YELLOWSTONE CUTTHROAT TROUT CONSERVATION STRATEGY FOR THE SHIELDS RIVER WATERSHED ABOVE CHADBOURNE DIVERSION

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Table of Contents

List of Figures

List of Tables

List of Abbreviations

BLM	Bureau of Land Management
BMP	Best management practice
DEQ	Department of Environmental Quality
DNRC	Department of Natural Resources and Conservation
EPA	Environmental Protection Agency
FWP	Montana Fish, Wildlife & Parks
GIS	Geographical information system
GNF	Gallatin National Forest
GPS	Global positioning system
GWIC	Groundwater Information Center
HUC	Hydrologic unit code
LIP	Landowner Incentive Program
MCA	Montana Code Annotated
MEPA	Montana Environmental Policy Act
MFISH	Montana Fisheries Information System
MNHP	Montana Natural Heritage Program
Agreement	Memorandum of understanding and conservation agreement
NEPA	National Environmental Policy Act
NHD	National Hydrological Data
Park CD	Park Conservation District
RBT	Rainbow trout
SNTEMP	Stream network temperature model
SSTEMP	Stream segment temperature model
SVWG	Shields Valley Watershed Group
TMDL	Total maximum daily load
UILT	Upper incipient lethal temperature
Forest Service	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service
USWA	Upper Shields Watershed Association
WRCC	Western Regional Climate Center
YCT	Yellowstone cutthroat trout
YCTCC	Yellowstone Cutthroat Trout Coordinating Committee
YNP	Yellowstone National Park

Executive Summary

The Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*), a Montana native fish, has declined markedly in abundance and distribution throughout its historic range. Factors contributing to this decline include hybridization with the closely related rainbow trout (*O. mykiss*), competition with nonnative brown (*Salmo trutta*) and brook trout (*Salvelinus fontanalis*), dewatering, and habitat degradation and fragmentation. In Montana, concerns for the persistence of Yellowstone cutthroat trout resulted in development of a cooperative agreement (the Agreement) aiming to conserve, protect, and enhance Yellowstone and westslope cutthroat trout (*O. c. lewisii*) within their historic range in the state. Signatories include a diverse group of state and federal agencies, tribes, and various stakeholder groups. The Agreement called for development of conservation strategies outlining an approach to achieve conservation objectives (FWP 2000 and FWP 2007a).

This document presents the conservation strategy required under the Agreement intended to conserve Yellowstone cutthroat trout in the Shields River watershed above the Chadbourne diversion, an irrigation diversion located in the lower reach of the Shields River (Figure 1-1). The rationale for addressing only this portion of the subbasin within this document is that the diversion presents a partial fish barrier that limits invasion of rainbow trout from Yellowstone River. This barrier to upstream invasion has contributed substantially to preservation of the widespread distribution of nonhybridized or slightly hybridized Yellowstone cutthroat trout remaining in the Shields River drainage, and provides a logical boundary for watershed level conservation efforts. A separate conservation strategy will address Yellowstone cutthroat trout in the Montana portions of its historic range, including the remaining streams in the Shields River watershed.

Although this conservation strategy is the product of collaboration among state and federal agencies, it acknowledges the need for involvement of private landowners in the drainage, and development of strategies that are compatible with the economic and social setting of this agricultural basin. The Park Conservation District (Park CD) and Shields Valley Watershed Group (SVWG), along with numerous private landowners, have already established an impressive list of conservation projects to benefit Yellowstone cutthroat trout. The conservation strategy will build on the existing relationships among agencies, Park CD, the SVWG, and private landowners.

The relatively intact distribution of Yellowstone cutthroat trout in the Shields River watershed gives the drainage high conservation value, and no other watershed in Montana has retained this spatial extent of Yellowstone cutthroat trout occupancy. Nonetheless, the remaining Yellowstone cutthroat trout face several threats. Nonnative fishes present the biggest near-term challenge to Yellowstone cutthroat trout persistence in numerous streams. Notably, brook trout continue to

invade streams in the upper watershed, resulting in rapid displacement of Yellowstone cutthroat trout in some areas. In addition, competition with, and predation by, brown trout possibly limit Yellowstone cutthroat trout abundance. Rainbow trout occur in several streams in the watershed, and present genetic threats to the pure Yellowstone cutthroat trout. Dewatering and habitat degradation limit the suitability of some streams to support Yellowstone cutthroat trout. Passage barriers in the form of road crossings or irrigation structures limit connectivity within the basin.

The proportion of streams in the basin occupied by nonnative trout is substantial. Over half of surveyed streams support at least one nonnative species. Fourteen out of 61 surveyed streams have 2 nonnative fishes, and 3 streams have all 3 introduced trout. Addressing the threats posed by these nonnative fishes will be a considerable component of Yellowstone cutthroat trout conservation in the Shields River watershed.

The conservation strategy includes general categories of actions to address the host of issues relating to Yellowstone cutthroat trout conservation in the Shields River Subbasin. These general categories are as follows:

- Reducing threats posed by nonnative fishes by limiting their expansion, removing them from some waters, and prohibiting their introduction into private ponds;
- Promoting in-stream flows through voluntary, cooperative agreements with water rights holders that emphasize sound data collection, potential compensation for contributed flows, and incorporation of agricultural producers' water rights and agricultural needs;
- Identifying barriers to fish movement throughout the basin, and modifying, removing, or maintaining these as warranted;
- Chemical or mechanical removal of nonnative fishes, coinciding with barrier construction as necessary;
- Restoring stream habitat and riparian health and function using agricultural best management practices (BMPs), riparian plantings, and stream restoration practices as warranted;
- Improving water quality with respect to nutrients and warm water temperatures by encouraging development and implementation of science-based water quality restoration plans to address these pollutants;
- Reducing sediment loading to streams by assisting the SVWG in implementing their watershed restoration plan (WRP; Confluence 2012);
- Identifying ditches entraining Yellowstone cutthroat trout, and developing solutions to reduce or prevent entrainment.

In addition to the general categories of conservation strategies, this document provides available characterizations of stream habitat and riparian health and function, which permits development of conceptual conservation approaches for many individual streams. These narratives include brief descriptions of potential actions integrated with available information on distribution and status of Yellowstone cutthroat trout. Detailed restoration planning for these streams will follow specific site characterizations, which will also incorporate the landowner's objectives for agricultural productivity, residential use, or associated interests. All actions entailing public funds or agency personnel will be the subject of environmental review, as required under the Montana Environmental Policy Act (MEPA), the National Environmental Policy Act (NEPA), or both. A strong monitoring component will accompany restoration projects to promote the adaptive management of the basin's Yellowstone cutthroat trout.

Numerous data gaps exist that limit the ability to develop a comprehensive restoration strategy for the Yellowstone cutthroat trout in the Shields River watershed. This conservation strategy also includes provisions for studies and monitoring to fill information gaps. In general, this strategy emphasizes the value of sound science and stakeholder participation in promoting the conservation of this important natural resource.

A note on hydrologic nomenclature may be useful in reading this document. The Natural Resources Conservation Service (NRCS) classification system designates hydrologic units hierarchically, according to a numeric coding system, which assigns a hydrologic unit code (HUC) and an associated term[4]. For example, the area draining into the Shields River to its confluence with the Yellowstone River comprises a 4th code HUC, and under this system its narrative descriptor is "subbasin"; therefore, the Shields River 4th code HUC is technically referred to as the Shields River Subbasin. The next smaller hydrologic division is a 5th code HUC, which this system denotes as a watershed. Potter Creek and its tributaries are a designated 5th code HUC, and the technical name for this hydrological unit is the Potter Creek Watershed. In common use, the terms watershed, basin, and drainage are used interchangeably and typically without regard to stream order or size of the watershed. Moreover, this terminology is not consistent with terms used by area residents or members of the SVWG. This document uses the NRCS nomenclature when specifically referring to designated HUCs. Otherwise, terms like watershed and drainage will be used generically. Notably, the portion of the Shields River Subbasin treated under this plan will be referred to as the Shields River watershed.

[4] http://www.nrcs.usda.gov/programs/rwa/Watershed_HU_HUC_WatershedApproach_defined_6-18-07.pdf

1.0 Introduction

Yellowstone cutthroat trout were once widely distributed in portions of the Yellowstone River drainage of south central Montana. A variety of factors have contributed to a significant decline in the distribution and abundance of Yellowstone cutthroat trout across their range, including introduction of nonnative salmonids, hybridization with rainbow trout, construction of migration barriers, dewatering, and habitat and water quality degradation. The Shields River Subbasin is rare among watersheds supporting Yellowstone cutthroat trout in Montana, as this fish occurs nearly throughout the basin, rather than being relegated to headwater reaches. Because of its importance to Yellowstone cutthroat trout, the Shields River Subbasin is a core area for conservation and restoration of the subspecies. This conservation strategy will guide the efforts of Montana Fish, Wildlife, & Parks (FWP) and its partners to protect and restore Yellowstone cutthroat trout in the Shields River watershed, upstream of the Chadbourne diversion.

FWP developed this strategy in accordance with the *Cooperative Conservation Agreement for Yellowstone Cutthroat Trout in Montana* (YCTCC 2000). The cooperative conservation agreement was originally developed with input from the Crow Tribe, FWP, DEQ, Montana Department of Natural Resources and Conservation (DNRC), U.S. Forest Service (Forest Service), U.S. Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (USFWS), and Yellowstone National Park (YNP). This group of cooperating entities came together in 1998 to facilitate effective conservation of Yellowstone cutthroat trout by protecting, enhancing, and restoring the species within its historic range in Montana (YCTCC 2000)**.** Although the conservation agreement expired in September 2005, an updated agreement entitled *Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat Trout and Yellowstone Cutthroat Trout in Montana* (FWP 2007a) has been developed to foster continued progress toward the conservation of cutthroat trout in Montana. This Agreement includes a commitment to develop conservation strategies for each subspecies of cutthroat trout, and to develop conservation plans for discrete regions of the range of cutthroat trout across Montana. This document is an extension of the Agreement and the conservation plan to guide Yellowstone cutthroat trout management in the Shields River watershed upstream of the Chadbourne diversion.

Although governmental agencies developed the Agreement and conservation plan, the plan acknowledges that local communities are essential partners in native species conservation. The Park CD will be a collaborator, as this strategy is consistent with their mission to serve as leaders, facilitators, and educators in the conservation of natural resources. In addition, the SVWG will be a valuable partner in Yellowstone cutthroat trout conservation. This group has completed numerous projects benefitting native fish, and has begun a basin-wide restoration planning effort to guide future efforts.

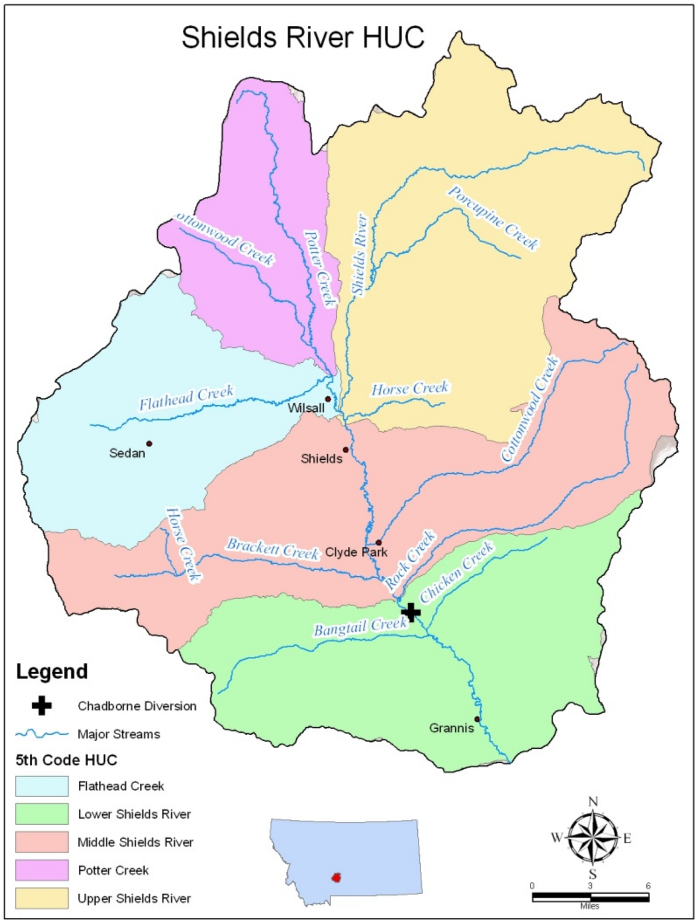

Figure 1-1: The Shields River Subbasin (4th Code HUC 10070003), major tributaries, and watersheds (5th code HUCs).

The spatial focus of this Yellowstone cutthroat trout restoration strategy is the Shields River watershed upstream of the Chadbourne diversion (Figure 1-1). The Chadbourne diversion was built in 1908, and was likely an impediment to fish passage historically, although rainbow trout probably can pass over the structure when flows are within a specific range (OASIS 2006). The Chadbourne diversion makes a logical management divider, because it has functionally isolated the Yellowstone cutthroat trout population from potential genetic introgression with rainbow trout. Yellowstone cutthroat trout above the Chadbourne diversion in the Shields River are only slightly hybridized, and many populations within tributaries show no evidence of introgression (Shepard 2004).

Conservation of native fishes in Montana's waters is a priority of the State of Montana and signatory federal agencies, including the U.S. Forest Service, which has a considerable amount of administered land in the subbasin. To that end, the conservation goal for Yellowstone cutthroat trout in the Shields River watershed is as follows:

> To ensure the long-term, self-sustaining persistence of Yellowstone cutthroat trout by maintaining the genetic diversity and life history strategies represented by the remaining local populations, and protecting their ecological, recreational, and economic values. To the extent practical and feasible, the drainage above Chadbourne diversion will be managed as one metapopulation.

To meet the goal of long-term conservation of Yellowstone cutthroat trout in the Shields River watershed, these objectives, adopted from the Agreement (FWP 2007a), will guide conservation efforts:

Objective 1.	Maintain, secure, and/or enhance all cutthroat trout populations designated as core or conservation populations.
Objective 2.	Continue to survey waters to locate additional cutthroat trout populations and determine their distribution, abundance, and genetic status.
Objective 3.	Seek collaborative opportunities to restore and/or expand Yellowstone cutthroat trout into selected suitable habitats within its historical ranges.
Objective 4.	Continue to monitor cutthroat trout distributions, genetic status, and abundance using a robust, range-wide, statistically sound monitoring design.
Objective 5.	Provide public outreach, technical information, inter-agency coordination, administrative assistance, and financial resources to meet the listed objectives and encourage conservation of Yellowstone cutthroat trout.

Metapopulation theory provides a framework for watershed scale management of salmonids, which will guide conservation activities in the Shields River watershed. A metapopulation consists of a group of spatially separated populations of the same species that interact on some level (Levins 1969). Each of these subpopulations faces an extinction risk relating to disturbance events or disease. Maintaining connectivity among subpopulations allows recolonization following disturbance, and allows for gene flow; thereby reducing threats of inbreeding in isolated populations. Managing the Shields River watershed above Chadbourne diversion as a metapopulation will involve promoting connectivity throughout the basin to promote dispersal of Yellowstone cutthroat trout, and other native fishes, which will increase the potential for recolonization and promote genetic diversity. This approach will increase the probability of persistence of Yellowstone cutthroat trout in the watershed as a whole. Moreover, the emphasis on promoting genetic diversity is consistent with conservation objectives established in the Agreement.

Although maintaining connectivity is a key component of the strategy in the Shields River watershed, effective conservation must also acknowledge the role of nonnative species in displacement of Yellowstone cutthroat trout. Brown trout and brook trout have wide distribution in the watershed, and these species displace Yellowstone cutthroat trout through competition, predation, or both. Rainbow trout have a more restricted distribution; however, invasion of this fish into new portions of the watershed puts the genetic integrity of the basin's Yellowstone cutthroat trout at risk. Specific actions to conserve Yellowstone cutthroat trout in the Shields River watershed will require balancing the threats associated with isolation with those posed by sympatry with nonnatives. In some cases, construction of a barrier to prevent upstream movement of nonnative trout may be the best alternative, even it if results in a loss of connectivity among Yellowstone cutthroat trout metapopulations.

2.0 Status of Yellowstone Cutthroat Trout

2.1 Range-Wide Population Assessment

Information on distribution and status of Yellowstone cutthroat trout across its historic range comes from a 2006 status review (May et al. 2007). This document is the second iteration in evaluating the range-wide status of Yellowstone cutthroat trout, and updates and refines the previous status review (May et al. 2003). Both reviews employed a replicable, quantitative approach within a project geographical information system (GIS). The 2006 effort expanded the protocol to include additional attribute information in four categories: 1) presence of nonnative fishes; 2) evaluation of habitat quality; 3) incorporation of stocking records at the stream or segment level; and 4) describing life history behaviors for each population (May and Shepard 2007).

During the assessments, biologists classified each cutthroat trout population as follows:

1) *core conservation populations*, which are genetically unaltered (< 1% genetic contribution from other species);
2) *conservation populations* that may be either genetically unaltered or slightly introgressed, but have attributes worthy of conservation (<10% genetic contribution from other species); and
3) *sport fish populations* that are managed primarily for their recreational fishery value (May et al. 2003).

Core conservation populations have important genetic value and could serve as donor sources for developing either captive brood or for refounding additional populations. Management will emphasize conservation, including potential expansion, of both core and conservation populations.

The Yellowstone cutthroat trout is native to waters in the upper portions of the Yellowstone River drainage in Montana and Wyoming, and the upper Snake River watershed in Idaho, Wyoming, Nevada, and Utah; however, distribution and abundance has changed substantially from the historic condition (Figure 2-1; May et al. 2007). The 2006 status review estimated Yellowstone cutthroat trout historically occupied over 17,700 stream miles range-wide, with about 43% of stream miles still occupied by core, conservation, and sport fishing populations (May et al. 2007). Genetically unaltered Yellowstone cutthroat trout were estimated to occupy a sizeable proportion of the current range, with 41% of miles still supporting fish tested as unaltered, and another 25% of stream miles with fish suspected to be unaltered (Table 2-1). Formal genetic testing of the populations within the suspected to be unaltered category is a significant research need that will allow generation of specific conclusions on the status Yellowstone cutthroat trout occupying these 1,854 stream miles.

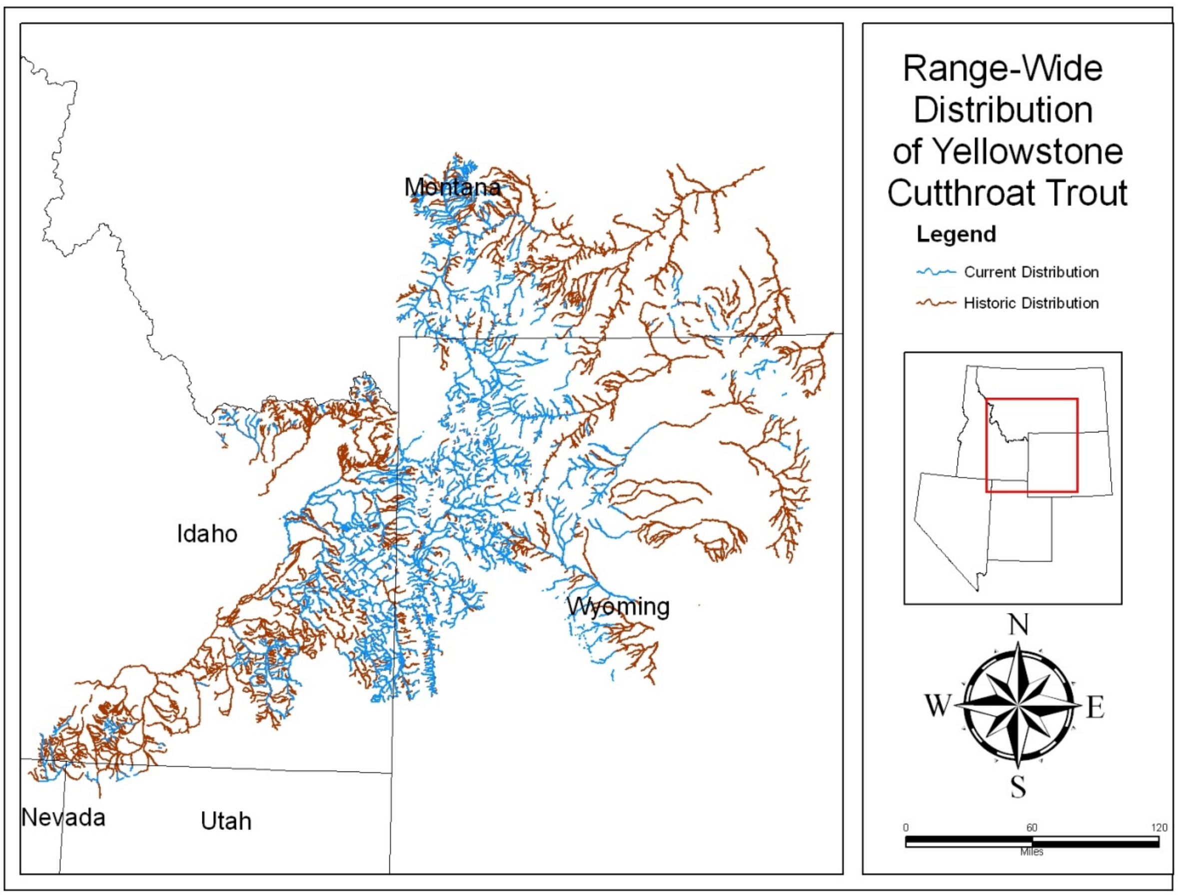

Figure 2-1: Historic and current distribution of Yellowstone cutthroat trout across its native range (FWP fisheries database).

Table 2-1: Genetic status for Yellowstone cutthroat trout by stream length (miles) within its current multi-state range as of 2006 (from May et al. 2007).

Genetic Status	*Stream Miles*	*% of Occupied*
Tested unaltered	3,112	41%
Tested; ≥ 1% to ≤ 10% introgression	612	8%
Tested; > 10% to ≤ 25% introgression	103	1%
Tested; > 25% introgression	56	1%
Suspected unaltered	1,854	25%
Potentially altered	1,614	21%
Mixed stock, altered and unaltered	169	2%
Not applicable	7	0%
Total	**7,527**	**100%**

Although distribution in streams has decreased, Yellowstone cutthroat trout have increased substantially in the number of lakes occupied, owing to introductions into previously fishless lakes. An estimated 205 lakes currently support Yellowstone cutthroat trout populations, compared to 61 historically occupied lakes (May et al. 2007).

In Montana, Yellowstone cutthroat trout historically occurred in nearly 4,300 miles of stream, which accounted for 24% of the fish's total historic distribution (May et al. 2007). Core, conservation and sport populations still reside in 32% of the fish's historic range in Montana (May et al. 2007). Analysis of the most recent genetic and distribution data finds genetically unaltered populations remain in 35% of the currently occupied stream habitat, and another 28% of stream miles potentially support unaltered populations (Table 2-2). Genetic analyses indicate 15% of currently occupied habitat support slightly hybridized fish, with less than 10% of genetic contributions from rainbow trout or westslope cutthroat trout. Another 28% of stream miles potentially support hybridized fish; however, testing is required to verify genetic status of these populations.

Table 2-2: Current genetic status for Yellowstone cutthroat trout by stream length (miles) within Montana (FWP database).

Genetic Status	*Stream Miles*	*% of occupied*
Tested unaltered	568	35%
Tested; ≥ 1% to ≤ 10% introgression	235	15%
Tested; unknown % introgressed	2	0%
Suspected unaltered	202	13%
Potentially altered	450	28%
Mixed stock, altered and unaltered	58	4%
Not Applicable	3	0%
Unknown	89	6%
Total	**1,607**	**100%**

Distribution of the remaining Yellowstone cutthroat trout populations is uneven across the fish's historic range. The western parts of its historic range, particularly in the Upper Yellowstone and Shields River subbasins, support the greatest extent of the remaining Yellowstone cutthroat trout populations (Figure 2-2). Proceeding east, fewer Yellowstone cutthroat trout populations exist, and these remaining populations are rarely connected with others.

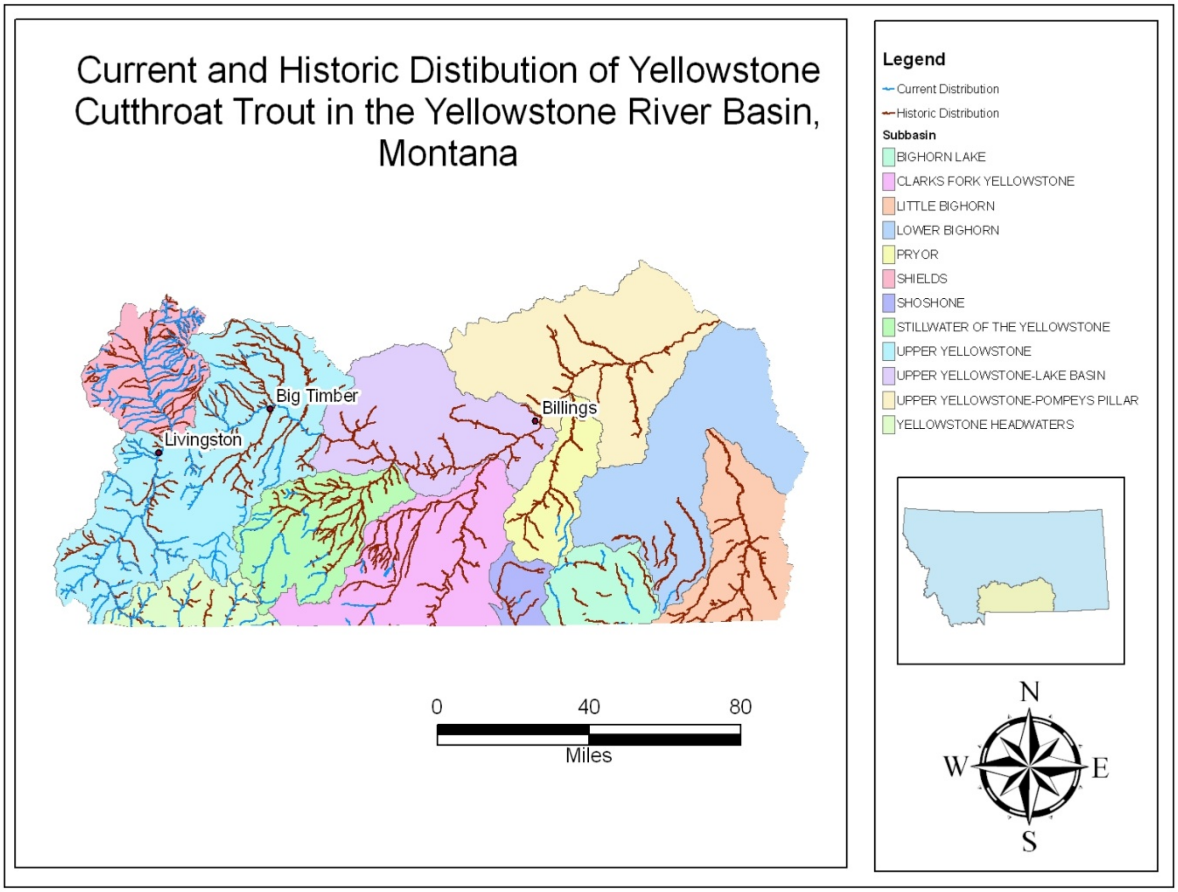

Figure 2-2: Current and historic distribution of Yellowstone cutthroat trout in streams in Montana.

Examination of the percent of historically occupied stream miles still supporting Yellowstone cutthroat trout further illustrates the trend for greater fragmentation and reduced distribution in the eastern extent of its range (Table 2-3). The Yellowstone Headwaters Subbasin, which lies mostly in Wyoming, supports a nearly intact extent of Yellowstone cutthroat trout, with 96% of historically occupied waters still containing this fish. The Shields River and Upper Yellowstone subbasins supported the second and third greatest extent of habitat still occupied, respectively. In other subbasins, Yellowstone cutthroat trout still reside in as little as 2% of their historic range, or have been extirpated.

Table 2-3: Comparison of historically and currently occupied stream miles for subbasins (4th Code HUCs) with water in Montana (from May et al. 2007).

Name	*HUC*	*Historically Occupied Miles*	*Currently Occupied Miles*	*Percent of Historic Still Occupied*
Yellowstone Headwaters	10070001	952	914	96%
Upper Yellowstone	10070002	1,116	560	50%
Shields	10070003	682	452	66%
Upper Yellowstone-Lake Basin	10070004	288		0%
Stillwater	10070005	416	103	25%
Clarks Fork Yellowstone	10070006	524	81	15%
Upper Yellowstone-Pompey's Pillar	10070007	273		0%
Pryor	10070008	225	26	12%
Bighorn Lake	10080010	277	65	23%
Shoshone	10080014	172	4	2%
Lower Bighorn	10080015	422	7	2%
Little Bighorn	10080016	224	20	9%

2.2 Distribution and Genetic Status of Yellowstone Cutthroat Trout in the Shields River Watershed

Investigations spanning the late 1980s through 2004 mapped Yellowstone cutthroat trout distribution and genetic purity throughout the basin (Tohtz 1999a; Jones and Shuler 2004; and Shepard 2004). Yellowstone cutthroat trout still occur throughout much of the watershed, including most of the main stem and a majority of tributaries, although they have been extirpated from some streams (Figure 2-3).

Genetic analyses of fish indicated pure Yellowstone cutthroat trout occupy a substantial number of stream miles (Figure 2-4). Moreover, no populations tested exhibited more than 8% hybridization with rainbow trout (Table 2-4). Of the 645 miles classified as historically occupied by Yellowstone cutthroat trout, core and conservation populations remain in 66% of this habitat (May et al. 2007). Analysis of current genetic and distributional data indicates 36% of occupied habitat supports pure Yellowstone cutthroat trout as indicated by genetic analyses, and another 25% of stream miles are likely to support unaltered fish (Table 2-5). Similar to May et al.'s findings, the most recent data indicate hybridized fish with less than 10% rainbow trout genes occupy 7% of the currently occupied stream miles, although another 20% of the presumed distribution may have some level of hybridization.

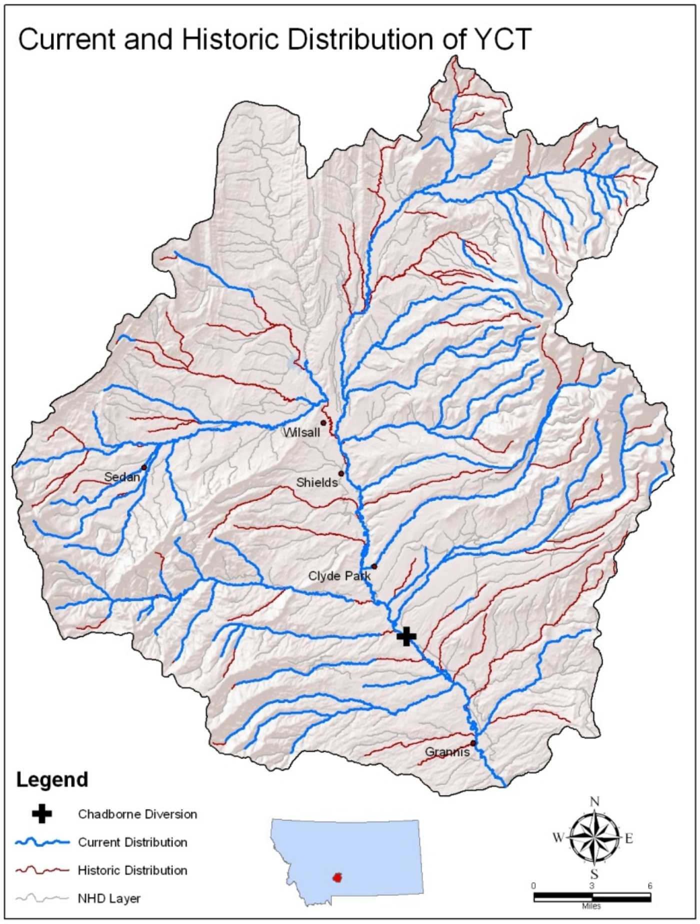

Figure 2-3: Current and historic distribution of Yellowstone cutthroat trout (YCT) in the Shields River Subbasin (MFISH database, January 2012).

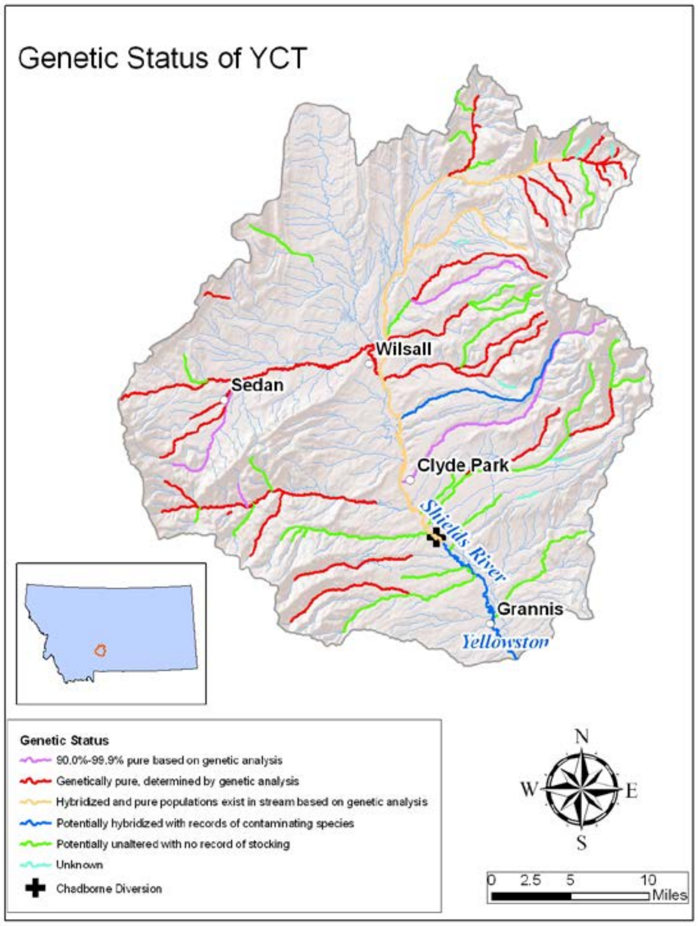

Figure 2-4: Genetic status of Yellowstone cutthroat trout (YCT) in the Shields River watershed (MFISH database, January 2012).

