Appendix 54

Status of Westslope Cutthroat Trout in the United States: 2002

Status of Westslope Cutthroat Trout (*Oncorhynchus clarki lewisi*) in the United States: 2002

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Executive Summary

The distribution and abundance of westslope cutthroat trout (*Oncorhynchus clarki lewisi*; WCT) have declined from historical levels over part or all of their historical range. For the U.S. range of WCT we used existing information provided by 112 fisheries professionals applied through a consistent methodology to assess the extent of WCT historical range, their current distribution, including genetic status, and evaluated the foreseeable risks to 539 populations designated as "conservation populations" by management agencies.

We estimated that WCT historically occupied about 56,500 miles of habitat within the U.S. WCT currently occupy an estimated 33,500 miles of historically occupied habitats (59%). Genetic testing has been completed across about 6,100 miles of habitat (18% of occupied habitats), but sample sizes were variable and sample sizes of 25 fish or more (a sample size that likely would detect as little as 1% levels of introgression with a 95% level of confidence) made up 30% of the samples. WCT with no evidence of genetic introgression currently occupied about 3,400 miles (10%) of currently occupied habitats. Another 1,000 miles of currently occupied habitats (3%) contained WCT that were probably part of a mixed stock where the WCT were not introgressed. We suggest that even though genetic sampling was nonrandom because sampling likely occurred more frequently in WCT populations that appeared non-introgressed, some, if not much, of the habitats currently occupied by WCT where no genetic testing has been done likely support populations that are not introgressed. Much of the habitat currently occupied by WCT was located in designated parks (2%), wilderness areas (19%), and roadless areas (40%), and almost 70% of habitats currently occupied lie within federally managed lands.

A total of 563 separate WCT populations currently occupying 24,450 miles of habitat were designated as "conservation populations". These conservation populations were spread throughout the historical range, occuring in 67 of the 70 hydrologic units historically occupied by WCT. Most of these conservation populations were believed to be "isolets" (457 or 81%); however, metapopulations occupied much more of the habitat (21,600 miles or 88%). Of the 563 designated conservation populations, 339 (60%) had at least some component that was genetically unaltered and 172 (30%) consisted entirely of stream segments that were genetically unaltered. For the 539 conservation populations for which risks to the population were asseessed, more isolet populations were at higher risks due to temporal variability, population size, and isolation than metapopulations, but these isolets were generally at less risk from genetic and disease factors than metapopulations.

This assessment clearly shows that WCT currently occupy significant portions of, and are well distributed across, their historical range. The data suggest that genetically unaltered WCT occupy at least 13% and possibly up to 35% of currently occupied habitats (8 to 20% of historical habitats). Conservation population designations suggest that two different conservation management strategies are needed and being implemented to conserve WCT. One strategy concentrates on preventing introgression, disease and competition risks through isolation of WCT, while the other concentrates on preserving metapopulation function and multiple life-history strategies by connecting occupied habitats.

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Introduction

Several status assessments have been conducted for westslope cutthroat trout (*Oncorhynchus clarki lewisi*; WCT) over part or all of their historical range in recent years (Liknes 1984; Liknes and Graham 1988; Rieman and Apperson 1989; McIntyre and Rieman 1995; Duff 1996; Thurow et al. 1997; Shepard et al. 1997; Lee et al. 1997); most of which were used by the U.S. Fish and Wildlife Service (FWS) in their "Status Review for Westslope Cutthroat Trout in the United States" (United States Fish and Wildlife Service 1999). Many of these previous assessments were either conducted over only a portion of the historical range, involved only a few experts knowledgeable about WCT, or suffered from a lack of consistency in the sources of information used. This report updates the past assessments using a protocol that was consistently applied throughout the historical range of WCT. We assessed the historically occupied range, current distribution and genetic status, and distribution and risk for designated "conservation populations" of WCT throughout their range. Fisheries professionals from throughout the historical range of WCT in Montana, Idaho, Washington, Oregon, and Wyoming (state agencies, Park Service, USFS, BLM, tribal, private, etc.) provided the information for this assessment. State fisheries staffs identified and designated "conservation populations", but information from many different sources was used to assess risks and threats to these populations. Although this assessment provides consistent and current information on WCT that the FWS can use to make their listing determination, the longer-term, and probably more significant use of this assessment, is as an information base that can be used by individual states and other agencies, working collaboratively, to assess and prioritize their ongoing and future conservation efforts.

The four states where WCT occur presently have the primary responsibility, under their respective state laws, to manage and conserve WCT. Within specific portions of WCT range Tribal governments and the National Park Service assume managerial authority for conservation and management of WCT. The Forest Service, BLM and other federal land management agencies are responsible for management of aquatic habitats on federal lands and for coordination of land uses consistent with laws, rules, and regulations. The FWS is charged with administration of the federal Endangered Species Act (ESA) and is currently re-evaluating a recent finding (Federal Register 65: 20120) that WCT do not warrant listing as a threatened species. It is mutually beneficial for the above parties to work together to: further the collective knowledge, improve habitat conditions, and provide the best scientific information to the FWS for making their listing determination.

Analysis Area

The analysis area included all of the known historical range of WCT within the United States. We relied primarily on Behnke (1992) to delineate the likely historical range (Figure 1). This area includes, from east to west, the upper portions of the Missouri, Saskatchewan, Columbia, and Snake river basins in Montana, Idaho, and Washington; the John Day basin in Oregon; and the Methow and Lake Chelan basins in Washington. This assessment does not include the Canadian portion of the WCT range.

Methods

We developed a standardized approach and consistent protocols that were used by all participants (Appendices A and B). Information was gathered and entered into geographic information system (GIS) and relational databases by having fishery professionals participate in facilitated workshops by geographic area. Many different sources of information were used in this assessment, but consistency was maintained by having one or two individuals attend all workshops and facilitate data entry and answer questions raised by workshop participants. Since this assessment relied upon existing information, sampling was not random, and in many cases not independent; therefore, there are undoubtedly biases associated with these data. We discuss the possible consequences of these biases when we present the results. We have attempted to qualify and disclose the quality of these data through citations and by having the people that provided information rate the relative data quality for each part of this assessment from 1 (primarily based on professional judgment) to 3 (field survey information).

Geographic Information System

We used the 4th code hydrologic unit code (8-digit EPA designation) as the primary unit for organizing data input from the fisheries professionals. We also summarized historical range and current status information using this stratification. The U.S. Geological Survey (USGS) created the hierarchical hydrologic unit code (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. The smallest HUC used in this study was approximately 448,000 acres (Hydrologic Units Maps of the Conterminous United States. Reston, VA. United States Geological Survey. August 2002. http://water.usgs.gov/GIS/metadata/usgswrd/huc250k.html).

We chose to use stream and river distance as measures of WCT occupancy, both for suspected historical and known currently occupied habitats. Consequently, lake occupancy was not directly assessed; however, all lakes that were located within the stream network were included, as length values, if the stream network bisected the lake. Our assessment update used GIS tools in Arcview 3.2 along with extensions created for this project (Steve Carson, Montana Fish Wildlife and Parks, Helena, Montana modified "ddeaccess.avx" and "routetool.avx" extensions that are available from ESRI at http://arcscripts.esri.com) as well as a relational database within Microsoft Access (modeled after the Montana Fish Wildlife and Parks' MFISH database that can be found at http://nris.state.mt.us/scripts/esrimap.dll?name=MFISH&Cmd=INST) for organizing and displaying the data.

A Latitude-Longitude Identifier (LLID) 1:100,000 hydrography layer that was edge-matched across state boundaries was used as the primary base-layer. The U.S. Geological Survey (USGS) in Portland, in cooperation with Bonneville Power Administration, the Northwest Power Planning Council, and other Federal and state agencies and NW Indian Tribes produced a 1:100,000-scale River Reach data layer for the Pacific Northwest in the early 1990s. The Pacific Northwest (PNW) River Reach Files are a geo-referenced river reach data layer that encompasses the Columbia River Basin within the conterminous United States, the coasts of

Oregon and Washington, Puget Sound in Washington, the Klamath and Goose Lake Basins in southern Oregon and the Bear Lake Basin in southeastern Idaho (PNW Reach File, Gladstone, Oregon: Stream Net, August 2002. http://www.streamnet.org/pnwr/pnwrhome.html). River reach files for Montana east of the Continental Divide were obtained from Montana Fish Wildlife and Parks (Streams. Helena, MT: Montana Fish Wildlife and Parks, August 2002 and are available at http://fwp.state.mt.us/insidefwp/fwplibrary/gis/). This LLID hydrography layer routes stream segments by uniquely identifying each stream. Delineating lower and upper segment boundaries as distances above each stream's mouth identified each stream segment occupied by WCT. All known fish barriers were located as points, also using distance upstream from a stream's mouth.

For a few LLID streams we found that the streams were routed in reverse, from the headwaters to the mouth. These errors became apparent when we computed lengths of stream segments and a negative length resulted. We used the absolute values of length to correct for this problem and neither the computed lengths nor the map locations were affected by this problem.

Scale issues

Using a standard 1:100,000 base-layer allowed for consistent summaries among states and other entities. However, summaries based on this scale will underestimate "true" field lengths of stream habitats due to scale-based error. There are several potential sources of bias associated with using 1:100,000 scale LLID hydrography. First, map-derived stream lengths under-estimate actual stream lengths. Firman and Jacobs (2002) found that while hip-chained measurements of Oregon coastal streams were significantly correlated to stream lengths computed using MapTech® Terrain Navigator software and 1:24,000-scale maps, map lengths needed to be multiplied by about 1.14 to estimate measured stream lengths.

Secondly, there are scale-differences between 1:100,000 and 1:24,000-scale hydrography. To evaluate the magnitude of these scale-differences, we compared lengths of 30 streams from three different 4th code HUC's (10 per HUC) and found that lengths of streams derived from 1:100,000-scale hydrography were only about 1% shorter than estimates of that same stream using 1:24,000-scale hydrography (Appendix C). Thirdly, there was some variability across the study area in designating which streams were included within the LLID hydrography layer (Appendix C). All named streams were included in the LLID layer for Idaho and Montana, while unnamed streams were not included. All named and most unnamed streams were included in the LLID hydrography for streams within Washington and Oregon. Unnamed streams were also included for those watersheds that spanned the border between Idaho and Washington. To evaluate potential differences between LLID information that included and excluded unnamed streams we compared stream densities between a HUC where unnamed streams were included (Priest) and one where unnamed streams were not included (Upper Coeur d'Alene). We found that inclusion of unnamed streams resulted in 35% higher stream densities (1.86 miles versus 1.20 miles per 1,000 acres; Appendix C). Therefore, stream lengths computed for basins located in Washington and Oregon will be higher relative to the rest of the study area, but these two states contain less of the historical and current range of WCT than Montana and Idaho (Figure 1). We assume that comparisons among proportions of habitats occupied by various classes should be relatively unbiased within HUC's since these proportions should have consistent biases due to the strong correlation between map length and field-measured length (Firman and

Jabcobs 2002). We have documentation that a few unnamed streams that did not appear on LLID hydrography layers actually support WCT, but these streams were not included in our assessment. Comparisons between regions that did and did not include unnamed streams would not be valid, but comparisons within each of these two regions should be. Estimated lengths of habitats historically and currently occupied by WCT will be higher for those HUC's that included unnamed streams, but proportions of habitats occupied should be comparable across their range.

Assessment Teams

A total of 112 fisheries professionals from 12 state, federal, and tribal agencies and private firms provided the information that was used in this assessment. These individuals met as part of nine different assessment workshops (Appendix A). In addition to the fisheries professionals, 21 GIS and data management specialists also participated in these workshops to assist with data entry and display of status information for on-site editing of data. Information stored in statewide databases was available in hard copy and on computer for each of these assessment workshops in tabular and map formats. From two to five information technology and data entry personnel also attended each workshop to provide technical support and enter information into computer databases. All fishery professionals were asked to bring field data summaries for their areas of responsibility so existing databases could be updated and used in this assessment. At each workshop fishery professionals who had relevant information or knowledge within each 4^{th} code HUC worked collaboratively to fill in data forms that were immediately entered into a computer database. Often individuals worked on several 4^{th} code HUC teams. As data were entered from paper data forms into the computerized database at least one individual from each 4^{th} code HUC team ensured that data were entered accurately. The fisheries professionals that completed these assessments had experience levels ranging from several months to several decades. Collectively, these fishery professionals had a combined total of 1,818 years of professional fisheries experience, of which 1,151 was directly applicable to WCT. The majority of participants had Master's of Science college degrees (68), four had PhD degrees, and all had at least a Bachelor of Science degree.

Historical Range

For the purposes of this assessment European "discovery" of the west was set as the benchmark time (~1800) for the historical range of WCT. While it is likely that the distribution of WCT has expanded and contracted over geological time, written documentation of historical distribution began around 1800. As Behnke (1995) states (p. 79), "The original distribution of westslope cutthroat trout is not known with certainty." Using Behnke's (1995) delineation of historical range as a starting point, we included all streams within any 4th code HUC's that had any streams Behnke identified as being historically occupied. Fishery professionals were then asked what stream segments should be excluded from historical range based on evidence for exclusion. Evidence for exclusion included: geological barriers with no evidence that WCT inhabited waters above the barriers; tectonic events that would have made regions uninhabitable and were likely either not colonized or ancient populations had gone extinct and not re-colonized prior to 1800; and habitat unsuitability based primarily on thermal regime and stream channel gradient (Appendix B). In a few cases entire 4th code HUC's were excluded. Information sources that supported inclusion of stream segments as historically occupied were noted, where available, and included current occupation by salmonids, historical journal entries, scientific reports, and evidence of basin transfers by headwater stream captures. All stream and river habitat was included within the historical range unless explicitly excluded by the fishery professionals. Our delineation of historical range refines previous assessments of historical range. The amount of historical range we estimated was then used as the baseline to compare to the current status.

Barriers to Fish Movement

Since barriers to upstream fish movement have important implications for both historical range and current status, barriers that were believed to significantly affect distribution of WCT were located and identified. Geological (i.e. bedrock waterfalls, naturally dry channel segments, etc.) and anthropogenic barriers were located and classified. Geological barriers were considered when potentially excluding lotic habitats from the historical range. Anthropogenic barriers were considered when assessing current distributions and various risks to conservation populations. Only barriers of believed significance were included; however, much of the area had not been surveyed for barriers. Significance of barriers as they related to risk and conservation of WCT was rated (Appendix B).

Current distribution

For the purposes of this assessment all stream segments of habitat currently occupied by WCT within their historical range were included and some, but not all, stream segments occupied by WCT outside historical range were included. We stratified the results to clearly show status within and outside historical range. Stream segments where WCT populations were supported or maintained by stocking were not included in current distribution; however, stream segments that may have been stocked with WCT in the past, but currently were maintained exclusively by natural reproduction were included. All waters that supported WCT and appeared on the LLID hydrography layer, regardless of level of introgression, were included; however, the genetic status of each stream segment was classified (see below). In addition to genetic status, a determination was made on the relative abundance of WCT inhabiting each stream segment. These results were summarized by length of habitat occupied and not by number of stream segments occupied. Number of stream segments was not a meaningful measure because this number does not equate to number of populations and lengths of stream segments varied widely. The stream segment information was aggregated within the "conservation population" assessment (see below).

Genetic Status

Seven classes identifying genetic status for stream segments were applied (Table 1). Five classes were used for those stream segments that had been genetically tested and two classes for those where no genetic testing had been done (Table 1). Genetic sampling involves many complex issues that can make clear interpretation and reporting of results difficult, especially within standardized databases (Appendix D). We will briefly address a few of these issues here, but suggest reading Appendix D for more detail.

Table 1. Genetic classes used for assessing genetic status of westslope cutthroat trout in 2002.

Code	Description	Report name
A	Genetically unaltered (<1% introgression) - tested via electrophoresis or DNA	Tested; Unaltered
B	Introgressed ≤ 10% - tested via electrophoresis or DNA	Tested; <= 10% introgressed
C	Introgressed >10% and ≤ 25% - tested via electrophoresis or DNA	Tested; <=25% to > 10% introgressed
D	Introgressed >25% - tested via electrophoresis or DNA	Tested; > 25% introgressed
H	Suspected unaltered with no record of stocking or contaminating species present	Suspected Unaltered
J	Potentially hybridized with records of contaminating species being stocked or occurring in stream	Potentially Altered
N	Hybridized and Pure populations co-exist in stream (use only if reproductive isolation is suspected and testing completed)	Mixed Stock; Altered and Unaltered

Genetic tests can detect introgression between WCT and potentially introgressing species or subspecies by finding alleles unique ("diagnostic alleles") to that potentially introgressing species or subspecies within WCT populations. The number, and thus the proportion, of potentially introgressing species or subspecies "diagnostic" alleles within WCT populations, is used to estimate the level of introgression. One consequence of this approach is that proving a stock of WCT to be genetically pure is essentially impossible: all individuals in a 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 this assessment we reported results of all genetic testing, regardless of sample size, and then displayed and summarized sample sizes for all genetic testing.

Different genetics laboratories, and sometimes even the same lab, may report genetic results differently; consequently, it can be difficult to compare genetic results across broad geographic areas. Especially when brief summaries of these data are stored in standardized fish resource databases. An example of where this type of problem may occur is that of a mixed stock population, where some individuals within the population may be genetically unaltered WCT and other individuals may be genetically unaltered rainbow trout (RBT). Unless either the local fisheries professional or the database indicated that non-random mating was occurring (code N; Table 1), we assumed genetic results were a function of random mating. If random matings were incorrectly assumed to be operating for the above hypothetical mixed stock population, genetic sample results would indicate introgression at levels in proportion to the proportion of RBT to WCT for this hypothetical population. Where there was evidence of non-random mating, some individuals within the population had no evidence of introgression, and biologists believed that reproductive isolation occurred between stocks in a particular stream segment it was designated as a mixed stock that had both "genetically altered" and "unaltered" individuals. However, when there was no evidence to support non-random mating, random mating was assumed and this likely introduced a bias toward classifying stream segments as introgressed when some may have been mixed stock populations.

The levels of introgression we assigned for genetically tested stream segments were based, in part, on the literature. For our genetically unaltered ("pure") populations (code A; Table 1) we selected $\leq$ 1% introgression, based on the most commonly defined level of introgression that genetic sampling is designed to detect. For the next level (90-99%; code B; Table 1) we relied on the indication that meristic counts are not different between individuals from populations that are not genetically altered and those that are from populations with 10% or less introgression (Leary, Gould, and Sage 1996). The class where both hybrids and pure individuals inhabit the same stream (code N; Table 1) indicated some reproductive isolation and more frequently occurred in larger streams and rivers where spawning by WCT probably occurred in specific headwater tributaries. The other two classes (codes C – 75-89% and D - <75%) were arbitrarily assigned.

Another major issue relates to whether introgression is natural (breeding between two native taxa) or anthropogenic (introgression by nonnative species stocked by humans; Allendorf et al. 2001). Genetic testing does not normally distinguish whether introgression is natural or anthropogenic; however, we reported all genetic results, regardless of the source of introgression. For stream segments where no genetic testing occurred, we considered WCT as "suspected" unaltered (code H; Table 1) if records indicated that no potentially introgressing species or subspecies had been stocked or currently occurred, even if these WCT were in sympatry with native species that could potentially introgress with them. WCT in those stream segments where potentially introgressing species or subspecies had been stocked or currently occurred were classified as "potentially hybridized" (code J; Table 1) unless genetic testing found no evidence of introgression.

Since genetic information was extremely limited for some large geographic areas that had been classified as both "potentially hybridized" and "suspected unaltered", particularly in the large tracts of wilderness and roadless land in central Idaho, we compared the limited genetic testing results that were available within a subset of these geographic areas to better evaluate potential biases in these two classifications. We did this by comparing the proportion of genetic testing results within each 4th code HUC that showed no introgression to the total area tested. The proportion of stream miles containing unaltered and genetically tested WCT was then compared to the proportions of miles of stream classified as "potentially hybridized" and "suspected pure" to better display likely biases in these classifications within these HUC's.

Abundance Relative to Habitat Potential

In addition to recording the length of stream occupied by WCT, their relative abundance, as it related to habitat "site potential", was rated as "at or near potential", "slightly below potential", "significantly below potential", or "unknown" for each stream segment occupied by WCT (Table 2; Appendix B). These results were summarized by length of habitat occupied and not by number of stream segments occupied. Number of stream segments was not a meaningful measure because this number does not equate to number of populations and lengths of stream segments varied widely. Where field data were available abundance was rated based on how similar the measured abundance was to measured abundances from areas of similar types of habitat that were not impacted by human activities. Where no field data were available, abundance classes were subjective and based, to a large extent, on the quality of the habitats occupied. Consequently, analyses between the relative abundance levels we assigned and land-use or other habitat-related variables were not independent.

Table 2. Codes and descriptions used for assessing relative abundance of westslope cutthroat trout in 2002.

Code	Description
99	Unknown
A	At or near site potential
C	Slightly below site potential
R	Significantly below site potential

Designated “Conservation Populations”

WCT are considered a game fish by all state and federal agencies that manage this subspecies. Consequently, all WCT populations have sport fish value and are managed as such by the various states and national parks in which they occur, regardless of their genetic status. Many populations of WCT are managed as “conservation populations” with additional management emphasis placed on preserving these populations. Most of the western states within the U.S. that support cutthroat trout developed a position paper on genetic management (Anon 2000). This position paper describes a hierarchical classification scheme for conserving cutthroat trout that includes: 1) a core made up of genetically unaltered populations or individuals; 2) designated conservation populations that may be either genetically unaltered or slightly introgressed; and 3) populations that are managed primarily for their recreational fishery value. Core populations are recognized as having important genetic value and would serve as donor sources for developing either captive brood or for re-founding additional populations. Management will emphasize conservation, including potential expansion, of both core and conservation populations, but conservation populations will likely not be used to re-found additional populations unless they have been tested as non-introgressed.

For this assessment any stream segment that supported WCT could potentially be designated as either an individual “conservation population”, or aggregated as part of a larger “conservation population”. Adjacent stream segments that supported WCT, and were connected, were aggregated into a single conservation population, especially if evidence existed that WCT moved between stream segments. Designated “conservation populations” that occupied two or more connected stream segments may function as “metapopulations” (Hanski and Gilpin 1991). Populations were designated as “conservation populations” based on how they fit into categories

(Table 3) using the following attributes: genetic status, expression of unique or multiple life-history strategies, adaptation to specific environmental or habitat conditions, and geographic location (Anon 2000; Allendorf et al. 2001).

Table 3. Criteria used for designating each conservation population.

Code	Description
1	Core Conservation Population (must be genetically unaltered - greater than 99% pure)
2	Known or Probable Unique Life History (fluvial, ad-fluvial, or resident)
3	Known or Probable Ecological Adaptation to extreme environmental condition
4	Known or Probable Predisposition for large size or unique coloration
5	Other - Population occupies habitat that is likely to become part of the WCT conservation focus

Almost all stream segments occupied by WCT where genetic testing found no evidence of introgression were classified as "conservation populations". A few isolated stream segments where WCT were genetically tested and there was no evidence of introgression were not classed as conservation populations. These populations occupied very little habitat and it was not deemed cost-effective to invest in expanding them because expanding these populations was infeasible given current restoration techniques. Some of these populations might be replicated by moving either fish or gametes in the future, but this restoration activity was speculative at this time.

All conservation populations were classified as either "isolates" or "metapopulations" depending upon their isolation or connectivity and likely genetic exchange between stream segments. We attempted to identify conservation populations as either a "source" or a "sink", but because many of the conservation populations may have had some stream segments classed as "source" populations and other stream segments classified as "sink" populations, application of these terms was not consistently applied across all conservation populations. Therefore, we excluded this attribute from the analysis.

