CP	*	remnant population
Mountain Dell Reservoir	*405 (1000)*	adfluvial	CP	*	transplant (Mt. Dell Creek)
Mill Creek [a] (1)	unknown	stream resident	MP	*	status unknown
Deaf Smith Creek, North Fork [a] (1)	4.0 (2.5)	stream resident	CP	*	remnant population
Little Cottonwood Canyon Creek (2)	0.6 (1.0)	stream resident	HP	*	remnant population

White Pine Creek (1)	unknown	unknown	MP	*	status unknown
Red Pine Lake Creek (1)	unknown	unknown	MP	*	status unknown
Bell Canyon Creek [a] (1)	5.6 (3.5)	stream resident	MP	*	remnant population

[a] = isolated population
* = estimate not available
CP = Conservation Population
MP = Management Population
HP = Hybrid Population

In the Jordan River drainage, BCT are known to occupy 60.0 km (37.3 mi) which is approximately 60% of the estimated suitable stream habitat. For purposes of this review, potential stream habitat includes known stream habitat that may be suitable for BCT and does not include stream sections that have been permanently altered or dewatered such that fish inhabitance is not possible. Most areas like this are reaches that have been piped, channelized or otherwise controlled through urban and residential communities of Salt Lake City.

This drainage contains 5 streams with remnant BCT Recent surveys indicate that, where they are found, BCT are common in abundance and are successfully recruiting. These BCT populations are stream residents with some adfluvial fish associated with the reservoirs. Connectivity amongst streams in this drainage is very low making these BCT populations susceptible to genetic and/or catastrophic loss. Past and present stocking of nonnative fishes including RBT, YCT, and BKT has resulted in the existence of these species in several streams in this drainage. However, genetic and meristic analyses indicate that little hybridization has occurred. The majority of these streams are managed as conservation populations.

American Fork Drainage (Utah Lake/Provo River)

Table 33. Waters containing BCT in the upper American Fork drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	**SL**	**LH**	**CS**	**DN**	**PS**
American Fork River, North Fork, Sect. 2,3 (1)	9.7 (6.0)	stream resident	CP	579-1031 (360-641)	remnant population
American Fork River, North Fork, Sect. 1 (1)		stream resident	CP	362 (225)	remnant population

* = estimate not available
CP = Conservation Population

In the American Fork drainage, BCT are known to occupy 9.7 km (6.0 mi) which is approximately half of estimated suitable stream habitat in the basin. All suitable habitat is within American Fork Canyon. The American Fork River becomes channelized and is diverted as it nears the mouth of American Fork Canyon. There is currently no potential habitat for BCT in the American Fork River through Provo Valley.

Recent surveys conducted on the remnant BCT on the North Fork American Fork River indicate they are common in abundance and are successfully recruiting. Connectivity amongst streams in

this drainage is limited leaving these BCT populations susceptible to genetic and/or catastrophic loss. Past and present stocking of nonnative fishes including RBT and BKT has allowed them to persist throughout the drainage. Although genetic and meristic analysis have not been conducted, phenotypic evaluation by local biologists indicated hybridization between BCT and RBT is present throughout the drainage. Despite the presence of some nonnative fishes and hybridization, the North Fork American Fork River is managed as a conservation population, because these BCT represent remnant BCT stock from this drainage. Although there are no current plans for removal of nonnatives, no stocking occurs in the North Fork, and BCT and its habitat is protected or improved where possible.

Provo River Drainage (Utah Lake/Provo River)

Table 34. Waters containing BCT in the Provo River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SM	LH	CS	DN	PS
Soapstone Creek (1)	unknown	stream resident	CP	177 (110)	remnant population
Rock Creek (1)	unknown	stream resident	CP	29.0 (18.0)	remnant population
Provo River, North Fork (2-3)	unknown	stream resident	MP	25.7 (16.0)	remnant population
Provo River, Upper North Fork (1)	unknown	stream resident	CP	*	remnant population
Boulder Creek (1)	unknown	stream resident	CP	75-492 (47-306)	remnant population
Provo River, Upper South Fork (1)	2.3 (1.5)	stream resident	CP	*	remnant population
Provo River, Little South Fork (2)	10.9 (6.8)	stream resident	CP	597 (371)	remnant population
Bench Creek (1)	3.2 (2.0)	stream resident	CP	*	remnant population
Main Creek, Section 2 [a] (1)	2.4 (1.5)	stream resident	MP	*	remnant population

[a] = isolated population
* = estimate not available
CP = Conservation Population
MP = Management Population

In the Provo River drainage, BCT are known to occupy 16.5 km (10.3 mi) which is about 20% of the estimated suitable stream habitat in the basin. These streams contain remnant BCT populations. Recent surveys indicate that BCT exhibit a stream resident life strategy and are typically common in abundance with good recruitment. The drainage is relatively well connected with most streams being connected to up to 3 other populations. Past and current stocking of nonnative fishes has distributed RBT, BNT, BKT, and YCT throughout the Provo River drainage. These species likely present a significant threat to BCT in these streams. However, genetic and meristic testing to date has indicated little hybridization in BCT, and BCT seemed to have persisted in the presence of this long-term stocking. Where BCT persist, populations are managed as conservation populations. However, management populations also occur in this drainage in areas that experience substantial angling and recreation pressure.

Although the Provo River and Utah Lake historically contained a lacustrine and adfluvial form and provided the type-locality for the original description of BCT, only headwater stream resident forms remain. Due to dewatering, overharvesting from commercial fishing and nonnative stocking, lower portions of the Provo River and Utah Lake no longer sustain adfluvial or lacustrine BCT. Current water quality conditions and numerous nonnative sportfish species such as white bass in Utah Lake and the delta of the Provo River preclude any restoration of BCT into Utah Lake in the near future, despite the historic value of the Utah Lake BCT to the pioneer communities and the uncommon lake forms of BCT.

Hobble Creek (Utah Lake/Provo River)

Table 35. Waters containing BCT in the Hobble Creek drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Hobble Creek, Right Fork (2)	9.6 (6.0)	stream resident	MP	93.3 (58.0)	remnant population
Wardsworth Creek (1)	6.4 (4.0)	stream resident	CP	*	remnant population
Hobble Creek, Left Fork (1)	16.0 (10.0)	stream resident	CP	*	remnant population

* = estimate not available
CP = Conservation Population
MP = Management Population

In Hobble Creek, a small watershed draining a central portion of the western face of the Wasatch Mountains in the Provo Valley drainage, BCT are known to occupy 32.0 km (20.0 mi) which is almost all of the estimated suitable stream habitat in the drainage. Recent surveys indicate that these remnant BCT exhibit a stream resident life strategy and are typically common in abundance. BCT are successfully recruiting in the Left Fork Hobble and Wardsworth Creeks but not in the Right Fork Hobble Creek.

There is high connectivity within this relatively small drainage with the 3 populations able to readily intermix. RBT are currently stocked in the Right Fork of Hobble Creek, potentially hybridizing with BCT in this drainage. Genetic and meristic testing is in progress to determine the purity status of BCT in the drainage. The Right Fork of Hobble Creek is treated as a management population because of the emphasis on RBT. Despite the potential for RBT to move into Wardsworth and the Left Fork of Hobble Creeks, these streams are managed as conservation populations. Results of genetic testing will provide information to support future endeavors to discontinue RBT stocking or to construct a barrier to protect upstream reaches.

Spanish Fork River (Utah Lake/Provo River)

Table 36. Waters containing BCT in the Spanish Fork River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS

Soldier Creek (2)	unknown	stream resident	potential CP	*	remnant population
Soldier Creek, South Fork (1)	unknown	stream resident	potential CP	*	remnant population
Bennion Creek (1)	11.2 (7.0)	stream resident	HP	*	remnant population
Tie Fork Creek (1)	unknown	stream resident	potential CP	25.7 (16.0)	remnant population
Lake Fork Creek (1)	unknown	unknown	MP	*	remnant population
Nebo Creek (2)	unknown	stream resident	CP	512 (318)	remnant population
Holman Creek (1)	unknown	stream resident	CP	*	remnant population
Beaver Dam Creek (1)	unknown	unknown	MP	*	status unknown
Bennie Creek (1)	unknown	unknown	MP	*	status unknown
Trout Creek (1)	unknown	unknown	MP	*	status unknown
Diamond Fork Creek (2)	unknown	unknown	MP	*	status unknown
Shingle Mill Creek (1)	unknown	stream resident	potential CP	*	remnant population
Chases Creek (1)	unknown	stream resident	potential CP	*	remnant population
Hall's Fork Creek (1)	unknown	stream resident	potential CP	*	remnant population
Sixth Water Creek (1)	unknown	stream resident	potential CP	*	reintroduction (Red Butte Res.)
Fifth Water Creek (1)	unknown	stream resident	potential CP	*	remnant population
Wanrhodes Creek (1)	3.2 (2.0)	stream resident	HP	*	remnant population
Little Diamond Fork Creek (1)	unknown	stream resident	potential CP	*	remnant population

* = estimate not available
CP = Conservation Population
HP = Hybrid Population

In the Spanish Fork drainage, BCT are known to occupy 14.5 km which is less than 10% of the estimated suitable stream habitat in the basin. BCT are known to occur throughout the drainage; however little is know as to the specific distribution and status of these populations. Therefore, it is possible that future surveys could identify BCT populations throughout this drainage. Past surveys indicate that known populations of BCT in the Spanish Fork drainage exhibit a stream resident life strategy. The presence of self-sustaining BCT populations indicate that recruitment is successful.

The Spanish Fork drainage is a relatively extensive drainage with a mixture of developed and undeveloped subdrainages. Sixth Water, a tributary to the Diamond Fork River in the Spanish Fork systems, receives water from the Strawberry River watershed in the Colorado River basin via a trans-basin diversion tunnel. In addition to altering the natural hydrology, it may be possible for nonnative fish from the Colorado River basin to pass through this waterway. Also, a wild population of BNT and RBT have become established in the Diamond Fork River. Local wildlife managers have focused efforts on surveys in the Spanish Fork drainage to learn more about BCT status and anticipate that this drainage provides excellent opportunity for restoration

of an extensive metapopulation of pure BCT.

Due to substantial historic and current stocking by UDWR, nonnative RBT and BNT are present throughout the drainage, and hybridization has been noted in at least 2 BCT populations. However, phenotypic evaluation by local biologists indicates that BCT in the more headwater reaches could be pure BCT. Genetic and meristic analyses of populations throughout the drainage are scheduled for upcoming years. The UDWR has plans to restore a large metapopulation in the Spanish Fork drainage and are currently in the process of gathering population, habitat, and genetic information that will guide future conservation actions of this drainage. Local biologists indicate that reintroduction efforts will begin when an appropriate source of BCT becomes available and purity of these populations is assessed.

Activities Threatening Long Term Persistence of BCT in the NGU

A. The Present or Threatened Destruction, Modification, or Curtailment of the Species' Habitat or Range.

Habitat degradation from multiple sources is a significant threat to BCT populations in the NGU. Central to habitat losses in this region is the close proximity of many streams in the NGU with urban areas along the Wasatch Front, the most densely populated area of in the range of BCT. The greatest threat to habitat in this GU is water development. Water diversions and dams that collect and distribute water for agriculture and municipal use have resulted in serious water losses from individual streams and drainages. A further result of dams and diversions in the NGU has been significant stream fragmentation, particularly in alluvial reaches when the stream leaves the high gradient canyons. Dewatered reaches, culverts, and other barriers have decreased available stream miles in most systems along the Wasatch Front. Major reservoirs on the Ogden River (Pineview), Weber River (Rockport and Echo) and Provo (Jordanelle and Deer Creek) have eliminated many miles of stream habitat, altered habitat conditions downstream and provide a source of nonnative fish species.

Water quality has been significantly decreased in localized areas due to problems associated with urban pollution (i.e. chlorine, zinc), reservoirs, and to a lesser extent mining. Historically, mining activities ranged throughout the Wasatch Mountains and many modern ski villages were originally mining communities. The main impact resulting from mining is impaired water quality by addition of heavy metals as water infiltrates mine tailings. Heavy metals have been identified as a potential problem in Little Cottonwood Canyon Creek, a main water source for Salt Lake City. However, the affects of heavy metals on the persistence of BCT are not known.

Other activities such as timber harvest, grazing, and recreation constitute substantial threats in localized areas. Although timber and grazing do not have the catastrophic impacts on watersheds they once did, these activities can still cause localized problems where regulations and implementation directions are not adequate or not adequately enforced. Grazing has been practically eliminated from the forest lands near urban areas. However, private agricultural and ranching activities in the Weber, Ogden and Spanish Fork drainages, such as in the Chalk Creek sub-drainage or along the Weber River below Echo Reservoir, have resulted in some localized impacts. In particular, loss of riparian vegetation, stream channel widening and loss of instream structural complexity is apparent in some agricultural or ranching lands.

Heavy impacts from recreation along the Wasatch Front on the east side of the Salt Lake Valley, is the result of picnicking, camping, hiking, and other recreational activities. The Salt Lake Ranger District of the Wasatch-Cache National Forest receives more than 5 million visitors each year. Other districts of the Wasatch-Cache National Forest receive heavy recreational traffic as well, particularly near the Mirror Lake Highway on the western end of the Uinta Mountains.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Commercial fishing is deemed one of the main reasons for the extinction of BCT from Utah Lake; however this industry ended when the fish became extremely low in numbers in the early 1900s. By the 1930s, BCT were extinct from Utah Lake. Over-fishing was also a problem in urban streams in the Salt Lake Valley. Water development and habitat destruction compounded problems from over-fishing. Today, streams within the Salt Lake Valley generally are not capable of sustaining healthy fish populations because of restricted habitat and flows.

