Appendix A

The Genesis and Evolution of the Status Assessment Protocol for Cutthroat Trout:
A Methods Review

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Introduction

Dr. Robert J. Behnke began drawing attention to the plight of native trout of Western North America beginning with his Masters thesis (1960) that addressed the taxonomy of the cutthroat trout of the Great Basin and culminating with his monograph on native trout of Western North America (Behnke 1992) and his book entitled "Trout and salmon of North America" (Behnke 2002). His work detailed much of what is currently understood regarding the phylogeny, zoogeography, and status of native western trout. Behnke credited the work of earlier naturalists, such as Girard, Jordan, Evermann, Gilbert, Suckley, Cope, Yarrow, and others, who provided detailed notes regarding the biota, including trout, of the western landscape in the mid to late 1800's. These individuals also collected type specimens of trout, including cutthroat trout, from across western North America. In 1988, the American Fisheries Society sponsored a symposium "Status and management of interior stocks of cutthroat trout" (Gresswell 1988). This symposium yielded 19 papers prepared by 30 authors and co-authors. Papers presented at the symposium addressed the status of many subspecies of cutthroat trout from a number of perspectives. In addition, there have been many other attempts to describe the status of site-specific populations or groupings of cutthroat trout within the context of state boundaries (Hanzel 1959; Hadley 1984; Haskins 1993; Scully 1993; Alves 1998) or from smaller geographical units (Nelson 1993; Whelan 1993; Duffield 1990; Shepard et al. 1997).

Passage of the Endangered Species Act (ESA), as amended in 1973, was an event of pivotal importance that led to status reviews for many species of native fish. Under this Act, Congress set in motion a wave of interest in the status of many native fish, including all subspecies of cutthroat trout. Under the auspices of the ESA, petitions for listing could be filed and, if upheld, these petitions triggered the completion of status reviews. Petitions have been filed for nine subspecies of cutthroat trout (e.g., Coastal, Colorado River, Bonneville, Greenback, Lahontan, Paiute, Rio Grande, westslope and Yellowstone cutthroat trout). ESA status reviews have been completed for Bonneville (USFWS 2004), Rio Grande (USFWS 2002), westslope (USFWS 1999), and Yellowstone cutthroat trout (USFWS 2006). Status reviews for Greenback, Lahontan and Paiute cutthroat trout were completed at the time of listing in the 1970's.

Several universal challenges have been associated with the completion of most status reviews and assessments. The first challenge has been dealing with the scope of each status review. Most status reviews have been conducted for a relatively broad spatial scale (e.g. entire range of a cutthroat trout subspecies), where reviewers generally had to rely on a limited amount of site-specific information that was expanded to predict distributions and abundance in other areas with lesser amounts of information. Another challenge was associated with determining a time frame

to define the historical condition. Behnke's (1992) monograph on western native trout included a composite distribution map for all native trout at the end of the 19th century. Behnke (1992) also included more detailed historical range maps for most of the species and subspecies. Each of these maps depicted the historical distributions from a very broad perspective that did not, in most cases, take into consideration vacant habitat that likely existed within the broad boundaries. A third challenge was the variable level of detail and lack of consistency for status information. For most subspecies of cutthroat trout, status information was derived from a number of sources. These sources often utilized different methodologies and approaches to collect, summarize, and display information. Consequently, it was usually difficult to evaluate the comparability and compatibility of the information.

More recently, unified efforts have been undertaken to describe the status of several cutthroat trout subspecies utilizing a procedure originally developed in 1993 that has been refined during the subsequent 13 years. This unified status procedure relies on a team approach for compiling information and assessing status. To ensure that information was consistently and comparably applied, a detailed protocol was developed. In this report we summarize the sequence of events and processes that led to the procedure now being applied to evaluate the range-wide status for several subspecies of cutthroat trout. We wish to acknowledge the many fishery professionals involved in developing these protocols through an adaptive process that involved diverse professionals meeting in teams and reaching consensus on both the protocols and in applying these protocols to evaluate the status of individual subspecies. The current status protocol has been modified and strengthened to not only provide reliable status information, but as a valuable tool that is being used by many private and governmental entities for conserving cutthroat trout.