Table 2-4: Summary of genetically tested populations of stream dwelling Yellowstone cutthroat trout in Shields River watershed (MFISH database). (YCT = Yellowstone cutthroat trout, RBT = rainbow trout)

Stream	*Tributary To*	*Year*	*Species*	*Number of Fish*	*Percent YCT Genes*	*Count*
Bangtail Creek	Shields River	2010	YCT	10	100%	0
Bangtail Creek	Shields River	1999	YCT	22	100%	0
Bangtail Creek	Shields River	1990	YCT	12	100%	0
Bennett Creek	Shields River	1990	YCT	10	100%	0
Brackett Creek	Shields River	2002	YCT	19	0%	18
Brackett Creek	Shields River	2002	YCT x RBT	19	0%	1
Brackett Creek	Shields River	1987	YCT	20	100%	0
Cache Creek	Fairy Creek	2001	YCT	22	97.33%	0
Carrol Creek	Fairy Creek	2001	YCT	2	0%	2
Carrol Creek	Fairy Creek	1990	YCT	19	100%	0
Cottonwood Creek	Shields River	1999	YCT	32	99.10%	0
Cottonwood Creek	Shields River	1999	RBT	32	0.90%	0
Daisy Dean Creek	Shields River	1999	YCT	25	100%	0
Deep Creek	Shields River	1990	YCT	10	100%	0
Dugout Creek	Shields River	1992	YCT	5	100%	0
East Fork Smith Creek	Smith Creek	1988	YCT	9	100%	0
Fairy Creek	Cache Creek	2002	YCT	10	100%	0
Fairy Creek	Cache Creek	1990	YCT	3	100%	0
Flathead Creek	Shields River	1990	YCT	9	100%	0
Hammond Creek	Rock Creek	2010	YCT	14	100%	0
Hammond Creek	Rock Creek	2010	YCT	16	100%	0
Horse Creek	Brackett Creek	1993	YCT	9	92.80%	0
Horse Creek	Brackett Creek	1993	RBT	9	7.20%	0
Horse Creek	Shields River	1999	YCT	30	100%	0
Lodgepole Creek	Shields River	1986	YCT	4	100%	0
Middle Fork Brackett Creek	Brackett Creek	1987	YCT	21	100%	0
Middle Fork Horse Creek	Horse Creek	1991	YCT	5	100%	0
Middle Fork Muddy Creek	North Fork Muddy Creek	2010	YCT	26	100%	0
Miles Creek	Brackett Creek	2002	YCT	26	100%	0
Mill Creek	Shields River	1990	YCT	11	100%	0
North Fork Brackett Creek	Brackett Creek	1987	YCT	21	100%	0
North Fork Elk Creek	Elk Creek	1999	YCT	44	100%	0
North Fork Elk Creek	Elk Creek	1993	YCT	13	100%	0
North Fork Willow Creek	Willow Creek	2010	YCT	16	100%	0
North Fork Willow Creek	Willow Creek	2002	YCT	19	100%	0
North Fork Willow Creek	Willow Creek	1993	YCT	17	100%	0
Porcupine Creek	Shields River	1999	YCT	34	0%	33
Porcupine Creek	Shields River	1999	YCT x RBT	34	0%	1
Rock Creek	Shields River	1988	YCT	20	100%	0
Scofield Creek	Shields River	1990	YCT	10	100%	0

Stream	*Tributary To*	*Year*	*Species*	*Number of Fish*	*Percent YCT Genes*	*Count*
Table 2-4 continued						
Shields River	Yellowstone River	1999	YCT	23	0%	20
Shields River	Yellowstone River	1999	YCT x RBT	23	0%	3
Shields River	Yellowstone River	1989	YCT	25	100%	0
Shields River	Yellowstone River	1989	YCT	25	100%	0
Shields River	Yellowstone River	1988	YCT	22	100%	0
Smith Creek	Shields River	1992	YCT	1	100%	0
Smith Creek	Shields River	1988	YCT	23	100%	0
South Fork Carrol Creek	Carrol Creek	1990	YCT	11	100%	0
South Fork Elk Creek	Elk Creek	1999	YCT	29	99.10%	0
South Fork Elk Creek	Elk Creek	1999	RBT	29	0.90%	0
South Fork Flathead Creek	Flathead Creek	1990	YCT	7	100%	0
South Fork Horse Creek	Horse Creek	1991	YCT	7	100%	0
South Fork Shields River	Shields River	1992	YCT	10	100%	0
Turkey Creek	Shields River	1986	YCT	13	100%	0
Unnamed Trib to Weasel Cr RM 0.4	Weasel Creek	2001	YCT	1	100%	0

Table 2-5: Summary of genetic status for stream dwelling Yellowstone cutthroat trout (FWP database, January 2012).

Genetic Status	*Stream Miles*	*% of Occupied*
Tested unaltered	162	39%
Tested; ≥ 1% to ≤ 10% introgression	40	10%
Suspected unaltered	123	29%
Potentially altered	27	6%
Mixed stock, altered and unaltered	59	14%
Unknown	7	2%
Total	417	100%

In summary, the wide distribution of Yellowstone cutthroat trout in the Shields River Subbasin, combined with the high degree of genetic purity, makes the subbasin one of the few remaining basin level strongholds for Yellowstone cutthroat trout in Montana. The conservation objectives established under the cutthroat trout Agreement (FWP 2007a) provide the framework for conserving existing populations, and restoring pure Yellowstone cutthroat trout within the Shields River watershed.

2.3 Distribution of Other Fish Species in the Shields River Subbasin

The Shields River Subbasin supports a fish assemblage composed of native and nonnative species (Table 2-6). Of the eleven species present, most are native, and include Yellowstone cutthroat trout, mountain whitefish, three suckers, two members of the minnow family, and mottled sculpin. Nonnatives include rainbow trout, brown trout, and brook trout.

Table 2-6: Fishes present in the Shields River Subasin.

Family	***Common Name***	***Scientific Name***	***Origin***
Sucker (Catostomidae)	Mountain sucker	*Catostomus platyrhynchus*	Native
	White sucker	*Catostomus commersoni*	Native
	Longnose sucker	*Catostomus catostomus*	Native
Minnow (Cyprinidae)	Lake chub	*Couesius plumbeus*	Native
	Longnose dace	*Rhinichthys cataractae*	Native
Trout (Salmonidae)	Rainbow trout	*Oncorhynchus mykiss*	Nonnative
	Yellowstone cutthroat trout	*O. clarkii bouvieri*	Native
	Brown trout	*Salmo trutta*	Nonnative
	Brook trout	*Salvelinus fontanalis*	Nonnative
	Mountain whitefish	*Prosopium williamsoni*	Native
Sculpin (Cottidae)	Mottled sculpin	*Cottus bairdi*	Native

Rainbow trout are a considerable threat to Yellowstone cutthroat trout persistence because of the risk of hybridization and genetic introgression between the species. Rainbow trout are mainly restricted to the lower portions of the Shields River and Cottonwood and Brackett creeks (Figure 2-5). Rainbow trout were stocked into Brackett, Cottonwood, and Daisy Dean creeks, and the Shields River until the early 1970s (Shepard 2004). In addition, rainbow trout can probably access the Shields River from lower source populations, particularly from the Yellowstone River, but the Chadbourne irrigation diversion has likely limited the ability of rainbow trout to invade the Shields River watershed. This diversion was believed to function as a near total barrier to upstream fish movement until relatively recently; however, hydraulic modeling suggests the diversion may be passable at some flows (OASIS 2006). Moreover, apparently fluvial rainbow trout are present in spring sampling efforts upstream of the Chadbourne diversion, and these fish are likely migrants from Yellowstone or lower Shields rivers (S.T. Opitz, FWP, personal communication). Genetic testing of fish collected from the Shields River near Clyde Park, Montana in 1999 found several fish that were first-generation hybrids between rainbow and Yellowstone cutthroat trout (Shepard 2004), which suggests a recent invasion event.

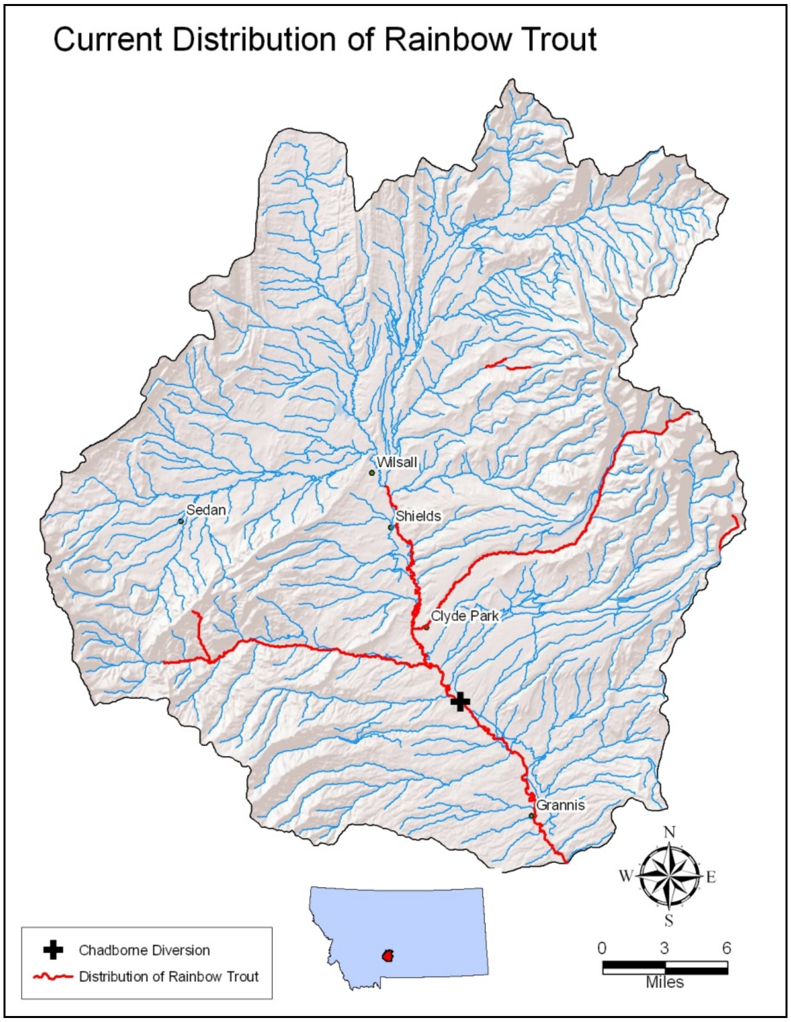

Figure 2-5: Distribution of rainbow trout in the Shields River watershed (FWP database, January 2012).

Brook trout occur throughout much of the basin (Figure 2-6), and are currently expanding into waters that previously supported Yellowstone cutthroat trout as the only salmonid (Shepard 2004; FWP, Livingston office files). Brook trout are likely to eventually invade all accessible habitat in the Shields River Subbasin (Shepard 2004). This rapid invasion is of extreme concern from a Yellowstone cutthroat trout conservation standpoint, as brook trout invasion often coincides with extirpation of Yellowstone cutthroat trout. Shepard (2004) found several streams where brook trout had likely eliminated Yellowstone cutthroat trout since the mid-1970s and a rapid invasion is underway in the headwaters of the Shields River (FWP, Livingston Office files). The threat brook trout pose to Yellowstone cutthroat trout, especially in headwaters streams, cannot be overstated.

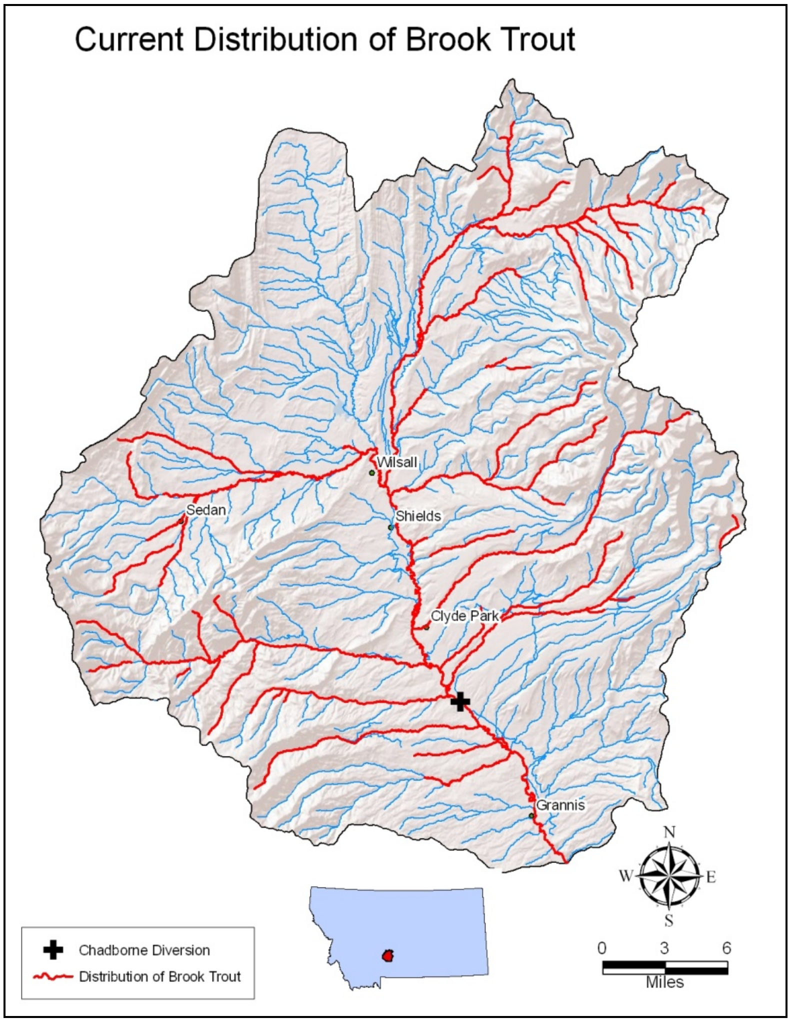

Figure 2-6: Distribution of brook trout in the Shields River watershed (FWP database, January 2012).

Brown trout are also present in the Shields River watershed and have wide distribution throughout the Shields River and the lower portions of most of its tributaries (Figure 2-7). Brown trout pose a threat through competition and perhaps predation. Overall, brown trout pose less of a risk to Yellowstone cutthroat trout than rainbow trout and brook trout, although brown trout tend to displace native fish in lower elevation streams (Behnke 1992; de la Hoz Franco and Budy 2005; Wood and Budy 2009) and this tendency appears to hold true for brown trout and Yellowstone cutthroat trout. Their abundance in the main stem of the Shields River and lower reaches of several tributaries may be among the reasons Yellowstone cutthroat trout are relatively rare in these areas, although other factors such as habitat condition, water temperature, and summer flow regime may be contributing factors.

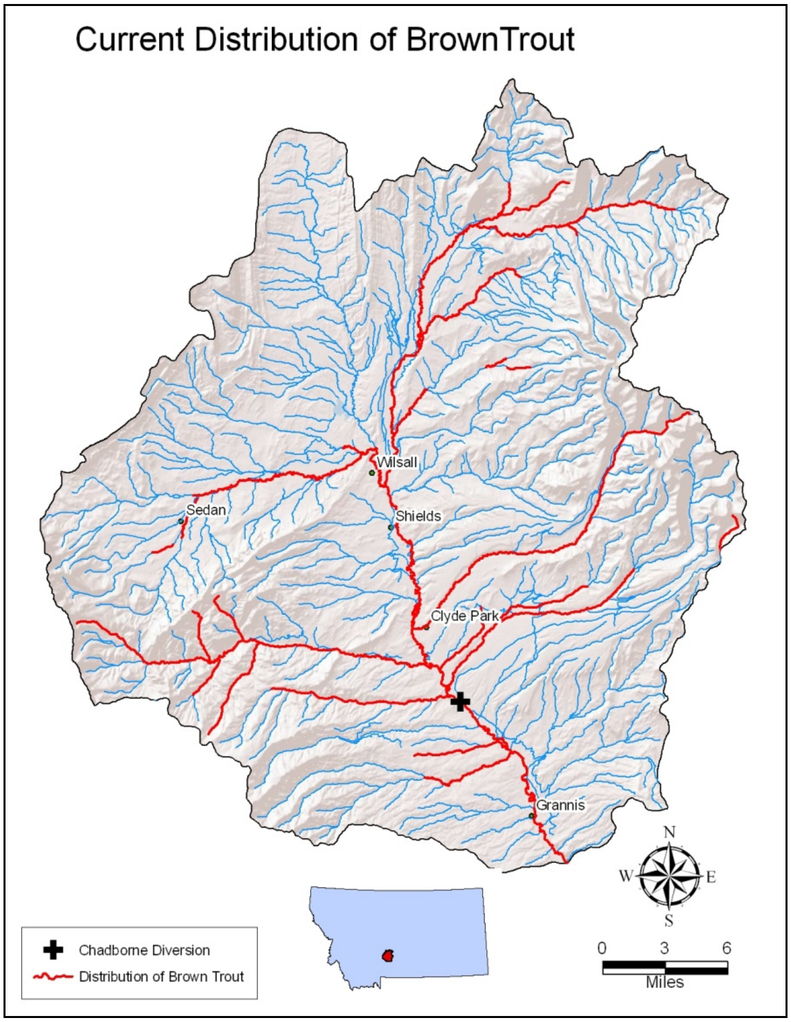

Figure 2-7: Distribution of brown trout in the Shields River watershed (FWP database, January 2012).

Although brown trout pose some risk to Yellowstone cutthroat trout, especially in lower elevation reaches, Yellowstone cutthroat trout are able to persist in sympatry in with brown trout in some higher elevation streams. For example, Yellowstone cutthroat trout coexisted with brown trout in Lower Deer Creek, a tributary of the Yellowstone River downstream of Big Timber, for decades, although brown trout were the more abundant species and appeared to be increasing relative to Yellowstone cutthroat trout in recent years (MFISH database). In contrast, fisheries investigations in East Fork Duck Creek, a stream draining the south end of the Crazy Mountains found a marked reversal in Yellowstone cutthroat trout abundance compared to brown trout between the early 1980s and 2007. In the 1980s, Yellowstone cutthroat trout outnumbered brown trout by up to sevenfold (White 1984; R.J. White, Trout Habitat Specialists, personal communication). In 2007, brown trout were three times as abundant as Yellowstone cutthroat trout, suggesting the possibility for future extirpation. Recent electrofishing surveys indicate brown trout are increasing their range into the upper Shields River watershed, which is a cause for concern and requires further study (B.B. Shepard, WCS, personal communication).

Continued invasion of brown trout into headwater strongholds for Yellowstone cutthroat trout is possible, but the extent of the threat remains unknown. Timing of spawning and associated abiotic factors may limit, but not prevent, the invasion of brown trout into higher elevation reaches (Wood and Budy 2009). Current and future research into species invasions in the Upper Shields River Watershed may shed light on the potential for brown trout to invade headwaters. Moreover, conservation efforts such as fish removal and barrier construction may protect the headwaters populations of Yellowstone cutthroat trout in the Shields River watershed from brook trout and brown trout.

Although brown trout are not entirely compatible with Yellowstone cutthroat trout, conservation of Yellowstone cutthroat trout will not entail suppression or eradication of this popular sport fish in most of the Shields River and its tributaries. Brown trout will continue to provide sportfishing opportunities in a considerable portion of the Shields River Subbasin. Any potential brown trout removal would likely be limited headwater streams. Therefore, the vast majority of the main stem of the Shields River and the lower elevation reaches of its tributaries would continue to be managed as a recreational fishery for brown trout, with catch-and-release regulations applying to Yellowstone cutthroat trout.

2.4 Recent Yellowstone Cutthroat Trout Population Trends in the Shields River Subbasin

Fisheries investigations in the 2000s examined distribution and abundance of Yellowstone cutthroat trout, genetic status, and presence of competing species in a number of tributary streams in the Shields River watershed. The results of these studies allow inference on population trends and shed light on the relative security of subpopulations.

From 2000 through 2003, Shepard (2004) sampled over 30 tributary streams in the Shields River watershed. This study involved a systematic sampling scheme to estimate the relative abundance and distribution of fishes, and to quantify stream habitat characteristics. Fish population estimates occurred at 2-mile intervals along assessed streams. In addition, sections sampled in the 1970s (Berg 1975) were resampled to evaluate temporal trends.

This effort confirmed the continued wide distribution of Yellowstone cutthroat trout in the Shields River watershed, as nearly all trout-bearing sites yielded Yellowstone cutthroat trout (Shepard 2004). Nonetheless, findings pertaining to brook trout provided cause for concern. Brook trout had expanded their range in the Shields River watershed, and were displacing

Yellowstone cutthroat trout at several locations. In addition, brook trout made up an increasing proportion of trout communities throughout much of the drainage. Shepard (2004) speculated that brook trout would ultimately invade all streams where they have physical access, which places Yellowstone cutthroat trout in the basin at risk of extirpation.

Fisheries investigations conducted by the U.S. Forest Service also demonstrate displacement of Yellowstone cutthroat trout by nonnative brook trout. These population surveys occurred on forestlands, primarily in the headwater reaches of Smith and Rock creeks, and the South Fork of the Shields River (Jones and Shuler 2004, Forest Service 2006 file data). Forest Service biologists have documented an expansion in the distribution of brook trout and declines, and potential extirpation, of Yellowstone cutthroat trout, especially where brook trout co-occur.

In 2009, FWP, the Gallatin National Forest (GNF), and YNP collaborated on an intensive survey of streams in the upper Shields River watershed, with streams upstream of the confluence with Smith Creek being the focus of the investigation. This effort found continued invasion of brook trout into these streams, and apparent displacement of Yellowstone cutthroat trout in some streams. On the positive side, all genetic samples collected in this effort showed no evidence of hybridization with rainbow trout.

The recent fisheries investigations provide cause for concern about the security of Yellowstone cutthroat trout in the Shields River watershed. Shrinking distribution following recent invasions of brook trout indicate intervention is consistent with conservation goals and objectives for Yellowstone cutthroat trout conservation. Likewise, increased distribution of brown trout is some headwaters streams presents a potential threat to Yellowstone cutthroat trout and warrants continued monitoring, with intervention occurring as warranted.

2.5 State and Federal Status

Declines in abundance and range of Yellowstone cutthroat trout have prompted state and federal agencies to assign special status to this species. The State of Montana considers the Yellowstone cutthroat trout a species of special concern, and Region 1 of the Forest Service classifies Yellowstone cutthroat trout as a sensitive species. The Montana Natural Heritage Program (MNHP) ranks Yellowstone cutthroat trout as a “G4, T2, S2 species”, which means cutthroat trout are secure globally, but Yellowstone cutthroat trout are imperiled over their range and within Montana (MNHP and FWP 2008).

Concerned about the potential for extinction of Yellowstone cutthroat trout, environmental advocacy groups petitioned the USFWS to list Yellowstone cutthroat trout as a threatened species under the Endangered Species Act (ESA) on August 18, 1998 (Smith 1998). Following review of the petition, and all available scientific and commercial information pertaining to

Yellowstone cutthroat trout, the USFWS found that the petition did not present sufficient information indicating listing the Yellowstone cutthroat trout was warranted (66 FR 11244). In January 2004, a civil suit filed in Colorado (Civil Action number 04-F-0108[OEs]) challenged this finding. The basis of this lawsuit was a decline in Yellowstone cutthroat trout abundance associated with habitat degradation or loss. The examples listed included livestock grazing, logging, mining, other human activities, and dewatering of streams. A settlement of the lawsuit initiated a status review under ESA, which affirmed the finding that listing Yellowstone cutthroat trout as a threatened species was “not warranted” (71 FR 8819). In May of 2006, petitioners issued a 60-day notice of intent to sue, indicating challenges to these findings are probable.

3.0 Shields River Subbasin Characterization

The Shields River Subbasin encompasses approximately 289,000 acres and flows into the Yellowstone River, east of Livingston, Montana (Figure 3-1). The Shields River valley is primarily agricultural land, and production of cattle, hay, and small grains is the foundation of the local economy. Rangeland makes up the majority of the land use at 59% (USWA 2001). Major towns in the region include Wilsall and Clyde Park, and agriculture provides the major economic base for these small communities. Private land ownership in the watershed constitutes 81% of the area, while the Forest Service administers 16% of land base, primarily in the headwater reaches on the east and west sides of the watershed (USWA 2001). BLM (0.4%) and state lands (2.5%) are typically small parcels (≤ 1 section) and are scattered throughout the watershed.

Most streams have headwaters in the mountains that form the eastern and western extents of the watershed and many of these streams flow through the GNF. The Crazy Mountains bound the watershed on the east, and the Bridger and Bangtail ranges form the western boundary. Elevations range from 4,300 feet at the mouth of the Shields River to 11,000 feet at the summit of Crazy Peak in the Crazy Mountains. The Bridger Range rises to an elevation of 9,500 feet. As most streams originate at high elevations, snowmelt is the primary driver of the hydrology resulting in a spring rise, followed by a decline to base flows by fall, although irrigation activities have altered the hydrograph from the natural regime. A few streams originate at lower elevations and function like warm-water prairie streams with lower gradients, finer bed material, and a less pronounced spring runoff.

Precipitation in the Shields River valley generally falls between 13 to 15 inches per year; however, the weather station at Wilsall reports a mean of just over 20 inches for the period of record from 1957 to 2004 (WRCC 2005). The Bridger Range in the west has an annual precipitation of over 50 inches, and the Crazy Mountains in the east average around 60 inches of annual precipitation. About 68% of the annual precipitation falls from April through September, and approximately 32% of the annual precipitation falls in the months of May and June for the entire watershed (WRCC 2005).

Thick layers of sedimentary rock underlie the majority of the watershed; however, localized areas of volcanic rock are common. Uplift of sedimentary rock formed the Bridger Range, and the Crazy Mountains were the result of large igneous intrusions. Four general soil types occur throughout the watershed: soils formed sedimentary rock in upland areas, from alluvium on high terraces, soils formed from alluvium on low terraces and soils formed on mountain slopes. Soils formed from sedimentary rock in upland areas are the most common and tend to be moderately fine to fine in texture. These soils are well drained and are commonly clay loam or silty clay loam. Soils formed from alluvium on high terraces are typically well-drained clay loam or clay with a gravelly or cobbly substratum. Alluvial soils formed on low terraces are typically deep and range from well drained to poorly drained. Textures of these soils also range from moderately coarse to fine. Soils formed on mountain slopes occur on steep slopes, are well drained, moderately deep, and have high amounts of rock fragments throughout (Davis and Shovic 1996).

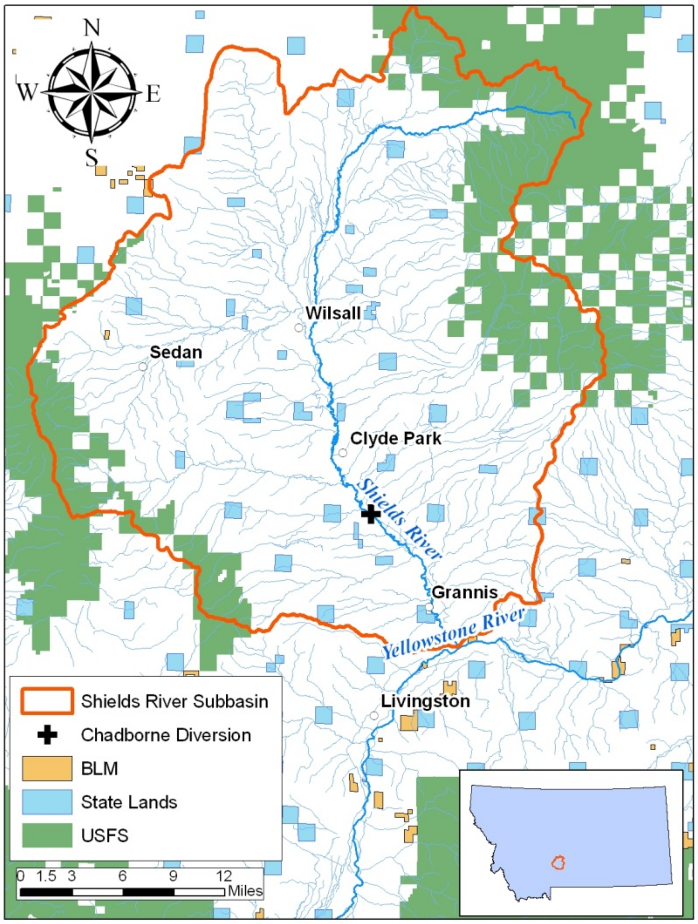

Figure 3-1: Overview of the in the Shields River watershed showing landownership.

4.0 General Conservation Strategies

Efforts to conserve and restore Yellowstone cutthroat trout in the Shields River watershed will focus on the key factors limiting their abundance and distribution in the basin. Habitat quality, water quantity and quality, competition with nonnative species, genetic introgression, and predation all reduce Yellowstone cutthroat trout in the Shields River Subbasin to some extent. Identifying limiting factors and designing projects to ameliorate their effects will remain at the core of restoration and conservation efforts.

4.1 Repair and Retrofit of Chadbourne Diversion and Associated Operations

Maintaining the Chadbourne diversion as a barrier to upstream movement of rainbow trout, and increasing its effectiveness at blocking fish are key conservation needs for the Shields River watershed upstream of this structure. Chadbourne diversion was built in 1908, and is currently in disrepair. Its structural failure would allow the abundant rainbow trout in the river system below free access to the Shields River and its tributaries. FWP and the Lower Shields River Canal Company are collaborating to repair and secure the diversion. Construction is slated to begin August of 2013.

Another potential component of the Chadbourne repairs and retrofits may be to install a bypass channel to allow selective passage of fishes. The channel would lead to a stock pen, where fisheries workers will identify fish ascending the ladder. Native fishes would be placed upstream of the diversion, and rainbow trout would be returned to the river downstream. The intent of this component of dam repairs and alterations is to restore connectivity for native fishes. This action is consistent with a goal of Yellowstone cutthroat trout conservation, which includes restoration and conservation of life history strategies, including migratory patterns.

4.2 Water Quality and Quantity

4.2.1 Water Quality

The total maximum daily load (TMDL) process is the primary water quality planning effort relevant to Yellowstone cutthroat trout conservation in the Shields River Subbasin. TMDL refers to the amount of a pollutant a body of water can assimilate and still support its beneficial uses. In simple terms, a TMDL plan has numeric goals for restoring water quality. Section 303(d) of the Clean Water Act requires development of TMDL plans for water-quality-impaired segments of streams, lakes, and wetlands. DEQ completed a TMDL plan that provides a general approach to restoring water quality with respect to sediment loading within the Shields River Subbasin (DEQ 2009). The SVWG collaborated with DEQ and a local consulting firm to develop a watershed restoration plan that details potential means of reducing sediment loading and identifies potential projects (Confluence 2012).

Many of the impairments listed for this watershed on the 303(d) list are related to water supply management and land use practices within or adjacent to the riparian corridor. Siltation, riparian degradation, low flows, and widening of some streams were noted in the stream surveys conducted by the Forest Service and FWP (Inter-Fluve 2001, Jones and Shuler 2004, May 1998, May et al. 2003, Shepard 2004). These results confirm that flow alteration, siltation, and riparian degradation are key impairments in the watershed. Timber harvest and associated road building on both public and private lands contribute to sedimentation and channel alterations.

Understanding the operational definitions used by the DEQ and Environmental Protection Agency (EPA) is important in understanding the role the TMDL plan will have in watershed level restoration in the Shields River Subbasin. These agencies make a distinction between pollutants, substances or conditions that are measurable in the water column or on the streambed, and pollution, which includes disturbances such as bank erosion or dewatering, which add pollutants to a body of water. TMDL plans address only pollutants directly. As sediment was the only pollutant on the 303(d) list during TMDL development for the Shields River Subbasin, the TMDL and watershed restoration plans address sediment.

Watershed assessment activities conducted to support TMDL planning will prove useful in Yellowstone cutthroat trout conservation. This effort included an extensive evaluation of aerial imagery, which classified stream reaches based on channel morphology, riparian condition, land use, and restoration potential. This assessment will provide a screen to identify potential restoration projects on all streams in the watershed. The SVWG, in conjunction with DEQ, will take the lead on this effort. FWP will provide technical assistance in project planning and grant applications.