Overutilization is no longer considered a primary threat to BCT in the NGU. However, much of this region exists in close proximity to urban areas and pressure from anglers can be acute along localized stream sections and lakes with direct public access. Where fishing pressure is heavy, frequent stocking is necessary to maintain a fishery. Stocking can occur on a weekly basis in a few highly used areas. Such public pressure can preclude conservation activities for BCT in these streams.

C. Disease or Predation

Whirling disease has been recently discovered in the Ogden, Weber, and Provo River sub-basins. Although a significant risk, it has not yet manifested itself through widespread mortality of fish in these drainages. The potential threat of this disease spreading further into native fish populations is greatly reduced by established procedures and protocols that require disease certification for transplanting live fish. In some areas, native cutthroat trout, by nature of their life-strategy, are not affected by whirling disease.

Whirling disease has been introduced through stocking of infected hatchery fish or through transportation of spores on animals or equipment. Because whirling disease attacks the cartilage present in young fish, adult fish are generally not susceptible to the detrimental affects. Therefore, if BCT exhibit a fluvial life stage, migrating into inaccessible headwater reaches to spawn, young BCT are not exposed to the spores that cause whirling disease present in lower reaches where hatchery fish have been stocked. It will take time and research to understand the full impacts of whirling disease on BCT.

Predation by nonnative salmonids (BNT or RBT) is a potential threat where wild populations of these nonnative fish have become established. Although the presence of BNT and RBT may prevent BCT from recolonizing or being restored to certain reaches or systems, predation is not considered a threat to the persistence of BCT in the NGU.

D. Inadequacy of Existing Regulatory Mechanisms

BCT populations do not appear to be threatened by any inadequacies in existing federal, state, or local regulatory mechanisms in this NGU. One exception may be the continued stocking of nonnative salmonids into streams that contain pure BCT. Long-term protection of BCT depends

on the continued appropriation of funding and commitment of the local management or regulatory agencies to fulfill their responsibilities and enforce regulations on wildlife and land use.

E. Other Natural or Manmade Mechanisms

As a result of current and historic stocking, nonnative fishes including BNT, BKT, RBT, Kokanee salmon, and other warmwater species have become established in the NGU. While genetic and meristic testing has determined many BCT populations in this region to be pure and persisting in the presence of nonnatives, hybridization has been detected in some streams within each of the five major drainages of the NGU. In some cases, stream fragmentation has protected BCT in upper reaches. In other cases, BCT appear to coexist with RBT without being genetically swamped. If stocking of RBT or other nonnative cutthroat trout were to increase, eventual loss of some BCT populations could occur. However, current trends in State stocking are for decreased RBT stocking or stocking of RBT only into areas where BCT conservation is not a priority.

Hybridization remains one of the main threats to the persistence of BCT in the NGU. Although current trends by the States in reducing RBT stocking have lessened the severity of this threat overall, there are still many opportunities to further reduce this threat through removal of RBT or discontinued stocking of RBT.

Conservation Actions

A. Population and Genetic Investigations:

The NGU is somewhat unique in that many streams have yet to be investigated for the presence and status of BCT. It is possible that the total occupied area of BCT in this GU could be expanded significantly through additional population surveys and genetic analyses. Each year, anywhere from 10 to 50 streams or stream reaches have been surveyed for presence of BCT and for assessment of habitat. Previously unexamined streams are surveyed each year. In addition, when data becomes obsolete, new surveys are conducted. Managers have been focusing on completing survey information for stream systems that may have BCT and have potential for conservation management. Future conservation actions will continue to focus on population surveys until stream surveys are complete for the NGU.

Detailed surveys describing the status and distribution of known BCT populations are ongoing. In addition, BCT samples from several streams in this drainage are awaiting genetic analyses to determine purity.

B. Range Expansion

Expansion of BCT populations through reintroductions has not been as extensive in the NGU as in other areas mainly because it is thought that remnant BCT still exist in many unexplored drainages. However, when surveys are complete and priority drainages are identified, some areas can be identified for removal of nonnatives and restoration of BCT. Currently, 17.6 km (11 mi) of stream habitat in Kilfoil, Hell Canyon, and Guildersleeve Creeks has been identified as potential BCT reintroduction areas. At this time, the first priority of the NGU is comprehensive surveys to document the specific status of BCT in previously unexplored drainages.

C. Habitat Restoration

The USFS has been actively involved in habitat and population surveys over the past decade. Surveys have been completed on over 80% of the streams in the NGU on the Wasatch-Cache National Forest. Habitat is assessed on a gross scale until priority drainages can be determined. Many specific watershed improvements and stream restoration activities that have already been completed. Riparian improvements, including road and campsite removals and bank stabilization, have occurred on Mill, Big Cottonwood, and Little Cottonwood Creeks and on the Ogden River. Instream flow requirements have been identified with water diversions on Big Cottonwood, Little Cottonwood, Wheeler, and Parrish Creeks. Additional restoration projects include road closures and construction of instream habitat structures or barriers to prevent immigration of nonnative salmonids.

D. Disease Control

State disease certification standards provide some level of protection against transference of disease through transplanted or introduced fish.

Conclusion

Currently, more than 730.7 km (452.3 mi) of stream habitat is occupied by approximately 141 BCT populations in the NGU. It is important to note that numerous BCT populations have either not been surveyed or are awaiting genetic analyses to determine purity. Many waters of the NGU are either scheduled for or have recently undergone BCT population surveys. Until these surveys are complete, the status of BCT in this GU cannot be fully known.

In the 1980s, wildlife managers knew of only a handful of pure BCT populations in the NGU and most cutthroat populations were suspected as being hybridized such that the original BCT stock was effectively lost. Today, there are more pure remnant BCT populations than in any other GU. In addition, it appears, from preliminary reports, that additional pure BCT populations exist. There are some localized problems with water development, degraded habitat and potential hybridization with RBT, and with stocking of nonnative salmonids; however the trend has been for increasing BCT populations in this GU.

Recommendations

Based on this summary, the Service recommends the following to further promote BCT in the Northern GU:

1) Continue to conduct surveys so that a comprehensive assessment of BCT among these drainages can be done and priority drainages, within which conservation actions should be focused, can be identified.

2) Stock BCT rather than RBT or BKT into appropriate stream reaches. By stocking BCT, UDWR can promote the sportfish and native species value of BCT while further reducing known threats. This action would be most appropriate where nonnative salmonid stocking continues in waters that are connected to areas occupied by pure BCT populations.

3) Continue cooperation with private and Federal land-owners in identifying and correcting habitat problems along streams that contain pure BCT (i.e. Chalk Creek).

4) Make conservation of pure BCT populations a priority in the planning, permitting and construction of future water development projects in the NGU.

Western Geographic Unit

Description of Geographic Unit

The Western Geographic Unit (WGU) encompasses the western portion of the Bonneville Basin known as the Snake Valley Arm. This region runs through west-central Utah and east-central Nevada near the border of the two states. When pluvial Lake Bonneville water levels dropped, the Snake Valley Arm population of BCT became isolated from the rest of the Basin (Behnke 1976). Thus the Snake Valley or Western Bonneville population of BCT has been geographically isolated from eastern populations for at least 8,000 years.

Streams elevations in the WGU range from more than 1830-2750 km (6000-9000 ft). The vegetational community is characterized at higher elevations by typical high mountain subalpine evergreen forests, while pinyon-juniper, sagebrush and grassland deserts dominate lower elevations. Riparian areas contain mainly aspen and birch (Lentsch et al.1997). Because of the desert climate, most streams draining the local mountains are small and/or ephemeral, commonly flowing subterranean before reaching the valley floor. There are no major river drainages in this GU.

Today, BCT are found only in the Deep Creek Range, Utah, and the Snake Range, Nevada, with scattered additional populations in adjacent ranges (Haskins 1999, Lentsch et al. 1997). Other mountain ranges in the western Bonneville basin of Utah have limited available habitat and probably did not contain BCT. Land ownership in the WGU is about 26% USFS including the Humboldt-Toiyabe National Forest, 20% BLM in Nevada and Utah, 24% NPS (Great Basin National Park), 23% Tribal (Confederated Tribes of the Goshute Reservation), and 7% private. Management of BCT is the responsibility of NDOW, UDWR, NPS, and the Goshute Tribe in cooperation with the Service. However, the BLM and USFS also take active roles in both land use and BCT management. The Great Basin and Southern Nevada Chapters and the Utah and Nevada Councils of Trout Unlimited have also been an active cooperators on BCT conservation activities in the WGU.

Background

BCT likely had access to and are assumed to have been present in all suitable perennial waters during the highest levels of ancient Lake Bonneville (Behnke 1992). In addition, historic references indicate that trout were common in many perennial stream reaches in the WGU (Behnke 1976, Hickman 1978, Cope 1955). Duff (1996) states that BCT currently are found in less than 1% of the estimated historical stream length in the WGU. This estimate is based solely on available water bodies and does not consider potentially fishless streams. Despite the possibility of some fishless drainages, there is no doubt that a substantial decline has occurred BCT populations throughout the WGU.

Population Status

Nevada

Several opinions exist as to the extent of the native range of BCT within the State of Nevada. According to the Nevada Division of Wildlife and identified in the State's 1987 Bonneville

Cutthroat Trout Species Management Plan (Haskins 1987), the historic range included the Bonneville Basin drainages along the eastern border area of the state, including the east slopes of the Snake and Goshute, the Pilot Peak Ranges, and the Thousand Springs Creek drainage. However, the only portion of these ranges with documented historic BCT presence is the Snake Valley drainage. Currently, the only known Nevada BCT populations are limited to the Deep Creek and Snake mountain ranges. Nevada formerly classified the BCT as a "state sensitive" species but in 1995 this designation was dropped, and BCT is currently only classified as a sport fish with no special harvest restrictions.

While we cannot know with certainty which streams supported BCT prior to European settlement of the west, historical records reference BCT populations in the Snake Valley of Nevada in Lehman and Hendry's Creeks on the east side of the Snake Range and in a couple creeks in the Deep Creek Range (Haskins 1999). Hybrid trout populations exhibiting cutthroat trout characteristics currently exist in several other streams in eastern Nevada, however, it is unclear whether these represent remnant populations of BCT, transplanted populations or remnants of other transplanted cutthroat subspecies. Generally, it is assumed that all perennial streams in the Snake Valley Basin had the potential to contain BCT.

There are currently five established BCT populations in Nevada: Hendry's Creek on the east side of the Snake Range, considered the only remnant population in the state; Pine and Ridge Creeks, (considered one population) on the west side of the Snake Range, in an interior drainage; Hampton Creek on the east side of the Snake Range consisting of an reintroduced population from Pine and Ridge Creeks; Goshute Creek which is located in the interior drainage of Spring Valley outside of the Bonneville Basin and is an introduced population from Pine and Ridge Creeks and; Mill Creek on the east side of the Snake Range consisting of remnant BCT recently found to be genetically pure despite the presence of nonnative trout.

Efforts to establish additional populations of BCT in the WGU are ongoing. Deep Creek (Quinn Mountains) was chemically rehabilitated and stocked with BCT from Goshute Creek in 1999 but the status of this population is uncertain at this time. Smith Creek (Snake Valley Drainage) and its tributaries Deadman and Deep Canyon Creeks were chemically treated for the purpose of reintroducing BCT. BCT from Hendry's Creek were stocked into Deadman Creek in 1997-1999 and in Smith and Deep Canyon Creeks in 1999. BCT from Mill Creek were stocked into Big Wash Creek in 2000. Additional transplants are planned for these streams in 2000-2002, or until a viable populations are established.

East Slope Snake Valley Range

Table 37. Present and potential BCT waters on the east slope of the Snake Valley Range with total occupied stream length in km (mi) or *surface area* of water body in *hectares (acres)* (SL/*SA*), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	**SL/*SA***	**LH**	**CS**	**DN**	**PS**
Mill Creek[a] (1)	2.9 (1.8)	stream resident	CP	644 (400)	remnant population
Hampton Creek[a] (1)	5.6 (3.5)	stream resident	CP	805-1609 (500-1000)	reintroduction (Pine and Ridge Creeks 1953)

Hendry's Creek[a] (1)	11.2 (7.0)	stream resident	CP	241-644 (150-400)	remnant population
Smith Creek (2)	3.2 (2.0)	stream resident	CP	*	reintroduction into upper reaches (Hendry's Creek 1999)
Deadman Creek (1)	4.0 (2.5)	stream resident	CP	*	reintroduction (Hendry's Creek 1997)
Deep Canyon Creek (1)	unknown	unknown	CP	*	reintroduction (Hendry's Creek 1999)
Big Wash Creek (2)	12.9 (8.0)	stream resident	CP	*	reintroduction (Mill Creek 2000)

[a] = isolated population
* = estimate not available
CP = Conservation Population
MP = Management Population

In the east slope Snake Valley region, BCT are known to occupy 26.9 km (16.8 mi). According to evaluations by local managers, BCT inhabit approximately 50% of the streams in this region. Other streams in this region are targeted for future reintroductions (See Conservation Actions) or are managed as nonnative sport fisheries. Mill Creek is located within GBNP. Hendry's Creek and Mill Creek are the only remaining remnant BCT populations in Nevada. Ranging from rare to abundant among streams, these BCT populations are highly variable. BCT populations in this drainage exhibit a stream resident life-strategy and successfully recruit under suitable conditions. However, RBT and BKT have established wild populations in many streams due to intensive stocking programs. Despite the presence of these nonnatives, genetic and meristic analyses indicate that BCT populations are not severely hybridized and in some cases, not hybridized at all where BCT occur with nonnative salmonids. The BCT populations within the Snake Range are currently small and fragmented, thus making them vulnerable to natural catastrophes such as floods.