The Beginning – Generation 1

In 1993, the USDA-Forest Service initiated an effort to develop "Habitat Conservation Assessments" (HCA) for five subspecies of cutthroat trout (i.e., Bonneville, Colorado River, Rio Grande, Westslope, and Yellowstone cutthroat trout; Young 1995; Duff 1996). These assessments targeted cutthroat trout occupying habitat on Forest Service administered land. The effort was intended to compile all existing information on life histories, abundance and distribution, habitat relationships and trends, biotic interactions, reasons for concern, and management considerations. This effort was divided into two tasks. First, the Rocky Mountain Research Station was charged with compiling all published information on these subspecies. Secondly, the Forest Service's Intermountain Region was charged with compiling all unpublished information on these subspecies. Specific individuals were selected to lead each task for each cutthroat trout subspecies. A standard set of instructions, definitions, and information forms was used. Information was compiled by sub-basin at a scale of 3rd to 5th level Hydrologic units (HUC). Each task leader was asked to complete the appropriate information forms for each subspecies using whatever information they had available. Some of these individuals relied primarily on their own information and experience, while others used as many sources of information as possible. There was no consistent effort to compile all available information during this assessment. Information collected outside Forest Service boundaries was usually ignored and different individuals exerted different levels of effort to compile the information.

Despite some limitations, the basic approach used for the HCA's appeared to address some of the shortcomings of earlier status assessments. First, there were a standard set of instructions, definitions and information forms to be used to assess each cutthroat trout subspecies. The instructions, definitions and information forms increased the potential for comparability and continuity. Secondly, the historical perspective was anchored to a specific point of time (i.e., "the last 100 years"). This allowed for reviewers to anchor the historical perspective to a time period for which there existed some documented field observations. There were, however, certain challenges associated with the HCA process that continued to plague development of realistic status appraisals. These challenges included: 1) the difficulty of tracking down all unpublished information; 2) problems associated with extrapolating information collected from one area to other areas where no information was available without the benefit of local information or experience; and, 3) the historical time frame was too short because significant changes in cutthroat status were known to have occurred before 1890. For most cutthroat trout subspecies, the 100-year time frame omitted significant amounts of time when anthropogenic influences that were responsible for reductions in cutthroat trout distribution and abundance had occurred.

The HCA status protocol was further modified to resolve most of the stated challenges when it was applied to the Yellowstone cutthroat trout subspecies. First, the assessment area included the entire historical range of Yellowstone cutthroat trout, including areas outside Forest Service administered lands. The historical range was then subdivided into smaller geographical areas and meetings or workshops were convened so fish professionals with knowledge and information within each area could get together to collaboratively complete the information sheets. All individuals who had either information or knowledge regarding Yellowstone cutthroat trout within each specific geographical area were invited to attend a workshop and present their information and points of view. Secondly, in situations where judgment calls or extrapolations of information were required, these calls were made by a consensus of individuals having first-hand knowledge for a given geographical area. Thirdly, the historical time frame was set to be the year 1800, ensuring that post-European expansion anthropogenic impacts were considered.

Additionally, reference maps of a consistent scale (1:100,000 for Montana and Idaho, and 1:24,000 for Wyoming) were used for identifying both historical and current distributions of Yellowstone cutthroat trout. Thus, stream lengths determined to be historically and currently occupied were estimated using a standardized procedure. Information was compiled on land administrative status, historical and current occupancy, and the condition of available habitat and factors influencing habitat condition. Each geographic team evaluated the relative risks and stability of Yellowstone cutthroat populations in their areas based on the compiled data and their judgment. This information was summarized in a final report (May 1996).