The TMDL (DEQ 2009) identified roads and hillslope erosion as sources of sediment loading to streams. The Forest Service has expansive plans to decommission and reclaim roads throughout the GNF, with substantial efforts slated for the Smith Creek watershed, in the headwaters of the Shields River. These actions will include recontouring eight miles of road, and decommissioning of 15 miles of road within the basin. The intent of these actions is to reduce sediment loading to streams, which will greatly benefit resident fish in the Smith Creek drainage and the Shields River. The watershed restoration plan (Confluence 2012) details priorities and potential approaches to reducing sediment loading from other roads and hillsides.

4.2.2 Water Temperature

Warm water temperatures relating to a variety of land uses can potentially limit habitat suitability for Yellowstone cutthroat trout and can give relatively tolerant nonnative fishes a competitive edge. Irrigation withdrawals decrease the volume of water, which allows the remaining water to heat more readily. (Conversely, irrigation return flows, when contributed from groundwater, can cool stream temperatures.) Similarly, removal of riparian shrubs and trees decreases shading of the water surface, and contributes to channel widening. Moreover, climate change presents a current and looming threat with projected effects on water temperature and quantity. Recent warming has already driven significant changes in the hydroclimate, with a shift towards more rainfall and less snow in the western US (Knowles et al. 2006). Likewise, the peak of spring snowmelt is two weeks earlier in recent years, and this trend is likely to continue (Stewart et al. 2004). Probable effects of climate change in the western US, including Montana, will be increased water shortages and warmer water temperatures during late summer, which unfortunately coincides with periods when irrigation demands exceed water supply and water temperatures are naturally at their highest (L.S. Dolan, DNRC, personal communication; D. Issac, USFS, personal communication).

Data allowing evaluation of thermal regime come from several sources. The USGS has been monitoring daily stream temperatures at its gage station located about 1.5 miles upstream of the confluence with the Yellowstone River since 1999 (Figure 4-1). FWP has five monitoring stations on the Shields River and deployed thermographs on numerous tributaries during the 2000s.

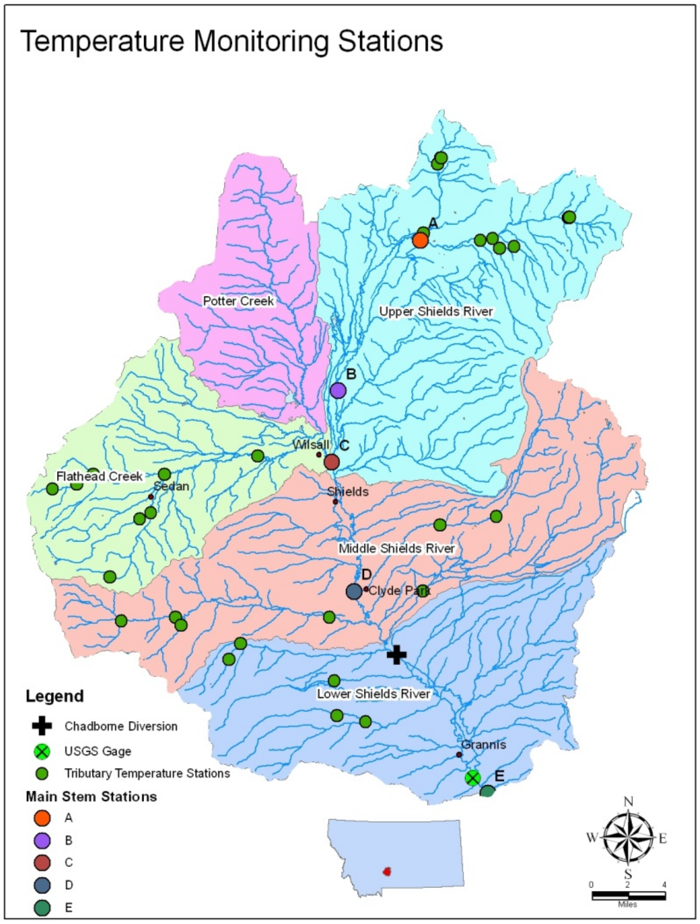

Figure 4-1: Water temperature monitoring stations in the Shields River Subbasin.

Ideally, interpretation of temperature data uses thermal tolerances and optima developed for the target species. These values have not yet been determined for Yellowstone cutthroat; however, a thermal study on the closely related westslope cutthroat trout provides a surrogate in evaluating potential thermal stress to Yellowstone cutthroat trout (Bear et al. 2007). This study identified 19.6 °C (67 °F) as the upper incipient lethal temperature (UILT) for westslope cutthroat trout, which is the temperature at which 50% of a test population survives for 60 days of exposure. Optimum temperatures were those where peak growth occurred and were between 13 and 15 °C (55 and 59 °F). Although a number of factors limit the certainty in applying the optima and UILT to Yellowstone cutthroat trout, this study is the best information we have currently to evaluate habitat suitability relating to temperature and the potential for thermal stress.

One consideration in the use of this research for Yellowstone cutthroat trout is that incidental observations suggest Yellowstone cutthroat trout may be less sensitive to thermal loading than westslope cutthroat trout (B.B. Shepard, Wildlife Conservation Society, personal communication). Furthermore, this investigation examined one life history stages (age-0 fish) and older fish may vary in their thermal optima or tolerance. Nevertheless, application of westslope cutthroat trout values to Yellowstone cutthroat trout provides a conservative approach to conserving Yellowstone cutthroat trout in face of uncertainty over thermal tolerances and optima for the subspecies. Conclusions drawn from the available data will acknowledge the considerable uncertainty.

Another important consideration in interpreting thermal optima is that this is the range where fish experience peak growth in the laboratory, but does not suggest that Yellowstone cutthroat trout cannot thrive in waters where the mean or maximum daily temperatures exceed this range. In nature, optimal conditions of various types may occur during brief windows for many species. Moreover, these laboratory studies hold temperatures steady with no daily variation, whereas stream temperatures show diel fluctuations following air temperatures and insolation of stream surfaces. Inclusion of the optimal ranges on the following figures is meant to be an informative comparison to measured optima, but does not imply that streams with mean or maximum temperatures that frequently exceed the thermal optima cannot support thriving populations of Yellowstone cutthroat trout.

The use of UILT as a measure of thermal stress brings similar limitations. In the laboratory, temperatures remain constant over the 60 days of exposure and fish do not experience the natural, daily temperature fluctuations that would provide respite from warm daytime temperatures. Moreover, this study design does not account for inter-day variability, where some days will be cooler and others warmer. As the controlled laboratory study did not account for natural variation within and across days, interpretation of recorded temperatures should acknowledge the considerable uncertainty in applying these values to field conditions. Evaluation of the frequency of occurrences over optima and the UILT, and the degree to which temperatures exceed these levels, allows inference on the role of thermal regime in shaping Yellowstone cutthroat trout distribution in the watershed and the potential for fish to experience thermal stress.

Other uncertainty associated with applying laboratory studies to field conditions is that it ignores fish behavior and movement relating to temperature. Fish are adept at finding upwellings of cooler groundwater within an otherwise warm stream. Alternatively, adult fish can move to other streams providing thermal refugia. Current research in the headwaters of the Shields River watershed is evaluating the role of temperature in shaping growth, brook trout invasion, and fish movement. Research of this type will provide a refined approach to evaluating how temperature shapes abundance, persistence, movement, and growth of Yellowstone cutthroat trout. Future iterations of this strategy will incorporate new research as a means to conserve Yellowstone cutthroat trout in the Shields River watershed, and elsewhere within their historic range.

Application of criteria prescribed in FWP's drought management policy for fishing closures provides another approach to evaluating suitability of temperature to support cold-water fisheries (FWP 2007b). According to the policy, daily maximum water temperature thresholds reaching or exceeding 73 °F (23 °C) during three consecutive days triggers a fishing closure. This analysis examined the number of periods meeting fishing closure thresholds, and the maximum number of consecutive days equaling or exceeding 73 °F.

Evaluation of daily maximum temperatures at the USGS gage station record indicates the lower main stem has a thermal regime potentially unfavorable to the of Yellowstone cutthroat trout in most summers. The USGS began daily monitoring of water temperatures in September of 1999, providing up to 62 days of monitoring for July and August for most years, although no data were available for 2007, or August of 2011 (Table 4-1). From 2000 to 2008, maximum daily temperatures occurring from July through August equaled or exceeded the UILT for westslope cutthroat trout on a majority of days, which suggests some thermal stress to Yellowstone cutthroat trout (Figure 4-2). The frequency of days in which temperatures exceeded the UILT was often substantial, with maximum daily temperatures greater than 70 °F on most of days in some years. Data were not available for 2007; however, as an exceptionally dry and warm year, water temperatures were likely less suitable for support of cold-water fisheries, especially sensitive Yellowstone cutthroat trout. Thermal regime was slightly less stressful to Yellowstone cutthroat trout in 2009 and 2010, with just under half of days reaching temperatures greater than the UILT for westslope cutthroat trout. In 2011, snowpack was at, or near, record levels, and maximum water temperatures rarely exceeded the UILT; however, data were available for July only, so late summer water temperatures are unknown.

Mean daily temperatures reflect maximum temperatures and cooling in the evening and nighttime hours (Figure 4-3). In most years, mean daily temperatures typically exceeded the optimal range and even the UILT on several occasions. The exception was 2011, when on the majority of days the mean daily temperature was within the optimal range. These data cover only July temperatures, so no inference is possible for temperatures during August. Overall, these results indicate that in most years, warm water temperatures were possible a limiting factor for Yellowstone cutthroat trout, and negatively affected the suitability of this habitat for Yellowstone cutthroat trout during the summer months. As noted above, these values of thermal optima and UILT do not reflect field conditions, diel fluctuations in stream temperature, and were not developed specifically for Yellowstone cutthroat trout.

Table 4-1Number of days with water temperature data for USGS gage station 6195600.

Year	*Number of Days with Temperature Monitoring Data*
1999	0
2000	58
2001	62
2002	59
2003	62
2004	62
2005	62
2006	62
2007	0
2008	60
2009	62
2010	60
2011	27
Total	636

Comparisons of average and maximum daily temperatures at the gage station near the mouth of the Shields River indicate they were highly correlated, with a correlation coefficient of 0.93 (Figure 4-4). Although a substantial number of maximum daily temperatures fell above the fishing closure threshold of 73 ^{o}F, cooler temperatures during evening through morning resulted in average temperatures that were less than the UILT, suggesting fish get respite from peak water temperatures. Evaluation of the number of hours a fish can survive temperatures 73 ^{o}F or greater, while controlling for cooler parts of the day would be informative in setting goals for water temperature that provide for support of Yellowstone cutthroat trout as a beneficial use.

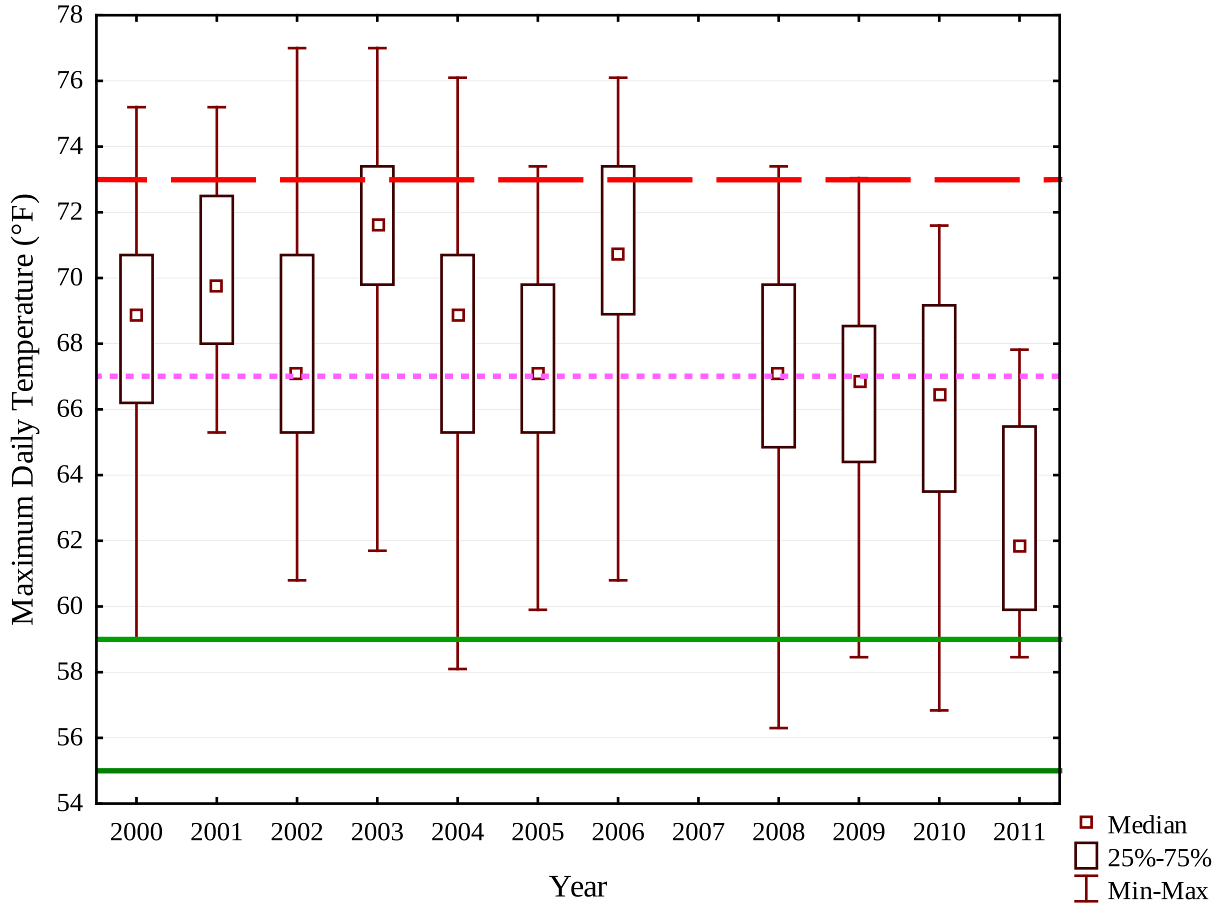

Figure 4-2: Distributional statistics for maximum daily water temperatures measured at USGS gage station 6195600 during July and August for the period of record, and comparison to thermal optimum and UILT of westslope cutthroat trout and drought closure criteria (> 3 days at 73 °F).

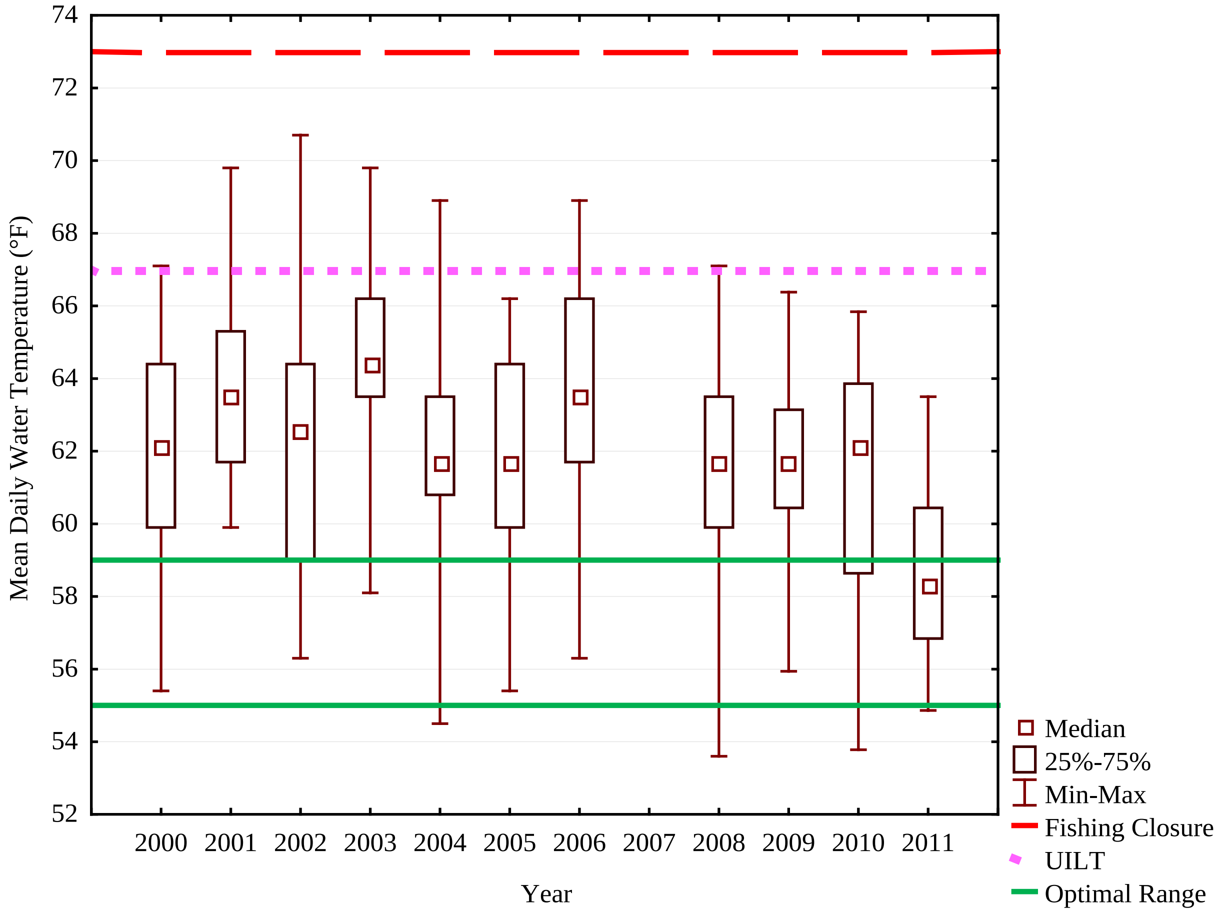

Figure 4-3: Distributional statistics for mean daily water temperatures measured at USGS gage station 6195600 during July and August, from 2000 through 2008, and comparison to thermal optimum and tolerances of westslope cutthroat trout.

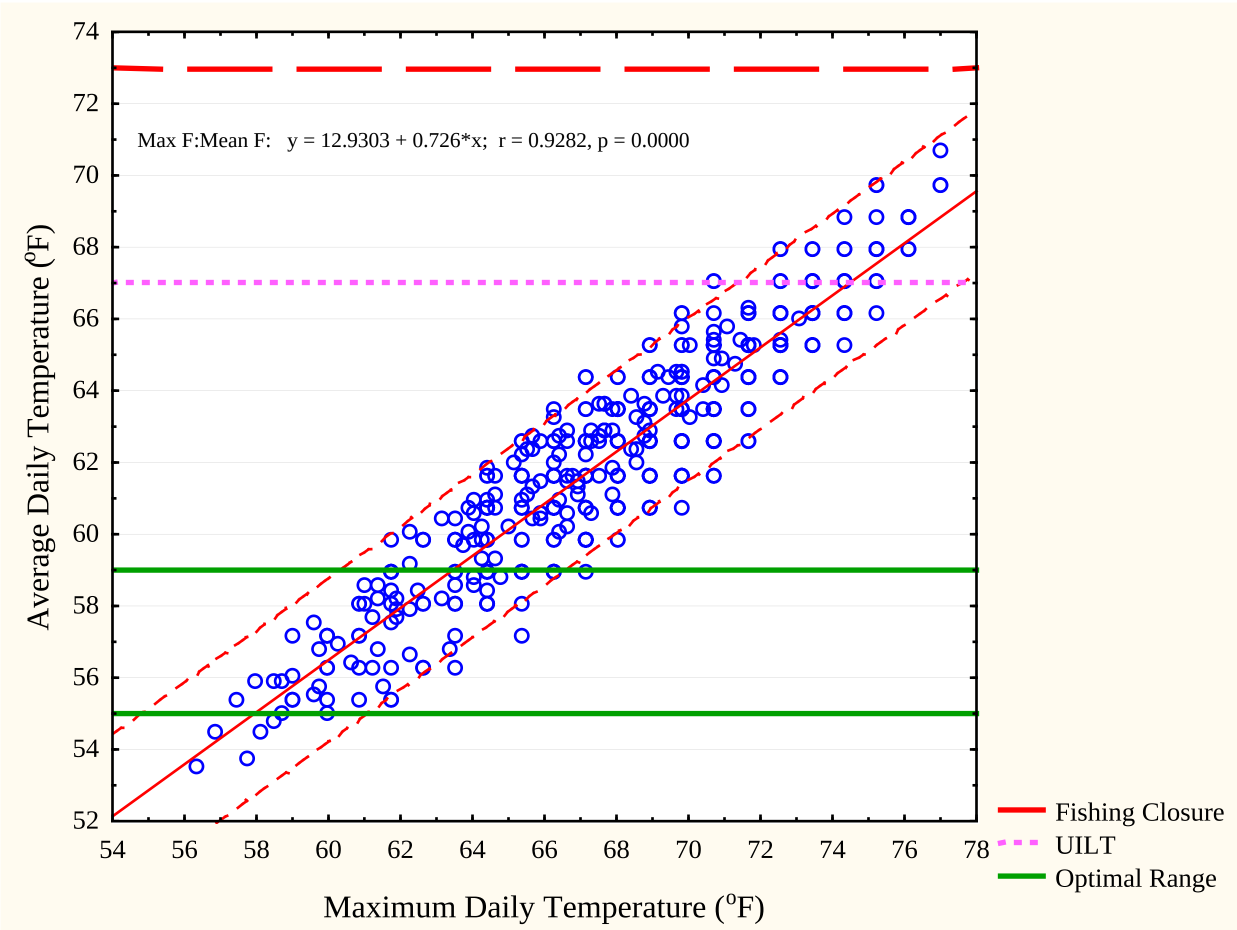

Figure 4-4: Comparison of average and maximum daily temperatures from USGS gage station 6195600.

Application of FWP fishing-closure-policy triggers to monitoring data at the USGS gage station indicates at least one fishing closure was warranted in five of eight years (Table 4-2). The number of periods with temperature exceeding the threshold was variable, from 1 to 4. In some years, maximum daily temperature exceeded 73 °F for extended periods. For example, maximum daily temperatures exceeded 73 °F for 13 consecutive days in 2003, and 10 days in 2006.

Table 4-2: Number of qualifying occasions triggering a fishing closure (maximum daily temperature ≥ 73 ° for 3+ consecutive days), and maximum number of consecutive days ≥ 73 °F for water temperatures measured at USGS gage station 6193500.

Year	*Number of Occasions Triggering Fishing Closure*	*Maximum Number of Consecutive Days exceeding 73 °F*
2000	0	2
2001	4	4
2002	1	4
2003	2	13
2004	1	4
2005	0	1
2006	2	10
2008	0	1
2009	0	1
2010	0	0
2011	0	0

FWP has been monitoring water temperatures at main stem sampling sites periodically from the late 1990s until the present. Analysis of most years' data is underway. Pending completion of this larger data analysis effort, this report addresses stream temperatures measured in 2007. As 2007 was an exceptionally warm year, these results represent a worst-case scenario in terms of stream temperatures in the Shields River. These data allow evaluation of the thermal regime across the length of the Shields River, and allow inference on what thermal regime may have been at the USGS gage station in 2007, the year lacking temperature monitoring.

In 2007, maximum daily water temperatures at all but the uppermost station were substantially higher than the UILT and the threshold for fishing closures (Figure 4-5). Water temperatures remained elevated throughout July, with August bringing some relief from daytime highs, which sometimes exceeded 80 °F. The monitoring station near Clyde Park frequently had the warmest temperatures, suggesting daily monitoring at the USGS gage may underestimate temperatures occurring upriver. Evaluation of mean daily water temperatures further shows the tendency for temperatures to be warmer at station D, near Clyde Park (Figure 4-6).

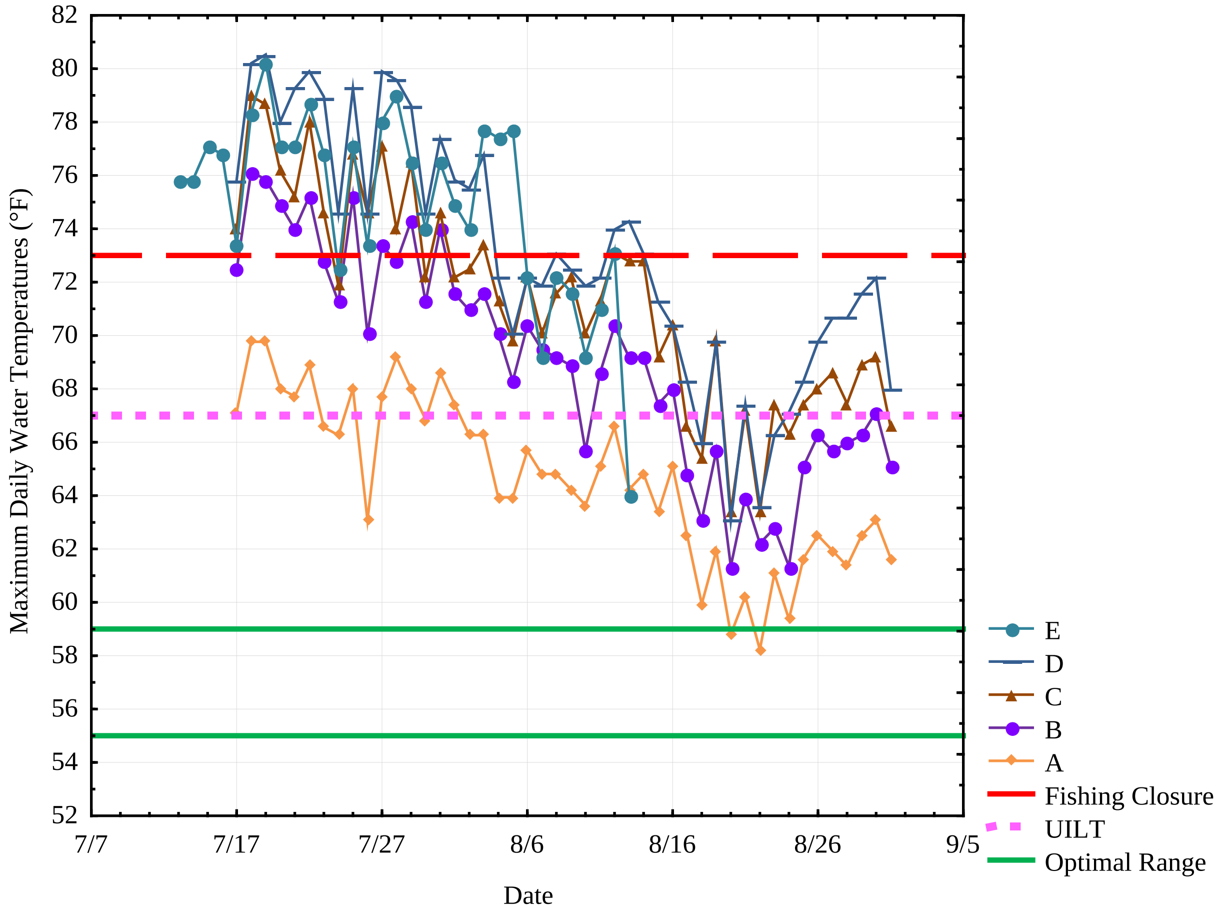

Figure 4-5: Maximum daily stream temperatures at FWP monitoring stations on the Shields River in 2007 (see Figure 4-1 for station locations).

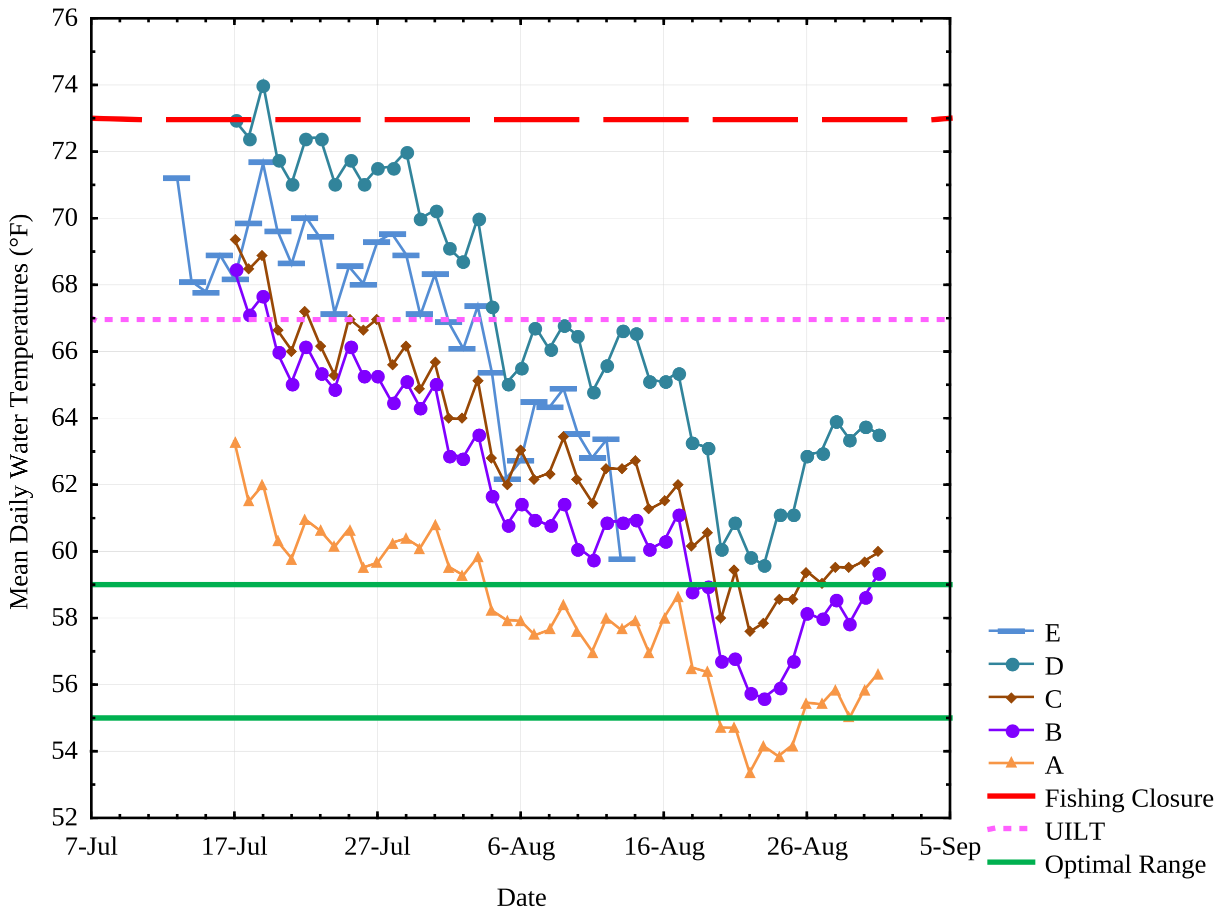

Figure 4-6: Mean daily stream temperatures at FWP monitoring stations on the Shields River in 2007 (see Figure 4-1 for monitoring station locations.)

FWP temperature monitoring on the tributaries included mostly headwater sites, although several stations occurred within the valley portions of some tributaries (Figure 4-1). Most stations within the Flathead Creek watershed were at relatively high elevation, and water temperatures tended to be cool through July and August (Figure 4-7). At the Cache Creek sites, and at Fairy Creek, maximum daily temperatures were frequently greater than the optimal range, but considerably lower than the UILT. The middle and south forks of Flathead Creek were exceptionally cool, with maximum daily temperatures less than or within the optimal range. The lowest sampling station on Flathead Creek had the highest water temperatures, which exceeded the UILT on approximately 20% of days, and ranged as high 74 °F on one occasion. Opportunities to decrease thermal loading through restoration of riparian shading, channel morphology, and water use efficiency may be available in Flathead Creek.