We summarized information for designated conservation populations based on length of stream occupied, number of populations, and geographic distribution. Since there was a very wide range of lengths of habitats occupied by the various conservation populations we chose to present these data both in terms of length occupied and number of populations.

Risk Classification

The risks identified in this assessment are potential risks that could occur in the "foreseeable future" which we considered to be two to three decades (based on an informal survey of our westslope cutthroat interagency conservation team). Risks were stratified into three major categories: genetic, disease, and population-level.

Genetic Risks

Genetic risk was defined by the risk of future introgression of WCT in a conservation population. Distance from potential sources of anthropogenic introgression and the presence of documented barriers between those sources and the conservation population were the two primary components that were assessed to determine genetic risk (Table 4). In addition, where there was documented evidence indicating that potentially introgressing species or subspecies were reproductively isolated from WCT, due to either temporal or spatial isolation during spawning, the genetic risk rating for that conservation population was reduced. The potential for natural introgression with either native redband or steelhead trout (*O. mykiss*) was not considered a genetic risk for those watersheds where these species co-evolved with WCT. Nonnative salmonids that could potentially hybridize with WCT, had been stocked, either legally or illegally, and were now reproducing naturally in the wild, were considered as posing a genetic risk to WCT.

Table 4. Ranks and descriptions used for assessing genetic risks to designated conservation populations of westslope cutthroat trout in 2002. Hybridizing species includes any introduced species or subspecies, but exclude native species (inland redband and steelhead trout), that could potentially hybridize with westslope cutthroat trout.

Rank	Activity
1	Hybridizing species CANNOT INTERACT with existing WCT population. Barrier provides complete blockage to upstream fish movement.
2	Hybridizing species are in same stream and/or drainage FURTHER THAN 10 KM from WCT population, but not in same stream segment as WCT, or may be WITHIN 10 KM WHERE BARRIER EXISTS, BUT MAY BE AT RISK OF FAILURE.
3	Hybridizing species are in same stream and/or drainage WITHIN 10 KM of WCT population and NO BARRIER EXISTS; however, hybridizing species not yet found in same stream segment as WCT population.
4	Hybridizing species are SYMPATRIC with WCT population in same stream segment.

Disease Risks

A disease risk assessment was made for each conservation population using a ranking of 1 to 5 to indicate low to progressively higher levels of risk associated with the potential influence of significant diseases (Table 5). Population isolation and security were important considerations but were not viewed as absolutes. Diseases of concern were those that could cause severe and significant impacts to population health and included, but were not limited to, whirling disease, furunculosis, and infectious pancreatic necrosis virus. Disease risk assessments were either completed or reviewed by fish health professionals from the respective state’s fish and wildlife agencies. The level of risk was not viewed as an absolute but rather as an indicator of potential risk.

Table 5. Ranks and descriptions for disease risks to designated conservation populations of westslope cutthroat trout in 2002.

Rank	Disease Risk
1	Significant diseases and the pathogens that cause these diseases have very limited opportunity to interact with existing WCT population. Significant disease and pathogens are not known to exist in stream or watershed associated with WCT population.
2	Significant diseases and/or pathogens have been introduced and/or identified in stream and/or drainage further than 10 km from WCT population, but not in same stream segment as WCT, or within 10 km where existing barriers exist, but may be at risk of failure.
3	Significant diseases and/or pathogens have been introduced and/or have been identified in same stream and/or drainage within 10km of WCT population and no barriers exist between disease and/or pathogens and diseased fish species and WCT population.
4	Significant disease and/or pathogens and disease carrying species are sympatric with WCT in same stream segment.
5	WCT population is known to be positive for significant disease and/or pathogens are present. WCT population has a history of impacts from significant disease. Environmental and/or biological condition may have intensified disease effects.

Population Risks

Demographic and stochastic population risks were assessed using criteria established by Rieman et al. (1993). Four separate types of risk were considered including: temporal variability, population size, population productivity, and isolation (Table 6). These four main factors were assessed individually and then weighted and summed to derive a final composite risk factor. Weightings were assigned to each risk factor based on advice from those who developed the demographic and stochastic population risk matrix (Rieman et al. 1993; D. Lee, U.S.D.A. Forest Service, Rocky Mountain Research Station, Boise, Idaho, personal communication) as: Temporal Variability = 0.7; Population Size = 1.2; Population Productivity (Growth/Survival) = 1.6; and Isolation = 0.5. Weighted composite risk scores could potentially range from 4 to 16 and were then ranked into four low to high risk categories by placing them in four nearly equal-sized bins (4 to < 7; 7 to < 10; 10 to <13; and 13 to 16).

Conservation Activities

A listing of potential conservation activities was provided to workshop participants. If any conservation activity had been applied to any portion of a conservation population, that activity was checked and linked to the conservation population (Table 7; Appendix B). Since we did not specifically ask how many miles of habitat that was occupied by a conservation population was also influenced by each type of activity, we summarized these data only by the number of conservation populations affected by each conservation activity. For many conservation populations, especially those that occupied larger areas of habitat, conservation activities only affected a portion of the population.

Table 6. Ranks and descriptions of population risks to designated conservation populations of westslope cutthroat trout in 2002.

Type of Risk	**Rank**	**Criteria**
Population Productivity	1	Population is increasing or fluctuating around an equilibrium that fills available habitat that is near potential. No nonnative competing or predating species present.
	2	Population has been reduced from potential, but is fluctuating around an equilibrium (population relatively stable and either habitat quality is less than potential, or another factor - disease, competition, etc. - is limiting the population).
	3	Population has been reduced and is declining (year-class failures are periodic; competition may be reducing survival; habitat limiting population).
	4	Population has been much reduced and has either been declining over a long time period or has been declining at a fast rate over a short time-period (year-class failures are common; competition or habitat dramatically reducing survival).
Temporal Variability	1	At least 75 km of connected habitats
	2	25-75 km of connected habitats
	3	10-25 km of connected habitats
	4	< 10 km of connected habitats
Isolation	1	Migratory forms must be present and migration corridors are open (connectivity maintained).
	2	Migratory forms are present, but connection with other migratory populations disrupted at a frequency that allows only occasional spawning.
	3	Questionable whether migratory form exists within connected habitat; however, possible infrequent straying of adults from other populations into area occupied by population.
	4	Population is isolated from any other population segment, usually due to barrier, but may be related to lack of movement or distance to nearest population.
Population Size	1	> 2,000 adults
	2	500-2,000 adults
	3	50-500 adults
	4	< 50 adults

Table 7. Codes and descriptions for conservation activities applied to designate conservation populations of westslope cutthroat trout assessed in 2002.

Code	Description
3	Water lease/Instream enhancement
4	Channel restoration
5	Bank stabilization
6	Riparian restoration
7	Diversion modification
8	Barrier removal
9	Barrier construction
10	Culvert replacement
11	Fish screens
12	Fish ladders
13	Spawning habitat enhancement
14	Woody debris
15	Pool development
16	Irrigation efficiency
17	Grade control
22	Instream cover habitat
24	Riparian Fencing
31	Physical removal of competing/hybridizing species
32	Chemical removal of competing/hybridizing species
71	Public outreach (Interpretive site)
72	Population restoration/expansion
73	Angling regulations
74	Land-use mitigation direction and requirements
75	Watershed under protective management (i.e. wilderness, etc.)
99	Other (specify in comments)

Land and Resource Management Impacts

Fishery professionals were asked to assess whether various land, water, and/or fish management activities affected each designated conservation population (Table 8; Appendix B). Participants were asked whether each activity resulted in a “known”, “possible”, or “no” (not checked) impact to the conservation population. Similar to the conservation activities, we did not specifically ask how many miles of habitat occupied by conservation populations each type of management activity influenced. Thus, we also summarized these data only by the number of conservation populations affected by each management activity. For many conservation populations, especially those that occupied larger areas of habitat, conservation activities only affected a portion of the population. Participants varied in how they rated whether a conservation population was impacted by a particular activity, especially for conservation populations that occupied relatively large areas of connected habitat and a particular activity was occurring only on a portion of the occupied habitat. For these types of conservation populations and activities some participants ranked impacts as none, some as possible, and some as known.

Table 8. Codes and descriptions for management activities that could potentially impact designated conservation populations of westslope cutthroat trout assessed in 2002.

Code	Activity
1	Timber Harvest
2	Range (livestock grazing)
3	Mining
4	Recreation (non-angling)
5	Angling
6	Roads
7	Dewatering
8	Fish stocking
9	Hydroelectric, water storage, and/or flood control
10	Other, specify in comments

Summaries from Database

Data provided by the fishery professionals were summarized directly from the Microsoft Access database using queries within Access. Summarized data were then copied to Excel spreadsheets where these data were further reduced to produce summary tables and figures. Most summaries within this report are summarized over the entire historical range of WCT. A few populations that inhabited waters outside the historical range were included in separate analyses. Additional summaries by 4^{th} code HUC are provided in appendices.

Summaries that Linked Database to GIS Layers

To better assess existing regulatory mechanisms associated with land management for the streams currently occupied by WCT we used Arcview to select ("clip" feature in Arcview) stream segments occupied by WCT that were within designated Forest Service wilderness areas, designated Forest Service "roadless" areas, USDI National Parks, all federally managed lands, and those Forest Service and BLM lands within the Upper Columbia River basin where INFISH (U.S. Department of Agriculture and U.S. Department of the Interior 1995a) and PACFISH (U.S. Department of Agriculture and U.S. Department of the Interior 1995b) restrictions are in place. After clipping the stream segments occupied by WCT using the above polygon layers we computed the length of streams occupied by WCT that were within the above land management designations using a query in Arcview ("[Shape].returnlength" query).

Results

Historical Range

Based on the LLID hydrography layer used, a total of about 56,500 miles of potential lotic habitat were identified as historically (circa 1800) occupied by WCT (Figure 1; Appendix E). The estimated amount of historical range in each state was about 33,000 miles in Montana (59%), over 19,000 miles in Idaho (34%), over 1,000 miles in Oregon (2%), almost 3,000 miles in Washington (5%), and under 100 miles in Wyoming (Yellowstone National Park; < 1%). Several 4th code river basins, including the Milk Headwaters, Upper Milk, Willow, Bullwhacker-Dog, Box Elder, and Upper and Middle, and Lower Musselshell in the Missouri River system, the Hangman basin in the Spokane system, and the North John Day system in Oregon were excluded as historical habitats, even though previous assessments may have included some or parts of these basins within the historical range.

Exclusion of the four Missouri River system basins was based on: 1) WCT were not found during any fishery surveys, either from historical or current records, in any waters within these basins; and 2) we found written historical accounts stating that the basin did not support trout. The only exception to the above two conditions was found in the Box Elder basin where a single tributary, Collar Gulch, presently has WCT, but anecdotal evidence from a local retired Game Warden indicated WCT were stocked into this drainage in the early 1900's.

The Hangman Creek (also known as Latah Creek in Washington) HUC was excluded from the historical range based on evidence that redband trout are native and WCT were introduced (Ron Peters, Coeur d'Alene Tribe Natural Resources Dept., personal communication). Hangman Creek is a low elevation tributary to the Spokane River downstream from Post Falls. Post Falls was an upstream migration block to anadromous fish, including steelhead, and is generally considered to be the upstream extent of *O. mykiss* in the Spokane system (although there is some question that Spokane Falls, located between Post Falls and the mouth of Hangman Creek, constituted the upstream extent of *O. mykiss*). Fish distribution information from the Spokane system downstream of Spokane Falls indicates that *O. mykiss* replaced WCT as the native trout. Other low elevation systems (e.g., lower Salmon River, Snake River downstream from the Salmon River) within the historical range of steelhead typically do not support WCT. Historical hatchery records indicate cutthroat trout stocking may have occurred during the first half of the 20th century in Lolo Creek, a tributary of Hangman Creek; however, there are at least three other Lolo creeks in Idaho and early records do not specify locations of stocked streams.

The North John Day system was excluded because historical records indicated WCT never occupied this basin and streams within this basin that now support WCT were stocked. Approximately 100 WCT taken from Deardorff Creek, a mainstem John Day River tributary, were stocked into South Fork Desolation Creek and another 100 were stocked into Clear Creek by Oregon Department of Fish and Wildlife (ODFW) in 1960 (Hewkin 1960). These were stocked in an attempt to re-establish populations of fish after spruce budworm spraying occurred in 1958. Gunckel (ODFW, personal communication) indicated Olive Lake was planted with WCT from Twin Lakes in the 1970's. The WCT in Twin Lakes originated from WCT taken

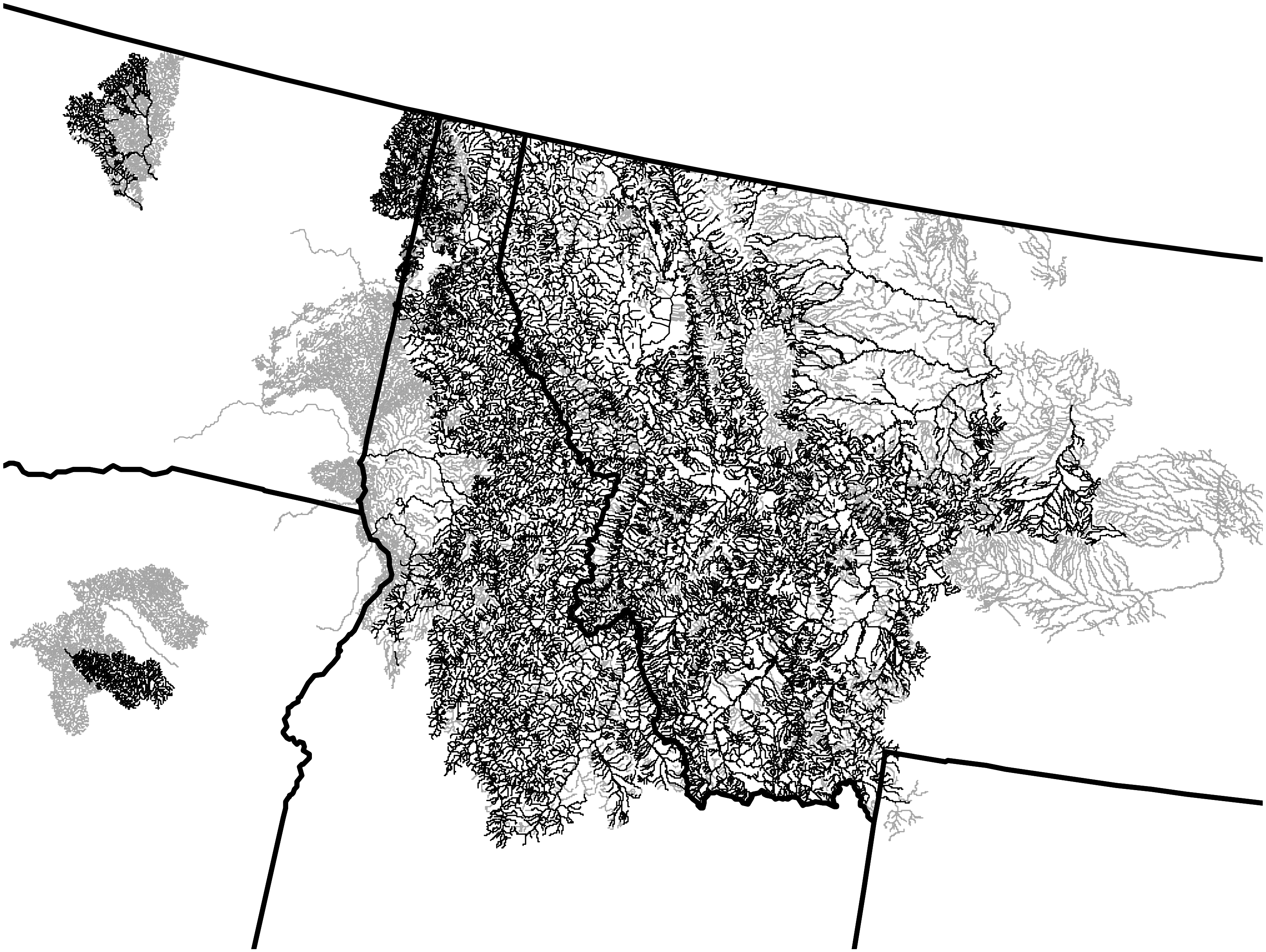


Figure 1. Streams that were included (dark) and excluded (light) from historical distribution of westslope cutthroat trout.

from Washington. This stocking likely explains why WCT are now found in Lake Creek, which drains Olive Lake.

Current Distribution

WCT currently occupy about 33,500 miles (59%) of the nearly 56,500 miles of historically occupied habitats. However, the genetic status of WCT across all this area has not been determined by genetic testing. WCT currently occupy over 18,000 miles in Idaho (95% of historical), almost 13,000 miles in Montana (39% of historical), about 250 miles in Oregon (21% of historical), and almost 2,000 miles in Washington (66% of historical).

Genetic Status

Most sampling for genetic testing was probably not done randomly. Consequently, the available genetics information probably does not constitute a simple random sample taken from the entire WCT population. Instead, there probably was a tendency to sample fish from populations that included fish that appeared to be phenotypic WCT. Genetic sampling has been conducted in over 6,100 miles of occupied habitats (18% of occupied habitats). No evidence of introgression was found from samples covering about 3,400 miles (56% of tested area, 10% of occupied habitats, and 6% of historical habitats; Table 9; Figures 2 and 3; Appendix F). WCT that made up part of a mixed stock population and were not introgressed occupied another 1,037 miles for a total of non-introgressed WCT occupying over 13% of currently occupied habitats. WCT that inhabited over 9,100 miles (27% of occupied habitats and 16% of historical habitats) are suspected of being genetically unaltered, based on the absence of introduced hybridizing species. WCT in about 17,300 miles (52% of occupied habitats and 31% of historical habitats) could possibly be hybridized due to the presence, or past stocking, of potentially hybridizing nonnative species or subspecies. In addition to those habitats within historical range that were occupied by WCT, we recorded information on WCT that currently occupy about 350 miles of habitat outside their historical range, but many stream segments that support WCT outside their historical range were not included (Table 9).

To better evaluate the quality of genetic sampling, we looked at the sample sizes of genetic sampling events related to whether more or less than a 1% level of introgression was found (Figure 4). The number of fish sampled represents each sampling event and, in some cases, more than one sampling event were probably pooled, but we had no way of assessing pooled samples. Of those samples that indicated a level of introgression of 1% or less, 30% had 25 fish or more and over 39% had 20 fish or more in the sample. Most genetic testing techniques allow for a 95% confidence at detecting a 1% level of introgression with a 25 fish sample.

Table 9. Genetic status for westslope cutthroat trout by stream length (miles) within and outside of their historical range as of 2002.

Genetic status	Within historical range			Miles outside historical range
	Miles	% of occupied	% of historical	
Tested; Unaltered	3472.7	10.3	6.2	6.6
Tested; ≤ 10% introgressed	1233.7	3.7	2.2	0.0
Tested; ≤ 25% to > 10% introgressed	501.4	1.5	0.9	0.0
Tested; > 25% introgressed	919.7	2.7	1.6	0.0
Suspected Unaltered	9107.8	27.1	16.1	93.4
Potentially Altered	17285.1	51.5	30.6	241.9
Mixed Stock; Altered and Unaltered	1036.7	3.1	1.8	10.9
TOTAL	33557.2	100.0	59.4	352.8

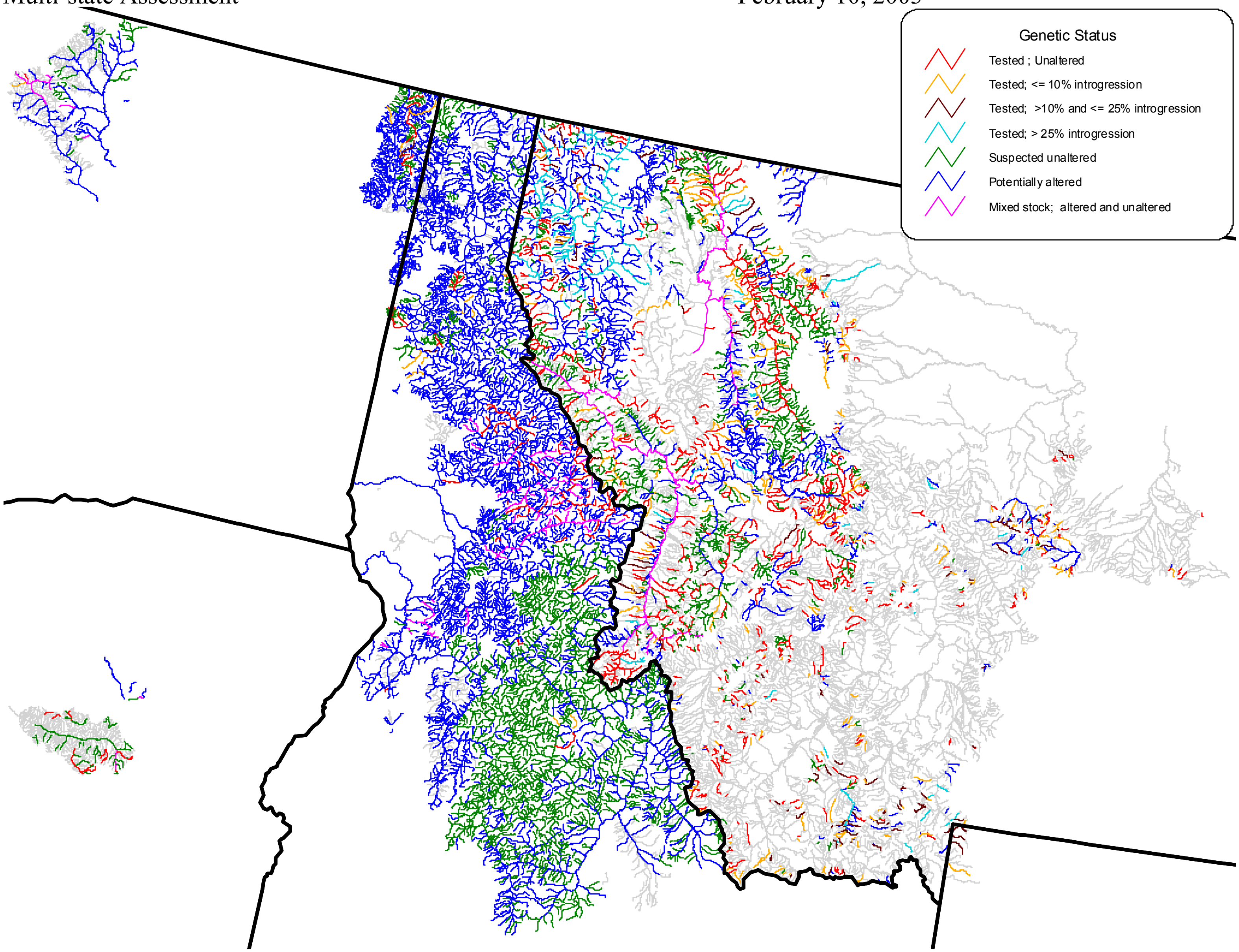


Figure 2. Genetic status of westslope cutthroat trout populations throughout their range. Gray lines indicate historical range.