West Slope Snake Valley Range

Table 38. Present and potential BCT waters on the west slope of the Snake Valley Range with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	**SL**	**LH**	**CS**	**DN** ***1984 estimates***	**PS**
Pine and Ridge Creeks[a] (1)	3.2 (2.0)	stream resident	CP	*665 (413) in Pine 509 (316) in Ridge*	introduction from unknown source

[a] = isolated population
* = estimate not available
CP = Conservation Population

This is a small isolated stream system outside of the Bonneville Basin with 6.4 km (4 mi) of suitable stream habitat of which BCT are known to occupy 3.2 km (2 mi). The origin of this BCT population is unknown but they are suspected to have been either stocked into this system by early settlers or have traveled via the Osceola Ditch, constructed in the 1890s, which flows from Lehman Creek on the east slope of Mt. Wheeler within the Bonneville Basin to the west slope which is out of the Bonneville Basin (Williams et al. 1999). BCT densities are considered common to abundant although this stream is very small and affected by drought and grazing. Due to the high gradient and "step-pool" habitat configuration, fish in upper reaches this stream are sometimes eliminated in certain reaches during high flows or periodic spates. A stream

resident life-strategy is exhibited by these BCT, and recruitment is considered successful based on intermittent sampling and persistence of a wild population. Nonnative salmonids have not been stocked into these streams, and genetic and meristic analysis indicate that BCT in these streams are pure. Although considered an out-of-basin population, this stream contains a known pure BCT population, used as a source for transplanting BCT for conservation and because it is undocumented as to whether BCT were stocked into these streams intentionally or moved in through a human-made ditch.

Steptoe Valley

Table 39. Present and potential BCT waters that drain into the Steptoe Valley with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
Goshute Creek [a] (Cherry Creek Range)(1)	6.4 (4.0)	stream resident	CP	*	transplant (Pine and Ridge Creeks 1960)
Deep Creek [a] (Quinn Canyon Range)(1)	>1.6 (1.0)	stream resident	MP	80.5 (50.0)	recent transplant (Goshute Creek 1999)

[a] = isolated population
* = estimate not available
CP = Conservation Population
MP = Management Population

Goshute Creek is an isolated stream found outside of the Bonneville Basin adjacent to the Snake Valley. Deep Creek, also outside of the Bonneville Basin, is found in the Quinn Canyon Range, on the Humboldt-Toiybe National Forest, in southwestern Nevada in the Railroad Valley interior basin. BCT inhabit greater than 7.0 km (5.0 mi) which constitutes nearly all of the estimated suitable habitat in these streams. Goshute Creek, which drains from the east slope of the Cherry Creek Range on BLM lands, has a population of BCT that was established in1960 as part of an effort to preserve BCT from the drought-vulnerable Pine and Ridge Creeks. Deep Creek was established in 1999 using BCT from Goshute Creek.

The NDOW BCT species Management Plan 1987, as amended, proposed out-of-basin transplants in streams with adequate flow and habitat conditions in an effort to secure the unique local Snake Valley BCT genetic and phenotypic type in Nevada. Streams with adequate flow and habitat conditions are not common in the western desert, which is why out-of-basin transplants, like Deep Creek, were selected. Although these out-of-basin streams are not considered to contribute towards the natural persistence of BCT within its native range, where they are not displacing or preventing restoration of other native species, such out-of-basin populations can be valuable for establishing brood sources where in-basin stream preclude reintroductions (due to lack of flow, nonnative presence or socio-political obstacles), and/or in creating public interest or support. The implementation of the GBNP Cutthroat Trout and Fisheries Management Plan (Williams et al. 2000) which proposes to reestablish six BCT populations in the GBNP eliminates the urgency for out-of-basin populations. Currently, no additional out-of-basin introductions are planned as concentrated interagency efforts will focus on waters within the Bonneville Basin.

Although historically stocked with RBT and YCT, nonnative fishes are currently absent from Goshute Creek. Until the Summer of 2001, Goshute Creek contained an abundant, self-sustaining, resident population of BCT. It is believed that unexpected high flows in Summer of 2001 may have washed most of the fish downstream into the flats. BCT were introduced into Deep Creek in the Quinn Canyon Range in 1999. Although the out-of-basin status of these populations precludes their standing as conservation populations, they are pure fish and add to known populations within BCT native range.

UTAH

The only BCT habitat, historic or current, in western Utah's Bonneville drainage exists in small streams draining the relatively steep, small Deep Creek mountain range (Lentsch et al. 1997) . Other mountain ranges in the western Bonneville basin of Utah have limited available habitat and may have contained BCT but are currently populated by nonnative trout.

The streams in the Deep Creek mountains flow down to the desert valley where they historically flowed into marsh or wetland habitat in the southern Great Salt Lake Desert sub-basin. Currently, many of the streams are diverted at where they flow out of canyons for agricultural use. The BCT habitat on the east slope of the Deep Creek mountains is considered to be in good to excellent condition. The remoteness and isolation of these mountains has kept fishing pressure relatively low. Historic stocking of nonnative RBT has greatly reduced the range of pure BCT located in the Deep Creek mountains. Two remnant populations of pure BCT exist in Trout and Birch Creeks. These populations have been used to reintroduce BCT to additional waters of the Deep Creek mountains. The UDWR has been working for 20 years to expand this small isolated population but their efforts have often been hindered by several unauthorized reintroductions of RBT.

Deep Creek Range - East Slope

Table 40. Present and potential BCT waters that drain the east slope of the Deep Creek Range with total occupied stream length in km (mi) or *surface area* of water body in *hectares (acres)* (SL/*SA*), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	**SL/*SA***	**LH**	**CS**	**DN**	**PS**
Basin Creek [a] (1)	3.2 (2.0)	stream resident	HP	*	remnant population
Thom's Creek [a] (1)	10.8 (6.3)	stream resident	CP	*	reintroduction (Trout Creek)
Indian Farm Creek [a] (1)	8.0 (5.0)	stream resident	HP	*	remnant population
Granite Creek [a] (1)	3.2 (2.0)	stream resident	CP	*	reintroduction (Trout Creek 2000)
Trout Creek [a] (1)	9.8 (6.1)	stream resident	CP	1931 (1200)	remnant population
Birch Creek [a] (1)	9.0 (5.6)	stream resident	CP	1287 (800)	remnant population (supplemented by Trout Creek)
Douglass Pond [a]	*0.2 (0.5*)	not applicable	CP	*	brood stock ponds

[a] = isolated population
* = estimate not available

CP = Conservation Population
HP = Hybrid Population

On the east slope of the Deep Creek Range, BCT are known to occupy 44.0 km (27.0 mi) of stream habitat which is over half of the estimated suitable habitat in the region. This area includes two remnant populations of BCT found in Trout and Birch Creeks. Trout Creek contains a healthy remnant population and is used as a source for reintroductions of BCT into other western Bonneville streams. These BCT are stream resident form BCT and based on ongoing monitoring are common in abundance. Due to historic stocking, Basin and Indian Farm Creeks in this drainage contain nonnative RBT or RBT/BCT hybrids. The remaining streams are reintroduced populations of pure BCT from Trout Creek. Fragmentation is of particular concern as BCT populations in this area reside in small, isolated stream reaches due to naturally low flows that either flow subterranean when they reach the valley or are diverted by local farmers. Although Birch Creek is a tributary to Trout Creek, they are connected only via an irrigation canal and migration is presently impossible. In addition to these streams, a brood source of BCT has been established in a local land-owners pond, known as Douglass' Pond. BCT in this pond have been used to supplement reintroduced populations.

Confederated Tribes of the Goshute Reservation
(Deep Creek Range-West Slope, Spring Creek Mountains)

Table 41. Present and potential BCT waters located on the Confederated Tribes of the Goshute Reservation with total occupied stream length in km (mi) or *surface area* of water body in *hectares (acres)* (SL/*SA*), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	**SL/*SA***	**LH**	**CS**	**DN**	**PS**
Fifteenmile Creek (2) and pond	16.0 (10.0)/ *0.4 (1.0)*	stream resident	CP	*	introduction into pond (FifteenmileCreek 1999)
Spring Creek [a] (1) and Nelm's Pond	9.6 (6.0)/ *0.2 (0.5)*	stream resident	CP	<3219 (<2000)	reintroduction (Birch Creek 1997)

[a] = isolated population
* = estimate not available
CP = Conservation Population

On the Confederated Tribes of the Goshute Reservation, BCT are known to occupy 25.6 km (16.0 mi) which is small proportion of the estimated suitable stream habitat in this area. Limited distribution of BCT is primarily due to historic stocking which resulted in the widespread occurrence of RBT and/or BCT/RBT hybrids. However, reintroductions are planned for the remainder of the suitable streams in this area (See Conservation Actions). Fifteenmile Creek drains the east slope of the Deep Creek range. An artificial pond, Nelm's Pond, constructed in the fall of 1998 and spring of 1999 on Fifteenmile Creek helps managers oversee stream side spawning and pond rearing of BCT. Spawning and rearing is actively managed by the Goshute Tribe in cooperation with the Service and TU. This spawning and rearing system is intended to provide a brood source of pure BCT to be used in future reintroductions of BCT into additional streams on Reservation lands.

The South and Deep Creek mountains form a V-Shaped valley where Spring Creek drains off and subsequently flows into Fifteenmile Creek near the Utah and Nevada border. BCT from Birch Creek on the East Slope were transplanted into Spring Creek in 1997. This stream is extremely productive as evidenced by dense instream vegetation and abundant BCT averaging 2000 fish per mile near the spring head. Productivity quickly drops off as the substrate becomes cemented due to high concentrations of calcium carbonate in the water. Ten miles below the spring head, fish densities were measured at just eight fish per mile. Based on annual monitoring, Spring Creek BCT are noted as resident fish that exhibit successful recruitment. Nelm's Pond,with two constructed spawning area, provides spawning and rearing habitat. Adult BCT have been observed building redds in the spawning channel, sampling efforts have revealed that juvenile fish are recruiting into the resident population, and many fish are utilizing the streamside pond. BCT produced in Spring Creek are intended to be used as a brood source for BCT reintroductions and for supplementing new BCT populations throughout the Deep Creek Mountain area.

Although irrigation diversions, natural, and artificial barriers exist, Fragmentation is much less of a problem for these streams (versus other streams in the WGU) are not diverted for irrigation. Several streams without pure BCT at this time are scheduled for chemical renovation and reintroduction during upcoming years under management of the Goshute Tribe. Timing and implementation of reintroductions will depend on funding and availability of brood sources. Overall, the Goshute Tribe anticipates managing streams within their reservation boundaries for the long-term persistence of BCT.

Activities Threatening Long Term Persistence of BCT

A. The Present or Threatened Destruction, Modification, or Curtailment of the Species' Habitat or Range.

Present habitat conditions are considered fair to good throughout this portion of the Bonneville Basin (Duff 1996), however, specific threats have the potential to become severe in localized areas. Historically, mining was common and continues to be a potential concern given the mineral richness in the region, particularly in the Hampton Creek drainage where an open pit garnet mine was proposed and limited exploration occurred.

The fragmented nature, both natural and artificial, of stream habitat in this unit is probably the greatest threat to the persistence of these BCT populations. This is of particular concern considering that many of these streams are susceptible to potentially catastrophic natural flood and fire events that could easily decimate a population where no other connected BCT populations can recolonize the stream.

Recreation (roads, ATV use, camping) and water development, also can have significant impacts and place stresses on stream and riparian habitat in localized areas where use is heavy. Irrigation diversions and small hydroelectric uses continue to impact available and potential habitat. Instream flow depletions in have removed one to two miles of BCT habitat despite a BLM water right that provides flow for fish, wildlife, and livestock.

The WGU has a long history of intense and ubiquitous grazing. Although many problem areas have improved with increased regulation from land management agencies, habitat degradation still remains. Despite diminished use, the vulnerability and previously degraded condition of the

riparian area makes it difficult to restore the naturally healthy stream ecosystem. Areas where streams are impacted by cattle grazing include areas within the GBNP, Humboldt-Toiyabe National Forest and BLM lands near Mt. Moriah and Mt. Wheeler. Some streams such as Hendry's, Hampton, Smith, and Deadman Creeks experience localized heavy impacts particularly in their headwater reaches. In addition, the Confederated Tribes of the Goshute Reservation is considering grazing 1200 head of cattle on the reservation. Multiple agencies including the Natural Resource Conservation Service have warned that this number of cattle would be 150% over carrying capacity of the land. If this plan goes through, grazing will impact BCT restoration efforts even more.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

The threat of over-harvesting from angling pressure on existing BCT populations is not acute at this time. Most streams are fairly remote and inaccessible making overuse unlikely. In addition, strict angling regulations designed to protect pure BCT populations are in place throughout much of the region. While overutilization is not currently considered a widespread threat in the WGU, it will be considered in further conservation of BCT in this region.