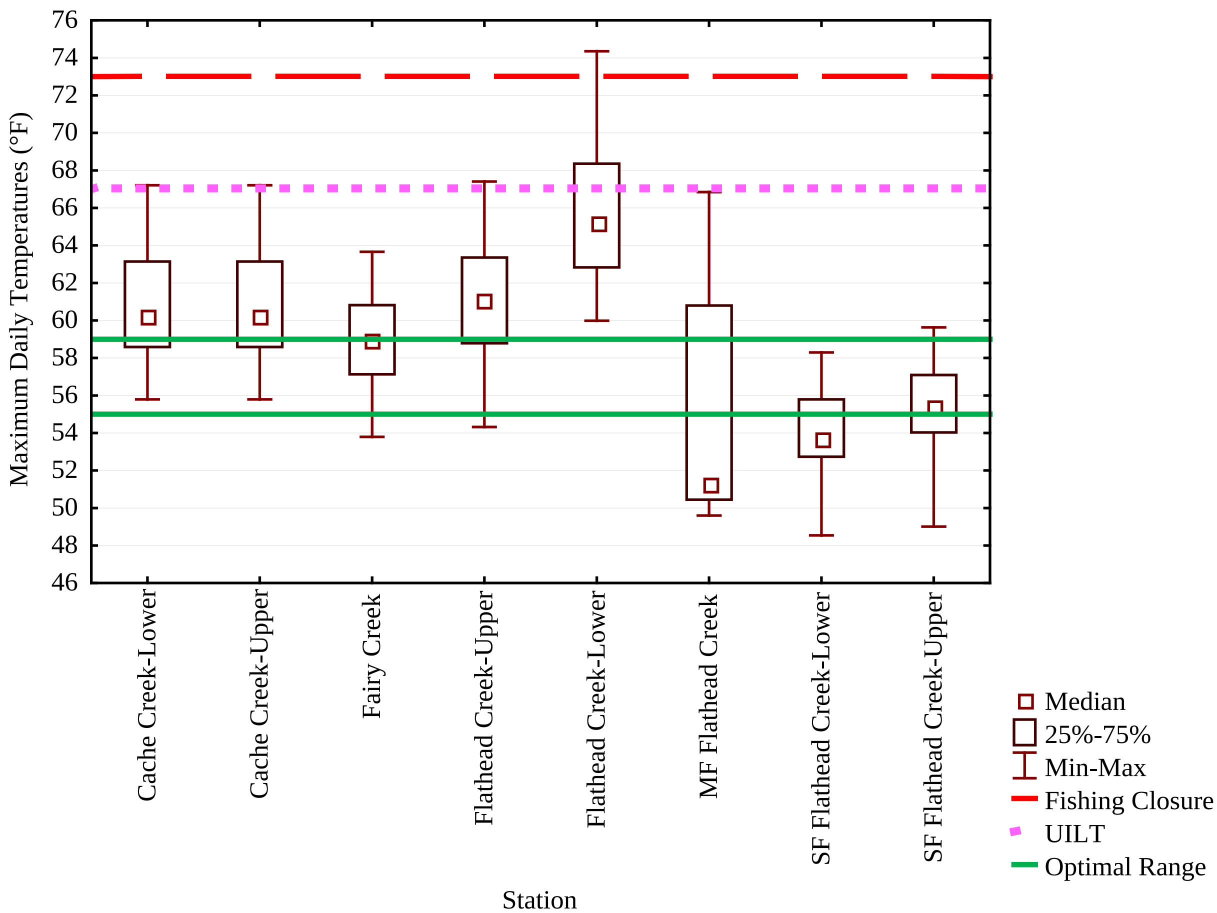

Figure 4-7: Distributional statistics for maximum daily temperatures measured on tributaries in the Flathead Creek 5th code HUC in July and August of 2002 (N = 62 per station).

FWP deployed thermographs over several years in the Upper Shields River Watershed (5th code HUC). Monitoring in 2003 found cool temperatures in Deep Creek, which were typically lower than the optimal range (Figure 4-8). The upper site on Mill Creek had maximum temperatures typically within the optimal range. The lower station on Mill Creek, and the South Fork Shields River were often higher than the optimal range, but less than the UILT, indicating thermal stress was not impairing Yellowstone cutthroat trout populations. The thermograph on lower Smith Creek registered relatively warm water temperatures for a headwater site, and most maximum daily temperatures were greater than the UILT. Investigating the sources of thermal loading may guide conservation actions to maintain cooler temperatures in Smith Creek. The apparently elevated temperatures in Smith Creek may give invading brook trout a competitive advantage.

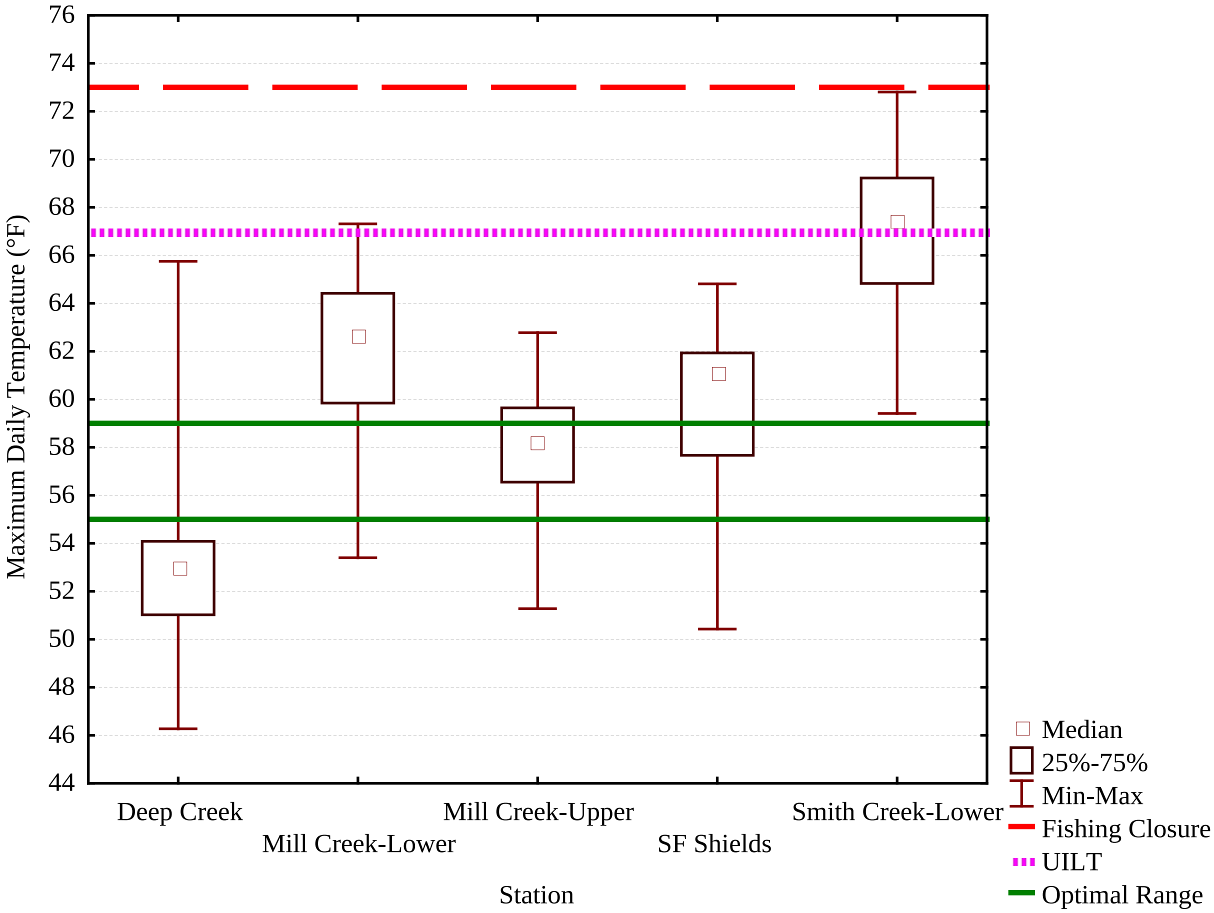

Figure 4-8: Distributional statistics for maximum daily temperatures measured on tributaries in the Upper Shields River 5th code HUC in July and August of 2003 (N = 62 per station).

Temperature monitoring in the Upper Shields River Watershed in 2005 occurred on Smith Creek and Dugout Creek. Maximum daily temperatures were cool, and were mostly within the optimal range (Figure 4-9). The upper and middle stations on Smith Creek were considerably cooler than measured at the lower station in 2003. These results suggest the reach between the middle and lower station is the major recipient of thermal loading.

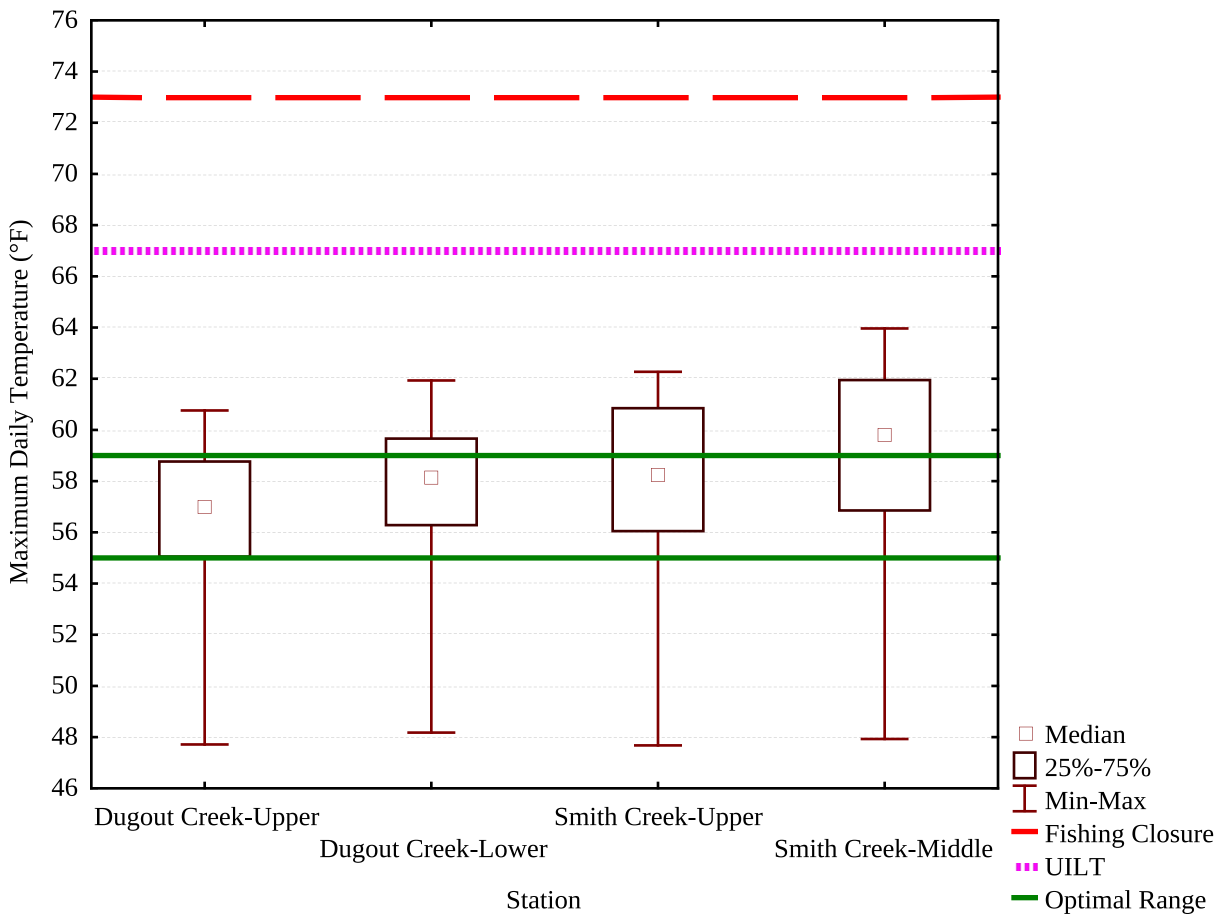

Figure 4-9: Distributional statistics for maximum daily temperatures measured on tributaries in the upper Shields River 6th code HUC in July and August of 2005 (N = 62 per station).

Temperature monitoring in the Upper Shields River Watershed suggested 2006 had a slightly warmer summer than 2005 (Figure 4-10). Maximum daily temperatures at the lower station on Dugout Creek typically exceeded the optimal range, although readings were still considerably lower than the UILT. The upper station on Smith Creek had similar values, with only rare occurrences of temperatures greater than the UILT.

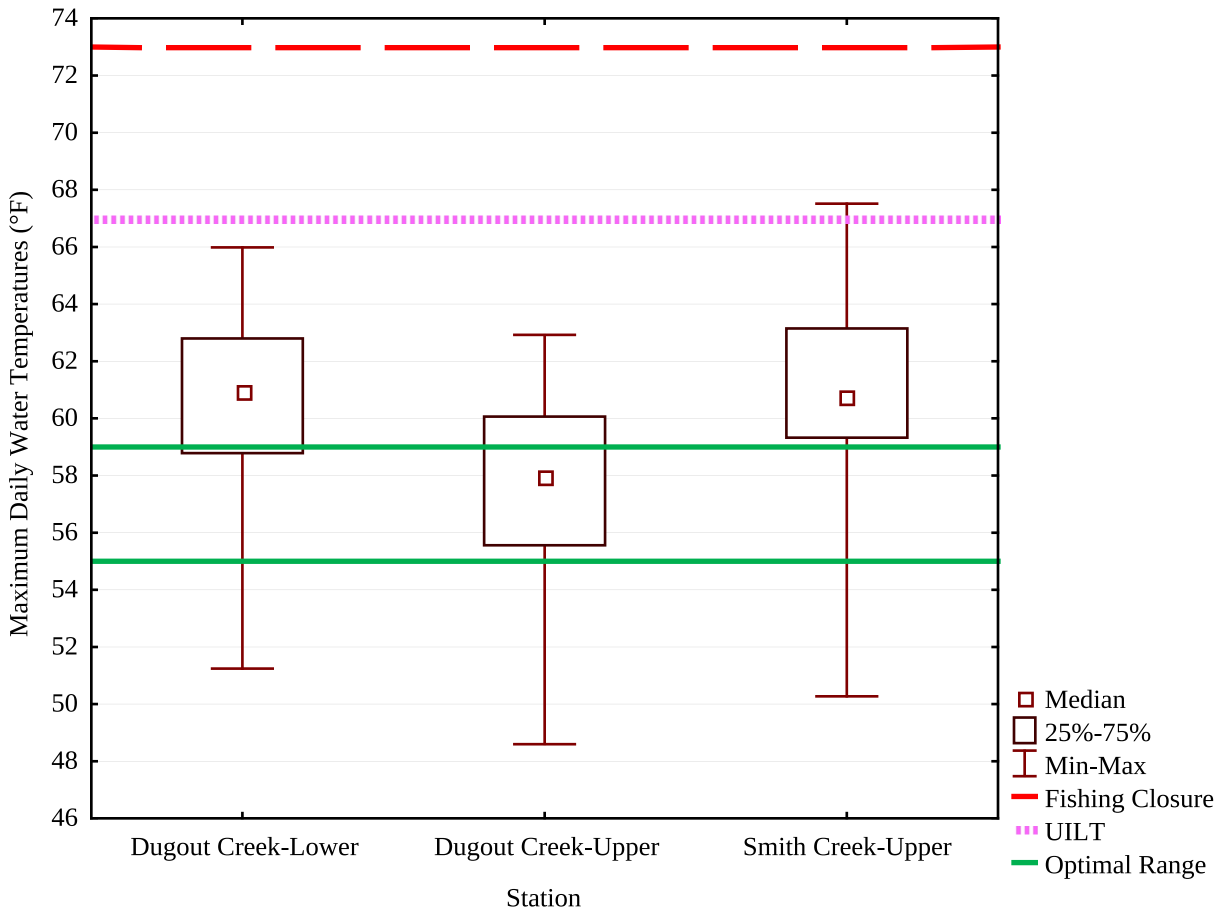

Figure 4-10: Distributional statistics for maximum daily temperatures measured on tributaries in the upper Shields River 6th code HUC in July and August of 2006 (N = 62 per station).

In 2002, FWP deployed thermographs at several locations in the Brackett Creek watershed, which lies in the Middle Shields River Watershed. Maximum daily temperatures at the lowest monitoring station on Brackett Creek exceeded the UILT on nearly 70% of days, suggesting sublethal stress to Yellowstone cutthroat trout (Figure 4-11). At the upper Brackett Creek station, and on Skunk Creek, maximum daily temperatures were typically within the optimal range. Temperatures on Horse Creek exceeded the optimal, but were always below the UILT, suggesting thermal stress was not limiting Yellowstone cutthroat trout.

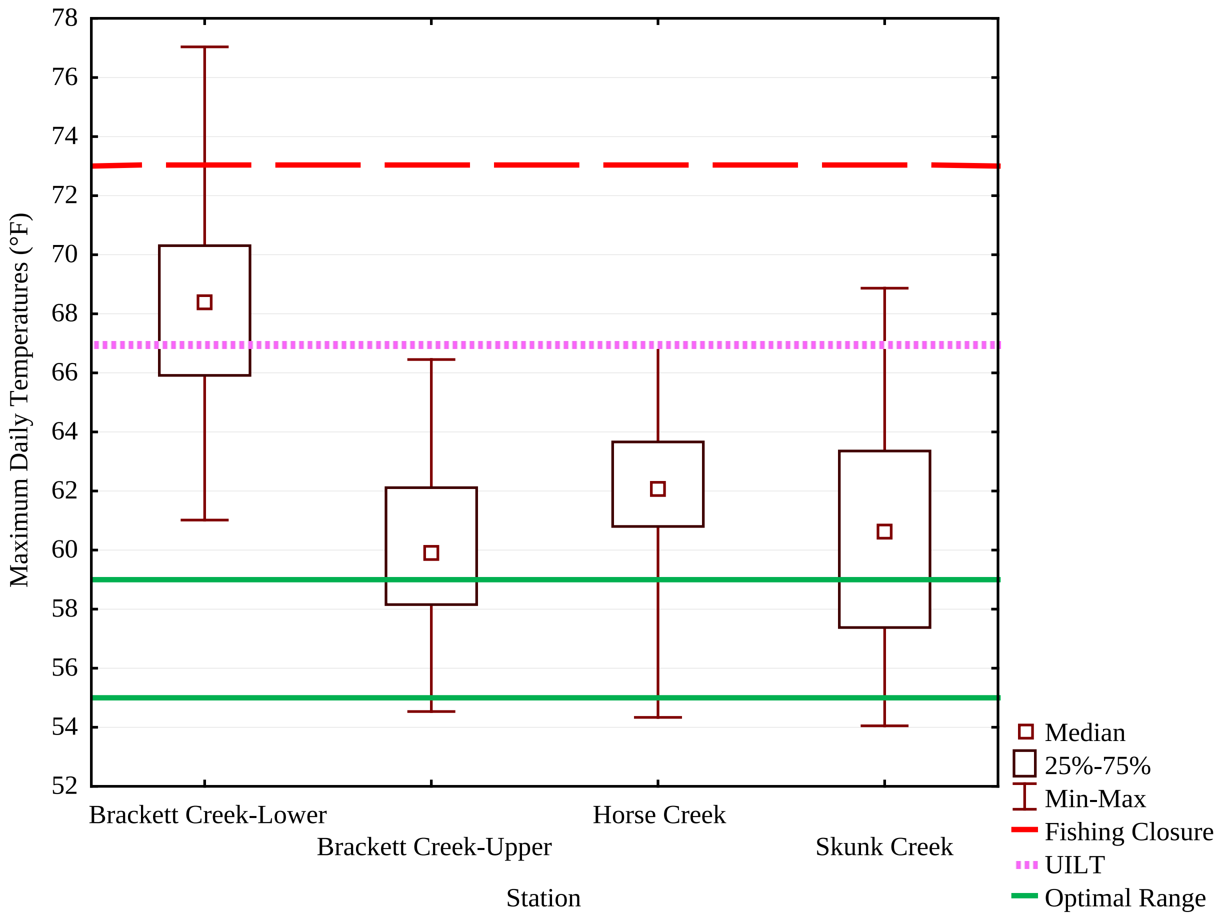

Figure 4-11: Distributional statistics for maximum daily water temperatures measured on tributaries in the Brackett Creek watershed in July and August of 2002 (N = 62 per station).

In 2003, FWP monitored temperatures in Cottonwood Creek and Rock Creek on the west side of the Middle Shields River Watershed (Figure 4-12). Thermal loading between stations on Cottonwood Creek was substantial, with an average of 4 °F gained across the four miles. Nonetheless, temperatures at the lower station were typically less than the UILT. Maximum daily temperatures at the Rock Creek station exceeded the UILT on about 35% of days, which suggests sublethal stress to Yellowstone cutthroat trout.

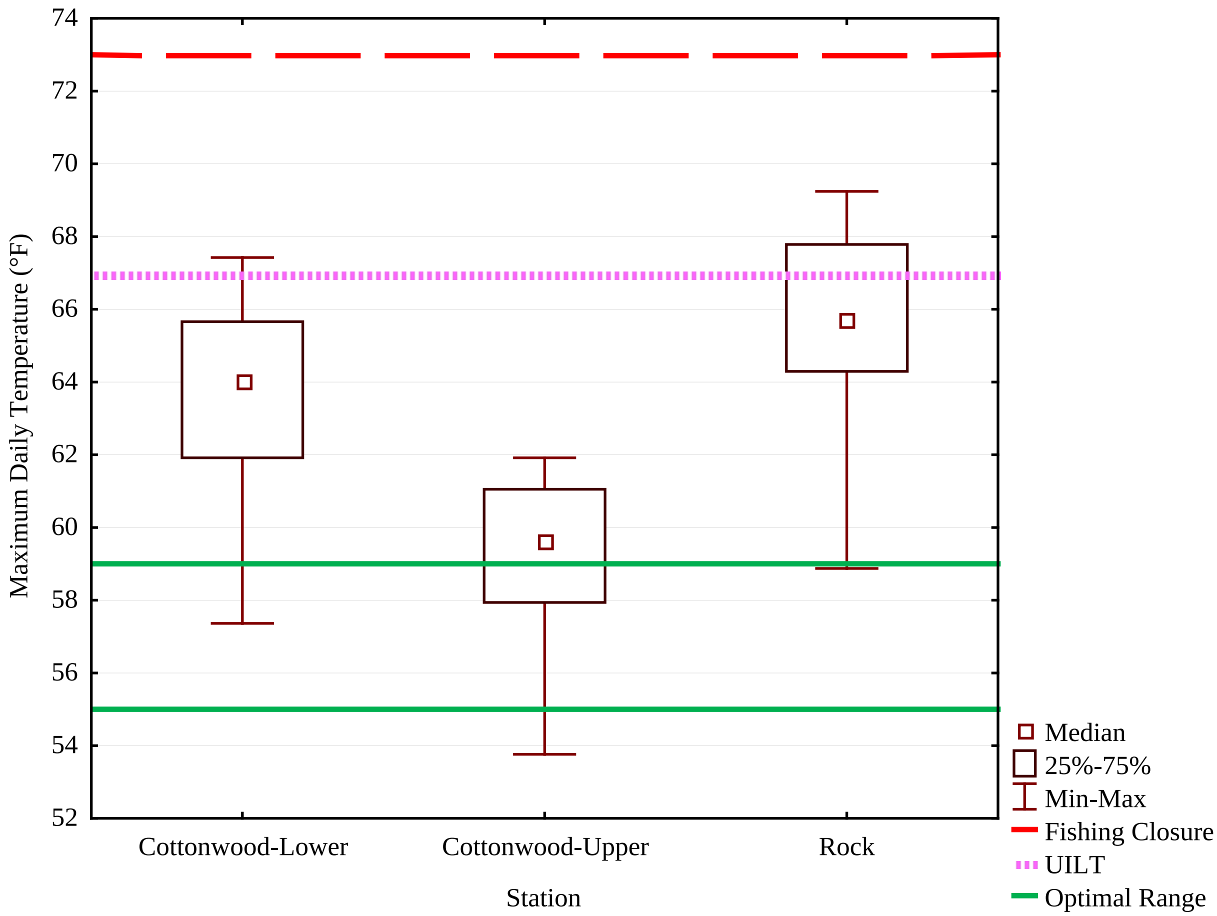

Figure 4-12: Distributional statistics for maximum daily water temperatures measured on Cottonwood and Rock creeks in July and August of.

FWP monitored temperatures at two locations in the Canyon Creek drainage in 2002 (Figure 4-13). Thermographs were installed on 7/10/2003 at the Canyon and Grouse Creek stations, resulting in 53 days of data. Maximum daily temperatures were typically above the optimal range. At the Grouse Creek station, temperatures did not meet or exceed the UILT. Maximum daily water temperatures at the Canyon Creek station exceeded the UILT on 9 of the 62 days. These results suggest minimal thermal stress in Canyon Creek and no thermal stress in Grouse Creek in 2002.

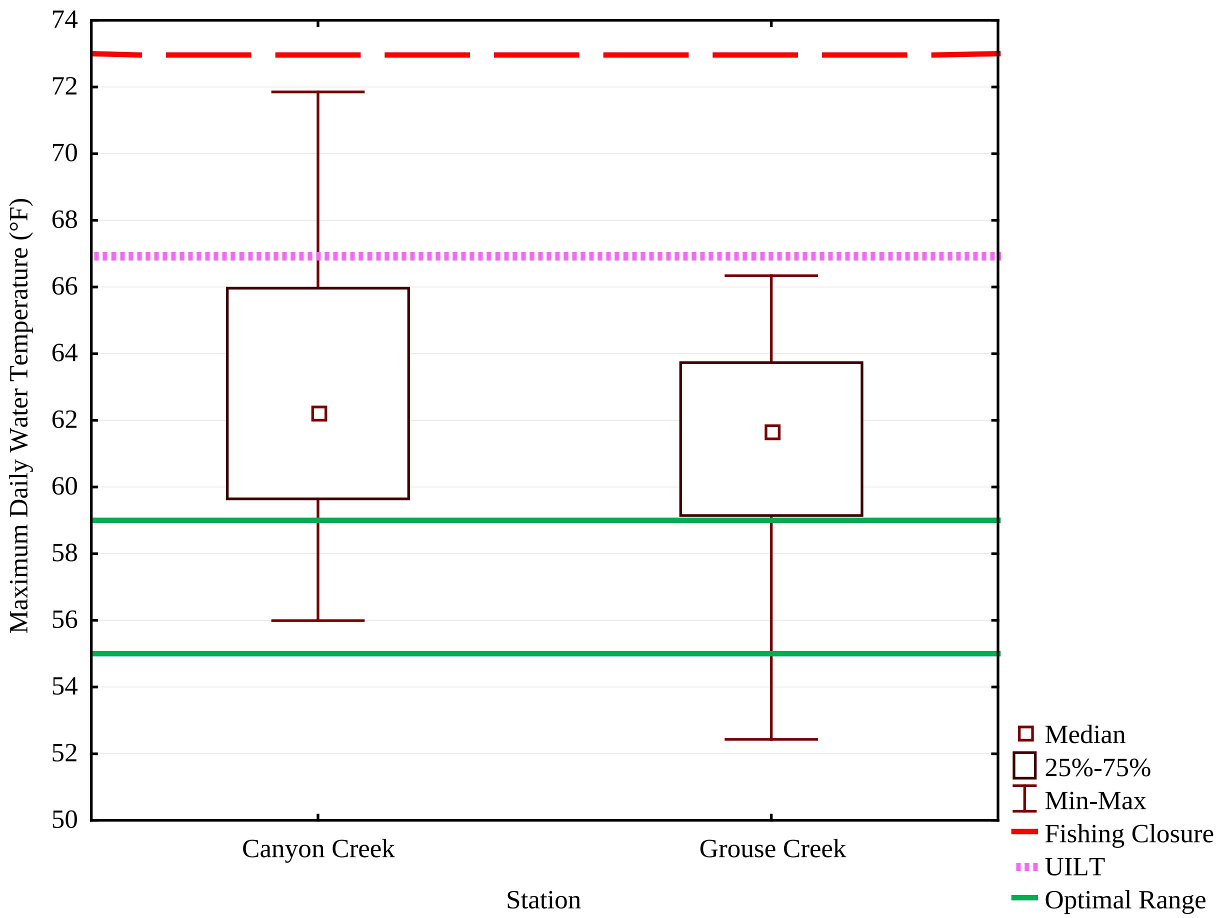

Figure 4-13: Distributional statistics of maximum daily water temperatures measured on streams in the lower Shields 5th order HUC in July and August 2002. (N = 62 per station.)

Comparison of daily maximum and average temperatures for all tributary sites from 2000 through 2012 indicate a high degree of concordance between these variables (Figure 4-14). The correlation coefficient approached 0.90 and the p value was exceptionally small. The analysis indicates that for the majority of the tributary monitoring stations, temperature rarely reaches stressful levels and a sizeable proportion of these data are within or cooler than the optimal range.

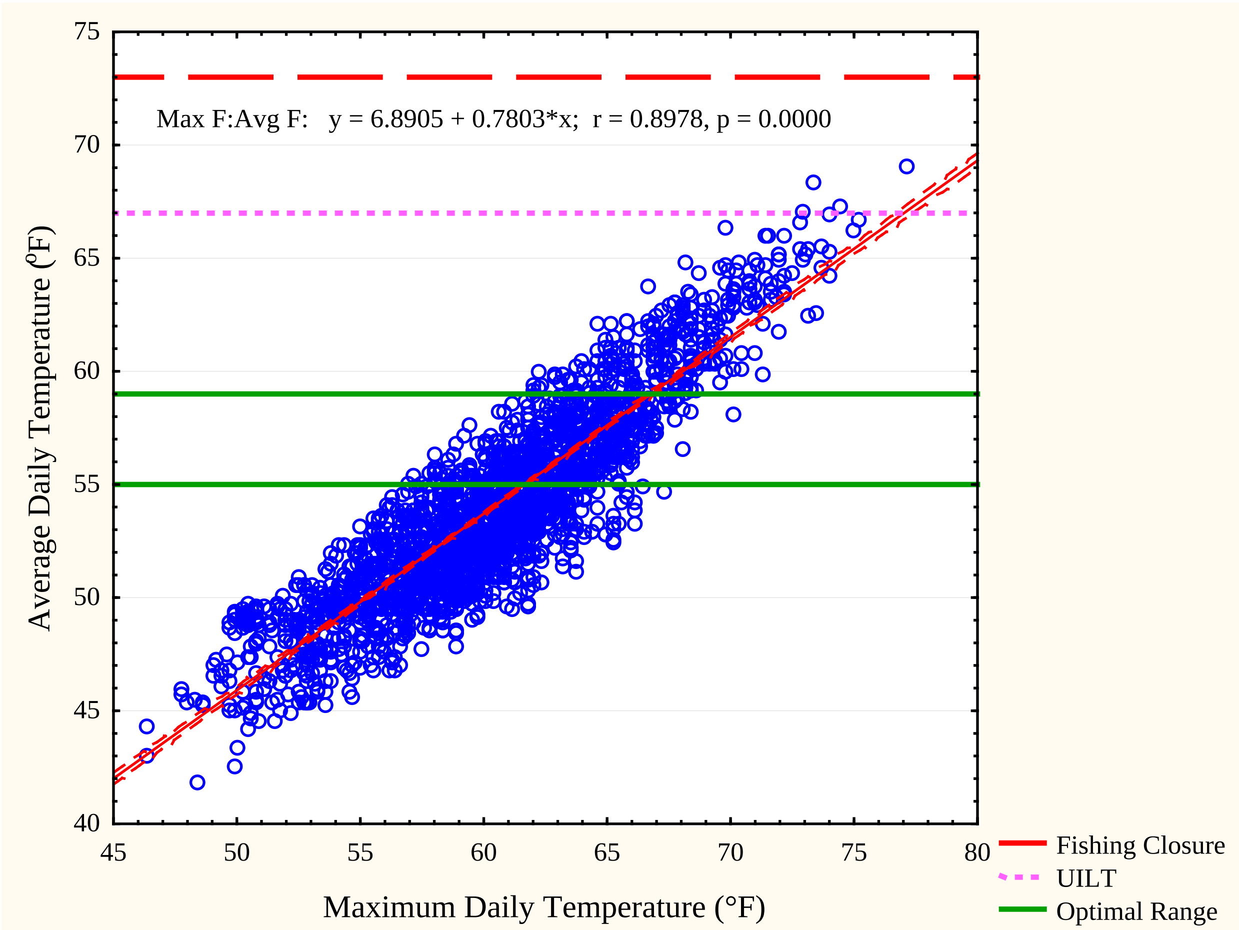

Figure 4-14: Comparison of average and maximum daily temperatures from tributary monitoring stations in the Shield River Subbasin.

Additional investigations are warranted to support conservation of Yellowstone cutthroat trout in the Shields River watershed with respect to the influence of thermal loading as a limiting factor. Researchers at the USGS, in collaboration with the Wildlife Conservation Society, have begun to evaluate stream temperatures measured at numerous locations throughout the watershed and relate these data to Yellowstone cutthroat trout growth and movements, and brook trout invasion. Another useful investigation would be development of a thermal model, such as the stream network temperature model (SNTEMP) developed by the USGS (Bartholow 2000). This model evaluates the role of three key factors (channel geometry, riparian shading, and stream flow) on water temperature, which allows development of targets to promote a suitable temperature regime to support coldwater fish. Laboratory and field studies investigating thermal tolerance of Yellowstone cutthroat trout would likewise guide conservation planning for Yellowstone cutthroat trout in the Shields River watershed, and elsewhere.

Most temperature monitoring has occurred on the main stem of the Shields River, or on its headwater tributaries. Evaluating temperature regimes within valley portions of tributaries would fill a substantial data gap, and would guide conservation activities for promoting water temperatures favorable for Yellowstone cutthroat trout.

In summary, warm water temperatures likely present a considerable constraint on Yellowstone cutthroat trout in portions of the Shields River watershed. Causal factors include irrigation withdrawals and reductions in habitat quality that increase solar inputs to the water surface. Climate change is bringing warmer summer temperatures and diminished summer stream flows, which complicates efforts to maintain cooler temperatures. The conservation approach will begin with identification of human-caused sources of thermal loading. FWP and its partners would then work towards voluntary implementation of practices that decrease the potential for streams to reach temperatures that are stressful to Yellowstone cutthroat trout.

4.2.3 Water Quantity

Low summer stream flows in the Shields River and several of its tributaries present a considerable constraint on the ability of these streams to support Yellowstone cutthroat trout. Graphical analysis of daily stream flows at the gage near the mouth of the Shields River demonstrate a potential effect of irrigation withdrawals on stream flow, with a relatively abrupt drop in average stream flow following the peak (Figure 4-15). In a stream not altered by irrigation withdrawals, the declining limb would be more gradual. Although irrigation withdrawals have potential to dewater streams to an extent that warm water temperatures and reduced habitat availability negatively affect fish, not all streams with irrigation withdrawals experience dewatering to a harmful extent. FWP maintains a list of dewatered streams, where irrigation withdrawals likely result in conditions unfavorable to support of cold-water fisheries (Table 4-3 and Figure 4-16).