Initial Application of GIS and geodatabase technology -- Generation 2

After completing the Yellowstone HCA in 1996, the process used in the HCA was evaluated by many of the fisheries professionals who participated. The impetus for this evaluation was driven, in part, by a recent petition to list Yellowstone cutthroat trout under ESA and the recognition that a more formal status review was needed. During this time period the state of Montana had initiated a formal coordinated conservation effort for Yellowstone cutthroat trout. In addition, Montana had a statewide fish resource database and a geographic information system (GIS) that state biologists and GIS specialists were using to store fisheries information. As a result of these events, we decided to update the HCA status assessment for Yellowstone cutthroat trout using a modified protocol that took advantage of GIS capabilities within the Forest Service and state of Montana and an existing Montana fish resource database. This modified protocol used an electronic Microsoft Access relational database linked to GIS layers for inputting and displaying fish distribution, abundance, and genetic information.

To validate the potential of a geo-referenced information base for assessing the status of Yellowstone cutthroat trout, a working group of fisheries professionals from within Montana convened during July 1998 and updated the Yellowstone cutthroat status using the revised assessment protocol. This assessment utilized the GIS capabilities of the Gallatin National Forest that linked a Montana Rivers Information System (MRIS) hydrography layer to an Access database. A latitude/longitude identifier (LLID) was used as a key field to link the database to the GIS layer. Historical and current distributions were physically identified and annotated on 5th level HUC maps and then transferred to the GIS hydrography layer. Attribute information associated with the historical and current distributions were entered on data forms and then transferred into an Access database. The focus of this assessment effort was on Yellowstone cutthroat trout that had been genetically tested.

Populations of Yellowstone cutthroat trout were identified for each individual stream they inhabited. Each stream's population was then evaluated to assess its relative risk of extinction based on deterministic, stochastic and genetic risks. Genetic risks were ranked from low to very high based on the presence of fish migration barriers and the proximity of the population to hybridizing fish. Deterministic and stochastic risks were also ranked from low to very high based on four factors (i.e., temporal variability based on potential recruitment and year class strength and watershed and habitat complexity; population size; growth and survival characteristics linked to habitat quality; and isolation) identified in a paper dealing with extinction risks for salmonids (Rieman et al. 1993). Application of the concepts contained in the Rieman et al. (1993) publication were felt to be applicable in determining the relative risk for each Yellowstone cutthroat trout population. The risk evaluation allowed for comparisons within each risk factor, or as a composite score for the four factors. Consultation with Danny Lee, a co-author of the Rieman et al. paper, produced a set of weighting coefficients that were applied to each risk factor to compute the composite score. In addition, an effort was taken to evaluate the influence of land uses on each population using a qualitative process based on the judgment of individuals within the working group.

This GIS-based assessment for Yellowstone cutthroat trout in Montana illustrated that a geo-referenced status procedure improved the effectiveness and efficiency of compiling status

information. The assessment group concluded that GIS capabilities coupled with the use of an electronic database in a workshop setting provided a means for: 1) faster data input; 2) better and quicker display of information for editing; 3) more consistent information across broad geographic areas; and 4) faster and more accurate summaries of the information. The group recommended that this procedure be used for future status updates for Yellowstone cutthroat trout, and possibly other cutthroat trout subspecies as well[7].

Range-wide Application of the GIS and geodatabase Approach (Yellowstone and westslope cutthroat trout) – Generation 3

During the time period between 1997 and 1999, several coordination meetings were held to discuss formation of a range-wide conservation effort for Yellowstone cutthroat trout. These discussions resulted in the completion of a range-wide Yellowstone cutthroat trout conservation memorandum of agreement that was signed by all five states historically occupied by Yellowstone cutthroat trout, the Forest Service and the National Park Service (Montana Fish, Wildlife & Parks 2000). Coordination between the signatories of the agreement was considered to be the focal point of the agreement. It should be noted that similar range-wide interagency agreements were also being prepared for Colorado River cutthroat, Bonneville cutthroat, Rio Grande cutthroat, and westslope cutthroat trout during this time period.