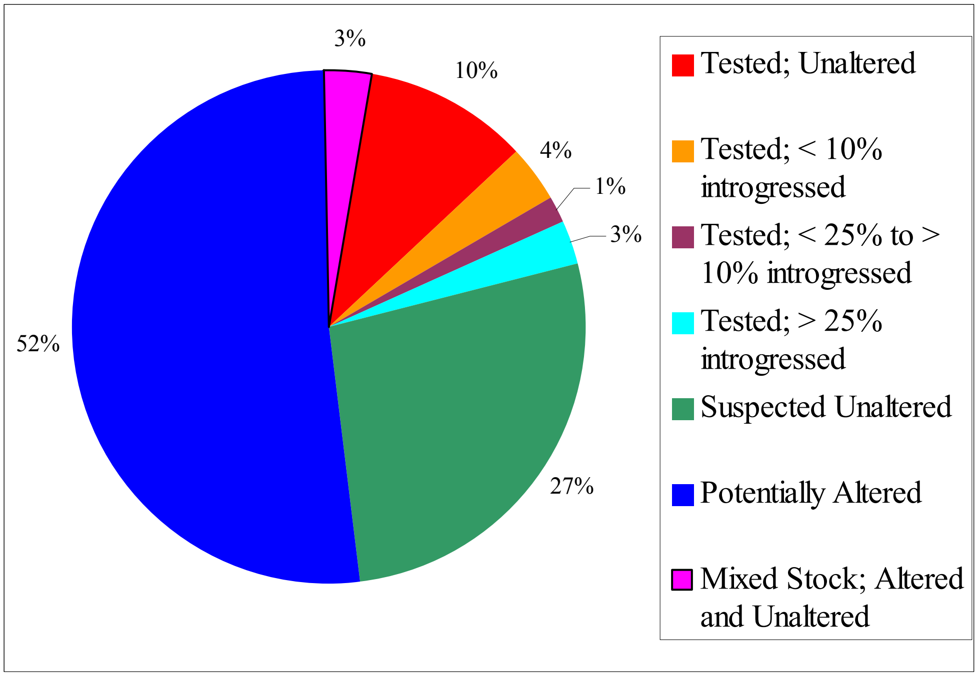


Figure 3. Genetic status of westslope cutthroat trout expressed as proportion of currently occupied habitats (in miles) classified within each genetic status category for assessment done in 2002.

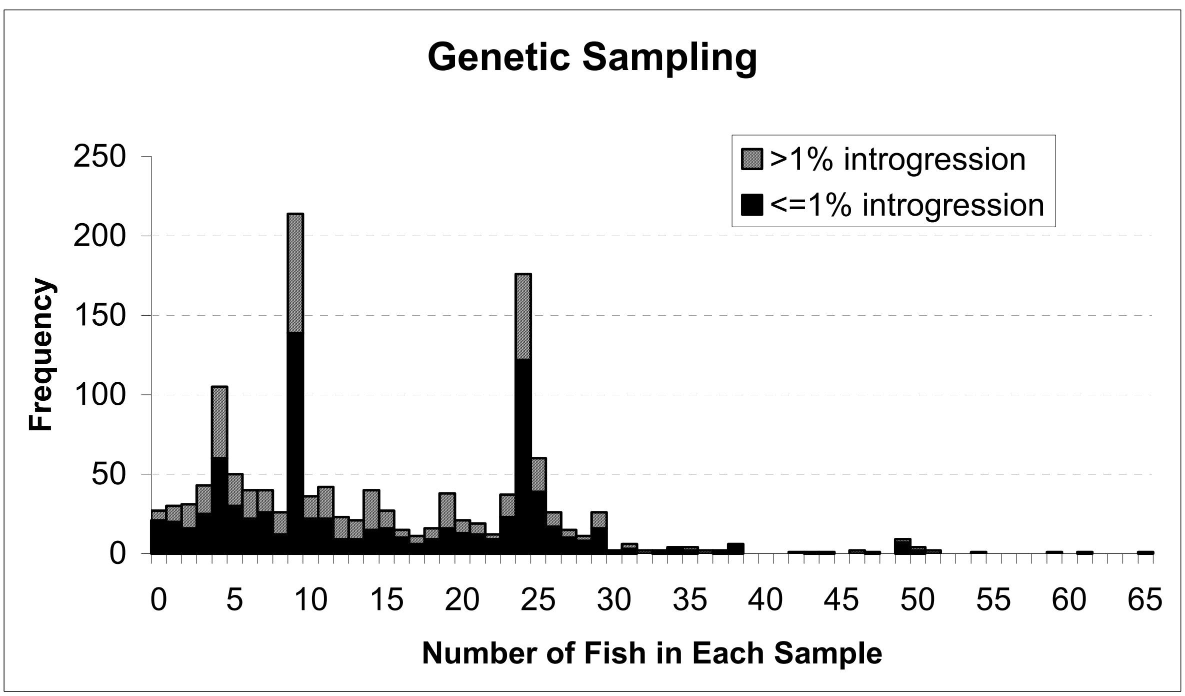


Figure 4. Distribution of the number of fish sampled for genetic testing, by level of introgression detected, for assessment done in 2002.

To provide insight into the likely genetic status of WCT within habitats classified as "Suspected Unaltered" and "Potentially Altered", especially in central Idaho where limited genetic testing has been conducted, we took a closer look at classification results for 17 4th code HUC's (Figure 5). For the ten HUC's that had stream reaches where some genetic testing was conducted we compared the level of introgression within tested stream segments to the classifications for stream segments where no genetic testing had been done (Table 10). Seven of these ten HUC's had the majority of the stream segments classified as "Potentially Altered". Of these seven, genetic testing in five HUC's found no evidence of introgression (HUC's 17010303, 17060303, 17060305, 17060307, 17060308; Table 10), 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 that supported WCT classed as being "Suspected Unaltered" have probably been introgressed (e.g. HUC 17060206; Table 10), although genetic testing found no evidence of introgression in the other two HUC's that were predominated by streams classified as "Suspected Unaltered". The potential for introgression is highest in stream segments that are connected to waters that support nonnative species or subspecies that could potentially interbreed with WCT.

Abundance Relative to Habitat Potential

A total of almost 9,700 miles of historically occupied habitats (29% of currently occupied habitats) supported populations believed to be at or near the habitat's potential capacity and over 9,300 miles of habitat (28% of occupied) supported populations significantly below potential (Table 11). Of the nearly 9,700 miles of habitat that had populations deemed at or near habitat capacity a total of about 1,190 miles (12% of miles deemed near capacity and 3% of occupied habitats) also had no evidence of genetic introgression based on genetic testing. Over 30% of habitats classified by abundance class had field estimates (high data quality) to support the classification, while 47% had low data quality indicating professional judgment was used (Table 12). Over 40% of the length of those steam segments that were classified as "At or Near Capacity" had field data to support that classification, while almost 40% were based on professional judgment.

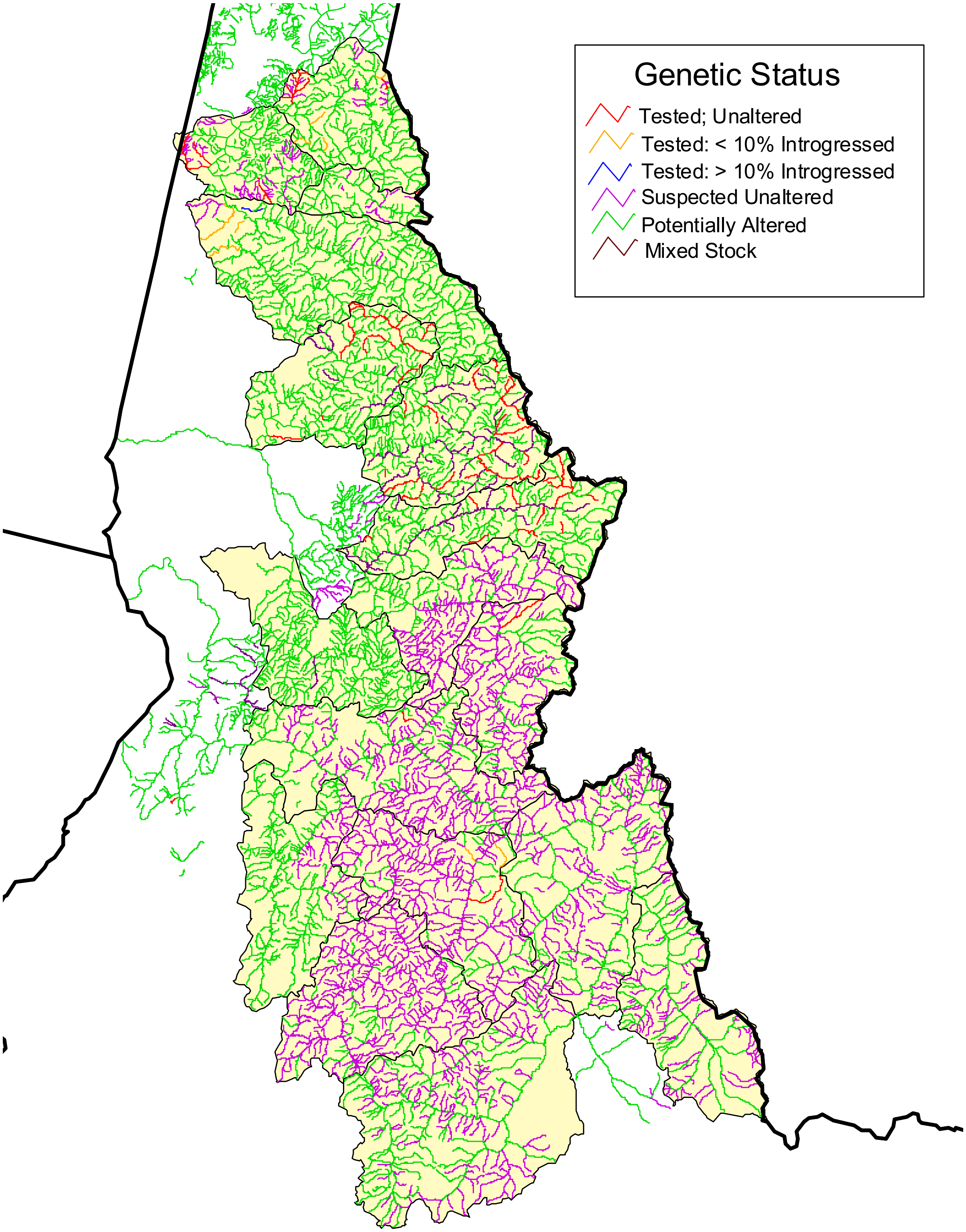


Figure 5. Map of central Idaho showing genetic status within 17 different 4th code HUC's where genetic testing was limited.

Table 10. Comparison between results from areas that have been genetically tested to those from areas that have not had genetic testing for 17 4th-code HUC's in Idaho. Bolded percentages within UNTESTED segments indicate predominant genetic status of untested segments where genetic testing had also been done.

	Genetic status of TESTED segments						Genetic status of UNTESTED segments			
	Miles				Unaltered as % of tested	Mixed and unaltered as % of tested	Suspected unaltered		Potentially altered	
HUC	Unaltered	Mixed stock	≤ 10% introgressed	> 10% introgressed			Miles	Percent of untested	Miles	Percent of untested
17060206	15.0		14.0		51.7	51.7	751.5	**85.0**	133.1	15.0
17060301	14.7				100.0	100.0	497.1	**72.8**	185.6	27.2
17060207	4.7				100.0	100.0	712.8	**65.3**	378.3	34.7
17010303	39.3				100.0	100.0	155.3	30.8	348.9	**69.2**
17010301	32.0		20.1		61.5	61.5	49.8	7.3	632.4	**92.7**
17010304			34.5	6.2	0.0	0.0	34.5	2.6	1272.2	**97.4**
17060303	74.8	115.6			39.3	100.0		0.0	642.2	**100.0**
17060305		10.3			0.0	100.0		0.0	882.5	**100.0**
17060307	143.5	222.5			39.2	100.0		0.0	684.6	**100.0**
17060308	96.2	41.9			69.6	100.0		0.0	698.6	**100.0**

Table 11. Miles of historical habitats currently occupied by westslope cutthroat trout by genetic status and relative abundance for assessment done in 2002.

	Abundance class				
Genetic status	At or near capacity	Slightly below capacity	Significantly below capacity	Unknown	Total
Tested; Unaltered	1187.8	783.9	1237.0	264.0	3472.7
Tested; <= 10% introgressed	358.8	269.3	468.0	137.7	1233.7
Tested; <=25% to > 10% introgressed	119.6	186.9	187.3	7.5	501.4
Tested; > 25% introgressed	271.7	396.7	200.0	51.3	919.7
Suspected Unaltered	4568.4	1580.0	1201.2	1758.1	9107.8
Potentially Altered	2809.9	4328.8	5607.5	4539.0	17285.1
Mixed Stock; Altered and Unaltered	368.8	201.8	451.1	15.0	1036.7
TOTAL	9685.1	7747.5	9352.1	6772.6	33557.2

Table 12. Miles (%) of habitats within historical range that are currently occupied by westslope cutthroat trout by relative abundance classes and data quality rating for assessment done in 2002.

	Data quality rating				
Abundance class	Low	--------------------------	> High	Total	
At or near capacity	3954.9	1513.1	4217.1	9685.1	28.9%
Slightly below capacity	3185.7	1814.2	2747.5	7747.5	23.1%
Significantly below	2178.2	3281.7	3892.2	9352.1	27.9%
Unknown	6439.9	309.0	23.7	6772.6	20.2%
TOTAL	15758.6	6918.0	10880.6	33557.2	100.0%
Percent	47.0%	20.6%	32.4%		

Occurrence in Special Management Areas

Of the over 33,000 miles of habitats currently occupied by WCT, 2% were in designated parks, 19% occurred within designated wilderness areas, 40% were within Forest Service roadless areas (including wilderness areas), and almost 70% occurred within federally managed lands (Table 13; Figure 6). Approximately 1.5% of currently occupied habitats that supported WCT with no evidence of introgression occurred within designated wilderness or parks (Table 13). Since we did not assess BLM wilderness or roadless areas in this assessment, the estimates of the proportions of habitat currently occupied by WCT within lands managed as wilderness and roadless are slight under-estimates.

Table 13. Miles of habitats occupied (% of occupied) by westslope cutthroat trout in Forest Service designated wilderness and roadless areas and within all federal lands.

	Parks		Wilderness		All roadless		All federal	
Genetic status	Miles		Miles		Miles		Miles	
Tested; Unaltered	68.2	0.2%	434.2	1.3%	1150.4	3.4%	2346.6	7.0%
Tested; <= 10% introgressed	55.2	0.2%	160.8	0.5%	408.2	1.2%	822.7	2.5%
Tested; <=25% to > 10% introgressed	74.1	0.2%	44.3	0.1%	141.6	0.4%	371.8	1.1%
Tested; > 25% introgressed	34.0	0.1%	54.0	0.2%	164.1	0.5%	476.9	1.4%
Suspected Unaltered	99.2	0.3%	3857.5	11.5%	5961.8	17.8%	8023.6	23.9%
Potentially Altered	150.7	0.4%	1779.5	5.3%	5340.5	15.9%	10749.7	32.0%
Mixed Stock; Altered and Unaltered	85.2	0.3%	18.1	0.1%	357.0	1.1%	589.4	1.8%
Total	566.7	1.7%	6348.4	18.9%	13523.7	40.3%	23380.7	69.7%

The spatial arrangement of WCT whose abundance was deemed at or near capacity were obviously clumped and appeared related to the presence of areas designated as wilderness, roadless, or national parks (Figure 6). About 3,800 miles classified as “At or Near Capacity” (39% of all miles in this class) were in wilderness and about 930 miles (10% of all miles in this class) had field data to support this classification (Table 14). Because assessments of abundance, regardless of data quality, were linked to quality of habitat, it is not surprising that most populations located in wilderness and roadless areas would be designated as being at or near capacity. Except where empirical observations indicated otherwise, nearly all habitats in wilderness areas were presumed to be in pristine condition. While assignment of 54% (2,055 miles) of the miles of habitat rated “At or Near Capacity” within wilderness was based on professional judgment (“Low” data quality), approximately 25% of the miles classified in this category in wilderness was supported by field data (“High” data quality).

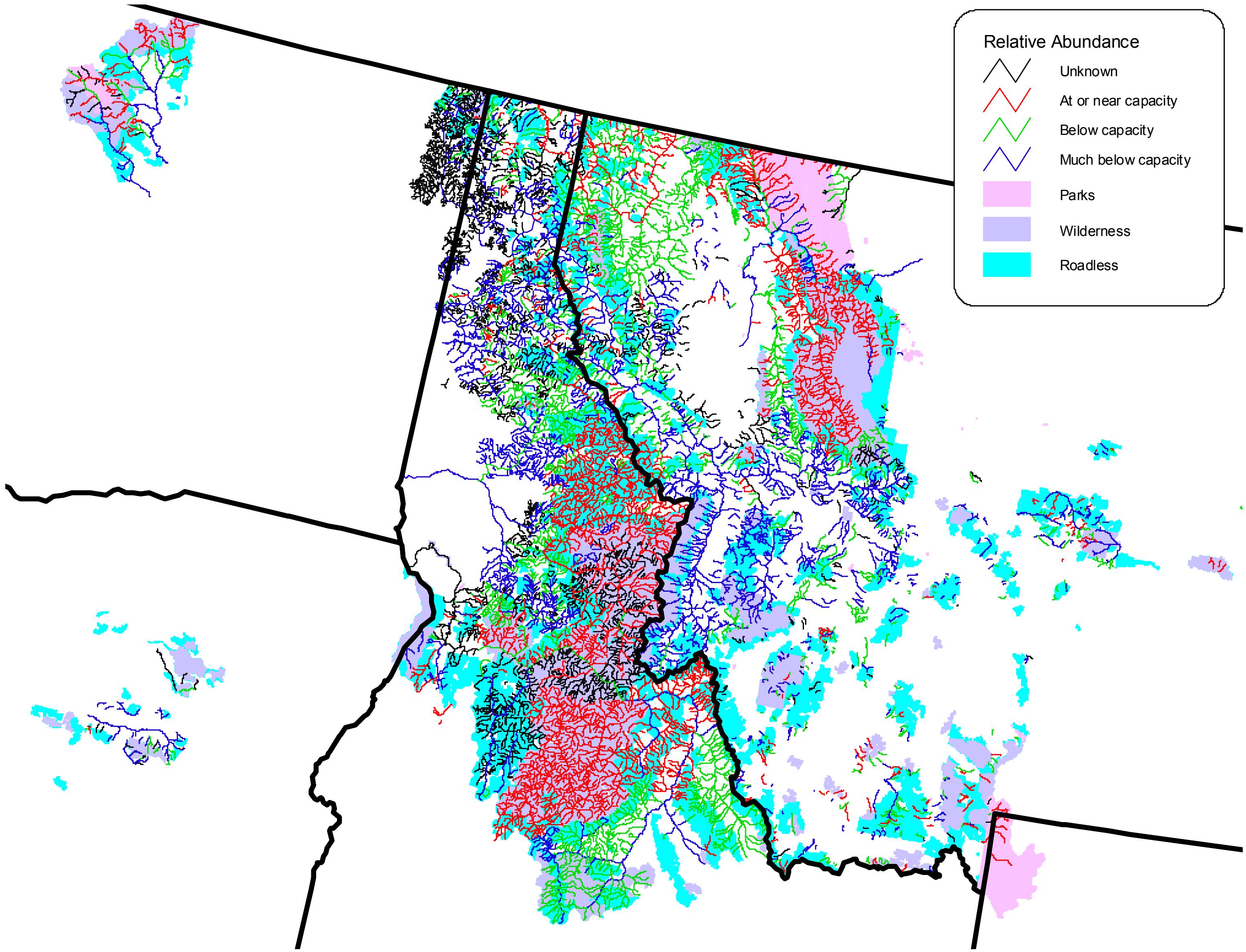


Figure 6. Relative abundance related to habitat potential overlaying designated wilderness and roadless areas and national parks.

Table 14. Miles of habitats supporting westslope cutthroat trout that were within Forest Service designated wilderness areas by abundance class for an assessment done in 2002.

	Data quality			
Relative abundance	Low	------------------->	High	Total
At or near capacity	2055.4	814.0	931.2	3800.6
Slightly below capacity	285.8	153.1	189.3	628.2
Significantly below capacity	165.0	235.8	125.3	526.0
Unknown	1256.8	5.5		1262.3
TOTAL	3762.9	1208.5	1245.8	6217.2

Conservation Populations

A total of 563 populations of WCT occupying about 24,450 miles of habitat (72% of occupied habitats) were identified as conservation populations (Figure 7; Appendix G). These designated conservation populations were spread throughout the historical range, occurring in 67 of the 70 HUC's historically occupied by WCT and one HUC outside of the historical range, but occupancy by conservation populations were obviously denser within the core of the historical range than near the fringes (Figure 7). Individual conservation populations occupied from 0.3 to over 6,000 miles of habitat (median = 5.6: Figure 8). The distribution of lengths of habitat occupied by these conservation populations was skewed with most of the populations occupying less than 10 miles. Most of the conservation populations were isolets; however, conservation populations that operated as connected metapopulations occupied much more habitat (Table 15). Populations that were isolates were much more likely to be "core" conservation populations, while populations that were designated as metapopulations were more likely to support unique life-history characteristics (Table 15).

Of the 563 designated conservation populations, 339 (60%) had at least some component that was genetically unaltered and 172 (30%) consisted entirely of stream segments that were genetically unaltered. The total length of stream occupied by those conservation populations where all stream segments making up the conservation population had been genetically tested and no genetic introgression had been found ranged from 0.4 to 12.8 miles.