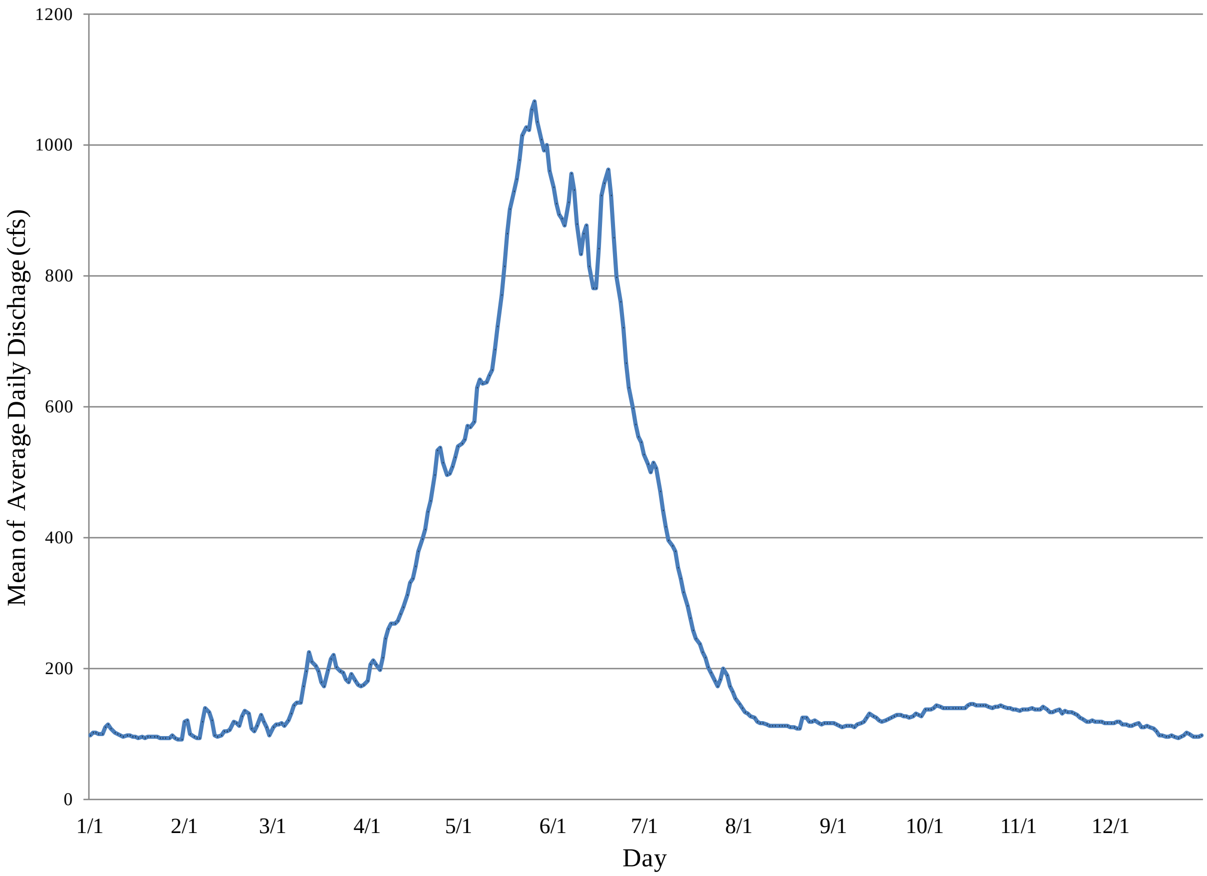

Figure 4-15: Average of mean daily stream flows from the USGS station near the mouth of the Shields River for the period of record (10/1/0978 though 4/8/2012).

Table 4-3: Streams included on FWP's list of dewatered streams.

Stream	***Rating***	***Dewatered River Miles***	***Streams with Water Reservation***
Bangtail Creek	Chronic	0 to 5	
Brackett Creek	Periodic	0 to 16.8	✓
Canyon Creek	Chronic	0.0 to 0.07	
Cottonwood Creek	Chronic	0 to 6	✓
Flathead Creek	Periodic	0 to 12	✓
Rock Creek	Chronic	0 to 2	✓
Shields River	Periodic	0 to 65.2	✓
Willow Creek	Chronic	0 to 11.8	

Chronic dewatering refers to streams where dewatering is a significant problem in virtually all years. Periodic dewatering applies to streams where dewatering is only a problem in drought or water short years.

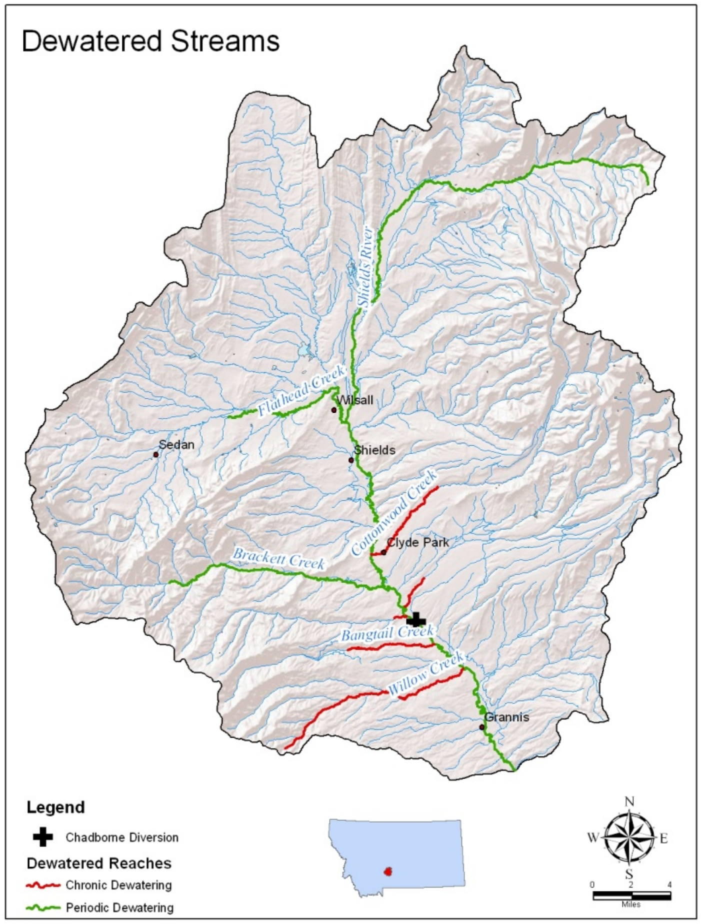

Figure 4-16: Streams designated as chronically or periodically dewatered in the Shields River watershed.

Five of the eight dewatered streams, in addition six other streams, have established water reservations under the Montana Water Use Act of 1973. This act established a mechanism for the protection of in-stream values through a systematic and comprehensive approach (Section 85-2-316, MCA). The act developed a process for future diversionary and consumptive uses by the state, the federal government, or any political subdivision or agency of state or federal government, to reserve water for existing or future beneficial uses, or to maintain a minimum flow for water quality (Section 85-2-316, MCA). In 2005, an amendment to the statute allowed individuals, associations, partnerships, or corporations to reserve water for in-stream flow (85-2-408(2) (b), MCA). Conservation organizations such as Trout Unlimited have been leasing water rights under this statute.

Promoting in-stream flow faces numerous challenges. Although FWP has in-stream flow reservations for over 170 stream segment and time frame combinations among the five streams with reservations[5], these reservations have a priority date of December 15, 1978, whereas many water rights in the watershed date to the late 1800s, giving these rights considerable seniority over FWP's reservations. Furthermore, water users rely on surface water for their livelihood; therefore, solutions to flow management must be compatible with the economic and social realities in an agricultural watershed. Other potential complications include unintended consequences in implementation of practices meant to keep flows in streams, but instead alter recharge processes that maintain late season flows in some streams (DNRC 2005). An example would be converting from flood irrigation to pivot, when recharge from flood irrigation was a source of late season stream flow. The combination of economic, hydrologic, and ecological issues relating to dewatering in the Shields River watershed results in a complex issue with no easy solutions.

Another concern is that even with the most efficient irrigation scenarios, irrigation demands on the Shields River will exceed the available water supply during late summer (L. S. Dolan, DNRC, personal communication). Moreover, dewatering has occurred in spring when the onset of irrigation occurred before substantial higher elevation snow melt. These issues may present considerable obstacles to maintaining in-stream flows during critical periods.

Despite the challenges, many opportunities exist to promote in-stream flows. The strategy is to work collaboratively with water users, while conducting the requisite investigations to promote an effective approach that meets user's needs, and potentially compensating water rights holders who contribute water to in-stream flows. Fundamental to this approach will be an understanding of existing conditions, available conservation opportunities, and limitations. The objective of this section is to summarize the available information and describe the components that will shape the approaches for promoting in-stream flows in the Shields River watershed.

Agriculture is the primary land use within the Shields River Subbasin. Open range comprises a large portion of the watershed, but significant irrigated lands and water diversions place a strong demand on the river and its tributaries during the summer season. In 2000, an irrigation study of in the upper basin (Compston 2002) identified approximately 5,000 acres of lands as irrigated with waters originating in the upper Shields watershed (excluding lands irrigated by Meadow Creek and the South Fork Shields River). During 2000, 90% of these lands were irrigated for grass or alfalfa hay, with the remaining 10% in grains (USWA 2001). The majority of the irrigation (80%) was flood systems, with smaller percentages using side-roll (12%) and center-pivot (8%) sprinklers.

[5] See the MFISH database for in-stream flow reservations for streams in the Shields River Subbasin (HUC 10070003) (http://fwp.mt.gov/fishing/mFish/)

Compston (2002) found that 2000 was a lower than average water year, and that water supply did not meet irrigators' needs after early July. By late August, the water supply was estimated to meet one-fifth of the total water need by irrigators. Many ditches were shut down in early July. Despite the low water year, the findings suggest that even in a median flow year, water supplies within the upper Shields are not sufficient to meet the irrigation demand past mid-July. Moreover, even under the most efficient irrigation scenarios, irrigation demands on the Shields River would still exceed the available water supply during the late summer (L.S. Dolan, DNRC, personal communication). Likewise, streams may be dewatered in spring if the irrigation season begins before the onset of snowmelt (L. S. Dolan, DNRC personal communication).

In the mid-1970s, FWP investigated flow regimes in order to determine flows required to support fish. The method used in establishing the minimum flow was the percent exceedance approach, which FWP has since replaced with the wetted perimeter method (Leathe and Nelson 1989). The percent exceedance approach calculated the flow exceeded 90% of the time for the period of record for a given stream. The percent exceedance approach yields values that are dependent on the temporal coverage of the existing data, have an unknown relationship to biological requirements, and reflect flows occurring in an altered hydrograph. In contrast, the wetted perimeter method prescribes minimum flows based on flows sufficient to inundate riffles. The rationale is that inundated riffles maintain in-stream productivity of invertebrates, and sufficient water is available to fill pools.

A limitation of the wetted perimeter approach is that it does not address flows to maintain a suitable thermal regime in streams experiencing dewatering. As discussed in 4.2.2 Water Temperature, development of a thermal model that accounts for channel geometry, streamside shading and stream flow provides an alternative to determine minimum flows to address temperature loading. Application of both approaches would be ideal to guide decision-making in the Shields River watershed. See section 6.6 Water Temperature for the conceptual approach to modeling the relationships among stream flow, channel geometry, shading, and water temperature.

Maintenance of minimum flows is not the only flow related concern for the Shields River and its tributaries. Promotion of peak flows of sufficient magnitude and duration to rework the streambed, transport bed load, and form pool habitat is another consideration. The available flow data do not allow evaluation of this potential in the Shields River. Collecting flow data across the hydrograph at key locations in the watershed would allow evaluation of the sufficiency of existing flows to perform channel maintenance functions.

Established gauge stations provide the majority of the information on stream flows in the Shields River watershed and will support future planning efforts. The USGS has operated seven gauge stations in the basin, with most being operational for a short period in the 1920s or 1930s (Table 4-4). The exception is the gauging station located near the mouth of the Shields River, near Livingston, which began operation from 1978 and is still active.

Table 4-4: USGS gauge stations and period of record for streams in the Shields River Subbasin.

Station Number	*Station Name*	*Begin*	*End*
6193000	Shields River near Wilsall, MT	5/1/1935	1/24/1938
6193500	Shields River at Clyde Park, MT	3/31/1921	12/25/1923
6194000	Brackett Creek near Clyde Park, MT	4/1/1921	12/26/1923
6194500	Canyon Creek near Chadbourne, MT	3/23/1923	4/14/1923
6195000	Bangtail Creek near Chadbourne, MT	3/23/1923	6/30/1923
6195500	Willow Creek near Chadbourne, MT	3/24/1923	4/28/1923
6195600	Shields River near Livingston, MT	10/1/1978	current

Low-cost, temporary flow monitoring devices, such as Trutracks™, provide a cost-effective means to augment the understanding of stream flow across the basin. The conservation strategy for the Shields River watershed will include development of a hydrological monitoring plan that will inform the adaptive management of stream flows, identify opportunities for water savings, and allow characterization of groundwater/surface water interactions.

Low mid-summer stream flows are a key factor limiting Yellowstone cutthroat trout populations, as well as influencing agricultural productivity in the basin. Conservation of water supplies through improved irrigation and conveyance efficiency may be a key component of conservation of Yellowstone cutthroat trout in the Shields River watershed. Working closely with the water users and the local watershed group, along with agency partners, will be an important step in implementing water conservation practices. Water leases through FWP or nonprofit groups may provide another avenue to promote in-stream flows.,

Although water use efficiency will undoubtedly be among the tools in promoting in-stream flows in the Shields River watershed, a study suggests reliance on irrigation efficiency is overly simplistic given the basin's complex hydrology (DNRC 2005). Seemingly inefficient practices actually promote late-season flows in some streams. For example, flood irrigation or leaking ditches may actually be beneficial to some streams in late summer. Therefore, water use planning in the basin needs to proceed cautiously and consider water rights, forage production requirements, and mechanisms of stream recharge. Efforts to conserve in-stream flows should include a monitoring component to support the adaptive management of water conservation in the basin.

Innovative practices, such as using flood irrigation during spring runoff may serve the dual purpose of promoting groundwater recharge for late season stream flows, and removing transported sediment from surface waters (B.B. Shepard, Wildlife Conservation Society, personal communication). Land application of sediment-rich waters would benefit soil productivity, just as the settling of sediments on floodplains during overbank flows increases soil fertility. Identification of existing but abandoned infrastructure for flood irrigation would be a component of this potential approach. To date, this method is untested; however, pilot studies would be useful in evaluating the utility of this method in promoting stream flow improvement and sediment load reductions.

Irrigation in the Shields River watershed is almost exclusively a surface-water issue; however, increasing residential land use taps the groundwater within the watershed as well. The over 1200 wells in the Shields River watershed have the potential to produce a total estimated yield of approximately 32,000 gallons per minute (GWIC database download 9/5/2012). These wells vary in depth from less than 75 feet to greater than 800 feet, with nearly 39% being relatively shallow at less than 75 feet (Table 4-5). The wells less than 75 feet have potential to yield over 15,500 gallons per minute.

Table 4-5: Number of wells in the Shields River watershed in each depth category (MBMG 2005).

Depth Category (feet)	***Count***	***Percent of Total***
0 - 74	488	39%
75 - 149	355	29%
150 - 224	202	16%
225 - 300	93	8%
> 300	100	8%
Total	1238	100%

Pressure on groundwater resources has varied across time, with 59% of the wells drilled since 1990 (Table 4-6). Although groundwater may not seem as important to Yellowstone cutthroat trout conservation as surface water, interactions between groundwater and surface water affect surface water supplies, and is a factor to consider in long-term planning. Reducing surface water withdrawals may have an immediate and direct effect on the amount of water available to Yellowstone cutthroat trout within a stream. Increasing demands on groundwater may play a part in reduced surface water supplies within the watershed, particularly in areas where wells appear to be concentrated, such as near the towns of Clyde Park, Grannis, and Wilsall, and near Skunk Creek along Brackett Creek (Figure 4-17). Moreover, nearly 40% of wells are relatively shallow (Table 4-7) and may affect recharge of surface water. The general concentration of wells along the main stem of the Shields River may also be intercepting waters that would recharge the river in low water periods (Figure 4-17). The relatively shallow depth of the majority of wells supports this hypothesis.

Table 4-6: Number of wells drilled in the Shields River watershed by time interval (GWIC database download 9/5/2012)

Period	*Number of Wells*	*Percent of Total*
Before 1910	40	3%
1910 - 1950	72	6%
1951- 1960	25	2%
1961 - 1970	56	5%
1971 - 1980	163	13%
1981 - 1990	151	12%
1991 - 2000	331	27%
2001 - 2010	400	32%
Total	973	100

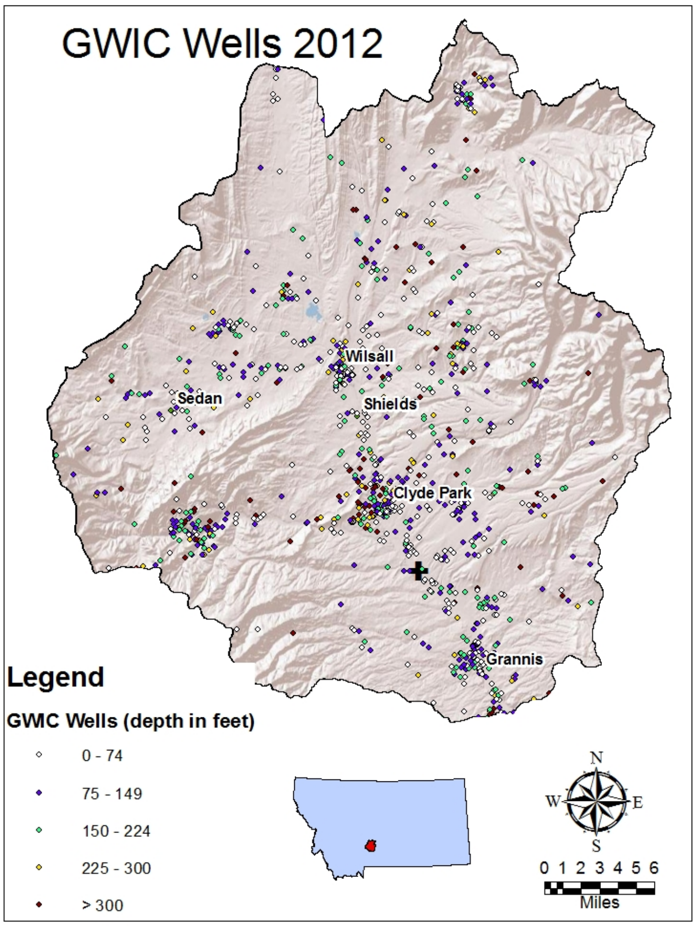

Figure 4-17: Groundwater wells and developed springs recorded by Montana Bureau of Mines and Geology in their Groundwater Information Center (GWIC) database for the Shields River Subbasin (GWIC download 9/5/2012)

Table 4-7: Depth of wells drilled in the Shields River watershed (GWIC database download 9/5/2012)

Well Depth (feet)	*Number of Wells*	*Percent of Total*
0 – 74	488	39%
75 – 149	355	29%
150 – 224	202	16%
225 – 300	93	8%
> 300	100	8%
Total	1238	100%

In summary, managing stream flows to benefit Yellowstone cutthroat trout in the Shields River and its tributaries will be a challenging endeavor given the competing interests in water availability, complex basin hydrology, and economic realities in an agricultural watershed. Climate change may be an additional factor, with its tendency to alter precipitation patterns and reduce stream flows. Nevertheless, opportunities exist to increase summer stream flows. The conservation strategy will emphasize cooperation and collaboration with water users, potential compensation for contributed flows, assistance in promoting irrigation efficiency, and a sound monitoring plan to promote the adaptive management of stream flow in the Shields River watershed. Collaborators in the process will include FWP, the SVWG, NRCS, and water users. Private conservation groups such as Trout Unlimited will also be collaborators.

4.3 Habitat Quality

4.3.1 Evaluated Habitat Conditions

The Forest Service and FWP have conducted habitat and electrofishing surveys of many of the tributaries in the Shields River watershed. Although not every tributary has been surveyed, adequate information exists to characterize broad habitat conditions within each of the 5th code HUCs displayed in Figure 1-1**.** Recent major survey efforts used to complete this section of the report include a survey of the Shields River tributaries (Shepard 2004), which focused on the western side of the drainage, and the Forest Service surveys of major tributaries on Forest Service administered lands (Jones and Shuler 2004, Forest Service file data 2006, 2007, 2008). In addition, Tohtz (1999b) and subsequent field biologists gathered information on east side tributaries both on and off Forest Service administered lands. Forest Service administered lands encompass much of the headwaters areas in the eastern side of the drainage.

In general, Shepard (2004) found the habitat on the western side of the watershed to be in functioning condition in most tributary streams; however, the lower portions of many tributaries had extremely low flows because of irrigation withdrawals and drought occurring during sampling. Disturbance from livestock grazing along stream channels was widespread, but was severe only at a few locations. Some areas appeared to be recovering following improvements in livestock management. Road and timber harvest effects to stream channels were apparent at several locations. High levels of fine sediment were evident in many of the western-side streams; however, the sources of this fine sediment were often difficult to identify. Shepard (2004) also recorded high water temperatures at some sites, and noted that high temperature may be limiting trout in some locations. The Forest Service surveys found similar conditions on the eastern-side tributaries. Many areas had siltation or bank instability listed as potentially limiting factors for fish habitat.

In 1998, representatives from the Forest Service and FWP flew over several tributaries within the Shields River basin to evaluate fish habitat and stream condition (Shuler 1999, Tohtz 1999b). The fisheries biologists flew over the main stem of the Shields River, Smith, Porcupine, North and South Fork Elk, Dry, Elk, Daisy Dean, South Fork Horse, Horse, and Cottonwood creeks and documented impaired reaches while making general recommendations on restoration opportunities. Results of this assessment guided specific conservation strategies described in Section 5.0 Data Review and Conservation Strategies and Opportunities by Stream/Watershed.

The TMDL planning effort also provides information on habitat quality through its investigations of bank erosion throughout the basin (DEQ 2009). This effort involved on-the-ground evaluations of bank erosion in selected reaches, combined with analyses of aerial photos to identify stream reaches with potential to be experiencing bank erosion associated with land use practices. Field data were incorporated into an erosion model (Rosgen 2001), which estimated load of sediment from bank erosion for each 6th code HUC, and a potential sediment load reduction with restoration of bank stability and riparian function. Information from the TMDL planning is the foundation of the recently completed watershed restoration plan that identifies potential treatments and priorities in reducing sediment delivery to streams from bank erosion, roads, and hillslope erosion.

An important consideration with using the available information on habitat quality is its age, with some evaluations being decades old. These investigations would not necessarily reflect current land use practices and ongoing efforts by landowners to implement BMPs. Moreover, basin-wide flooding in 2011 resulted in marked channel adjustments in numerous streams. Nonetheless, the existing information provides a useful, initial screen in identifying opportunities for habitat restoration.

4.3.2 Habitat Management

High quality fish habitat requires sufficient water quantity and quality flowing through functional, dynamic stream channels that transport sediments efficiently, lined by healthy riparian areas that provide cover and nutrients and stabilize stream banks. The Forest Service is responsible for habitat management on its administered lands. A variety of state and federal agencies have jurisdiction over streams and wetlands on private and public lands. The Natural Streambed and Land Preservation Act (310 law), the Stream Protection Act (SPA) (124 permit), Short-Term Water Quality Standard for Turbidity Related to Construction Activity (318 Authorization), and the private pond laws are examples of state laws that require permitting and inspection of a proposed projects that may affect stream habitat. Federal laws also play a role in habitat protection, such as the Clean Water Act's Section 404, which regulates the placement of fill in state waters, or the National Forest Management Act. Agency cooperators will continue to work with landowners through the permitting processes to ensure that high quality habitats can be maintained.

4.3.3 Habitat Restoration

Although many of the streams in the Shields River watershed are in excellent condition, a variety of land and water management practices has altered the health and stability of some streams. Many opportunities exist to restore high quality habitats in the Shields River watershed and benefit Yellowstone cutthroat trout. Actions such as changes in grazing management, fencing, off-channel livestock watering stations, maintenance of riparian buffers along stream corridors, and other innovative projects that enhance or improve stream function, water quality and quantity, are necessary to conserve and restore Yellowstone cutthroat trout in the Shields River watershed. Positive, cooperative working relationships with landowners, the SVWG, and cooperating agencies are critical for implementing habitat restoration projects. Beginning in 2003, FWP established a position for a fish biologist to provide technical and financial to private landowners seeking to implement conservation projects on their properties. FWP also administers the Future Fisheries Improvement Program, which provides grants to landowners to restore habitats on their lands. Many other state, federal, and nongovernmental organizations have grant programs targeted towards restoring stream habitats. Successful projects have been underway in the Shields River Subbasin for several years. Chapter 0 summarizes habitat restoration projects undertaken by Forest Service, FWP, and private landowners.

Technical assistance from NRCS and the Montana State University Extension Service will play a role in development of grazing management strategies that meet forage production goals and protect riparian health and function. Grazing specialists from these entities bring expertise that considers upland and riparian health, and the understanding that promoting healthy, nutritious forage in the uplands will benefit riparian areas, as livestock will exert less pressure on streams.

The TMDL plan (DEQ 20009) and its ancillary watershed restoration plan (Confluence 2012) will also guide identification of potential projects and solutions to restore habitat quality and reduce sediment loading. The watershed plan includes conceptual approaches to decreasing sediment loading and identifies over 50 projects with known or potential landowner interest. Federal 319 funds may be available for projects identified in the watershed restoration plan.

4.3.4 Connectivity

Managing Yellowstone cutthroat trout in the Shields River watershed as a metapopulation requires connectivity within the basin to ensure gene flow and allow recolonization where localized disturbance has extirpated existing populations. Features that limit connectivity within agricultural and forested watersheds like the Shields include impassable culverts at road crossings and irrigation structures. Eliminating these fish passage barriers will be an important component of Yellowstone cutthroat trout conservation in the Shields River watershed.

The strategy to address connectivity in the Shields River watershed will be a multi-step process. Conducting an inventory of diversions and road crossings is the first stage, followed by evaluation to determine the potential to block fish passage. To date, the GNF has already inventoried its road crossings and assessed each for ability to pass fish. Identification of fish barriers in the rest of the basin has not followed a formal process. Development of a database of road crossings, irrigation diversions, and dams will guide field investigations to evaluate passage. Potential fish barriers will be prioritized based on cost and potential benefit to Yellowstone cutthroat trout. In some cases, certain barriers may be beneficial by preventing upstream movement of nonnatives, and maintaining these barriers would be a conservation priority.

Collaborators in this process include a variety of entities. Parties responsible for road management include the state, county, Forest Service, and private landowners. Modifications to irrigation diversions will require the collaboration of ditch companies and individual irrigators. FWP will work with these groups to promote fish passage where passage is desirable.

4.3.5 Entrainment in Irrigation Ditches

Irrigation diversions pose a threat to Yellowstone cutthroat trout populations, as fish can become entrained and lost to the system. For example, an investigation of habitat use and movements of Yellowstone River fish found 3 of 44 radio-tagged Yellowstone cutthroat trout died following entrainment into irrigation ditches (DeRito 2004). Fish loss has the potential to be significant, especially in drought years when ditches carry more flow than stream channels. Reduction or elimination of entrainment is possible through several approaches, including managing ditch shut off to allow fish an opportunity to return to the stream, and construction of fish screens.

Rapid shutdown of ditch operations leads to fish becoming stranded in irrigation ditches. Staggering the shut down over three days prompts fish to move up the ditch until they reach the river or find refugia such as pools. Maintaining ditches so they retain a uniform and smooth channel will further encourage fish to return to the stream by limiting holding areas.

Installation of fish screens on irrigation diversions is another approach to preventing loss of Yellowstone cutthroat trout to irrigation ditches. Several types of fish screens are available such as turbulent fountains, Coanda screens, and rotating drum screens. Numerous funding sources are available to pay for these improvements.

Although fish screens are important potential tools in reducing entrainment of adult and juvenile Yellowstone cutthroat trout, these are expensive to install and maintain, and should be justified following investigation of fish losses to individual ditches. Furthermore, investigations into habitat use and seasonal movements of Yellowstone cutthroat trout in Shields watershed streams are warranted to identify key spawning and rearing areas. Diversions with observed entrainment of adults or fry would be prioritized for screens.

FWP will bear primary responsibility for working with irrigators on practices to reduce entrainment of Yellowstone cutthroat trout into irrigation diversions. Partners will include the SVWG, ditch companies, and individual irrigators. FWP will work toward an inventory of irrigation diversions to identify those with potential for substantial entrainment of Yellowstone cutthroat trout. In addition, a diversion inventory would identify impassable structures, and head gates where modifications or repairs may increase water use efficiency.

4.4 Fisheries Management

The State of Montana's fisheries management policy is to establish and promote self-sustaining populations of wild fish in rivers and streams. Meeting this policy requires maintenance of high quality habitat, monitoring of fish populations, and management of exploitation by anglers. Fishing pressure in the Shields River Subbasin is relatively low, and unlikely to affect local fish populations negatively. Fishing regulations will continue to protect Yellowstone cutthroat by requiring catch-and-release only fishing. Other trout may be kept at the rate of five in possession per licensed angler per day during the regular fishing season for the Shields River (see http://fwp.mt.gov/fishing/regulations/ for the most recent fishing regulations).

Conservation of Yellowstone cutthroat trout requires managing not only the existing populations, but also learning how introduced species interact with and affect Yellowstone cutthroat trout in their native habitats. Nonnative salmonids regularly displace cutthroat trout following invasion into new waters in the western United States (Behnke 1992, Gresswell 1988, Young 1995) and this displacement is happening in the Shields River watershed. Brook trout are rapidly supplanting Yellowstone cutthroat trout in headwaters in the Shields River watershed. Rainbow trout exert a major, irreversible impact on Yellowstone cutthroat trout through hybridization. Recent research suggests negative consequences on fitness for hybridized westslope cutthroat trout (Muhlfeld et al. 2009). That Yellowstone cutthroat trout suffer similar decreases in fitness when hybridized is conjectural; however, fisheries management should consider this possibility until the requisite studies are conducted. Until more information on interspecific interactions is available, FWP intends to manage the Shields River Subbasin to minimize interspecific competition between Yellowstone cutthroat trout and nonnative species by prohibiting stocking of nonnative species in the watershed.

FWP's goal is to monitor trout populations in the Shields River and tributaries on a rotating basis. Electrofishing is the primary technique for population monitoring. Long-term sampling sections have been established on the main stem Shields River, but additional sections should be established in the upper Shields River watershed and tributaries to document population trends and adapt management strategies.

Removal of nonnatives is a commonly used approach in conserving native inland salmonids. Options include mechanical removal, and application of piscicide, such as rotenone. Piscicide is the most effective option in most circumstances, although suppression and mechanical removal are feasible and cost effective approaches in some situations (Shepard 2010). The conservation strategy to promote Yellowstone cutthroat trout in sympatry with rainbow trout, brown trout, or brook trout follows several steps. First is to identify streams where Yellowstone cutthroat trout co-occur with competing species. Each stream will be evaluated for factors relating to potential for effective removal of competing species, such as proximity of other potential sources of nonnative fishes and complexity of the habitat. Following the required environmental review process (MEPA or NEPA), removal will occur in streams with a high potential for success. Suppression will follow an adaptive management approach, where subsequent monitoring results inform future efforts. In many cases, construction of a barrier may be warranted to prevent reinvasion of nonnative fishes into treated waters.

A substantial number of streams are candidates for removal or suppression of nonnative salmonids. Of the 61 streams evaluated, 59 still support Yellowstone cutthroat trout (Table 4-8). Brook trout are likely present in just under half, and brown trout are probable in 22 of these streams. Rainbow trout are probable in five of the 61 streams. Yellowstone cutthroat trout co-occur with just one nonnative species in 20 of the 61 streams.