Established nonnative fisheries, such as Baker Lake and Baker Creek in GBNP, are considered an important environmental resource. These populations are managed as sport fisheries by GBNP. However, native species will be given priority and preference in all waters in the Park. GBNPs currently approved plan provides for BCT conservation and management populations within the Park. Barriers and remote sites are present to allow BCT restoration to proceed; threats from nonnatives should be minimized by barriers.

A potential threat to BCT in this GU may be continued removal of BCT adults and eggs from specific streams for use in reintroductions and broodstock development projects. This could be a long-term problem for remnant populations which are the focus of such efforts until artificial brood sources can be better established (Lentsch et al. 1997). In recent years, significant progress has been made by UDWR in cooperation with private landowners on the east slope and the Service, TU, and the Goshute Tribe on the west slope of the Deep Creeks in establishing artificial brood sources so that remnant streams will not be needed as sources for reintroductions.

C. Disease or Predation

Whirling disease has not been found in the WGU. The potential threat of this disease spreading throughout the BCT range is greatly reduced by established procedures and protocols, such as disease certifications, that protects populations and requires approval for transplanting live fish. If a BCT broodstock program is to be developed, then all wild fish must go through a multi-year disease certification process before they can be used for production purposes at any Federal, State, or Tribal hatchery.

Predation has not been found to pose a significant threat to BCT in the WGU. However, due to the presence of BNT, BKT, and RBT through this GU, predation remains a potential threat and may hinder expansion and restoration of BCT into its native range.

D. Inadequacy of Existing Regulatory Mechanisms

Enforcement of grazing regulations is of concern in some areas of the WGU. In the Snake Valley, grazing regulations are in place to protect streams, riparian areas and watersheds; however, land management agencies have varying levels of personnel and time committed to ensuring these regulations are upheld in remote areas of the region.

There are no additional evident inadequacies in existing federal, state, or local regulatory mechanisms that affect BCT in this drainage. However, protection of BCT depends on the continued appropriation of funding and commitment of the local management or regulatory agencies to fulfill their responsibilities. Depending on management and protection of nonnative species in GBNP, these nonnatives may be a potential threat to BCT.

E. Other Natural or Manmade Mechanisms

As a result of extensive historical stocking, nonnative fishes including RBT, have become established throughout the WGU. While many BCT populations have been genetically and meristically determined to be pure, hybridization is considered a potential threat throughout the region. Nonnative species found in the drainage represent a continual threat to the survival and expansion of BCT in the region.

On the east slope of the Deep Creek Mountains, the local community and nonresident anglers have expressed their concern with renovation of streams where it means there will be fishless streams for a period of time. In some cases, restoration efforts, involving removal of nonnative salmonids, have been hindered by illegal reintroductions of nonnative salmonids (C. Thompson, pers.comm.). However, in the past few years, the local community has been more supportive of the BCT restoration efforts where local fish managers are willing to allow harvest in some streams or provide alternative fish sources until BCT populations can become established to the extent that they can sustain some angling harvest.

Social pressure from an unsupportive local community can reduce effectiveness of BCT efforts or completely prevent them. Commonly, such pressure is the result of either a fear of introducing a fish that could become federally protected, unwillingness of the community to tolerate loss of angling opportunity through renovation efforts that take multiple years, or preference of other sportfish like RBT, BKT or BNT.

In more popular and accessible areas, like the main Ogden River, nonnative salmonids have been stocked for decades and continue to be important to the local angling community. Where BCT continue to exist in these systems, they are considered important. However, these systems are managed for their value to the sportfishing community rather than for the long-term persistence of BCT. This means that management decisions could be made for optimal sport-fishing conditions first and BCT persistence, secondarily.

In small fragmented systems like these desert streams, flood and drought are considered substantial threats, particularly where BCT populations are not connected to other populations which could recolonize after a flood or drought. In addition, natural variation in demographic population parameters such as birth, survival and mortality rates can result in extinction where BCT populations are very small (Hilderbrand 2000). For such streams, it may be important to

regularly monitor and stock BCT populations to prevent extinction.

Conservation Actions

The UDWR developed and signed a Conservation Agreement and Strategy (Agreement) with six other resource agencies, including the Confederated Tribes of the Goshute Reservation, to protect the long-term persistence of BCT. This Agreement, describes that will occur in the WGU. These efforts include removal of nonnative salmonids and reintroduction of pure BCT into their native waters. These efforts have been underway for over a decade, but the Agreement has increased awareness and inter-agency cooperation to ensure that activities are successfully implemented.

The NDOW is in the process of developing a statewide interagency Conservation Agreement and Strategy (Agreement) for BCT. Other involved parties include GBNP, the USFS, BLM and the Service. A draft of this Agreement identifies numerous actions that will be taken in the future or have already been initiated to minimize or eliminate any threats and to ensure the longterm conservation of BCT in Nevada. These actions include: collecting baseline BCT population and habitat conditions; determining and maintaining genetic integrity; enhancing, maintaining and protecting habitat; selectively controlling nonnative species; expanding BCT populations and range through introduction or reintroduction from transplanted wild stock or other methods; monitoring populations and habitat; and developing mitigation protocols for proposed water development and future habitat alteration, where needed. Numerous projects have already been initiated to expand the range of BCT in Nevada. Included in these actions are the eradication of nonnative species in the following streams; Smith, Deadman, and Deep Canyon Creeks. Once eradications are deemed successful, BCT will be transplanted into these creeks, all three of which occur in the northern Snake Range within the historic range of BCT.

Numerous additional streams have been proposed, in Nevada's Bonneville Cutthroat Trout Species Management Plan (Haskins 1987) and the Great Basin National Park Bonneville Cutthroat Trout Reintroduction and Recreational Fisheries Management Plan (Williams et al. 1999), for chemical renovation and reintroductions of BCT. These streams include; Strawberry, Mill, Big Wash, South Fork Baker, Lehman, and Snake Creeks. Each of these occurs in the southern Snake Range and currently contains a variety of hybridizing or competitive salmonids which were historically introduced. Also, the Park recently worked with ranchers and The Nature Conservancy to retire grazing permits on Strawberry Creek.

As part of the NDOW Conservation Agreement, but also more specifically within GBNP, the current Fisheries Management Plan proposes to eradicate nonnative salmonids from selected streams and reintroduce BCT into approximately 29.0 km (18 mi) of stream, establishing six populations during the initial 10-year reintroduction plan.

The GBNP General Management Plan specifically identifies that, "the Park Service would reestablish Bonneville cutthroat trout into selected streams on the east side of the park. The drainages containing populations of Bonneville cutthroat trout on the west side would be zoned as protected natural areas, and domestic sheep grazing would be prohibited within those areas. No new stocking of nonnative fish species would be permitted in park waters."

The Humbolt National Forest Land and Resource Management Plan, which encompasses several BCT streams in Nevada, specifically directs the USFS to, “provide habitat for sensitive and Federally listed T&E species” and advises that the, “First priority is to coordinate other resource activities with Lahontan and Bonneville cutthroat trout habitat management”; to “accomplish structural improvement work in suitable areas to improve habitat for Lahontan and Bonneville cutthroat trout” and; to “Strive to achieve and maintain at least 90% of the natural bank stability for streams supporting Lahontan and Bonneville cutthroat trout.”

The Fifteenmile Creek subbasin which includes the entire mainstem and tributaries has been designated for BCT conservation. This area will constitute a metapopulation once planned reintroductions are complete and is managed by TU.

In August 1999, the Service entered into a 10-year cooperative agreement with Walden Properties, Joint Venture (Hidden Canyon Guest Ranch), and TU (Great Basin Chapter) for the purpose of restoring and maintaining the Big Wash Creek watershed. The long-term goal of this effort was to allow NDOW to remove BKT and reintroduce BCT into Big Wash Creek. This agreement was proposed to fund the following stream-riparian restoration activities along Big Wash Creek: 1) relocation of a 1/4 mile road; 2)construction of a small pedestrian bridge; 3)installation of pasture fencing; 4)repair and construction of approximately twenty-five instream fish habitat structures; and 5)planting of native trees, shrubs, and grasses. The proposed pasture fencing will create at least four pastures perpendicular to Big Wash Creek. This will allow the ranch manager to initiate grazing practices that are conducive to restoring and maintaining good stream-riparian health. These restoration activities have been completed.

A. Population and Genetic Investigations

Since the 1970's, monitoring has taken place at some level within the WGU. Since the mid-1990s, UDWR, NDOW, the Service, the Goshute Tribe and GBNP have been implementing monitoring programs to follow the success of recent introductions as well as to determine the status of other populations. In Nevada, all streams within BCT historic range have been surveyed through the cooperative efforts of the Nevada Division of Wildlife, USFS-Humboldt-Toiyabe National Forest, BLM-Ely Field Office, and Great Basin National Park. Furthermore, habitat surveys have been completed on all streams with existing populations and those proposed for reintroductions or introductions. Efforts are currently focusing on introducing BCT into streams in and around Great Basin National Park.

Genetic evaluations have been a high priority for managers in the WGU. Over the past two decades, BCT collected from Trout Creek have been evaluated for genetic purity on different occasions and determined pure. Genetics evaluations continue to be important for determining the extent of hybridization and potential brood sources among BCT populations in the WGU. Several streams have been targeted for future genetics evaluation to determine genetic purity. Of particular importance, headwater reaches of the South Fork of Johnson Creek on the west slope of the Deep Creeks may contain pure BCT in its headwaters reaches. Fish from this stream have been collected and are awaiting genetic analyses. If determined pure, this population would be the second pure remnant BCT population in the Deep Creek Mountains and the only pure remnant population on the west slope.

B. Population expansion

Expansion and protection of BCT populations have been and will continue to be priorities for wildlife and land managers in the WGU. Detailed surveys describing the status and distribution of all known BCT populations in the WGU either were recently completed or are scheduled for the near future. BCT populations in the region have been expanded by an order of magnitude by transplanting BCT from pure remnant populations into other area streams. Streams scheduled for transplant were renovated with rotenone to remove nonnative trout species. Artificial barriers were constructed where necessary to protect newly established BCT populations from invasion by nonnatives in downstream reaches or other connected streams. Stocking of nonnative fishes has been discontinued in the WGU and preventing the further expansion of nonnatives is a continuing priority in this region.

Many streams in the WGU are currently targeted for reintroduction of BCT. On the east slope of the Snake Range, Strawberry, Lehman, South Fork Baker, Snake, Johnson, Big Wash, and South Fork Big Wash Creeks have the potential to provide 65.1 km (40.7 mi)of BCT habitat. Reintroduction of BCT is planned for Red Cedar Creek on the east slope of the Deep Creek Range and would provide 8.0 km (5.0 mi)of habitat. Reintroductions are planned for Birch, Sam's, Steve's and Dad's Creeks on the Goshute Reservation and would provide an additional 30.4 km (19.0 mi) of stream habitat.

A brood stock and rearing program was developed by the Goshute Tribe, UDWR, NDOW, the Service, and Trout Unlimited to provide a source of BCT for stocking on both the east and west slopes of the Deep Creek Mountains. Wild adult BCT have been captured, spawned, and their eggs hatched and reared into stream-side incubators to supplement natural recruitment. Also, spawning channels and broodstock grow-out ponds built to enhance existing stream habitats. These efforts have been extremely successful and have greatly facilitated BCT expansion and enhancement in this region in the past five years.

C. Habitat Restoration

Habitat surveys have taken place or are ongoing in most streams throughout this GU as part of ongoing population surveying. Most habitat renovation has occurred as part of agency policy changes. Some fencing has occurred (Pine and Ridge creeks) to prevent grazing damage of riparian areas. In addition, designation of the Mt. Moriah Wilderness in the Snake Range provides additional protection, because it prohibits certain land uses (roads, use of mechanized equipment).

In Nevada, the BLM-Ely District wrote a Habitat Management Plan (HMP) for Goshute Creek in 1968. It was revised in 1971 and again in 1980. The HMP focused primarily on protection and improvement of the Goshute Creek watershed for BCT. Implementation of this plan has resulted in numerous habitat improvements benefitting BCT in 11.3 km (7 mi) of Goshute Creek. The Egan Resource Management Plan (1987), amended for oil and gas (1994), addressed protection for BCT and further implementation of the Goshute Creek HMP. Currently, BLM is addressing impacts of livestock, wild horses, and wildlife in the Goshute Basin and Cherry Creek allotments. Multiple-use decisions are expected to be issued in 2000 which will further address improving conditions in the Goshute Creek watershed. In addition, the BLM-Ely District is

working with the NDOW, USFS, and GBNP to implement expansion and improvement of habitat for BCT on eight streams in Snake and Spring valleys.

Several management actions undertaken during the 1990s have reduced the level of livestock grazing impacts to BCT habitat on the Humboldt-Toiyabe National Forest. The primary action was the incorporation of grazing standards and guidelines from the Humboldt Forest Plan Amendment Number Two into term grazing Annual Operating Permits in 1991. All BCT habitats on the forest were categorized as Category 1 riparian areas either due to BCT occurrence or inclusion within the Mount Moriah Wilderness. Enforcement of grazing standards has been phased in over several years.

Overall, cattle grazing in Hendry's and Hampton Creeks did not exceed forage utilization standards, but localized areas of overuse occurred, especially in the upper elevation headwater areas. This led to conflicts with recreationists, as well as increasing sedimentation into the creeks. Livestock management in Hendry's and Hampton Creeks is constrained by the rugged terrain, which also precluded changing the season of use of the upper areas to reduce impacts. The permittee waived the Term Grazing permit back to the USFS. This action implemented a Forest Plan Amendment dated December 15, 1998 which closed these drainages to livestock grazing.