During a Yellowstone cutthroat trout range-wide coordination meeting in August 2000 there was interest by all parties in completing a range-wide status update to complement the status assessment reported in 1996. The interagency coordination group reviewed the geo-referenced status effort for Yellowstone cutthroat trout in Montana completed in 1998 and agreed to apply a similar approach to a range-wide status update. A subgroup was organized to finalize the protocol and logistics for the effort. The final protocol included three parts: 1) re-validation of the historical distribution; 2) an update of current distribution information and identification of conservation populations; and 3) an evaluation of risks to genetic integrity and population persistence for those populations identified as conservation populations. This range-wide status assessment was conducted at three formal workshops where biologists and database specialists entered information into a geo-referenced database.

The protocol development subgroup decided to utilize standardized 4th level HUC paper maps that showed 1:100,000 scale hydrography and paper information forms to facilitate quality control for the effort. At each workshop, biologists identified stream sections occupied historically and currently by Yellowstone cutthroat trout. The biologists also located all known fish migration barriers on these maps and completed data forms specifically designed to track barrier attributes.

Next, biologists identified populations of Yellowstone cutthroat trout, using primarily genetic integrity and life history expression criteria, through a consensus process (Utah Division of Wildlife Resources 2000). After identifying conservation populations, groups of biologists collectively rated genetic and population risks for each conservation population through a consensus process. These risk rankings were entered onto appropriate forms for each

[7] May, B. E. 1996. Yellowstone cutthroat trout: current status and conservation recommendations within the State of Montana. An Executive Summary. 10 pp.

conservation population by the biologists. After all forms were completed for each Yellowstone cutthroat trout population within a HUC, these forms and the map were forwarded on to the database specialists for entry into the geo-referenced database. After data entry, biologists could check updated GIS maps on a computer screen to confirm that historical and current distributions were correctly entered and appropriate conservation populations were correctly identified and displayed.

Important improvements to the assessment protocol included: 1) addition of barriers to the GIS map along with specific information for each barrier; 2) addition of an information quality score and source index that allowed for tracking information reliability; 3) a method for tracking genetic information and the source of that information; 4) a qualitative characterization of fish abundance for each occupied habitat segment; 5) identification of conservation populations based on specific genetic and life history criteria; 6) the ability to link several individual stream populations into single conservation populations based on the ability of cutthroat trout to move and interact as a unit (i.e., movement had to be able to occur uniformly within the group of fish); and 7) adjusting population risk evaluations to reflect changes in conservation views associated with population resilience and viability (Hilderbrand and Kershner 2000; Harig and Fausch. 2001; Soulé 1980). Aspects of the updated protocol that still generated concerns and challenges included: 1) inability to identify conservation/restoration activities for a particular population or stream segment, and 2) inability to identify land-uses and their potential impacts to cutthroat trout at the stream segment scale. Identification of conservation/restoration activities at the stream segment level was difficult because there was confusion regarding whether to identify conservation actions based on a specific location or to a broader area that could potentially be influenced by the conservation action. The protocol allowed for entering land-use impacts as either "known" or "possible" impacts and it was often not clear why a particular impact was entered either way. Similar to conservation actions there was confusion regarding land uses and how to judge influences (e.g. specific stream segment versus a number of segments). A status update report for Yellowstone cutthroat trout information collected in 2001 was completed in 2003 (May et al. 2003).

A range-wide status update for westslope cutthroat trout was needed in 2002. In 1999, a status review for westslope cutthroat was completed by the Fish and Wildlife Service (FWS 1999). The ESA listing finding associated with this status review was subsequently challenged in court. As a result, the FWS was directed by the Court to re-visit the status review and listing decision. Based on the FWS's review and acceptance of the protocol used to complete the status update for Yellowstone cutthroat trout in 2001, the FWS supported completion of a similar effort for westslope in 2002.

For the 2002 westslope cutthroat trout status update, several aspects of the Yellowstone cutthroat trout 2001 status protocol were adjusted to address specific changes needed to more accurately evaluate the status of westslope cutthroat trout. Changes were also made to address the confusion associated with attributing the habitat segments with conservation action and land-use information. Changes to the 2001 protocol included: 1) adjusting the genetic information table to account for co-existence of westslope and native red-band rainbow trout; 2) evaluating abundance information based on habitat potential; and, 3) changing the scale at which information associated with conservation actions and land-use influences conservation

populations to the population level rather than the stream segment level. A status update report for westslope cutthroat trout was completed in 2003 (Shepard et al. 2003) and a publication based on this assessment was completed in 2004 (Shepard et al. 2004).