Table 4-8: Known or suspected presence of Yellowstone cutthroat trout, brown trout, brook trout, and rainbow trout in streams within the Shields River watershed above the Chadbourne diversion (MFISH database). A=abundant, C=common, R=rare, U=unknown

Fifth Code HUC	*Stream*	*Brook Trout*	*Brown Trout*	*Rainbow Trout*	*Yellowstone Cutthroat Trout*
Upper Shields	Shields River	A	C		C
	Bennett Creek	A			A
	Buck Creek				A
	Clear Creek				A
	Crandall Creek	A			
	Daisy Dean Creek				A
	Deep Creek	A			A
	Dugout Creek				A
	East Fork Smith Creek				R
	Elk Creek		A		A
	Goat Creek	A			A
	Horse Creek	A		A	R
	Lodgepole Creek				A
	Meadow Creek	A	A		A
	Middle Fork Horse Creek				A
	Mill Creek	A	A		A
	North Fork Daisy Dean Creek				A
	North Fork Elk Creek				A
	North Fork Horse Creek	A			A
	Porcupine Creek		A		A
	Scofield Creek				A
	Smith Creek	C	A		R
	South Fork Daisy Dean Creek				A
	South Fork Elk Creek				A
	South Fork Horse Creek	A			A
	South Fork Shields River	A	A		A
	Turkey Creek				A
Potter	Potter Creek				A
	Cottonwood Creek	C			
Flathead	Cache Creek	A	A		A
	Carrol Creek	A			A
	Dry Creek	A			A
	Fairy Creek	A	A		A
	Green Canyon Creek				A

Fifth Code HUC	*Stream*	*Brook Trout*	*Brown Trout*	*Rainbow Trout*	*Yellowstone Cutthroat Trout*
	(Table 4-8 continued)				
	Flathead Creek	C	R		A
	Middle Fork Muddy Creek				
	Muddy Creek	A	A		A
	North Fork Flathead Creek	A			A
	South Fork Carrol Creek				A
	South Fork Flathead Creek				A
Middle Shields	Brackett Creek	A	C	A	A
	Fox Creek				A
	Horse Creek			A	A
	Middle Fork Brackett Creek	A			A
	Miles Creek		A		A
	Nixon Creek		A		A
	North Fork Brackett Creek	A	A		A
	Skunk Creek	A	A		A
	South Fork Brackett Creek				A
	Weasel Creek				A
	Cottonwood Creek	A	A	A	C
	East Fork Rock Creek				A
	East Fork Spring Creek		A		A
	Hammond Creek	A	A		A
	Indian Creek				A
	Rock Creek	C	C		U
	Grouse Creek	A			A
	Spring Creek		A		A
Lower Shields	Bridgman Creek	A			A
	Canyon Creek	A	A		A
	Sheep Creek				A

4.5 Private Pond Permitting

FWP is authorized to regulate the importation of fish for stocking as well as the stocking of fish pursuant to MCA 87-3-105, 87-5-711, and 87-5-713. The list of species that can be considered for planting in private ponds is provided in MCA 87-5-714 and ARM 12.7.701.

Montana places a high value on its wild and native fisheries. The introduction of nonnative fish can have a detrimental effect on the distribution and abundance of native fish populations through predation, competition, and hybridization. As stated in FWP’s private pond policy, to avoid the threat of hybridization with extant native fish populations, FWP **WILL NOT** issue a permit for the stocking of rainbow or westslope cutthroat trout in private ponds within tributary drainages that support or are connected to habitats that support Yellowstone cutthroat trout conservation populations. To avoid the threat of competition with extant native species populations, FWP **WILL NOT** issue a permit for:

1) the stocking of brook trout in private ponds within tributary drainages that support or are connected to habitats that support westslope or Yellowstone cutthroat trout conservation populations; or
2) the stocking of brown trout in private ponds within tributary drainages that support or are connected to habitats that support westslope or Yellowstone cutthroat trout conservation populations.

In addition, all ponds must provide and maintain adequate screening of surface water connections to the pond in order to keep wild fish out of the pond, as well as preventing escape of fish stocked in the pond. Pond permitting regulations require that private pond must stock fish obtained from an approved aquaculture facility. FWP approves these facilities on an annual basis to ensure that various fish diseases and aquatic invasive species are not transferred to a private pond and subsequently to wild populations.

Private ponds are subject to review and permit renewal every ten years. Ponds that are found to be in violation of the above policy will be required to come into compliance, or the permit will not be renewed and the existing fishery will be removed.

5.0 Data Review and Conservation Strategies and Opportunities by Stream/Watershed

5.1 Shields River

5.1.1 Shields River Historical and Current Conditions

The Shields River originates in the Crazy Mountains, and flows for 65 miles until its confluence with the Yellowstone River (Figure 5-1). With the exception of its upper 6 miles, which are on the GNF, the Shields River flows nearly entirely through privately owned lands. The Shields River has been the focus of considerable study to determine fish distribution and population trends. In addition, several studies have evaluated habitat condition and stream flow, which are relevant to restoration planning for Yellowstone cutthroat trout.

Fisheries investigations in the Shields River watershed began in the 1950s, with a combination of creel census records and field surveys providing information on cutthroat trout presence and relative abundance of other species (Hanzel 1959). Cutthroat trout rated as being second or third in abundance compared to other trout species in three sections assessed, with rainbow trout, brown trout, and brook trout also being present. The locations of these reaches are not apparent from the document.

In the 1970s, Berg (1975) sampled 15 reaches along the length of the Shields River. Yellowstone cutthroat trout and mottled sculpin had the widest distribution within the main stem, and each occurred throughout the entire river, although Yellowstone cutthroat trout were relatively rare in the lower 25 miles of river. Rainbow trout were common in the lower 5 miles of river, downstream of the Chadbourne diversion, but had limited distribution up to Wilsall. Brown trout rated as common from the mouth to river mile 50, which is near the confluence with Smith Creek. Brook trout were limited to a 10- to 15-mile reach of river upstream of Wilsall. Berg attributed their presence there as indicative of their ability to withstand the “severe dewatering” occurring in that reach.

FWP conducts fisheries investigations in the Shields River annually and two of the three regularly sampled reaches are above the Chadbourne diversion. The Zimmerman section is about 4,800 feet long and is upstream of Wilsall, and the 7,500-foot long Todd section is north of Clyde Park (Figure 5-1). Sampling follows mark/recapture protocols, where all fish captured on the first sampling date receive a specific mark, such as a hole punched in the lower caudal fin. The reach is resampled about 2 weeks later, and the number of marked and unmarked fish recaptured is recorded. FWP calculates a population estimate using a log-likelihood or modified Peterson model using the Fisheries Analysis + software (FWP 2004).

Brown trout and mountain whitefish are the most abundant fish captured in these reaches, and most of the reporting focuses on these species, as sufficient numbers are captured to calculate a population estimate. Other species encountered in these reaches include Yellowstone cutthroat trout, brook trout, mottled sculpin, and several species of sucker. Low numbers of rainbow trout are typically present, and the relatively large size of some of the fish suggests they may be fluvial migrants able to pass over the Chadbourne diversion (S. T. Opitz, FWP, personal communication).

Evaluation of the number of Yellowstone cutthroat trout captured within the Zimmerman and Todd sections (FWP, Livingston fisheries office files) suggests a decline in Yellowstone cutthroat trout numbers in the Shields River over the past decades. In the Zimmerman section, the highest numbers of Yellowstone cutthroat trout captured occurred in the 1970s, although considerable variability between mark and recapture events was common (Figure 5-2). The subsequent decades did not see capture rates close to those occurring in 1975 and 1976. For the majority of sampling efforts since the 1970s, less than 5 Yellowstone cutthroat trout were captured per effort in this 4,800 foot long reach. In contrast, population estimates for mountain whitefish ranged from 253 to 2,988 per mile, and brown trout population estimates ranged from 322 to 549 per mile (MFISH database). Yellowstone cutthroat trout are comparably rare members of the fish assemblage in this portion of the Shields River.

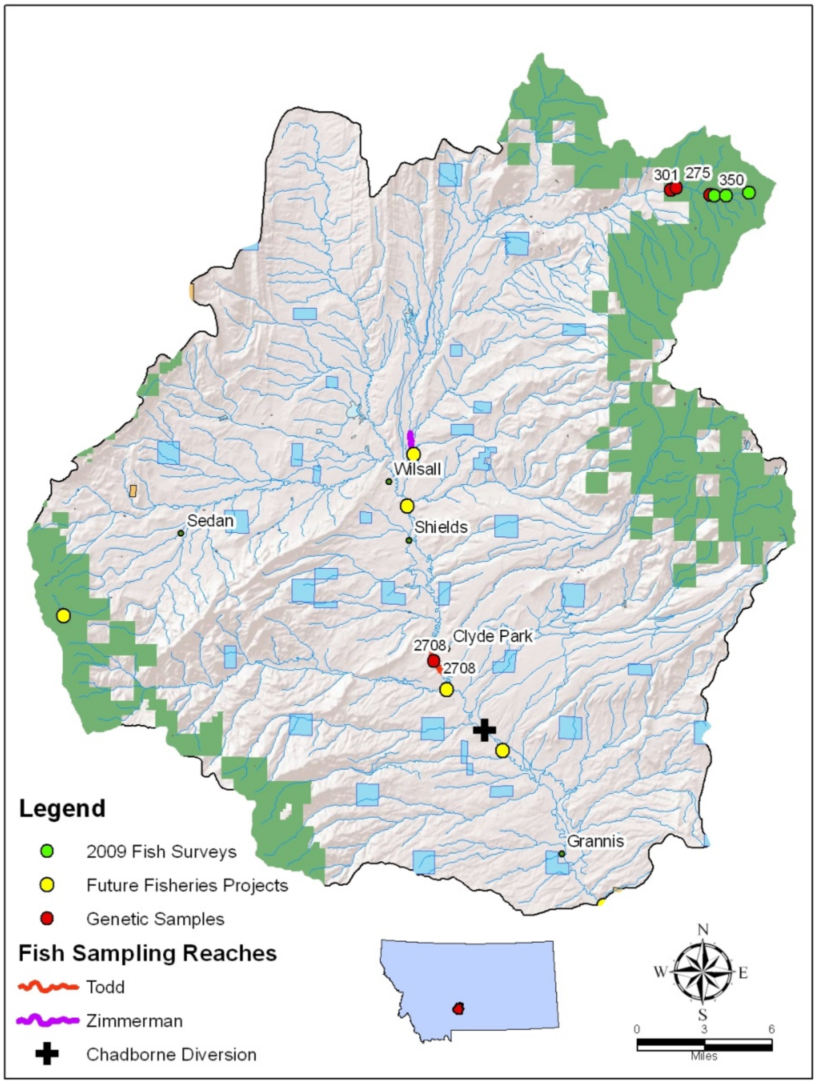

Figure 5-1: Shields River fish sampling locations and Future Fisheries Improvement Program project locations.

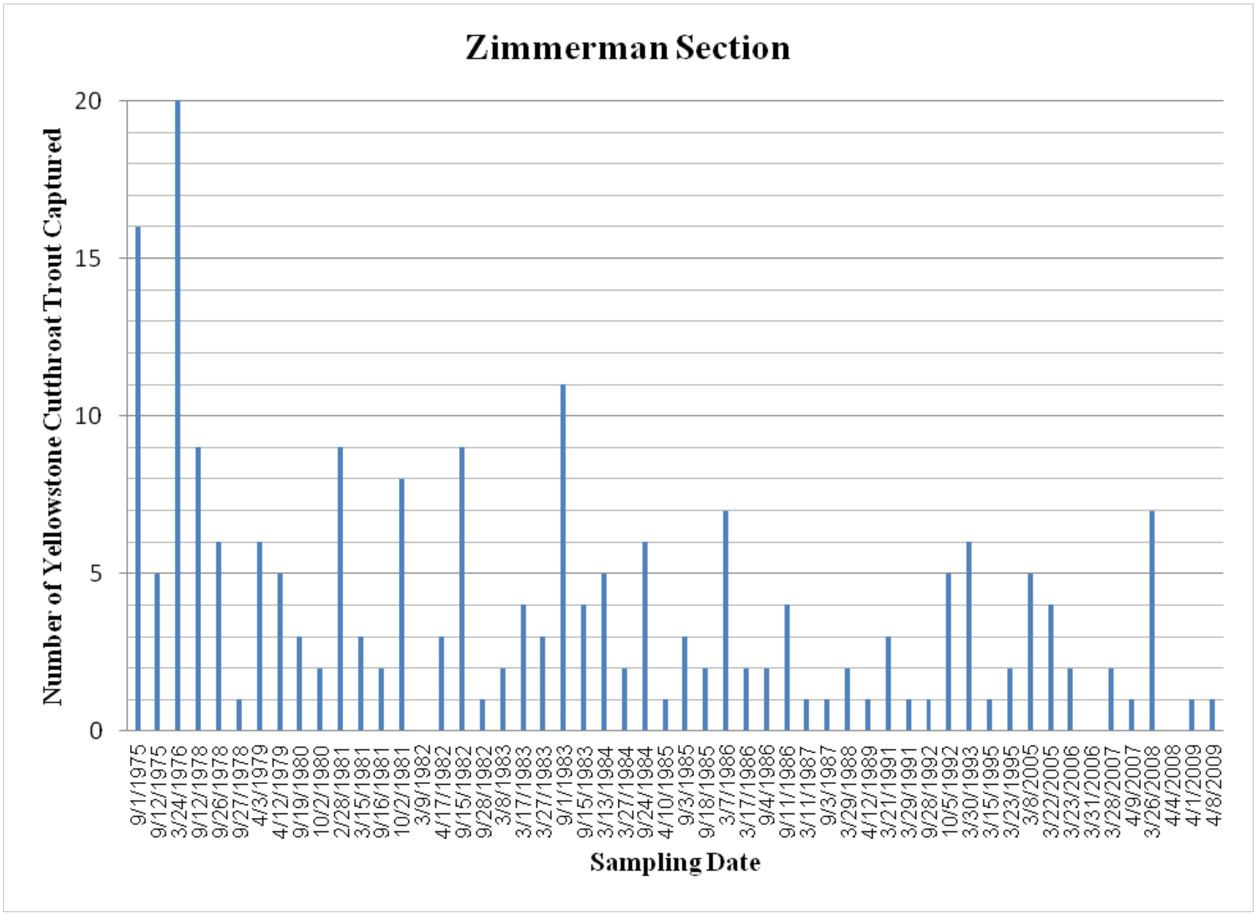

Figure 5-2: Number of Yellowstone cutthroat trout captured in the Zimmerman section per sampling event.

Sampling in the Todd section occurred from the mid-1990s to 2006. The highest capture rates for Yellowstone cutthroat trout were in 1997 through 2000, with up to 16 cutthroat trout being captured (Figure 5-3). Their numbers decreased substantially in the following years, and catch rates ranged from 0 to 4 fish. Population estimates for brown trout and mountain whitefish for this section provide perspective on the rarity of Yellowstone cutthroat trout in this 7,500-foot long reach. Brown trout ranged from 120 to 248 fish per mile, and mountain whitefish ranged from 1,048 to 1,300 fish per mile in 3 population estimates (MFISH database).

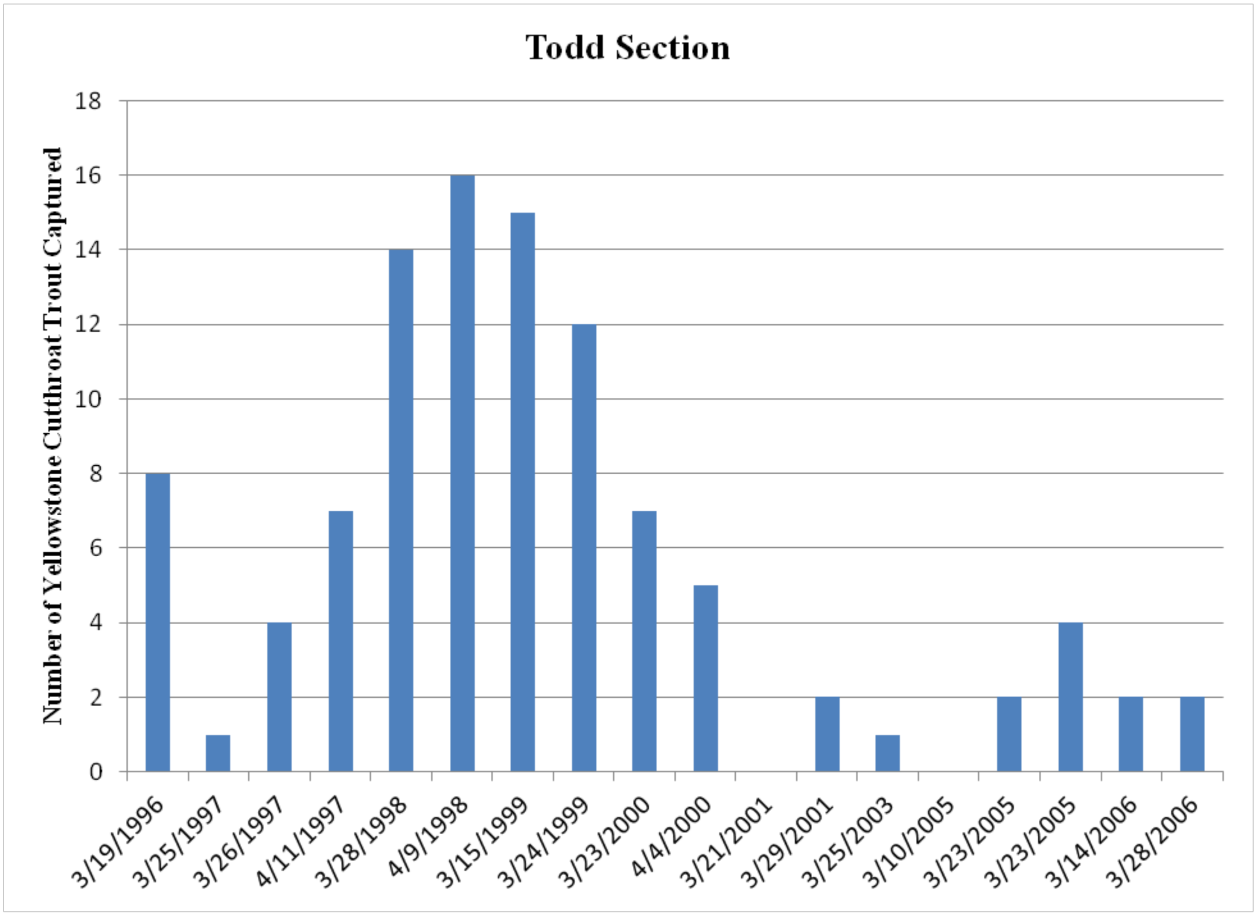

Figure 5-3: Number of Yellowstone cutthroat trout captured in the Todd section per sampling event.

In 2009, the headwaters of the Shields River watershed above the confluence of Smith Creek was the focus of intensive fish survey efforts to document species distribution and genetic status of Yellowstone cutthroat trout. Three 330-foot-long sections on the main stem Shields River within the GNF were part of this effort (Figure 5-1). In each reach, mottled sculpin and Yellowstone cutthroat trout were the only species encountered (MFISH database). The apparent absence of brook trout and brown trout from this portion of the Shields River was a promising find; however, surveys in tributaries indicated a brook trout invasion is underway in the upper basin, placing the headwaters Yellowstone cutthroat trout at risk of extirpation through niche overlap. Sampling in 2011 found further upstream expansion of brook trout in Dugout and Lodgepole creeks, and recent invasion into an unnamed tributary just downstream of Dugout Creek (B.B. Shepard, Wildlife Conservation Society, personal communication).

Genetic status of the Shields River's Yellowstone cutthroat trout varies across its length. Samples collected in the late 1980s in the headwaters found only nonhybridized Yellowstone cutthroat trout (Table 5-1). Likewise, samples collected in headwaters tributaries in 2009 showed no evidence of hybridization (Kalinowski 2010a; Kalinowski 2010b). Some hybridization is apparent lower in the river, with 3 of 23 fish testing as hybrids. The sample location lists the Todd section as the sample location; however, these fish were pooled from several locations in Shields River valley above the Chadbourne diversion. Additional analyses of genetic status of Yellowstone cutthroat trout along the length of the Shields River is a priority.

Table 5-1: Genetic analyses of Yellowstone cutthroat trout sampled in the Shields River (MFISH database).

Sample Number	***Collection Date***	***Number of Fish***	***Count***	***Percent***	***Species***
275	10/28/1988	22		100%	Yellowstone cutthroat trout
301	7/28/1989	25		100%	Yellowstone cutthroat trout
350	9/7/1989	25		100%	Yellowstone cutthroat trout
2708	3/24/1999	23	20	0	Yellowstone cutthroat trout
2708	3/24/1999	23	3	0	YCT x rainbow trout

Although no hybridization has been documented in the headwaters of the Shields River, FWP receives occasional reports from anglers of hybrids caught in the upper river (S.T. Opitz, FWP, personal communication). As no barriers are known to exist that would protect the upper reaches from invasion of rainbow trout and hybrids, the headwater population is not secure from the threat of hybridization.

Several studies have examined habitat quality throughout the length of the Shields River. A rapid aerial assessment in 1999 focused on the headwater reaches (Tohtz 1999b). This investigation identified timber harvest during the 1970s and 1980s in the headwaters as likely having had an influence on water yield and sediment yield in the upper Shields River. The 1999 aerial assessment documented extensive logging in the headwaters of the Shields, which included some riparian harvest. Likewise, the geomorphic assessment noted braiding in the upper portions of the Shields River suggesting loading of sediment in excess of the stream’s ability to transport it efficiently. With regrowth of timber stands since the 1980s, water yield has likely returned to near pre-harvest levels; however, the effects on stream morphology will take longer to recover.

Other information on habitat quality comes from a geomorphic investigation commissioned by the predecessor of the SVWG (Inter-Fluve 2001). This study evaluated geomorphology of the Shields River from Clyde Park to its headwaters. In addition, this report includes management recommendations and identifies specific projects that would restore fluvial function. Among the findings were observations of the influence of chronic dewatering on fluvial form and function.

The TMDL effort also evaluated stream morphology, and bank and riparian condition using field surveys and an analysis of aerial photos (DEQ 2009). The watershed restoration process currently underway will identify specific projects that will reduce sediment loading and improve habitat. Typical projects will likely include changes in grazing management to control livestock's use of stream corridors and stream bank restoration where the extent of degradation warrants. Grazing specialists from NRCS and Montana State University Extension Service will provide technical assistance in developing site specific approaches that meet the producer's needs, while promoting fisheries conservation.

Although the TMDL plan's aerial photo analysis has utility as an initial screen, the age of the imagery is a limitation in its usefulness. The TMDL effort used aerial photos from the mid-1990s, and conditions may have changed substantially in the interim. In some cases, changes in land use practices may have resulted in improvements in some locales. In contrast, record flooding in 2011 was a significant disturbance causing extensive erosion and channel alterations

FWP lists the Shields River as a chronically dewatered stream, and dewatering likely limits resident Yellowstone cutthroat trout through several mechanisms. The influence on summer high temperatures can be profound, especially in drought years. As described in 4.2.2 *Water Temperature*, water temperature monitoring indicates maximum daily temperatures in July and August can substantially exceed temperatures demonstrated to result in sublethal to lethal stress to the closely related westslope cutthroat trout (Figure 4-2 and Figure 4-5). Warmer temperatures may give nonnative brown trout a competitive advantage, as the upper incipient lethal temperature for brown trout is 76 °F (Elliot 1981), compared to 67 °F for westslope cutthroat trout (Bear 2005). Dewatering also negatively affects fish by reducing the amount of available habitat, which concentrates fish and increases competitive interactions for space. The low numbers of Yellowstone cutthroat trout in the Shields River is likely related, at least in part, to the chronic dewatering in summer months.

5.1.2 Conservation Strategy for the Shields River

The conservation strategy for the Shields River will involve several components and will vary along the length of the river. As the headwaters remain a stronghold for pure Yellowstone cutthroat trout, protecting these fish is the highest priority, which is consistent with the Agreement for conserving Yellowstone cutthroat trout in Montana. Threats to these fish include competition with nonnative brook trout and the potential for competition or predation by brown trout. Although no rainbow trout have been captured in the headwaters during fisheries investigations, no known barriers exist to prevent rainbow trout from invading the reach within the Upper Shields River Watershed.

Three options are under consideration to protect the nonhybridized Yellowstone cutthroat trout in the upper Shields River watershed upstream of Smith Creek (Sestrich 2012). The first option would involve construction of a main stem barrier upstream of the GNF boundary. As fundraising, design, and construction of large barriers take considerable time, installation of temporary barriers on select streams where brook trout have not yet invaded would protect remaining strongholds. As many of these streams provide marginal overwintering habitat, habitat enhancement may provide a temporary means of supporting these small stream populations. Following construction of a main stem barrier, mechanical and chemical removal of nonnative fishes would follow.

The second option is similar to the first, except an additional barrier upstream would provide added protection in the event of failure of the downstream barrier. The selected site would need to have sufficient amount of habitat to support a population of Yellowstone cutthroat trout over the long-term. Identification of an appropriate stream would follow research on population viability and amount of available habitat (Hilderbrand and Kershner 2000; Peterson et al. 2008).

The third option is the least preferable, as it would result in considerable isolation of individual populations, which is contrary to the goal of maintaining connectivity. Nonetheless, if construction of a main stem barrier is infeasible, construction of barriers on multiple streams may protect isolated populations. This downside to this option is that it limits gene flow and the potential for natural recolonization, should a catastrophic event decimate a stream's Yellowstone cutthroat trout population. This option would require continued monitoring to evaluate fish numbers and evaluate the potential for inbreeding depression.

In the lower 50 miles of the Shields River, the primary threats to the population of Yellowstone cutthroat trout still residing in the main stem include competition and predation with nonnative brown trout, hybridization with rainbow trout, chronic dewatering that renders much of the river unsuitable for cutthroat trout during the irrigation season, and habitat and water quality degradation. Maintaining the structural integrity and impassability of the Chadbourne diversion is the highest priority overall, as this diversion blocks upstream movement of rainbow trout from the river below.

A number of options are available to ameliorate the effects of dewatering on Yellowstone cutthroat trout in the Shields River, and 4.2.3 *Water Quantity* describes these in detail. In general, the approach is to work with interested water rights holders on increasing water use efficiency, and potentially providing financial compensation for leaving saved water in the stream. Specific projects need to incorporate an understanding of the local hydrology, as some seemingly inefficient practices actually promote late season flows that benefit fish. In addition, studies to determine recommended minimum flows are needed to guide water use planning in the basin.

Habitat restoration will be another component of Yellowstone cutthroat trout conservation in the main stem Shields River. Landowners have a solid record of initiating these projects, and several bank restoration and riparian fencing projects have been implemented since the 1990s (Appendix A: Completed and Ongoing Restoration and Conservation Projects in the Shields River Watershed). The watershed restoration plan that is being developed for TMDL implementation will generate a list of potential projects that will improve habitat and reduce sediment loading to streams.

5.2 Potter Creek Watershed (5th Code HUC): Data Review and Restoration Strategies

The Potter Creek Watershed enters the Shields River from the north and west and drains approximately 58,000 acres (Figure 5-4). Major tributaries to Potter Creek include Cottonwood and Rice creeks. Rangeland and other agricultural uses are the dominant land uses in the Potter Creek drainage. The Potter Creek Watershed has the lowest percentage of publicly held lands of the four 5th code HUCs in the Shields River Subbasin.

5.2.1 Potter Creek

Unlike most streams in the Shields River watershed, Potter Creek originates in relatively low-gradient, valley portions of the watershed, a factor that influences its hydrology, ecology, and potential to support Yellowstone cutthroat trout. Lacking headwaters in the mountains, Potter Creek has prairie stream affinities, such as less dependence on snowmelt to drive the hydrograph, warmer stream temperatures, and naturally finer substrate. Nonetheless, land use activities on Potter Creek, which is entirely within private ownership, have potential to influence cold-water fisheries in the Shields River system by contributing fine sediment to trout-bearing streams. Moreover, state law requires full support of all beneficial uses, including warm-water fisheries consisting of minnows, chubs, and suckers, if that is the water’s natural potential, so promoting stream health is a relevant concern.

Fisheries investigations were consistent with a tendency towards support of warm-water fishes in Potter Creek (Shepard 2004). Among the five reaches visited, only the lower three had sufficient water to permit sampling. Species captured in these reaches included longnose sucker, longnose dace, and mottled sculpin. Lake chub are also present in Potter Creek (C.L. Endicott, FWP, personal communication). The minnow and sucker species have broad ecological tolerances, and thrive in cold-water and warm-water systems. Dominance of these species, and apparent absence of salmonids, is consistent with Potter Creek’s prairie stream affinities.

DEQ lists Potter Creek as impaired for low flow alterations and several causes relating to sediment (DEQ 2012). Potter Creek receives irrigation water discharged from Cottonwood Reservoir, which has exceeded the channel’s capacity, resulting in considerable channel down-cutting and associated bank erosion. This flow augmentation is inconsistent with the inclusion of “low flow alterations as a probable cause of impairment, but is likely an easy modification to make in DEQ’s next integrated report.

Most of the Potter Creek channel below the confluence with Cottonwood Creek has little to no shade from riparian vegetation, and silt dominates the streambed. Livestock grazing may also be a contributing factor to channel and riparian degradation, with widening linked to livestock access in some instances (Shuler 1999). In general, banks along narrow reaches were more heavily vegetated. Thermographs in the lower reaches of Potter Creek recorded water temperatures exceeding 80°F that would be lethal for trout (Shuler 1999). Given its prairie stream affinities, Potter Creek is likely warmer than other streams with headwaters in higher elevations, although reduced riparian shading may contribute to warming above natural levels.

Restoration strategies for Potter Creek should address channel instability associated with conveyance of irrigation water from Cottonwood Reservoir, and livestock effects on riparian vegetation and bank condition. Management of flows from the reservoir needs to be compatible with delivery of water to irrigators according their water rights. Appropriate strategies to limit damage from livestock include development of a compatible grazing management strategies, and alternative means to provide water to livestock. The landowner who owns the reach of Potter Creek downstream of the release from Cottonwood Reservoir is working with the NRCS and the SVWG to implement these changes.

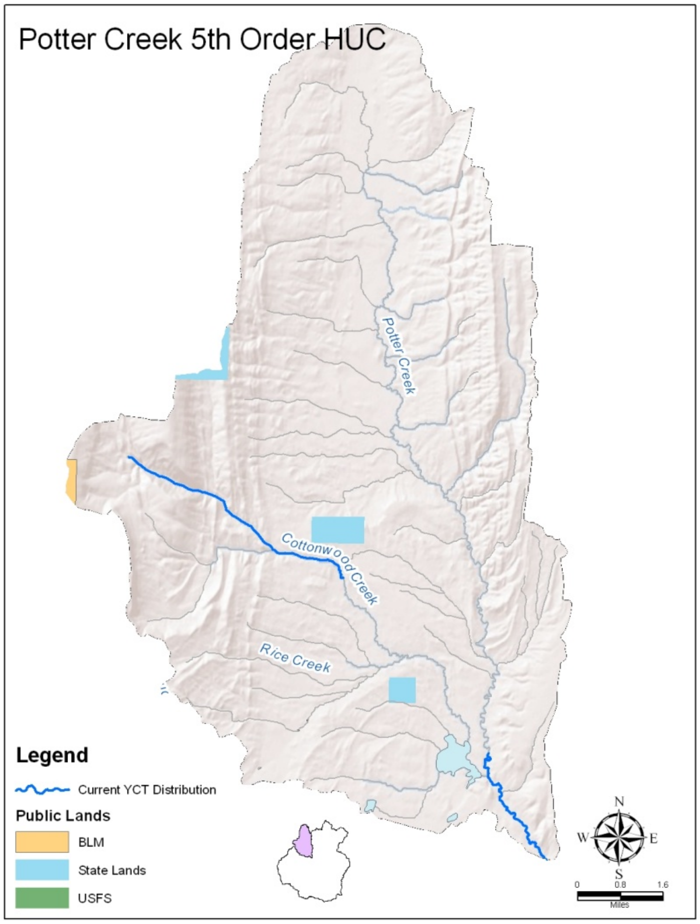

Figure 5-4: Current distribution of Yellowstone cutthroat trout in the Potter Creek Watershed.

From a Yellowstone cutthroat trout conservation perspective, restoration on Potter Creek is a lower priority. As Potter Creek functions more like a warm-water prairie stream, it has little inherent value for Yellowstone cutthroat trout. Furthermore, as Yellowstone cutthroat trout are relatively rare in the Shields River for a host of reasons, reductions in sediment loading, although beneficial to other fish and aquatic life, will not translate into a large conservation benefit to Yellowstone cutthroat trout. On the other hand, Potter Creek has been identified as a significant contributor of stream bank sediment to the Shields River (DEQ 2009), and addressing this source will be important in meeting TMDL targets for this Shields River TMDL planning area. FWP will support the watershed group’s efforts to reduce sediment loading in Potter Creek, so long as the restoration approach is compatible with stream function.

Several entities have responsibility for promoting implementation of restoration practices on Potter Creek. FWP will work with private landowners, irrigators, DNRC, and the SVWG to address grazing effects and channel stability. In addition, because of Potter Creek's 303(d) list status, DEQ may provide technical and financial assistance to restore water quality in Potter Creek and reduce its contribution of sediment to Flathead Creek and ultimately the Shields River.

5.2.2 Cottonwood Creek

Cottonwood Creek flows to the east from Elkhorn Ridge to its confluence with Potter Creek (Figure 5-4). Cottonwood Creek has a 237-acre irrigation reservoir located just upstream from its mouth at Potter Creek. This reservoir typically fills during the spring, and is drained throughout the summer irrigation season. The 2001 habitat survey (Shepard 2004) found that in-stream cover was relatively high in all three sections. Woody debris was the primary type of cover in the lower reaches, and substrate contributed to in-stream cover in the upper reaches (Shepard 2004). Spawning habitat varied along the length of the creek, with silt and sediments degrading available gravels in some sections (Shepard 2004). Alder and willow provided most bank cover in the lower two sections. Riparian use was moderate to high in all three sections.

The aerial survey found much of Cottonwood Creek to be stable, and the braiding observed in the middle section was attributed to natural bed-load adjustments (Tohtz 1999b). Small, localized areas where agricultural practices have damaged the riparian corridor were noted, but were described as easily remedied (Tohtz 1999b).

