Range-Wide Status Assessment for Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouvieri*): 2006

March 2007

Dedication

His peers on the Yellowstone Cutthroat Trout Interagency Coordination Group dedicate this report to Bruce May. Bruce was the lead author and driving force behind this report. He has long championed the cause of status assessments for cutthroat trout throughout the west, highlighting the need for improvement in our capabilities to measure progress in restoration and conservation efforts. The future of cutthroat trout is in better hands today, in part because of the efforts of Bruce May.

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This status assessment was developed and completed under the oversight of the Yellowstone Cutthroat Interagency Coordination Group, who in addition to representing the primary authors and the many biologists associated with the coordination group, contributed information and editorial oversight necessary to the completion of this status report. Members of the coordination group are representatives of the entities that were signatory for the range-wide conservation agreement for Yellowstone cutthroat trout. Special acknowledgement is given to Montana Fish, Wildlife & Parks, Idaho Department of Fish and Game, members of the Greater Yellowstone Coordination Committee and the USDI Fish and Wildlife Service for funding the database update and completion of this report.

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Executive Summary

The distribution and abundance of Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*; YCT) has changed substantially from the historical conditions that existed when European “discovery” of the western portion of North America occurred in the early 1800’s. Factors associated with these changes have been linked to anthropogenic influences that accompanied early settlement of the west. In recent years, there have been numerous efforts to describe the changes that have occurred. Early status assessments for YCT described the changes in general, qualitative terms; however, few assessments applied a quantitative approach that could be replicated through time. A detailed description of the changes in the assessment methods through time can be found in Appendix A.

This (2006) status assessment represents the second iteration of an assessment approach designed to provide comparable information through time. Thirty-two fisheries professionals who had personal knowledge of YCT within the assessment area provided the information for this status assessment. These biologists served as representatives of 10 agencies and they had a combined level of professional experience of 480 years, of which 365 years were directly applicable to YCT conservation and management. Information associated with YCT was obtained through application of a consistent methodology that was developed specifically to provide information pertinent to cutthroat trout conservation. This status assessment used the National Hydrography Dataset (NHD), at the 1:24,000 map scale, coupled with geographic information system (GIS) tools and personal geo-database compatible with ArcGIS 9.0 as the base foundation for the status assessment. Fourth level hydrologic units (HUC) were used as accounting units for data storage and retrieval. YCT information for the status assessment was obtained during two workshops where groups of biologists (Appendix B) and data entry personnel completed the questions contained in the status protocol (Appendix C) and the information was entered into a geo-database. The status assessment also evaluated foreseeable population risks linked to disease and the maintenance of genetic integrity. A general population health evaluation was also completed for each conservation population of YCT.

Historical habitat for YCT was estimated to include 17,721 miles of stream and 61 lakes. These historical habitat estimates represented a refinement of historical estimates obtained in 2001 (i.e., 17,393 miles; 118 lakes). The estimate of currently occupied (conservation and sportfishing populations) habitat was 7,527 miles (43%) of historical habitat. The number of lakes currently occupied by YCT was estimated to be 205. The amount of stream habitat with genetic testing data increased to 4,052 miles (a 34% increase). Results showed that a substantial number of YCT occur in a genetically unaltered condition. In addition, there were another 1,854 miles of stream that were classified as untested and suspected to be unaltered based on the absence of hybridizing fish in close proximity to the YCT. Most YCT represent aboriginal populations and most occupied habitat is judged to be in excellent (14%) and good (52%) condition. Slightly more than one half of stream dwelling YCT co-existed with non-native fish. YCT densities were mostly in the 1- to 151-fish/mile density range. Much of the habitat currently occupied by YCT (65%) was located within federal jurisdictions or under the authority of tribal governments (e.g., Forest Service, National Park Service, the Crow Tribe, etc.). Eleven hundred and forty six miles were administered as wilderness.

A total of 383 separate YCT conservation populations (7,204 miles) were identified in the 2006 status assessment. This number was almost 100% higher than the number of populations identified in 2001. YCT conservation populations occurred in 35 of the 39 historical watersheds. Two hundred and sixty one (261) YCT populations were associated with only stream environments, 45 populations were associated with habitat that was composed of both stream and lake environments, and 76 YCT populations were associated with only lake environments. Many populations occupied less than 1 mile of stream habitat. Population numbers were variable and ranged from a few fish to nearly 100,000 fish. An evaluation of risk to genetic integrity indicated that populations occupying smaller less complex habitats were less likely to be at risk from hybridization. The majority of populations occupied less than 10 miles of habitat. These population were, however, much more likely to have smaller population sizes, reduced temporal variability and more apt to have simple habitat networks (e.g., non-networks or weak networks). The converse of these conditions was evident for populations occupying larger units of habitat. These populations tended to have higher population numbers and they occupied larger habitat networks resulting in higher temporal variability scores. These populations tended to be at higher risk to compromised genetic integrity. The risk of disease was judged as being minimal to low for most YCT populations regardless what other conditions prevailed.

Evaluation of restoration and expansion opportunities indicated that some options were potentially available. An appraisal of restoration or expansion potential for 6,970 miles of suitable habitat was completed as a component of the status assessment. The analysis indicated that between 15 to 40 % of the suitable habitat provided a reasonable opportunity for population restoration or expansion.

The 2006 status assessment substantiated that genetically unaltered YCT currently occupy significant portions of the historical habitat. Even though YCT tend to have a higher presence within the central core of the range, they do exist within many watersheds on the perimeter of the historical range. Data on conservation populations suggest that two different conservation strategies are reflected in the characterizations associated with the populations. One strategy is associated with reduced risks to genetic integrity and competition from non-native species, but the approach is also associated with lower population health conditions due to lower temporal variability and population size. The other strategy is associated with larger populations that occupied more diverse habitat networks. These larger populations have higher health scores associated with temporal variables and larger population size, but they reflect a greater risk to genetic integrity. Most populations were identified as having a minimal or low risk from disease.

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Introduction

This status assessment for Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri* YCT) was designed to compliment and expand upon the status assessment completed in 2001 (May et al. 2003). Like the former status assessment, this assessment provides a range-wide perspective built upon information obtained from several perspectives and at multiple scales or levels. The perspectives included a historical point of view, a current distribution perspective based on habitat occupancy of phenotypically correct YCT (e.g., cutthroat trout with an outward appearance of Yellowstone cutthroat trout), an effort to delineate discrete populations of YCT, and a perspective related to the potential for restoration or expansion of conservation populations. The various scales or levels, in ascending order, from which the information was developed included: the habitat feature level (e.g., a specific barrier); the habitat segment scale level for a given stream or lake; the complete stream or lake level; the watershed level based on hydrologic units (HUC) at different scales; the geographical management unit scale (GMU); the various administrative units (e.g., state and/or agency boundaries); and, the range-wide perspective.

Most previous YCT status assessments had various limitations based on a number of considerations (May et al. 2003). Those limitations included the following: 1) an assessment was conducted for only a portion of YCT historic range, 2) the assessment provided a range-wide perspective based on information extrapolated from a few localized areas from within the range-wide area, or, 3) the assessment suffered from a lack of consistency in how the information was obtained and applied. This assessment utilized a format and procedure initiated in 1993 (May 1996) and improved and expanded through application over a 13-year period of time[1] (Shepard et al. 2003; May et al. 2003; May and Albeke 2005; Hirsch et al. 2006)[2]. Environmental Site Assessment (ESA) listing findings (USFWS 2003; USFWS 2006) utilized information obtained through application of the status assessment procedure to a significant extent. Even though this assessment protocol (Appendix C) added a substantial number of new attributes and characterizations, a concerted effort was made to maintain a level of comparability for certain parameters of significance in evaluating the effectiveness of the conservation effort for YCT over the long term.

This status assessment was designed to utilize the collective knowledge of professional biologists involved in YCT conservation including fisheries professionals from Montana, Idaho, Wyoming, Utah and Nevada (i.e., state agencies, Park Service, U.S. Forest Service (USFS), Bureau of Land Management (BLM), Tribal, private, etc.; Appendix B).

In this assessment, we further fine-tune estimates of the historically occupied range and current distribution for YCT. YCT conservation populations identified in 2001 were re-validated and additional conservation populations were identified and incorporated into the database. Additional information and attributes (e.g., for lakes and streams) associated with the current distribution of YCT and the identified conservation populations were added to the database. A significant addition was the evaluation and prioritization of population restoration and expansion

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[1] Executive summary of YCT status for Montana, 1999. Author: Bruce E. May

[2] Applied to Rio Grande cutthroat in 2006 with report pending. Personal communication Shannon Albeke, SEAM Biometrics.

potentials. While this and the earlier YCT status assessment can be used to provide consistent information to the U.S. Fish Wildlife & Service (FWS) for ESA decisions, the longer-term and probably more significant use of these status updates continues to be as an information base to be used by individual states and other agencies, working collaboratively to assess, plan and prioritize ongoing and future YCT conservation efforts.

As is the case for most databases, especially of the size and complexity of this one, some information will be incorrect. Data entry errors and/or lack of full understanding of the assessment protocol by some fishery biologists are likely contributors to any incorrect information. It is imperative that subsequent status updates aggressively seek to correct these inconsistencies and errors. This report presents the YCT information as it currently exists in the database. As possible errors and inconsistencies were encountered, they were noted to facilitate future correction. Finally, it should be noted that this report does not address all the information contained in the database. The sheer volume of information that has been amassed makes it impractical to identify, analyze, and interpret all the information in a single report.

Analysis Area

The analysis area included all of the historical range of YCT within the western United States as identified in May et al. (2003). This area included, from east to west, the upper portions of the Yellowstone River Drainage within Montana and Wyoming and the upper Snake River Drainage in Idaho, Wyoming, Nevada and Utah. There were 39 4^{th} level hydrological units associated with the historical range (Appendix D). Similar to the 2001 assessment, this status assessment does not include information for YCT that have been introduced into areas outside of the watersheds of the historical range.

Within the assessment area two forms of YCT have been identified, a large-spotted form dominant in most of the upper Yellowstone River Basin and the lower Snake River Basin and a fine-spotted form dominant in portions of four watersheds in the upper Snake River Basin. In certain portions of the historical range, YCT representing both spotting patterns reside together in some habitat segments. This assessment, like the 2001 and other assessments, does not attempt to address or resolve the issue of whether the two differing morphologies represent different species or subspecies. That issue is beyond the scope of this assessment. What can be said is that genetic differentiation, based on spotting pattern, has not been conclusive at this point in time. The assessment protocol allowed for tracking and evaluating information based on spotting pattern. Using primarily empirical information, this report will provide information on the status of YCT from several perspectives including a broad overview of the entire assessment area based on information obtained at the site specific stream or lake segment level, a review of some information for the large and fine-spotted forms, a summary of specific conservation population status information, and a review of expansion and restoration potentials. To the extent practicable, the report discusses the change in conditions between the 2001 status assessment and this 2006 assessment. As acknowledged in the introduction, this report does not include or address all information that is contained in the database.

Methods

This status assessment used a standardized approach (Appendix A and C) with comparable protocols based on the foundation approach used in 2001 (May et al. 2003). The empirical information for this report was primarily provided by biologists who attended two workshops (Appendix B). Even though information sources varied from professional judgment to detailed aquatic sampling, consistency in application of the protocol was maintained by having one or two individuals attend each workshop to facilitate data entry, answer questions and settle disputes raised by workshop participants. We acknowledge that the approach applied was not designed to be random, nor were the sources completely independent; therefore, there are undoubtedly biases associated with some information. An effort to qualify and disclose the nature of the information, either by citation or application of an information source rating system (e.g., identifying information primarily based on professional judgment versus information provided by detailed level field observation and data collection) was applied to most characterizations. Data source tables were included in the database (Table 1). Information associated with judgment calls and anecdotal sources, in general, could be viewed as being less reliable and/or accurate than information developed as part of detailed surveys and studies that have undergone substantial analysis and review.

Geographic Information System and Database

The status assessment used the National Hydrography Dataset (NHD) as the base for the assessment (see http://nhd.usgs.gov/ for more information on NHD). The 1:24,000 scale NHD was used for all waters within the analysis area. The USDA Forest Service's Natural Resource Information System (NRIS) provided an ArcGIS event creation tool to geo-reference YCT population segments. The tool utilized a "point–and-click" user interface to reference these population segments against the NHD networks by creating route events. This assessment used GIS tools and personal geo-databases compatible with ArcGIS 9.0. To increase continuity and consistency only streams, primarily perennial, and lakes identified on the NHD data set had information entered into the database. We acknowledge that intermittent and ephemeral streams may provide habitat used by YCT during specific time periods. We also fully anticipate that some perennial streams that support YCT were not part of the NHD stream layer and were not included in this assessment. It is anticipated that these streams will be added as efforts to improve NHD occur. Based on the above protocol decisions and NHD stream layer limitations, this assessment provides for more conservative estimates of YCT distribution.

We used the 4th level hydrologic units (8-digit EPA designation) as the primary units for organizing data input from the fisheries professionals. We summarized historical range and current distribution information using this stratification. The U.S. Geological Survey (USGS) created the HUC system for the United States in the 1970's. This system divides the country into 21 Regions, 222 Sub-regions, 352 Accounting Units, and 2,149 cataloging units based on surface hydrologic features (Hydrologic Units Maps of the Conterminous United States 2002).

Database Summaries

Data provided by the fishery professionals were summarized directly from the geo-database using queries built within Microsoft Access. Summarized data were then copied to Microsoft Excel spreadsheets. These data were further reduced to produce tables and figures for the report.

Information summaries were based on watershed boundaries, state boundaries and other administrative boundaries associated with the historical and current distribution of YCT. Additional summaries of associated conservation populations were also provided.

To better assess existing regulatory mechanisms associated with land management for the habitats currently occupied by YCT, the "Identity" tool within ArcGIS was used to overlay NHD layers with both an ownership layer and the USFS Wilderness Areas layer. Route events of the NHD-ownership/wilderness layers were then generated and intersected with the YCT currently occupied route events to identify segments occupied by YCT that were within designated Forest Service wilderness, designated Forest Service "primitive" areas, wilderness study areas, Wild and Scenic Rivers, Research Natural Areas, National Parks and other ownerships. Stream segment lengths occupied by YCT within the above land management designations were then calculated.

Finally, issues directly associated with the logistics of data generation, entering data and data quality control were handled by making the effort a "real time" exercise. Two workshops were held and within each workshop specific working groups, consisting of fishery biologists and GIS-data entry personnel, generated the status information. In order to assure consistency and completeness, each specific work group (team) completed the entire assessment for a given 4^{th} level HUC before moving to another HUC. There were 39 4^{th} level HUCs analyzed within the delineated historic range of YCT. During the completion of the assessment, the work teams were asked to employ a systematic approach to insure that all pertinent information was provided using an orderly process. The use of 4^{th} level HUCs was for accounting purposes only. The actual stream layers, either as specific points, habitat segments or discrete populations, were attributed within a geo-referenced database.

Table 1. Example look-up table for data sources with a relative index for information reliability and accuracy.

Information 'Source	Relative Degree of Reliability
Professional Judgment	Lower
Anecdotal Information	Lower
News Accounts	Lower
Correspondence	Moderate
Data Files	Moderate
Agency Report	Moderate
Published Paper	Higher
Thesis or Dissertation	Higher

The geo-database was partitioned into four components. First, a historical component based on habitats believed to have been occupied by YCT at the time of the first European exploration (approximately 1800) of the Northern Rocky Mountains. The historical coverage map from the 2001 assessment was provided as a reference to initiate re-evaluation of historical distribution. Second, the current distribution of YCT based on habitat segments along with specific attributes (e.g., spotting pattern, fish density, genetic status, fish stocking history, presence of non-native species and habitat information) were re-evaluated and new information was entered in the geo-database. Current distribution information, from the 2001 status assessment, was provided to initiate current distribution re-evaluation. The third component, of the 2006 status assessment, was associated with re-evaluation of previously identified conservation populations and the identification of new populations. New information relating to the conservation populations was added to the geo-databases (Appendix C). Conservation populations were identified primarily on the basis of known or perceived reproductive interaction within a group of YCT occupying either an individual stream or lake or a network of connected streams and/or lakes. For each identified conservation population, the reproductive interaction had to be two directional resulting in both upstream and downstream exchange of genetic material. In addition to identifying several attributes of importance to each conservation population, a relative health evaluation was completed for all populations that occupied stream habitat. The associated risks to each population from genetic introgression and diseases were also determined. Health and risk determinations were intended to represent relative conditions indicating higher or lower levels of concern. It is important to note that YCT populations supported entirely by annual or routine stocking were not included as part of the current distribution or conservation population evaluations. The only exception was for YCT serving as wild broods that might require periodic stocking to bring in new genetic material as part of a brood maintenance program. The fourth component of the assessment was associated with evaluating the potential for restoration or expansion of conservation populations within the historical portion of YCT range that is not currently occupied by conservation populations.

Assessment Teams and Workshops

Information for this status assessment was primarily collected at two workshops. One workshop was held in Idaho Falls, Idaho during the week of May 1, 2006 and the other workshop was held in Billings, Montana during the week of May 8, 2006. At each workshop a systematic application of the assessment protocol was undertaken. During each workshop, fishery professionals who had relevant information or knowledge within each 4th level HUC worked collaboratively, within assessment teams, to provide information that was entered into the geo-database by data entry professionals. All fishery professionals were asked to bring field data summaries and reports from their areas of responsibility as reference materials, but some information was provided after the workshops had ended.

The Status Assessment Protocol

The 2006 status protocol closely mirrored the approach applied to status updates recently implemented for Bonneville cutthroat trout (May and Albeke 2005), Colorado River cutthroat trout (Hirsch et al. 2006), and Rio Grande cutthroat trout (In preparation). It was recognized that such assessments would contain substantial amounts of information based on expert opinion and that, particularly when historically occupied range was identified, the assessments would be qualitative and subjective.

Historical Range

Consistent with the 2001 YCT status assessment and other subspecies assessments, the period of European “discovery” of the West was set as the reference time period (~1800) for the historical range of YCT. It is likely that a pre-historical perspective of the distribution of YCT could have included expansions and contractions over geological time due to significant stochastic events (e.g., extended periods of abundant moisture or drought). For the time period between 1800 and the present time, we do have written documentation and personal accounts upon which to anchor a recent historical distribution perspective (May 1996). This historic perspective also reduces the amount of speculation associated with stochastic events, and allows for a determination of the significance of deterministic influences that have occurred subsequent to 1800.

Using the historical delineation of YCT range identified in 2001 (May et al. 2003), each assessment team re-evaluated the historical distribution contained in the 39 4^{th} level HUCs. In addition, lake environments believed to be part of the historical distribution were identified. Fishery professionals were asked to re-evaluate the historic distribution information in the geo-database and to make corrections and additions as appropriate. Four factors were considered in the historical distribution determination: 1) presence of complete geological barriers that would have limited YCT expansion; 2) tectonic or climatic conditions that could have made regions uninhabitable; 3) habitats where ancient populations may have been extirpated by stochastic events and the areas were unable to be re-colonized prior to 1800; and, 4) habitats judged as historically unsuitable were based primarily on judgment, thermal conditions, channel gradient, and/or insufficient stream flows (Appendix C). Important information sources were historical journals and scientific reports. Current occupancy of streams by cold-water biota was also used as a consideration in the rationale for inclusion of YCT within the historical range. This delineation of historical range refines the previous assessment completed in 2001. The projected historical distribution provided a baseline for comparison with information associated with current distribution, conservation populations and potentials for population restoration or expansion.

Barriers to Fish Movement

This status assessment re-verified barriers identified in 2001 and added to the barrier information with new information. Barriers to upstream fish movement have important implications for both historical and current status. Geological (i.e., bedrock waterfalls, naturally dry channel segments, etc.) and anthropogenic barriers were located and characterized. Geological barriers were re-evaluated for their influence on historical range. Other natural and anthropogenic barriers were re-evaluated when assessing current distributions and in re-evaluating various risks to conservation populations. Only barriers of believed significance were included in the geo-database (Appendix C).

Current Distribution

Using the current distribution map from 2001, current distributions of YCT for 2006 were re-evaluated. Only information from streams and lakes supporting YCT maintained entirely by natural recruitment were included in the geo-database. The exceptions were those habitats occupied by YCT that were part of a wild brood program. All YCT that occupied habitat included within the broad historical boundary were included regardless of level of genetic introgression and other considerations. Specific characterizations of the occupied habitat included genetic status, abundance, past stocking records, origin of YCT, migratory considerations, presence of competing species (principally non-native salmonids) and quality of habitat and relative width of stream habitat. Not all characterizations were applied to lake environments.

Genetic Considerations
For 2006, seven categories associated with genetic status were identified (Table 2). Five classes were associated with YCT that had been genetically tested and two categories were associated with YCT where no genetic testing had been completed. Genetic sampling involved many complex issues that made clear interpretation and reporting of genetic results difficult. For a more complete discussion regarding these complex issues we suggest reading Appendix D in Shepard et al. (2003).

Table 2. Genetic categories used for assessing genetic status of Yellowstone cutthroat trout in 2006.

Code	Genetic Status
1	Genetically unaltered (<1% introgression detected) as a result of introduced species interaction–tested via electrophoresis or DNA
2	≥1% to ≤10% introgression (hybridized) with introduced species – tested via allozyme or DNA and introgression indicated to be from a hybrid swarm
3	>10% to ≤25% introgression (hybridized) with introduced species – tested via allozyme or DNA and introgression indicated to be from a hybrid swarm
4	>25% introgression (hybridized) with introduced species – tested via allozyme or DNA and introgression indicated to be from a hybrid swarm
5	Not genetically tested -- Suspected unaltered with no record of stocking or contaminating species present
6	Not genetically tested -- Potentially hybridized with records of introduced hybridizing species being stocked or occurring in stream
7	Hybridized and pure populations co-exist (sympatric mixed-stock) in stream (use only if there is evidence of reproductive isolation, non-random mating, and/or genetic testing has been completed)

The levels of introgression we assigned for genetically tested stream segments were based, in part, on the literature but they also linked to conservation planning considerations. For our genetically unaltered ("pure") category, we selected less than 1% introgression as the basis for identifying genetically unaltered YCT. Most genetic sampling is designed to detect at least a 1% level of genetic introgression within a standard sample size of 25 fish (Utah Division of Wildlife Resources 2000). The next three levels (i.e., ≥1% to ≤10%, >10% and ≤25%, and >25% introgression) were assigned based primarily on conservation planning considerations. For the group tested from ≥1% to ≤10% introgression, there are indications that the phenotype and morphological characteristics of the YCT were not distinguishably different from individuals in populations known to be genetically unaltered (Leary et al. 1996; Campton and Kaeding 2005). YCT tested and found to fall within the >10% and ≤25% and even the >25% categories could still appear to be genetically unaltered to the untrained eye.

Abundance, Habitat Quality and Quantity, Fish Stocking, Origin of YCT, Migratory Life History, and Presence of Non-Native Fish
Density characterizations for YCT in the 2006 status information were changed from a purely qualitative determination (May et al. 2003) to determinations based on quantification of sexually mature YCT numbers for each occupied habitat segment (Table 3). YCT densities were based on number per mile. Sexually mature adults were defined as those YCT with minimum lengths of 15 cm for small streams and lakes with non-migratory fish to minimum lengths of 30 cm for

larger streams, rivers and lakes with non-migratory and migratory fish. Included were those YCT that utilized stream habitat to support recruitment to lake environments. In addition, several new characterizations were added to the 2006 status assessment. These characterizations provided information on fish stocking, habitat quality, stream width, origin of YCT, migratory life histories and presence of non-native fish. These characterizations were added to the geo-database for the current distribution.

The sources of current distribution characterizations were identified and entered into the geo-database. These new parameters associated with current distribution were discussed in Appendix C.

Table 3. Sexually mature YCT density ranges (Check the one that best applies).

Code	Mapping Segment Adult Fish Density
1	0 to 50 fish per mile (Specific density within this range, if available__________)
2	50 to 150 fish per mile (Specific density within this range, if available__________)
3	151 to 400 fish per mile (Specific density within this range, if available__________)
4	401 to 1000 fish per mile (Specific density within this range, if available__________)
5	Over 1000 fish per mile (Specific density within this range, if available__________)
6	1001 to 2000 fish per mile (Specific density within this range, if available __________)
7	Over 2000 fish per mile (Specific density if available __________)
8	Unknown

Conservation Population

Conservation populations were also re-evaluated in the 2006 database update. The 2001 information served as a reference for re-evaluation of YCT conservation populations. As with the 2001 status assessment, a determination was made relative to which occupied habitat segments supported discrete groupings of YCT. In many cases the populations identified in 2001 were re-affirmed and new attribute information was added to the geo-database for these populations. In other instances, a new population was identified and attribute information was added to the database.

The major criterion for identification of an individual conservation population continued to be associated with the potential for reproductive exchange within a grouping of occupied habitat segments (e.g., lakes and/or streams). Reproductive exchange (i.e., genetic drift) had to be associated with the potential for genetic material to be exchanged in both an upstream and downstream manner. As such a complete or total passage barrier could not subdivide a conservation population. Each conservation population was given a population qualifier characterization based on the interagency decisions contained in a genetic management position paper (Utah Division of Wildlife Resources 2000). Conservation populations were further characterized based on degree of within population connectedness into population networks (e.g., a single stream versus many streams). Conservation populations could be genetically unaltered (i.e., core conservation populations) or selected based on specific attributes of conservation significance in the presence of genetic introgression (i.e., conservation populations). The level of introgression was of secondary importance for non-core conservation populations.

For each conservation population a set of characterizations were added to the geo-database. These characterizations included qualitative identification of human influences associated with each population. Also identified were the conservation actions applied to each conservation population. Generalized risk evaluations for both genetic integrity and disease were completed for each population, as was a general or relative health evaluation (Appendix C).

Genetic Risks
Genetic risk was defined by the nature of potential or continued introgression of YCT genetics within a conservation population. Distance from potential sources of non-YCT genes and the presence of barriers between those sources and the conservation population were the two primary components of the genetic risk assessment (Table 4). Nonnative salmonids that could potentially hybridize with YCT were considered as posing a risk to YCT genetic integrity.