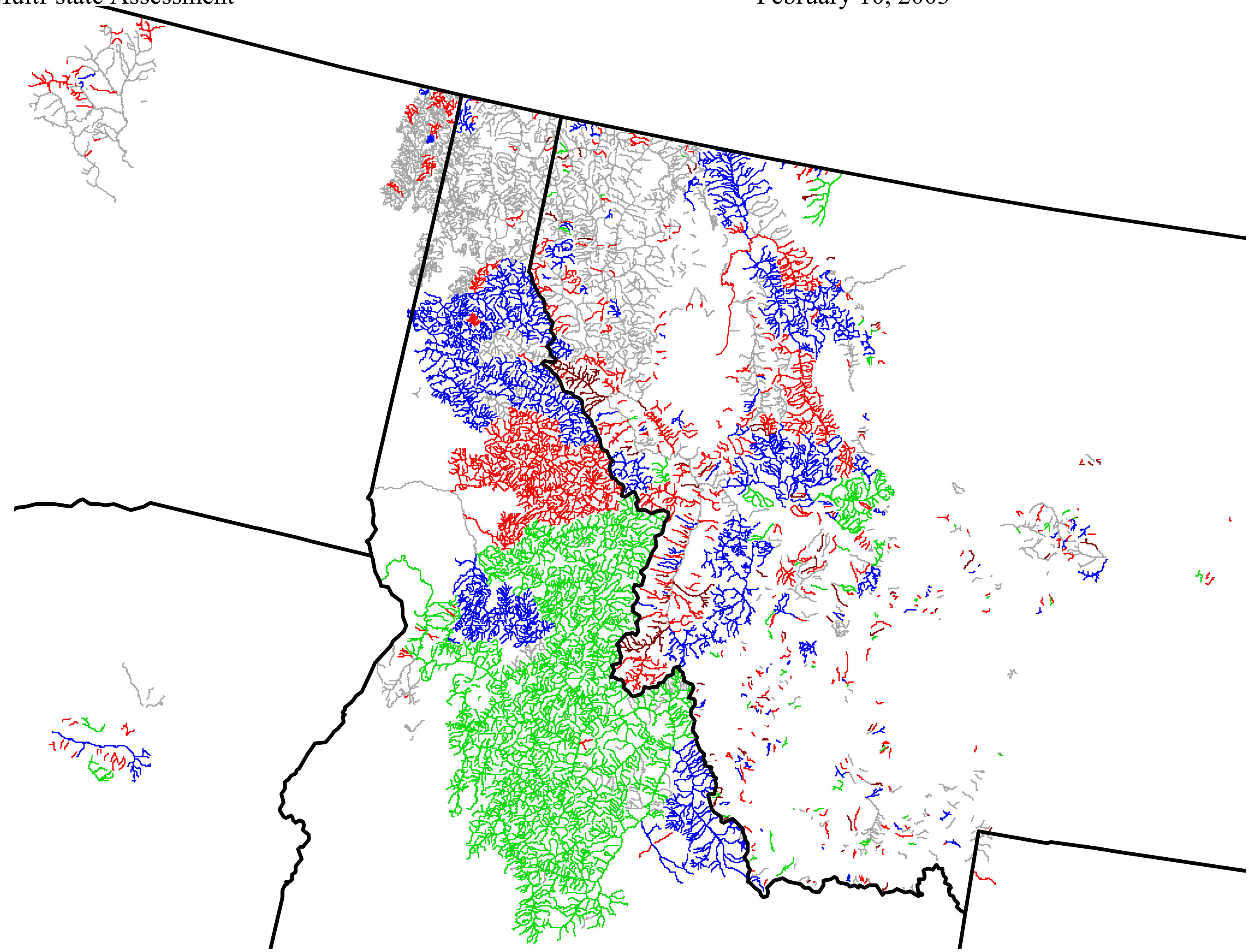
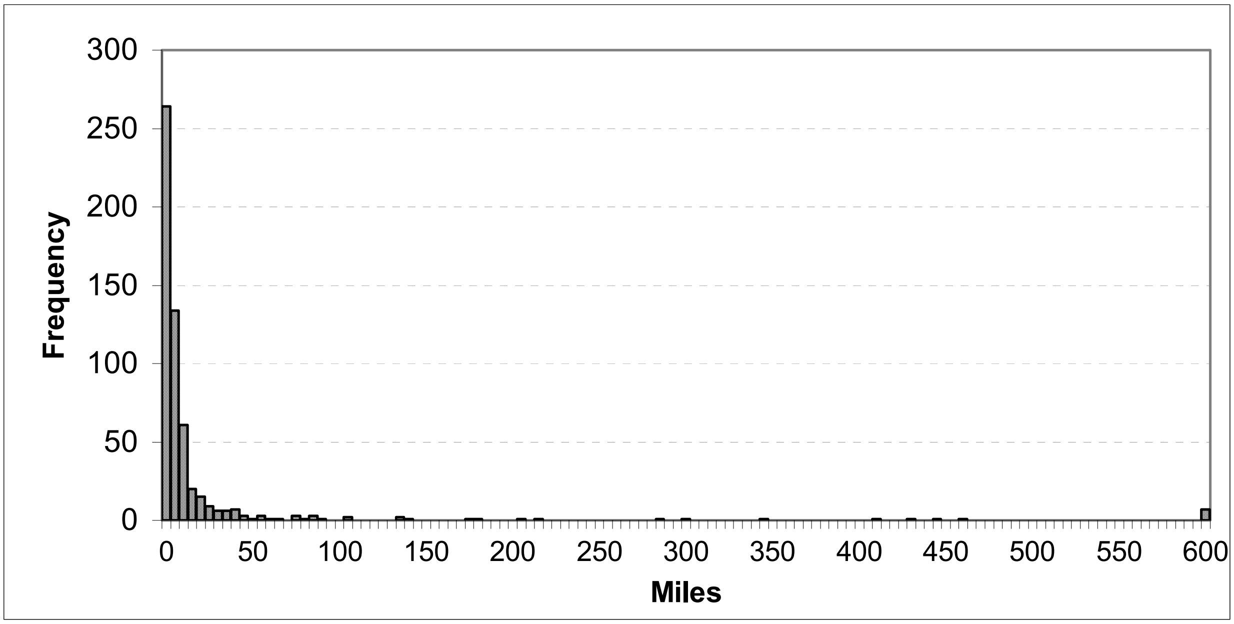


Figure 7. Designated conservation populations of westslope cutthroat trout (colored streams) throughout their range shown overlaying their current distribution (gray streams) as of 2002.

Table 15. Number and miles of designated conservation populations of westslope cutthroat trout by reason for assigning those populations as conservation populations along with proportions of those populations by number and miles within isolets and metapopulations.

	Isolets		Metapopulations		Total	
Reason for conservation population	Number	Miles	Number	Miles	Number	Miles
Core Conservation Population (must be genetically unaltered - greater than 99% pure)	260	1574.6	43	2520.9	303	4095.5
Known or Probable Unique Life History (fluvial, ad-fluvial, or resident)	144	935.1	46	18302.6	190	19237.7
Known or Probable Ecological Adaptation to extreme environmental condition	2	5.8	1	12.0	3	17.9
Other - Population occupies habitat that is likely to become part of the WCT conservation focus	51	296.3	16	805.1	67	1101.3
TOTAL	457	2811.8	106	21640.6	563	24452.5
	81.2%	11.5%	18.8%	88.5%		



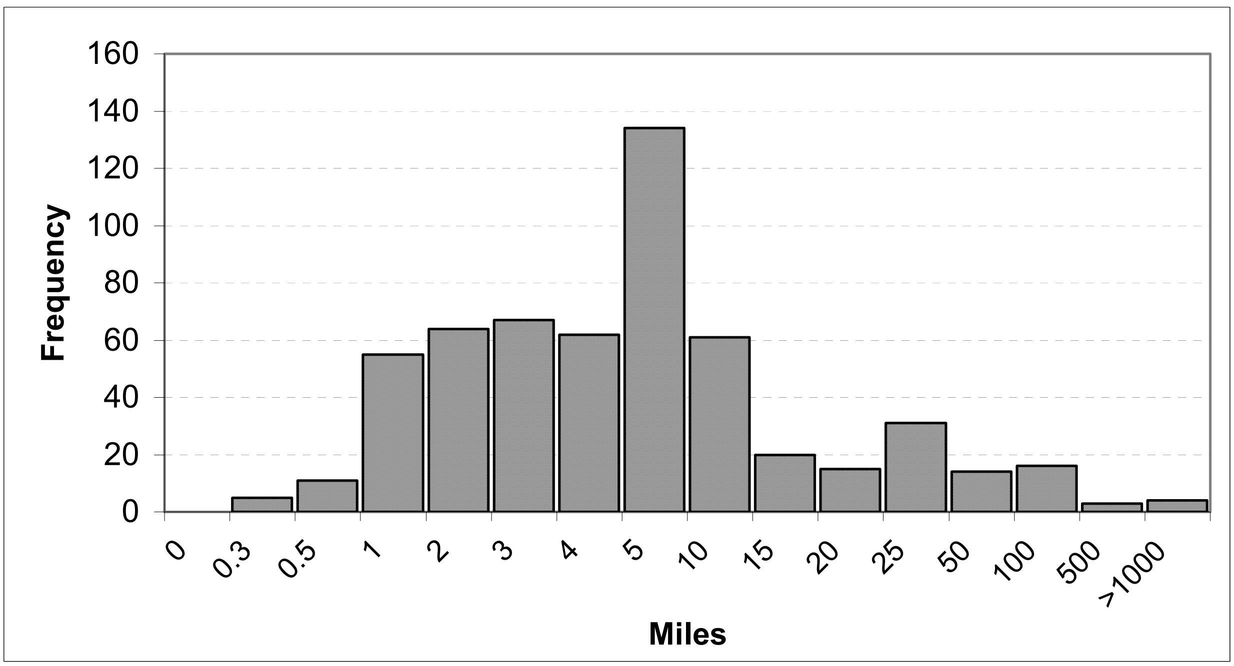


Figure 8. Frequencies of the number of miles occupied by designated conservation populations of westslope cutthroat trout throughout their range. Mileage bins are uniformly assigned at 5.0 mile intervals in top graph and non-uniformly assigned in bottom graph.

Ranked Risks to Conservation Populations

We rated risks to 539 of the 563 designated WCT conservation populations by miles of habitat occupied (Table 16 and Figure 9) and by number of populations (Table 16 and Figure 10). No risk assessment was done for 24 populations located within some lands administered by one tribal council in Montana. The two distinct types of conservation populations, "isolets" and "metapopulations", were segregated in the analyses. In general, more isolet populations were **at higher risk** due to temporal variability, population size, and isolation than metapopulations, especially when rated by number of populations (Table 16), but more isolet populations were **at less risk** than metapopulations due to genetic introgression, disease, and population demographics. This is indicative of the fact that while smaller, isolated populations are usually much more susceptible to population level risks due to isolation, small population size, and temporal variability; their isolation makes them less susceptible to genetic introgression and disease risks. Conversely, while more metapopulations (large, connected populations) were **less vulnerable to population risks** such as temporal variability, isolation, and small population size, their connectedness made them **more susceptible** to genetic introgression and disease risks (Table 16). Composite population risk scores ranged from a low of 4 to a high of 16 with most scores being over 10 for isolet populations and under 9.5 for metapopulations (Figure 11). "Isolets" are at relatively high risk from population-type risks, but at much lower risk from genetic and disease risks than "metapopulations".

Restoration Activities Implemented for Conservation Populations

Restoration, conservation, and management activities that have been implemented to conserve designated conservation populations were evaluated for the 539 conservation populations for which risk assessments had been completed (Table 17). Angling and land management restrictions have been implemented in waters and adjacent lands that affect over half of the designated conservation populations. Angling restrictions often consisted of "catch and release" fishing for WCT, but other restrictions such as bag and size limits and gear restrictions were also included. Restoration activities, such as culvert replacement, channel restoration, bank stabilization, riparian fencing, have occurred for 5 to 10% of the conservation populations. Ten percent of the conservation populations are, either partly or wholly, within protected lands (wilderness, national parks, etc.).

Table 16. Ranked risks to designated conservation populations of westslope cutthroat trout that functioned as "isolets", "metapopulations", and combined by number of conservation populations and miles of habitat that these conservation populations occupied by risk factor as of 2002. Bold population composite risk scores are weighted scores for temporal variability, population size, demographics, and isolation re-classified into low to high categories (see Methods for details).

Type of population	Risk Factor	Ranked risk by miles				Ranked risk by number of populations			
		Low -------------------------> High				Low -------------------------> High			
Isolets	Genetics	1236.7	862.8	418.7	198.2	191	163	59	24
	Disease	1128.7	1163.5	411.0	13.3	173	210	52	2
	Temporal Variability	107.0	434.6	1223.4	951.5	6	19	95	317
	Population Size	275.1	913.4	1258.6	269.4	25	104	214	94
	Demographics	606.3	1537.2	410.5	162.5	97	235	76	29
	Isolation	182.6	105.7	367.1	2061.1	12	6	40	379
	Composite	**117.8**	**975.5**	**1366.1**	**257.1**	**8**	**103**	**248**	**78**
Metapopulations	Genetics	575.7	525.9	12789.9	7677.5	15	10	51	26
	Disease	2376.0	2007.0	5701.3	11484.7	40	36	13	13
	Temporal Variability	20265.1	1036.9	236.9	30.1	36	31	24	11
	Population Size	19805.9	1427.8	328.7	6.6	52	30	18	2
	Demographics	1388.5	19687.7	458.7	34.1	16	75	10	1
	Isolation	12263.7	7492.5	1438.9	374.0	41	18	32	11
	Composite	**19135.1**	**2292.6**	**137.4**	**3.9**	**39**	**51**	**11**	**1**
COMBINED	Genetics	1812.4	1388.7	13208.6	7875.7	206	173	110	50
	Disease	3504.7	3170.5	6112.3	11498.0	213	246	65	15
	Temporal Variability	20372.1	1471.5	1460.4	981.5	41	55	145	298
	Population Size	20081.0	2341.2	1587.3	276.0	77	134	232	96
	Demographics	1994.8	21224.9	869.2	196.6	113	310	86	30
	Isolation	12446.3	7598.2	1805.9	2435.0	53	24	72	390
	Composite	**19252.9**	**3268.2**	**1503.5**	**261.0**	**47**	**154**	**259**	**79**

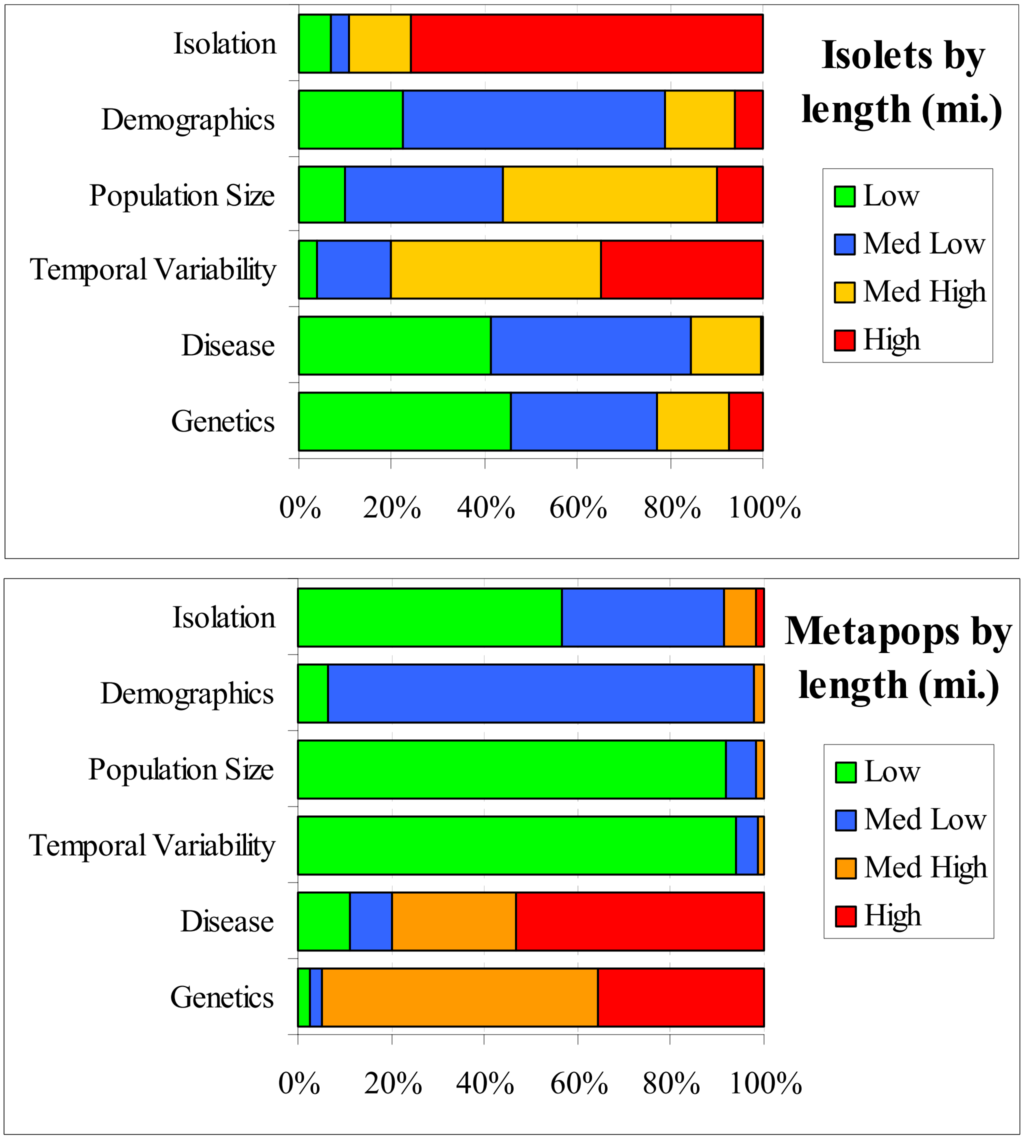
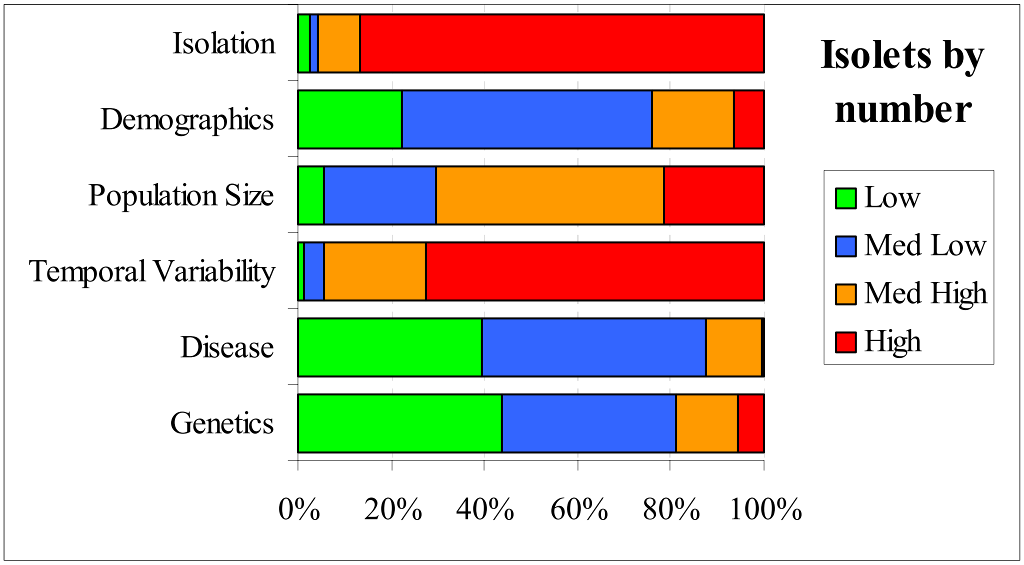


Figure 9. Proportions of miles occupied by designated "isolet" (top) and metapopulation (bottom) westslope cutthroat trout conservation populations ranked into low to high levels of risk by risk factor (vertical axes).



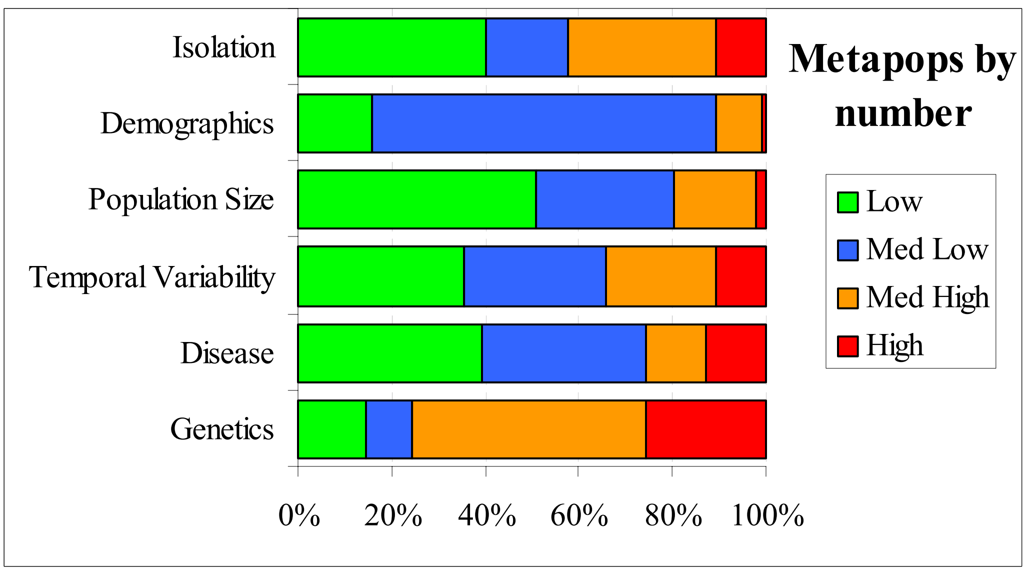


Figure 10. Proportions for numbers of designated "isolet" (top) and metapopulation (bottom) westslope cutthroat trout conservation populations ranked into low to high levels of risk by risk factor (vertical axes).

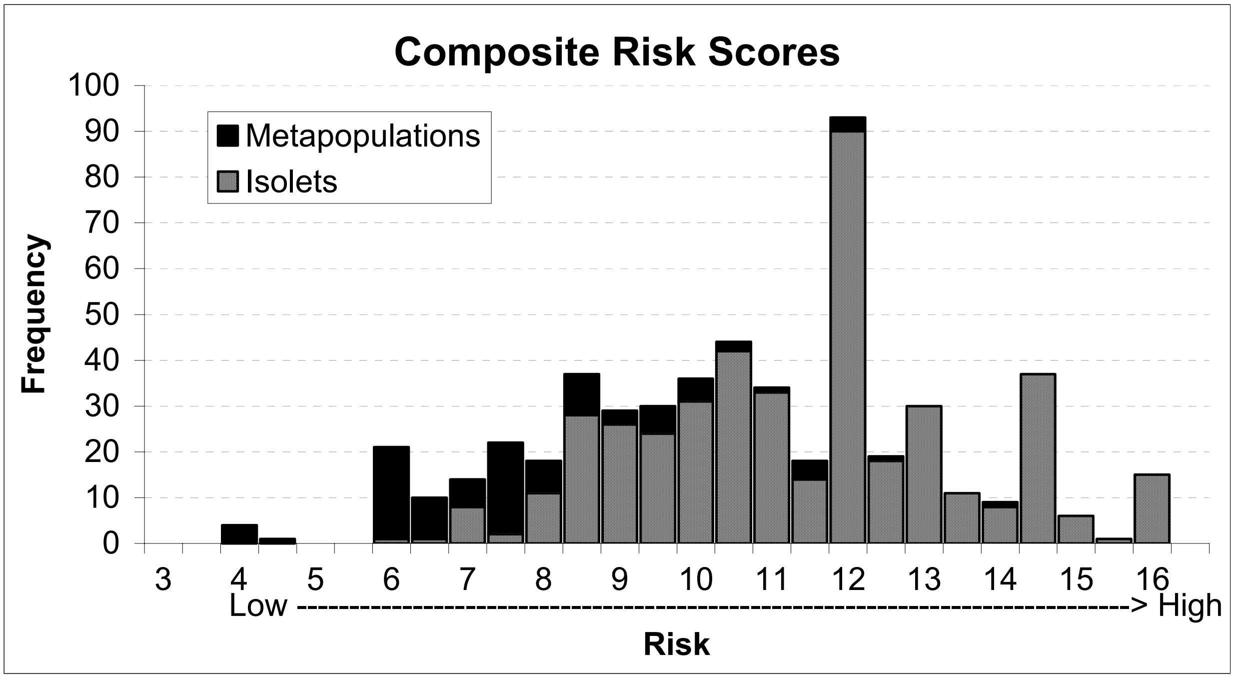


Figure 11. Distribution of the number of designated westslope cutthroat trout populations by composite population risk scores and population type (excludes genetics and disease risks).

Table 17. Number and percentage (based on the 539 conservation populations that were evaluated) of westslope cutthroat trout designated conservation populations that have had various types of conservation, restoration, and management actions applied to conserve them as of 2002.