Fisheries surveys in 2002 found Yellowstone cutthroat trout throughout the length of Cottonwood Creek (Shepard 2004), although genetic composition of this subpopulation has not been evaluated. Nonetheless, the widespread distribution of Yellowstone cutthroat trout in Cottonwood Creek makes it a priority for habitat management and restoration. The lack of nonnative salmonids from sampled reaches was a promising finding, although periodic monitoring is warranted to detect potential invasion. Determining the genetic status of the Cottonwood Creek's Yellowstone cutthroat trout population is a high priority.

Implementation of agricultural BMPs should be the primary emphasis in the restoration strategy for Cottonwood Creek. Managing livestock grazing to maintain riparian health and function, and maintaining a sufficient buffer between cultivated lands and the stream should be the focus to allow natural recovery of riparian vegetation. Nonetheless, mechanical alterations to banks and the stream channel and riparian plantings may be appropriate in some locations. Similar to Potter Creek, Cottonwood Creek flows through private lands. As a result, collaborators in restoration activities on this stream will include FWP, NRCS, SVWG, MSU Extension, and private landowners.

5.2.3 Rice Creek

Rice Creek is a tributary to Cottonwood Creek. Currently, no data are available to evaluate fish populations or habitat on this stream, although the aerial photo analysis and sediment modeling conducted during TMDL planning efforts may contribute to determining the status of riparian health and stream morphology and provide an initial screen for potential habitat impairment. The conservation strategy for Rice Creek is to conduct baseline investigations, which will guide conservation actions as needed.

5.3 Flathead Creek Watershed (5th Code HUC): Data Review and Conservation Strategies

The Flathead Creek Watershed originates in the Bridger Range on the west side of the Shields River valley (Figure 5-5). Most of the more than 80,000 acres are in private ownership. The headwater portions of some streams lie within the GNF, and several parcels of state-owned lands are within the valley portions of the watershed. Yellowstone cutthroat trout reside throughout the basin's streams. Genetic analyses have found only pure Yellowstone cutthroat trout in the Flathead Creek HUC, although presence of hybrids is possible.

5.3.1 Flathead Creek

Flathead Creek is the largest stream in the hydrologic unit, and originates in the Bridger Range. Flathead Creek has several named tributaries including Dry, Cache, Fairy, Frazier, and Green Canyon creeks, and the three forks at the headwaters: North, Middle, and South. Assessment information is available for most streams, except Dry Creek and the Middle Fork of Flathead Creek.

Fisheries investigations found a diverse fishery, including Yellowstone cutthroat trout in sympatry with brown and brook trout (Shepard 2004). Flathead Creek also supports several members of the native fish assemblage, including mountain whitefish, longnose and white suckers, lake chub, and mottled sculpin. Presence of competing species and potential predators, brook trout and brown trout, makes removal of nonnatives a potential option for this stream.

Genetic status of resident Yellowstone cutthroat trout has been evaluated at several locations in the Flathead Creek watershed (Leary 1990, Cook 2003). Most of the tested fish have shown no evidence of hybridization. The exceptions were fish collected in Cache Creek in 2001, where 2 of the 22 fish captured had alleles typical of rainbow trout (Cook 2003). One of these fish appeared to be a first generation hybrid, indicating recent introduction of rainbow trout genes into the population.

The 1998 aerial assessment found several reaches of Flathead Creek to have impaired riparian health and function (Tohtz 1999b). In places, the lack of riparian vegetation contributed significantly to bank erosion. Feedlots adjacent to the stream were potential sources of nutrients and sediment. Intact reaches were abundant in the headwater areas. Two diversions were observed, and should be evaluated to determine if significant fish losses to ditches are occurring during the irrigation season and if these diversions are passable.

A 2002 habitat survey at the uppermost sample section found cobble and large gravel dominated the streambed (Shepard 2004). Woody debris was moderately abundant in this section, originating mostly from willow, but none of this woody debris spanned the wetted channel. Spawning habitat was relatively abundant, and spawning gravels were relatively clear of fine sediments. Ratings of in-stream and bank cover, bank stability, and pool quality were all moderately high, while riparian use by livestock rated as relatively low. Woody debris made up most of the in-stream cover. Some historical livestock use had influenced a few of the stream banks, but abundant woody vegetation and debris helped stabilize most areas. Undercut banks were among the habitat features favorable for fish.

No sampling or observations were made downstream of mile 7.5 in Flathead Creek (Shepard 2004). The middle reaches of the stream consisted of an unconfined channel that flowed through grasslands and sagebrush with scattered areas of willow. Pools were relatively abundant and formed primarily by lateral scouring of the channel. Livestock use has affected some areas of the stream channel and many of the stream's banks were unstable in this middle reach. No sampling occurred from mile 8.7 up to mile 15. Immediately below the junction of the forks near the headwaters, the channel gradient increases and willow stands become much denser than was observed in the lower portions of the stream. Lateral scour pools provided substantial habitat for fish. The channel contains more woody debris, but this debris was primarily willow. The channel in this upper reach had fewer observed disturbance related to livestock and the stream's banks were much more stable than in the middle reach.

TMDL assessments and modeling identified the lower Flathead Creek watershed as one of the larger contributors of sediment from bank erosion (DEQ 2009). Aerial surveys of stream and riparian condition provided the basis for identifying riparian and stream condition in Flathead Creek. A site visit and aerial photo analyses conducted in 2012 identified cut off of several meanders, which likely led to the marked downcutting observed in the lower reach, near Wilsall (C.L. Endicott, FWP, personal communication). Addressing bank erosion and riparian condition will reduce sediment loading and improve habitat for the Yellowstone cutthroat trout occupying Flathead Creek.

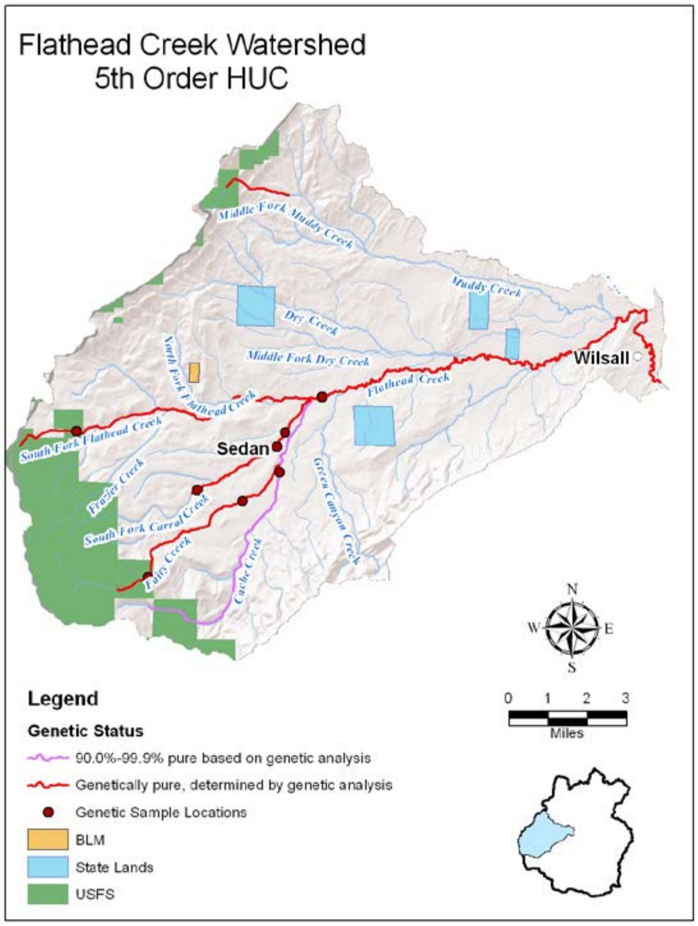

Figure 5-5: Distribution and genetic status of Yellowstone cutthroat trout in the Flathead Creek Watershed.

Dewatering is also a constraint on coldwater fisheries in Flathead Creek and FWP lists the lower 12 miles as periodically dewatered relating to irrigation withdrawals. Conservation strategies that increase water use efficiency while meeting forage production goals may provide opportunities to promote in-stream flows to benefit Yellowstone cutthroat trout.

The conservation strategy for Flathead Creek calls for voluntary implementation of agricultural BMPs to reverse existing riparian degradation and increase water use efficiency. Evaluations of eroding banks will guide more site-specific strategies such as mechanical bank stabilization using bioengineering approaches. Decommissioning of several miles of old timber harvest roads is among potential conservation actions on the GNF, and these actions could reduce sediment loading to Fairy Creek, Frazier Creek, and South Fork Flathead Creek. As most of Flathead Creek flows through private lands, major collaborators will include FWP, NRCS, SVWG, private landowners, and irrigators. Private, nonprofit groups such as Trout Unlimited may be partners in leasing water rights to promote in-stream flows.

Presence of brook trout, brown trout and hybrids are threats to the basin's Yellowstone cutthroat trout. Determining the source of rainbow trout is a priority. Likewise, FWP and the Forest Service will consider actions to reduce or eliminate nonnative fishes.

The headwaters of Frazier Creek may be suitable for expansion of Yellowstone cutthroat trout distribution. Currently, this reach and Frazier Lake are fishless; however, habitat and stream flow above the Forest Service boundary appear to be suitable to support Yellowstone cutthroat trout. The Forest Service and FWP will explore the option of introducing pure strain Yellowstone cutthroat trout.

5.3.2 Muddy Creek

Little fisheries or associated information is available for Muddy Creek, or its forks. In the 1970s, investigators found Yellowstone cutthroat trout, along with brown trout, mountain whitefish, and three species of sucker near its confluence with Flathead Creek (MFISH database). In 2005, Forest Service personnel sampled portions of the Middle Fork Muddy Creek and found high numbers of age-0 Yellowstone cutthroat trout above the forest boundary, along with three adult Yellowstone cutthroat trout (B. C. Roberts, GNF, personal communication). No brook trout or other species were captured. The Kisther-Hardy Dam possibly isolates the upper forks of Muddy Creek, providing a refuge for Yellowstone cutthroat trout. Determining species composition and distribution in the Muddy Creek drainage is a priority, which will guide development of appropriate conservation needs.

5.4 Upper Shields River Watershed (5th Code HUC): Data Review and Conservation Strategies

The Upper Shields River Watershed includes the area upstream of the confluence with Flathead Creek on the east side of the basin (see inset Figure 5-6). The GNF owns lands in the headwaters portion of the watershed, and state-owned lands are scattered throughout the valley. The majority of the watershed is under private ownership. This watershed drains approximately 145,000 acres, and has several major tributaries, including the South Fork Shields River, and Porcupine, Elk, Daisy Dean, and Horse creeks to the south and east; and Smith Creek which flows in from the north. The headwaters of these creeks are in the Crazy Mountain range. Progressing upstream, the valley bottom vegetation begins to include more evergreens, and Engelmann spruce (*Picea engelmannii)* becomes the dominant overstory species (USWA 2001). A significant amount of logging has occurred within the GNF, and these stands are in various stages of regrowth. Some of the private lands just downstream of the National Forest have also been logged and are now used for hay, open pasture, and livestock grazing. The valley transitions into cottonwood bottomland, which continues to the lower reaches, and agricultural use predominates in the form of cropping, hay, open pasture, and livestock grazing (USWA 2001).

5.4.1 Smith Creek Watershed

Smith Creek is the northernmost stream in the Shields River watershed and drains due south from the Crazy Mountains (Figure 5-6). Tributaries include Meadow, Goat, East Fork Smith, and Bitter creeks. Historically, the Smith Creek watershed was the subject of extensive timber harvest and road building. As of 1993, approximately 37% of the land area in the Smith Creek watershed had experienced some type of timber harvest, including riparian harvest. In 1993, the Forest Service implemented a watershed restoration program in the upper Shields River drainage that included portions of the Smith Creek drainage. Because of this restoration, sediment levels in streams dropped and habitat quality is improving. In 2008, the Forest Service implemented an extensive road-maintenance and gravel-surfacing project to reduce sediment loading from roads. Disturbance related to livestock grazing is minimal on a watershed scale, but localized areas of adverse effects need attention. High sediment loads and lack of large woody debris in streams of the watershed currently limit the amount of habitat available for Yellowstone cutthroat trout (Tohtz 1999b, Jones and Shuler 2004).

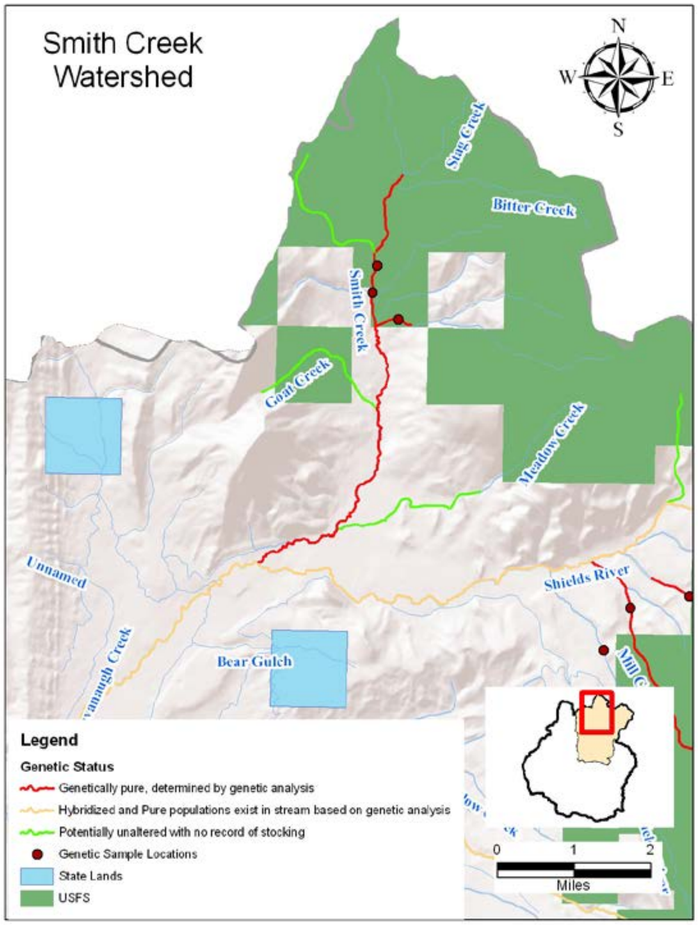

Figure 5-6: Distribution and genetic status of Yellowstone cutthroat trout in the Smith Creek watershed.

Smith Creek supports a genetically pure population of Yellowstone cutthroat trout, in addition to brook trout and mottled sculpin. Fisheries investigations in the 1970s found Yellowstone cutthroat trout to be the most abundant salmonid, greatly outnumbering brook trout (Berg 1975). Brown trout were also present in the mid-1970s, although at low numbers. The dominance of Yellowstone cutthroat trout reversed by 2003, with brook trout outnumbering Yellowstone cutthroat trout (Shepard 2004). Fish sampling efforts around culverts found brook trout to be abundant in East Fork Smith Creek (N = 45), whereas only 4 Yellowstone cutthroat trout were captured in this stream (Forest Service 2003 files). Likewise, this effort confirmed presence of only brook trout in Meadow Creek and an unnamed tributary of Smith Creek. In 2006, no Yellowstone cutthroat trout were found in East Fork Smith, Stag, or Bitter creeks, and brook trout comprised 70 % of trout captured in Smith Creek (Forest Service 2006 files). Fish surveys from 2005 through 2007 in upper Smith Creek found that brook trout were rapidly displacing cutthroat trout (Shepard et al. 2009).

In August 1998, the Forest Service conducted a habitat survey from the mouth of the East Fork of Smith Creek upstream to the headwaters. Low-gradient riffles dominated Smith Creek, resulting in low pool frequencies. Pools were moderate in size, and generally had sufficient depth to provide overwintering habitat for Yellowstone cutthroat trout. Large woody debris frequencies were low; however, large woody debris contributed to approximately 25% of the pools occurring within the survey area. Other pool forming features included boulders, bedrock, and lateral scours. Much of the stream bank was actively eroding, with many eroded banks up to 10 feet in height. As a result, surface sedimentation is moderate to high in many areas. In addition, several large areas of gravel and cobble deposition were present, indicating channel instability.

Although pool frequencies are moderate, existing pools lack sufficient habitat complexity due to a deficiency of large woody debris. Adequate rearing areas of undercut banks, side pools and low-gradient riffles currently exist in Smith Creek. Spawning habitats and spawning gravels are abundant in Smith Creek. Reported surface fines are moderate to high, which reduce the quality of available spawning habitat. These conservation populations were designated because they had no evidence of introgression or hybridization from other trout species. Consequently, Smith Creek is considered a class “A” stream under the Trout Unlimited agreement to the GNF Plan. This classification calls for the maintenance of at least 90% of the inherent habitat potential of the stream. The 90% habitat potential is based on various habitat attributes such as pool frequency, pool habitat quality, and fine sediment concentrations in spawning gravels. In 2005, the Forest Service implemented habitat restoration projects to address pool frequency concerns.

Currently, pool frequencies in Smith Creek and the East Fork of Smith Creek are below the potential of the stream. Meadow Creek meets habitat-potential guidelines above the Forest Service boundary, logging and road building likely influence stream function and water quality below the forest boundary. Habitat conditions in Stag Creek, Goat Creek, and Bitter Creek are largely unknown. The Forest Service has primary responsibility for maintaining and restoring habitat on its holdings. FWP will explore opportunities to work with private landowners in identifying potential projects in improve habitat quality in Smith Creek, although the abundance of nonnative fishes places this sub-watershed as a lower priority for habitat restoration.

Removal or suppression of brook trout are among the options for addressing the rapid displacement of Yellowstone cutthroat trout in the Smith Creek watershed. The complexity of the habitat, and the fact that much of the land in the Smith Creek drainage is in small parcels with numerous landowners, limits our ability to conserve cutthroat trout in this basin. Consequently, conservation of cutthroat trout in this basin presents considerable challenges, which makes restoration of the sub-watershed’s Yellowstone cutthroat trout a lower priority than areas with a higher probability of success. Nonetheless, FWP will explore opportunities to work with landowners to find options for Yellowstone cutthroat trout conservation.

5.4.2 South Fork Shields River

The South Fork Shields River is a major tributary of the Shields River, with most of its nearly 8-mile length occurring within the GNF (Figure 5-7). Its lowest 2 miles flow through privately owned lands in the upper Shields River valley.

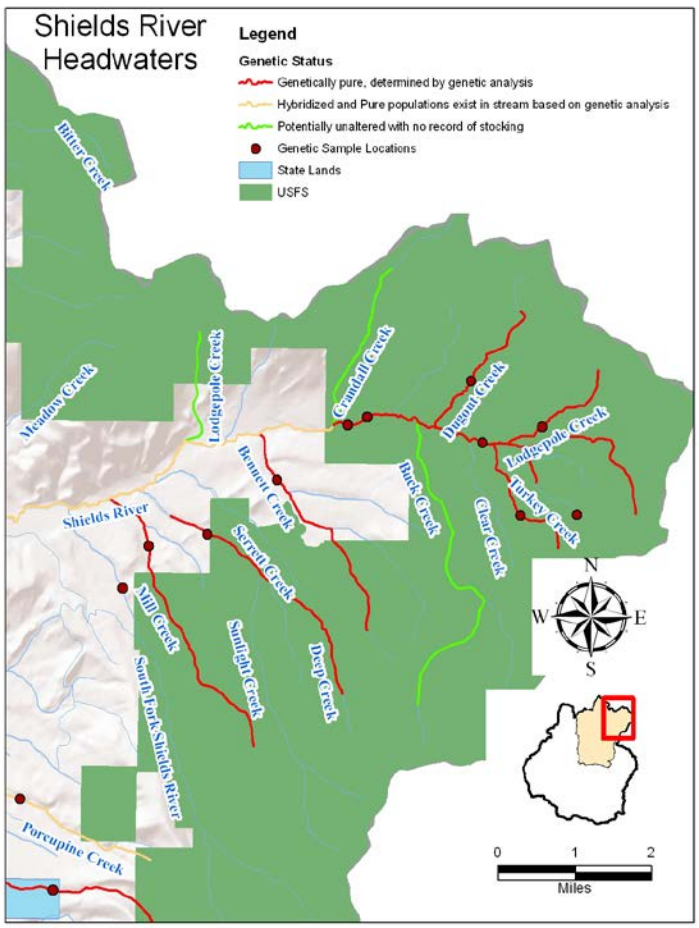

Figure 5-7: Distribution and genetic status of Yellowstone cutthroat trout in the headwaters of the Shields River.

The first fisheries investigations in South Fork Shields River occurred in 1974 (Berg 1975). Nearly equal numbers of Yellowstone cutthroat trout and brook trout were captured in a 500-foot reach sampled near the mouth. No recent data are available for the lower, privately-owned portions. In the 1990s, only Yellowstone cutthroat trout were captured with the GNF (S.W. Shuler, GNF, personal communication). A survey in 2003 conducted near the mouth of the South

Fork Shields River found brook trout to be the most abundant salmonid, followed by Yellowstone cutthroat trout and brown trout (Shepard 2004). Sampling during 2009 found no Yellowstone cutthroat trout above the Forest Service boundary, and although brook trout were found in sections immediately above the Forest Service boundary, no fish were found in the upper portions of the South Fork from about 1.5 miles above the Forest Service boundary upstream (MFISH database).

The pattern of brook trout invasion, followed by displacement of Yellowstone cutthroat trout, is a typical scenario that warrants intervention to secure the South Fork Shields for native Yellowstone cutthroat trout. Likewise, brown trout in this stream present a threat to the persistence of Yellowstone cutthroat trout. Options for the South Fork Shields River include chemical or mechanical removal of nonnatives, combined with installation of a barrier to prevent reinvasion of nonnatives. Subsequent planning will evaluate fish removal and barrier placement options.

Available information on habitat in the South Fork Shields River is relegated to Forest Service holdings, which accounts for about ¾ of the stream's length. Recent habitat surveys (Jones and Shuler 2004) reported that the stream is generally stable and functioning. Supporting visual evidence includes high pool frequencies, stable banks, and low surface fines. Sediment core data also suggest that sedimentation is low to moderate. Watershed restoration efforts within the drainage have lowered annual sediment yield to approximately 17% over natural conditions, and survey results from 1998 suggest that stream stability has increased since 1992. Because the majority of the drainage is remote, current conditions will likely persist until natural disturbance occurs. Habitat conditions in the South Fork of the Shields River exceed 90% of the stream's inherent habitat potential. Habitat factors limiting Yellowstone cutthroat trout numbers are largely due to natural stream conditions (Jones and Shuler 2004).

As the majority of the South Fork Shields River flows through Forest Service lands, this agency has primary responsibility for managing land use and habitat. The South Fork of the Shields River is a class A stream under the GNF Plan, as it supports a population of nonhybridized Yellowstone cutthroat trout (Jones and Shuler 2004). This classification calls for the maintenance of at least 90% of inherent habitat potential of the stream. The 90% habitat potential is based on various habitat attributes such as pool frequency, pool habitat quality, and fine sediment concentrations in spawning gravels. Recreation is the predominant use of this sub-watershed, with multiple-use trails providing access to high-elevation lakes in the Crazy Mountains. Therefore, managing trail use to minimize sediment inputs and channel alterations will be the management focus to protect the genetically pure Yellowstone cutthroat trout populations. The GNF plans to retain the road culvert on the Shields River Road near the mouth of the South Fork as a barrier to upstream fish movement.

Evaluations of habitat conditions on privately owned portions of the South Fork Shields River will inform the need to pursue conservation practices. In the event that management activities are warranted, FWP will work with private landowners and the SVWG to implement practices that will benefit Yellowstone cutthroat trout conservation. The watershed restoration plan under development to reduce sediment loading (see 4.3.3 *Habitat Restoration*) may also identify projects that will reduce sediment loading and improve habitat in the South Fork Shields River.

5.4.3 *Mill Creek*

Mill Creek is the next drainage to the east of the South Fork Shields River. It originates in the GNF, and flows north for about 4 miles before its confluence with the Shields River (Figure 5-7). It enters private land about 1 mile from its mouth.

Fisheries investigations in Mill Creek indicate brook trout and brown trout have invaded the stream in recent years, although they appear to be limited to the lower sections. Berg (1975) found only Yellowstone cutthroat trout in a 300-foot long section near the confluence with the Shields River. Similarly, only Yellowstone cutthroat trout were present in a sampling effort in 1990 (MFISH database). In 2003, brook trout were present in 3 sampling reaches in the lower mile, and their abundance was similar to Yellowstone cutthroat trout (Shepard 2004). Low numbers of brown trout were also present in 2003. In 2009, sampling occurred within 2 reaches upstream of the GNF boundary. Low numbers of nonhybridized Yellowstone cutthroat trout were found at the lower sampling reach, located immediately upstream of the Forest Service boundary. The next reach was 0.5 miles above the boundary, and yielded no fish.

Codominance of brook trout and Yellowstone cutthroat trout in the lower reaches of Mill Creek, within perhaps a decade after invasion, is similar to other streams in the upper Shields River watershed, where brook trout populations increase dramatically in numbers soon after gaining access to streams. Consistent with this pattern, brook trout will likely totally displace Yellowstone cutthroat trout in at least lower Mill Creek, unless fisheries biologists intervene. The apparent absence of brook trout from upper Mill Creek may be related to the steepness of the stream, as Yellowstone cutthroat trout may be better adapted to persisting in this type of environment.

Conservation actions for Mill Creek should include a strategy to secure Yellowstone cutthroat trout in face of the ongoing brook trout invasion. The Forest Service has agreed to retain the existing road culvert on the Shields River Road as a potential barrier to upstream movement by fish into Mill Creek. Determination of the extent of the invasion and nonnative fish removal are among the needed conservation actions.

5.4.4 Deep Creek

Deep Creek is one of the larger tributaries in the upper Shields River HUC (Figure 5-7). Most of its 4.5 miles flow through GNF, with the lowest mile entering private land.

Deep Creek has been sampled several times since the 1970s, and these efforts describe a trend for invasion of brook trout, followed by eventual displacement of Yellowstone cutthroat trout. In the 1970s, Yellowstone cutthroat trout was the only species of trout captured in Deep Creek (Berg 1975). In 1990, nearly equal numbers of brook trout and Yellowstone cutthroat trout were found in a sampling reach about 1 mile from its mouth (MFISH database). In 2003, brook trout were considerably more abundant than Yellowstone cutthroat trout, and outnumbered the native trout by about 10 to 1. In 2009, sampling yielded only a few brook trout and sculpin in two sections of Deep Creek located in the lower 1.5 miles of stream (MFISH database). Sampling in two sections located 2.0 to 2.5 miles from the mouth found no fish. These results suggest potential extirpation of Yellowstone cutthroat trout from Deep Creek; however, the low numbers of fish in general are indicative of some type of environmental stress, such as extended drought.

Deep Creek is a potential candidate for restoring Yellowstone cutthroat trout to historically held habitat. Long-term persistence of a restored population would require removing brook trout and preventing their reinvasion. Given the abundant brook trout in neighboring Smith Creek, this would require construction of a barrier. Factors to consider in making Deep Creek a priority is if enough habitat could be secured to protect a large enough population of Yellowstone cutthroat trout.

5.4.5 Sunlight Creek

Sunlight Creek is a tributary of Deep Creek (Figure 5-7) that flows entirely through Forest Service lands for its 4-mile length. Until recently, no survey data were available for Sunlight Creek, although Yellowstone cutthroat trout were presumed to be the species present. In 2009, two sections were sampled for fish composition in 2009 about 0.5 mile above the Forest Service road, and only four brook trout were captured in these two sections during July and August. Additional fish sampling in three sections located 0.5 miles apart from 1.0 to 2.5 miles above this road found no fish. The section about 2.5 miles above the road was located immediately below an approximately 25-foot tall waterfall.

Sunlight Lake is located near the headwaters of Sunlight Creek. No fisheries information is available for this lake. Fish surveys above the waterfall and in Sunlight Lake are proposed actions to determine the potential of upper Sunlight Creek for conserving Yellowstone cutthroat trout.

As a tributary of Deep Creek, Sunlight Creek adds stream length within this sub-watershed that could result in sufficient habitat for reestablishment of a Yellowstone cutthroat trout population, if such an action is feasible. Evaluation of the extent of habitat suitable for Yellowstone cutthroat trout is a conservation priority. The Deep Creek sub-watershed may be a candidate for nonnative removal, should a means to prevent reinvasion be available.

5.4.6 Serrett Creek

Serrett Creek is the next drainage upstream of Deep Creek (Figure 5-7). Most of its 3-mile length occurs on the GNF, although its lowest mile flows through private lands in the Shields River valley.

Fish sampling in Serrett Creek during 2009 found that brook trout outnumbered Yellowstone cutthroat near the mouth of the creek, but Yellowstone cutthroat trout made up an increasing proportion of the population as sampling proceeded upstream until only cutthroat trout were captured from 1.5 miles above the mouth upstream (MFISH database). Fish sampling near culverts found no fish in 2003 (S.W. Shuler, GNF, personal communication). No barriers to upstream migrating fish were found during 2009 sampling.

Protecting this population of Yellowstone cutthroat trout from brook trout invasion is the conservation priority for Serrett Creek. Installation of a barrier and removal of brook trout are among the potential options for Serrett Creek. The amount of available habitat will be among the factors considered in prioritizing such actions.

5.4.7 Bennett Creek

Bennett Creek is a small tributary of the Shields River located close to its headwaters in the northeast portion of the watershed (Figure 5-7). About half of its 4-mile length flows through GNF lands.

Fisheries investigations over several years have documented dominance of nonhybridized Yellowstone cutthroat trout in Bennett Creek in most of the watershed; however, a brook trout invasion is underway, putting the stream’s Yellowstone cutthroat trout at risk. The earliest sampling event occurred in 1974, with only Yellowstone cutthroat trout found in a 200-foot sampling reach located near the mouth of Bennett Creek (Berg 1975). Low numbers of brook trout were found in 2003, although Yellowstone cutthroat trout were still abundant and comprised 99% of trout captured in 4 sampling reaches in Bennett Creek (Shepard 2004). Field crews from the GNF did not find fish in their fisheries surveys associated with culverts, suggesting fishless reaches are present (Forest Service 2003 files). In a tributary of Bennett Creek, Forest Service crews found mostly Yellowstone cutthroat trout, with one brook trout being present. By 2009, brook trout numbers had increased substantially, with this nonnative comprising from 30-50% of the fish populations sampled in Bennett Creek (MFISH database). Brook trout dominated the northeast fork of upper Bennett Creek, and comprised nearly 90% of the fish captured (FWP, unpublished data).

Without intervention, brook trout will likely continue to increase in abundance, ultimately displacing Yellowstone cutthroat trout from Bennett Creek. Potential actions to protect the remaining cutthroat trout may include removal of brook trout, in conjunction with barrier construction somewhere in the larger basin.

As Bennett Creek lies mostly on Forest Service lands, the Forest Service has primary responsibility for managing habitat. Forest service roads occupy the basin and cross Bennett Creek at two locations. Managing sediment inputs from roads and ensuring passage through culverts will be major management concerns. Nonetheless, culverts may be preventing upstream invasion of brook trout in Bennett Creek. Removal of brook trout should precede opening passage throughout the watershed.

5.4.8 Buck Creek

Buck Creek is one of the longer tributaries in the upper Shields River watershed (Figure 5-7). Its 5-mile length flows entirely through forested portions of the GNF.

The available data suggest Buck Creek has a low potential to support a substantial fishery. The first fisheries survey in Buck Creek occurred in 1974. This initial survey did not yield any fish in either section sampled (Berg 1975). Likewise, in 1990, sampling did not find any fish in a section located near the mouth of Buck Creek. Fish surveys around culverts in 2003 found 2 Yellowstone cutthroat trout (Forest Service 2003 files).

Fish sampling during 2009 found low abundance of fish in general. Only one Yellowstone cutthroat trout was captured below the Shields River Road, no fish immediately above the road, and one brook trout and one cutthroat trout about 1.0 mile above the road (S.T. Opitz, FWP, personal communication). No evidence of genetic introgression was found in the one Yellowstone cutthroat trout captured below the Shields River Road (Kalinowski 2010a). Further genetic sampling between the mouth road should be done to confirm the genetic purity of this population. Conservation priorities for Buck Creek include protecting the existing, albeit small population of Yellowstone cutthroat trout.

As Buck Creek is entirely within the GNF, it has potential to be among the streams protected should the main stem barrier option discussed in 5.1.2 *Conservation Strategy for the Shields River* be feasible, and if the barrier would be downstream of its confluence with the Shields

River. Brook trout removal would need to be a component of the overall strategy for these streams within the GNF.

5.4.9 Clear Creek

Clear Creek is a small stream to the east of Buck Creek (Figure 5-7). It flows entirely within the GNF. Fisheries investigations have found Clear Creek to be apparently fishless. In 1973, electrofishing in its lowest mile yielded no fish. In 2003, the Forest Service did not find fish in a section near a road crossing (Forest Service, 2003 files). Likewise, no fish were found in three sections of Clear Creek located from its mouth upstream 1.5 miles that were sampled during 2009 (MFISH database).

As Clear Creek has an apparently limited ability to support a fishery, this stream is a low priority for Yellowstone cutthroat trout conservation. As conservation activities proceed in the headwaters of the Shields River, continued monitoring to ensure the stream does not become a refuge for brook trout is the only indicated action warranted for this stream.

5.4.10 Scofield Creek

Scofield Creek lies to the east of Clear Creek (Figure 5-7). This small stream, less than 2 miles in length, has been the subject of several fisheries investigations. Only Yellowstone cutthroat trout were found in Scofield Creek during sampling conducted in the 1974, 1990, 2003, and 2005 (Berg 1975; Shepard 2004; Forest Service files), but by 2009 one brook trout was present (MFISH database).