Table 4. Ranks and descriptions used for assessing genetic risks to designated conservation populations of Yellowstone cutthroat trout in 2006. Hybridizing species includes any introduced species or subspecies that could potentially hybridize with Yellowstone cutthroat trout.

Rank	Genetic Integrity Risk Characterization
1	Introduced potentially hybridizing fish **cannot interact** with existing YCT population. **Barrier provides complete blockage to upstream fish movement or potentially hybridizing fish are not present in same or adjacent drainages**.
2	Introduced potentially hybridizing fish are in same stream and/or drainage **further than 10 km** from YCT population, but not in same stream segment as YCT, **or within 10 km of existing barriers that may be at risk of failure.**
3	Introduced potentially hybridizing fish are in same stream and/or drainage **within 10 km of YCT population and no barriers exist** between introduced species and YCT population. However, introduced hybridizing species have not yet been found in same stream segment as YCT population.
4	Introduced potentially hybridizing fish are **sympatric** with YCT.

Disease Risks
A disease risk assessment was made for each conservation population using a numerical ranking based on level of risk (Table 5). The ranking included five characterizations based on distance from potential sources of disease and the presence of barriers between those sources and the conservation population. Population isolation and security were again viewed as important considerations but they could not be viewed as absolutes given that contamination could be associated with avian or human sources. The catastrophic diseases of concern were those that could cause severe and significant impacts to overall population health. These diseases included but were not limited to whirling disease, furunculosis and infectious pancreatic necrosis virus.

Table 5. Ranks and descriptions used for assessing disease risk to designated conservation populations of YCT in 2006.

Rank	Disease Risk Characterization
1	Significant diseases and the pathogens that cause these diseases **have very limited opportunity to interact** with existing YCT population. Significant disease and pathogens are not known to exist in the stream or watershed associated with YCT population. **Barrier provides complete blockage to upstream fish movement**. Stocking of fish from other sources does not occur.
2	Significant diseases and/or pathogens have been introduced and/or identified in the same stream and/or drainage **further than 10 km** from the YCT population, but not in same stream segment as YCT, **or within 10 km of existing barriers that may be at risk of failure.** Stocking of fish from others source areas requires fish health screening and pathogen free clearance.
3	Significant diseases and/or pathogens have been introduced and/or have been identified in the same stream and/or drainage **within 10 km of the YCT population and no barriers exist** between the disease, pathogens and/or diseased fish species and the YCT population. However, diseases and/or pathogens have not yet been found in same stream segment as the YCT population.
4	Significant disease and/or pathogens and disease carrying species are **sympatric** with YCT in same stream segment but YCT have not tested positive.
5	YCT population is known to be positive for significant disease and pathogens are present. YCT population has a history of impacts from significant diseases. Environmental and/or biological conditions may have intensified disease impact.

Population Health Evaluation

A generalized population health evaluation was completed for each conservation population using an indexed ranking that included consideration of four factors (Appendix C). General population health was indexed by a rating from low to high using a numerical ranking applied to the four variables. The basic approach was consistent with the approach proposed for evaluating extinction risks for salmonids (Rieman et al. 1993) and the approaches applied in the medical profession for evaluation of personal and population health of humans. The basic premise is based on the assumption that expressed conditions associated with certain attributes can be used to estimate general health or overall well being. The first variable (attribute) in the population health evaluation was temporal variability defined as the total stream miles occupied by the conservation population. Total miles were obtained from the habitat segment information in the current distribution geo-database. The general health rationale associated with this variable was linked to the assumption that larger amounts of occupied habitat would be equated to larger drainage basins that would support more stable flow conditions and higher habitat and watershed complexities necessary for protection and maintenance of a diversity of YCT life histories.

Population size of YCT was the second variable considered important to population health. Total numbers of sexually mature YCT (15 cm and larger) were obtained from the fish density information in the current distribution geo-database. For each population, the estimate of total adult fish was obtained by multiplying fish density for each occupied habitat segment by the miles of stream for that segment and then aggregating these segment estimates into a total estimate for the population. The size criterion was believed to reasonably reflect the sexually active component of a YCT population (e.g., grossly approximating an effective population).

This size criterion could be related to multiple age classes of YCT within a population. Multiple age classes may provide an advantage in maintaining population resilience.

The third variable was associated with population production potential for the occupied habitat. The subcomponents for this variable were habitat quality, disease risk and presence of non-native fish, principally non-native salmonids. High quality habitats provide necessary the environment to enhance year class survival and population production that can favorably influence population resilience and persistence. Disease and competition with non-native fish can serve to nullify the benefits of habitat quality. The health score for production potential was obtained by determining the proportion of occupied habitat characterized by the various quality considerations (e.g., excellent, good, fair or poor). The presence of disease and/or non-native species served to lower the health score.

The fourth variable was the degree of population connectivity based on the nature of the habitat networks. It was assumed that YCT and most other cutthroat trout subspecies would continue to exist in relatively small patches of habitat (Dunham et al. 2002). That being the case, population health was believed to be enhanced by more complex habitat networks (e.g., multiple streams), even within relatively small patches of habitat. Stochastic and possibly deterministic influences may be dampened by the complexity of the habitat network. Strong habitat networks (e.g., more that 5 streams) increase the opportunity for movement of individual fish within the population, thereby potentially reducing negative influences resulting from stochastic and deterministic influences. The health determination for within population connectivity (nature of habitat networks) was derived by summing the number of streams associated with a given YCT population.

A composite score of the individual variables was developed into an overall health score for each population by applying weighted coefficients to each health variable and developing a composite score or rating. These coefficients were 0.7 for temporal variability, 1.2 for population size, 1.7 for population production potential, and 0.5 for within population connectivity. The weighted coefficients were initially obtained for the 2001 YCT status assessment (May et al. 2003) through consultation with a co-author[3] of the Rieman et al. (1993) report. The same coefficient values have been applied to the population health evaluations for westslope, Colorado River, Bonneville, Rio Grande and Greenback cutthroat trout.

Several other characterizations associated with the conservation population were included in the geo-database. Details on these attributes can be found in Appendix C.

Evaluation of YCT Population Restoration and Expansion Opportunities

Evaluation of potential population and expansion opportunities was based on a review of historically occupied stream segments and lakes that were not currently occupied by conservation populations. The upper and lower bounds for stream segments and lakes not occupied by conservation populations were identified and evaluated. Each assessment team systematically proceeded to identify and evaluate YCT restoration and expansion opportunities using the historical habitat layer within each 4th level HUC as a base that was over laid with the

[3] Personal communication with Danny Lee, co-author of the Rieman et al. 1993 report.

coverage specifically associated with conservation populations. Unoccupied habitats were identified and attributed. Locations of complete barriers, or partial barriers having the potential to be upgraded to complete barriers, were logical break points for the unoccupied habitat segments.

Only historically occupied habitat was evaluated in this exercise. Other suitable habitat (i.e., suitable habitat not identified as historical) should be dealt with in subsequent analyses. The initial step was to identify which historical habitats were no longer suitable for sustaining YCT populations. The associated reasons for the unsuitable determination were linked to physical habitat (e.g., insufficient flows or degraded habitat), temperature conditions or both (Tables 6 and 7). The evaluation of potential restoration and expansion opportunities was applied to the remaining habitat segments.

Table 6. Criteria used to determine habitat inability to support self-sustaining populations of Yellowstone cutthroat trout. (Identify the one that best applies).

Code		Non-native Fish Stocking and/or Presence Status
1	H	The stream or stream segment has habitat that is incapable of supporting a self-sustaining population of YCT (i.e., there are severe habitat deficiencies).
2	T	The stream or stream segment has water temperatures that preclude supporting a self-sustaining population of YCT (i.e., water temperatures that are too high or too low).
3	HT	The stream or stream segment has both habitat and temperature deficiencies.

Table 7. Source of information used to judge habitat capability for restoration or expansion of Yellowstone cutthroat trout. (Identify the one that best applies).

Code	Source of habitat information
1	Judgment, extrapolated information from other streams
2	Judgment with ocular reconnaissance
3	Spot habitat sampling
4	Trend habitat sampling
5	Detailed habitat sampling

Barrier locations were the primarily factor used to identified habitat segments to be considered for restoration or expansion potential. Each habitat segment was evaluated for restoration or expansion potential based on four variables that included fish stocking and/or presence of fish, habitat quality, significance of any associated fishery, and complexity of fish removal (Appendix C). Each variable was rated on a scale of 1 to 4 with 1 being the highest potential and 4 being the lowest potential. The ratings for the four variables were combined into a composite score. For this exercise all variables were weighted equally (Table 8).

Table 8. Summary of factors considered in the assessment of restoration or expansion potential.

Variable	Description	Rank	Criteria
Biological Considerations Associated with YCT Restoration Opportunities	Specifically addresses the biological considerations associated with the presence of other trout in potential restoration segments.	1	No record of fish stocking and the segment is barren of fish
		2	Hybridized YCT are present in the absence of other trout and segment is not part of a conservation population.
		3	YCT may be present and non-native trout are present in low numbers. Segment is not part of conservation population.
		4	YCT maybe present and non-native trout are present in high numbers. Segment is not part of conservation population
Habitat Considerations Associated with YCT Restoration Opportunities	Specifically addresses habitat quality of potential restoration segments.	1	Excellent habitat quality
		2	Good habitat quality
		3	Fair habitat quality
		4	Poor habitat quality
Social and Political Considerations Associated with YCT Restoration Opportunities	Specifically addresses the relative significance of an existing fishery.	1	No fishery present.
		2	Minor fishery (i.e., minimal use)
		3	Moderate fishery
		4	Major fishery (i.e., significant use level)
Relative Complexity Considerations Associated with YCT Restoration Opportunities	Specifically addresses the complexity of non-native trout or hybrid YCT removals (chemical or physical).	1	No fish present
		2	Minor complexity.
		3	Moderate complexity.
		4	Major complexity.

Results and Discussion

Workshops, Assessment Teams, and Use of HUCs as Accounting Units

Two workshops were held to obtain the information for this status assessment. One workshop was held in Idaho Falls, Idaho and the other workshop was held in Billings, Montana. At each workshop, a systematic application of the assessment protocol was undertaken (Appendix C). A total of 32 fisheries professionals provided information used in the 2006 assessment. These biologists represented 5 state agencies, 3 federal agencies and 2 private organizations. In addition to the fisheries professionals, 14 GIS and data management specialists participated in the workshops to assist with data entry and display of status information. At each workshop consistency was maintained by having an individual with knowledge of the protocol and procedure in attendance at both workshops. GIS and database oversight at each workshop also ensured consistency and continuity. Some GIS specialists participated in both workshops. To the degree possible, the information on YCT was quality control checked and edited at each workshop.

Fisheries professionals associated with the 2006 YCT status assessment had experience levels ranging from several months to several decades. Collectively, these fishery professionals had a total of 480 years of professional fisheries experience, of which 365 years (77%) were directly applicable to YCT conservation and management. The majority of participants had Master of Science degrees (26), 4 had Bachelor of Science degrees, one had a Master of Art degree, and one had a PhD (Appendix B).

A total of 39 4th level HUCs were re-evaluated during the 2006 status assessment. Each hydrologic unit was associated with an eight-digit identification number. Application of a 1:24,000 scale NHD stream layer and comparable lake layer were used to facilitate tracking of pertinent status information. Attribute information for the four parts (e.g., historical, currently occupied habitat, conservation populations and restoration or enhancement potentials) of the status assessment were captured in a geo-database specifically designed for YCT. In total, there were 87, 976 GIS records and 33,109 attribute records associated with this status assessment. Not all information in the geo-database will be presented and discussed in this report. It is anticipated that other reports and papers will be developed in the future as the information is updated and used in the coordinated conservation program.

Historical Distribution

As previously described, the historical perspective for this status assessment was based on habitat hypothesized to be occupied by YCT when early European explorers entered western portions of the North American Continent (circa 1800 AD). Anecdotal information contained in journals and diaries of early visitors to this region of the North American continent provided some supportive information for inclusion or exclusion of YCT habitat in the historical database. The information contained in this 2006 assessment serves as a refinement of the historically occupied habitat presented in the 2001 status assessment. The 2001 status assessment utilized a process that required biologists to make specific notations on historical occupancy maps. This information was then transposed onto a 1:100,000-hydrography stream layer. For this status assessment, the 2001 historic the distribution was converted to the 1:24,000-NHD stream coverage. The resulting coverage was used as a template for re-evaluation of historical distribution. The 2006 status assessment also added lakes to the inventory of historically occupied habitats. These changes were added to the geo-database using tools in ArcGIS 9.0.

The base NHD 1:24,000 scale stream coverage contained just over 133,714 miles of stream channel. Included in this mileage were a significant number of ephemeral and intermittent channels that would not have been capable of supporting YCT. Conversion of the base historical distribution, determined in 2001, to the NHD 1:24,000 scale coverage, along with a minor amount of adjustment based on re-evaluation, resulted in the removal of a total of 115,994 miles (87%) of stream channel that were judged as being incapable of historically supporting YCT. Stream miles that were excluded included a significant number of streams with ephemeral or intermittent flows, mislabeled canals and ditches, stream segments above complete fish passage barriers that would have precluded YCT occupancy on or before 1800, and stream segments that were judged to have insufficient habitat necessary to support YCT populations.

For the stream segments above complete passage barriers, the location and type of barrier (e.g., waterfall, velocity, temperature, etc.) were noted. All historical barriers had to be a complete blockage to upstream fish movement and they were identified in the database as having historical significance. At the completion of this systematic review, approximately 17,721 miles of stream habitat were judged as having the potential of being historically (circa 1800) occupied by YCT (Figure 1; Appendix D). All 39 HUCs that were analyzed contained a portion of the total stream miles judged as being historically occupied. The estimated amount of historically occupied habitat in each state was 6,713 miles in Wyoming (38%), 6,471 miles in Idaho (37%), 4,296 miles in Montana (24%), 130 miles (<1%) in Utah and 111 miles (<1%) in Nevada (Table 9; Figure 2).

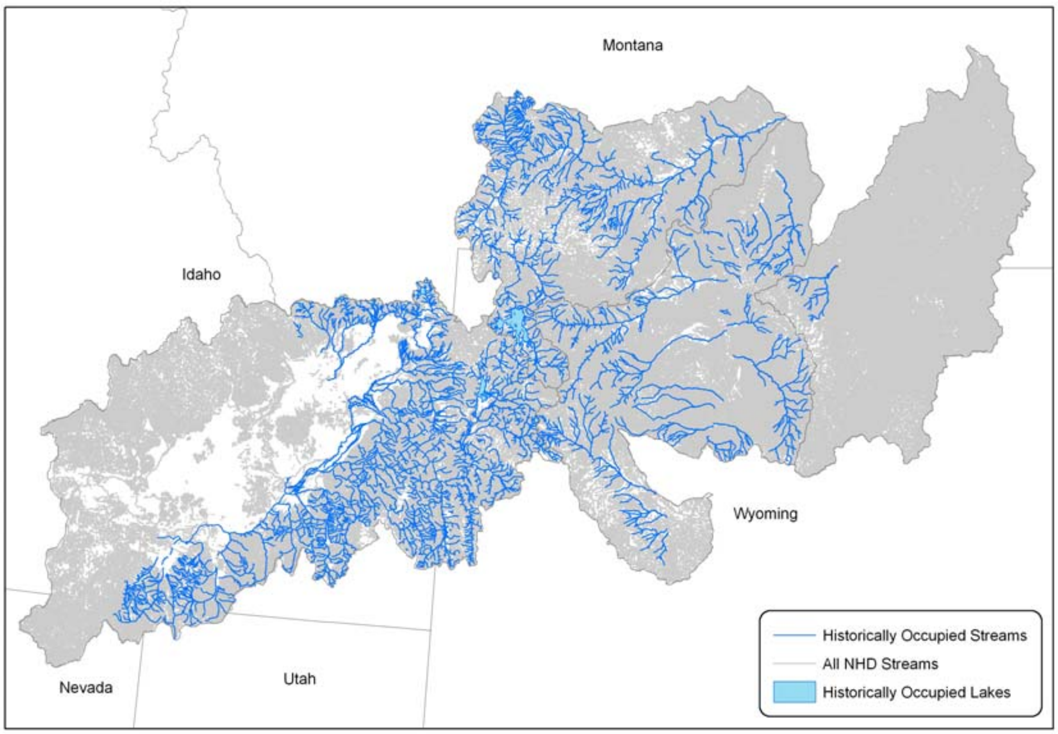


Figure 1. Historically occupied stream and lake habitats (blue) and the base NHD stream layer (gray).

Table 9. Historically occupied stream habitats within the five states with percent of historical habitat in parentheses.

State	Historically Occupied Stream Miles	Percent of Historically Occupied
Wyoming	6,713	(38%)
Idaho	6,471	(37%)
Montana	4,296	(24%)
Nevada	111	(<1%)
Utah	130	(<1%)
Totals	17,721	

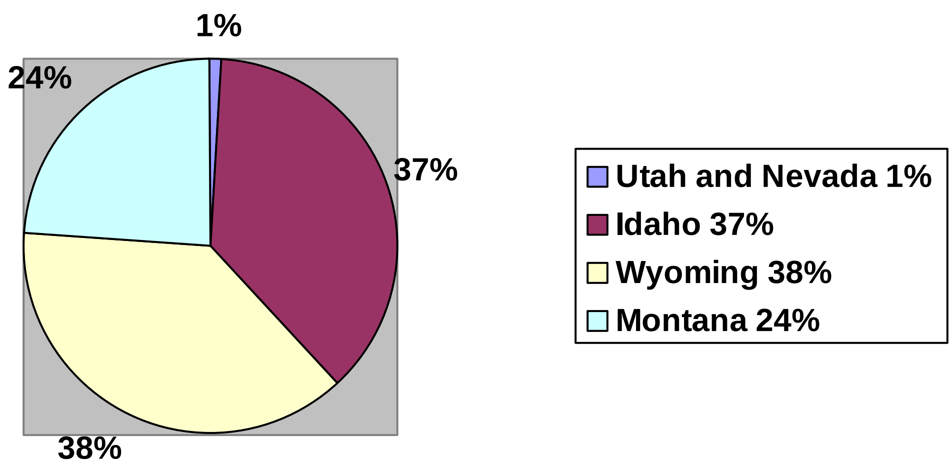


Figure 2. Percent of historically occupied stream miles by state.

A breakdown of historically occupied stream habitat by HUC is presented in Table 10. The largest number of miles was identified in the upper Yellowstone watershed and the fewest number of miles was in the Popo Agie watershed.

Table 10. The amount of historically occupied stream habitat for the 39 4th level HUCs analyzed in 2006.

Name	HUC	Stream Miles	Stream KM
Yellowstone Headwaters	10070001	952.47	1532.89
Upper Yellowstone	10070002	1115.96	1795.94
Shields	10070003	682.12	1097.64
Upper Yellowstone-Lake Basin	10070004	287.99	463.45
Stillwater	10070005	416.22	670.11
Clarks Fork Yellowstone	10070006	524.61	844.72
Upper Yellowstone-Pompey's Pillar	10070007	273.41	440.17
Pryor	10070008	225.89	363.51
Upper Wind	10080001	548.89	883.41
Little Wind	10080002	178.68	287.52
Popo Agie	10080003	129.8	208.94
Upper Bighorn	10080007	629.5	1013.47
Nowood	10080008	555.45	893.84
Greybull	10080009	311.53	501.5
Big Horn Lake	10080010	277.76	447
North Fork Shoshone	10080012	183	294.56
South Fork Shoshone	10080013	319.91	514.96
Shoshone	10080014	172.48	277.58
Lower Bighorn	10080015	422.48	679.69
Little Bighorn	10080016	223.56	359.73
Upper Tongue	10090101	663.22	1067.3
Snake Headwaters	17040101	317.02	510.18
Gros Ventre	17040102	826.09	1329.41
Greys-Hoback	17040103	362.11	582.65
Palisades	17040104	580.37	934.31
Salt	17040105	272.7	439.01
Idaho Falls	17040201	582.88	938.16
Upper Henrys	17040202	290.81	467.84
Lower Henrys	17040203	579.18	932.15
Teton	17040204	393.92	633.73
Willow	17040205	542.64	873.3
American Falls	17040206	632.21	1017.35
Blackfoot	17040207	823.61	1325.55
Portneuf	17040208	277.89	447.07
Lake Walcott	17040209	661.21	1064.4
Raft	17040210	594.74	957.27
Goose	17040211	457.65	736.63
Beaver-Camas	17040214	159.61	256.9
Medicine Lodge	17040215	952.47	1532.89
	Totals	**17,721**	**28,520**

The database contained information on a total of 61 lakes that were identified as being historically occupied by YCT. The surface area of these 61 lakes was estimated at 124,716 acres (Table 11). Lakes identified ranged in size from Yellowstone Lake in Yellowstone National Park and Henry's Lake in Idaho, as the largest lakes, to many smaller (e.g., ≤10 acres) high elevation lakes. The estimated lake habitat within each state was 118,594 acres in Wyoming and 6,122 acres in Idaho. It should be noted, that information associated with several lakes within Montana that were believed to be historically occupied were inadvertently omitted during data entry. As a result the number of lakes included in the database and the surface area associated with these lakes represents an underestimate of the actual amount of lake environment believed to have been historically occupied by YCT. This error will be corrected during the next update scheduled for 2007.

Table 11. Number of lakes and surface areas estimated to have been historically occupied.

Watershed Name	HUC Identification Number	Total Acres of Historically Occupied Lake Habitat	Number of Lakes
Yellowstone Headwaters	10070001	84442.0	1
Snake Headwaters	17040101	33404.6	30
Gros Ventre	17040102	148.6	13
Greys-Hoback	17040103	598.6	15
Upper Henrys	17040202	6116.9	1
Teton	17040204	5.0	1
Totals		**124,715.6**	**61**

Current Distribution

The analysis procedure for determining current distribution of YCT focused on determining the extent of habitat, both stream and lake, that are currently occupied by YCT. To complete this task, biologists were asked to systematically re-evaluate the current distribution map that was converted from the 2001 assessment, and to adjust the current distribution information as needed. The 2006 status database utilized the NHD stream and lake coverage, at the 1:24,000 map scale and these coverage were attributed as individual stream or lake segments. Each lake was identified as a single habitat segment. The focus was to re-evaluate all habitats currently occupied by YCT within the broad perimeter of the historical distribution, and to develop an expanded set of condition characterizations that would be of value to conservation planning and evaluation. Current distribution information included some habitats from within the broad perimeter of historical range, which were not identified as being historically occupied (e.g., habitats above historical barriers that are currently occupied). Use of the NHD coverage allowed for tracking of current distribution characterizations at a very "fine scale" due to the nature of stream segmenting that accompanied the NHD stream layer and the application of the event creation tool, supplied by the NRIS team. In total there were 1,314 stream segments and 205 lake segments identified as being currently occupied by YCT (both spotting patterns combined). Attached to these current distribution segments was an expanded set of attribute characterizations deemed important to YCT conservation.

Summation of currently occupied stream segments resulted in a determination that 7,527 miles of habitat were occupied by YCT (43% of historically occupied stream habitat; Figure 3). YCT currently occupy about 4,048 miles in Wyoming (54% of currently occupied stream habitat; 23% of historical stream habitat in Wyoming), 2,033 miles in Idaho (27% of currently occupied stream habitat; 31% of historical stream habitat in Idaho), 1,339 miles in Montana (18% of currently occupied stream; 31% of historical stream habitat in Montana), about 58 miles in Nevada (0.8% of currently occupied stream habitat; 52% of historical stream habitat in Nevada), and 49 miles in Utah (0.7% of currently occupied habitat, 38% of historical stream habitat in Utah; Table 12; Figure 4).

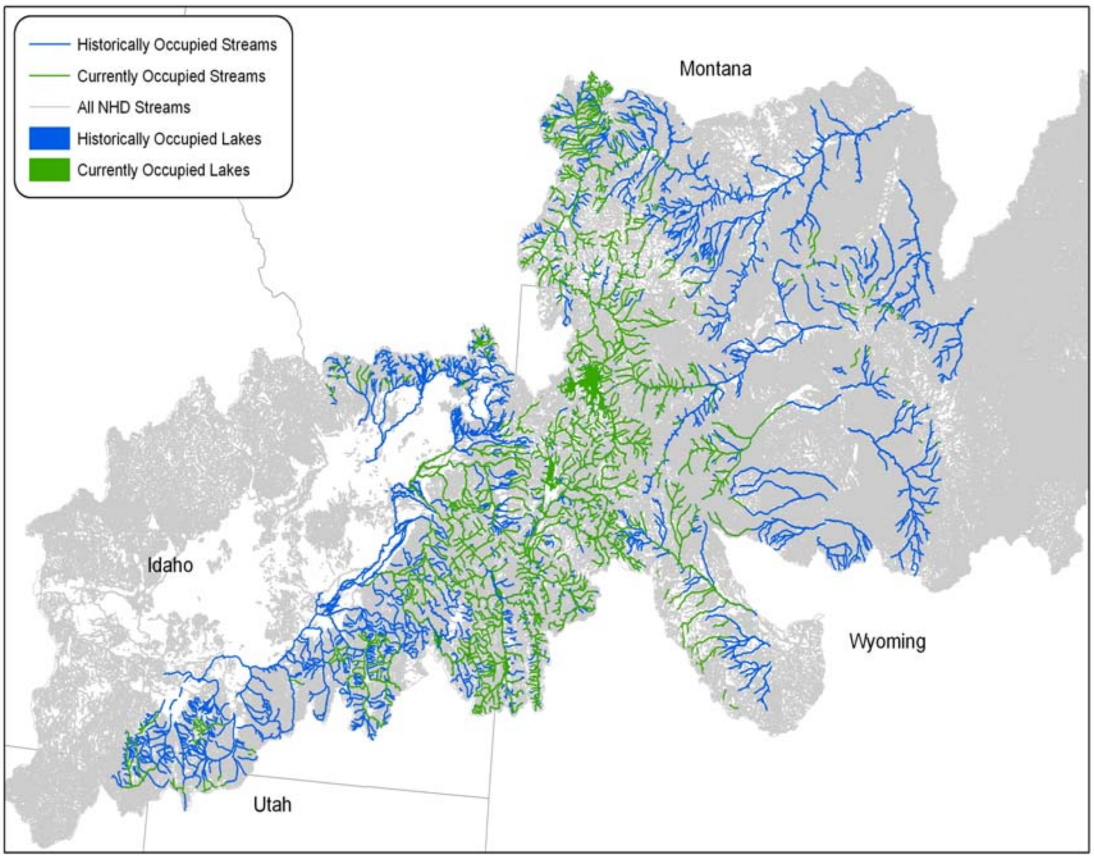


Figure 3. Currently occupied stream segments (green) overlaying the historically designated stream segments (blue) and the base hydrography layer (gray).