The reintroduction streams of Smith, Deep, and Deadman Creeks are in another grazing allotment. Most of Deep, major portions of Deadman, and localized portions of Smith Creeks have some grazing impacts because vegetation or terrain limit access by cattle. Ironically, improved access into Deadman and lower Deep/Deadman Creeks for renovation treatments has increased grazing use of these areas. The headwaters of Deadman and Smith Creeks, and several segments of Smith Creek receive use levels that exceed grazing standards. The Humboldt-Toiyabe National Forest actions to reduce these grazing impacts have included improved monitoring and enforcement of grazing standards, including some temporary permit actions. Some of the problems along middle Smith Creek are due to cattle watering on the Forest while grazing adjacent BLM lands. The USFS plans to address this problem in the near future by working with the BLM to develop alternative water sources and improve gap fencing to restrict access to Smith Creek.

Aquatic macroinvertebrate monitoring has been conducted on all of these creeks in the Moriah Division, which provides some data on grazing impacts. In addition, the Humboldt-Toiyabe National Forest and NDOW have cooperated on conducting stream surveys of these streams. Most have been completed, and Deep and Deadman Creeks will be completed in 2000. These stream surveys have helped quantify stream impacts from grazing.

Monitoring and enforcement of grazing standards and coordination and communication with the livestock permittee on the out-of-basin Pine/Ridge Creek has been improved since 1993, when several sheep bedding grounds were found along the creek. The EA and AMPs completed in 1996 established a maximum utilization level of 35% on these drainages due to the presence of BCT. This level is more restrictive than the maximum allowed by the Humboldt Forest Plan and has reduced grazing impacts in recent years.

The newly planted (in a barren stream) out-of-basin Deep Creek population is in a vacant allotment. The district has been taking steps to reduce feral and trespass livestock impacts in this area during the 1990s, and almost no livestock use has occurred along the perennial stream portion of this drainage above the gap fence in the last few years. The riparian area is making a dramatic recovery.

Restructuring and regulation of grazing practices has also been a focus for streams in GBNP. Livestock grazing, which has been ongoing for decades, has impacted habitat in streams within the Park since its inception in 1986. As of the year 2000, all cattle will be removed from within Park boundaries.

D. Regulation

NDOW ceased stocking of nonnative salmonids in waters containing BCT over 40 years ago. Furthermore, this activity is now prohibited by Nevada Board of Wildlife Commissioners Policy. UDWR does not currently stock nonnative salmonids into any streams in the WGU.

The fishing regulations at Trout and Birch Creeks, previously closed to fishing, were amended in 1999 to allow a four trout limit. Previously, fishing regulations allowed the take of up to eight trout all year in Granite and Red Cedar Creeks. These streams have now been closed to fishing to allow for nonnative removal and reintroduction of native BCT. The fishing regulations at Thom's Creek, previously closed to fishing, were amended in 1999 to allow a four trout limit.

Conclusion

In summary, there are currently more known BCT populations in the WGU than there had been since before the 1960s. Currently 17 stream populations exist occupying about 50% of the available stream reaches 106.7 km (66.3 mi). There have been two brood sources developed in the Deep Creek Mountains that include spawning and rearing habitat. Remnant populations are used as sources of fish for nearby reintroductions. Three out-of-basin BCT populations exist. Although these populations do not contribute to the long-term persistence of BCT within its native range, these populations provide anglers with opportunity to become familiar with BCT and also can provide a source of fish for transplant, reintroduction or supplementation. Such transplants may be very important for the characteristically small, fragmented streams that naturally occur in the deserts of Utah and Nevada that are prone to catastrophic drought or flood.

State, Federal, and Tribal agency conservation plans are in place and actions are being implemented to continue restoration and protection of BCT in this GU as described above. In addition, collaboration with both TU and private land owners has contributed greatly to the success of BCT restoration activities in this area. Although a fairly remote part of the Bonneville basin, human activities can conflict with wildlife and ecosystem management. However, current management has made protection and restoration of BCT a priority within certain stream drainages in this GU. Although localized problems exist, the trend in planning and implementation is for increased range and improved population status of BCT as well as improved habitat conditions.

Recommendations

The Service supports the restoration of BCT in the WGU. Based on the findings in this report, the Service recommends:

1) Development, implement, and enforce grazing regulations to prevent acute impacts from grazing in streams and along riparian areas. Although regulations have been developed, some are not adequately enforced to protect BCT in certain drainages.

2) Focus on identification of remnant populations, range expansion within the native BCT range and restoring connectivity among small, fragmented streams where potential exists.

3) Secure long-term protection of habitat and instream flows where possible to protect BCT populations.

4) Make BCT in-basin reintroductions a priority over BCT out-of-basin transplants.

Southern Geographic Unit

Description of Geographic Unit

The Southern Geographic Unit (SGU) encompasses the southwest corner of the Bonneville Basin. Located in southwestern Utah, today this area primarily comprises the Sevier River basin that drains the ranges and plateaus of south-central Utah. The SGU also includes the Beaver River drainage, a relatively large and geographically distinct tributary to the Sevier River, that drains the Tushar Mountains. The region also contains some streams draining the Pine Valley Mountains in the northern portion of the Virgin River drainage, a drainage outside of the Bonneville Basin, part of the Colorado River Basin. The SGU is characterized by relatively small, fragmented streams draining mountain ranges isolated by desert valleys. The mainstem of the Sevier River is often isolated from tributary streams because of subterranean flows in alluvial areas or irrigation diversions on tributaries.

The elevation of the SGU ranges from 5000 to over 10,000 feet. The arid climate is characterized by low elevation desert vegetational communities in the southern most extreme area of this GU. Typically, high elevation streams (>7000 ft) flow through subalpine forests with aspen and willow meadows. At lower elevations, pinyon-juniper forests become dominant with sagebrush or grassland meadows. Hydrology of the unit is typical of high mountain desert streams with spring flooding and low to intermittent base flows. During drought periods, remnant BCT populations in small streams have become reduced to a few miles of stream habitat but then are found to expand during better water years.

The range of BCT in the Southern GU extends just outside of the Bonneville Basin and into the Virgin River of the Colorado River Basin (upper Santa Clara River). It was thought that early pioneers may have transplanted BCT from the Bonneville to the Colorado River Basin from nearby streams as early as the 1860s or that natural stream capture events allowed movement of BCT outside of the Bonneville Basin (Behnke 1992; Duff 1996). More recent geologic evaluations and reports of abundant trout in 1859 suggest BCT occurred naturally in the upper

Santa Clara River portion of the Virgin River drainage (Cleland and Brooks 1983, Hepworth et al. 1997). BCT is currently managed as a native species in the Santa Clara River of the Virgin River drainage.

The USFS owns the vast majority (~93%) of the land containing BCT in the SGU on the Fishlake and Dixie National Forests. BLM owns about 6% of the lands with BCT, and the State of Utah owns about 1%. Very little habitat containing BCT is under private ownership and management of BCT in this GU is the responsibility of UDWR. However, the BLM and USFS are responsible for land management actions and BCT habitat. Currently, one full-time fisheries biologist position is cooperatively funded between UDWR and the USFS for the main purpose of coordinating and implementing conservation actions for BCT among agencies and biologists in the SGU.

Background

Miller (1961) referenced an 'old timer' account of cutthroat trout presence in the Santa Clara at Pine Valley, Utah in 1863, but D. Hepworth (pers. comm.) more recently found references to abundant trout in the Pine Valley headwaters of the Santa Clara as early as 1859 (Cleland and Brooks 1983). These same pioneer journal references also reported trout from Panguitch Lake and the Sevier River near the town of Panguitch. For purposes of this review, it is assumed that BCT occupied areas where suitable habitat was available. In 1973, only three populations of BCT were known to exist in this GU, one in the Beaver and two Virgin River drainage (Duff 1996). Duff (1996) suggested that these populations, occurring in 7 stream miles, accounted for less than 0.002% of total historic stream miles. Hepworth et al. (1997a and b) also reported finding additional remnant populations in the North Fork North Creek (Beaver River drainage), in Deep Creek (Sevier River drainage), and in Ranch Creek (Sevier River drainage) and described other population expansions through transplants.

Population Status

Sevier River Drainage

Table 42. Waters containing BCT in the Sevier River drainage with total occupied stream length in km (mi) or *surface area* of water body in *hectares (acres)* (SL/*SA*), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL/*SA*	LH	CS	DN	PS
Manning Creek (2)	19.3 (12.0)	stream resident	CP	*	reintroduction (Manning Meadow Res.)
Manning Creek, East Fork (1)	1.0 (0.6)	stream resident	CP	*	reintroduction (Manning Meadow Res.)
Barney Outlet (1)	1.6 (1.0)	stream resident	CP	*	reintroduction (Manning Meadow Res.)
Vale Creek (1)	1.9 (1.2)	stream resident	CP	*	reintroduction (Manning Meadow Res.)

Manning Meadow Reservoir	*23.2 (58.0)*	adfluvial	MP	*	introduced brood source (Pine Creek)
Threemile Creek (2)	8.8 (5.5)	stream resident	CP	*	reintroduction (Birch Creek, Beaver River drainage)
Delong Creek (1)	1.6 (1.0)	stream resident	CP	*	reintroduction (Birch Creek, Beaver River drainage)
Indian Hollow Creek (1)	1.6 (1.0)	stream resident	CP	*	reintroduction (Birch Creek, Beaver River drainage)
Sam Stowe Creek[a] (1)	4.8 (3.0)	stream resident	CP	306 (190)	reintroduction (Birch Creek, Beaver River drainage)
Deep Creek[a] (1)	9.7 (6.0)	stream resident	CP	276 (171)	remnant population
Sandy Creek[a] (1)	0.8 (0.5)	stream resident	CP	*	reintroduction (Deep Creek 1999)
Sanford Creek, Left Fork[a] (1)	0.8 (0.5)	stream resident	CP	*	reintroduction (Deep Creek 1999)
Ranch Creek[a] (1)	4.5 (2.8)	stream resident	CP	171 (106)	remnant population

[a] = isolated population
* = estimate not available
CP = Conservation Population
MP = Management Population

In the Sevier River drainage, BCT are known to occupy approximately 56.4 km (35.0 miles) which is over half of the estimated stream habitat in the drainage. BCT also occupy Manning Meadow Reservoir which has a surface area totaling 23.2 hectares (58 acres). BCT in this drainage are typically abundant with densities averaging 251 fish per km (156 fish per mile). However, many of these streams have smaller populations because they have been only recently renovated and their populations are still expanding (Hepworth et al. 1997a). Most BCT in this drainage are stream residents. Established and expanding populations display good recruitment. Connectivity in the Sevier River drainage is variable; some streams are more complex with three or more interconnected tributary populations while other areas contain isolated populations with limited habitat. As recently as the 1990's, most of the streams in this drainage consisted populations of nonnative RBT, BRN, BKT, or YCT. For many years, nonnative salmonids stocked into streams, lakes, and reservoirs within the historical range of BCT. Currently, BCT is becoming used more commonly to satisfy angler interests and replace nonnative salmonids. The streams in the Sevier River drainage are managed as conservation populations. Manning Meadow Reservoir is treated as a management population because of emphasis on nonnative angling.

Beaver River Drainage

Table 43. Waters containing BCT in the Beaver River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS
North Creek, North Fork (2)	6.8-8.8 (4.2-5.5)	stream resident	CP	214 (132)	remnant population
Pole Creek (1)	4.6 (2.9)	stream resident	CP	*	reintroduction (North Fork of North Creek 1995)
Briggs Creek[a] (1)	1.4 (0.9)	stream resident	CP	124 (77)	introduction (Birch Creek 1988)
Birch Creek[a] (1)	6.8-8.8 (4.2-5.5)	stream resident	CP	160 (99)	remnant population
Pine Creek[a] (1)	6.3 (3.9)	stream resident	CP	228 (141)	reintroduction (Birch, Water Canyon and Reservoir Canyon Creek in 1980, 1984, and 1994)

[a] = isolated population
* = estimate not available
CP = Conservation Population

The Beaver River is a tributary to the Sevier, but their confluence occurs approximately sixty miles downstream from perennial flows and salmonid habitat on the Beaver River. Fish communities remain effectively isolated from each other by modern hydrologic regimes and contemporary human water development although connectivity was historically limited. In the Beaver River drainage, BCT occupy about 25.9 - 29.9 km (16.1 - 18.6 mi) of habitat which is almost 95% of the estimated suitable stream habitat in the basin. BCT in these streams are considered abundant averaging about 181.5 fish per km (113 fish per mile). All BCT exhibit a stream resident life history. Ongoing population sampling has found recruitment to be good. These BCT populations are not well connected with only 2 connected streams in the drainage (North Fork North and Pole Creeks); however the potential for more connectivity is being investigated and habitat are being implemented to ensure better status of existing populations.

Over the past century, native BCT populations have been gradually replaced by nonnative RBT or BCT-RBT hybrids as a result of nonnative stockings. Due to ongoing BCT restoration, BCT are being restored to satisfy both angler interests and conservation needs. Although many nonnative remain, pure BCT populations exist and additional populations are being established through current multi-agency management cooperative efforts. In particular, UDWR and USFS are working cooperatively to restore populations and improve habitat conditions so that newly established BCT populations are better able to persist. BLM is also working with these agencies where their lands are involved.