The status update procedure continued to utilize the consensus approach where biologists generated the status information at workshops and used paper maps and attribute forms to initially record the status information. Database specialists were provided packets of information of each 4th level HUC prepared by the biologist and they completed data entry into the geo-referenced database. Latitude and longitude identifiers (LLID) continued to be used to link the database to the GIS layer

Moving GIS and Geo-database Capabilities to a Higher Level – Generation 4

In 2004, the Colorado River and Bonneville cutthroat trout interagency conservation working groups decided to complete status updates for these subspecies with the protocol that was refined for Yellowstone and westslope cutthroat trout (i.e., addressing the three components associated with historical distribution, current distribution and identification of conservation populations). These two efforts included one significant change from previous protocols. Rather than use a 1:100,000 LLID-based hydrography layer, the National Hydrography Dataset (NHD) was used (see http://nhd.usgs.gov/ for more information on NHD). The 1:24,000 scale NHD was used for most waters within each analysis area. The USDA Forest Service's Natural Resource Information System (NRIS) provided an ArcGIS event creation tool to geo-reference cutthroat population segments. The tool utilized a "point–and-click" user interface to reference these population segments against the NHD networks by creating route events. These status updates used GIS tools and personal geo-databases compatible with ArcGIS format. In addition, these efforts also tracked cutthroat use of lake environments.

Another very important change to the GIS and personal geo-database component of these status updates was incorporating the ability to enter data directly into the database during the update process and providing "real time" updates for both the databases and maps that could be immediately checked and edited by the biologists. The effectiveness and efficiency of the status updates were improved by eliminating the use of paper maps and forms. Quality control was substantially improved by having the data entry specialists as a member of each analysis team. Only streams, primarily perennial, and lakes identified on the NHD data set had information entered into the database.

The protocol was also expanded to include additional attribute information. The additional information included information on: 1) presence of non-native fish species; 2) an evaluation of habitat quality for supporting the species or subspecies of interest; 3) incorporating stocking records at the stream or stream segment level; and 4) describing life history behaviors for each population. The status protocol was also expanded to evaluate the restoration or expansion potentials within the context of the historically occupied habitat. Risks to conservation populations were inverted to compute relative population health and these general health evaluations were derived from information contained in the current distribution database to reduce potential subjectivity. The biologists were no longer asked to make a separate determination related to population health and risk factors.

The most significant benefits that accrued from these GIS and database changes were associated with timesavings and the improvement in the quality of the information. Due to the improvement in efficiency, updates to the geo-databases are now occurring on an annual basis for both the Colorado River and the Bonneville cutthroat trout. Status update reports were completed for the Bonneville cutthroat trout in 2005 (May and Albeke 2005) and for the Colorado River cutthroat trout in 2006 (Hirsch et al. 2006).

Continued Protocol Refinement and Evaluation– Generation 5

In 2006, the cutthroat trout status protocol of 2004 was used to update status information of Yellowstone cutthroat trout. The protocol was also used in 2006 to generate status information for Rio Grande and Greenback cutthroat trout. Application of the protocol was only slightly modified for the 2006 Yellowstone cutthroat status update to accommodate differences in spotting patterns for two distinct groups of Yellowstone cutthroat trout (e.g. fine spotted and large spotted forms). In addition, the origin of the cutthroat was also identified in the 2006 effort to verify if the population was of aboriginal or introduced origin. The personal geo-database was improved to allow for more efficient extraction of information and generation of reports.

A 2006 status update report for Yellowstone cutthroat is being prepared (May and Albeke In preparation). Status updates for Rio Grande and Greenback cutthroat trout using the protocol described in this report are currently in progress. Components of the protocol will also likely to be used in an ESA status review currently being completed for Lahontan cutthroat trout.