This total occupied stream habitat included some streams located within the broad perimeter of historical habitat that were not viewed as being historically occupied. YCT were identified as occupying 205 lakes within the broad historical range boundary. The number represents a 366% increase over the 61 lakes identified as being historically occupied. YCT occupied habitat in 37 of the 39 HUCs that were identified as containing historical habitat.

Table 12. Currently occupied stream habitat within the five states with percent of historical habitat in parentheses.

State	Currently Occupied Stream Miles	Percent of Currently Occupied	Percent of Historically Occupied within State
Wyoming	4,048	53.7%	60.3%
Idaho	2,033	27.0%	30.0%
Montana	1,339	17.8%	31.2%
Nevada	58	0.8%	37.7%
Utah	49	0.7%	52.3%
Totals	**7,527**		

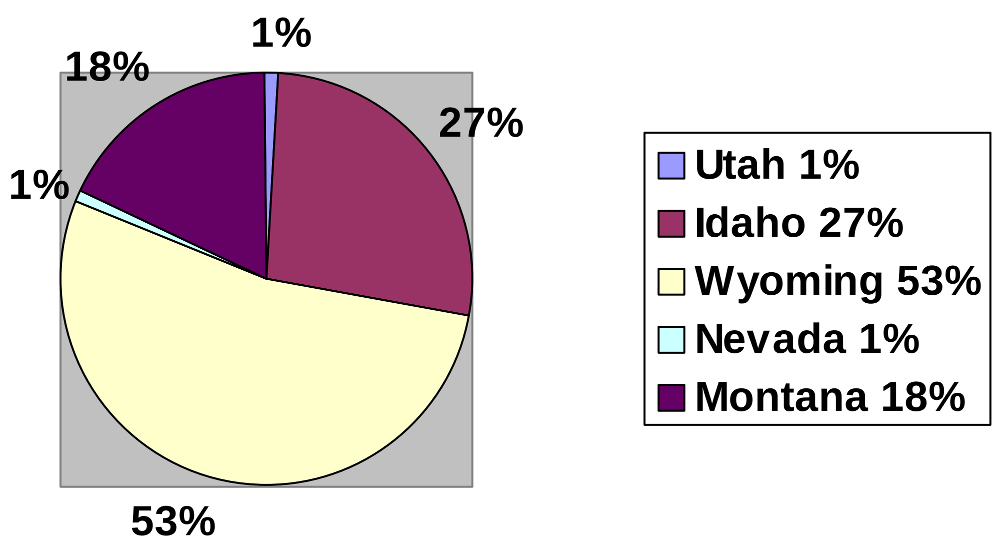


Figure 4. Percent of currently occupied habitat expressed as stream miles, by state.

Fish Passage Barriers

Identification of barriers was a significant part of both the historical and current distribution evaluations. An accurate depiction of the location and characterization of fish passage barriers was determined to be fundamental to conservation planning and implementation for YCT. Specific information associated with each barrier was used to assess whether individual stream segments were likely to be historically occupied by YCT, to assess potential influences from non-native salmonids and other fish species, to assess potential influences from genetic and disease sources, and to determine the potential of connectivity between populations and subpopulations of YCT. From a historical perspective, long-term geological barriers served to maintain significant portions of some drainages in a fishless condition with regard to YCT (Jordan, D.S. 1891).

Barrier locations were located (as points in ArcGIS) on the NHD layer and specific characterizations associated with each barrier were added to the geo-database. Only barriers of known or perceived significant to YCT were included in the geo-database.

There were a total of 902 barriers identified. The barrier locations were noted as specific points in ArcGIS. Each barrier was attributed with information associated with barrier type, blockage extent and barrier significance. There were 638 complete or total barriers to upstream fish passage. Four hundred and nineteen (419) of these barriers were identified during the determination of historically occupied habitat. For a barrier to be identified as having historical significance, the barrier had to provide complete blockage of upstream fish passage. The remaining 219 total barriers were associated with the current distribution of YCT. In total there were 207 partial barriers identified. These were barriers that were judged to have an influence on fish passage on a seasonal and/or intermittent basis. Of the 426 barriers identified during the determination of currently occupied habitat, 219 were total barriers, 207 were partial barriers and 57 had their blockage extent judged as unknown. With regard to barrier type, the largest proportion of barriers were associated with waterfalls, followed by barriers created by culverts, water diversions, velocity barriers, and man-made dams (Figure 5). The remaining barrier types included insufficient flows, bedrock features, water pollution, and water temperatures. Twenty-five barriers were placed in the unknown category or were placed in the "other" characterization for barrier type with no description. A complete range-wide inventory of all barriers associated with YCT distributions has not been completed, and it is probable that current barrier information represents a conservative assessment of fish passage barriers.

Origin of Current Distributions and Migratory Life Histories

The origin of YCT within the current distribution and the migratory life histories within the habitat segments were part of the additional information collected in 2006. These parameters were added to provide an improved picture of current distribution for YCT. For stream environments occupied by YCT, 6,733 miles (89%) were occupied by fish of aboriginal origin and approximately 686 (9%) miles originated from anthropogenic intervention associated with stocking. YCT in 108 stream miles were of unknown origin (Table 13).

The origin of YCT currently occupying lake segments, as expected, reflected a much higher level of human intervention associated with stocking of YCT (Table 14). Nevada and Utah did not identify any lakes that were either historically or currently occupied by YCT.

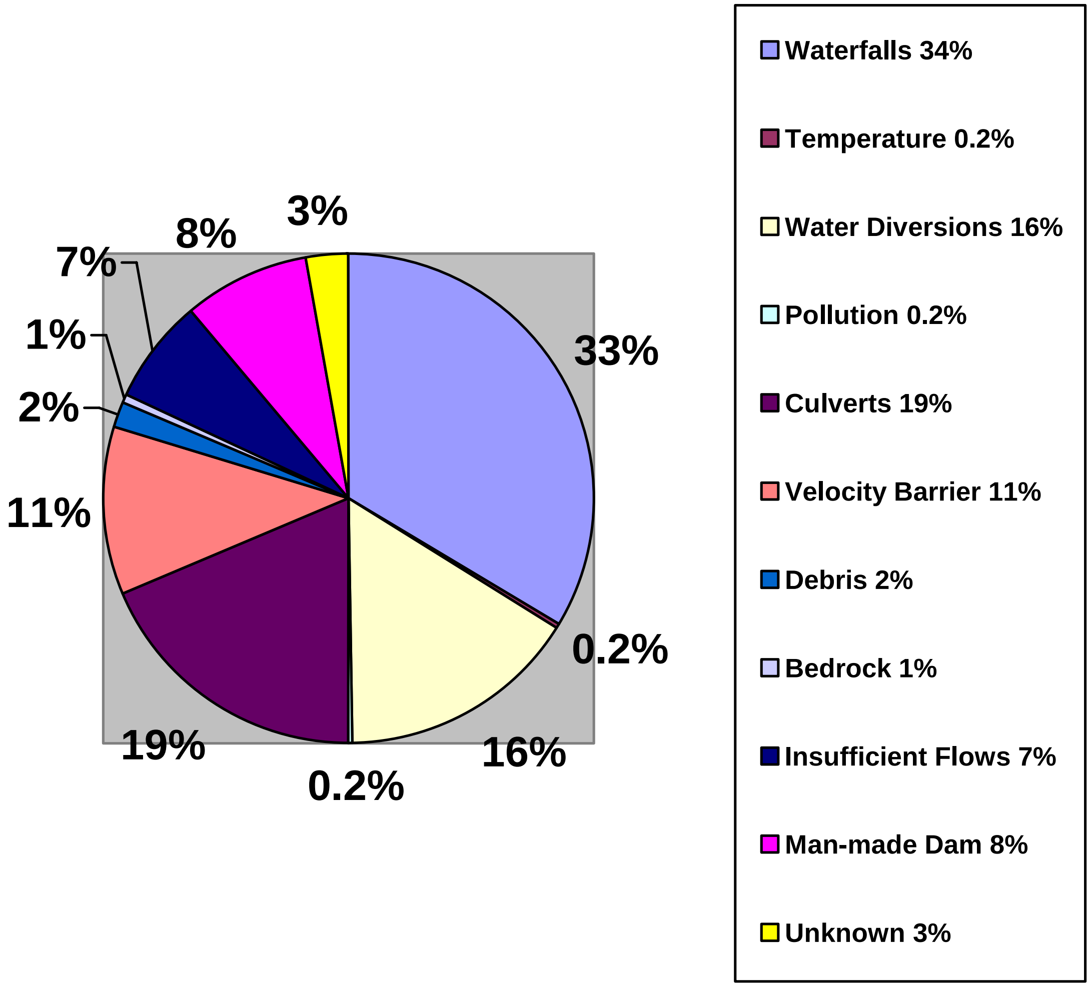


Figure 5. Barrier types identified during the assessment (pollution and water temperature barriers made up less than 1%).

Table 13. Origin of stream dwelling YCT (by state and stream miles).

State	Aboriginal Origin (Miles)	Anthropogenic Origin) (Miles)	Unknown Origin (Miles)
Wyoming	3,466	521	61
Idaho	2,024	2	7
Montana	1,136	163	40
Nevada	58	--	--
Utah	49	--	--
Total miles	**6,733**	**686**	**108**

Table 14. Origin of lake dwelling YCT (by state and number of lakes).

State	Aboriginal Origin (Lakes)	Anthropogenic Origin (Lakes)	Unknown Origin (Lakes)
Wyoming	54	114	2
Idaho	6	1	--
Montana	--	26	2
Totals	**60**	**141**	**4**

Migratory life histories associated with current YCT distributions indicated that 1,700 miles (23%) of stream environment contained only non-migratory fish. YCT with a migratory life history occupied approximately 1,199 miles of stream. The largest proportion of stream habitat (4,374 miles) was occupied by fish that demonstrated both migratory and non-migratory life histories (Table 15). The migratory life history in 254 miles of stream was identified as being unknown.

The migratory life history determinations of lake dwelling YCT reflected a significant degree of uncertainty and confusion as to how this characterization should be applied (Table 16). It is highly unlikely that YCT dwelling in lake environments did so without the influence of flowing water to meet the reproductive requirements. Few lakes would have habitat conditions (e.g., within lake springs) capable of providing the flows needed to successfully hatch eggs and develop sac-fry. Unless there is specific documentation that within lake spawning was successful, lake dwelling YCT should be judged to have migratory behavior. A more thorough review of the migratory life history information should be undertaken in subsequent updates to more fully validate the migratory life histories of lake dwelling YCT.

Table 15. Migratory life histories of stream dwelling YCT.

State	Non-Migratory (Miles)	Migratory (Miles)	Non-Migratory and Migratory (Miles)	Unknown Migratory Status (Miles)
Wyoming	629	804	2,458	157
Idaho	582	249	1154	48
Montana	387	146	761	46
Nevada	54	--	1	3
Utah	49	--	--	--
Total Miles	**1,701**	**1199**	**4,374**	**254**

Table 16. Migratory life history of lake dwelling YCT (by state and number of lakes).

State	Non-Migratory Life History (Lakes)	Migratory Life History (Lakes)	Non-Migratory and Migratory Life Histories (Lakes)	Unknown Migratory Life History (Lakes)
Wyoming	29	6	119	16
Idaho	1	5	1	--
Montana	28	--	--	--
Total lakes	**58**	**11**	**120**	**16**

Stocking and Presence of Non-Native Species

The record of fish stocking and the presence of non-native fish within the occupied habitat segments were part of the new information collected in 2006. These parameters were added to provide an improved picture of the current distribution of YCT. For the stream environments occupied by YCT, 2,333 miles of occupied stream (31%) had no record of fish stocking, 1,045 miles of stream (14%) had records that indicated that YCT (either large spotted and/or fine spotted forms) had been stocked, and 4,149 miles of occupied stream (55%) had stocking records indicating that various non-native fish (e.g., rainbow, brown, brook trout etc.) had been stocked (Table 17).

Table 17. Records of fish stocking associated with current distributions of YCT (recorded by state and stream miles).

State	No Record of Stocking (Miles)	Record of YCT Stocking (Miles)	Record of Non-Native Stocking (Miles)
Wyoming	1,100	696	2,253
Idaho	866	25	1,142
Montana	330	325	684
Nevada	13	--	45
Utah	24	--	24
Total miles	**2,333**	**1,045**	**4,149**

Records of fish stocking within lakes current occupied by YCT indicated that 71 lakes had no record of fish stocking, 62 had records indicating that YCT (large spot and/or fine spotted forms) had been stocked, and 72 lakes had records that indicated that various non-native fish had been stocked (Table 18).

Table 18. Fish stocking status associated with current distribution of YCT for 2006.

State	No Record of Stocking (Lakes)	Record of YCT Stocking (Lakes)	Record of Non-Native Stocking (Lakes)
Wyoming	60	46	64
Idaho	1	1	5
Montana	10	15	3
Totals	**71**	**62**	**72**

Even more pertinent to YCT conservation was the added information collected in 2006 associated with the presence of non-native fish that were considered to be sympatric with YCT. Within the currently occupied stream habitat there were 3,504 miles (47%) that were identified as having no non-native fish present. A total of 4,024 miles (53%) of occupied stream habitat were identified as having YCT and non-native fish considered to be in a sympatric condition (Table 19; Figure 6).

Table 19. Non-native fish presence with YCT (by state and stream miles) based on 2006 information.

State	No Non-Native Fish Present (Miles)	Non-Native Fish Present (Miles)
Wyoming	2,144	1,905
Idaho	756	1,277
Montana	510	829
Nevada	55	3
Utah	39	10
Total miles	**3,504**	**4,024**

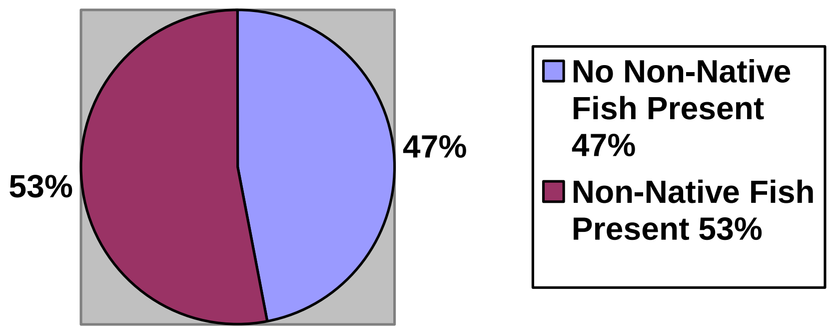


Figure 6. Presence of non-native fish in sympatry with YCT (by percent of occupied stream habitat).

The presence of non-native fish in lake environments occupied by YCT was substantially less (Table 20; Figure 7), compared to stream habitats. It should be noted YCT were not historically present in many of these lakes.

Table 20. Record of non-native fish presence with YCT (by state and number of lakes).

State	**No Non-Native Fish Present (Lakes)**	**Non-Native Fish Present (Lakes)**
Wyoming	139	31
Idaho	1	6
Montana	27	1
Total lakes	**167**	**38**

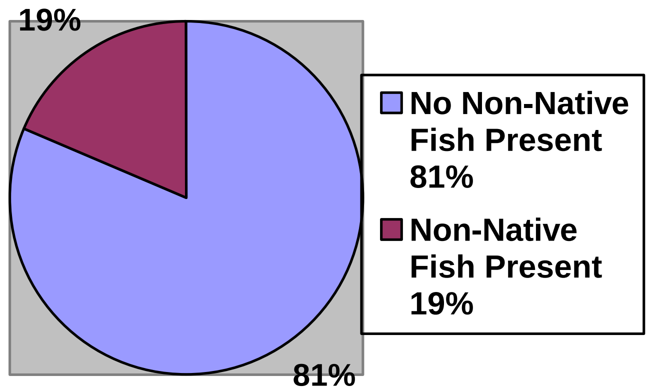


Figure 7. Presence of non-native fish sympatric with YCT (by percent of occupied lakes).

Genetic Status

Genetic testing of YCT across all currently occupied habitats was incomplete. Most genetic testing has not been completed in a structured fashion. Consequently, the available genetics information does not constitute a representative sample taken from the entire YCT population. Instead, there has been a tendency to sample fish from populations that appeared to be typical of the YCT phenotype. Genetic sampling and analysis has been conducted on a sample basis for 4,052 miles of occupied stream habitat (54% of occupied habitats). No evidence of introgression has been found in samples covering about 3,112 miles (80%) of sampled area (Table 21; Figure 8). YCT sampled from 771 miles (20% of sampled miles; 10% of currently occupied stream habitat) reflected varying levels of hybridization. The genetic results reflect a composite of genetic condition over the time span that sampling has been occurring. It is anticipated that site-specific results may change to some extent as sampling continues through time. YCT within 1,854 miles (24% of occupied habitats) were suspected of being genetically unaltered, based on the absence of introduced hybridizing species and/or the lack of records associated with stocking of hybridizing species. YCT sampled from another 1,614 miles of occupied habitat were identified as having the potential of being hybridized due to the presence, and/or past stocking of hybridizing nonnative species or subspecies. One hundred and sixty nine miles were linked to YCT that occupied habitat as a mixed stock of genetically unaltered and altered individuals. For an unexplained reason, 7 miles of stream habitat were tracked as “not applicable” with regard to genetic characterization.

Table 21. Genetic status for Yellowstone cutthroat trout by stream length (miles) within the current range as of 2006.		
Genetic status	**Miles**	**% of occupied**
Tested; Unaltered (<1% introgression)	3,112	41%
Tested; >=1% to <=10% introgression	612	8%
Tested; >10% to >=25% introgression	103	1%
Tested, >25% introgression	56	1%
Suspected Unaltered	1,854	25%
Potentially Altered	1,614	21%
Mixed Stock; Altered and Unaltered	169	2%
Not Applicable	7	0%
TOTAL	**7,527**	**100%**

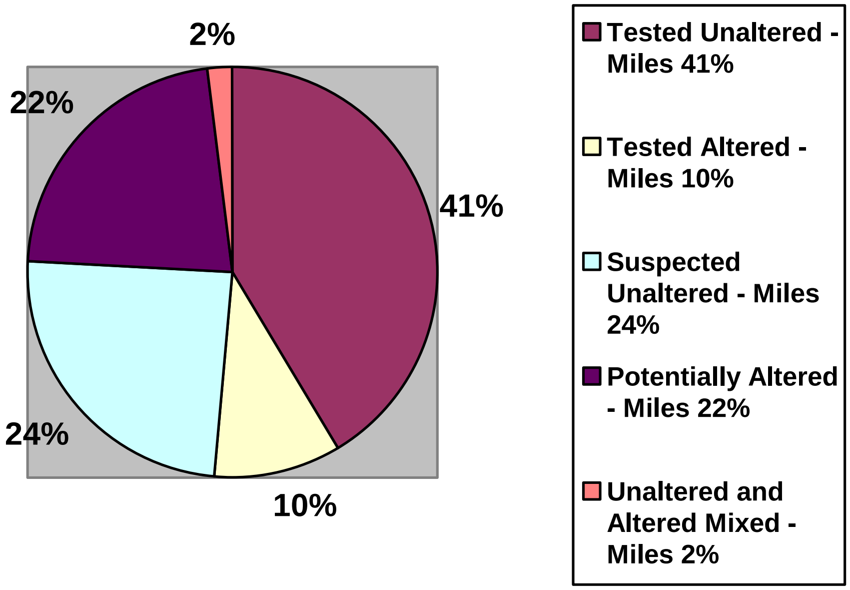


Figure 8. Genetic status of Yellowstone cutthroat trout expressed as percentage of currently occupied habitats (miles) classified within each genetic status category for this assessment completed in 2006.

Genetic results associated with lake sampling reflected the results of a substantially reduced sampling effort. Only 12 of the 205 lakes identified as containing YCT were reported as having genetic data. Nine lakes were tested and found to be genetically unaltered and 3 lakes were tested and found to have some level of non-native trout genes. Most lakes (154) were identified as being untested and suspected of being genetically unaltered due to the fact that YCT that were used to establish a population in many lakes were from genetically unaltered sources. Thirty-eight lakes were judged to have a high probability of being hybridized based on stocking records and/or the known presence of hybridizing fish that are sympatric with YCT (Table 22; Figure 9).

Table 22. Genetic status for Yellowstone cutthroat trout by number of lakes within the current range as of 2006.

Genetic status	Number of Lakes Occupied	Percent of Lakes Occupied
Tested; Unaltered (<1% introgression)	9	4%
Tested; ≥1% to ≤ 10% introgression	2	1%
Tested; >10% to ≥ 25% introgression	0	--
Tested, >25% introgression	1	<1%
Suspected Unaltered	154	77%
Potentially Altered	38	17%
Mixed stock; Altered and Unaltered	1	<1%
TOTAL	**205**	**100.0**

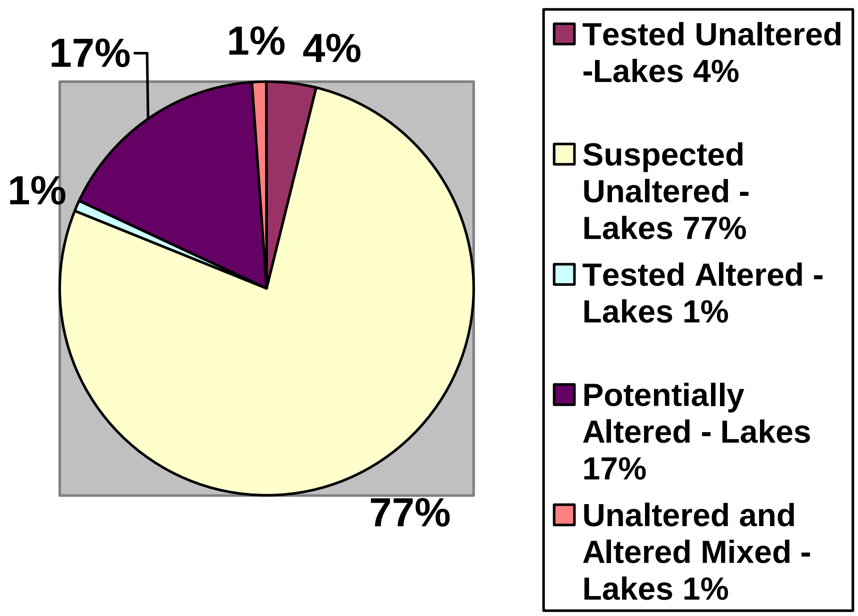


Figure 9. Genetic status of Yellowstone cutthroat trout currently occupying lake habitat (number of lakes).

To provide insight into the likely genetic status of YCT within habitats classified as "Untested - Suspected Unaltered" and "Untested - Potentially Hybridized" we refer the reader to the westslope cutthroat (WCT) status assessment that was completed in February, 2003 (Shepard et al. 2003). For central Idaho where limited genetic testing had been conducted, the WCT assessment team took a closer look at classification results for 10 separate 4th code HUCs where some genetic testing had been conducted, they compared the level of introgression within tested stream segments to the classifications for stream segments where no genetic testing had been done. Seven of these ten HUCs had the majority of the stream segments classified as "Potentially Hybridized." Of these seven, genetic testing in five HUCs found no evidence of introgression, while genetic testing in one HUC found 65% of tested stream length had no evidence of introgression and testing in another HUC found evidence of introgression in all tested samples. Conversely, some stream segments in one HUC, that supported WCT that were classified as "Suspected Unaltered", tested as hybridized, while genetic testing in two other HUCs that were predominated by streams classified as "Suspected Unaltered" found no evidence of introgression. We feel the situation for YCT maybe somewhat similar to that of WCT in that the potential for introgression is highest in stream segments that are connected to waters that support nonnative species or subspecies that could interbreed with YCT.

We caution against drawing specific conclusions about genetic status of YCT for those populations identified as suspected unaltered or potentially hybridized from a genetic perspective. The only definitive way of determining genetic status is through formal genetic testing using a sampling methodology that is both time and location specific.

YCT Abundance

Densities of sexually mature YCT (15 cm and larger) were re-evaluated in 2006 using a more quantified approach than was applied in 2001. The 2001 status assessment called for making broad level qualitative determinations (e.g., abundant, common, rare or unknown) for the abundance of YCT based on population information associated with the occupied habitat segments. In addition, the 2001 assessment employed a second option of determining abundance based on habitat or site potential. As a result, there was uncertainty in how the abundance determinations were made. The 2006 status assessment revised the protocol to reflect a more quantitative approach based on estimated or known numbers of adults per miles for each stream segment. Densities of YCT occupying lake habitats were not included in the database. Instead, YCT that were associated with lake environments were included in the stream densities associated with the stream segments utilized by the lake populations for spawning. Stream segment densities were characterized by density ranges (Table 23). When sampling was sufficient for population estimation, these estimates were included in the database and the estimated density was included in the proper density range. A total of 2,398 miles of occupied habitat (32% of currently occupied habitats) supported YCT identified within the 0- to 50-fish/mile density range. Within the 51- to 150-fish/mile range there were 2,036 miles (27%) of occupied stream habitat. Densities in the 151- to 400-fish/mile range occurred in 1,781 stream miles (15%). Densities in the 401- to 1,000-fish/mile range and the 1001- to 2000-fish/mile range occurred in 626 miles (9%) and 106 miles (1%), respectively. Stream segments associated with 580 miles of stream were reported to have unknown YCT densities.