Type of restoration or management activity	Number of populations	
Water lease/Instream enhancement	9	1.7%
Channel restoration	39	7.2%
Bank stabilization	39	7.2%
Riparian restoration	53	9.8%
Diversion modification	18	3.3%
Barrier removal	24	4.5%
Barrier construction	21	3.9%
Culvert replacement	50	9.3%
Fish screens	21	3.9%
Fish ladders	11	2.0%
Spawning habitat enhancement	13	2.4%
Woody debris	30	5.6%
Pool development	27	5.0%
Irrigation efficiency	9	1.7%
Grade control	11	2.0%
Instream cover habitat	16	3.0%
Riparian Fencing	48	8.9%
Physical removal of competing/hybridizing species	27	5.0%
Chemical removal of competing/hybridizing species	3	0.6%
Public outreach (Interpretive site)	31	5.8%
Population restoration/expansion	23	4.3%
Angling regulations	298	55.3%
Land-use mitigation direction and requirements	304	56.4%
Watershed under protective mgt (Nat'l Park, wilderness, etc.)	54	10.0%
Other	33	6.1%

Management Impacts on Conservation Populations

While it was difficult to definitively link land use impacts to specific portions of conservation populations, at least some portion of habitats in over 50% of the conservation populations were considered to have been impacted by land use activities such as timber harvest, livestock grazing, or roads (Table 18). Angling and water withdrawals were identified as having known impacts to about 15% of the populations. Mining was having known impacts to about 7% of the populations. "Possible" impacts affected a higher number of conservation populations than those that were "Known", and the proportions of conservation populations that were impacted by each type of activity were similar for all activities except timber harvest and angling,

Table 18. Number and percentage (based on the 539 conservation populations that were evaluated) of designated westslope cutthroat trout conservation populations where human management activities were known or believed (possible) to have impacted the population by type of management activity.

	Known Impacts		Possible Impacts	
Type of activity	Number		Number	
Timber harvest	96	17.8%	173	32.1%
Range (livestock grazing)	139	25.8%	158	29.3%
Mining	38	7.1%	60	11.1%
Recreation (non-angling)	24	4.5%	61	11.3%
Angling	17	3.2%	93	17.3%
Roads	128	23.7%	170	31.5%
Dewatering	61	11.3%	62	11.5%
Fish stocking	29	5.4%	48	8.9%
Hydroelectric, water storage, and/or flood control	14	2.6%	18	3.3%
Other, specify in comments	12	2.2%	10	1.9%

Discussion and Conclusions

Historical Range

Although the historical habitats of WCT delineated by this assessment differ from previous assessments (Hanzel 1959; Behnke 1979; Liknes 1984; Liknes and Graham 1988; Behnke 1992; Van Eimeren 1996; Lee et al. 1997; Shepard et al. 1997; Thurow et al. 1997; U.S. Fish and Wildlife Service 1999), our review provides the most comprehensive and current assessment of historical range. Behnke (1979; 1992) included the headwater portions of a few 4th code HUC's that we excluded (Milk Headwaters and Upper Musselshell); however, he based his inclusion of the Musselshell system primarily on information compiled by Hanzel (1959) and the Milk system primarily on information compiled by Willock (1969). Hanzel's (1959) inclusion of many of these areas was based on creel census information that he acknowledged was of questionable value due to the inability of some anglers to differentiate between cutthroat trout and other species. While Willock (1969) found WCT "limited to the cooler waters of the North Fork of the Milk River" in Alberta, Canada, he points out that the North Fork of the Milk is connected to the St. Mary's River in the South Saskatchewan system via the St. Mary's Canal that flows from the St. Mary's to the North Fork. We have included the St. Mary's drainage in the historical range, but excluded the Milk because WCT originating from the St. Mary's may have colonized the North Fork of the Milk through the St. Mary's Canal. Whether the headwaters of the Milk River were historical WCT range will probably never be known with certainty.

The Upper Musselshell was included in many previous assessments as part of the historical range of WCT (Hanzel 1959; Behnke 1979 and 1992; Shepard et al. 1997; U.S. Fish and Wildlife Service 1999), but we excluded this 4th code HUC based on the fact that neither historical nor current fish surveys found any WCT populations in this HUC and we have several anecdotal accounts, including one historical newspaper article (Castle News, April 26, 1888), and Hanzel's thesis (1957) indicating that this portion of the Musselshell drainage was barren of fish until stocking occurred in the late 1800's, probably by U.S. Army troops (letter to B. Shepard from R. Behnke 1996). WCT populations currently occur within two tributaries to the lower Musselshell River, Box Elder and Flatwillow creeks. We suspect that the WCT population in Half Moon Creek, a tributary to Flatwillow Creek, originated from a drainage divide transfer from the Judith River drainage, while the Collar Gulch population in Box Elder Creek was probably stocked (see above in Results).

We estimated that slightly over 33,000 miles of habitats in Montana historically supported WCT and that the South Saskatchewan, Missouri, and Columbia basins contained about 0.5%, 51.6%, and 47.9% of the historical range, respectively. Liknes and Graham (1988) conservatively estimated that approximately 25,500 km (15,845 miles) of stream habitats in Montana were historically occupied by WCT, based primarily on earlier work by Liknes (1984), and that the Saskatchewan, Missouri, and Columbia basins contained about 0.9%, 44.7%, and 54.4% of the historical range, respectively. While Liknes and Graham's estimates of the total historical habitat occupied by WCT in Montana was less than half the amount we estimated, the proportions of this habitat that were distributed in each of the three major basins were similar. The difference in total length of historical habitat may have been related primarily to the different scales at which these assessments were done (1:250,000 for Liknes and Graham's assessment and 1:100,000 for this assessment).

Van Eimeren (1996) estimated that Montana contained just over 57,000 miles of historical WCT habitat. Shepard et al. (1997) estimated that approximately 93,000 km (57,780 miles) of habitats in the Missouri basin of Montana were historically occupied by WCT. We estimated that about 17,500 miles of habitat within the Missouri River basin of Montana were historically occupied. While this difference was large, Shepard et al.'s earlier (1997) assessment included many 4th code HUC's that we excluded, Milk Headwaters, Willow, Bullwhacker-Dog, Box Elder, and Upper and Middle Musselshell. Shepard et al. also made no effort to exclude any habitats within those areas they believed were historically occupied. The discrepancy between Van Eimeren's

(1996) estimate and our estimate was likely due to differences primarily in the Missouri River system discussed above.

Rieman and Apperson (1989) estimated that WCT were historically present in approximately 10,900 miles of streams in Idaho, while we estimated that over 18,000 miles were historically occupied. Much of this discrepancy is likely due to mapping scale differences.

Lee et al. (1997) and Thurow et al. (1997) assessed the status of native fishes in the upper and middle portions of the Columbia River basin including delineating historical ranges. For WCT their designation of historical range was similar to ours for Idaho and Oregon, but they included more 4th code HUC's in Washington on the east side of the Cascade Mountains, including the Yakima, Wenatchee, and Naches basins, than either we or the U.S. Fish and Wildlife Service (1999) included. Our estimation for the distribution of native WCT populations in Washington was based on their known presence prior to the proliferation of hatchery stocking. Though it is possible that this assessment underestimates the historical distribution of WCT, historical presence of native WCT populations outside of Lake Chelan, the Methow and Pend Oreille River basins cannot be documented with available information (Williams 1998). Van Eimeren (1996) also included these basins within the historical range of WCT in his assessment.

Current Distribution

WCT currently occupy about 33,500 miles in 7,071 tributaries throughout their historical range. The U.S. Fish and Wildlife Service (1999) estimated that WCT occupied about 23,000 miles in 4,275 tributaries. The differences between these two estimates are likely due to several reasons. First, more populations of WCT have been documented in the four-year period between 1998 and 2002. Second, our assessment provided more detailed information that was gathered and summarized more consistently than was available to the FWS when they conducted their earlier status review. Third, the scale at which we collected and summarized information was finer than the scale at which some data were provided to the FWS.

McIntyre and Rieman (1995), citing Rieman and Apperson (1989), estimated that WCT populations whose abundance were at least 50% of potential occupied only 11% of historical range in Idaho. We estimated that WCT occupied almost 96% of historical range in Idaho and that stream segments that supported WCT "Slightly Below" to "Near" habitat capacity occupied about 50% of historical range. We are uncertain why these two different assessments had such a large difference; however, it is likely that different biologists made different interpretations. For example, Rieman and Apperson (1989) noted that biologists classified WCT populations in the Middle Fork Salmon River drainage as depressed, because they occurred at relatively low densities. Our assessments of abundance were tied to habitat potential. In the Middle Fork Salmon drainage, wilderness designation results in habitat generally being regarded as pristine. However, wilderness streams located in the central Idaho batholith have inherently low productivity, thus where stream productivity is expected to be low due to underlying geology, WCT will also be relatively low, even though their abundance is at or near capacity. Additionally, WCT in the Middle Fork Salmon have been managed with catch and release regulations since the 1970s, and harvest is not affecting population abundance. In addition, since publication of the Rieman and Apperson (1989) report, a substantial number of new field studies have been initiated in Idaho WCT habitats that provided abundance data, additional waters are being managed with restrictive fishing regulations, and there has been considerable effort directed at maintaining and improving habitat conditions. Furthermore, drought conditions in the mid to late 1980s may have temporarily depressed fish populations. New information, responses of some populations to protective measures, and assessments made during drought conditions without the benefit of long term trend data may all contribute to discrepancies between this analysis and that of Rieman and Apperson (1989).

Conversely, Lee et al. (1997) and Thurow et al. (1997) estimated that WCT occupied 85% of their historical range in the upper and middle Columbia River basin by subwatershed (6^{th} code level HUC). Their findings were slightly higher than ours, but were more consistent with our results because they considered any occurrence of WCT within a subwatershed as occupancy and we delineated the actual lengths of occupied and vacant habitats.

Liknes (1984) and Liknes and Graham (1988) estimated that WCT occurred in 27% (4,280 miles) of their historical range in Montana and that genetically unaltered WCT occupied only 2.5% (390 miles) of the historical range. Van Eimeren (1996) estimated that WCT occupied about 19% of an historical range that he estimated was 57,000 miles, or occupancy of about 10,800 miles in Montana. For Montana, we estimated that WCT currently occupied almost 13,000 miles (39% of what we considered historical range) and genetically unaltered WCT occupied almost 3,000 miles (9% of historical range). While the miles of habitats currently occupied by WCT differed among these three assessments, we believe the primary reasons for these differences are the discovery of both more streams that support WCT, due to increased survey efforts, and increased genetic sampling over time.

Other assessments of WCT status and distribution (Liknes and Graham 1988; Marnell 1988; Rieman and Apperson 1989; Thurow et al. 1997) suggested that wilderness and roadless areas provide important strongholds for WCT. While this assessment supports these previous findings, the relationship between abundance of WCT and presence of wilderness or roadless areas is confounded by the lack of independence between abundance classifications and habitat quality, particularly for those stream segments where abundance class was based on professional judgment (Table 14).

Designated Conservation Populations

There are two types of conservation strategies represented in how the states designated WCT “conservation populations”. One strategy emphasizes conserving genetic integrity by isolating WCT populations that have no evidence of genetic introgression to prevent introgression and competition by nonnative fish. The other strategy emphasizes maintaining connectivity among WCT populations by protecting relatively large areas of continuous habitat that will allow WCT to express all life-history traits, especially migratory life-histories. As we showed in the results, the types of risks inherent in these two different conservation strategies are dramatically different.

For those WCT populations where genetic integrity is emphasized, risks due to isolation, small population size, and temporal variability are high, while other types of risk are relatively low. The assumption made in rating these population risks as high is that WCT populations need to occupy relatively large habitats that allow for connection among many subpopulations. Some authors have indicated that cutthroat trout populations need to be supported by an effective population of 500 reproducing adults based on the 50/500 "rule" (Franklin 1980; Soulé 1980), thus they believed that most isolated small populations of cutthroat trout were at an extremely high risk of extinction (Kruse et al. 2001; Hilderbrand and Kershner 2000). Harig and Fausch (2002) found that cutthroat trout translocations were most successful when the drainage area was at least 5.6 $mi.^2$ (14.7 km^2), which likely translates to inhabited stream lengths of at least 2 to 3 miles. 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 WCT in the Coeur d'Alene basin of Idaho. Of the 172 conservation populations we evaluated that consisted exclusively of WCT with no evidence of introgression, 39 (23%) occupied more than 5.5 miles, 105 (61%) occupied more than 3 miles, and 132 (77%) occupied 2 miles or more. Conservation populations that were considered "isolets" accounted for 168 (98%) of these 172 conservation populations with no evidence of introgression. Conservation of genetic integrity was the reason for designating 161 (94%) of these populations that had no evidence of introgression as conservation populations and most (157 or 98%) were "isolets". Of the 168 "isolet" conservation populations that had no evidence of introgression, 56 (33%) were genetically secured by the presence of a barrier.

Since genetic introgression and nonnative competition threats probably outweigh stochastic risks over the short-term for many extant WCT populations, isolating remaining non-introgressed WCT populations may be a prudent, short-term conservation strategy. Replicating and re-founding existing isolated, non-introgressed WCT populations that may be lost due to stochastic or demographic pressures, and using humans as the dispersal agent via conservation stocking to re-found WCT populations that are lost from isolated habitats due to stochastic processes have been recognized as viable conservation strategies (e.g. Montana Fish, Wildlife and Parks 1999; Shepard et al. *in press*).

For the other type of "metapopulation" conservation population, population risks are relatively low, while genetic and disease risks are high. While 70 of the 106 conservation populations classed as "metapopulations" had a component that had no evidence of genetic introgression, only four consisted exclusively of nonintrogressed WCT. These four occupied relatively short lengths of habitat (2.8 to 8.3 miles), consequently they may have been misclassified as "metapopulations".

Long-term abundance data from four Idaho systems located in central Idaho (Middle Fork Salmon, Selway, St. Joe and Coeur d'Alene rivers) indicated a high level of resiliency for populations in these basins (Idaho Department of Fish Game 2003), providing further evidence that population-level risks are likely low for conservation populations designated as metapopulations. The Middle Fork Salmon and Selway rivers are primarily in wilderness areas, and drain the unproductive granitic geology of the Idaho batholith, while the St. Joe and Coeur d'Alene systems drain more productive belt series geologies. The IDFG (2003) data also supported the "at or near capacity" abundance designation assigned to most wilderness stream segments and the "significantly below capacity" designation for many of the stream segments in the Coeur d'Alene system. WCT from these two rivers were included within a single large metapopulation, and many of the stream segments contained within this metapopulation were genetically classified as “Potentially Altered”. Genetic risk to this metapopulations was considered to be relatively high, although genetic testing of fish from portions of this metapopulation suggests hybridization may not be widespread (Figure 5 and Table 10).

Conclusions

This assessment clearly shows that WCT currently occupy significant portions of, and are well distributed across, their historical range. WCT currently occupy a higher proportion of their historical habitats near the core of their historical range, with sparser occupancy near range fringe areas, particularly in the Missouri River system of Montana. 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).

The precise genetic status of most WCT populations is uncertain because genetic testing is expensive and time-consuming, thus genetic testing has not been completed for most occupied stream segments. Also, even for some populations where genetic testing has been completed, sample sizes are so small that the absence of introgression cannot be statistically inferred with any degree of confidence. Existing genetic information suggests that WCT with no evidence of introgression currently occupy 13% of the habitats where WCT are currently found (8% of historical). While it is probable that future evidence of introgression will be found in some of the populations that currently have shown no evidence of introgression, it is also likely that more of the currently untested populations of WCT will be found to have no evidence of introgression, once they are genetically tested.

In addition, we know that the data were biased because stream segments were assigned as introgressed when we could not determine from the database whether a particular sample was from a population where random or non-random mating occurred. Thus, unless a biologist or geneticist knew that non-random mating occurred, we assumed random mating had occurred for all genetic samples where introgression was detected and the level of introgression was computed based on that assumption. Over 1,000 miles of habitat supported WCT that biologists knew were part of a mixed stock population (non-random mating) adding another 3% to the proportion of currently occupied habitats that supported WCT where no evidence of introgression was found (and another 2% to proportion of historical range).

We contend that a minimum of 13% of the currently occupied habitats (8% of historical range) should be considered as supporting genetically unaltered WCT. This contention is supported both by the trends observed between assessments done over time, indicating that as more testing is conducted, more streams are found that support unaltered WCT; and by the information presented in this assessment indicating that in Idaho basins where limited genetic testing had been done most testing found no evidence of introgression (Table 10). If we assume that half of the area that we classified as supporting “Suspected Unaltered” and 20% of the areas classified as “Potentially Altered” WCT are, in fact, supporting currently unaltered WCT, then the total miles of likely unaltered WCT increases to over 12,500 miles (37% of currently occupied habitats and 22% of historical range). In conclusion, we suspect that from 13 to 35% of habitats currently occupied by WCT have not experienced genetic introgression (8 to 20% of historical range). All of the agencies and tribes responsible for managing WCT throughout their range in the U.S. recognize the importance of conserving populations that have no detectable introgression, illustrated by the the inclusion of almost all genetically tested and unaltered WCT populations within designated conservation populations.

Agencies and tribes responsible for fish population management should regulate sport fisheries on WCT populations to ensure that both harvest and incidental hooking mortality do not cause these populations to decline in a deterministic fashion. Angler-caused mortality should be low enough to ensure that each WCT population has adequate resiliency to recover rapidly from stochastic environmental events that could severely reduce that population. We also recommend that fish managers continue their efforts to reduce the potential for genetic introgression resulting from fish stocking practices and management of nonnative species that may potentially introgress with WCT. Land management agencies need to conserve aquatic habitats to a level that ensures that remaining WCT populations persist and, preferably, 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 potential in these areas. Since so much of the remaining habitat occupied by WCT is located within federally managed lands, good stewardship of these lands is critical for maintaining WCT. Of the nearly 70% of currently occupied habitats within federally managed lands, over 21,000 miles, or 90%, are within Forest Service and BLM managed lands within the upper Columbia River basin where special protective measures are in place to protect native fishes (INFISH and PACFISH; U.S. Department of Agriculture and U.S. Department of the Interior 1995a, 1995b).

This assessment will serve as a baseline for measuring future conservation progress. In addition, this information will be used for prioritizing WCT conservation efforts and assist in conservation planning by the states, tribes, and others with fish management responsibility. Updating this database with data from a well-designed field-monitoring program could serve as a barometer to monitor the status of WCT over time.

Acknowledgements

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Appendix A. Fisheries Professionals Who Completed the Assessment and their Experience

Name	Affiliation	Position Title	Highest Degree	Years Experience	Years of Cutthroat Trout Mgt/Conservation Experience
Leo Marnell	National Park Service	Fishery Biologist	PhD	25	25
Jim Dunnigan	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	10	6
Lee Brundin	USDA Forest Service		BS	14	14
Amee Rief	USDA Forest Service		MS	6	6
John Carlson	USDA Forest Service	Forest Fishery Leader	MS	18	6
Guentier Heinz	USDA Forest Service		BS	17	17
Pat Price	USDA Forest Service		BS	10	10
Tom Weaver	Montana Fish, Wildlife and Parks		MS	26	26
Mark Deleray	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	12	12
Clint Muhlfeld	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	8	8
Beth Gardner	USDA Forest Service	Forest Fishery Biologist	BS	14	8
Grant Grisak	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	11	4
Pat Van Eimeren	USDA Forest Service	Forest Fishery Biologist	MS	17	11
Roger Lindahl	USDA Forest Service			11	11
Dean Sirucek	USDA Forest Service		BS	25	5
Lynda Fried	USDA Forest Service		BS	3	3
Steve Phillips	USDA Forest Service	Forest Fishery Leader	BS	24	9
Scott Rumsay	Montana Fish, Wildlife and Parks	Fishery Biologist	BS	26	26
Rick Stemens	USDA Forest Service		MS	6	1
Phil Howell	USDA Forest Service	Fishery Biologist		26	12
Tim Unterwegner	Oregon Fish and Wildlife	Fishery Biologist	BS	25	8
Larry Bright	USDA Forest Service	Forest T&E Biologist	BS	37	2
Rich Gritz	USDA Forest Service	Forest Fishery Leader	BS	25	4
Jackie Haskins	USDA Forest Service	Fishery Biologist	MS	12	3
Dick O'Conner	Washington Fish and Wildlife	Fish Data Mgr	MS	25	
Art Viola	Washington Fish and Wildlife	Fishery Biologist	MS	23	3
Phil Archibald	USDA Forest Service	Fishery Biologist	BS	12	4
Heather Bartlett	Washington Fish and Wildlife	Fishery Biologist	BS	11	3

Name	Affiliation	Position Title	Highest Degree	Years Experience	Years of Cutthroat Trout Mgt/Conservation Experience
Jody Brostrom	US Fish and Wildlife Service	Fishery Biologist	MS	20	10
Scott Russell	USDA Forest Service	Forest Fishery Leader	BS	20	10
Betsy Konerak	USDA Forest Service	Fishery Biologist	BS	10	5
Tim Cochnauer	Idaho Fish and Game	Fishery Biologist	PhD	38	20
Pat Murphy	USDA Forest Service	Forest Fishery Leader	BS	28	18
Katherine Thompson	USDA Forest Service	Fishery Biologist	MS	15	13
Wayne Paradis	USDA Forest Service	Fishery Biologist	BS	23	13
Craig Johnson	Bureau of Land Management	Fishery Biologist	MS	25	15
Paul Janssen	Idaho Fish and Game	Fishery Biologist	MS	22	20
Robert Hand	Idaho Fish and Game	Fishery Biologist	MS	3	1
Nathan Brindza	Idaho Fish and Game	Fishery Biologist	MS	2	1
Ed Schriever	Idaho Fish and Game	Regional Fishery Manager	BS	18	13
Garry Seloske	USDA Forest Service	Fishery Biologist	BS	20	10
Kim Munson	USDA Forest Service	Fishery Biologist		13	10
Dave Mays	USDA Forest Service	Fishery Biologist	MS	15	10
Scott Spaulding	USDA Forest Service	Fishery Biologist	MS	16	2
Chad Fealko	USDA Forest Service	Fishery Biologist	BS	5	3
Archie Harper	USDA Forest Service	Fishery Biologist	BS	16	12
Chris Clancy	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	24	22
Rob Brassfield	USDA Forest Service	Fishery Biologist	MS	15	12
Don Hair	USDA Forest Service	Fishery Biologist	MS	30	20
Jim Brammer	USDA Forest Service	Forest Fishery Leader	MS	13	13
Ladd Knotek	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	7	7
Jennifer Copenhouer	USDA Forest Service	Fishery Biologist	BS	1	1
Laura Burns	USDA Forest Service	Fishery Biologist	BS	11	10
Shane Hendrickson	USDA Forest Service	Fishery Biologist	BS	12	12
Rod Berg	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	29	20
Len Walch	USDA Forest Service	Forest Fishery Leader	MS	25	19
Eric Reiland	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	10	6
Joe Christensen	Bureau of Land Management	Fishery Biologist			

Name	Affiliation	Position Title	Highest Degree	Years Experience	Years of Cutthroat Trout Mgt/Conservation Experience
Brian Riggers	USDA Forest Service	Fishery Biologist	MS	10	10
Wayne Hadley	Montana Fish, Wildlife and Parks	Fishery Biologist	PhD	39	39
Lee Nelson	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	9	4
Ken Staigmiller	Montana Fish, Wildlife and Parks	Fish Health Specialist	BS	7	7
Scott Barndt	USDA Forest Service	Fishery Biologist	MS	8	6
Wally McClure	USDA Forest Service	Forest Fishery Leader	MS	12	12
Pat Clancey	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	20	10
Dan Mahony	National Park Service	Fishery Biologist	MS	22	17
Buddy Drake	Private Company	Fishery Consultant	BS	20	3
Todd Koel	National Park Service	Fishery Program Leader	PhD	5	2
Brad Shepard	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	24	20
Dick Oswald	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	23	23
Scott Opitz	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	7	2
Steven Kujala	USDA Forest Service	Fishery Biologist	BS	5	2
Paul Hutchinson	Bureau of Land Management	Fishery Biologist	BS	5	2
Pat Byorth	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	12	4
Ron Spoon	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	22	10
Robbin Wagner	US Fish and Wildlife Service	Fishery Biologist	BS	17	17
Anne Tews	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	10	8
Michael Enk	USDA Forest Service	Forest Fishery Leader	MS	26	22
Stan VanSickle	USDA Forest Service	Fishery Biologist	BS	8	7
David Moser	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	12	7
Steve Leathe	Montana Fish, Wildlife and Parks	Regional Fishery Manager	MS	24	16
Jim Mogan	US Fish and Wildlife Service	Fishery Biologist	MS	5	5
Bob Esselman	Idaho Fish and Game	Fishery Biologist	BS	18	1
Dan Garcia	USDA Forest Service	Fishery Biologist	BS	16	16
Paddy Murphy	Idaho Fish and Game	Fishery Biologist	MS	7	4
Chip Corsi	Idaho Fish and Game	State Fishery Manager	MS	22	22
Arnie Brimmer	Idaho Fish and Game	Fishery Biologist	MS	11	3
Tom Curet	Idaho Fish and Game	Regional Fishery Manager	MS	18	9