Virgin River Drainage

Table 44. Waters containing BCT in the Virgin River drainage with total occupied stream length in km (mi) (SL), life history strategy (LH), conservation status of population (CS), BCT density (DN) in fish per km (mi), and population status (PS).

Stream/Tributary (stream order)	SL	LH	CS	DN	PS

Leeds Creek (2)	11.3 (7.0)	stream resident	CP	254 (158)	reintroduction (Water Canyon & Reservoir Canyon Creeks in 1988-89)
Horse Creek (1)	3.4 (2.1)	stream resident	CP	*	introduction (Water Canyon Creek)
Pig Creek (1)	1.6 (1.0)	stream resident	CP	230 (143)	reintroduction (Water Canyon & Reservoir Canyon Creeks)
Spirit Creek (1)	3.5 (2.2)	stream resident	CP	261 (162)	reintroduction (Water Canyon & Reservoir Canyon Creeks)
South Ash Creek (2)	6.0 (3.7)	stream resident	CP	189 (117)	reintroduction (Reservoir Canyon Creek in 1986)
Harmon Creek (1)	4.8 (3.0)	stream resident	CP	174 (108)	reintroduction (Water Canyon & Reservoir Canyon Creeks)
Mill Creek (1)	7.4 (4.6)	stream resident	CP	252 (157)	reintroduction (Reservoir Canyon Creek)
Leap Canyon Creek[a] (1)	2.7-3.2 (1.7-2.0)	stream resident	CP	130 (81)	reintroduction (Water Canyon Creek in 1986)
Reservoir Canyon Creek [a] (1)	3.2 (2.0)	stream resident	CP	546 (339)	remnant population (discovered 1973)
Water Canyon Creek [a] (1)	0.8-3.2 (0.5-2.0)	stream resident	CP	118 (73)	remnant population (discovered 1973)

[a] = isolated population
* = estimate not available
CP = Conservation Population

In the Virgin River drainage, BCT are known to occupy approximately 44.7-47.6 km (27.7-29.5 miles) of stream habitat which 84-89% of the estimated suitable habitat in the basin. Remnant BCT populations were first discovered in 1973 in Water Canyon and Reservoir Canyon creeks. Since then, these streams have been used as a source of fish to establish new BCT populations in nearby Pine Valley Mountain drainages. BCT in these streams are considered abundant with densities averaging about 239 fish per km (149 fish per mile) based on ongoing population monitoring. These BCT are stream resident forms that exhibit good recruitment. Although most streams are relatively isolated, there is some connectivity among some of the smaller tributaries to Leeds Creek and South Ash Creek.

The Virgin River system is within the Colorado River Basin and not the Bonneville Basin. Managers have chosen to use BCT in this area because, as previously detailed, they were historically found in this portion of the drainage (upper Santa Clara River). Based on the zoogeographical relationships of the native fish of the Virgin river, a native trout would be expected to be derived from the Gila or Apache Trout of the Gila River system (Behnke 1970a *in* Hickman 1978). However, no other trout species have ever been found to naturally occur in this area.

Actions Threatening Long Term Persistence of BCT

A. The Present or Threatened Destruction, Modification, or Curtailment of the Species'

Habitat or Range.
Although Duff (1996) considers the majority of stream habitat in the SGU to be either in excellent or good condition, potential threats to habitat quality exist.

Within the Virgin River drainage, water development is a continuing threat to the native fishery including BCT. From 1980 to 1990 the growth in Washington County reached 52%. This high growth rate is expected to continue. Projected population estimates are expected to increase to 380,000 people by 2040 compared to 48,560 in 1990. With this growth comes a need for new water developments. While no known currently planned developments will impact BCT populations, the potential for future development cannot be dismissed. The remoteness and inaccessibility of most of the BCT occupied streams within this drainage will be a safeguard for these populations; however, if larger order streams are developed, it could potentially threaten BCT metapopulation development and maintenance.

Water quality is not a severe problem in this GU; however, some problems exist. Manning Meadow Reservoir is currently listed on the Utah State impaired waters list for low dissolved oxygen.

Livestock grazing has been identified as a continuing problem, particularly for the Sevier River drainage. Although many areas have been improved over the past decades, problems still occur. Specifically, reduced riparian vegetation, bank instability, channel widening and fine sediment input have been noted as problems in these streams such as Pine Creek, Threemile Creek and Ranch Creek. The BLM and USFS have made and continue to make changes in grazing regulations to address these problems; however some acute problems still exist.

Unauthorized alteration of Ranch Creek has caused some habitat damage. Unauthorized activities have resulted in the removal of rocks and woody debris and attempts to channelize a short stretch of the stream for efficient water delivery. However, land and fisheries managers are attempting to correct the problem.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
The threat of over-harvesting from angling pressure is not acute at this time. Most streams have either large areas that are not likely to be over-fished or the streams are fairly remote making overuse unlikely. In addition, small streams do not produce the large trout of interest to most anglers. While overutilization is not currently considered a threat in the SGU, the effects of angling on BCT populations status should continue to be evaluated.

C. Disease or Predation
While whirling disease is not currently found in any BCT occupied waters in the southern drainage, it has been documented in the East Fork of the Sevier River and the Beaver River drainage. Currently, the disease is found in naturally few waters in Utah but will likely spread to others. Established disease certification and transplant protocols should help limit the spread of the disease and allow time to apply research and management actions on specific sites.

Remoteness and isolation of most BCT in this GU should give them additional protection. A particular concern in the SGU is the potential for illegal movement of fishes around the region that can occur for a variety of reasons.

The potential for predation does not currently pose a significant threat to BCT in the SGU due to isolation from other native and nonnative fish populations in this drainage. The limited presence of BRN, BKT, and RBT throughout the region suggests that predation is a potential threat as expansion and enhancement of BCT populations.

D. Inadequacy of Existing Regulatory Mechanisms

Currently, some inadequate regulations, primarily lack of restrictions on road building in the Dixie National Forest, has resulted in local damage to some streams in this region. In addition, grazing restrictions in specific areas are considered too liberal to provide adequate protection for riparian and stream habitat. Continued protection of BCT depends on the continued appropriation of funding and commitment of the local management or regulatory agencies to fulfill their responsibilities.

E. Other Natural or Manmade Mechanisms

The isolated and fragmented status of many BCT populations in the SGU make them vulnerable to natural climatic events such as fire and floods or even demographic stochasticity. However, vulnerability is reduced as the population size, habitat availability and complexity, and connectivity between populations increases.

As a result of past stocking, nonnative fishes including BRN, BKT, and RBT have become established in the SGU. While genetic and meristic testing has determined that most existing BCT populations in this region are pure, some hybridization has been observed in individual streams where RBT are present. The presence of hybrids and nonnative fishes represents a threat to the survival and expansion of BCT in the SGU.

There has also been a recent socio-political threat to continued conservation activities as a result of the perception that the species may become listed in the near future and with the State and Federal sensitive species designation for the BCT. Many proposed conservation activities, particularly those that require NEPA analysis or must be brought before the States' Regional Advisory Council, are being denied or challenged by private entities because of the perception that land use or fishing restrictions will be imposed because of the species sensitive status or if the species were to become listed under the Endangered Species Act. This pressure limits or inhibits implementation of conservation actions. However, local biologists and managers have been working with the local community to educate them on conservation activities and the value of native fisheries as well as enlisting their support for future activities. The socio-political pressure has been somewhat alleviated in recent years due to public relation efforts of local managers and is not considered a significant threat to the long-term persistence of BCT in the SGU at this time.

In Utah, it has been reported that there is socio-political threat to continued conservation activities as a result of the perception that the species may become listed in the near future. Also, State and Federal sensitive species designation has aggravated this problem. All proposed conservation actions involving movements, transplants, and stocking of BCT must be approved by local governments as required by 1998 Utah State legislation. Furthermore, after local approval, plans must be approved by the Regional Advisory Councils and the State Wildlife Board. Although local governments remain highly skeptical, concerns have been reduced through completion of BCT Conservation Agreements. Thus far, plans have been approved by local governments. If Federal listing were to take place, all current approvals transplants, stockings, and broodstock programs would be void under Utah State law. No further actions could take place until new plans were approved by local governments. This could result in the state-wide loss of millions of dollars of hatchery and broodstock programs and the loss of millions of BCT. Furthermore, local governments would be hesitant and restrictive in approving new plans for BCT.

Conservation Actions to protect BCT

In the SGU, emphasis has been placed on range expansion of BCT. Specifically, removal of nonnative salmonids and reintroduction of BCT have taken place throughout the main SGU drainages and additional renovations are planned for future years. In addition, the USFS and BLM have been working cooperatively with UDWR to improve stream habitat, fence riparian areas where needed, construct fish barriers to protect pure BCT populations or construct instream habitat structures where needed.

A. Research

Some life history studies have been conducted on BCT in Birch Creek and in Manning Meadow Reservoir. Some examples of studies include the food habits of BCT in Birch Creek (May et al. 1978), brood source development in Manning Meadow Reservoir (Hepworth et al. 1993), comparative sport fish performance of BCT (Hepworth et al. 1999). Also studies on population dynamics and colonization of renovated streams (Hepworth et al. 1997 a and b). Other studies on whirling disease and nonnative interactions are also underway.

B. Population and Genetic Investigations

Detailed surveys describing the status and distribution of all known BCT populations in the SGU were completed by the UDWR in 1995. Population sampling and monitoring is ongoing. Although a few steams still exist that have not been investigated for BCT presence, most of the SGU has been surveyed. Monitoring is ongoing for newly established populations. Plans are to complete population surveys on all known BCT populations every 7-8 years and provide a report that compares results to previous surveys.

Genetic analyses have been conducted on BCT from all streams that either are suspected as hybridized because of nonnative presence, past stocking or morphology or for streams that have been newly identified as containing BCT. Only genetically pure remnant BCT such as in Water Canyon, Reservoir Canyon, or Birch creeks are transplanted for reintroduction or population supplementation. Genetic surveys are updated as new techniques are developed.

C. Population Expansion

Expansion of BCT populations has been and continues to be a priority for managers in the SGU. BCT populations were expanded and enhanced by transplanting fish from pure strain remnant populations into other area streams. Streams scheduled for transplant were renovated with rotenone to remove nonnative trout species. Artificial barriers were constructed where necessary to prevent nonnatives from downstream reaches or other connected streams from intermixing with the reintroduced populations.

Manning Meadow Reservoir provides and maintains a wild broodstock of BCT for introductions and reintroductions into the SGU. In 1988 the State of Utah purchased all water storage rights to Manning Meadow Reservoir with the intent of developing a brood source of BCT for statewide management purposes. A water management plan was developed and put into place in 1988 to meet these goals. In 1989 the reservoir, located at the top of the drainage, was treated with rotenone to remove nonnative species. In 1990 and 1991, 469 and 245 pure BCT were respectively introduced into the reservoir from Pine Creek. Every year since 1992 eggs from these adults have been taken, incubated, hatched and reared at state facilities, and used for reestablishing BCT elsewhere in the drainage. Following State of Utah law regarding transplants of fish, BCT from Manning Meadow Reservoir are tested annually and have been certified disease free. In 1997 a concrete spawning trap was constructed at the Reservoir to facilitate the taking of eggs. The population is considered stable. Since 1993, over 290,000 BCT have been produced from the Manning Meadow broodstock and reintroduced into more than 30 waters in the SGU mainly for sportfishing purposes (Hepworth et al. 2000).

As early as 1977, Sam Stowe Creek was treated to remove nonnative rainbow trout and stocked with a remnant population of BCT from Birch Creek. In the early 1990's the population became hybridized with rainbow trout. In 1997, Sam Stowe Creek was again renovated to remove nonnative rainbow trout and rainbow-cutthroat hybrids by the Utah Division of Wildlife Resources and a fish barrier was constructed. In 1998, 100 BCT from Birch Creek were transplanted into Sam Stowe Creek. In 1978, Threemile Creek contained BKT, BNT, RBT and some YCT. Stream habitat was considered in poor condition. Over the following decade, land changes were implemented, and renovation of Threemile Creek was completed in 1994 and included removal of all nonnative species and reintroduction of BCT from Birch Creek. Manning Creek and its tributaries, Barney Outlet, Collins and Vale Creeks, were renovated in 1995 and 1996 to remove nonnative species. Over 2,000 BCT were introduced in 1996 and 1997. BCT were transplanted from Deep Creek into Left Fork Stanford and Sandy Creeks in 1999, all in the Sevier Basin.

In 1986, South Ash Creek and its two tributaries, Harmon and Mill Creeks were renovated and transplanted with BCT from Reservoir Canyon fish. Leap Creek was renovated and BCT introduced in 1986. Leeds Creek is a complex consisting of three tributaries, Pig, Spirit and Horse Creeks. This population of BCT was established from Water Canyon and Reservoir Canyon Creeks transplants in 1988 and 1989. The most remote tributary, Horse Creek, received a transplant of BCT in 1995. Briggs Creek contains a transplanted population of BCT, founded in 1988 from Birch Creek stock. Pine Creek contains a population of BCT founded from

transplants in 1980 from Birch Creek, Water Canyon and Reservoir Canyon Creek BCT. In 1995, BCT were stocked into, Pole Creek, a tributary of North Fork of North Creek. Renovation of the stream, completed in 1992, removed competing RBT and BNT trout from the upper portion of the stream.