Table 23. Sexually mature YCT (≥15 cm in total length) densities for currently occupied stream habitat (miles). Percentages represent the proportions of each density range.

Density Range (fish/mile)	Occupied Stream Habitat (Miles)	Percent of Occupied Habitat
0 to 50	2,398	32
51 to 150	2,036	27
151 to 400	1,781	24
401 to 1000	626	8
1001 to 2000	106	1
Over 2000	0	--
Unknown	580	8
Totals	**7,527**	

Habitat Quality
Habitat quality and average bankfull stream widths were two new parameters added to the 2006 status protocol. The total amount of YCT habitat viewed as excellent was approximately 1,080 miles (14% of currently occupied stream habitat). Habitat amounts associated with good, fair and poor conditions were 3,943 (52%), 1,468 (20%), and 380 (5%) miles of stream, respectively. A total of 653 (9%) miles of occupied habitat were reported to have unknown habitat quality (Figure 10). Habitat quality considerations by state are presented in Table 24. Habitat quality was only assessed for stream environments.

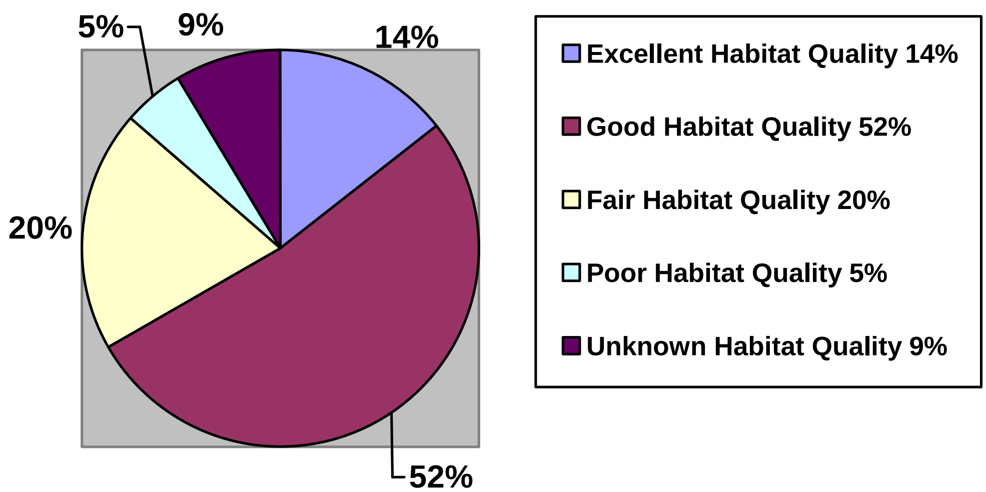


Figure 10. Habitat quality ratings for currently occupied stream habitat.

Table 24. YCT habitat quality for currently occupied habitat (stream miles) in the five states.

Habitat Quality	Wyoming	Idaho	Montana	Nevada	Utah	Totals
Excellent	539	390	151	--	--	1,080
Good	2,592	746	604	--	3	3,946
Fair	717	448	225	48	29	1,468
Poor	101	262	8	--	9	380
Unknown	99	188	351	10	7	653
Total miles						**7,527**

Stream segment bankfull widths were placed into stream width categories. The majority of occupied stream habitat (2,604 miles) was associated with widths in the 5 to 15 feet category. The next highest amount of stream habitat (1,878 miles) was in the 16 to 25 feet category. Twelve hundred and seventeen miles of habitat were in the 26 to 50 feet category and 907 miles had widths greater than 50 feet. YCT occupied 574 miles of stream habitat that was less than 5 feet in width and other 346 miles of occupied stream habitat was classified as having unknown stream widths (Figure 11).

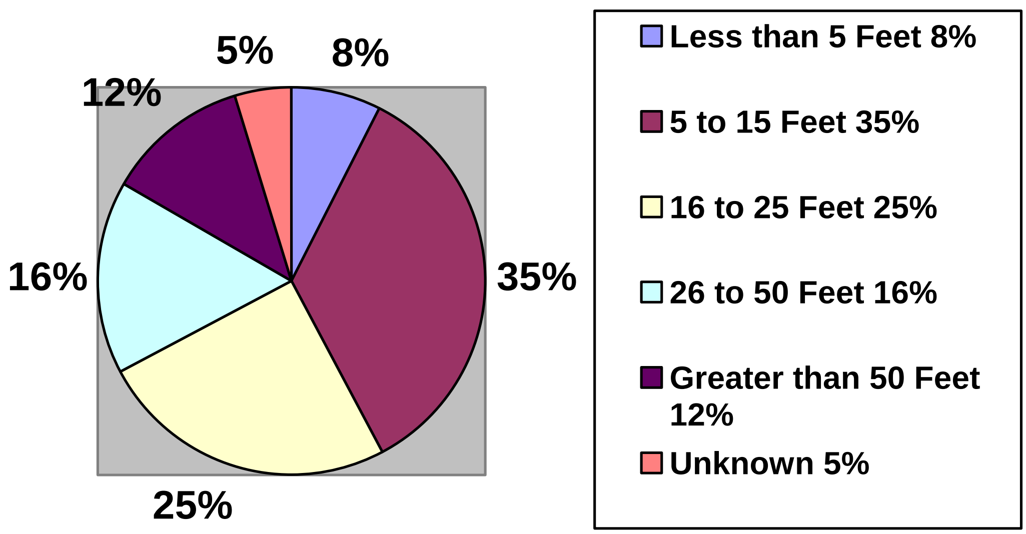


Figure 11. Percentage of occupied stream habitat (miles) by bankfull width category.

Land Ownership Patterns for Current YCT Distribution

Of the 7,527 miles of habitats currently identified as being occupied by YCT (both spotting patterns combined), approximately 4,886 miles (65%) were associated with land administrated by specific Federal agencies and Tribal governments. An estimated 962 miles were in designated National Parks (NPS); 3,488 miles were within Forest Service administered lands (excluding miles with the wilderness category); 231 miles were associated with Tribal governments; 176 miles were administered by the Bureau of Land Management; and, 26 miles were administered by the Fish and Wildlife Service. A significant amount of the habitat (1,146 miles) associated with Federal administration was within a category called “wilderness.” This category included areas with special management emphasis that provided additional protection to YCT habitats. A substantial amount of stream habitat was associated with private properties (2,055 miles; 27%) and a lesser amount was linked to state ownership (207 miles; 3%). Three hundred and eight miles of stream habitat were placed in an “other” category (Figure 12). The breakdown of currently occupied YCT stream habitats associated with land ownership and Federal administration is provided in Table 25.

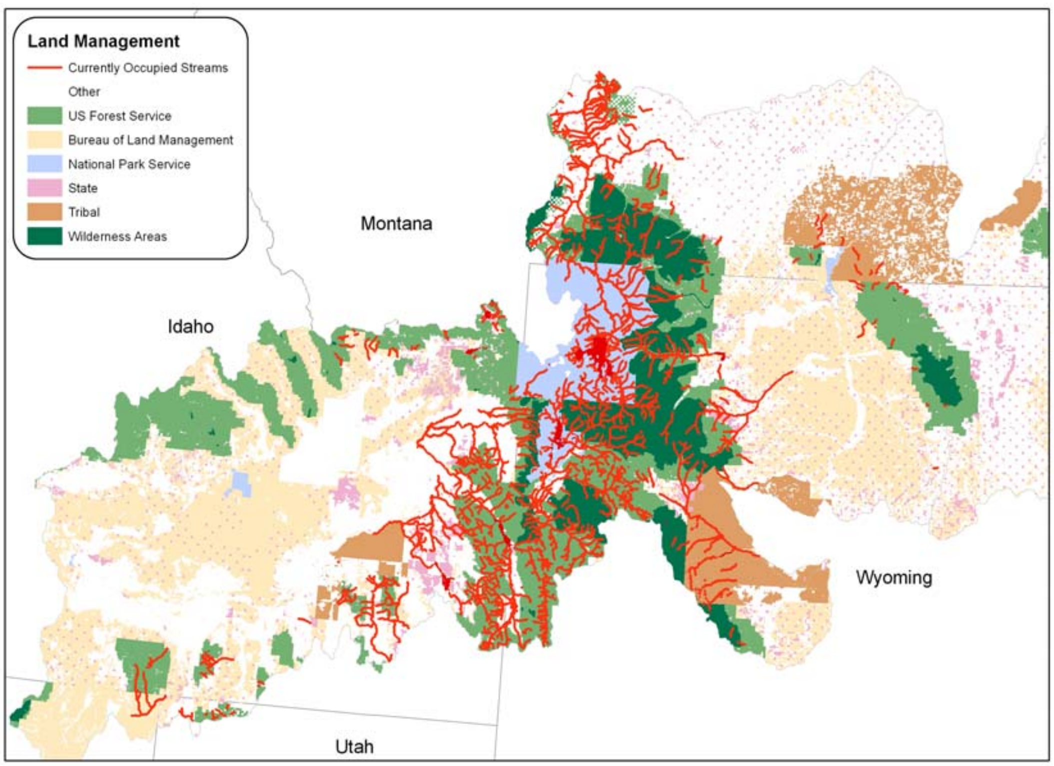


Figure 12. Land ownership patterns for current YCT distribution.

Table 25. Currently occupied YCT habitat (stream miles) by land ownership and administration.

Land Ownership and Administration	Wyoming (Miles)	Idaho (Miles)	Montana (Miles)	Nevada (Miles)	Utah (Miles)	Totals
Forest Service (including "wilderness")	2,124	848	500	--	16	**3,488**
National Park Service	926	3	34	--	--	**962**
Bureau of Land Management	38	122	2	10	5	**176**
Bureau of Indian Affairs	174	17	41	--	--	**231**
Fish and Wildlife Service	26	--	--	--	--	**26**
State Lands	78	114	15	--	--	**207**
Private Lands	538	815	627	48	28	**2,056**
Other Lands	144	112	122	--	--	**378**
Total miles	**4,049**	**2,033**	**1,338**	**58**	**49**	**7,527**

Conservation Populations

A total of 382 individual conservation populations of YCT were identified during the 2006 status assessment. The criteria applied during conservation population identification included: aggregation of habitat segments (stream and/or lake) that supported YCT that functioned as a reproductive unit (i.e., genetic exchange within the population occurred in both an upstream and downstream manner); and complete barriers to upstream fish passage could not exist within the habitat network associated with the population. These 382 conservation populations occupied approximately 7,204 miles of stream habitat (96% of currently occupied stream habitats; 41% of historical stream habitat) and 165,717 acres of habitat within 198 lakes (Figure 13).

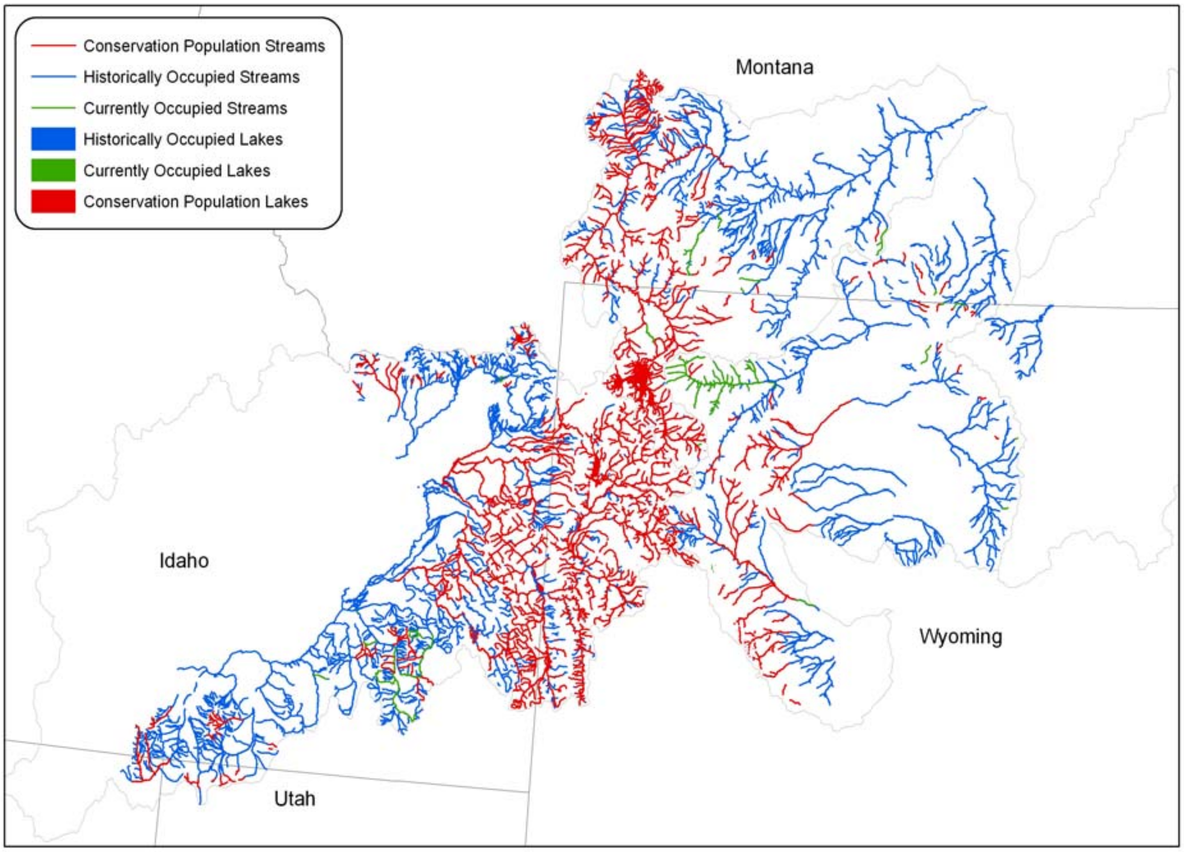


Figure 13. Distribution of YCT conservation populations (red) throughout their range as of 2006. Shown overlaying their current distribution (green) and the historic distribution (blue). The NHD layer is shown in light gray.

Conservation populations were spread throughout the historical range, occupying habitat in all five states and in 37 of the 39 HUCs identified as being historically occupied by YCT. Two hundred and sixty (261) conservation populations were confined only in stream environments, 45 conservation populations occupied both stream and lake habitats and 76 conservation populations were confined to only lake environments. For the group of conservation populations that were identified as occupying only lake environments it was highly likely that some flowing water was associated with each lake and that NHD mapping may have overlooked many small stream courses that were associated with these lakes. In other instances, biologists may have overlooked the status protocol's requirement that YCT be self-sustaining and some lakes may have been inappropriately included as conservation populations. These lake only populations should be re-evaluated during the next status update scheduled for 2007.

Most conservation populations were confined within a single state. Conservation populations were more densely concentrated within the central portion of the historical range (Figure 13).

The amount of habitat occupied by each conservation populations was highly variable. The occupied stream habitat for individual conservation populations varied from 0.2 miles to over 485 miles. The average length of occupied stream for the conservation population was approximately 24 miles. A frequency histogram of mileage groupings by conservation population is presented in Figure 14. The distribution of stream lengths occupied by YCT conservation populations continued to be skewed toward smaller streams. Most conservation populations (63%) in stream environments occupied stream lengths of 10 miles or less.

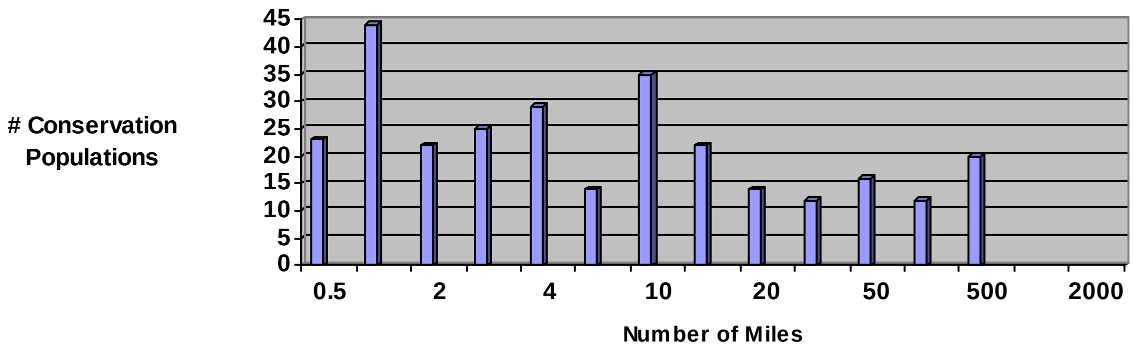


Figure 14. Frequencies of the number of miles (x-axis) occupied by number of conservation populations (y-axis) of Yellowstone cutthroat trout throughout their range. Mileage bins were non-uniformly assigned.

The surface area of the 198 lakes that were associated with the conservation populations ranged from <1 acre to over 84,700 acres. The average surface area of occupied lake habitat was approximately 1,380 acres. Similar to the occupied stream habitat, the size distribution for occupied lakes was skewed toward smaller lakes. The number of lakes associated with the individual conservation populations ranged from 1 to 15 lakes indicating a migratory connection between some lakes.

Conservation Population Qualifier

Each conservation population was assigned a specific conservation population qualifier code. The qualification associated with "core" conservation population code included the requirement that genetic testing had verified that some or all mapping segments were genetically unaltered. Any non-tested mapping segments for "core" populations had to be suspected to be unaltered due to no stocking record of hybridizing fish and/or that hybridizing fish were known not to be sympatric with the population. Additional conservation qualifier codes included known or probable unique life histories, known or probable unique environmental adaptations, known or probable predisposition to manifest a unique physical trait (e.g., large size, distinctive coloration, etc.), and there was an "other" category. The "other" category was used to identify conservation populations that did not specifically fit into one of the other categories. In a few instances, the "other" category was used to track conservation populations that had been established in non-historic habitats within the broad perimeter of the historical range. Another application of the "other" category was for identifying specific habitat units identified as having future conservation value. The inclusion of part 4 in the 2006 YCT protocol allowed specific identification of restoration or expansion options thereby making the use of the "other" category for protection of future conservation options unnecessary. For all conservation population qualifier categories except the "Core" category some level of genetic introgression was likely present. The breakdown for 306 conservation populations that were associated with stream habitats and those that included both stream and lake habitats was 138 core conservation populations, 81 conservation population with unique life histories, 3 conservation populations with special environmental adaptation, 2 conservation populations with a predisposition for large size or distinctive coloration and 82 conservation populations in the "other" category (Figures 15 and 16). It is anticipated that the majority of the 76 conservation populations that were confined only to lake habitats will eventually fall within the core conservation category when genetic testing is completed. Most of these lake populations were established through stocking of fish that came from genetically unaltered sources.

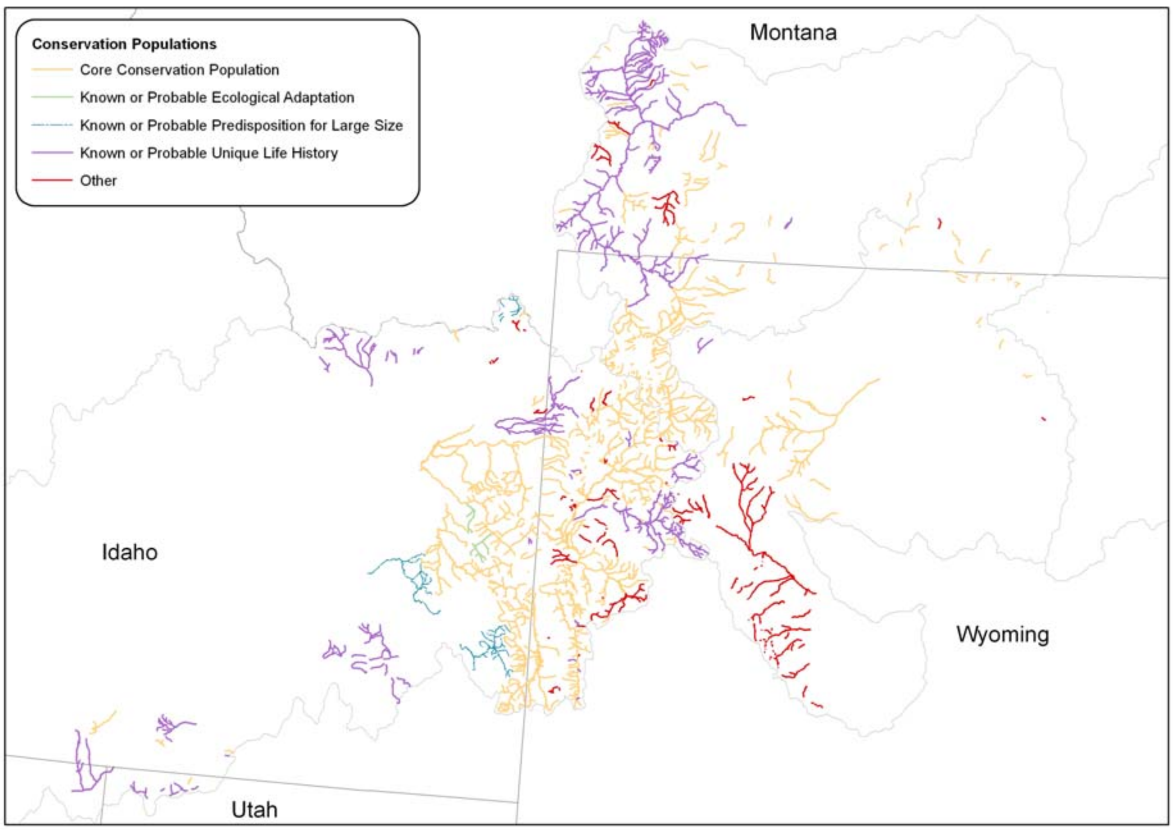


Figure 15. Distribution of conservation populations associated with their population qualifier category.

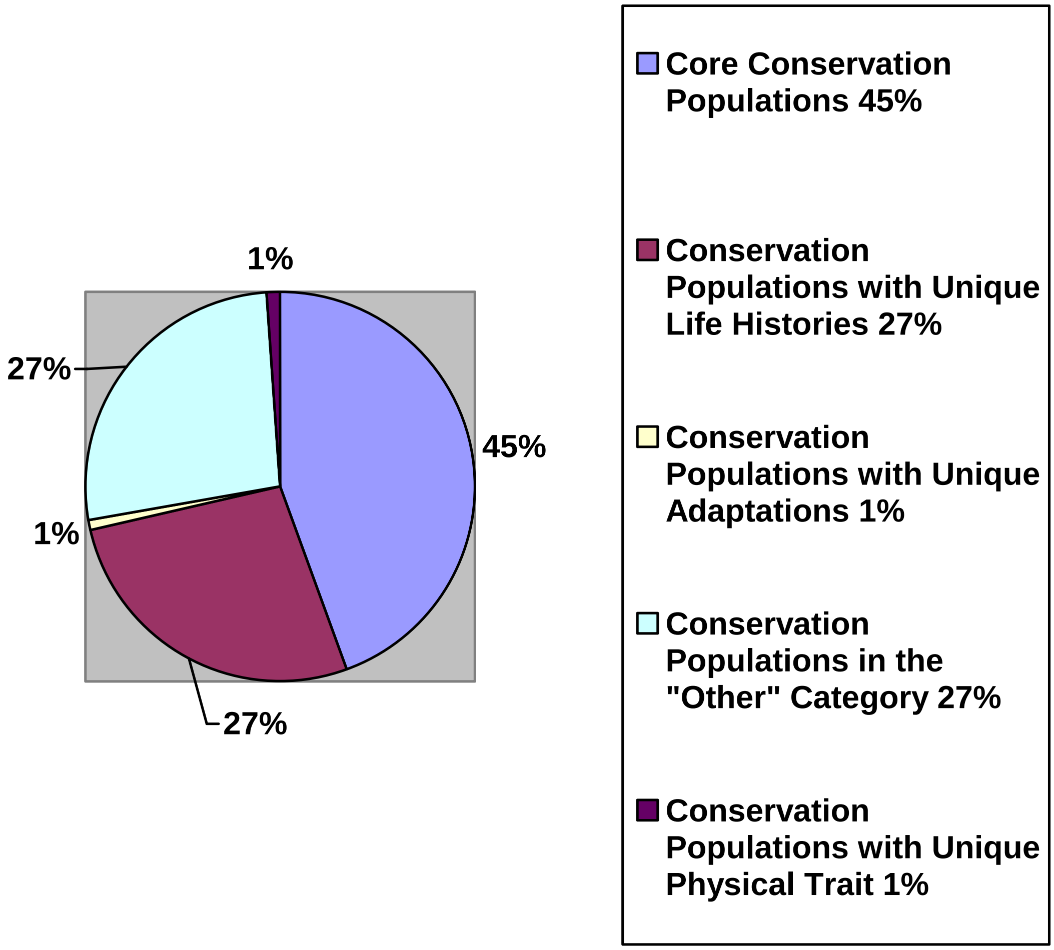


Figure 16. Percentage of conservation populations associated with the population qualifier categories for the stream only and stream and lake conservation populations.

Conservation Population Networks

The approach for identifying population networks in the 2006 status assessment was substantially different than the approach used in the 2001 assessment. In 2001 only two categories were used. Populations that occupied a single stream were viewed as "isolates" and populations that occupied more that one stream were identified as "meta-populations." The approach applied in 2006 allowed for further partitioning of conservation populations based on stream networks defined by the number of occupied streams. As related to conservation population resilience in the face of potential natural and anthropogenic influences, conservation populations having stronger and more diverse habitat networks were suspected of having resilience and a greater potential for long-term persistence (Rieman et al. 1993).

Most conservation populations (262) were identified as a non-network (e.g., a single stream or lake). Forty-seven conservation populations were identified as very weakly defined networks (e.g., 2 to 3 streams); 36 populations had a moderate network of stream habitat (e.g., 4 to 5 streams); and 37 conservation populations were viewed as having strong networks with more than 5 streams (Table 26). When that amount of occupied habitat is considered, populations existing as moderate and strong networks occupy 79% of stream habitat. A substantial number of inconsistencies were observed during the analysis of the information associated with habitat networks. A careful review of the habitat network information should be included in the database update scheduled for 2007.