Conclusions

Conservation of cutthroat trout is dependent upon having reliable information on the distribution and genetic status of current populations and identifying those populations that warrant conservation efforts. The status assessment protocol we described above has enhanced our ability to compile existing information in a consistent, timely, and efficient manner. Use of GIS technologies and geo-referenced databases have strengthened conservation programs by keeping them focused on conserving mutually agreed-upon conservation populations. An added benefit is that locations of these conservation populations and the relative conservation priorities for these populations can be easily displayed using maps. These databases and the associated GIS information have allowed fish managers to better prioritize and coordinate conservation efforts among many diverse interest groups and agencies. The participation by individuals from many different private, tribal, and governmental entities in these status updates have fostered better collaboration and cooperation among these entities and has resulted in many more collaborative conservation efforts.

The status protocol outlined in this methods review has been applied to westslope, Yellowstone, Colorado River, Bonneville, Rio Grande and Greenback cutthroat trout with the specific intent of providing consistent empirical information upon which judgments related to subspecies status can be made. An evaluation of status based on theoretically based models was not a focus of the protocol. Rather the status update procedure was designed to provide a consistent way of

developing status information a consistent and comparable manner across the entire range of a given cutthroat trout subspecies.

The status update protocol was primarily designed to provide information upon which conservation programs could be planned and evaluated. A secondary benefit of this status protocol has been generating quality, comparable information that can be used in ESA status reviews. A simple comparison of the status review procedures used to generate information for an ESA status review and finding for westslope cutthroat trout (USFWS 1999) to the status update procedures described in this report reflects a significant improvement in efficiency and effectiveness. Use of westslope cutthroat trout status information obtained using the status update procedure (Shepard et al. 2004) was viewed as constituting "best available science" because the information was derived by using a consistent approach that was applied in a comparable manner across the entire westslope cutthroat range.[8] A status review for Yellowstone cutthroat trout (USFWS 2006) also relied substantially upon status information derived from application of the status update procedure (May et al. 2003).

It is anticipated that future refinements to the status protocol will be made as conservation efforts for cutthroat trout continue and as conservation theory evolves through time. As discussed, the current protocol represents an adaptive approach based on a foundation structured around consistency and comparability. Future refinements must be sensitive to the need for maintaining a base level of comparability.

[8] Lynn Kaeding, Personal communication. 2007.

References

Alves, J. 1998. Status of Rio Grande cutthroat trout in Colorado. Colorado Division of Wildlife Report. 10 pp.

Behnke, R. J. 1960. Taxonomy of the cutthroat trout of the Great Basin with notes on the rainbow series. Master's Thesis. University of California, Berkeley.

Behnke, R. J. 1992. Native trout of Western North America. American Fisheries Society, Monograph 6, Bethesda, Maryland.

Behnke, R. J. 2002. Trout and salmon of North America. The Free Press. 359 pp.

Duff, D. A. 1996. Conservation assessment for inland cutthroat trout: distribution, status, and habitat management implications. U.S.D.A. Forest Service, Intermountain Region, Ogden, Utah.

Duffield, D. 1990. Management plan and status report: Native cutthroat trout of the Dixie National Forest. Dixie National Forest. Cedar City, UT 19pp.

Gresswell, R. E. 1988. Status and management of interior stocks of cutthroat trout. Yellowstone cutthroat trout. American Fisheries Society Symposium 4.

Hadley, K. 1984. Status report on the Yellowstone cutthroat trout (*Salmo clarki bouvieri*) in Montana. Montana Fish, Wildlife & Parks Report. 74 pp.

Hanzel, D. A. 1959. The distribution of cutthroat trout (*Salmo clarki*) in Montana. Proceedings Montana Academy of Science. 19:32-71.

Harig, A. L., and K. D. Fausch. 2001. Minimum habitat requirements for establishing translocated cutthroat trout populations. Ecological Applications 12:535-551.

Haskins, R. L. 1993. Current status of Bonneville cutthroat trout in Nevada. Nevada Department of Wildlife. Reno. NV.

Hilderbrand, R. H., and J. L. Kershner. 2000. Conserving inland cutthroat trout in small streams: how much stream is enough? North American Journal of Fisheries Management 20:513-520.