Currently, three streams in the SGU are scheduled for reintroduction of BCT. Center, Tenmile, and Birch Creeks, all in the Sevier Drainage, will provide 19.7 km (12.2 mi) of additional stream habitat. In addition, Robs Reservoir, also in the Sevier Basin, is scheduled to introduction of BCT and will provide and additional 0.8 ha (2 ac) of BCT habitat.

D. Habitat Restoration

Habitat quality has also been a primary focus for BCT management in the SGU. All waters in this region are scheduled for or have recently had habitat surveys completed. For Some streams, specific habitat modifications or improvements have been performed. Transplant sites were selected in part because of generally good habitat with few problems and to avoid possible conflicts with other land management uses. Restructuring and regulation of grazing practices has also been a concern. Restrictions, riparian enclosures, and sometimes complete removal of livestock had taken place on streams selected for BCT transplants. Similarly, fences were constructed and alteration or removal of existing roads was performed to minimize impacts on stream habitat. The Virgin River basin has also recently benefitted from an agreement with the Washington County Water Conservancy District that insures adequate flows for several streams in this drainage.

A habitat enhancement project to replace rocky substrate that had been removed was completed on Ranch Creek in 1997. The USFS is in the planning stages of constructing riparian fences along the stream to further improve the habitat. Renovation of the North Fork of North Creek, completed in 1992, removed competing rainbow and brown trout from the upper portion of the stream, placed a fish-migration barrier to prevent repopulation of the upper stream by rainbow and brown trout, and enhanced BCT habitat through the placement of instream structures and willow planting.

Along with the barrier constructed on Sam Stowe Creek in 1997, instream structures, fencing, and changes in livestock grazing practices were also implemented by the USFS. In addition, State Parks and Recreation purchased private property on the lower end if the stream.

The Threemile Creek population of BCT includes Threemile Creek itself and the DeLong and Indian Hollow tributaries. As early as 1978 the Dixie National Forest and BLM initiated land use changes to protect and enhance the fishery and riparian zone of Threemile Creek. Traditional practices had resulted in erosion problems and poor riparian condition. At the time the stream contained a population of brook trout, brown trout, rainbow trout and a limited number of Strawberry/Yellowstone cutthroat trout. In 1989 a riparian fence was constructed along 2.5 miles of the stream to temporarily exclude cattle and instream habitat improvement structures were constructed to provide trout habitat. The BLM also conducted an intensive riparian rehabilitation program on the lower portion of the stream, including reseeding and riparian fencing to

temporarily exclude cattle. Renovation of this stream was completed in 1994 and included removal of all nonnative species and reintroduction of BCT from Birch Creek. A fish migration barrier was constructed in 1998 by the BLM to expand the portion of the stream managed for BCT.

In Manning Creek, a fish migration barrier was constructed at the lower end of the drainage on BLM lands to prevent future migrations of nonnative species into BCT waters. Over 2,000 BCT were introduced in 1996 and 1997. Instream flow water rights for the protection of aquatic resources were purchased in 1997 along with private property on the lower end of the stream.

To protect Deep Creek and enhance habitat, the Dixie National Forest closed roads, enacted restrictive grazing practices and restricted stream access in 1997.

Habitat restoration activities also occurred on Birch Creek. Work Conducted in the 1980's included riparian fencing to prevent over-grazing by livestock, road closures where the road previously paralleled the stream, and installation of instream habitat structures. Such work was conducted on both USFS and BLM lands. Results of this work include extension of perennial flows and BCT populations downstream. Also, during periods of drought, BCT occupy a greater amount of the stream than prior to the habitat improvements.

E. Nonnative control

Preventing the further expansion of nonnatives is a continuing focus in this region. Current UDWR policy excludes stocking of nonnative fishes in streams with transplanted or remnant populations of BCT (Lentsch et al. 1997). Before BCT are introduced or reintroduced into a stream, nonnative fish are removed to prevent future hybridization and to prevent competition or predation by nonnative fish. It is commonly necessary to construct upstream migration barriers where an upper section of a stream is being renovated through nonnative removal prior to a BCT introduction. Use of sterile hybrid trout for stocking is being experimentally investigated to provide added protection to BCT populations adjacent to stocked streams. Also, sterile hybrids such as splake and tiger trout are being experimentally transplanted to provide sport fishing in popular areas that have been renovated while introduced BCT naturally repopulate streams and eventually replace the hybrids.

F. Disease control

UDWR conducts disease certification according to State law for any population that will be used as a brood source. Following State of Utah law regarding transplants of fish, BCT from Manning Meadow Reservoir are tested annually and certified disease free. Eggs and fish can then be cultured in State facilities. In addition, studies are being conducted on cutthroat streams with whirling disease to determine susceptibility and control options.

G. Regulation

Current angling regulations allow the take of up to eight trout, 365 days a year in all BCT streams in the SGU. In Manning Meadow Reservoir only artificial flies and lures are allowed, the season is closed from Jan. 1 to July 10, and catch and release on all trout is required. Restrictive

regulations also apply to Robs Reservoir in the Manning Creek drainage. Although seemingly liberal creel limits, local managers are attempting to promote BCT as a sportfish throughout the SGU which would increase popular demand for this fish. Most streams where BCT occur are not extremely large or considered destination trout fishery streams. In addition, they are relatively remote. Therefore, extensive angling pressure is not expected, and generous creel limits are not expected to negatively affect BCT population status. Angling regulations are reviewed annually and can be changed accordingly if needed.

Conclusion

In summary, the status of BCT populations in the SGU has improved dramatically over the past 22 years. None of the BCT populations in the SGU are faced with imminent threats. Therefore, the SGU BCT are considered to be very secure, improving, and expanding. Between 1977 and 1994-95, when intensive surveys and reports were completed on current abundance and distribution, BCT numbers in the southern drainage increased by 955% (Hepworth et al 1997a). As of 1999 BCT populations in the southern drainages have now been expanded to 1,961% of 1977 conditions (D. Hepworth pers. comm.). When conservation management of BCT started in southern Utah in 1977, three pure BCT populations had been identified occupying about 6.4 stream kilometers (4 miles). There are currently 27 waters containing pure BCT and 1 reservoir population, and approximately 120 km (75 miles) of occupied stream habitat and 23.2 ha (58 ac) of reservoir habitat. Since 1996, BCT have been the only cutthroat trout stocked into the Southern Bonneville drainage and no nonnative salmonids have been stocked onto known pure BCT populations.

State and Federal agency conservation plans are in place and actions are being implemented to continue restoration and protection of BCT in this GU as described above. Current management has made protection and restoration of BCT a priority within certain stream drainages in this GU particularly through emphasis on BCT as a sportfish and reintroduction of BCT into streams previously occupied by RBT. Managers have indicated that given an adequate source of BCT, BCT could be used for stocking into streams where RBT are being used currently. Although localized problems exist for land-use, the trend in planning and implementation is for increased range and improved population status of BCT.

Recommendations

Based on this summary, the Service recommends the following to further promote BCT in the Southern GU:

1) Secure long-term protection of habitat and instream flows where possible to protect BCT populations.

2) Continue focusing on identification of remnant populations, range expansion within the native BCT range and restoring connectivity among small, fragmented streams where potential exists.

3) Development, implementation and enforcement of grazing regulations to prevent acute impacts from grazing in streams and along riparian areas. Although regulations have been

developed, some are not adequately enforced to protect BCT in certain drainages.

4) Develop and improve communication with the public. Make efforts to further educate and inform the community about BCT and other native species issues to bolster the local support that is necessary for successful management programs and actions.

VI. CONCLUSIONS

Status and distribution of BCT throughout its range.
Currently, BCT occupy a total of 1372 km (852 mi) of stream habitat and 28,352 ha (70,059 ac) of lake habitat with a total of 291 populations. Remaining potential exists to discover additional BCT populations in streams which have not been recently surveyed or explored. This potential is greatest in the Bear River and Northern GU which contain extensive natural water systems.

Assuming BCT occupied all suitable available habitat in the Bonneville Basin, there may have been an order of magnitude more populations at that time than today. It is impossible to know the exact status and distribution of BCT at that time; however it was no doubt greater than it is today. By the late 1930s to 1970s, experts were speculating that pure BCT were extinct or very rare (Tanner 1936; Cope 1955; Sigler and Miller 1963; Holden et al 1974). By the mid-1970s, Behnke and Hickman had identified 1 lake and 14 stream BCT populations. For the purposes of the 1984 status report on BCT conducted for the Service, 17 creek and 1 lake populations were identified as pure BCT. In 1993, an additional status report that was never finalized reported 48 pure BCT populations. With the onset of the conservation programs for BCT in the four states, BCT expansion and restoration activities accelerated. With the development and implementation of State management and conservation plans and Conservation Agreements in Idaho, Nevada, Utah and Wyoming, more than 80 BCT populations had been identified by 1997 for conservation management in Idaho, Nevada, Utah and Wyoming.

The range of BCT has been expanded outside of its native range in a few areas of Nevada (WGU) and in areas in southern Utah (SGU). Although the Service does not consider these populations to contribute to the long-term persistence of BCT within its native range, out-of-basin populations are recognized as beneficial towards conservation of BCT by providing individuals for reintroduction efforts within native BCT range or as a refugia population until BCT have become better established within their native range. This is true where BCT have been transplanted into fishless out-of-basin streams. To date, out-of-basin populations account for only 13 BCT populations in its entire range: 10 in the SGU and 3 in the WGU.

Figure 7. shows the status of BCT over the past 150 years. The area on the graph marked as (a) represents a hypothetical population level of BCT before survey and identification data were available. The upper line is a likely high number and the lower line a likely low number of populations that may have existed. Because there is no way to determine the precise historic number of BCT populations, the graphical depiction in (a) is a hypothetical model demonstrating the conspicuous decline in BCT populations during this period as noted by species experts.

The area labeled (b) shown by the solid line represents confirmed data collected from the early 1970s through the present time. This line represents the increase in known number of BCT populations through 3 distinct periods: 1) in the 1984 Service status report (17 populations), 2) the 1993 Service draft status report (48 populations), and 3) the number identified in this document (291 populations).

The area on the graph labeled (c) is intended to represent a hypothetical trajectory for the status of BCT populations over the next 30 years based on ongoing management and conservation plans. The two lines represent a likely range of BCT status based on ongoing and projected management, research and societal values. This figure demonstrates that although there was a precipitous decline in BCT from 1850s until the early to mid-1900s, the past two decades of restoration and conservation have identified or restored BCT populations at an increasing rate which has markedly improved the status of BCT and that the increasing trend is likely to continue into future years based on ongoing and planned conservation efforts.

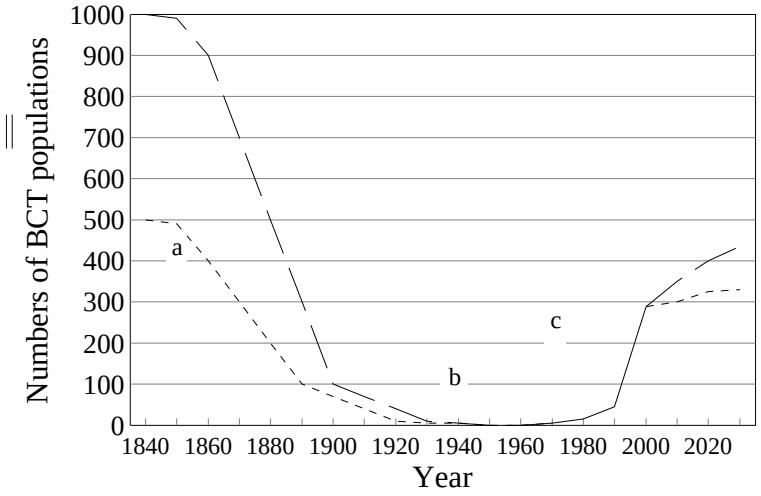

Figure 7. Status of BCT over the last 150 years.

Overview of decline of BCT

The overall level of threats to the long-term persistence of BCT has been determined to have decreased during the past 50 years based on information available for this status report. The majority of activities that caused the severe decline in BCT throughout its range occurred from 1850 to 1950. These activities included water development, commercial fish harvest, timber harvest, livestock grazing, and introduction of nonnative salmonids. The devastating affects of these threats is discussed in detail in the section describing the background status of BCT in this document. Although most of these activities still occur to some extent in different regions of the Bonneville Basin, there is no longer the same level of devastating impacts on BCT and its habitat that resulted in wide-spread habitat destruction and BCT population demise. Regulations are in place to control fish harvest, fish stocking and land-use which incorporate an emphasis on the long-term persistence of BCT.

This is not to say that threats have been eliminated. Localized areas continue to be impacted by specific problem activities. However, mechanisms are in place, through Federal, State and local conservation and land-use plans to identify these activities, correct the problems and protect BCT populations. In addition, State, wildlife and Federal land management agencies have been implementing conservation actions that have led to substantial improvements in the status of BCT and its habitat. These agencies have incorporated conservation of BCT into their fundamental planning documents which should ensure continued improvements into future years. This is evidenced by the improved status of BCT throughout its range in the past three decades. The greater concern to the Service is the effect of cumulative impacts of wide-range watershed and land-use activities such as recreation and resource development. At this time, regulatory mechanisms are in place to address these issues; however it is important to track the ongoing trend of BCT to ensure these regulatory mechanisms are being enforced and are adequate to ensure protection of BCT throughout its range.