Table 26. Information associated with the nature of habitat networks for the conservation populations of YCT.

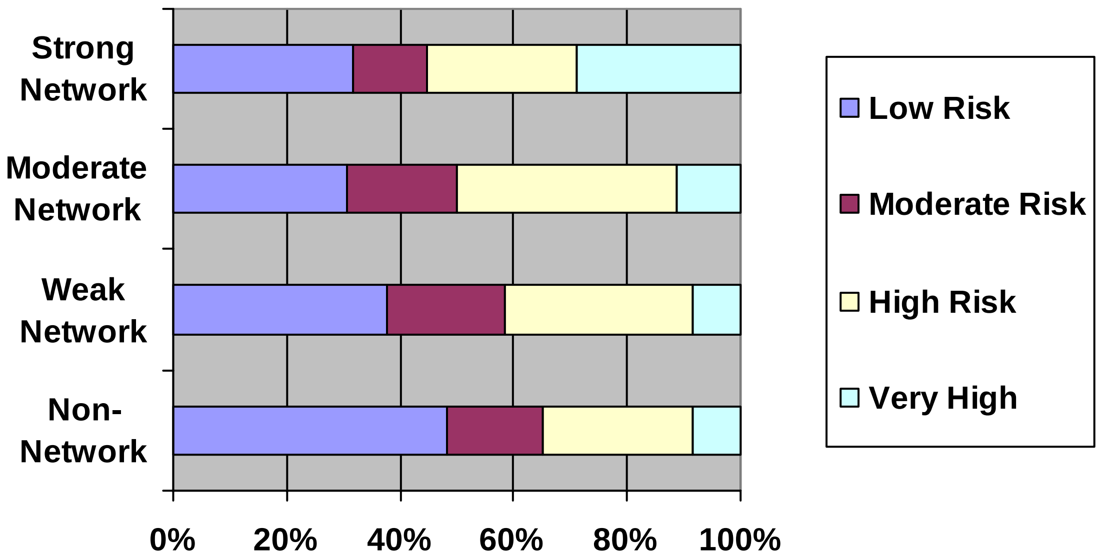
	Non-Network	Weak Network	Moderate Network	Strong Network	Totals
Conservation Populations	262	47	36	37	**382**
Stream Miles	912	582	1,347	4,363	**7,204**
Lake Acres	6,043	828	6,895	151,951	**165,717**

Genetic and Disease Risks Associated with Conservation Populations

The relative risks of both genetic introgression and disease to the 382 YCT conservation populations were linked to the nature of the habitat network for each population. Genetic risk was based on the relationship between each individual conservation population and the potential for initial or continued genetic introgression. The genetic risk was also based on the presence of complete barriers and distance between the conservation population and contaminating species. In general, moderate to strong habitat networks tended to be associated with increased genetic risk to YCT populations. By contrast, non-networked or weakly defined habitat networks were judged to be at lower risk of genetic contamination (Table 27; Figure 17).

Table 27. Ranked genetic risks to YCT conservation populations related to the number and acres of occupied habitat and the nature of each population's degree of connectedness (degree of habitat networking).

	Introgression risk ranked by number of populations				Introgression risk ranked by miles				Introgression risk ranked by acres			
Type of Habitat Network	**Low**	**Moderate**	**High**	**Very High**	**Low**	**Moderate**	**High**	**Very High**	**Low**	**Moderate**	**High**	**Very High**
Non-Network	125	44	69	22	381	1,135	221	75	1,763	416	483	3,383
Weak Network	18	10	16	4	127	228	208	26	441	0	128	259
Moderate Network	11	7	14	4	159	473	310	405	467	182	60	6,185
Strong Network	12	5	10	11	827	542	1,416	1,669	46,588	16,881	87,197	1,285
Totals	166	66	109	41	1,495	1,379	2,155	2,175	49,258	17,479	87,869	11,111



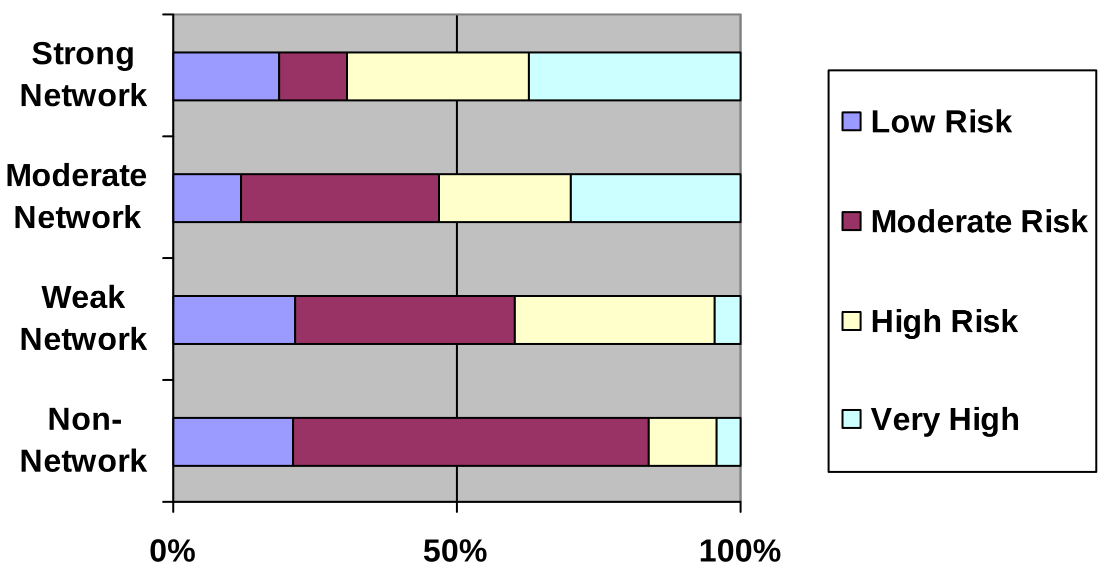


Figure 17. Percentage of YCT conservation populations (by number) for genetic risk and habitat connectivity or networks (top chart) and the percentages of conservation populations (by stream miles) for genetic risk and habitat connectivity (bottom chart).

The relative risks of significant diseases (e.g., whirling disease, furunculosis or infectious pancreatic necrosis) to the 382 YCT conservation populations were also evaluated based on the nature of the habitat network for each population. Disease risk was based on the relationship between each individual conservation population and the potential for initial or continued influence from the major diseases. Presence of complete barriers and separation distance between the conservation population and the sources of disease were factors in the disease risk rating. There was a slightly higher disease risk associated with strong and moderate habitat networks (Figure 18). Non-networked and weakly networked populations were judged to be at a somewhat lower risk from significant diseases (Figure 19; Table 28).

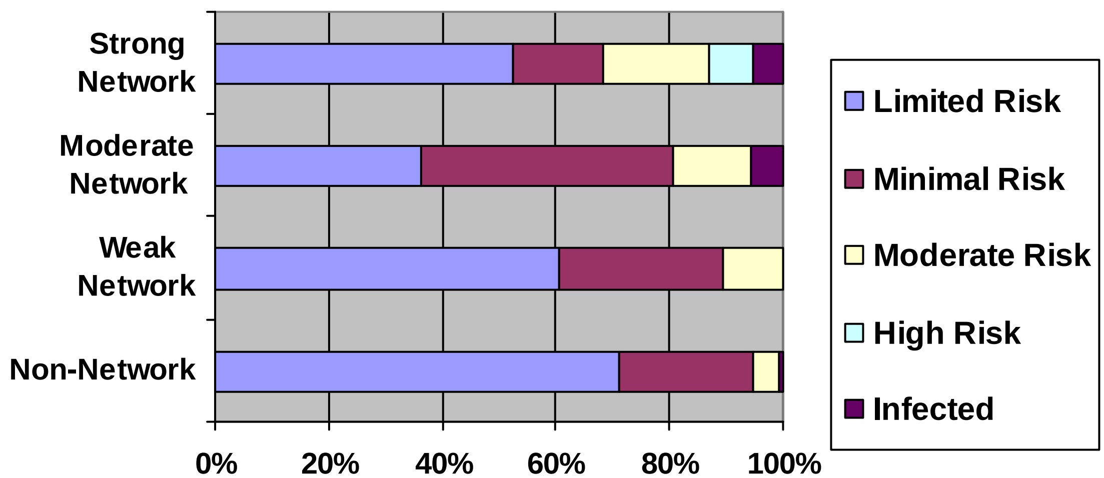


Figure 18. Percentage of YCT conservation populations (by number) for disease risk and habitat connectivity or networks.

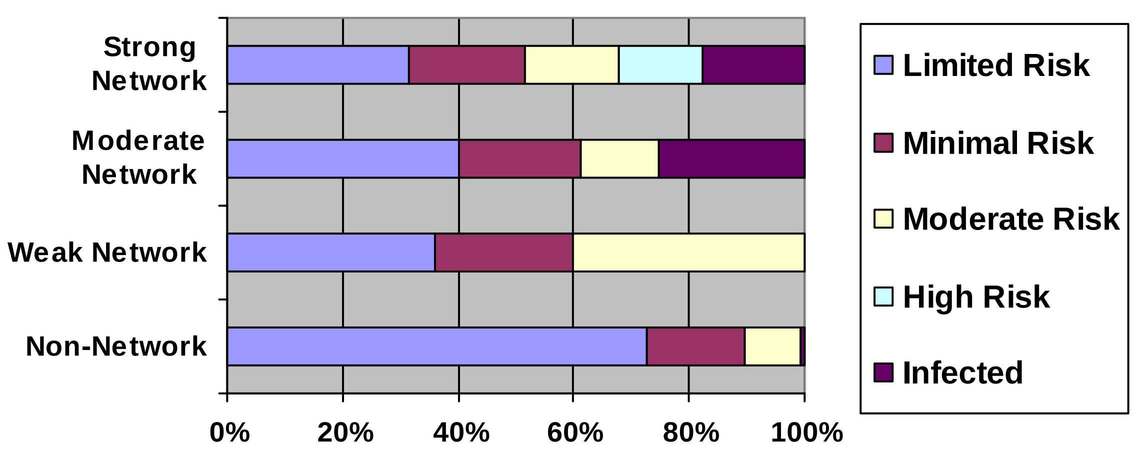


Figure 19. Percentages of conservation populations (by stream miles) for disease risk and habitat connectivity or networks.

Table 28. Ranked disease risks to YCT conservation populations related to the number and acres of occupied habitat and the nature of each population's degree of connectedness (degree of networking).

Type of Habitat Network	Disease Risk Ranked by number of populations					Disease Risk Ranked by miles					Disease Risk Ranked by Acres				
	Limited Risk	Minimal Risk	Moderate Risk	High Risk	Population Infected	Limited Risk	Minimal Risk	Moderate Risk	High Risk	Population Infected	Limited Risk	Minimal Risk	Moderate Risk	High Risk	Population Infected
Non-Network	185	61	12	0	2	591	139	77	0	7	2,060	1,043	2,942	0	0
Weak Network	29	14	5	0	0	213	141	236	0	0	535	293	0	0	0
Moderate Network	13	16	5	0	2	540	283	186	0	338	6,306	585	0	0	5
Strong Network	20	6	7	3	2	1,405	884	732	644	789	31,469	2,527	33,248	0	84,707
Totals	247	97	29	3	6	2,749	1,447	1,231	644	1,133	40,367	4,447	36,190	0	84,712

Conservation Population General Health Evaluation

A generalized population health evaluation based on four indicators hypothesized to be related to population health was completed for 306 conservation populations. Due to the nature of information used in the health evaluation, only those populations that utilized stream habitat were included in the general health evaluation. In other words, general health evaluations were not completed for the 76 YCT conservation populations that occupied lake environments with no stream habitats identified as being present. Components of the health evaluation included: 1) temporal variability associated the amount of occupied stream habitat as an indicator of potential resiliency, 2) population size of sexually mature adults (≥15 cm or larger) as a course estimator of effective population size, 3) population demographics based on habitat quality, presence of non-native fish and disease, and 4) degree of population connectedness based on the nature of the stream network associated with each population. These indicators of general health were analyzed individually and as a composite based on a weighted formula (Appendix C). It is important to note that individual health indicators and the composite rating for these indicators do not represent absolutes in terms of definitive population health. Rather they are presented as a relative indicator of general health much like a physician's general physical exam or a general health screening.

Temporal variability information indicated that a large number (169) of conservation populations (55%) were associated with a very low health score due to the limited amount of habitat that was occupied (e.g., less than 6 miles in length) by the populations. Eighty-one populations were given a low temporal variability health score, 24 were assigned a moderate health score and 32 were characterized as having a high health score for temporal variability (Figure 20; Table 29). With regard to the number of stream miles included within each temporal variability characterization; 5,180 miles were associated with a rating of high general health, 759 miles were linked to moderate health, 854 miles were associated with low relative health, and 411 miles of occupied habitat reflected a very low general health based on amount of occupied habitat by each population. The average number of stream miles occupied by YCT populations in the high temporal variability category was 161.8 miles. The average number of stream miles occupied by YCT populations in the moderate temporal variability category was 31.6 miles. The average number of miles occupied by populations in the low and the very low temporal variability characterizations were 10.5 miles and 2.4 miles, respectively.

Information associated with population abundance of mature YCT suggested a slightly different result. There were 67 conservation populations that were associated with a high health scores based on adult density exceeding 2,000 individuals (Figure 20; Table 29). The average number of YCT per population for this group was 18,516 adult YCT. Sixty-five populations were judged to have population numbers in the 500- to 2,000-range, which placed them in the moderate population health characterization. Average number of YCT per population in this group was 1,036 adult YCT. There were 110 YCT populations identified as having a low population health score and 64 YCT populations were rated with a very low health score. Average population numbers for the low quality grouping was 209 fish. Within the very low quality category 24 conservation populations had unknown densities and they were automatically included in the very low health category. For the remaining 41 populations the average number of YCT per population was 23 fish. Natural log transformations of the abundance information and the use of a box diagram helped to clarify the nature of the population abundance information (Figure 21).

With regard to stream miles included within each population size category; 5,849 miles (83%) were associated with populations having more than 2,000 sexually mature YCT, 683 miles were linked to populations in the moderate characterization having YCT numbers in the 500 to 2,000 range, 532 miles were associated with low relative population health associated YCT population numbers, and 141 miles were associated with populations having population numbers of less that 50 adults. Included within this group were 60 populations that occupied less than one mile of habitat. The average number of stream miles occupied by YCT populations in each population category was 35 miles for the high health category, 11 miles for the moderate health category, and 5 miles for the low health grouping and approximately 2 miles for the very low health grouping.

None of the 306 YCT populations were judged to have a high population health rating for population production potential based on demographics associated with habitat quality, presence of non-native fish and disease based on the way that these three variables were addressed in the analysis. In the production analysis, presence of non-native fish resulted in down grading to the next lower health rating. Two hundred and twenty eight (228) populations (75%) were judged to have a moderate population health characterization related to factors associated with production potential (Figure 20; Table 29). The remaining 78 populations were judged to have either low production potential (37) or very low production potential (41). The average number of stream miles occupied by YCT populations in each population production category was 5.8 miles for the moderate production category, 15 miles for the low production category and 129.5 miles for the very low production grouping.

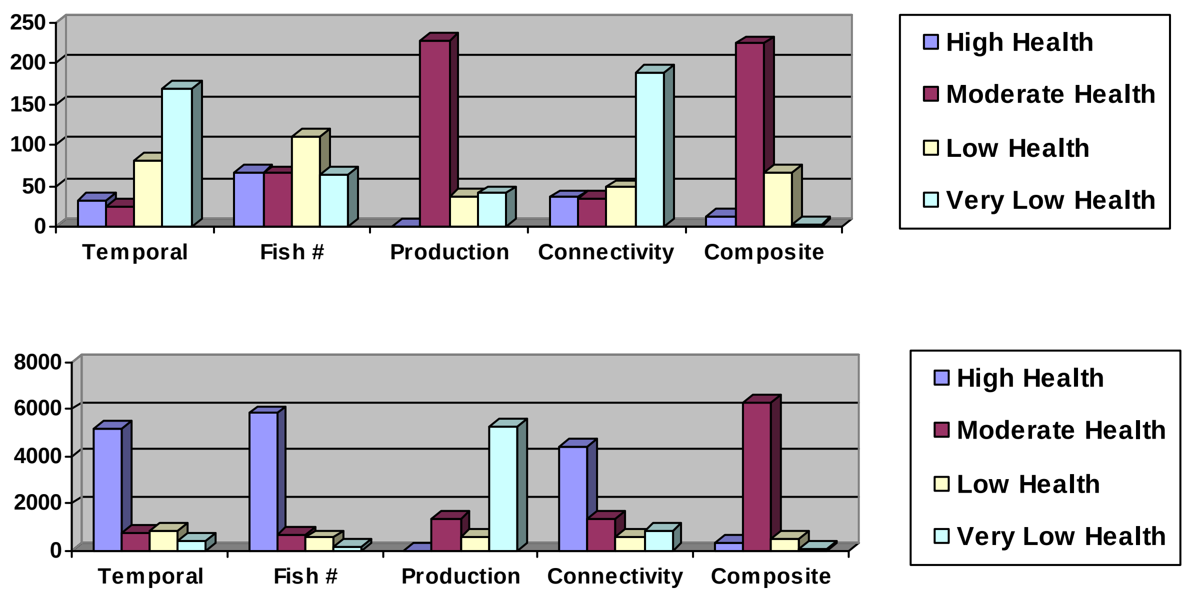


Figure 20. Ranked health scores by number of populations (top graph) and stream miles occupied (bottom graph). Yellowstone cutthroat trout conservation populations are ranked into low to high levels of health.

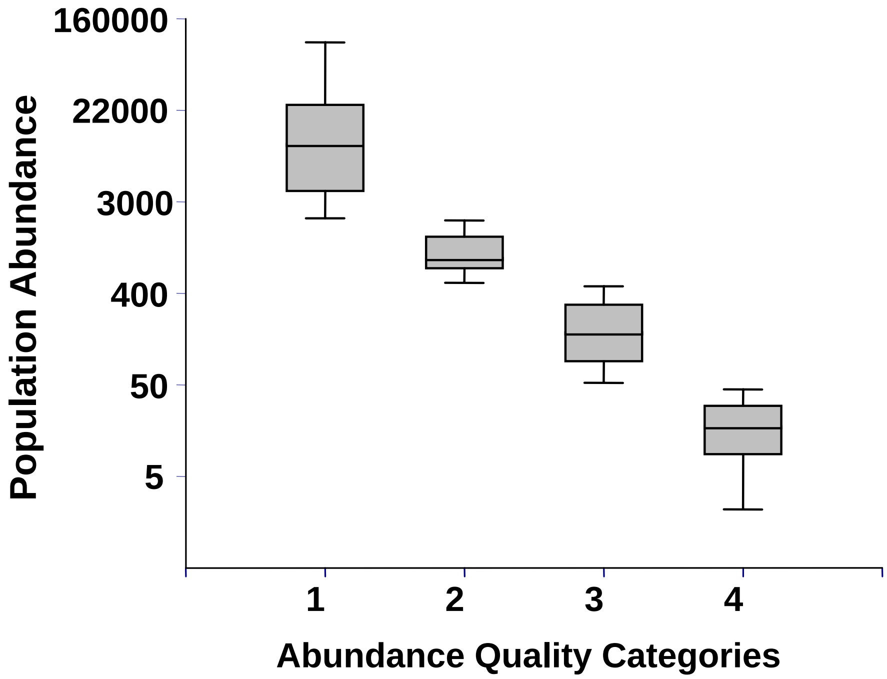


Figure 21. Natural log transformed abundance information by abundance quality categories. Box plots indicated the median value within the box, inter-quartile range by the box itself, and the range of values by horizontal lines at the end of vertical lines.

Table 29. Population health ratings for 306 YCT conservation populations by number of populations and miles of stream occupied.

Health Scores	**Health Scores by Number of Populations**					**Health Scores by Miles Occupied**				
	High Health 1	**Mod-Health 2**	**Low Health 3**	**Very Low Health 4**	**Total**	**High Health 1**	**Mod-Health 2**	**Low Health 3**	**Very Low Health 4**	**Total Miles**
Temporal Variability-	32	24	81	169	**306**	5,180	759	854	411	**7,204**
Population Size-Mature Adults	177	65	37	27	**306**	6,807	256	32	110	**7,204**
Production Potential-	0	228	37	41	**306**	0	1,334	558	5,312	**7,204**
Population Networks	36	34	48	188	**306**	4,454	1,347	590	813	**7,204**
Composite Score	13	224	66	3	**306**	462	6,559	172	11	**7,204**

Composite scores of general population health for the 306 conservation populations (Table 29; Figure 20) allowed for a more balanced or perhaps tempered perspective of general health conditions associated with YCT conservation populations. Only 8 conservation populations (3%) were judged to have a high degree of overall general population health. One hundred and forty one (141) YCT conservation populations (46%) were judged to have overall population health rated as moderate quality. Of the remaining populations, 148 (48%) were judged to have low general health and 9 (3%) had a very low level of general health. The average number of stream miles occupied by YCT populations in each composite health category was 332 miles for the high general health grouping. The moderate composite health category had 6,341 miles. The low composite health category had 484 miles, and the very low composite health category had 47 miles of occupied stream habitat.

Another comparison of general population health can be obtained by reviewing the relationships among temporal variability, population size and population production potential against the nature of the habitat networks associated with the YCT populations (Figure 22). Assessment of population habitat networks indicated that a substantial majority of populations (188) existed as non-networked entities (e.g., single streams). Weakly networked populations were second in abundance (48); followed by 34 moderately networked populations and 36 strongly networked populations. The average number of stream miles occupied by YCT populations in each connectivity category was 123.7 miles per population in the strongly networked category, 39.6 miles in the moderate network category, 12.3 miles per population for the low network category and 4.3 miles per population in the very low network grouping.

Of the 188 populations identified as "non-networks" and the majority (124) were rated as having a moderate composite health quality rating (Figure 22). Sixty populations had a low composite health quality rating. The other four populations were equally split between the high and very low composite health ratings. The health factor of most concern for these "non-networked" populations was temporal variability due to most populations (144) occupying less than 6 miles of habitat. The health factor associated with population size was more evenly distributed across the population abundance characterizations (e.g., high quality - 9 populations, moderate quality – 42 populations; low quality – 80 populations; and very low – 57 populations). The very low quality grouping included 24 populations without fish density information. Population production potentials for these non-networked populations were rated as either high (171) or moderate (17). Many of these non-networked populations (83) were identified as core conservation populations. The majority of non-networked populations (175) were judged to be at limited risk of disease and 136 were judged to be at low to moderate risk from influences to the genetic integrity of the populations.

Forty-eight conservation populations that were evaluated for general population health were identified as having weak habitat networks (e.g., 2 to 3 streams in the habitat network). The majority (43) were judged to have a moderate level of population health (Figure 22). Four populations were given a low composite health score and 1 received a very low health score.

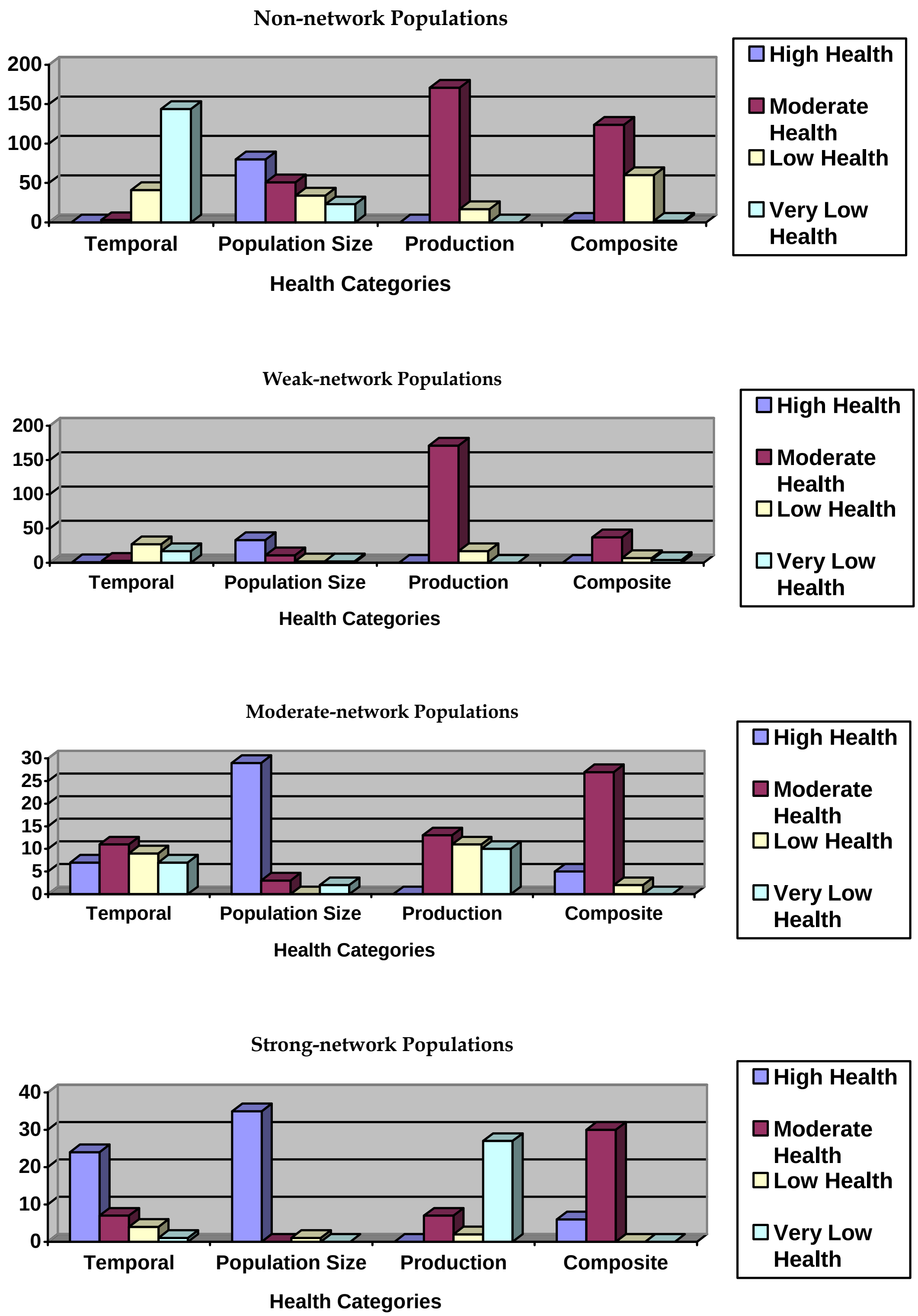


Figure 22. Ranked health scores by number of populations for each population health characterization and the nature of population habitat networks.