Name	Affiliation	Position Title	Highest Degree	Years Experience	Years of Cutthroat Trout Mgt/Conservation Experience
Jeff Dillon	Idaho Fish and Game	Regional Fishery Manager	MS	14	5
Bruce Smith	USDA Forest Service	Forest Fishery Leader	BS	30	28
Bruce Roberts	USDA Forest Service	Fishery Biologist	MS	15	15
Mark Moulton	USDA Forest Service	Forest Fishery Leader	BS	17	17
Bart Gammett	USDA Forest Service	Fishery Biologist	MS	12	5
Sean Moran	AVISTA Corp.	Fishery Biologist	MS	10	6
Doug Grapenhoff	USDA Forest Service	Fishery Biologist	BS	15	10
Chad Beaconrind	USDA Forest Service	Fishery Biologist	BS	7	7
Matthew Davis	USDA Forest Service	Fishery Biologist	MS	14	5
Laura Katzman	Montana Fish, Wildlife and Parks	Fishery Biologist	MS	9	5
Joe Dupont	Idaho Fish and Game	Fishery Biologist	MS	15	9
Shanda Fallau Dekome	USDA Forest Service	Forest Fishery Leader	MS	15	15
Jody Walters	Idaho Fish and Game	Fishery Biologist	MS	15	1
Mark Liter	Idaho Fish and Game	Fishery Biologist	BS	11	11
Vaughn Paragamian	Idaho Fish and Game	Fishery Biologist	MS	32	8
Jason McLellan	Washington Fish and Wildlife	Fishery Biologist	MS	4	3
Curt Vail	Washington Fish and Wildlife	Fishery Biologist	BS	27	20
Ed Lider	USDA Forest Service	Fishery Biologist	MS	30	25
John Whalen	Washington Fish and Wildlife	Regional Fishery Manager	MS	17	5
Ronald Peters	Coeur D' Alene Tribe	Fishery Program Leader	MS	15	7
Bruce May	USDA Forest Service	Cutthroat Conservation Coord.	MS	33	30
Bob Snyder	Montana Fish, Wildlife and Parks	Native Fish Coordinator	BS	25	10
Ken McDonald	Montana Fish, Wildlife and Parks	Special Projects Coordinator	MS	12	5
Ron Pierce	Montana Fish, Wildlife and Parks	Fishery Biologist	BS	15	14
Wendi Urie	USDA Forest Service	GIS Technician			
Taylor Greenup	USDA Forest Service	GIS Technician			
Steve Carson	Montana Fish, Wildlife and Parks	GIS Technician			
Jenny Corbin	Montana Fish, Wildlife and Parks	GIS Technician			
Bart Butterfield	Idaho Fish and Game	GIS Technician			
Evan Brown	Idaho Fish and Game	GIS Technician			
Tim Williams	Idaho Fish and Game	GIS Technician			

Name	Affiliation	Position Title	Highest Degree	Years Experience	Years of Cutthroat Trout Mgt/Conservation Experience
Connie Kirtlan	USDA Forest Service	Data Entry			
Diane Brower	USDA Forest Service	Data Entry			
Geraldine Ann Howlett	USDA Forest Service	Data Entry			
Helen Phillips	USDA Forest Service	Data Entry			
Lori Wollan	USDA Forest Service	Data Entry			
Mary Gonzales	USDA Forest Service	Data Entry			
Ruth Roberson	USDA Forest Service	Data Entry			
Sam Martin	USDA Forest Service	Data Entry			
Stan Vansickle	USDA Forest Service	Data Entry			
Stephanie Grub	USDA Forest Service	Data Entry			
Susan Lamont	USDA Forest Service	Data Entry			
Timothy Horn	USDA Forest Service	Data Entry			
Ema Braunberge	USDA Forest Service	Data Entry			
Marcia Smiley	USDA Forest Service	Data Entry			

Appendix B. Assessment Protocol and Data Forms

Westslope Cutthroat Trout Range-wide Assessment Update Historical Range, Current Status, and Risk: Protocols - July 2002

An interstate and interagency group of fishery staff, managers, and biologists representing the states of Idaho, Montana, Oregon, Washington, U.S. Fish and Wildlife Service, and Forest Service met May 23rd, 2002 in Coeur d'Alene, Idaho to initiate a range-wide conservation and coordination effort for westslope cutthroat trout (WCT; *Oncorhynchus clarki lewisi*). The discussion at that meeting included consideration of conducting a range-wide assessment for WCT that could include: 1) estimating range that was historically occupied; 2) determining current distributional and genetic status; and 3) assessing risk using a ranking system approach similar to that proposed by Rieman et al. (1993). The group briefly discussed using an approach similar to the assessment of Yellowstone cutthroat trout (*O. c. bouvieri*). It was recognized that such an assessment would be based primarily on expert opinion and that, particularly when historically occupied range was assessed, the assessment would be qualitative. However, where field data were available these data would be used and referenced. The protocol detailed below represents a modified version of the Yellowstone cutthroat assessment protocol specifically tailored to a WCT status update. A court decision, filed March, 2002 remanded the FWS to complete a follow up status review for WCT. Completion of a status update will be helpful in meeting the objectives of the range-wide conservation effort for WCT and the court ordered requirements associated with reconsidering whether WCT warrant listing as a threatened species.

The first issue when conducting any large-scale assessment is determining the map scale that will be used for the assessment. It was decided that 1:100,000 scale hydrography (stream layer) would be used and that any information geo-referenced to this hydrography scale must meet the needs of the states involved and be useful for federal agencies. The USGS 1:100,000-scale hydrography that is routed using LLID identifiers and that can be transferred to NHD format was selected as the base hydrography layer. The hydrography layer will primarily include named streams. Only those streams identified on the stream layer will have information entered into the database. We fully anticipate that some streams that support WCT will not be shown on the stream layer and therefore they will not be included in this assessment. It is anticipated that these streams will be added in the future during subsequent assessments. In the mean time, to compensate for this situation each watershed will have a separate form that will allow for a partial accounting of these streams.

The second issue involves data quality and reliability. This assessment update will use two protocols for determining data quality and availability. First, a rating system will be used to indicate the data quality (DQI; Table 1; tables provide codes and look-up descriptors that will be used in the database). Second, an effort will be made to document source material for all information used in this assessment (Table 2) and a text field will allow entering a citation which details where the information can be found.

Finally, several issues directly associated with the logistics of keeping data entry consistent and dealing with a consistent GIS database emerged. The use of 4th level hydrologic units will be for accounting purposes only. The actual stream layers, either as cutthroat mapping units or used to identify discrete populations, will be attributed through a database with the specific information developed during the status up date.

Table 1. Look-up table for data quality index (DQI) for information entered.

RatingID	Rating	GeneticValue	UseValue = Data source	PopSurveyValue
1	Low - judgment only	1-9 fish sample	Judgment only	Low quality
2	Med - some observations	10-24 fish sample	Extrapolated from surveys	Medium quality
3	High - many observations	25+ fish sample	Extensive samples or monitoring sections	Good quality

Table 2. Look-up table for type of source information used.

SourceCode	Description
1	Judgment
2	Anecdotal Information
3	Letter
4	News Account
5	Data Files
6	Agency Report
7	Published Paper
8	Thesis or Dissertation

This protocol is partitioned into three primary components for conducting this assessment (Refer to assessment flow chart). First, the historical range that was occupied by WCT at the time of the first European exploration of the Northern Rocky Mountains will be estimated. Second, the current distribution, density and genetic status information for WCT will be developed and displayed on a mapping segment basis. Lastly conservation populations, either as isolated and meta-populations (networked or connected populations – e.g. interbreeding populations) will be identified and population viability risk, genetic risk and disease risk assessments will be made for each of these populations. Risk will be assessed at three levels: 1) risk of genetic introgression, 2) risk associated with disease and 3) general population level risk. Risk assessments represent relative determinations indicating a higher or lower level of concern. The mapping and risk assessments will be completed for all populations including those associated with lakes (ad-fluvial) that are maintained by natural reproduction. The actual location of lakes will not be shown on the initial maps but can be added at a later date. Cutthroat populations supported or augmented by stocking will not be included as part of this assessment.

Definitions of terms used for this protocol are provided in italics as they are first used.

Population mapping unit (segment) *– each stream, or occupied segment of stream, will be treated as a separate population (stock) mapping unit or segment and connectivity between these segments will determine whether these segments function in terms of an isolate population or as a "metapopulation (connected)".*

Conservation Populations - those cutthroat populations existing in a genetically unaltered condition (core conservation populations with genetic analysis indicating greater than 99% purity) and/or populations having unique ecological, genetic and behavioral attribute of significance that maybe genetically introgressed (See Cutthroat Trout Management: A Position Paper – Genetic Considerations Associated with Cutthroat Trout Management). Conservation populations may exist as isolates or networks of subpopulations.

Meta-population- *infers that interbreeding between subpopulations (population mapping segments) can occur within a few generations (3-15 years). Also referred to as a connected or networked population.*

Isolated Population *- Some populations occupy isolated habitat fragments (isolates) and these populations exist independently from connected groups of subpopulations.*

Genetic Risk *– risk of initial or on-going genetic introgression (hybridization) with introduced species or subspecies.*

Population Risk *– risk of deterministic or stochastic declines in a population that could lead to a reduced probability of viability for that population. Linked to temporal, population size, production considerations and degree of isolation.*

Significant Disease (Pathogens) – *Those diseases and the associated pathogens that have the potential to cause significant detrimental influences on population health. Including but not limited to the following: whirling disease, furunculosis, infectious pancreatic necrosis virus, etc.*

Competing Species *– Those species that compete with cutthroat trout for food and space. Can be salmonid and non-salmonid. Generally, non-natives that have been introduced within cutthroat trout habitats. Certain competing species (i.e. brown trout) are predatory on cutthroat trout. Introduced rainbow trout can be viewed as both a competitive and hybridizing species.*

Hybridizing Species *– Those species or subspecies of trout that readily hybridize with cutthroat trout, primarily introduced rainbow trout. Can also include introduced subspecies of cutthroat trout that have been introduced to habitats outside of their respective historic range.* ***It should be noted that in specific portions of the WCT range native redband or rainbow trout (anadromous or resident) co-evolved with WCT. At this point there is uncertainty on the degree and significance of "natural" introgression between these species. For the purposes of this assessment, only introgression (hybridization) between WCT and introduced salmonids will be treated as being a potential influence on WCT.***

Genetic and density information will be provided for each mapping segment. Genetic, disease and population risk assessments will be done for each conservation population.

Barriers

Since barriers to upstream fish movement (either long-term geologic, natural short-term, or anthropogenic barriers) will be used to assess whether individual stream segments were likely historically occupied by WCT, or for assessing risk of genetic introgression or disease to existing WCT populations, or whether existing subpopulations are connected with other subpopulations, identification of their location and distinguishing characters is very important. During the effort to describe the historical distribution identify those barriers that represent long-term geologic features that would serve to influence historical distributions. These barrier locations will be located (as points in ARCVIEW) on the population mapping segments. During current population distribution mapping identify other significant barriers (e.g. natural short-term and/or anthropogenic barriers) locations (as points in ARCVIEW), including barrier type (Table 4), blockage extent (Table 5), and barrier significance (Table 6). Identify only those barriers that are believed to have a significant influence cutthroat distribution or population integrity. Barrier identification is the first action taken in parts 1 and 2 of the assessment.

Table 4. Look-up table for types of barriers to fish movement upstream.

	Barrier Type
	Water diversion
	Fish culture facility/research facility
	Temperature
	Bedrock
	Culvert
	Debris
	Insufficient flow
	Manmade Dam
	Pollution
	Beaver dams
	Velocity barrier
	Waterfall
	Unknown

Table 5. Look-up table for extent of blockage caused by barriers.

	Blockage Extent
	Complete
	Partial
	Unknown

Table 6. Look-up table for barrier significance.

	Barrier Significance
	Prevents introgression
	Prevents ingress of competing species
	Temporary, but presently prevents introgression or ingress of competing species
	Confines population to small area of usable habitat
	Limits or precludes opportunity for population re-founding
	Limits expression of life history characteristics
	Unknown

Part 1 -- Historical Distribution

The historically occupied range of WCT will be assessed based on their believed distribution at the time Europeans first entered the Rocky Mountain West (approximately 1800. . This assessment will be done at a relatively coarse level. Fourth-code level Hydrologic Units will be used for accounting purposes. The 1:100,000 hydrography layer will be used to maintain consistency of information. Fishery professionals familiar with each major drainage basin (Fourth-code HUC) will define historical distribution for stream mapping segments within each 4^{th} code HUC by identifying the historical range based on their personal knowledge of the area, known anecdotal information, known habitat restrictions, known geologic barriers, and historical fisheries data and reports. This information will be used to edit WCT historical range maps at the 1:100,000 scale. WCT will be assumed to have occupied all streams within their broad known historical distribution unless information or professional judgment indicates WCT likely did not occupy specific mapping segments of stream based on a documented rationale (Table 3). Data sources used to determine whether stream segments were historically occupied, or not occupied, will be provided (Table 2), along with a reference documenting why each stream segment was included or excluded, when applicable.

Table 3. Look-up table for reasons to exclude or include a stream segment as historical WCT habitat.

	Description
E-1	Habitat limited - gradient, elevation, temperature
E-2	Known geologic barrier – must correspond to a mapped barrier location.
I-1	Anecdotal information
I-2	Historical scientific survey data

Part 2 -- Current Distribution, Genetic Status and Densities

Lower and upper bounds of all stream segments presently occupied by naturally self-sustaining populations of WCT will be located and data quality associated with the locations of these boundaries of current distribution will be rated (DQI; Tables 1 and 2). Genetic information and status will be identified for each WCT mapping unit (Tables 7 and 8) along with their DQI. For Table 7, base the category determination on information from the largest sample and/or the most recent sample. Only naturally occurring, self-sustaining populations (i.e. no routine augmentation with hatchery fish) of WCT will be addresses in this status review. Relative density (based on a qualitative estimation of projected numbers of adults and sub-adults, excludes YOY and yearlings, relative to site potential) for each WCT mapping segment will also be identified (Table 9).

Table 7. Look-up table for genetic status of a population mapping segment.

Genetic Status
Genetically unaltered (>99.0%) as a result of introduced species interaction– tested via electrophoresis or DNA
Introgressed (hybridized) with introduced species – tested and found to be 90% to 99% WCT genetic material in individual fish throughout population
Introgressed (hybridized) with introduced species – tested and found to be 75% to 89% WCT genetic material in individual fish throughout the population
Introgressed (hybridized) with introduced species– tested and found to be less than 75% WCT genetic material in individual fish throughout population
Suspected unaltered with no record of stocking or contaminating species present
Potentially hybridized with records of introduced hybridizing species being stocked or occurring in stream
Hybridized and Pure populations co-exist (sympatric) in stream (use only if reproductive isolation is suspected and/or testing has been completed)

Table 8. Specify the specific information associated with genetic sampling and analysis. More than one entry can be made for a population mapping segment.

SAMPLE_NO	COLL_DATE	COLL_ID	NO_FISH	ANAL_DATE	ANAL_TYPE	% WCT

Genetic Analysis Type
Allozymes
PINES
Microsatellites
DNA

Table 9. Look-up table for relative population density of adults and sub-adults (excludes YOY and yearlings). Density expressed as a **qualitative** characterization based on mapping segment site potential. Projected number of adults and sub-adults, excluding YOY and yearlings for each WCT mapping segment.

Mapping Segment Density
At or above site potential (habitat has been enhanced)
Somewhat below site potential
Substantially below site potential
Unknown

Part 3 -- Change in Focus – Identification of Individual Conservation Populations and Application of Risk Evaluations for each Population

At this point the assessment will change from the focus on population mapping segments to a level of assessment related to conservation populations and the risks that influence the well-being of the identified populations. At this point, a determination will be made relative to which population mapping units will be combined into a conservation population having a conservation objective and which mapping units will be assigned to a recreational fishery objective. **Those segments identified as having a recreational objective, only, will not be carried forward in the genetic and population risk assessments.** Population mapping units having a conservation objective will be further sub-divided based on connectedness or isolation into meta-populations or isolated populations (isolates). Both meta-populations and isolates can serve as conservation populations. Conservation populations can be genetically unaltered or they can reflect a focus on unique traits and characteristics in the presence of hybridization. From this point, only conservation populations will be evaluated for genetic, disease and general population risks. Information on conservation activities, land-use and fishery management will be identified for each conservation population.

Genetic Risk Assessment

A genetic risk assessment will be made for each conservation population (e.g meta- or isolate) using a ranking of 1 to 4 to indicate low to progressively higher levels of possible risk (Table 10). **The level of risk should not be viewed as an absolute but rather as a indicator of possible or potential risk**. Take into consideration those actions and activities (Tables 13 and 14) that may have an influence on genetic risk.

Table 10. Look-up table for genetic risk ranking.

Rank	Risk Characterization
1	Introduced hybridizing species **cannot interact** with existing WCT population. **Barrier provides complete blockage to upstream fish movement**. Native hybridizing species (e.g. resident or anadromous redband) may be present in connected system.
2	Introduced hybridizing species are in same stream and/or drainage **further than 10 km** from WCT population, but not in same stream segment as WCT, **or within 10 km where existing barriers exist, but may be at risk of failure.** Native hybridizing species (e.g. resident or anadromous redband) may be present in connected system.
3	Introduced hybridizing species are in same stream and/or drainage **within 10 km of WCT population and no barriers exist** between introduced species and WCT population. However, introduced hybridizing species have not yet been found in same stream segment as WCT population. Native hybridizing species (e.g. resident or anadromous redband) may be present in connected system.
4	Introduced hybridizing species are **sympatric** with WCT in same stream segment.

Significant Disease Risk Assessment

A disease risk assessment will be made for each meta- (networked) or isolate population using a ranking of 1 to 5 to indicate low to progressively higher levels of risk associated with the possible or potential influence of significant diseases (Table 11). Population isolation and security are important considerations but cannot be viewed as absolutes. The diseases of concern are those that cause severe and significant impacts to population health and include but are not limited to whirling disease, furunculosis, infectious pancreatic necrosis virus, etc. Disease risk assessment should be completed and/or reviewed by fish health professional. Take into consideration those actions and activities (Tables 13 and 14) that may have an influence on genetic risk. **The level of risk should not be viewed as an absolute but rather as a indicator of possible or potential risk**.

Table 11. Look-up table for significant diseases risk ranking.

Rank	Risk Characterization
1	Significant diseases and the pathogens that cause these diseases **have very limited opportunity to interact** with existing WCT population. Significant disease and pathogens are not known to exist stream or watershed associated with WCT 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 same stream and/or drainage **further than 10 km** from WCT population, but not in same stream segment as WCT, **or within 10 km where existing barriers exist, but 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 same stream and/or drainage **within 10 km of WCT population and no barriers exist** between disease and/or pathogens and diseased fish species and the WCT population. However, diseases and/or pathogens have not yet been found in same stream segment as WCT population.
4	Significant disease and/or pathogens and disease carrying species are **sympatric** with WCT in same stream segment but WCT have not tested positive.
5	WCT population is known to be positive for significant disease and/or pathogens are present. WCT population has a history of impacts from significant diseases. Environmental and/or biological conditions may have intensified disease impact.

Conservation Population Risk Assessment

Population risk assessments will be done for each meta- or isolate population using a ranking that includes consideration of four factors. Risks will be ranked from low to high by using a 1 to 4 ranking system based on four variables identified by Rieman et al. (1993) (Table 12). These four main factors will be weighted to derive a final risk factor as follows: Temporal Variability = 0.7; Population Size = 1.2; Population Productivity (Growth/Survival) = 1.6; and Isolation = 0.5. Take into consideration those actions and activities (Tables 13 and 14) that may have an influence on population risk. **The level of risk <u>should not be viewed</u> as an absolute but rather as a indicator of possible or potential risk**.

For each conservation population it is important to identify those conservation actions, past or ongoing, that have been intended to protect, conserve and enhance the specific conservation population (Table 13). Each watershed folder will contain summary forms that will allow for adding quantitative information associated with the conservation actions taken. It is also important to identify those land-uses (Table 14) that are or maybe exerting negative impacts to the conservation population and/or the associated habitat. The information on conservation actions and land-use influences can be important as genetic and population risks are assessed. <u>**For land use activities level of significance is important. Identify only those activities that have either a known (has been documented) or a possible influence on total population integrity (viability). DO NOT IDENTIFY ACTIVITIES THAT ONLY HAVE AN INFLUENCE ON A MINOR NUMBER OF INDIVIDUALS WITH IN A POPULATION.**</u>

Table 12. Ranks of various types of viability risk to conservation populations.

Variable	Description	Rank	Criteria
Temporal Variability – Influence of stochastic catastrophic events on a whole population	Habitat Quantity -- Stream length occupied will be used to index temporal variability. Assumption is that larger habitat patch sizes will be less likely to be in synchrony with regard to stochastic events and, to a degree, with deterministic influences.	1	At least 75 km of connected habitat
		2	25 - 75 km of connected habitat
		3	10 - 25 km of connected habitat
		4	< 10 km of connected habitat
Population Size – Whole population	Defined as the number of mature adults within the population (refer to density determinations and/or specific population survey information).	1	> 2,000
		2	500 – 2,000
		3	50 - 500
		4	< 50
Population Production (Growth/ Survival)- Influence of deterministic demographic factors on whole population	Factors that influence population production include habitat quality, disease, competition, and predation. Important considerations include land-use influence on habitat and angling pressures that could be influencing a population's potential.	1	Population is increasing or fluctuating around an equilibrium that fills a habitat that is near optimal potential. No non-native competitive species present. Use this ranking if there are substantial refugia habitats (e.g. springs, seeps, off-channel areas, etc.) associated with the population.
		2	Population has been reduced, but is fluctuating around an equilibrium value that indicates the population is at a level that is less than its potential (i.e. habitat quality is less than potential or another factor is limiting the population – i.e. competition, disease, angling influences occuring).

Variable	Description	Rank	Criteria
		3	Population has been reduced and is declining (year-class failures may be periodic; e.g. competition, disease or angling reducing survival, habitat quality fair to poor).
			Population has been much reduced and declining over long-term or at a fast rate (year-class failures common, habitat quality poor, competition, disease or angling dramatically reducing survival)
Isolation	How isolated or connected is the conservation population from other conservation populations?	1	Migratory forms must be present and migration corridors must be open (connected)
		2	Migratory forms are present, but connection with migratory populations disrupted at a frequency that allows only occasional genetic exchange.
		3	Questionable whether migratory form exists within connected habitat; however, possible infrequent straying of adults into area occupied by population
		4	Population is isolated from any other population segment, usually due to a barrier, but possibly due to lack of movement.

Table 13. Look-up table for conservation/restoration activities that have been implemented for the conservation population. In cases where cutthroat trout co-exist with a listed species, include those activities designed for the listed species that would have a "spill over" beneficial influence.