More information is needed on threats such as whirling disease before its full potential for affecting the long-term persistence of BCT can be assessed. Whirling disease was introduced into North America in the late 1950s and has primarily damaged wild RBT populations where the parasite becomes established. Although other salmonids may also be infected, the extent of disease manifested in other salmonids has not been fully assessed.

The life cycle of the parasite involves a robust spore that can withstand freezing and dessication. In addition, the spore can persist for years or even decades and is therefore very difficult to eradicate from water systems. When ingested by a tiny common aquatic worm, *Tubifex tubifex*, the parasite transforms into its more fragile state that must infect young fish within several days or it will die (Whirling Disease Foundation 2000).

Whirling disease is caused from *Myxobolus cerebralis*, a metazoan parasite that penetrates head and spinal cartilage of young-of-year salmonids. Once into the cartilage, the parasite multiplies quickly affecting equilibrium of the fish. This can cause the fish to swim erratically or to have difficulty feeding or avoiding predators. If surviving into adulthood, fish with whirling disease can reproduce without passing on the disease; however they may suffer from skeletal deformities

and upon their demise, even undiseased fish will release the parasites into the waters. Recent research indicates that disease manifestation varies depending on species, extent of infection, age of fish, habitat conditions and other variables.

Within the range of BCT, whirling disease has been confirmed in several major water systems. Three of major concern for BCT include the Logan, Weber and Provo river drainages. Although documented in certain reaches or streams in these drainages, not all portions of the drainage are contaminated. Isolated or inaccessible headwater reaches may not be affected. To date, there have been no documented population declines of BCT attributable to whirling disease. At this point, it is unclear if such a demise is inevitable or not likely. Based on results of studies as summarized in the 6th Annual Whirling Disease Symposium and based on conversations with state fisheries managers and fish health experts in the Bonneville Basin, the following are some general notes pertaining to whirling disease in cutthroat trout (Granath 2000).

Spatial and temporal factors may play a role in the extent of damage to cutthroat populations from whirling disease. Timing of reproduction may influence extent of infection if cutthroat larvae are hatched before or after the peak concentrations of the parasite. It has been further hypothesized that fluvial cutthroat trout may migrate to headwater reaches of streams to spawn where hatched larvae may be either outside the range of contaminated reaches or amidst habitat conditions where the tubifex worms and spores may not or are less likely to accumulate in damaging or lethal concentrations. However, studies are preliminary and little can be predicted about the long-term impacts of whirling disease on cutthroat populations. In addition, one study suggests that cutthroat trout simply may develop less severe physiological disease compared to RBT.

Overall, recent research on whirling disease has uncovered substantial information being utilized in management and control of spread of this disease. Federal, state and private sport-fishing interests have invested much effort and funds into finding a way to eradicate, control or cure whirling disease. Although not necessarily intended for the conservation of native cutthroat, on-going research undoubtedly benefits these native populations as managers seek to sustain, and/or protect wild nonnative fisheries. In addition to research, fisheries health programs are focused on frequent and comprehensive testing of natural water systems and hatchery facilities to ensure early detection of the parasite. Strict regulations on fish culture, transport and angling have been implemented. Also, public education programs on whirling disease and how to prevent its spread by the angling public are becoming widespread throughout angling communities.

Stocking of RBT and other nonnative salmonids continues to be a potential threat that may not be adequately addressed at this time. Although recent surveys and research indicate hybridization between BCT and other nonnative salmonids is not as prevalent as previously thought, the threat of hybridization remains in drainages where RBT are stocked in close proximity to pure BCT populations or where stocking of these species prevents reintroduction or colonization of BCT. The State wildlife agencies have in some cases implemented or have indicated a willingness to revisit or modify stocking plans in upcoming years. Yet, nonnative salmonids continue to be upheld and promoted for stocking and in hatcheries to satisfy angling demand. Use of BCT for

large-scale sportfishing stocking purposes has not been seriously entertained. RBT continue to be reared in hatchery systems and stocked into waters without serious investigation into the feasibility of using BCT in some situations. Although some State stocking protocols have been changed to prevent stocking of nonnative salmonids into BCT streams, the success of proposed and implemented changes on reducing the threats from hybridization, competition and predation of nonnative salmonids on BCT is yet to be seen. Overall, the State wildlife agencies appear to be directing focus on the problem of widespread stocking of nonnative salmonids.

Future Conservation of BCT

Based on the development and implementation of conservation plans and agreements by Federal, State and local organizations, it can be projected that the status of BCT will continue to improve over the next decade. Currently, Idaho, Nevada, Utah and Wyoming have developed and/or are participants in conservation programs for BCT both through State wildlife management plans, cooperative conservation agreements, and through Federal land-management planning. The extent and effectiveness of land-use emphasis on the conservation of BCT varies among different National Forests and BLM districts; however, most Federal land-management plans have incorporated planning for the protection and conservation of BCT in its native range.

Although not binding, these programs are currently being implemented voluntarily at varying levels of resource commitment. As such, they provide an element of security for the future long-term conservation of BCT. In addition, the general public has become more aware of both the inherent value of BCT and its value as a sportfish such that BCT conservation is supported through local fishing organizations (Trout Unlimited) and the general fishing public to a much greater extent than 20 years ago. This public support for BCT is expected to continue to increase as BCT become more common and BCT conservation and angling is promoted through State angling programs.

There are several examples of the increased public awareness of the value of BCT as a native species. In 1998, the Utah State Legislation designated BCT as the State Fish of Utah replacing the nonnative RBT. In the west deserts of Utah, local land-owners are working with the Service, UDWR, the Goshute Tribe and TU to construct ponds, improve habitat and develop and monitor brood sources of pure BCT which will provide fish for future reintroduction and supplementation projects. Whereas in past decades, the local community in the west deserts of Utah was not supportive of BCT restoration efforts which they viewed as a threat to local RBT fishery and land-use, in the past few years, the community has become involved in restoration activities and is gaining ownership in efforts to reestablish their native salmonid, BCT.

In Wyoming, WGF developed a program to promote angling for native cutthroat species, the 'CutSlam' Program, through which anglers can get State recognition for catching all four native cutthroat trout of Wyoming including BCT. In addition, WGF continues to monitor existing BCT populations and implement population and habitat restoration projects where opportunity exists.

On the Smith's Fork of the Bear River in Wyoming, local livestock ranchers (formally organized

as the Smith's Fork Grazing Association) have collaborated with the BLM, TU and other interested parties to develop watershed improvement guidelines and livestock grazing plans. Some activities include hiring extra personnel and technical consultants, constructing structural habitat improvements, and developing protocols for livestock grazing (see more detailed description of these efforts under Conservation Actions for the BRGU). The resulting management plan and observed watershed improvements are an example of the success that can ensue from cooperative planning among land-users with different interests. Although not all problems are resolved immediately, these cooperative efforts provide a vehicle for finding resolution to land-use conflicts and for funding watershed improvements and BCT restoration projects.

There are numerous federal and state regulatory mechanisms that, if properly administered and implemented, will continue to provide protection for BCT and its habitats throughout the range of the subspecies. In addition, the USFS, state game and fish departments, and NPS reported numerous ongoing projects that are completed or being completed for the protection and restoration of BCT and their habitats. In addition, each state wildlife agency has in place conservation plans, conservation agreements or other such interagency cooperative efforts to ensure the long-term persistence of BCT. A range-wide Conservation Agreement was recently finalized and includes all four state wildlife agencies as well as the Service, USFS, BLM, URMCC and NPS. Such an agreement is anticipated to improve coordination and effectiveness of conservation actions across state boundaries.

Specific conservation actions are discussed and described at semi-annual inter-agency meetings of BCT experts (agency and academic). Originally meetings to review actions described under the Utah conservation agreement for BCT, these meetings have expanded to include Wyoming, Idaho and Nevada State and Federal agencies. Aquatic managers and BCT experts review upcoming plans for conservation actions as well as describing actions implemented in the past field season. In addition, general topics related to native cutthroat trout management is discussed and the group provides a forum for developing standards on different issues such as assessing purity, chemical treatments for restoration, brood source development, inter- and intra-basin transfers and stocking protocols as well as other general topics.

These meetings include participation by all four State wildlife management agencies as well as by the main Federal land management agencies, Trout Unlimited and local academic experts and some private citizens active in BCT conservation. Funds are allocated from different sources including State sportfishing monies, Federal Aid in Sportfishing monies and Federal land management agency funds and administered cooperatively among involved agencies. Coordination among agencies and groups and increased funding has led to substantial success and effectiveness in implementing conservation efforts in every GU. Specific conservation actions implemented are described within sections of this document describing BCT status among drainages and GUs.

VII. FINDINGS

The Service has compiled and analyzed to the extent possible the most recent and best scientific and commercial data available on BCT to complete this status review. This information included published and unpublished reports, manuscripts, books and data, comments, memorandums, letters, phone communications, email correspondence and informational gathering meetings. In addition, those considered species experts on BCT were provided opportunity to comment on the data used in this report to ensure it was the most accurate and updated information available and that it was interpreted accurately.

Based on this analysis, the overall the status of BCT has improved in every GU since the 1970s when researchers first began to investigate the status of BCT for the purpose of its long-term conservation. Currently, BCT occupy a total of 1372 km (852 mi) of stream habitat and 28,352 ha (70,059 ac) of lake habitat with a total of 291 populations. Remaining potential exists to discover additional BCT populations in streams which have not been recently surveyed or explored. This potential is greatest in the Bear River and Northern GU which contain extensive natural water systems. Viable, self-sustaining BCT populations occur within all five Geographic Units, including remnant populations in each of these areas. Almost every major drainage within the five GUs supports BCT populations, either remnant or reintroduced. Furthermore, unsurveyed streams exist which may reveal additional remnant BCT populations as yet unidentified. The potential for finding new remnant BCT populations is particularly true for the NGU which contains extensive water bodies with abundant water in inaccessible and undeveloped watersheds.

Although these numbers are very likely lower than the historical number of populations, the number of known pure BCT populations has increased by an order of magnitude or more in the past three decades. Based on information from early accounts of pioneer settlement and early descriptions of land-use and wildlife management, a noted decline in BCT populations occurred from 1850 to 1950. This decline was due to devastating impacts from land-use activities such as extensive water development, overharvest of fish through commercial industry, nonnative salmonid introductions, tie-hacking of timber, and improper livestock grazing. Although threats have by no means been eliminated, the devastating disregard for land and wildlife no longer occurs to the extent that it did from 1850 to 1950. In addition, the majority populations are located on lands publicly owned and managed by the USFS, NPS and BLM. Although some acute problems occur on lands managed by these agencies, public ownership provides some element of protection from development and guarantees public review of major activities which may adversely affect wildlife through compliance with NEPA.

Numerous Federal and State regulatory mechanisms exist that, if properly administered and implemented, protect the long-term persistence of BCT and its habitat. However, this is dependant on the ability of those agencies to appropriate adequate resources, (personnel and funding) towards fulfilling their responsibilities to environmental protection. Where regulations are not adequately enforced, BCT can be adversely impacted. According to information collected for this review, the level of adequate Federal and State regulation varies among areas

and among agencies but generally has been improving over the past 30 years. Although some problem areas still exist, the commitment from these agencies for the protection of environmental resources including BCT is greater than it has ever been. In addition, there is more collaboration with local communities and local governing entities with State and Federal agencies which allows more amicable resolution to land-use conflicts and better funding and commitment to conservation activities for BCT. However, the Service remains cautious about future management and will necessarily reevaluate the status of BCT if this trend towards improving wildlife and land management ethics appears to be reversing or if it is not timely to ensure long-term persistence of BCT. The Service's commitment to state and range-wide conservation agreement programs provides a means for the Service to annually track the status of the species, the level of threats and success of conservation actions.

The improved status of BCT in the past 30 years, can be attributed to: increased sampling effort, improved technology for identification of pure populations (both genetic and meristic), population expansion efforts (transplants and brood source development) that have resulted in establishment of additional pure BCT populations, and improved habitat and flow conditions in some streams. Because current management plans are ongoing and describe BCT conservation activities for future decades, it is likely numerous pure BCT populations will continue to be identified, additional reintroduced BCT populations will become established, and stream habitat and flow conditions will continue to be improved. There will likely be a point at which the status of BCT will stabilize as surveys are completed and conservation activities are completed.

Although it is impossible to know the societal values of the future, based on the current societal climate it is likely the public will continue to support the protection and restoration of BCT in future decades. Also, land-use ethics and land-use has been changing to improve stream habitat conditions for BCT. Although some threats continue and may increase, the trend is for an improved status of BCT throughout its range into future years. Most threats are being addressed through existing management plans and at this time do not threaten the long-term persistence of BCT. Those that are not adequately addressed are not severe at this point to the extent that they threaten the long-term persistence of BCT. If the severity of threats changes in the future or if future research or newly acquired information on the level of threats changes such that the status of BCT or its habitat degenerates in the future, the status of BCT should be reevaluated. Such a reversal in trend will be apparent to the Service through involvement and commitment to state and range-wide conservation agreement programs.

Based on this analysis, the trajectory of BCT status is towards an increasing number of populations, reduced threats and improved habitat conditions. Although some populations may be more impacted than others by future development, land-use and stocking, at this time, there is no indication that BCT is endangered with extinction or likely to become threatened with extinction in the foreseeable future throughout its range or in any of the five distinct geographic units within its range. This conclusion is based solely on the status of BCT and its habitat within its native range.

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