The health factor of most concern for these "weak networked" populations was temporal variability. Twenty-seven of these populations occupied between 6 to 19 miles of habitat and another 17 populations occupied less than six miles of habitat. Health factors associated with population size and production potential for the majority of populations were viewed as lesser population health concerns. The majority of weakly networked populations (43) were judged to be at limited to minimal risk from disease. Genetic integrity for this group of conservation populations included 28 populations (58%) considered to have low to moderate risks to genetic integrity and 20 populations (42%) with high to very high risk to genetic integrity.

General health composite scores for 34 moderately networked populations (i.e., 4 to 5 streams in the habitat network) were: 3 populations with a high health characterization, 26 populations with a moderate health rating, and 5 populations with a low health characterization (Figure 22). Health factors of most concern for these "moderately networked" populations were temporal variability and production potential. The health factor associated with population size was judged to be in the high quality category. The majority of moderately networked populations (27) were judged to be at limited to minimal risk from disease. Genetic integrity for this group of conservation populations had a slightly higher level of uncertainty with regard to genetic integrity. Nearly 50% of moderately networked populations were judged to be at high to very high risk to genetic integrity.

General health composite scores for 36 strongly networked populations (i.e., more than 5 streams in the habitat network) were: 4 populations with a high health characterization, 31 populations with a moderate health characterization, and 1 population with a very low quality score (Figure 22). The health factor of most associated these "strongly networked" populations was temporal variability. The health factors associated with population size were judged to be predominately in the high health quality category. The majority of strongly networked populations (24) were judged to be at limited to minimal risk from disease. Genetic integrity for this group of conservation populations had a higher level of uncertainty with regard to genetic integrity. Nearly 58% of strongly networked populations were judged to be at high to very high risk of introgression with non-native trout.

As a reminder, it is important that individual health indicators and the composite ratings for these relative health ratings do not represent absolutes in terms of definitive population health. They do, however, provide a general or relative view of population health based on the four variables considered individually or in combination.

Conservation Actions and Land Use Influences

Restoration, conservation, and management activities that had been implemented to conserve conservation populations were identified for the 382 YCT populations (Table 30). The majority of populations (57%) had one or more conservation actions (e.g., activities or projects) implemented to improve conditions. A significant number (153) of conservation populations (40%) had no specific conservation actions implemented to improve conditions. During this status assessment there was no attempt to define levels of significance of the conservation actions, either on a specific YCT population or with regard to the broad conservation effort.

Relative significance will have to be addressed in subsequent assessments that will be conducted within the coordinated conservation effort.

Land uses and human influences associated with each YCT conservation population were also tracked (Table 31). The most pervasive land uses were non-angling recreation (i.e., recreational trails), livestock grazing, angling and roads. Land uses that were less frequently identified included channel de-watering, timber harvest and mining. For a significant number of conservation populations (95), the types of land uses were identified as unknown. There was no attempt to define levels of significance of the various human influences, either on a specific YCT population basis or with regard to the broad conservation effort. Relative significance will have to be addressed in subsequent assessments yet to be conducted by the coordinated conservation effort.

Table 30. Number and percentage of YCT conservation populations associated with the various conservation actions taken to improve conditions.

Conservation Action	Count	Percent of Total YCT Populations
None	153	40
Special angling regulations	139	36
Land-use mitigation direction and requirements (e.g., Forest Plan direction, regulation, permit req., coordination stipulations, etc)	103	27
Population covered by special protective mgt. emphasis (e.g., Nat'l Park, wilderness, special mgt. area, conservation easement, etc.)	65	17
Culvert replacement	49	12
Riparian restoration	36	9
Bank stabilization	28	7
Channel restoration	26	7
Population restoration/expansion	24	6
Riparian fencing	20	5
Chemical removal of competing/hybridizing species	16	4
Public outreach efforts at site (Interpretative site)	15	4
In-stream cover habitat	11	3
Spawning habitat enhancement	11	3
Barrier removal	10	3
Water lease/In-stream flow enhancement	10	3
Woody debris placement	9	2
Diversion modification	8	2
Physical removal of competing/hybridizing species	8	2
Pool development	8	2
Population supplementation (e.g., to implement genetic swamping or to reduce potential of genetic drift, etc.)	8	2
Other (List in comments)	8	2

Table 31. Number and percentage of YCT conservation populations that had human land-use activities associated with them.

Land Use Activity	Count	Percent of Total YCT Populations
Recreation (non-angling)	228	60
Range (Livestock grazing)	210	55
Angling	208	54
Roads	161	42
De-watering	88	23
Timber harvest	68	18
Mining	35	9
Fish stocking (e.g., non-native fish)	18	5
Hydroelectric, water storage and/or flood control	13	3
Other (list in comments)	8	2
None	7	2
Unknown	95	25

YCT Restoration and Expansion Evaluation

The initial status assessment completed in 2001 did not include an assessment of potential opportunities for restoration or expansion of YCT populations. This assessment (2006) did include a specific component that addressed restoration and expansion opportunities. The restoration and expansion evaluation was only applied to those stream segments, not currently occupied by conservation populations of YCT, that were initially identified as being part of the historically occupied range. In addition, a second criterion was applied to the currently unoccupied habitat that addressed the habitat's current ability to support "cold water biota" and more specifically YCT. Lake environments and stream habitats outside of the identified historical range were not evaluated. These opportunities may be reviewed within the coordinated effort at a later date.

Of the 17,721 miles of historical habitat, approximately 10,517 miles (61%) were identified as not being occupied by YCT conservation populations (Figure 23). In order to objectively evaluate the restoration or expansion potential within these unoccupied habitats it was deemed important to determine how much of this historical stream habitat (6,746 miles) was currently capable of supporting YCT. Those stream miles judged as being incapable (3,771 miles) were eliminated from further consideration due to significant environmental changes. The working groups reviewed the unoccupied historical stream segments for each watershed (Figure 24).

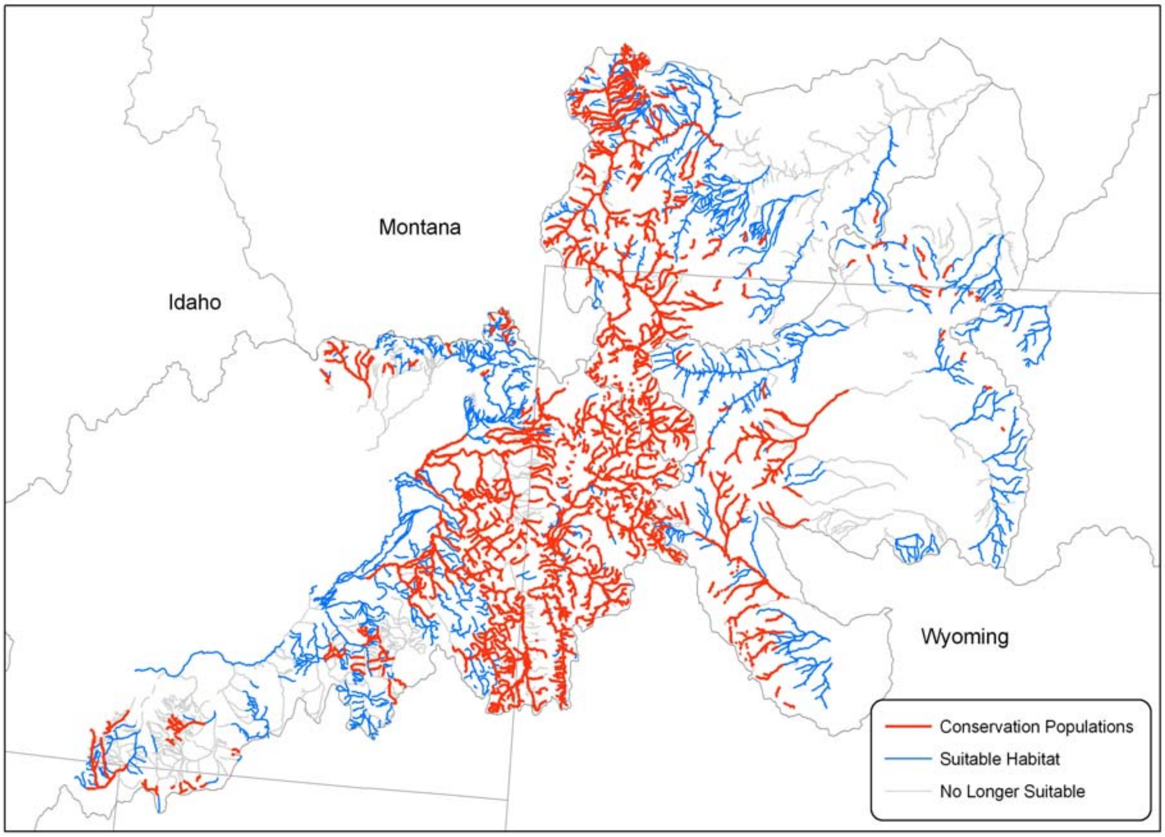


Figure 23. Map displaying historic habitat currently occupied by conservation populations (red), currently suitable habitat (blue) and currently unsuitable habitat (gray) for YCT restoration and expansion.

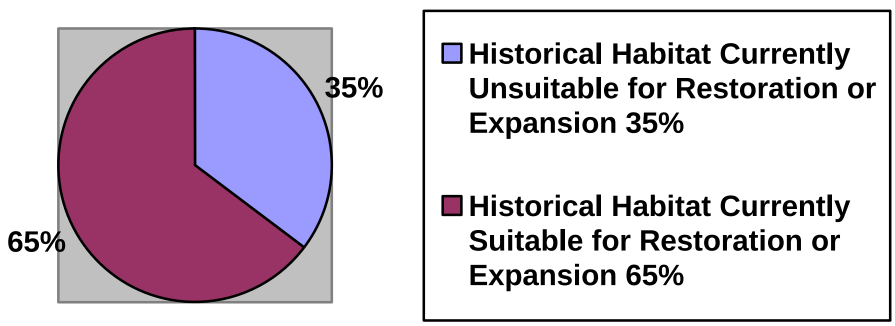


Figure 24. Proportions of historical YCT habitat considered as suitable for restoration or expansion.

In actuality, the geo-database contained restoration and expansion information for an additional 223 miles of stream habitat. The exact source of this overage is unknown, but it is likely that there was a misunderstanding in the application of the protocol and some stream segments outside of the historical stream coverage (e.g., stream habitats above a historical barrier) were inadvertently included in the restoration and expansion analysis. In total, 6,969 stream miles were judged to be suitable and carried through the restoration or expansion evaluation. They were rated in relation to their potential for restoration or expansion of YCT conservation populations (Table 32) based on current capability to support YCT.

There were four general attributes deemed of particular importance to the potential success of restoration or expansion in these suitable habitats. The first attribute related to past stocking and/or presence of non-native fish, especially other trout species that would compete or hybridize with YCT. The second attribute addressed the relative quality of the habitat. The third attribute considered the significance of existing fisheries within the suitable habitat segments. And last, an attribute associated with the relative complexity of fish removal within the stream segments was included in the evaluation. These attributes were assessed individually and in combination. There was also consideration given to the presence of barriers that could provide security from competing and/or hybridizing species of fish.

Table 32. Potential restoration and expansion opportunity assessment base information by watershed (miles).

Watershed Name	Watershed Number	Restoration or Expansion Base Layer	Habitat Judged as Unsuitable	Habitat Judged as Suitable
Yellowstone Headwaters	10070001	69.9	0.0	69.9
Upper Yellowstone	10070002	587.0	0.0	587.0
Shields	10070003	222.4	32.2	190.2
Upper Yellowstone-Lake Basin	10070004	288.5	288.5	0.0
Stillwater	10070005	523.1	66.4	456.8
Clarks Fork Yellowstone	10070006	523.6	166.2	357.4
Upper Yellowstone-Pompey's Pillar	10070007	277.9	277.9	0.0
Pryor	10070008	211.4	0.0	211.4
Upper Wind	10080001	209.9	4.6	205.3
Little Wind	10080002	161.7	0.0	161.7
Popo Agie	10080003	126.5	0.0	126.5
Upper Bighorn	10080007	586.5	429.1	157.4
Nowood	10080008	551.6	168.9	382.7
Greybull	10080009	83.2	75.2	8.1
Big Horn Lake	10080010	263.7	43.1	220.6
North Fork Shoshone	10080012	261.3	4.7	256.6
South Fork Shoshone	10080013	137.6	7.7	129.9
Shoshone	10080014	345.5	146.5	199.0
Lower Bighorn	10080015	167.5	156.5	11.0
Little Bighorn	10080016	424.7	194.2	230.5
Upper Tongue	10090101	268.8	24.5	244.3
Snake Headwaters	17040101	37.2	0.0	37.2
Gros Ventre	17040102	4.7	0.0	4.7
Greys-Hoback	17040103	74.9	0.0	74.9
Palisades	17040104	12.0	0.0	12.0
Idaho Falls	17040201	248.6	0.0	248.6
Upper Henrys	17040202	518.9	0.0	518.9
Lower Henrys	17040203	135.8	42.4	93.4
Teton	17040204	185.6	185.6	0.0
Willow	17040205	192.1	0.0	192.1
American Falls	17040206	484.6	78.2	406.4
Blackfoot	17040207	331.9	0.0	331.9
Portneuf	17040208	489.8	184.2	305.6
Lake Walcott	17040209	280.1	191.9	88.2
Raft	17040210	493.2	372.0	121.3
Goose	17040211	480.6	308.6	172.0
Beaver-Camas	17040214	434.8	287.1	147.7
Medicine Lodge	17040215	43.6	35.0	8.6

Past Stocking and/or Presence of Non-native Trout
With regard to presence of non-native trout, of the 6,969 stream miles identified as being suitable for conservation population restoration or expansion, 310 miles (4%) had no record of non-native fish stocking and were judged to be barren of fish. Another 3,332 miles (49%) of stream habitat had records indicating that non-native trout were present in high numbers. Another 1,843 miles (26%) had non-native trout in low numbers and in the remaining 1,484 miles (21%) were unknown as to whether non-native trout were present (Figure 25).

Table 33. Information relative to non-native stocking and/or presence for habitat (miles) being considered for conservation population restoration or expansion.

Record of Stocking and Presence or Non-Native Trout	Miles of Suitable Historical Habitat
No record of stocking--segment is barren	310 (4%)
Record of stocking and/or presence of only YCT – not included in conservation population	0
Record of stocking and segment has non-native trout in low numbers	1,843 (26%)
Record of stocking and segment has non-native trout in high numbers	3,332 (49%)
Unknown presence of non-native trout	1,484 (21%)
Total	**6,969**

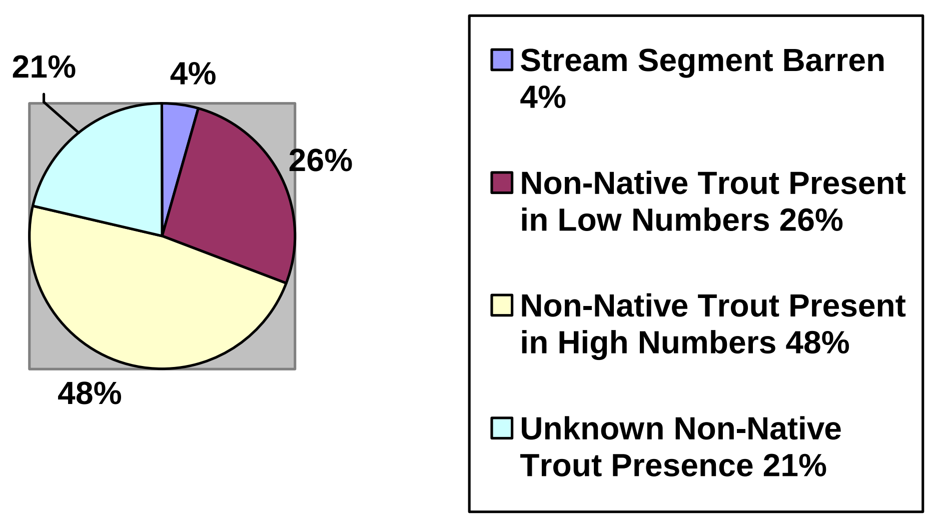


Figure 25. YCT restoration or expansion opportunity based on presence of non-native trout.

Habitat Quality Associated with Restoration and Expansion of YCT
Of the 6,969 stream miles of habitat considered suitable for population restoration or expansion, 125 miles (2%) had habitat quality rated as excellent. Another 2,733 miles (39%) had habitat quality rated as good. Twenty two hundred and seventy seven miles (33%) had habitat rated as fair. Another 503 miles (7%) had habitat quality rated as poor, and 1,332 miles (19%) of suitable habitat had unknown quality (Table 34; Figure 26).

Table 34. Information relative to habitat quality of suitable habitat (miles) being considered for conservation population restoration or expansion.

Habitat Quality	Miles of Suitable Historical Habitat
Excellent	125 (2%)
Good	2,733 (39%)
Fair	2,277 (33%)
Poor	503 (7%)
Unknown	1,333 (19%)
Total	**6,969**

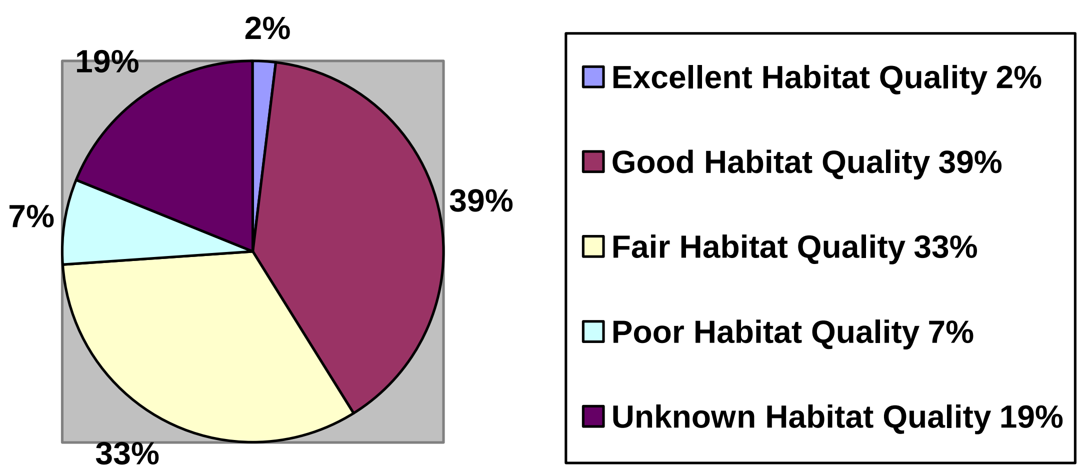


Figure 26. Habitat suitability for YCT restoration or expansion based on presence of non-native trout.

Recreational Fisheries Associated with Restoration and Expansion of YCT

Of the 6,969 stream miles of habitat considered suitable for population restoration or expansion, 152 miles (2%) had habitat with no fishery present. Another 2,634 miles (39%) had fisheries of minor significance. Sixteen hundred and sixteen miles (23%) had habitat rated as having a fishery of moderate significance. Another 1,143 miles (16%) had habitat rated as having a major fishery and for 1,424 miles (20%) the fishery significance was unknown (Table 35; Figure 27).

Table 35. Information for significance of fisheries associated with stream habitat (miles) being considered for YCT conservation population restoration or expansion.

Significance of Fisheries	Miles of Suitable Historical Habitat
No fisheries present	152 (2%)
Minor	2,634 (39%)
Moderate	1,616 (23%)
Major	1,143 (16%)
Unknown	1,424 (20%)
Total	**6,969**

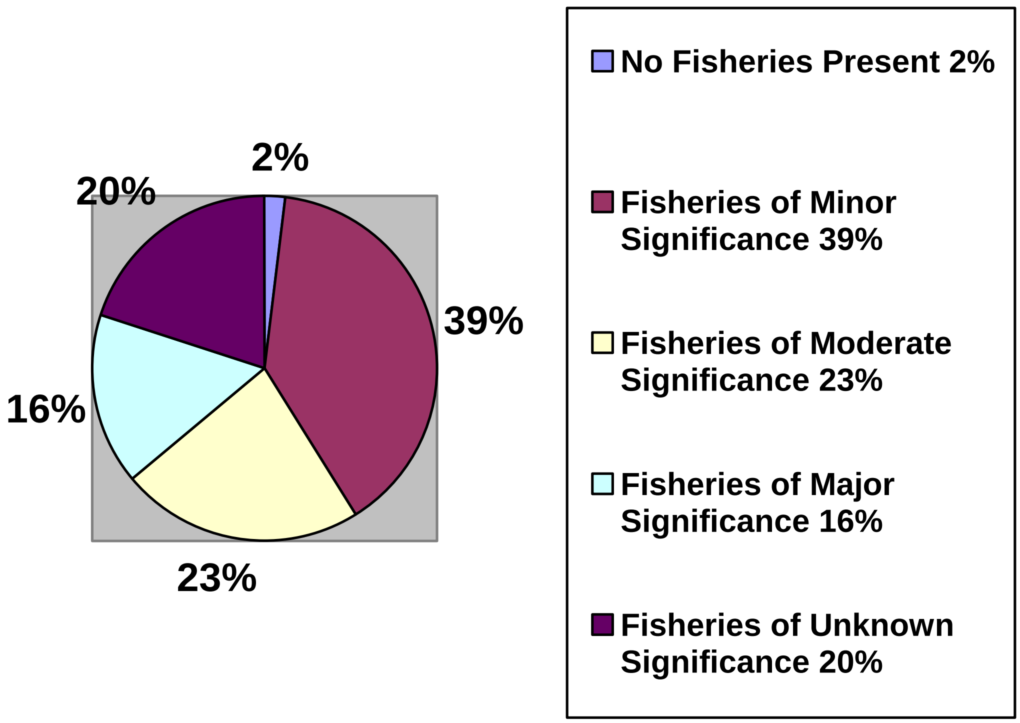


Figure 27. Habitat suitability for YCT restoration or expansion based on significance of existing fisheries.

Considerations Associated with the Complexity of Removal of Non-Native Fish
Of the 6,969 stream miles of judged suitable for restoration or expansion, 179 miles (3%) were judged to have no fish present and removal would not be needed. Another 122 miles (2%) were judged to have a minor level of complexity in relation to fish removal. Eleven hundred and twenty nine miles (16%) were rated as having a moderate level of complexity related to the removal of unwanted fish. Another 3,978 miles (57%) were rated as having a major complexity related to fish removals, and for 1,562 miles (22%) the complexity related to fish removals was identified as being unknown (Table 36; Figure 28).

Table 36. Information relative to the complexity of fish removals that is associated with habitat (miles) being considered for YCT conservation population restoration or expansion.

Complexity of Fish Removal	Miles of Suitable Historical Habitat
No fish present	179 (3%)
Minor	122 (2%)
Moderate	1,129 (16%)
Major	3,978 (57%)
Unknown	1,561 (22%)
Total	**6,969**

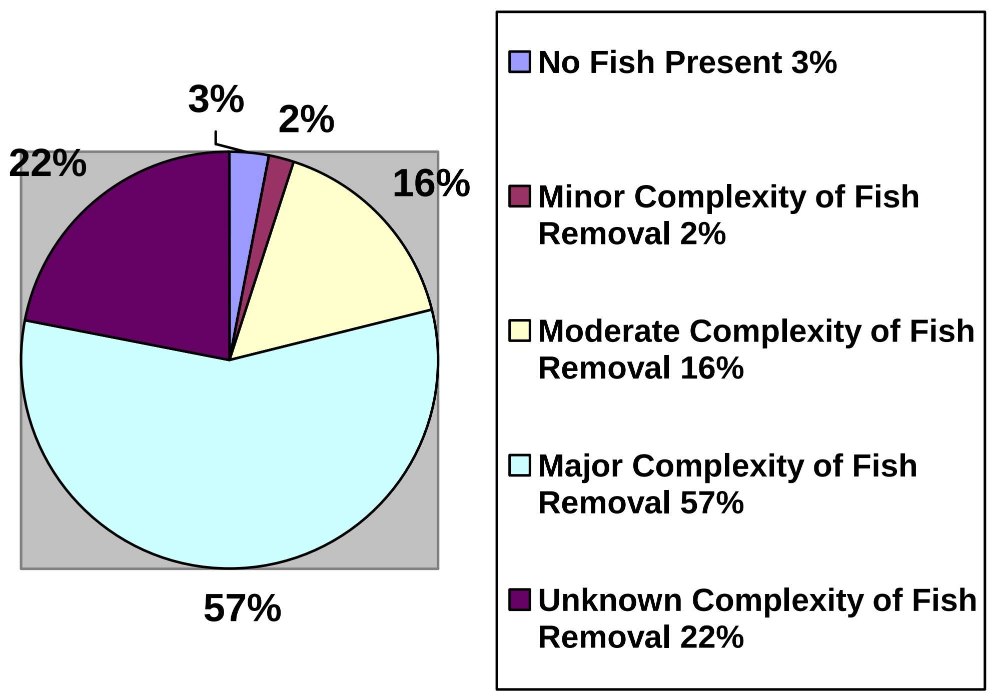


Figure 28. Potential for YCT conservation population restoration or expansion based on the complexity of existing fish removal.