Hirsch, C. L., S. E. Albeke, and T. P. Nesler. 2006. Range-wide status of Colorado River cutthroat trout (*Oncorhynchus clarkii pleuriticus*): 2005. Colorado River cutthroat trout Conservation Team Report. Colorado Division of Wildlife, Fort Collins, Colorado.

May, B. E. 1996. Yellowstone cutthroat trout (*Oncorhynchus clarki utah*). In: Conservation Assessment for Inland Cutthroat Trout. D. D. Duff Technical Editor. USDA Forest Service, Intermountain Region Report. pp. 11-34.

May, B. E., W. Urie, and B. Shepard. 2003. Range-Wide Status of Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*): 2001. USDA Forest Service, Gallatin National Forest, Bozeman, Montana. 201 p. Available at: http://www.wildlife.utah.gov/pdf/cuttpos.pdf.

May, B. E., and S. E. Albeke. 2005. Range-wide status of Bonneville cutthroat trout (*Oncorhynchus clarki utah*): 2004. Utah Department of Wildlife Resources, Salt Lake City, UT Printed Agency Report. 139 p. Available at: http://www.wildlife.utah.gov/pdf/cuttpos.pdf. Accessed 17 April 2006.

Montana Fish, Wildlife & Parks. 2000. Cooperative conservation agreement for Yellowstone cutthroat trout within Montana. MFWP. Helena, Montana. 57 pp.

Nelson, K. 1993. Status of the Yellowstone cutthroat trout in the Bridger-Teton National Forest, Wyoming. USDA-Forest Service. Administrative Report.

Rieman, B., D. Lee, J. McIntyre, K. Overton, and R. Thurow. 1993. Consideration of extinction risks for salmonids. FHR Currents, Fish Habitat Relationships, Technical Bulletin 14 December. USDA Forest Service, Boise, Idaho.

Scully, R. J. 1993. Bonneville cutthroat trout in Idaho: 1993 status. Idaho Department of Fish and Game. Administrative Report. Boise.

Shepard, B. B., B. Sanborn, L. Ulmer and D. C. Lee. 1997. Status and risk of extinction for westslope cutthroat trout in the Upper Missouri River Basin, Montana. North American Journal of Fisheries Management 17:1158-1172.

Shepard, B. B., B. E. May, and W. Urie. 2003. Status of westslope cutthroat trout (*Oncorhynchus clarki lewisi*) in the United States. Printed Agency Report. 94 pp.

Shepard, B. B., B. E. May, and W. Urie. 2003. Status of westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) in the United States. Montana Fish, Wildlife & Parks. Printed Agency Report. 94 pp.

Soulé, M. E. 1980. Thresholds for survival: maintaining fitness and evolutionary potential. Pages 151-169 in M. E. Soulé, and B. A. Wilcox, editors. Conservation biology: an evolutionary-ecological perspective. Sinauer, Sunderland, MA.

USFWS. 1999. Status review for westslope cutthroat trout in the United States. USDI-Fish and Wildlife Service. Regions 1 and 6. 188 pp.

USFWS. 2001. Status review for Bonneville cutthroat trout (*Oncorhynchus clarki utah*) USDI-U.S. Fish and Wildlife Service. 153 pp.

USFWS. 2000. Status review for Rio Grande cutthroat trout in the United States. US Fish and Wildlife Service.

USFWS. 2006. Endangered and threatened wildlife and plants: 12-month finding for a petition to list the Yellowstone cutthroat trout as threatened. Federal Register vol. 71: 8818-8831.

Utah Division of Wildlife Resources. 2000. Cutthroat trout management: a position paper, genetic considerations associated with cutthroat trout management. Publication Number 00-26. Utah Division of Wildlife Resources, Salt Lake City, Utah.

Whelan, J. 1993. Bonneville cutthroat trout status and management information. USDA-Forest Service. Ely Ranger District. Ely, NV. 6pp.

Young, M. K. 1995. Conservation assessment for inland cutthroat trout. General Technical Report RM-256, U.S.D.A. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.