Conservation Actions
Water lease/Instream flow enhancement
Channel restoration
Bank stabilization
Riparian restoration
Diversion modification
Barrier removal
Barrier construction
Culvert replacement
Installation of fish screens to prevent loss
Fish ladders to provide access
Spawning habitat enhancement
Woody debris placement
Pool development
Increase irrigation efficiency
Grade control
Instream cover habitat
Re-founding pure population
Riparian fencing
Physical removal of competing/hybridizing species
Chemical removal of competing/hybridizing species
Public outreach efforts at site (Interpretative site)
Population Restoration/Expansion
Angling Regulations
Land-use mitigation direction and requirements (e.g. Forest Plan direction, regulation, permit req., coordination stipulations, etc.)
Population covered by special protective mgt emphasis (e.g. Nat'l Park, wilderness, special mgt area, conservation easement, etc.
Other:
Other:

Table 14. Land-use and fishery management activities having potential to impact a conservation population.

Known Impact	Possible Impact	Activity
Check box	Check box	Timber Harvest
Check box	Check box	Range (Livestock grazing)
Check box	Check box	Mining
Check box	Check box	Recreation (non-angling)
Check box	Check box	Angling
Check box	Check box	Roads
Check box	Check box	De-watering
Check box	Check box	Fish Stocking (e.g. non-native fish)
Check box	Check box	Hydroelectric, water storage and/or flood control
Check box	Check box	Other

The population assessment will address source/sink relationships that may exist between headwater WCT conservation populations and those conservation populations lower in a drainage, especially where barriers to upstream movement might exist. While headwater WCT populations may include those isolated by impassible barriers to upstream fish movement (and thus could not be re-founded or receive external genetic material without human intervention), these headwater populations may be important sources for re-founding and augmenting lower populations. This will be handled by a simple identifier check indicating that a given population operates as a source. Any downstream population would then automatically become a “sink” recipient.

WCT ASSESSMENT FLOW CHART

The assessment will be completed using ten sub-area workshops to convene teams of knowledgeable individuals to complete a standard set of forms and to make specific notations on historical and current distribution maps. Each sub-area is composed of several 4th level HUC's associated with a specific portion of the WCT historical distribution area. The information collected at the workshops will be entered into a GIS referenced database for subsequent analysis and display.

PART 1 – HISTORICAL DISTRIBUTION INFORMATION

This component of the status assessment relates to the historical distribution of WCT referenced to the time of first European exploration and occupation of the Northern Rocky Mountains (circa 1800). **The initial assumption is that the entire hydrography layer would have been occupied unless barriers and/or habitat limitation would have precluded occupation.** An important consideration is the occurrence of barriers that would have influenced historical distribution.

Step 1: Refer to 4 HUD map and designate map as Historical.
Step 2: Identify all barriers that would have influenced historical distributions. These would primarily be geologic features (e.g. falls) but could be otherwise (e.g. thermal barriers). Mark barrier location and number each barrier within a box (i.e.) in numerical sequence.
Step 3: Fill out a barrier form for each barrier.
Step 4: Develop a color legion on the map to signify rationale for excluding stream sections or including stream sections (i.e. E-1, E-2, I-1 or I-2). Use green for E-1. Orange for E-2. Yellow for I-1. Brown for I-2.
Step 5: With the appropriate color marker identify on the map stream segments to be Excluded or included.
Step: 6 Fill out a historical distribution form corresponding to rationale for excluding or including stream sections.
Step: 7 Transfer the forms and maps to data entry person. NOTE: If sufficient team members are available it would be have one team member assist the data entry person.

PART 2 – CURRENT DISTRIBUTION INFORMATION

This component of the status assessment provides information on current distribution of all WCT. In this part of the assessment, the upper and lower bounds of all stream segments presently occupied by naturally self-sustaining WCT will be located on the current distribution map with a colored marker. **Important Note:** **This part of the assessment proceeds specific identification of actual populations. At this point we are only identifying where WCT occur within stream segments of each 4th level HUC.** Highlight all stream segments currently occupied by WCT. A stream can be defined as a single mapping segment or can be subdivided into several mapping segments (e.g. above and below a barrier; above and below a tributary of significance; or, based on presence or absence of non-native fish; etc.). **Mapping segments (units) cannot include multiple streams.**

Step 1: Refer to 4 HUD map and designate map as Current.
Step 2. Identify all barriers that are believed to have a substantial influence on current

WCT distributions. Mark barrier on the map and number each barrier within a box (i.e.) expanding on the numerical sequence initiated for historical distribution barriers.

Step 3: Fill out a barrier form for each barrier.

Step 4: Using a colored marker highlight each stream mapping segment and give that mapping segment a circled number (e.g.) in numerical sequence. The recommended mapping segment identification convention is to start with the mainstem then move to the tributaries starting with the left side of the lower most portion of the mainstem then proceed, up the drainage identifying and numbering the mapping segments associated with the tributaries and sub-tributaries in clockwise fashion until returning to the starting point.

Step 5: Fill out a mapping segment form for each identified segment.

Step 6: Complete the supplemental stream information form, as appropriate, that is contained within the watershed folder. This form allows for identifying streams not shown on the 1:100,000 stream layer.

PART 3 – CONSERVATION POPULATION INFORMATION

At this point, the assessment focus will change from identification of where WCT current exist to identification of how WCT are possibly organized into populations and more specifically into conservation populations. A determination will be made relative to which mapping segments will be combined into a conservation population. Mapping segments not included into a conservation population will automatically be treated as having a recreational fishery objective. **Those segments identified as having a recreational focus, only, will not be carried forward in the subsequent risk determinations.**

Step 1: Using the current distribution map use a colored marker draw a polygon around the specific mapping segments believed to define an individual conservation population.

Step 2: Number each conservation population in numerical sequence and identify within a triangle (i.e.).

Step 3: Complete a conservation population risk assessment form for each identified population.

Step 4: Complete the supplemental conservation activity form, as appropriate, that is contained within the watershed folder.

Step 5: Transfer the current and conservation information forms and maps to data entry person. NOTE: If sufficient team members are available it would be have one team member assist the data entry person.

DATA FORMS

I BARRIERS

Mark Geologic Barriers on Both Maps and Give Unique Number with a square around it.
Mark all other Barriers on Current Map and continue with assignment of unique numbers. Geologic barriers – waterfalls- use HIGH for DQ Rating and Judgment for Source

Huc Number: _______________ Barrier Number: _______________

Barrier Type (Check One Only)

	BarrierTYpe
	Water diversion
	Fish culture facility/research facility
	Temperature
	Bedrock
	Culvert
	Debris
	Insufficient flow
	Manmade Dam
	Pollution
	Beaver dams
os	Velocity barrier
	Waterfall
	Unknown

Blockage Extent (Check One Only)

	BlockageExtent
	Complete
	Partial
	Unknown

Barrier Significance (Check one that apply)

	Barrier Significance
	Prevents introgression
	Prevents ingress of competing species
	Temporary or partial, but presently prevents introgression or ingress of competing species
	Confines population to small area of usable habitat
	Limits or precludes opportunity for population re-founding
	Limits expression of life history characteristics
	Unknown

Data Quality Rating (Check one only)

	DQ Rating
	Low - Judgment only
	Med -Medium
	High -High

Source (Check one)

	Source
	Judgment
	Anecdotal Information
	Letter
	News Account
	Data files
	Agency Report
	Published Paper
	Thesis or Dissertation
	Other

II HISTORICAL DISTRIBUTION

All streams segments identified on the map are assumed to be included by reason of "Judgment Only" to start. Highlight all areas to exclude, label all highlighted streams with an E and the unique number identifier. . Fill out form below. Highlight all areas to include for reasons other than "Judgment Only", label all highlighted streams with an **I** and the unique number. Fill out form below.

HUC Number:_________________
Historic Distribution Mapping Number (please circle number on map):____________

Reason (Circle) Data Quality (Check one) Source (Circle one)

	Reason to Include/Exclude
E-1	Habitat limited - gradient, elevation, temperature
E-2	Known geologic barrier at lower boundary – must Correspond to a mapped barrier location.
I-1	Anecdotal information
I-2	Historical scientific survey data

DQ Rating
Low - Judgment only
Med -Medium
High -High

Source
Judgment
Anecdotal Information
Letter
News Account
Data files
Agency Report
Published Paper
Thesis or Dissertation

HUC Number:_________________
Historic Distribution Mapping Number (please circle number on map):____________

Reason (Circle one) Data Quality (Check one)
Source (Circle one)

	Reason to Include/Exclude
E-1	Habitat limited - gradient, elevation, temperature, Etc.
E-2	Known geologic barrier at lower boundary – must Correspond to a mapped barrier location.
I-1	Anecdotal information
I-2	Historical scientific survey data

DQ Rating
Low - Judgment only
Med -Medium
High -High

Judgment
Anecdotal Information
Letter
News Account
Data files
Agency Report
Published Paper
Thesis or Dissertation
Other

III CURRENT DISTRIBUTION

Highlight all stream segments currently occupied by cutthroat trout. A stream can be defined as a single mapping segment or can be sub-divided (e.g .above and below barrier). Mapping units cannot include multiple streams. Give each population mapping unit (segment) a unique number, circle the number on the map, identify upper and lower bounds for the mapping segment, and fill out form below. Also complete genetic analysis information if samples are available.

HUC Number:___________________
Population Mapping Unit (segment) Number:__________________

Genetic Status (Check one that best applies)
Table 7. Look-up table for genetic status of a population mapping segment.

	Genetic Status
	Genetically unaltered (>99.0%) with introduced species – tested via electrophoresis or DNA
	Introgressed (hybridized) with introduced species – tested and found to be 90% to 99% WCT genetic material in individual fish throughout population
	Introgressed (hybridized) with introduced species – tested and found to be 75% to 89% WCT genetic material in individual fish throughout population
	Introgressed (hybridized) with introduced species – tested and found to be less than 75% WCT genetic material in individual fish throughout population
	Suspected unaltered with no record of stocking or contaminating species present
	Potentially hybridized with records of contaminating species being stocked or occurring in stream
	Hybridized and Pure populations co-exist (sympatric) in stream (use only if reproductive isolation is suspected and/or testing has been completed)

Genetic Analyses

Fill in form below for each sample associated with the above mapping unit:

Mark sample location on map and label with sample number.

SAMPLE_NO	COLLECTOR	COLL_DATE	NO_FISH	ANAL_DATE	ANAL_TYPE	% WCT

GenAnalType
Allozymes
PINES
Microsatellites
DNA

Source (Check <u>one</u>)

	Source
	Judgement
	Anecdotal Information
	Letter
	News Account
	Data files
	Agency Report
	Published Paper
	Thesis or Dissertation
	Other

Density (Check <u>one</u> only)

	Mapping Segment Density
	At or above site potential
	Slightly below site potential
	Significantly below site potential
	Unknown

Data Quality (Circle <u>one</u> only)

	DQ Rating
	Low - Judgment only
	Med -Medium
	High -High

IV WESTSLOPE CUTTHROAT CONSERVATION POPULATION RISK ASSESSMENT

For each mapping unit managed as a conservation population determine whether it is part of a meta-population or an isolet. Draw circles around the meta-population or isolate. Give unique numbers to each and draw a triangle around each number and identify on map. Fill out form below.

HUC Number:____________________

Meta-population/isolet unique number:_______________

Meta-Population or **Isolet** (Circle one)
Resident

Population believed to have co-evolved w/ and/or Anadromous redband or rainbow
Y or N (Circle one)

Downstream Source Y or N (Circle one)

Downstream Sink Y or N (Circle one)

Conservation Population Qualifier (Check one)

	Conservation Population Qualifier
	Core Conservation Population (must be genetically unaltered – greater than 99% pure)
	Known or Probable Unique Life History (fluvial, ad-fluvial, or resident) May include populations that represent the last, best WCT population within a given watershed or drainage basin.
	Known or Probable Ecological Adaptation to extreme environmental condition (e.g. temperature, alkalinity, pH, sediment)
	Known or Probable Predisposition for large size or unique coloration
	Other – Population occupies habitat that is likely to become part of the WCT conservation focus

Life History Attribute(s) (Check all that apply to this population)

	Life History Attributes
	Resident Life History (e.g. Resides in one stream or a network of smaller streams for entire life)
	Fluvial Life History (e.g. Resides primarily in a larger stream or river but migrates to other streams to spawn)
	Ad-fluvial Life History (e.g. Resides primarily in a lake environment but migrates to riverine environments to spawn)

Conservation Population Sympatric with Non-native fish (Check those that apply)

	Presence of Non-Native Fish
	Rainbow trout (or redband rainbow) from hatchery origin or transplanted from source outside of historic range
	Brown trout
	Brook trout
	Lake trout
	Other cutthroat trout subspecies (Specify:)
	Other trout (Specify:)
	Other fish (Specify:)

Genetic Risk Assessment: (Check one taking into consideration those actions and activities that may influence genetic risk)

Rank	Risk Characterization
1	Introduced hybridizing species **cannot interact** with existing WCT population. **Barrier provides complete blockage to upstream fish movement**. Native hybridizing species (e.g. resident or anadromous redband) may be present in connected system.
2	Introduced hybridizing species are in same stream and/or drainage **further than 10 km** from WCT population, but not in same stream segment as WCT, **or within 10 km where existing barriers exist, but may be at risk of failure.** Native hybridizing species (e.g. resident or anadromous redband) may be present in connected system.
3	Introduced hybridizing species are in same stream and/or drainage **within 10 km of WCT population and no barriers exist** between introduced species and WCT population. However, introduced hybridizing species have not yet been found in same stream segment as WCT population. Native hybridizing species (e.g. resident or anadromous redband) may be present in connected system.
4	Introduced hybridizing species are **sympatric** with WCT in same stream segment.

DQ Rating for Genetic Risk (Check one**)**

	DQ Rating
	Low - Judgment only
	Med -Medium
	High -High

Significant Disease Risk Assessment

A disease risk assessment will be made for each meta- (networked) or isolate population using a ranking of 1 to 4 to indicate low to progressively higher levels of risk associated with significant diseases. Population isolation and security are important considerations but cannot be viewed as absolutes. The diseases of concern are those that cause severe and significant impacts to population health and include but are not limited to whirling disease, furunculosis, infectious pancreatic necrosis virus. Take into consideration those actions and activities (Tables 13 and 14) that may have an influence on genetic risk.

Look-up table for significant disease risk ranking. (To be completed and/or reviewed by fish health professional. Check the one that best applies).

Rank	Activity
1	Significant diseases and the pathogens that cause these diseases **have very limited opportunity to interact** with existing WCT population. Significant disease and pathogens are not known to exist stream or watershed associated with WCT population. **Barrier provides complete blockage to upstream fish movement**. Stocking of fish from others sources does not occur.
2	Significant diseases and/or pathogens have been introduced and/or identified in same stream and/or drainage **further than 10 km** from WCT population, but not in same stream segment as WCT, **or within 10 km where existing barriers exist, but 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 same stream and/or drainage **within 10 km of WCT population and no barriers exist** between disease and/or pathogens and diseased fish species and WCT population. However, diseases and/or pathogens have not yet been found in same stream segment as WCT population.
4	Significant disease and/or pathogens and disease carrying species are **sympatric** with WCT in same stream segment but WCT have not tested positive for disease.
5	WCT population is known to be positive for significant disease and/or pathogens are present. WCT population has a history of impacts from significant disease. Environmental and/or biological condition may have intensified disease effects.

DQ Rating for Significant Disease Risk (Check one**)**

	DQ Rating
	Low - Judgment only
	Med -Medium
	High -High

Population Risk Assessment: (Circle ranking for each risk factor and give a data quality rating based on table below)

Risk Factor	Description	Rank	Criteria	Data Quality
Temporal Variability – **Influence of stochastic catastrophic events on a whole population**	Habitat Quantity -- Stream length occupied will be used to index temporal variability. Assumption is that larger habitat patch sizes will be less likely to be in synchrony with regard to stochastic events and, to a degree, deterministic influences also.	1	At least 75 km of connected habitats	
		2	25 - 75 km of connected habitats	
		3	10 - 25 km of connected habitats	
		4	< 10 km of connected habitats	
Population Size – whole population	Defined as the number of mature adults within the population (refer to abundance determinations in the mapping units of the conservation population).	1	> 2,000	
		2	500 – 2,000	
		3	50 - 500	
		4	< 50	
Population Production (Growth/ Survival) **-** **Influence of deterministic demographic factors on whole population/ also include consideration of refugia habitats that can have a significant influence on population production potential.**	Factors that influence population production include habitat quality, disease, competition, and predation. Important considerations include land-use influence on habitat and angling pressures that could be influencing a population's potential.	1	Population is increasing or fluctuating around an equilibrium that fills a habitat that is near optimal potential. <u>No non-native competitive species present.</u> Use this ranking if there are substantial refugia habitats (e.g. springs, seeps, off-channel areas, etc.) associated with population.	
		2	Population has been reduced, but is fluctuating around an equilibrium value that indicates the population is at a level that is less than its potential (i.e. habitat quality is less than potential or another factor is limiting the population – competition and/or disease influences occuring)	

Risk Factor	Description	Rank	Criteria	Data Quality
		3	Population has been reduced and is declining (year-class failures may be periodic, competition and/or disease reducing survival, habitat quality fair to poor)	
			Population has been much reduced and declining over long-term or at a fast rate (year-class failures common, habitat quality very poor, competition and/or disease dramatically reducing survival)	
Isolation	Deals with how isolated or networked a conservation population is?	1	Migratory forms must be present and migration corridors must be open (connected)	
		2	Migratory forms are present, but connection with migratory populations disrupted at a frequency that allows only occasional spawning	
		3	Questionable whether migratory form exists within connected habitat; however, possible infrequent straying of adults into area occupied by population	
		4	Population is isolated from any other population segment, usually due to a barrier, but possibly due to lack of movement and distance.	

Check source of conservation population risk data.

	Source
	Judgement
	Anecdotal Information
	Letter
	News Account
	Data files
	Agency Report
	Published Paper
	Thesis or Dissertation
	Other

DQ Rating (Check one)

	DQ Rating
	Low - Judgment only
	Med -Medium
	High -High

Conservation Activities (Check all that apply to this conservation population.)

	Conservation Activity	X
	Water lease/Instream enhancement	
	Channel restoration	
	Bank stabilization	
	Riparian restoration	
	Diversion modification	
	Barrier removal	
	Barrier construction	
	Culvert replacement	
	Fish screens	
	Fish ladders	
	Spawning habitat enhancement	
	Woody debris	
	Pool development	
	Irrigation efficiency	
	Grade control	
	Instream cover habitat	
	Riparian Fencing	
	Physical removal of competing/hybridizing species	
	Chemical removal of competing/hybridizing species	
	Public outreach (Interpretive site)	
	Population Restoration/Expansion	

	Conservation Activity	X
	Angling Regulations	
	Land-use mitigation direction and requirments	
	Watershed under protective mgt (Nat'l Park, wilderness, special mgt, conservation easement, etc.)	
	Other (specify)	

Land-use and/or fishery management activities with potential to impact conservation population: (Check all that apply for this conservation population). **Documentation is mandatory for a known determination. Should be linked to significant impacts to the total population.**

Land Use Activity	Known Impact X	Possible Impact X
Timber Harvest		
Range (livestock grazing)		
Mining		
Recreation (non-angling)		
Angling		
Roads		
Dewatering		
Fish Stocking (e.g. non-native fish)		
Hydroelectric, water storage, and/or flood control		
Other, specify:		

Appendix C – GIS scale issues

Differences between 1:100,000 scale stream layer and
1:24,000 scale stream layer stream lengths

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December 2002

We conducted a comparison of stream lengths on the 1:100,000 scale LLID layer and the 1:24,000 scale National Elevation Dataset available for portions of the study area. We selected 10 streams each from the Jefferson, South Fork Flathead and Lower North Fork Clearwater watersheds for both scales. Lengths were compared using regression analysis. The 1:100,000 scale streams were found to be only 1% shorter than their equivalent 1:24,000 scale representation. Thus the streams included in the 1:100,000 scale LLID stream layer represent approximately the same number of stream miles as the corresponding streams in the 1:24,000 scale National Elevation Dataset.

Spatial Variability in Streams Represented in the LLID Streams Layer

The LLID stream layer contained some variability in the selection of streams represented across the study area. The streams represented in Idaho and Montana (with a few exceptions in MT) are only the named streams. All unnamed streams were not included in the LLID layer. In Washington, Oregon and those watersheds spanning the boarder with Idaho unnamed streams were included. Thus the density of stream miles in a watershed was much greater in these watersheds. To compare two watersheds we looked at the Priest (on the border between ID and WA) and the Upper Coeur d'Alene (ID). There are approximately 1.86 miles of stream per 1000 acres in the Priest watershed and 1.20 miles of stream per 1000 acres in the Upper Coeur d'Alene watershed. There is approximately 35% more stream miles represented in the Priest watershed and thus 35% more potential habitat to include in historic or current range. Therefore the watersheds with unnamed streams represented had the potential for approximately 35% more historically and currently occupied range. The following tables list the miles of unnamed streams in these watersheds that were included in the historically and currently occupied habitat.

NAME	Miles of Unnamed Stream Included in Historic Range
Pend Oreille Lake	313.07
Priest	233.08
Pend Oreille	483.74
Coeur d'Alene Lake	236.64
Upper Spokane	110.15
Methow	231.93
Lake Chelan	209.50
Upper John Day	282.47

NAME	Miles of Unnamed Stream Included in Current Range
Pend Oreille Lake	334.32
Priest	211.58
Pend Oreille	447.79
Coeur d'Alene Lake	222.85
Upper Spokane	107.13
Hangman	1.77
Methow	20.64
Lake Chelan	6.61
Upper John Day	4.99

Thus the historically occupied range for these watersheds may be as much as 35% more than in watersheds without mapped unnamed streams. In the Pend Oreille Lake, Priest, Pend Oreille, Coeur d'Alene Lake and Upper Spokane watersheds many unnamed streams were considered occupied where as in other watersheds unnamed streams may have been assumed to be habitat limited.

Appendix D. Genetic Considerations for Fish Managers

Factors that influence hybridization and introgression between introduced non-native trout and indigenous westslope cutthroat trout: Genetic considerations and management implications

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Fishery Geneticist, Idaho Department of Fish and Game

Introductions of non-native trout for fisheries management purposes have occurred throughout the range of westslope cutthroat trout for more than 100 years. It has been well documented that these introductions have often led to hybridization and introgression, a potentially serious, on-going genetic hazard throughout much of the species present range (Weigel et al. 2002, Sage et al. 1992, Leary et al. 1995). However, there is also research that has failed to show evidence of hybridization and introgression within populations even though non-native trout have been previously stocked (Williams et al. 1996, Mays 2001).

There are many factors that determine whether non-native trout (e.g. rainbow trout, Yellowstone cutthroat, golden trout) introductions will result in hybridization (i.e., the interbreeding of introduced non-native trout with indigenous westslope cutthroat trout) and introgression (i.e., the incorporation of genes of non-native trout into the gene pool of a westslope cutthroat population).

One or more of the following factors may influence levels of hybridization and introgression:

- The number of non-native trout stocked;
- The number of times stocked, time of year stocked, time since last stocking, age/size at stocking, strain or subspecies stocked, survival of stocked fish, size of the indigenous westslope cutthroat population, and fishing pressure on stocked streams;
- Presence/Absence of isolating mechanisms (both pre-mating and post-mating mechanisms). For instance, the presence or absence of isolating mechanisms may depend on whether rainbow trout are stocked on westslope cutthroat populations that are naturally sympatric with native populations of *O. mykiss*, or whether they are stocked on westslope populations that have not previously lived in sympatry with *O. mykiss*);
- Dispersal patterns and reproductive success of introduced trout and hybrids;
- Ecological conditions can influence many aspects of stocked rainbow trout survival, the presence/absence of isolating mechanisms, fitness of hybrids, gene flow between populations, as well as the geographical distribution of introduced non-native trout, native trout, and hybrids within an area.