Combined Rating of Restoration and Expansion Rankings for YCT

An effort was made to combine the results of the four variables into a composite rating. To facilitate development of an overall view of restoration or expansion potential, the ratings for the four variables were weighted equally and then summed to give a final score. In situations where one or more of the individual variables were considered as unknown these suitable miles were automatically included in the unknown category. Of the 6,969 miles of habitat judged as suitable to be considered for YCT restoration or expansion, only 83 miles (1%) were judged to have a high combined score related to YCT restoration or expansion. Another 167 miles (2%) were judged to have only an intermediate potential for expansion or restoration. Thirty seven hundred and eight miles (53%) were rated has having a low potential for restoration or expansion. Thirteen hundred and sixty nine miles (20%) were rated as having very low potential for YCT restoration or expansion, and 1,642 miles were identified as having unknown potential for restoration or expansion (Table 37; Figure 29).

Table 37. Composite rating of restoration or expansion potential for YCT conservation populations.

YCT Restoration or Expansion Combined Rating	**Miles of Suitable Historical Habitat**
High overall potential	83 (1%)
Intermediate potential	167 (2%)
Low potential	3,708 (53%)
Very low potential	1,369 (20%)
Unknown	1,642 (24%)
Total miles	**6,969**

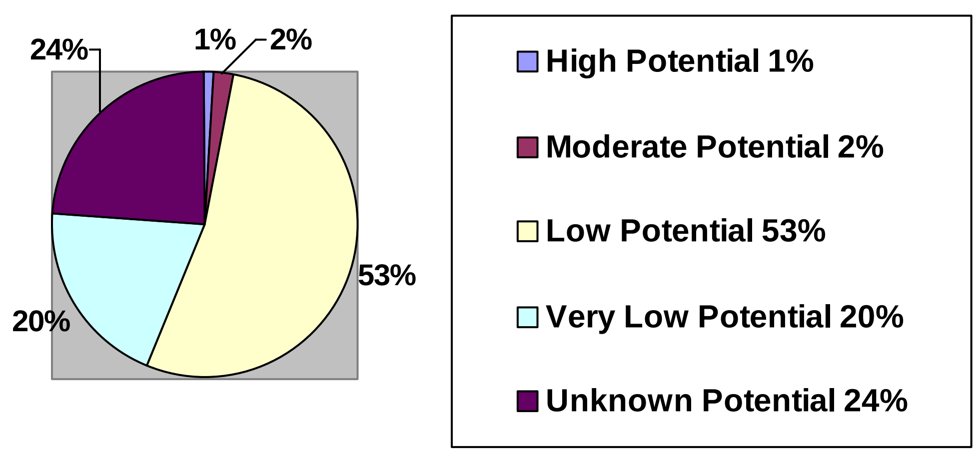


Figure 29. YCT conservation population restoration or expansion based on the composite rating of the four variables evaluated.

Comparisons of Fine-Spotted and Large Spotted Forms of YCT

Consistent with the 2001 status assessment, we hypothesize that both large and fine-spotted YCT historically occupied stream and lake environments within the historical range described in this report. In some instances both forms were likely present in sympatry. We further hypothesize that fine spotted YCT historically occupied only those HUCs (i.e., Snake Headwaters, Gros Ventre, Greys-Hoback, Salt and Palisades) in the uppermost portion of the Snake River Basin. There was no effort to project the amount of historical habitat occupied by YCT based on spotting pattern. This assessment continued to partition information on the basis of spotting pattern.

Information collected for current distributions of YCT based on spotting patterns within the 7,527 miles of occupied habitat, indicated that 4,620 miles (61%) were occupied only by the large spotted form, 1,132 miles (15%) were occupied only by the fine spotted form, and 1,775 miles (24%) were occupied by both large and fine spotted YCT in a sympatric relationship (Table 38; Figure 30). Wyoming had the greatest amount of habitat (2,318 miles) occupied by fine spotted YCT. Idaho had mostly large spotted YCT (1,445 miles) and a lesser number of miles (583) occupied by both large and fine spotted YCT. Idaho reported only 5 miles of stream habitat occupied by only fine spotted YCT. Habitats in Montana, Nevada and Utah supported only large spotted YCT. Of the 205 lakes currently occupied by YCT, 86 contained only the large spotted form of YCT, 91 were identified as supporting only the fine spotted form, and 28 contained both large and fine spotted YCT. The associated acreages were 125,313 acres for the large spotted YCT, 33,775 acres for the fine spotted YCT, and 21,123 acres for YCT with both spotting patterns occupying the same habitat (Table 39). Initial analysis of the spotting pattern information for lakes appeared to have inconsistencies and likely reflects errors that occurred during data entry (e.g., lakes within the Yellowstone Headwaters HUC were identified as supporting both large and fine spotted YCT). This report will present the information as it now exists in the database, but it is anticipated that changes will occur as the database is corrected in the scheduled update planned for 2007.

Table 38. Occupied stream habitat associated with the various spotting patterns of YCT

	Occupied Stream Habitat (Miles)					
Spotting Pattern	**Wyoming**	**Idaho**	**Montana**	**Nevada**	**Utah**	**Totals**
Both large and fine spot	1,192	583	--	--	--	1,775
Fine spot only	1,126	5	--	--	--	1,132
Large spot only	1,730	1,445	1,339	58	49	4,620
Totals	**4,049**	**2,033**	**1,339**	**58**	**49**	**7,527**

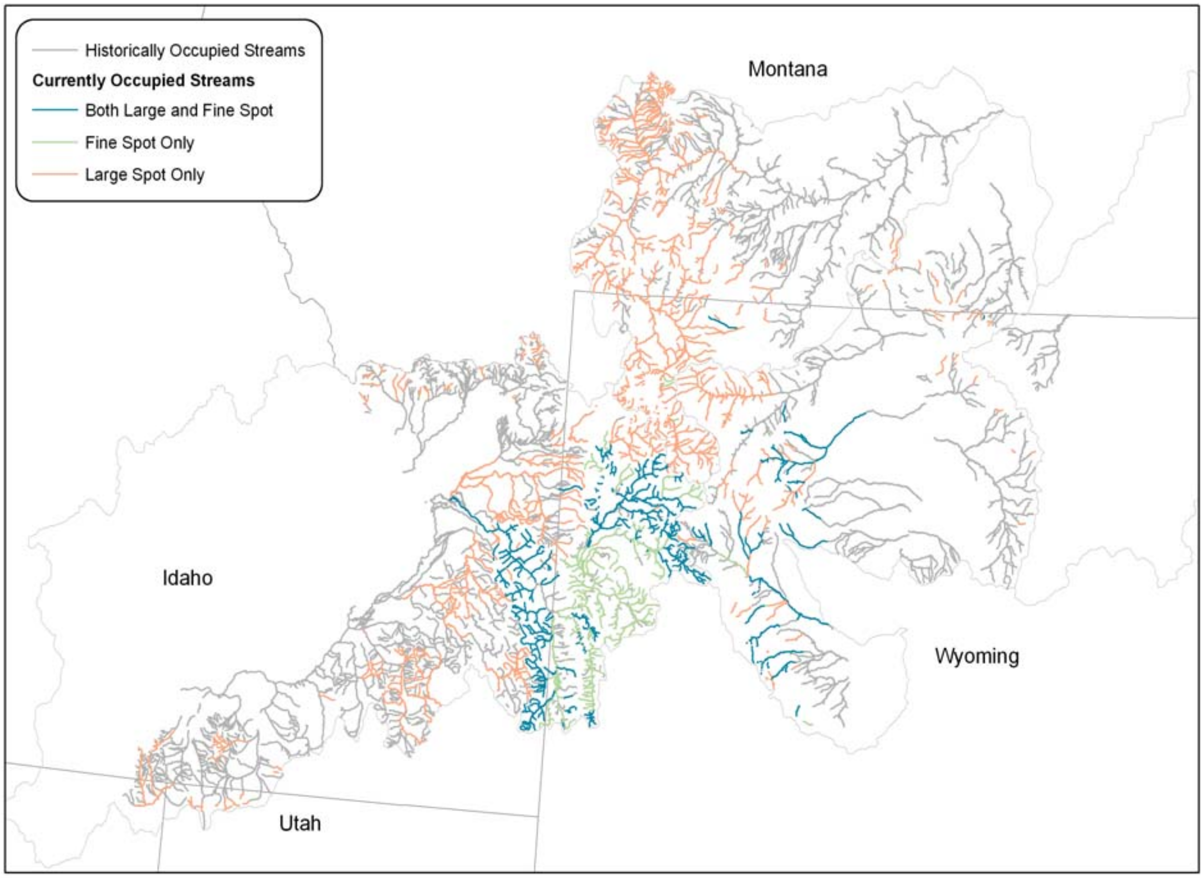


Figure 30. Current distribution of YCT based on the three spotting pattern categories.

Table 39. Occupied lake habitat associated with the various spotting patterns of YCT.

	Occupied Lake Habitat (# of lakes)			Occupied Lake Habitat (Acres)		
Spotting Pattern	**Wyoming**	**Idaho**	**Montana**	**Wyoming**	**Idaho**	**Montana**
Large Spot Only	53	5	28	94,282	30,332	698
Fine Spot Only	91	--	--	33,775	--	--
Both Large and Fine Spot	26	2	--	5,236	15,887	--
Totals	**170**	**7**	**28**	**133,293**	**46,220**	**698**

Twenty-one HUCs contained habitat occupied by the large spotted YCT. Six watersheds had some habitat occupied only by large spotted YCT, but other habitats were occupied with both large and fine spotted YCT that were sympatric. Two watersheds contained habitat that supported only large and fine spotted YCT that were sympatric. Two watersheds had some habitat that supported only fine spotted YCT and other habitats that support both large and fine spotted YCT that were sympatric. One watershed supported both large and fine spotted YCT in separate habitats, and 5 watersheds had separate habitats that support all combinations associated with spotting pattern (Table 40). Eight watersheds contained lakes supporting only large spotted YCT. Four watersheds contained lakes having all three spotting pattern combinations. Three watersheds contained lake supporting only fine spotted YCT, and 1 watershed contained lakes supporting both spotting patterns that were sympatric (Table 41). Expansion of the fine spotted form of YCT into so many watersheds is largely related to the use of these fish in contemporary fishery management, especially in Wyoming. Also, some lakes in Montana were inadvertently omitted from the geo-database. These lakes would have been occupied by large spotted YCT.

Table 40. Watersheds and associated stream miles occupied by the various spotting patterns of YCT.

Watershed Name	HUC Code	Spotting Pattern	Miles
Yellowstone Headwaters	10070001	Fine Spot Only	17.2
Upper Wind	10080001	Fine Spot Only	24.3
Little Wind	10080002	Fine Spot Only	0.3
Popo Agie	10080003	Fine Spot Only	4.4
Snake Headwaters	17040101	Fine Spot Only	122.5
Gros Ventre	17040102	Fine Spot Only	132.8
Greys-Hoback	17040103	Fine Spot Only	663.6
Salt	17040105	Fine Spot Only	166.7
		Total	**1,132.0**
Clarks Fork Yellowstone	10070006	Both Large and Fine Spot	15.5
Upper Wind	10080001	Both Large and Fine Spot	198.0
Little Wind	10080002	Both Large and Fine Spot	47.0
Popo Agie	10080003	Both Large and Fine Spot	5.7
Upper Bighorn	10080007	Both Large and Fine Spot	44.2
Greybull	10080009	Both Large and Fine Spot	142.1
South Fork Shoshone	10080013	Both Large and Fine Spot	14.1
Little Bighorn	10080016	Both Large and Fine Spot	1.3
Snake Headwaters	17040101	Both Large and Fine Spot	420.6
Gros Ventre	17040102	Both Large and Fine Spot	171.4
Greys-Hoback	17040103	Both Large and Fine Spot	72.0
Palisades	17040104	Both Large and Fine Spot	287.7
Salt	17040105	Both Large and Fine Spot	317.2
Idaho Falls	17040201	Both Large and Fine Spot	27.4
Teton	17040204	Both Large and Fine Spot	11.4
		Total	**1,775.0**

Table 40. Continued.

Yellowstone Headwaters	10070001	Large Spot Only	914.5
Upper Yellowstone	10070002	Large Spot Only	560.2
Shields	10070003	Large Spot Only	452.7
Stillwater	10070005	Large Spot Only	103.4
Clarks Fork Yellowstone	10070006	Large Spot Only	81.0
Pryor	10070008	Large Spot Only	26.8
Upper Wind	10080001	Large Spot Only	123.0
Little Wind	10080002	Large Spot Only	23.3
Nowood	10080008	Large Spot Only	11.2
Greybull	10080009	Large Spot Only	89.1
Big Horn Lake	10080010	Large Spot Only	64.5
North Fork Shoshone	10080012	Large Spot Only	253.3
South Fork Shoshone	10080013	Large Spot Only	23.6
Shoshone	10080014	Large Spot Only	4.1
Lower Bighorn	10080015	Large Spot Only	7.0
Little Bighorn	10080016	Large Spot Only	20.0
Upper Tongue	10090101	Large Spot Only	0.6
Snake Headwaters	17040101	Large Spot Only	153.5
Gros Ventre	17040102	Large Spot Only	2.2
Greys-Hoback	17040103	Large Spot Only	3.3
Palisades	17040104	Large Spot Only	32.8
Upper Henrys	17040202	Large Spot Only	71.5
Lower Henrys	17040203	Large Spot Only	156.0
Teton	17040204	Large Spot Only	387.7
Willow	17040205	Large Spot Only	195.9
American Falls	17040206	Large Spot Only	17.9
Blackfoot	17040207	Large Spot Only	271.3
Portneuf	17040208	Large Spot Only	264.3
Lake Walcott	17040209	Large Spot Only	7.8
Raft	17040210	Large Spot Only	102.3
Goose	17040211	Large Spot Only	119.2
Beaver-Camas	17040214	Large Spot Only	18.1
Medicine Lodge	17040215	Large Spot Only	58.1
		Total	**4,620.0**

Table 41. Watersheds and the number of lakes occupied by the various spotting pattern combinations.

Watershed Name	Watershed Number	Large Spot Only	Fine Spot Only	Both Spotting Patterns
Yellowstone Headwaters	10070001	4		
Stillwater	10070005	24		
Clarks Fork Yellowstone	10070006	4		
Upper Wind	10080001	26	21	11
Little Wind	10080002	9	26	8
Popo Agie	10080003		3	
Nowood	10080008	1		
North Fork Shoshone	10080012	2		
Snake Headwaters	17040101	10	15	5
Gros Ventre	17040102		16	
Greys-Hoback	17040103	1	8	2
Palisades	17040104			2
Salt	17040105		2	
Upper Henry's	17040202	3		
Teton	17040204	1		
Blackfoot	17040207	1		
Totals		86	91	28

Genetic Comparisons by Spotting Pattern

Genetic information for streams occupied by only large spotted YCT (Figure 31) indicated that genetically unaltered fish occurred in 1,390 miles (30%), large spotted YCT with less than 10% introgression occurred in 492 miles (11%), large spotted fish with introgression in the range from >10 and ≤25% occupied 84 miles (2%), and those large spotted YCT with more than 25% introgression occupied 56 miles (1%). There were 136 miles of habitat occupied only by large spotted YCT where both genetically unaltered and altered fish occurred in a sympatric condition. Genetic testing has not been completed for a substantial amount of occupied habitat and for these areas the biologists were asked to project the genetic condition based on the history of stocking and/or the presence or absence of genetically contaminating fish. For untested stream segments containing only large spotted YCT, 1,236 miles (27%) were judged as suspected unaltered, and 1,219 (26%) were viewed as being potentially altered (Table 42).

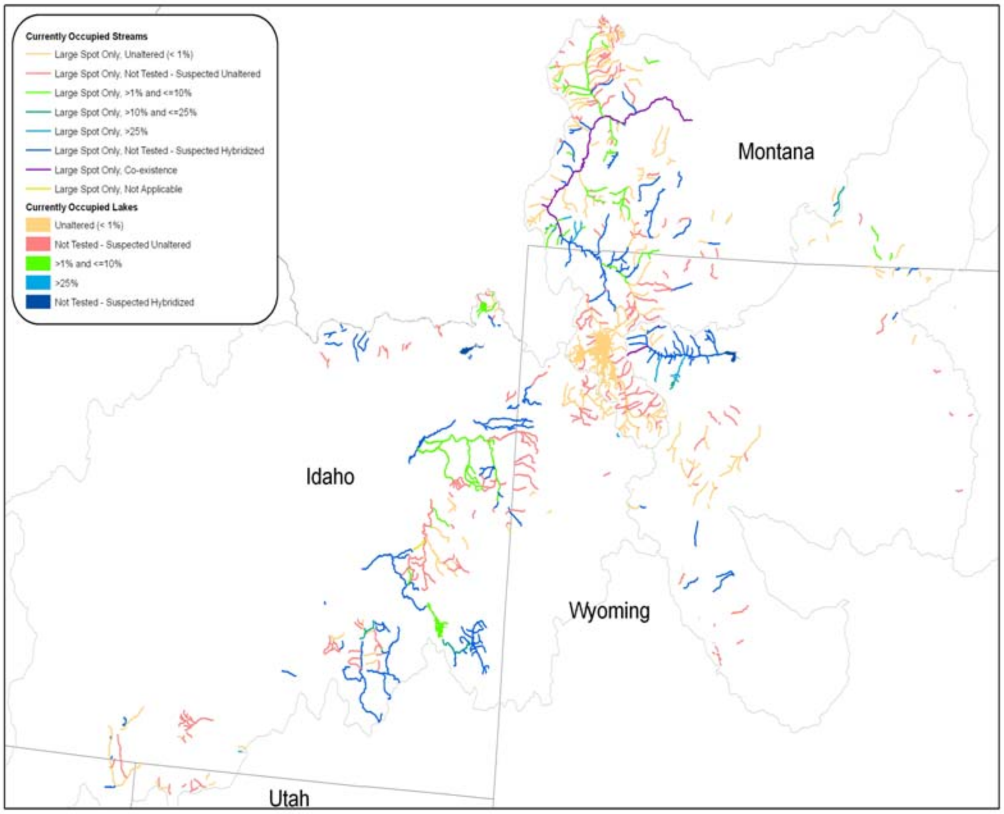


Figure 31. Genetic information associated with stream habitat occupied only by large spotted YCT.

For those stream habitats (1,132 miles) occupied only by fine spotted YCT (Figure 32), 905 miles (80%) were tested and found to be genetically unaltered, and another 100 miles (9%) were suspected of being unaltered based on stocking history and/or absence of genetically contaminating (Table 42). Thirty-six miles (3%) were found to have low levels of introgression and 57 miles (5%) had fish that were potentially altered genetically. The remaining 34 miles (3%) of stream habitat occupied by fine spotted YCT were judged to support both unaltered and altered that were sympatric.

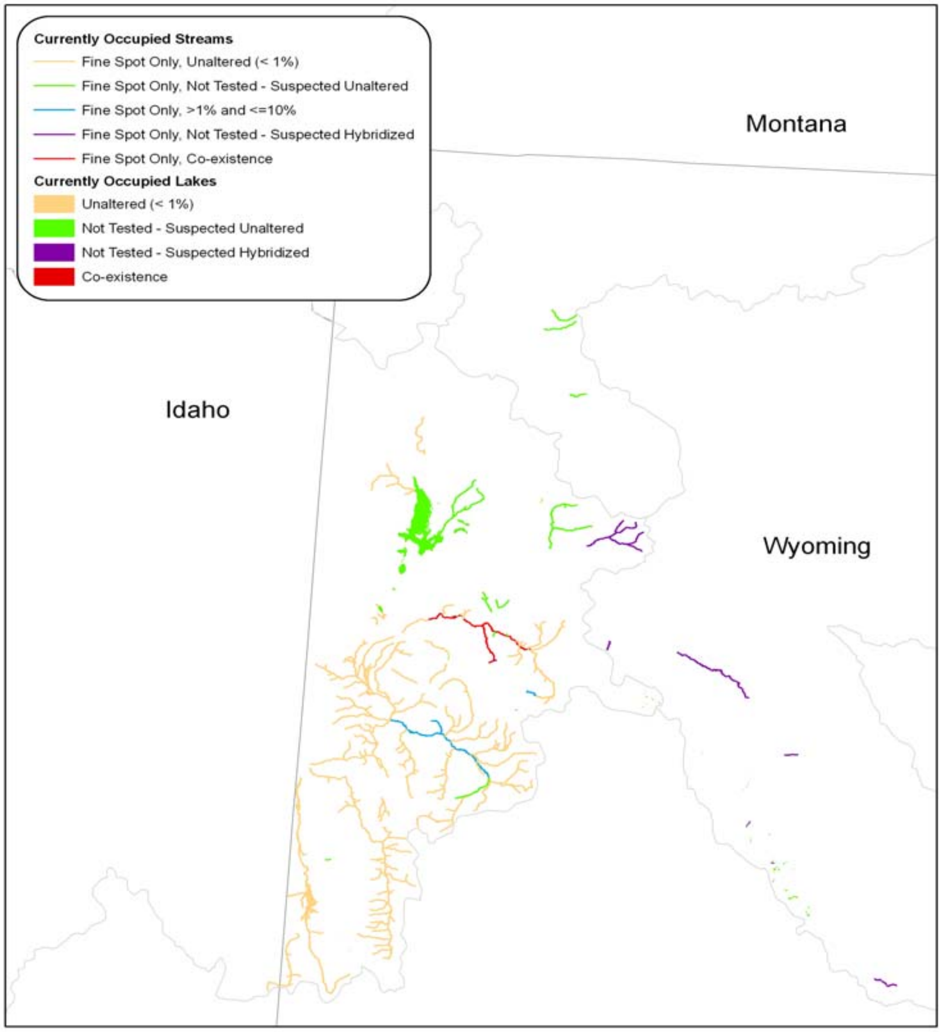


Figure 32. Genetic information associated with stream habitat occupied only by fine spotted YCT.

The remaining spotting pattern category had both large and fine spotted YCT in a sympatric condition. The genetic information collected for this grouping identified 817 miles (46%) as being genetically unaltered, 517 miles (29%) were untested but suspected of being unaltered, 84 miles (5%) were tested and found to be slightly hybridized, and another 19 miles (1%) were in the hybridized category of >10 and ≤25%. Three hundred and thirty eight miles (19%) were not tested but judged as being potentially hybridized (Figure 33).

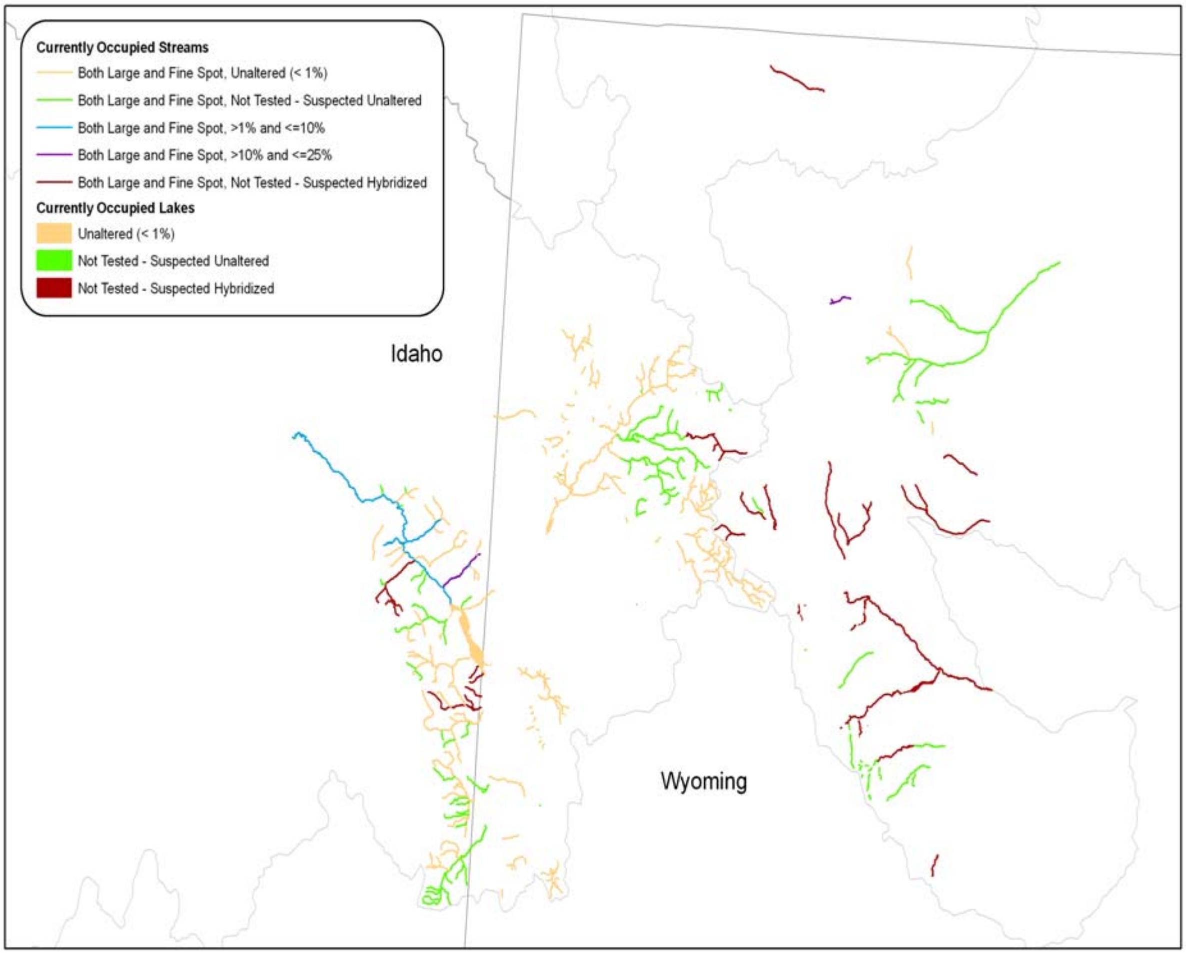


Figure 33. Genetic information associated with stream habitat occupied only by both large and fine spotted YCT in a sympatric condition.

Table 42. Genetic results by spotting pattern and genetic category for currently occupied habitat. Values are miles of occupied stream habitat.

	Spotting Pattern Category (Miles of Occupied Stream Habitat)			
Genetic Category	**Large Spot Only**	**Fine Spot Only**	**Large and Fine Spot**	**Total**
Unaltered	1,390	905	817	**3,112**
>1% and ≤10%	492	36	84	**612**
>10 and ≤25%	84	--	19	**103**
>25%	56	--	--	**56**
Not tested – suspected unaltered	1,236	100	517	**1,854**
Not tested -- potentially altered	1,219	57	338	**1,614**
Altered and unaltered co-exist	136	34	--	**169**
Totals	**4,620**	**1,132**	**1,775**	**7,527**

Conservation Population Comparisons by Spotting Pattern

Of the 382 conservation populations, 210 (55%) were comprised of the large-spotted form, 79 (21%) were comprised of the fine-spotted form and 93 (24%) represented a mixture of both spotting patterns (Table 43). Large-spotted YCT conservation populations were identified as being broadly distributed throughout the current range of YCT (Figure 30). Large-spotted YCT existing, as conservation populations, without the presence of the fine-spotted form occurred in 3,349 miles of stream (47% of habitat occupied by conservation populations). The fine-spotted form existing, as conservation populations, without the presence of the large-spotted form occurred in 576 miles of stream (8%). Conservation populations represented by both spotting patterns occurred in 3,279 miles of stream (46%). Conservation populations with only fine-spotted YCT were primarily located within headwaters of the Snake River. A lesser number of fine-spotted YCT conservation populations were identified in drainages in Wyoming that were outside of the Snake River basin (Figure 30). The fine-spotted form of YCT has been widely used within recreational fishery management program for Wyoming; therefore, they have been introduced into many watersheds outside of their historical area.

Table 43. Summary of conservation populations based on spotting patterns within the various populations. Values are miles of streams.

Spotting Pattern	Number of Populations	Miles of Stream Occupied
Large spotted YCT only	210	3,349
Fine spotted YCT only	79	576
Both large and fine spotted YCT	93	3,279
Totals	**382**	**7,204**

Conclusions, Comparisons, and Recommendations

The 2006 status assessment was intended to provide a second appraisal of the status of YCT from a variety of perspectives and at various scales or levels. The perspectives included a historical point of view, a current distribution perspective based on habitat occupancy of phenotypically correct (i.e., they look like) YCT, an effort to delineate discrete populations of YCT identified for their conservation value, and a perspective related to the potential for restoration or expansion of YCT conservation populations. The various scales or levels, in ascending order, from which information can be derived included: 1) the habitat feature level (e.g., a specific barrier); 2) the habitat segment scale level; 3) the stream or lake level; 4) the watershed level; 5) the geographical management unit (GMU) level; 6) the administrative unit level (e.g., state and/or agency boundaries); and 7) the range-wide level.

YCT are considered game fish by all state, federal and tribal agencies that have management authority for this subspecies of cutthroat trout. Consequently, all YCT have sport fish value and have been managed as such by the various states, national parks and Tribal authorities in which they occur, regardless of their conservation status or other considerations associated with this status assessment. Most YCT were also managed as "conservation populations" with additional management emphasis being placed on conservation or preservation as a primary management focus and recreational public use (i.e., sport fishing) as a secondary emphasis. Conservation objectives included maintenance of genetic integrity, concern for resilience and viability at both subspecies and population levels, and protection and enhancement of specific aquatic environments and associated watersheds linked to the conservation populations. Conservation objectives also included investment in public outreach and conservation education. Since 2000, YCT have been managed under a range-wide conservation agreement as a partnership of state and federal agencies. Prior to 2000, YCT conservation was provided by the various partners on an individual basis. Many western states having management and conservation authority for cutthroat trout participated in the development of a position paper on genetic management and conservation (Utah Division of Wildlife Resources 2000) of cutthroat trout. A hierarchical classification for conserving cutthroat trout genetics included: 1) a core component of genetically unaltered populations or individuals; 2) designation of conservation populations that may be either genetically unaltered or slightly hybridized but have other attributes worthy of conservation (e.g., unique life histories or environmental adaptations); and 3) populations that are managed primarily for their recreational fishery value. Core populations were recognized as having important genetic value, and they would serve as donor sources for developing either captive or wild broods or for re-founding additional populations through replication of existing YCT populations. Management of conservation populations has emphasized conservation actions that include maintenance of genetic integrity, population expansion, of both core and conservation populations, restoration of core populations, protection and enhancement of habitats and watersheds and elimination of non-native fish.

Status Comparisons

The exact evolutionary (phylogenetic) origins and zoogeographical processes taken during the speciation process for the various cutthroat trout subspecies continue to generate much speculation and debate (Behnke 1992, Smith et al. 2002 and others). More recent advances in genetic testing methodologies have offered new insight into the pre-historical cutthroat trout story. Recent status updates (1996, 2001 and 2006) did not attempt to address the pre-historical picture of YCT. Rather, the focus has been on a more recent historical point of reference that could more reliably be validated and explained. Additionally, this contemporary perspective provided for a better opportunity of understanding anthropogenic influences that have had substantial impacts on current YCT conditions over the last 200 years.

Historical habitats of YCT delineated in the 1996 status assessment (May 1996), the 2001 status assessment (May et al. 2003), and the estimated historical habitat in this status assessment, differ substantially from earlier assessments. A notable difference was associated with the reference period of historical occupancy. The work of Behnke (1979; 1992) provided a pre-historical perspective of YCT distribution that has been cited in most assessments (Hadley 1984; Varley and Gresswell 1988; Thurow et al. 1988; Gresswell 1995; Kruse et al. 2000; Meyer et al. 2003). The range-wide YCT status assessment completed in 1996 (May 1996) initiated discussion of the historical range of YCT from a more immediate perspective using European exploration of the inland portion of west (circa 1800) as the historical benchmark. Kruse et al. (2000) completed an intensive status assessment of YCT in specific drainages of the Bighorn River and anchored his historical perspective to this more recent time period.

Another substantial difference among the status updates of 1996, 2001 and 2006 and many previous assessments was associated with the base representation of occupied habitat across the historical range. Behnke (1979, 1988 and 1992) used narratives and generalized maps to describe the outer most boundaries of YCT historical range. These publications made reference to field notes and observations, but did not attempt to provide quantification, in terms of miles of stream or acres of lake, for the historically occupied habitat. Hadley (1984) provided a very limited qualitative reference to historical occupancy in the Yellowstone River Basin in Montana. Varley and Gresswell (1988) cited Behnke's publications relative to the broad boundary of the historic range and then provided some quantitative detail. They estimated that the historic range of YCT was comprised of 44,500 ha (107,550 acres) of lake habitat and 24,000 km (15,000 miles) of stream environment. Varley and Gresswell (1988) did not, however, provide an explanation on how they arrived at these estimates. A status assessment for inland YCT completed in 1996 (May 1996), included an attempt to quantify historical range based on an exercise that utilized area biologists and others having specific local knowledge to identify the extent of historical distribution on land status maps using 1800 as the reference time period. The approach used in the 1996 assessment was in contrast to most early status evaluations that generally implied that all or most streams within the broad boundary were occupied by YCT. The 1996 report referenced several historical publications, journal entries and personal contacts with "elder" residents of the historical range to provide further validation of the historical distribution.

Behnke's distribution maps (Behnke 1992) encompassed many 4th level watersheds (e.g., the lower Tongue River, lower Rosebud Watershed within the Tongue River Basin, Badwater, Muskrat, and Lower Bighorn watersheds in the Bighorn River Basin, and several watersheds on the north side of the mainstem Yellowstone River). Inclusion of these areas resulted in an over estimate of the amount of habitat that would have been historically occupied. The approach applied in the 1996 and 2001 assessments, and validated in this 2006 status assessment excluded the above watersheds based on information provided by historical accounts, and a focused review by individuals knowledgeable about aquatic and watershed conditions in these specific geographical areas.

The extent of historically occupied stream habitat in the 2001 status assessment (May et al. 2003) estimated that YCT occupied 17,407 miles of habitat. The 2001 status assessment did not project historical occupancy for lake environments. The 2006 status assessment refined that estimate of historically occupied stream habitat and increased it to 17,721 miles. The 2006 status assessment also identified 61 lakes, covering 124,715 surface acres, as being historically occupied. A further comparison can also be made with the 1996 YCT assessment (Table 44). In the 1996 assessment, YCT were estimated to occupy 16,686 miles of riverine habitat (May 1996).

Table 44. Comparison of the miles of streams and number of lakes of estimated historical habitat for YCT, by assessment year.

State	1996	2001	2006
Streams			
Wyoming	10,969	6,886	6,713
Idaho	3,587	6,267	6,471
Montana	1,920	4,040	4,296
Utah	210 combined	103	130
Nevada		97	111
Total miles	**16,686**	**17,393**	**17,721**
Lakes[4]			
Wyoming	113	--	59
Idaho	3	--	2
Montana	2	--	--
Utah	0	--	0
Nevada	0	--	0
Total lakes	**118**	**--**	**61**

[4] The 2001 status assessment for YCT did not include a specific effort to identify lake environments occupied by YCT. In retrospect, this oversight should not have happened.

There were 118 lake environments identified as being historically occupied in the 1996 status assessment (Table 44). The vast majority of these lakes were in Wyoming. The 2001 status assessment did not specifically address lake environments in either the historical or current distribution reviews. Rather, the stream course segments that bisected the lakes were attributed as being occupied by lacustrine-adfluvial YCT if they were believed to be present.

The differences in stream mileages for the two assessments were likely linked to differences in map scales for the efforts. In 2001, the map scale was 1:100,000 as compared to a 1:24,000 scale used in the 2006 status assessment. Another difference was the nature of hydrography coverage between the 2001 assessment and the 2006 assessment. In 2001, the stream coverage contained nearly 32,220 miles of digitized stream course. Excluded from that coverage were ephemeral and intermittent streams and most ditches and canals. From that total, the estimated amount of historical stream habitat (17,393 miles) was derived through a process of elimination based on the influence of passage barriers (e.g., falls and temperature) that would have controlled upstream fish passage and a determination of the capability of habitats (e.g., linked minimal flows, excessive gradients, intermittent or ephemeral flows, etc.) to support and maintain YCT. Some stream reaches were excluded because of historical references and anecdotal observations indicating that the stream was barren of fish (May 1996). Other habitats were included on the basis of historical journal entries, scientific reports, anecdotal information on presence, evidence of basin transfers and presence of trout when no barriers were present. By comparison, the 2006 assessment utilized a NHD stream coverage that contained over 199,000 digitized miles of stream course. This coverage included ephemeral and intermittent channels and many ditches and canals. From this new coverage, the projected amount of historical stream habitat (17,721 miles) was derived using similar considerations applied in 2001.

While the total amount of historically occupied stream habitat was relatively similar for the three recent status updates, there were substantial differences in mileages projected for the various states. The differences between these estimates at the state level could be explained in two ways. First, there was a substantial amount of refinement in the assessment protocol that occurred between the status assessment reported in 1996 and the status assessment completed in 2006. Secondly, the 1996 status assessment maps at a very broad scale (1:200,000) for delineating historical habitat. Comparison of historical information obtained in the three recent status updates with the estimate of approximately 15,000 miles provided by Varley and Gresswell (1988) reflected a comparable estimation of historically occupied habitat. Since Varley and Gresswell (1988) did not provide a rationale of how they derived the number of historically occupied stream miles, we did not attempt to complete a detailed comparison with the 2006 information. The number of lakes and the associated surface area for historically occupied lakes varied to a greater extent. In 1996 there were 118 lakes identified as being historically occupied but no estimates of surface acreages were provided. No explicit projection of historical use of lakes was associated with the 2001 status assessment. The 2006 status assessment included an estimate of lake environments occupied by YCT. Sixty-one lakes (125,716 surface acres) were projected to be historically occupied. Varley and Gresswell (1988) estimated the historical lake acreage to be approximately 44,500 hectares (approximately 107,500 surface acres). Similar to the estimated stream mileage, Varley and Gresswell (1988) did not provide a rationale on how they derived their lake estimates.

The 2006 status assessment estimated that YCT (e.g., phenotypically correct YCT) currently occupied 7,527 miles of habitat (42% of historically occupied habitat) within the historical range (Figure 3). Of these miles, YCT occupied 4,048 miles (54%) in Wyoming, 2,033 miles (27%) in Idaho, 1,339 miles (18%) in Montana and Nevada and Utah having 58 and 49 miles, respectively (Table 45). Comparison of current distribution information from the 1996, 2001 and 2006 assessments provided comparable results associated with the amount of occupied habitat (Table 45). It is probable that differences for the individual states reflected the influence of different map scales associated with the stream layers, and better information associated with the more recent status updates. The reason for the significantly large difference in currently occupied habitat within Montana was because during the 1996 assessment only those YCT that had been genetically tested were counted in that assessment (May 1996). The estimated number of currently occupied lakes in 2006 was 205 lakes; this was a 366% increase over the 61 lakes identified as being historically occupied. Varley and Gresswell (1988) estimated that YCT, in their pure form, currently occupied 38,500 ha of lake habitat (~80,900 acres) and 2,400 km (~1,500 miles) of stream habitat. A reason for this estimate being significantly lower could be linked to the identification of habitats supporting only "pure" YCT. Varley and Gresswell (1988) did not provide a discussion of how purity was determined to support their estimate of current distribution.

Table 45. Comparison of current YCT distribution estimates from three recent status assessments. Values are expressed as miles.

State	1996	2001	2006
Wyoming	4,624	3,861	4,048
Idaho	1,622[5]	2,174	2,033
Montana	625	1,417	1,339
Nevada	--	44	58
Utah	--	42	49
Total miles	**6,817**	**7,538**	**7,527**

Use of the NHD stream and lake layers at the 1:24,000 scale, application of a revised protocol and database, and the availability of substantial amounts of new information increased the ability of the 2006 status assessment to provide the necessary information upon which to base conservation decisions. The 2006 protocol added new characterizations for each occupied habitat segment that included the origin of YCT, migratory life histories, stocking records, genetic status, fish density, habitat quality and quantity, and information on non-native fish presence. The 2006 protocol also tracked the source of information, ranging from professional judgment to detailed sampling and analysis, for each of these characterizations. Characterizations were applied to both stream and lake segments. Use of the NHD format and the "event creation" tool will allow future updates to be even more precise.

With regard to genetic status, there was a substantial increase in the total number of genetic samples taken and the amount of habitat that was associated with these samples. In 2001, genetic sampling was reported from 1,776 miles of habitat (Table 46). This level of sampling was estimated to be 25% of the 7,538 miles identified as currently occupied. By contrast, the 2006

[5] The 1,622 stream miles in Idaho include the stream miles for Utah and Nevada that occur in Goose Creek and Raft River.

status assessment identified that genetic samples had been taken from 3,883 miles of occupied habitat. This level of sampling was estimated to be 42% of the 7,527 miles of occupied habitat.

Table 46. Comparison of genetic results and determinations reported in the 2001 and 2006 status updates.

Genetic Testing	2001	2006
Tested - unaltered	1,301	3,112
Tested – altered	475	771
Sub-total of miles tested	**(1,776)**	**(3,883)**
Untested – suspected unaltered	3,019	1,854
Untested – potentially altered	2,630	1,614

Genetic tests can detect introgression between YCT and potentially hybridizing species or subspecies by detecting alleles unique ("diagnostic alleles") to the hybridizing species or subspecies within YCT populations. The number, and thus the proportion, of "diagnostic alleles" within YCT populations were used to estimate the level of introgression in the YCT population. A consequence associated with this approach is that proving a stock of YCT to be genetically pure is essentially impossible: all individuals in the population would have to be tested. Therefore, sample size must be considered when evaluating the reliability of any genetic test. Generally, sample sizes should be large enough to determine, with a pre-determined level of statistical reliability (95% has often been used), that a 1% or less level of introgression would be detected. Both the number of fish sampled and the number of alleles that are "diagnostic" between species or subspecies determine the sample size needed for a pre-determined level of statistical reliability. Thus, when genetic testing finds no evidence of introgression, sample size is very important for assessing how valid the result may be. For the 2006 status assessment, we reported the most current results of all genetic testing, regardless of sample size. The geo-database contains information on sample sizes and sampling dates for all genetic testing and this information can be used if more detailed genetic analysis is desired. In this report, we did not address changes in genetic status that might have been observed over time for a given habitat segment.

YCT abundance for currently occupied habitat was the only other characterization addressed in the 2001 status assessment that could be compared to the information in the 2006 status assessment. Due to the qualitative approach applied in 2001 it was necessary to develop a "cross walk" between the status updates. To accomplish this the qualitative characterizations of rare, common and abundant in the 2001 assessment were matched with one or more of the quantitative density ranges in the 2006 assessment (Table 47).

Table 47. Comparison of abundance or density estimates from the 2001 and 2006 status assessments.			
Density Category Conversion		**Density Comparison**	
2001	**2006**	**2001**	**2006**
Rare	0 to 50 fish/mile	1,506	2,398
Common	51 to 150 fish/mile	3,302	2,036
Abundant[6]	151 to 2000 fish/mile	2,282	2,513
Unknown	Unknown	439	580

The change from the very qualitative approach in 2001 to the more quantitative approach in 2006 represented a significant improvement in the status protocol. The change reduced subjectivity and decreased the amount of time required by the assessment teams to arrive at an abundance determination. Having a quantitative characterization will facilitate comparison with future status updates.

For the new information associated with origin, migratory behaviors, fish stocking, habitat quality and non-native fish presence that was collected in 2006, much of this information was used to complete the evaluations associated with conservation population health and well-being. Specific comparison of the new characterization information with the 2001 status assessment could not be completed due to the lack of this information in the 2001 assessment. It is anticipated that such comparisons will become valuable as future assessments are completed.

With regard to conservation populations, there continued to be two types of conservation strategies represented within the YCT populations identified in 2001 and those re-evaluated and identified in 2006. One strategy was associated with conserving genetic integrity and reducing the influence of non-native species through isolation of YCT populations (Kruse et al. 2001). The other strategy was associated with maintenance of connectivity within YCT populations by providing relatively large areas of continuous habitat that would allow YCT to express a range of life history behaviors, particularly migratory behaviors. As was detailed in the results, the inherent risks and influences on relative population health from the two conservation strategies were different.

For those YCT conservation populations where genetic integrity and isolation from competing species were emphasized by the population characterizations, negative health influences linked to lower population size, reduced temporal variability expressed as the amount of occupied stream habitat, and reduced within population connection were generally more pronounced. The assumptions associated with these negative influences was that YCT populations benefit from a larger number of fish that occupy relatively large amounts of habitat with well defined habitat networks that allow for connection among sub-components of the population. Some authors have indicated that populations need to be supported by an effective population of at least 500 reproducing adults based on the 50/500 “rule” (Franklin 1980; Soulé 1980); thus, many small populations of cutthroat trout are believed to be at a high risk of local extinctions (Kruse et al. 2001; Hilderbrand and Kershner 2000). Harig and Fausch (2001) found that cutthroat trout

[6] The conversion of the 2001 abundance category required merging three density ranges from the 2006 status update.

translocations were reproductively successful, more than 50% of the time, when the drainage area was at least 14.7 km² (5.6 mi.^{2}). This likely translates to inhabited stream lengths of at least 2 to 3 miles. Translocations were predicted to be successful 90% of the time when drainage areas were greater than 33 km². Stream lengths associated with these larger watersheds would likely be within the 5 to 7 mile range. Hilderbrand and Kershner (2000) estimated that cutthroat trout needed at least 5.7 miles (9.3 km) of habitat at moderately high densities to persist under the "500 rule." Rieman and Dunham (2000) provided data that indicated small, isolated populations of WCT might not be as prone to extinction as other vertebrates, and even other salmonids, based on their evaluation of the persistence of isolated headwater populations of westslope cutthroat trout in the Coeur d'Alene Basin of Idaho. Fausch et al. (2006) provided a thorough review of the challenges associated with salmonid populations isolated above passage barriers in small habitat patches. Information obtained in the 2006 status assessment indicated that 67 YCT conservation populations had population sizes that exceeded 2,000 adult fish. Most of these populations (57) had habitats that exceeding 10 miles of stream. Ten of these populations occupied habitats with less than 10 miles.

For YCT conservation populations identified in 2006 that occupied larger and more complex and connected habitat units, the negative health characterizations associated with temporal variability and population size were generally lower. Population production potentials tended to be lower for this group principally because these populations had a higher occurrence of non-native fish co-existing with the YCT populations. Population abundance for a substantial number of these populations exceeded 2000 mature adults. Many populations had abundances exceeding 4,000 adults. Risk to genetic integrity for populations occupying larger habitat units was higher than for the smaller non-networked or weakly networked populations. Risks associated with catastrophic diseases for the majority of YCT populations were viewed as being limited or low regardless of which conservation strategy was manifested.

General Conclusions

This assessment clearly re-affirmed that YCT currently occupy and are distributed across significant portions of their historical range. YCT currently occupy a higher proportion of habitat near the core of their historical range. Several studies, both theoretical and empirical, have suggested a decline in the proportion of sites occupied and in population densities from the center to the fringe of a species range for many vertebrate species (e.g., Brown 1984; Caughley et al. 1988; Lawton 1993). Meyer et al. (2003) observed that most YCT populations in southeastern Idaho had neither declined in abundance nor distribution over the last two decades.

Efforts to determine the genetic status of YCT increased by 64% between 2001 and 2006 based on the number of stream miles associated with genetic sampling. Genetic results demonstrated that a significant number of YCT continue to persist as genetically unaltered fish. Conservation populations were identified as occupying 96% of the habitat currently occupied by YCT. Three hundred and eighty three conservation populations were identified. Seventy-six of these populations occupied only lake environments. Of the remaining 306 conservation populations, 45 populations occupied habitats consisting of a combination of stream and lake environments and 261 occupied habitat limited to stream environments. A high percentage of the conservation populations were identified as "core" conservation entities reflecting an unaltered genetic condition.

A component of the current YCT conservation effort that was not specifically addressed in this status assessment was associated with the effectiveness of the coordinated conservation effort initiated among states and agencies. In 2000, five states (Montana, Idaho, Wyoming, Nevada and Utah) along with the USDA Forest Service, and the National Park Service entered into a Memorandum of Understanding (MOU) for the conservation and management of YCT. Parties to the MOU identified a common conservation goal and seven objectives that would collectively and individually guide future conservation efforts. The goal included the intent to ensure persistence of YCT within the historic range, and to preserve genetic integrity, and to provide adequate numbers and populations to provide for protection and maintenance of intrinsic and recreational values of YCT. The objectives included: efforts to identify all existing populations, securing and enhancing conservation populations, restoration of populations, public outreach, data sharing, improved coordination, and a stated intent of implement actions and activities necessary to meet the stated goal and objectives. At present, Montana has developed a state level conservation plan for all cutthroat trout that is consistent with the MOU. Wyoming likewise has a state level plan in place. Idaho is in the process of finalizing a similar plan. Currently, Idaho, Utah and Nevada provide for YCT conservation as part of their resident trout management plans. The Forest Service and other Federal governmental agencies (e.g., FWS, NPS and BLM) are implementing conservation actions on an annual basis consistent with their authorities and programs. Tribes with management responsibility for YCT are implementing their own management and conservation actions. Completion of this status assessment was viewed as a priority coordination action necessary to provide both a qualitative and quantitative basis for future conservation action. Through the coordinated conservation effort state, federal and tribal managers have employed recreational fishery management sufficient to regulate sport fisheries on YCT populations to ensure that both harvest and incidental hooking mortality do not cause these populations to decline due to angler use. Agency fish managers should continue their efforts to reduce the potential for genetic introgression resulting from sport fish stocking practices, and aggressively manage to reduce threats from nonnative species that may hybridize and/or compete with YCT. Land management agencies need to manage for aquatic habitats at a high habitat quality level to ensure that remaining YCT populations flourish. In particular, we recommend that existing roadless areas, parks, and wilderness areas continue to be managed so that aquatic habitats are maintained at or near their habitat potential. Since so much of the remaining habitat occupied by YCT is located within federally managed lands, good stewardship of these lands is critical for conserving YCT.

There is little doubt that YCT distribution and numbers have been reduced during the last 200 years. Most reductions probably occurred in the late 1800's and early 1900's due to severe habitat changes, introduction of non-native fish species, and overharvest. It is also clear that many current YCT populations face challenges associated with resiliency and persistence based on small population size, limited habitat, competition with non-native fish and loss of genetic integrity due to hybridization and limited gene flow. To some the future of YCT may appear dim; to others there is hope and optimism. The recent coordinated conservation efforts that are associated with the interagency YCT conservation work group provide a basis for this hope and optimism. As the conservation effort matures and develops, challenges currently facing the YCT populations will continue to be addressed and progress associated with ensuring persistence and viability will be achieved. Human intervention will be necessary to bring about the changes required to reduce or eliminate the challenges facing YCT. Will YCT be reinstated to their historical condition? Not likely. Will YCT continue to persist? Yes. But in a changed condition that will require vigilance and continual conservation action.

Recommendations

1. We recommend that the geo-database be updated on an annual basis for at least the next 10 years. Adjustments to that frequency, if deemed warranted by consensus of all members of the conservation work group, can be determined after that time period. Each geo-database update should be archived for future reference.
2. The next database update should focus on correction of data entry errors and inconsistencies in the information (e.g., lake information, habitat network information, conservation population determination, etc.) as a primary focus. Addition of new information should be a secondary objective.
3. We support the use of geographical management units (GMU) to partition the YCT conservation effort into manageable units. And we recommend the creation of specific GMU implementation teams, each with a designated team leader, to facilitate information collection and database updates.
4. We also recommend that GMU teams be used to plan, implement and evaluate conservation efforts on an annual basis.
5. We recommend the formulation of a GIS/database working group to insure consistency and provide oversight necessary to maintain the quality of the database. This group would also serve as "clearing house" for changes to the status protocol and should provide training for GIS/database specialists.
6. We recommend that each GMU team have as a member, an assigned GIS/database specialist to facilitate geo-database updates and develop data queries to be used in conservation planning and evaluations.
7. Each database update should be archived and maintained as a separate entity to allow for tracking of changes in the information over time.

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