There are also numerous complicating factors that determine whether the percentage of non-native alleles within a population, the number of hybrids in a population, or the number of hybridized populations will increase, decrease, or remain unchanged over time. The fate of non-native trout alleles introduced into a westslope cutthroat trout population depend on the extent to which introduced trout and westslope cutthroat trout hybridize, the subsequent reproductive fitness of hybrids and the extent to which the hybridizing populations depart from Hardy-Weinberg expectations of an ideal population.

For example, if 20 rainbow trout (breeding adults) are introduced onto a cutthroat population (80 breeding adults, no other individuals), before any mating, the sample of fish is composed of 20% rainbow trout (RBT) alleles and 80% westslope cutthroat trout (WCT) alleles. If the introduced RBT randomly mate with the WCT and the subsequent hybrids are as fit as the parents, then the percentage of RBT alleles and WCT alleles will not change from generation to generation. What will change, early on, is the number of hybrids in the population. Before any mating the number of hybrid individuals is zero. As random mating progresses, the number of hybrids in the population increases each generation until eventually all of the individuals are hybrids and the RBT alleles are randomly distributed throughout the population (a hybrid swarm). The percentage of RBT alleles does not increase, however (the potential effects of drift are ignored for this example). Sample observations would indicate 20% RBT alleles and 80% WCT alleles, which is the true frequencies for the population. If enough diagnostic genetic markers are available to detect introgression in the individual (requiring ~15 loci, 30 alleles to detect 20% RBT introgression) then a genetic screen will likely demonstrate that all individuals sampled are hybrids to some degree and the level of introgression among the individuals will be consistent with a binomial distribution of RBT alleles across the population. The more diagnostic loci available, the greater power to detect introgression at low levels in the population and individual.

The increase or decrease of RBT introgression (the percentage of RBT alleles within a population) depends on whether new RBT alleles are continually introduced into the population, the relative fitness of hybrid genotypes, genetic drift, and the potential for the increased mating among related individuals (phenotypic advantage). As new RBT alleles enter the population (stocking) and if hybridization and introgression occurs, the percentage of RBT alleles in the population will increase. If hybrid genotypes/RBT alleles are more fit than WCT genotypes/alleles (outbreeding enhancement or heterosis), then the percentage of RBT alleles in the population will increase even after stocking has stopped due to this selective advantage. Alternatively, if hybrid genotypes/RBT alleles are less fit than WCT genotypes/alleles (outbreeding depression or negative heterosis), then the percentage of RBT alleles in the population will decrease after stocking has stopped, depending on the level in which they are expressed and selected against within the population. Genetic drift (change in allele frequency from generation to generation due to statistical chance) may also change the percentage of RBT alleles within a population, especially if the population is small. However, genetic drift is non-directional, providing equal opportunity for RBT or WCT allele frequencies to change significantly. Rainbow trout alleles will also increase in the WCT population if rainbow trout or hybrid phenotypes are preferred partners for mating (both equally or unequally among sexes). The increase in mating success will result in an overall increase in RBT alleles in the population and a departure from random mating evidenced by examining linkage and/or gametic disequilibrium among individuals.

Whether the number of populations that are introgressed in an area increases, depends on a number of factors including the stocking history (how long ago were non-native trout stocked, whether non-native trout are stocked in places now that they were not in the past), whether the stocking of non-natives has resulted self-sustaining populations, the dispersal of stocked trout and hybrids, and the amount of natural gene flow that occurs between WCT populations. If stocking took place in areas that had not been stocked prior to the first study, then subsequent re-sampling and genetic analysis may find an increase in the number of populations that show introgressive hybridization. If RBT are introduced into an area with WCT and there is subsequent introgressive hybridization, gene flow will move RBT alleles into surrounding populations. In some areas, stocking has resulted in self-sustaining RBT populations (Hitt et al. submitted). If these introduced populations increase in size and/or individuals disperse and immigrate, both the percentage of RBT alleles within populations, as well as the number of introgressed populations can increase, if those immigrants are reproductively successful.

It is important that managers continue to screen WCT populations for hybridization and introgression and they also continue to investigate the ecological and genetic factors that influence the consequences of non-native introductions. In some cases the outcome of stocking non-native trout on indigenous WCT populations has been severe enough as to have led to the formation of hybrid swarms (Hitt et al. submitted). However, it is likely that a number of factors, including existing reproductive isolating mechanisms (e.g. those found in naturally sympatric populations) or environmental conditions which select against non-native trout and hybrids, have limited the incidence of hybridization and spread of introgression in a number of drainages, and has thus preserved genetic integrity of the native parental populations. This is not to suggest that the practice of stocking fertile, non-native trout on indigenous WCT populations should continue. The States of Idaho, Montana, Oregon, and Washington have already adopted policies focused either on the cessation of stocking non-native trout in WCT waters, or the use of sterile triploid rainbow trout in hatchery supported fisheries which are adjacent or connected to waters supporting westslope cutthroat trout.

It is also important that managers monitor and document possible changes in the level of introgression within a population or changes in the number of populations in which hybridization and introgression is observed. Populations in which introgression has increased over time should not receive the same conservation status and should be managed differently than populations in which introgression levels have remained stable or are decreasing. Documenting areas in which population-level introgression is increasing or where the number of hybridized populations is increasing is essential because it may highlight areas in which management actions should change (e.g. stopping further introductions of hatchery rainbow trout, Rubidge et al. 2001).

Ideally, research studies that examine temporal changes among vagile animals should attempt to compare samples collected from the exact same location and at the same time of year. Additionally, samples sizes should be similar and the genetic methods used should be similar in their precision and accuracy of detecting hybridization and introgression. Preferably, the exact same diagnostic loci would be used so that frequencies of specific diagnostic alleles could be monitored over time in the population.

Recent research in the Flathead River system in Montana (Hitt et al. submitted), and in the Kootenay River drainage in British Columbia (Rubidge et al. 2001) has reported the rapid spread of RBT introgression into WCT populations previously reported as free from detectable levels of introgressive hybridization. Some researchers, who have addressed the question of how to define a 'pure' WCT population, have argued that management plans that attempt to set some arbitrary limit of admixture (introgressive hybridization) below which a population will be considered 'pure' (e.g. 1%, 10%) are problematic because, as cited above, the amount of admixture in many WCT populations is rapidly increasing. Research reporting the rapid spread of introgression is significant and will have to be considered carefully by the agencies responsible for managing these particular WCT populations. However, as reviewed previously, it is highly unlikely that every WCT population that has experienced some level of hybridization and introgression would experience an increase in the percentage of RBT introgression over time or that introgression would spread rapidly from one population to many populations throughout a drainage. Importantly, the reportedly continuing spread of RBT introgression within the Flathead River system is likely due to the establishment of self-reproducing populations of introduced rainbow trout and the dispersal of hybrids into areas containing pure cutthroat populations (Hitt et al. submitted). In the case of the observed increase in hybridization and introgression within the tributaries of the upper Kootenai River, those authors mention that "the most likely reason for the apparent increase is the continued and expanded introductions of rainbow trout into the Koocanusa Reservoir and adjacent tributaries" (Rubidge et al. 2002).

It is also important to separate out two different issues with regards to setting limits of introgression. One issue would be the scientific rigor and precision associated with estimating the level of introgression in a population using molecular genetic information. It may be reasonable to set a limit of introgression below which a population will be considered 'pure' if it is appropriate to be conservative due to imprecision associated with the genetic markers. Genetic markers used to detect introgressive hybridization are often assumed to be "fixed" between RBT and WCT (meaning that a certain marker is only observed in RBT and never observed in WCT or vice versa). However, markers continually have to be tested to ensure that they are in fact fixed within populations. The recent work by Rubidge et al. (2001) reports that the nuclear DNA marker Ikaros (IK) digested with Hinf-I yields fixed differences between RBT and WCT. Work by IDFG on WCT populations in the Middle Fork of the Salmon River indicates that the IK/*Hinf-I* marker is not fixed within these populations, stressing the importance of using multiple diagnostic genetic markers when assessing introgressive hybridization.

Hitt (2002) (using dominant PINE markers) described procedures for being conservative in describing a population as admixed or not following procedures outline by Forbes and Allendorf (1991). When individuals from a population only show a "RBT" band (based on its electrophoretic mobility through a gel) at one marker/locus, then the population is considered pure and the observed "RBT" band is considered to be a WCT allele with the same electrophoretic mobility as the true diagnostic RBT allele. Hitt (2002) described 6 populations as being unhybridized WCT populations despite that fact that they exhibited "RBT" bands. These "RBT" bands were used as evidence for RBT introgression in other populations when other diagnostic markers also demonstrated RBT introgression.

A second issue regarding setting limits of admixture involves the setting of introgression levels at some level from which populations should be prioritized and conservation and management decisions made (e.g. *Cutthroat Trout Management: A Position Paper, Genetic Considerations Associated with cutthroat trout management* UDWR 2000; http://www.nr.utah.gov/dwr/PDF/cuttpos.PDF). This document was developed by the states of Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming, to help guide managers working with cutthroat trout. Cutthroat trout with a measured introgression level of less than 1% are designated as “core conservation populations”, and are considered pure. The less than 1% limit allows for possible imprecision associated with genetic markers. A second category, “conservation population”, is used for populations with less than 10% introgression (but may extend to a greater amount depending upon circumstances and the values and attributes to be preserved). The less than 10% criterion is not suggesting that populations with introgression levels between 1% and 10% be considered ‘pure’ or managed as a ‘pure’ populations, rather it is an agreed upon decision to manage populations a certain way given that a particular level of introgression is observed (in this case, <10%). Importantly, the primary management goal of the “conservation population” designation is to protect and conserve populations that, while existing in a introgressed condition, still contain a unique or essential portion of ecological, behavioral, physiological, or genetic diversity found within the subspecies.

A concern with setting such threshold criteria based on percentages is that those criteria may not accurately describe the true hybridization status of a sample location. The percentage corresponds to the number of non-native alleles observed among the total alleles examined, and is only useful in situations where the researcher is using dominant markers and can determine there is no evidence the sample consists of more than one population. Certainly in the cases of sympatric populations of native RBT and native WCT, even those in which a certain level of hybridization and introgression has occurred, the documentation of the percentage RBT alleles out of the total examined does not accurately describe the status of the population. The same is true in situations where F1 hybrids are observed, but no backcross hybrids are observed. For instance, if 30 individuals are sampled, and 10 of them have genotypes indicative of F1 hybrids, 10 have genotypes indicative of WCT, and 10 have genotypes indicative of RBT, the results could be interpreted to say the population is introgressed at a level of 50%, when in fact, these results demonstrate no RBT introgression. This particular situation would be important to document and manage since it represents a loss in reproductive effort for both species, but it has very different management and conservation implications than a hybrid swarm consisting of a mixture of 50% WCT alleles and 50% RBT alleles. A more informative way of describing hybridization and introgression within sympatric populations is to first delineate populations and then to describe the observed genotypes and their frequencies within those populations.

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Appendix E – Miles of Habitat Historically (circa 1800) Occupied by Westslope Cutthroat Trout in the U.S.

River	Basin Name	Occupied	Unoccupied	Total
Sasketchewan	Belly	26.3	77.3	103.6
	St. Mary	158.8	97.9	256.7
Missouri	Red Rock	1664.8	64.3	1729.1
	Beaverhead	828.3	182.4	1010.8
	Ruby	896.4	20.7	917.2
	Big Hole	2140.8	56.9	2197.6
	Jefferson	789.4	80.1	869.5
	Boulder	573.6	29.0	602.5
	Madison	1221.7	377.6	1599.2
	Gallatin	1066.6	273.2	1339.8
	Upper Missouri	1858.8	563.1	2421.9
	Upper Missouri-Dearborn	1002.1	610.1	1612.2
	Smith	1444.2	94.1	1538.3
	Sun	372.5	840.5	1213.0
	Belt	313.8	259.5	573.3
	Two Medicine	620.1	299.1	919.2
	Cut Bank	129.3	441.9	571.3
	Marias	171.5	1394.3	1565.7
	Teton	542.4	560.9	1103.2
	Judith	1449.5	443.9	1893.4
	Milk Headwaters	0.0	285.9	285.9
	Upper Milk	0.0	463.0	463.0
	Bullwacker-Dog	0.0	943.9	943.9
	Willow	0.0	556.7	556.7
	Arrow	282.7	478.4	761.1
	Lower Musselshell	0.0	1109.0	1109.0
	Upper and Middle Musselshell	0.0	2564.6	2564.6
	Box Elder	0.0	706.3	706.3
	Flatwillow	97.2	339.8	437.0
Columbia	Upper Kootenai	1212.7	217.5	1430.2
	Fisher	416.4	37.7	454.0
	Yaak	355.7	13.5	369.2
	Lower Kootenai	525.5	5.9	531.4
	Moyie	129.6	8.5	138.1
	Upper Clark Fork	1644.6	25.6	1670.2
	Flint-Rock	975.3	64.1	1039.5

River	Basin Name	Occupied	Unoccupied	Total
	Blackfoot	1545.0	179.4	1724.3
	Middle Clark Fork	1386.1	249.1	1635.1
	Bitterroot	2063.4	282.2	2345.6
	North Fork Flathead	506.8	67.9	574.7
	Middle Fork Flathead	610.1	88.3	698.5
	Flathead Lake	378.7	147.4	526.0
	South Fork Flathead	958.8	320.5	1279.3
	Stillwater	510.6	138.3	649.0
	Swan	537.2	103.2	640.4
	Lower Flathead	1085.5	0.0	1085.5
	Lower Clark Fork	1384.0	59.7	1443.7
	Pend Oreille Lake	844.8	376.3	1221.1
	Priest	851.0	317.6	1168.6
	Pend Oreille	1271.4	2.4	1273.8
	Upper Coeur d'Alene	689.5	0.0	689.5
	South Fork Coeur d'Alene	209.2	0.0	209.2
	Coeur d'Alene Lake	620.4	73.5	693.9
	St. Joe	1357.6	0.0	1357.6
	Upper Spokane	262.3	201.9	464.2
	Hangman	0.0	775.7	775.7
	Methow	683.6	1602.0	2285.6
	Lake Chelan	738.6	307.8	1046.4
	Upper Salmon	1354.5	160.4	1514.9
	Pahsimeroi	318.8	138.4	457.2
	Middle Salmon-Panther	1065.9	138.1	1203.9
	Lemhi	703.1	102.8	805.9
	Upper Middle Fork Salmon	1168.7	0.0	1168.7
	Lower Middle Fork Salmon	913.6	39.5	953.2
	Middle Salmon-Chamberlain	1157.6	150.2	1307.8
	South Fork Salmon	952.8	50.4	1003.2
	Lower Salmon	391.5	509.2	900.7
	Little Salmon	170.1	254.6	424.7
	Upper Selway	665.5	42.4	708.0
	Lower Selway	736.1	13.3	749.3
	Lochsa	835.0	13.7	848.7
	Middle Fork Clearwater	158.1	14.1	172.2
	South Fork Clearwater	889.6	101.1	990.7
	Clearwater	449.1	955.7	1404.8

River	Basin Name	Occupied	Unoccupied	Total
	Upper North Fork Clearwater	1050.6	15.4	1066.0
	Lower North Fork Clearwater	837.7	63.5	901.2
	Upper John Day	1228.7	1393.0	2621.8
	TOTAL	56452.3	24036.3	80488.5

Appendix F – Genetic Status of Westslope Cutthroat Trout in U.S. by River Basin

		Genetically Tested							
River	Basin	Unaltered	≤ 10%	>10% and ≤ 25%	> 25%	Suspected unaltered	Potentially altered	Tested; Mixed stock	Total
Missouri	Belly						22.8		22.8
	St. Mary	2.4	6.2				119.7		128.3
	Red Rock	89.2	62.7	22.1	0.6	16.6	11.0		202.3
	Beaverhead	54.0	20.2	8.9	5.4	15.4	2.7		106.7
	Ruby	28.6	49.6	48.9	31.8	18.5	28.6		206.0
	Big Hole	103.3	28.0	6.0	7.6	25.9	23.6		194.5
	Jefferson	6.4	3.7	4.0		8.2	7.0		29.2
	Boulder	28.9	3.5			1.6			33.9
	Madison	8.4	42.6	51.2	6.4	0.5	31.1		140.2
	Gallatin	4.2	15.0	47.5	24.1		22.6		113.4
	Upper Missouri	45.4	20.0	6.6	15.3	9.8	30.7		127.8
	Upper Missouri-Dearborn	2.7		5.3	8.6		30.3		46.9
	Smith	21.1	17.8	33.5	11.1		47.1		130.5
	Sun	3.3	39.4	4.3			37.7		84.6
	Belt	40.3	24.9	5.2	2.5	4.8	49.5		127.3
	Two Medicine	39.5	38.3	5.7	45.1	6.1	17.1		151.8
	Teton	15.4	26.3			1.4	6.4		49.5
	Arrow	3.5				1.1			4.7
	Judith	19.5	45.9	8.9			56.5		130.8
	Flatwillow	5.6							5.6
Columbia	Upper Kootenai	67.9	21.3	54.7	321.3	65.6	699.8		1230.5
	Fisher	20.2		5.7	156.8	6.0	227.6		416.4
	Yaak	54.4	8.2	25.9	98.4	15.8	155.9		358.6
	Lower Kootenai					91.1	313.8		404.9

		Genetically Tested						Tested;	
River	Basin	Unaltered	≤ 10%	>10% and ≤ 25%	> 25%	Suspected unaltered	Potentially altered	Mixed stock	Total
Columbia	Moyie					18.6	92.1		110.6
	Upper Clark Fork	297.1	24.4	11.4	1.1	120.1	241.7		695.7
	Flint-Rock	96.7	23.8	5.8		410.6	70.9		607.9
	Blackfoot	371.0	137.7		25.0	232.9	681.6		1448.1
	Middle Clark Fork	163.8	82.8	4.4	9.8	401.4	90.7	152.0	905.0
	Bitterroot	377.1	61.8	49.5	37.1	228.8	187.8	160.9	1103.0
	North Fork Flathead	108.4	111.4	30.2	30.1	185.0	4.8	57.6	527.5
	Middle Fork Flathead	89.4	25.5	15.5		340.6	130.4		601.4
	Flathead Lake	9.3	6.8	3.9		8.7	31.4	83.2	143.3
	South Fork Flathead	350.5	87.7		17.0	468.0	48.6		971.8
	Stillwater	27.5	12.0		2.9	97.1	49.7		189.2
	Swan	4.9	14.0	8.5	0.5	60.6	176.8	77.4	342.9
	Lower Flathead	150.1	36.3		5.6				191.9
	Lower Clark Fork	216.9	22.3	8.6	47.0	186.4	846.8		1327.9
	Pend Oreille Lake					2.4	855.7		858.2
	Priest					132.5	658.2		790.7
	Pend Oreille	55.7	37.6	12.9	8.4	169.6	906.1		1190.3
	Upper Coeur D'alene	32.0	20.1			49.8	632.4		734.3
	South Fork Coeur D'alene					29.7	164.8		194.5
	Coeur D'alene Lake	39.3				155.3	348.9		543.5
	St. Joe		34.5	6.2		34.5	1272.2		1347.4
	Upper Spokane					3.8	255.5		259.3
	Hangman						7.0		7.0
	Methow					157.6	364.7	12.5	534.7
	Lake Chelan	2.7	7.6			5.0	267.3	45.7	328.3
	Hells Canyon						26.8		26.8

		Genetically Tested						Tested;	
River	Basin	Unaltered	≤ 10%	>10% and ≤ 25%	> 25%	Suspected unaltered	Potentially altered	Mixed stock	Total
Columbia	Upper Salmon					613.2	730.7		1343.9
	Middle Salmon-Panther					606.9	424.3		1031.2
	Lemhi					292.5	391.5		684.0
	Upper Middle Fork Salmon					1015.6	153.1		1168.6
	Lower Middle Fork Salmon	15.0	14.0			751.5	133.1		913.6
	Middle Salmon-Chamberlain	4.7				712.8	378.3		1095.7
	South Fork Salmon					171.4	644.9		816.3
	Lower Salmon					7.3	325.5	54.1	386.9
	Little Salmon	2.0					150.9		152.9
	Upper Selway	14.7				497.1	185.6		697.3
	Lower Selway					490.5	237.6		728.0
	Lochsa	74.8					642.2	115.6	832.6
	Middle Fork Clearwater					43.6	120.2		163.8
	South Fork Clearwater						882.5	10.3	892.8
	Clearwater					23.7	267.8		291.6
	Upper North Fork Clearwater	143.5					684.6	222.5	1050.6
	Lower North Fork Clearwater	96.2					698.6	41.9	836.8
	Upper John Day	69.6				171.4		10.7	251.7
	North Fork John Day					4.55	38.04	3.05	45.64
	TOTALS	3477.5	1233.7	501.4	919.7	9196.6	17489.0	1044.6	33862.5

Appendix G – Miles and Number of Conservation Populations by HUC

River	Basin	Miles	Number
Saskatchewan	Belly	22.8	2
	St. Mary	128.3	6
Missouri	Red Rock	153.7	38
	Beaverhead	89.2	18
	Ruby	103.0	16
	Big Hole	167.1	45
	Jefferson	22.3	7
	Boulder	32.3	6
	Madison	63.1	13
	Gallatin	20.0	4
	Upper Missouri	80.0	21
	Upper Missouri-Dearborn	2.7	1
	Smith	32.4	12
	Sun	17.6	5
	Belt	70.5	18
	Two Medicine	83.3	12
	Teton	49.5	4
	Arrow	4.7	2
	Judith	82.8	7
	Flatwillow	5.6	1
	Box Elder	1.8	1
Columbia	Upper Kootenai	128.5	19
	Fisher	26.2	4
	Yaak	75.8	9
	Lower Kootenai	3.4	1
	Moyie	10.9	2
	Upper Clark Fork	446.4	37
	Flint-Rock	584.3	6
	Blackfoot	1448.1	17
	Middle Clark Fork	708.1	29
	Bitterroot	1015.2	43
	North Fork Flathead	466.9	3
	Middle Fork Flathead	539.5	5
	Flathead Lake	90.2	3
	South Fork Flathead	865.4	4
	Stillwater	56.0	4
	Swan	99.9	14
	Lower Flathead	174.0	24

	Lower Clark Fork	450.5	22
River	Basin	Miles	Number
Colmbia	Pend Oreille Lake	48.8	2
	Priest	96.4	4
	Pend Oreille	258.4	13
	Upper Coeur d'Alene	714.1	2
	South Fork Coeur d'Alene	16.1	3
	Coeur d'Alene Lake	542.4	2
	St. Joe	1232.5	1
	Upper Spokane	9.7	1
	Methow	124.7	14
	Lake Chelan	65.9	3
	Upper Salmon	1322.8	1
	Pahsimeroi	95.6	3
	Middle Salmon-Panther	866.3	1
	Lemhi	674.3	1
	Upper Middle Fork Salmon	1168.6	1
	Lower Middle Fork Salmon	887.2	2
	Middle Salmon-Chamberlain	1031.6	1
	South Fork Salmon	816.3	1
	Lower Salmon	386.9	7
	Little Salmon	12.3	2
	Upper Selway	697.3	1
	Lower Selway	728.0	1
	Lochsa	826.5	1
	Middle Fork Clearwater	160.2	2
	South Fork Clearwater	892.8	1
	Clearwater	217.3	1
	Upper North Fork Clearwater	1050.6	1
	Lower North Fork Clearwater	836.8	1
	Upper John Day	251.7	16