Protecting Scofield Creek's Yellowstone cutthroat trout population in face of invasion by brook trout is the conservation priority. Construction of a barrier as described in 5.1.2 *Conservation Strategy for the Shields River* may secure the habitat in Scofield Creek, should a suitable location be available.

5.4.11 Turkey Creek

Turkey Creek is a small, headwaters stream near the northeastern extent of the Upper Shields River Watershed (Figure 5-7). Fish sampling in 1974, 2003, and 2009 found only Yellowstone cutthroat trout in Turkey Creek within about the lower mile of the stream (Berg 1975; Shepard 2004; MFISH database). Genetic analyses of fish captured in 2009 found no evidence of hybridization (Kalinowski 2010a). The Forest Service sampled above and below a road crossing on North Fork Turkey Creek, and did not find any fish (Forest Service, 2003 files).

Invasion of brook trout into Turkey Creek is likely given their presence in neighboring streams. Protecting this pure population of Yellowstone cutthroat trout in the face of likely invasion is the conservation priority. As with neighboring streams, Yellowstone cutthroat trout conservation would be part of a larger scale effort to remove nonnative fishes, and protect these waters from reinvasion. A main stem barrier on the Shields River, or barrier on Turkey Creek are among options; however, with only about a mile of suitable habitat available, a barrier on Turkey Creek would be a low priority.

5.4.12 Lodgepole Creek (east of Dugout Creek)

The upper Shields River includes 2 streams named Lodgepole Creek, located only 2 miles apart. This section addresses the upper Lodgepole Creek, which to the east of Dugout Creek (Figure 5-7). Fisheries investigations spanning the 1970s through 2009 have found only nonhybridized Yellowstone cutthroat trout in Lodgepole Creek (Berg 1975; Clancy 1987; Kalinowski 2010a; MFISH database). In 2011, investigators documented the first brook trout in Lodgepole Creek (B.B. Shepard, Wildlife Conservation Society, personal communication). These most recent data have not yet been incorporated into fisheries database, so this invasion does not show up on distribution maps (Figure 2-6).

Documentation of invasion of brook trout into Lodgepole was an alarming, but not unexpected find. The strategy to conserve Yellowstone cutthroat trout in Lodgepole Creek will involve one of the options described in 5.1.2 *Conservation Strategy for the Shields River*, which include options of a single main stem barrier, construction of two main stem barrier, or least-preferably, construction of barriers on individual tributaries. The second component would involve removal of brook trout, using either mechanical or chemical means.

5.4.13 Dugout Creek

Dugout Creek drains from the north, and joins the Shields River about 1 mile downstream of the confluence of Lodgepole Creek (Figure 5-7). Fish sampling during the 1970s and 2003 found only Yellowstone cutthroat trout in Dugout Creek near the Forest Service road (Berg 1975; Shepard 2004), while sampling from 2005 through 2009 found increasing numbers of brook trout in the stream (FWP, Livingston fisheries office files). In 2011, researchers found brook trout had invaded further upstream than they were previously found (B.B. Shepard, Wildlife Conservation Society, personal communication). Genetic investigations of fish captured in 2009 found no evidence of introgression with rainbow trout (Kalinowski 2010a).

Potential strategies to protect Dugout Creek's Yellowstone cutthroat trout population relates to options aimed at preventing future invasion of nonnatives, combined with removal of brook trout already present. The specific approach will be determined following evaluation of the feasibility of barrier placement described in 5.1.2 *Conservation Strategy for the Shields River*.

5.4.14 Crandall Creek

Crandall Creek flows for over 3 miles through the GNF before its confluence with the Shields River (Figure 5-7). Fisheries investigations in Crandall Creek occurred in 2004 and 2009 (MFISH database). In both efforts, Yellowstone cutthroat trout, brook trout, and mottled sculpin were present in the lower reaches of Crandall Creek. In 2009, sampling 1.5 miles from the mouth yielded no fish. Genetic sampling of 21 Yellowstone cutthroat trout captured in 2009 found no evidence of introgression (Kalinowski 2010a).

As Crandall Creek supports nonhybridized Yellowstone cutthroat trout, protecting this population is consistent with the highest priority under the Agreement. Crandall Creek is among streams likely to be protected through the barrier options described in 5.1.2 *Conservation Strategy for the Shields River*. Mechanical or chemical removal of nonnatives would also be among likely actions.

5.4.15 Lodgepole Creek (west of Crandall Creek)

This Lodgepole Creek, located about 2 miles west of Crandall Creek, flows through the GNF for about 0.5 miles before entering private land (Figure 5-7). Before the 2009 survey effort, no formal fisheries investigations had occurred in this stream. Sampling in 2009 found brook trout to be much more abundant than Yellowstone cutthroat trout in the lower mile of Lodgepole Creek and no fish were found over one mile above the mouth (files, Montana FWP, Livingston). Genetic sampling of 11 fish found no evidence of introgression (Kalinowski 2010a).

Conservation options for Lodgepole Creek are similar to other tributaries in this portion of the Shields River watershed. As this Lodgepole Creek enters the Shields River downstream of the forest service boundary, the potential main stem barrier would not exclude nonnatives from this stream. Securing the native cutthroat trout through removal of competing brook trout, along with construction of a barrier to prevent reinvasion of nonnative fishes are among the potential future actions. Given the limited extent of available habitat, barrier construction would be a lower priority for Lodgepole Creek.

5.4.16 Kavanaugh Creek

Kavanaugh Creek originates in the foothills on the northwest edge of the Crazy Mountains (Figure 5-8). Information on fisheries is limited to a survey in 2008, which found no fish in a 330-foot long section located about 5 miles from its mouth (MFISH database). Otherwise, the potential for Kavanaugh Creek to support a fishery within its lower reaches is unknown. Additional survey and evaluation of the potential for Kavanaugh Creek to support a viable Yellowstone cutthroat trout population are proposed conservation actions.

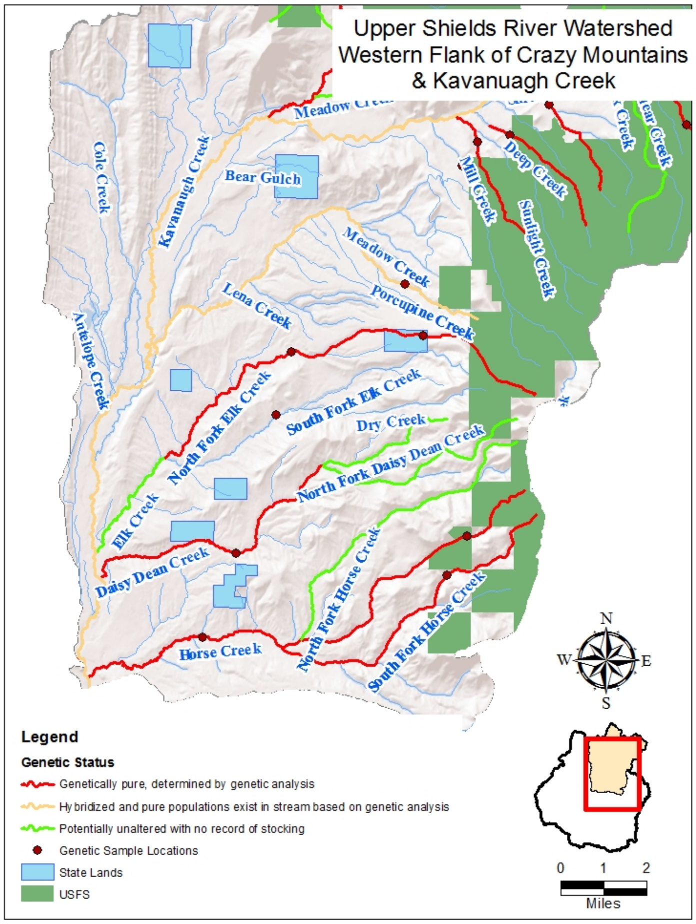

Figure 5-8: Streams draining the western flank of the Crazy Mountains in the Upper Shields River Watershed, and Kavanaugh Creek.

5.4.17 Porcupine Creek

Porcupine Creek is a tributary of the Shields River that flows from forested headwaters in the Crazy Mountains, through rangeland in the valley portions of the watershed (Figure 5-8). The majority of Porcupine Creek flows through private lands. Livestock grazing is the primary land use within its watershed.

Fisheries investigations in Porcupine Creek began in the early 1970s. Berg (1975) sampled two sections and found Yellowstone cutthroat trout, along with mountain whitefish, brown trout, longnose sucker, and lake chub. In 1999, FWP sampled a section about 10 river miles from the mouth, and found relatively abundant Yellowstone cutthroat trout, along with suckers, longnose dace, and lake chub (Tohtz 1999a). Genetic testing of these fish found 33 nonhybridized Yellowstone cutthroat trout, and one Yellowstone cutthroat trout x rainbow trout hybrid (Leary

2001). In 2009, sampling about 1.5 miles above the mouth yielded numerous longnose dace, lake chub, and white suckers. In 2009, sampling in tributaries yielded a single Yellowstone cutthroat trout near the mouth of the North Fork Lena Creek, but no fish in South Fork Lena Creek or two sections of Meadow Creek.

Habitat information for Porcupine Creek includes a rapid aerial assessment (Tohtz 1999b). Livestock grazing practices had an apparent negative influence on riparian function, bank stability, and sediment delivery. Reduced riparian cover on stream banks and braided channels were among the observed disturbances.

The conservation strategy for Porcupine Creek will begin with determining more about the status of Yellowstone cutthroat trout in the stream and evaluating habitat condition along its length. Implementation of agricultural BMPs and habitat restoration may follow as warranted. As this stream occupies mostly private lands, collaborators in its management will include FWP, the SVWG, and private landowners.

5.4.18 Elk Creek

The Elk Creek watershed contains two forks, which originate in the foothills of the Crazy Mountains and meet about 5 miles downstream to form the main stem (Figure 5-8). Elk Creek, and its north and south forks, flow primarily through rangeland. Water withdrawn from Elk Creek irrigates forage crops; however, FWP does not consider Elk Creek chronically or periodically dewatered.

Fisheries data on the main stem of Elk Creek are limited. In 1974, A 250-foot-long section sampled near the mouth yielded mountain whitefish, Yellowstone cutthroat trout, brown trout, white and longnose suckers, and lake chub. Longnose suckers were the dominant species, accounting for 23 of the 42 fish captured. Five Yellowstone cutthroat trout were captured, and brown trout were relatively rare, with only 1 captured.

The 1974 fish survey also included the forks of Elk Creek. No fish were captured in a 200-foot-long reach in North Fork Elk Creek located about 5 miles from its confluence with Elk Creek. Sampling within a 150-foot reach of South Fork Elk Creek near its mouth yielded 5 Yellowstone cutthroat trout. In 1999, Yellowstone cutthroat trout were found to be abundant in South Fork Elk Creek (Tohtz 1999a), and genetic testing found these to be slightly hybridized with an average contribution of 99.1% of alleles from Yellowstone cutthroat trout, and 0.9% of alleles from rainbow trout (Leary 2001). Of the 44 fish tested from North Fork Elk Creek, all tested as being nonhybridized Yellowstone cutthroat trout.

Fish survey efforts in 2009 also suggested hybrids may be present in South Fork Elk Creek. A 330-foot- long section just above the confluence of Dry Creek yielded only one trout that appeared to be a rainbow trout or hybrid (files, FWP, Livingston). Likewise, apparent hybrids were also found in a 330-foot reach on Dry Creek.

Available habitat data include a rapid aerial assessment conducted in 1999 (Tohtz 1999b). This effort found agricultural uses to be contributing to localized riparian and stream-habitat degradation (Tohtz 1999b). This stream appeared to be a good candidate for restoration if landowner cooperation could be secured (Tohtz 1999b). A few private ponds were mapped in the South Fork of Elk Creek, which raise the concerns of potential hybridizing fish and disease introductions, but no problems have been reported thus far (Tohtz 1999b). DEQ lists Elk Creek as impaired because of alterations in streamside or littoral vegetative covers with grazing in riparian areas being the probable source of impairment (DEQ 2012).

Potential conservation actions for the Elk Creek watershed will emphasize protecting the basin's nonhybridized and slightly hybridized Yellowstone cutthroat trout. Surveys to determine species distribution throughout the drainage, especially in the South Fork Elk Creek drainage would aid in conservation planning. Sources of rainbow trout, perhaps from private ponds, may be present in the drainage, and these need to be identified and eliminated if present. In addition, collaboration with landowners will lead to implementation of BMPs and stream restoration to promote healthy riparian areas and high quality in-stream habitat. At least one landowner has already begun such efforts with installation of riparian fencing and off-channel water, along with mechanical re-sloping of vertical, eroding stream banks. This rancher-initiated project provides an example of reducing sediment loading and promoting fish conservation while maintaining agricultural values on a working cattle ranch.

5.4.19 Daisy Dean Creek

Daisy Dean Creek, the next drainage to the south from Elk Creek, originates the foothills of the Crazy Mountains (Figure 5-8). This stream flows almost entirely through private lands, and livestock grazing is the predominant land use. Production of livestock forage and small grains is another common activity in this sub-watershed.

The first formal fish survey on Daisy Dean Creek occurred in 1974, with a 300-foot section being sampled about 5 miles from its mouth (Berg 1975). This effort yielded 1 Yellowstone cutthroat trout. Genetic analyses of cutthroat trout captured in 1999 found alleles characteristic of only Yellowstone cutthroat trout, indicating this population was likely nonhybridized. In 2009, sampling in a 330-foot section of North Fork of Daisy Dean yielded 30 Yellowstone cutthroat trout and 1 lake chub. Genetic analyses of 25 of the captured fish found no evidence of introgression (Kalinowski 2010).

Habitat investigations found a mix of riparian and stream conditions. Actively eroding banks were present near fields cropped close to, or up to, the stream edge, resulting in a lack of a riparian buffer. Elsewhere, substantial areas of intact and functioning riparian corridors existed (Tohtz 1999b). These reaches may provide potential reference areas for restoration within this creek.

Conservation priorities for Daisy Dean Creek include the need for additional surveys to determine longitudinal species composition, identify potential barriers protecting the pure Yellowstone cutthroat trout present in this stream, and implement BMPs to reduce sediment delivery and improve in-stream habitat quality where warranted. As most of Daisy Dean Creek flows through private lands, collaboration of several parties will result in implementation of conservation activities to benefit Yellowstone cutthroat trout. Participants will include FWP, the SVWG, and private landowners. The conservation strategy for Daisy Dean Creek will likely emphasize implementation of agricultural BMPs; however, mechanical restoration of stream banks and riparian plantings may be appropriate in some reaches. Similar to Elk Creek, restoration of reaches with substantial potential to contribute sediment underwent restoration in 2006.

5.4.20 Horse Creek

Horse Creek originates in the foothills of the Crazy Mountains, and flows to the west until its confluence with the Shields River (Figure 5-8). Land uses in the drainage include livestock grazing and irrigated forage-crop production. The majority of the watershed is in private ownership, although the headwaters portions of several of its forks are within the GNF.

Fisheries investigations in the Horse Creek drainage began in the early 1970s, and continued through 2009. The first effort occurred in August of 1974, and involved electrofishing a 500-foot-long section of Horse Creek, located about 2.6 miles from its confluence with the Shields River (Berg 1975). This report referred to Horse Creek as “Horsefly Creek”, and reported capture of 30 Yellowstone cutthroat trout and no other species. The section was resampled in late June of 2003, and no trout of any species were captured (Shepard 2004). As this effort coincided with spawning period, the apparent absence of Yellowstone cutthroat trout the result of seasonal movement associated with spawning.

A section several miles upstream has been sampled on two occasions. On October 13, 1999, FWP biologists conducted a 3-pass depletion estimate in a 750-foot-long reach of Horse Creek, located about 1.5 miles downstream of the confluence its north and south forks (Tohtz 1999a). Yellowstone cutthroat trout were “surprisingly abundant”, yielding a population estimate of over 870 fish per mile. Likewise, the size-class structure indicated a well-established, self-sustaining population. Genetic analyses of tissue collected from 30 fish found only alleles characteristic of

Yellowstone cutthroat trout (Leary 2001), making this a core population in Yellowstone cutthroat trout conservation efforts. Other species reported present were mottled sculpin, longnose dace, and an unidentified species of sucker. All of these species are native to the Shields River watershed. In 2008, FWP resampled this reach and found healthy numbers of Yellowstone cutthroat trout, although not at the densities found in 1999 (Endicott 2010). Low numbers of brook trout and brown trout were also present, marking the first time a nonnative salmonid had been captured in the main stem of Horse Creek. The genetic integrity of the Yellowstone cutthroat trout population was compromised by the presence of an apparent F1 hybrid between rainbow trout and Yellowstone cutthroat trout among the 25 fish tested (Kalinowski 2009).

Fisheries investigations have also occurred in the tributaries of Horse Creek. In 1991, FWP conducted genetic testing of Yellowstone cutthroat trout captured in two of its forks. Electrophoretic analysis of 5 fish from Middle Fork Horse Creek, and 7 fish from South Fork Horse Creek found alleles characteristic of only Yellowstone cutthroat trout (Leary 1992). The apparent absence of rainbow trout genes suggested these streams supported pure populations of Yellowstone cutthroat trout; however, the small sample size limited certainty in the results. Leary (1992) recommended managing these streams as pure Yellowstone cutthroat trout, unless further testing demonstrated otherwise. In 2008, brook trout and Yellowstone cutthroat trout were found in lower South Fork Horse Creek (Endicott 2010), and none of the 18 Yellowstone cutthroat trout tested showed any indications of hybridization (Kalinowski 2009). In 2009, crews found brook trout to dominate in a 330-foot section downstream of the confluence with Basin Creek, with 42 brook trout and only 5 Yellowstone cutthroat trout captured (MFISH database). About even numbers of brook trout and Yellowstone cutthroat trout were present in a section sampled in Basin Creek. None of the 14 Yellowstone cutthroat trout from South Fork Horse Creek, nor the 21 fish from Basin Creek, showed evidence of introgression with rainbow trout (Kalinowski 2010b).

Habitat condition is variable in the Horse Creek watershed, with high quality and impaired reaches being present. FWP identified several reaches where streamside management of livestock had contributed to degraded riparian health and function, and excessive stream bank erosion, others had high quality habitat and intact riparian areas (Endicott 2007a; Endicott 2007b; Endicott 2009; Endicott 2010). Landowners along several of the impaired reaches have recently implemented conservation actions such as riparian fencing, and a bank restoration project was completed in fall of 2011. These efforts will result in local improvements in habitat quality. In addition, these actions are consistent with watershed planning efforts to reduce sediment loading to Horse Creek, and ultimately, the Shields River.

A culvert at a county road crossing over South Fork Horse Creek has been the subject of investigations to determine whether opening passage is desirable. The culvert under Horse Creek Road is perched and steep, conditions that likely make it a leap and velocity barrier to upstream movement of fish (Endicott 2007a). In addition, this culvert is problematic during high flows, and often contributes to flooding over Horse Creek Road; so finding solutions to fish passage and floodwater conveyance had potential to benefit a range of stakeholders. The presence of hybridized Yellowstone cutthroat trout downstream of this culvert, along with apparent absence of hybridization above the culverts indicates that opening passage through this culvert is not consistent with the conservation priority of protecting remaining pure populations. Solutions to flood flow conveyance at this culvert needs to preserve the impassability of the road crossing.

Conservation of the Yellowstone cutthroat trout in the Horse Creek watershed will likely involve an integrative approach that addresses habitat quality, management of nonnative fishes, and additional investigation of fish distribution and genetic status. Implementation of agricultural BMPs that promote health and vigor of riparian vegetation, and reduce stress on stream banks will likely be a considerable component of this approach, and will build on improvements already underway. Other potential agricultural-related BMPs such as increasing water use efficiency or preventing entrainment of Yellowstone cutthroat trout into irrigation canals may be appropriate. Management of nonnative salmonids, through removal or suppression, will also be a among possible options. Promoting connectivity will occur on a case-by-case basis, when field investigations indicate opening access will not threaten nonhybridized fish. Determining seasonal habitat use and movements would also be beneficial in maintaining connectivity and conserving migratory life-history strategies, which have potential to be significant as suggested by seasonal comparisons of Yellowstone cutthroat trout occupancy (Berg 1975; Shepard 2004). Additional survey work is needed to document fish distribution and genetic status of Yellowstone cutthroat trout in the north and middle forks of Horse Creek.

5.5 Middle and Lower Shields River Watersheds (5th Code HUCs): Data Review and Conservation Strategies

As only a small portion of the Lower Shields River watershed lies within the planning area, this section combines the middle and lower HUCs. The Middle Shields River Watershed encompasses 145,000 acres on both sides of the Shields River valley (Figure 5-9). The Canyon Creek watershed is the only significant, named waterway in the lower Shields River HUC. Private land comprises the majority of these HUCs, especially in valley portions. The GNF holds lands in the headwaters of many tributaries, and state lands occur throughout the valley portions.

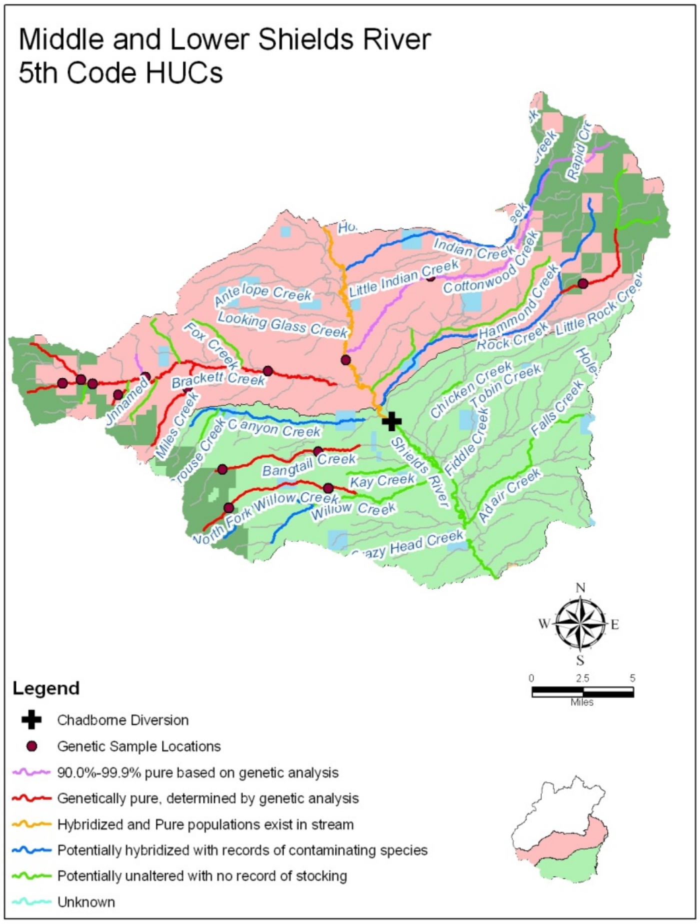

Figure 5-9: Middle and lower Shields River 5th code HUCs.

5.5.1 Indian Creek

Indian Creek originates in the Crazy Mountain range on the east side of the watershed, and flows for 13 miles before its confluence with the Shields River (Figure 5-10). Its upper 2 miles are within the GNF, and its remaining length is through privately owned land. Little fisheries information is available for Indian Creek. Yellowstone cutthroat trout are presumed present, although these fish may be hybridized (MFISH database).

Conservation priorities for Indian Creek involve determination of distribution and genetic status of Yellowstone cutthroat trout, and other species in the stream, and identification of any factors limiting the ability of Indian Creek to support Yellowstone cutthroat trout. These investigations would guide development of a strategy to meet conservation objectives for Yellowstone cutthroat trout if warranted.

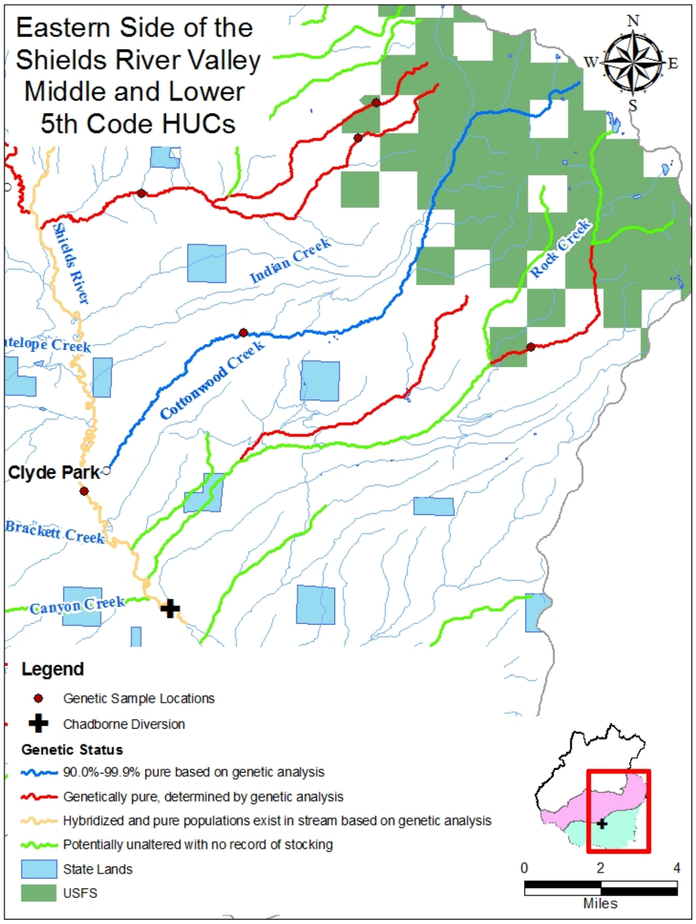

Figure 5-10: Eastern side of the middle and lower Shields River 5th code HUCs.

5.5.2 Cottonwood Creek

Cottonwood Creek originates in the Crazy Mountains at Cottonwood Lake (Figure 5-10). It flows through approximately six miles of Forest Service lands before entering private lands in the foothills of the Crazy Mountains. Recreation is the primary land use in the forested portion of the watershed with a hiking trail paralleling the stream for most of its length. Agriculture, including livestock grazing and irrigated crop forage crop production occurs within the valley. Irrigation withdrawals are significant along Cottonwood Creek, and FWP lists this stream as chronically dewatered.

Fisheries information for Cottonwood Creek includes fish surveys (Tohtz 1999a, Shepard 2004) and results of genetic analyses (Leary 2001). Yellowstone cutthroat trout are common in Cottonwood Creek, but live in sympatry with brown and brook trout. Genetic analyses of fish tissue samples indicated slight introgression with rainbow trout. A potential conservation action for Cottonwood Creek is development of a plan to protect the resident Yellowstone cutthroat trout through removal or suppression of the nonnative trout species, and preventing further hybridization with rainbow trout.

Currently, habitat information on Cottonwood Creek is limited. As a 303(d)-listed stream, Cottonwood Creek was the subject of considerable effort to characterize habitat, including an extensive assessment of aerial photography, and intensive evaluation channel conditions riparian vegetative cover. These data will be useful in identifying potential restoration projects.

As a chronically dewatered stream, finding opportunities to increase summer stream flows and prevent entrainment of Yellowstone cutthroat trout into irrigation ditches are the identifiable conservation actions for Cottonwood Creek. Collaborators in this process include FWP, SVWG, and water users. Maintenance of recreational trails to protect channel integrity and limit sediment loading in forested lands falls to the Forest Service.

5.5.3 Rock Creek

Similar to Cottonwood Creek, Rock Creek originates from a high-elevation lake in the Crazy Mountains (Figure 5-10). A recreational trail follows the stream through much of its length within forested portions of the watershed. As the stream enters the Shields River valley, agricultural land uses predominate and include livestock grazing and production of irrigated forage crops. FWP lists Rock Creek as periodically dewatered, which limits habitat availability in its lower reaches.

Fisheries information on Rock Creek includes population estimates at several locations along the stream (Shepard 2004). Yellowstone cutthroat trout occur sympatrically with brown trout and brook trout, which were both more numerous than Yellowstone cutthroat trout. Nonnative fish removal or suppression are among the options for conserving Yellowstone cutthroat trout in the Rock Creek drainage.

Habitat information collected through TMDL planning efforts includes field investigations and evaluations of aerial imagery. These investigations will be useful in identifying limiting factors and potential restoration projects. Collaborators in implementation of warranted restoration and management activities will include FWP, Forest Service, SVWG, NRCS, and private landowners.

5.5.4 Antelope Creek

Antelope Creek flows from the west side of the basin until its confluence with the Shields River midway between Wilsall and Clyde Park (Figure 5-11). Antelope Creek’s headwaters originate in the foothills of Rattlesnake Ridge. Lacking a large drainage area and high elevations supporting snow pack, Antelope Creek tends to be intermittent for much of its length and has prairie stream affinities such as warm water temperatures, fine substrate, and low gradient.

Fisheries data are lacking for Antelope Creek; however, best professional judgment from fisheries biologists indicate longnose dace, lake chub, and one or more members of the sucker family are likely present (Carson 2005). Although salmonids, including Yellowstone cutthroat trout, may make incidental use of Antelope Creek, it has a low natural potential to provide substantial habitat for cold-water fisheries.

Antelope Creek likely contributes pollutants to the Shields River. Currently, DEQ lists Antelope Creek for a sediment-related pollutant category and excess algal growth, which is considered "pollution" and does not require a TMDL. Of course, excessive algal growth is typically the result of nutrient loading, and DEQ is monitoring nutrient concentrations in the area. TMDLs for appropriate pollutants in Antelope Creek will not occur until after 2014. The SVWG and DEQ are the primary entities involved in addressing water quality concerns in Antelope Creek.

5.5.5 *Brackett Creek*

Brackett Creek originates in the Bridger Range, and flows for 16 miles before joining the Shields River near Clyde Park (Figure 5-11). Information allowing inference about the status of Brackett Creek includes fish and habitat surveys conducted by FWP (Shepard 2004), and reports prepared by private consultants (Confluence 2002). Fishes present in the Brackett Creek drainage included Yellowstone cutthroat trout, rainbow trout, mountain whitefish, longnose and white sucker, mottled sculpin, longnose dace, and lake chub. Genetic analyses of Yellowstone cutthroat trout in 1987 found these were nonhybridized (Leary 1987). In 2002, of the 19 fish tested, 18 were nonhybridized Yellowstone cutthroat trout and one was an F1 Yellowstone cutthroat trout × rainbow trout hybrid (Cook 2002).

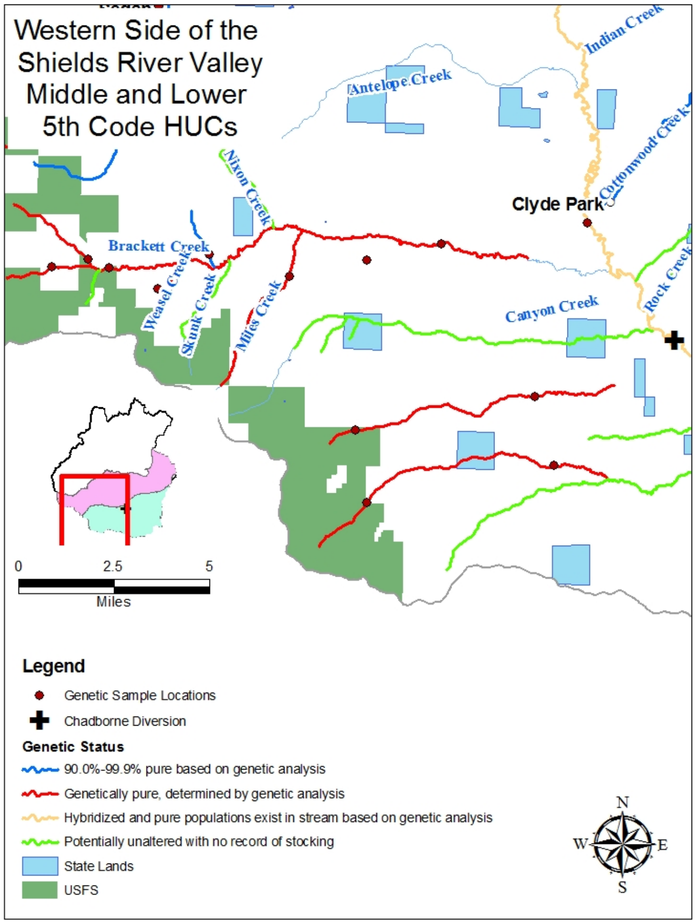

Figure 5-11: West side of the middle and lower Shields River 5th code HUCs.

Livestock grazing, channelization, bank erosion, and fish passage barriers are among the reported perturbations likely to limit Yellowstone cutthroat trout in the Brackett Creek watershed (Shepard 2004, Confluence 2002). Extensive areas of eroding stream banks contributed high levels of fine sediment. Confluence (2002) observed considerable siltation, and suggested that fine sediment limited fish reproduction, as evidenced by a low numbers among the young year-classes.

Restoration has been ongoing in Brackett Creek, with most efforts relating to habitat restoration. In recent years, several landowners have initiated projects to reverse habitat degradation and improve fisheries on private lands. For example, projects funded partially under the Future Fisheries Improvement Program resulted in stabilization of 7,000 feet of eroding bank, elimination of a fish barrier caused by an irrigation diversion, and re-naturalization of 1,300 feet of channel to its historic location. Combined, these projects have likely improved water quality by reducing sediment and thermal loading. Likewise, an increase in habitat availability and quality, with an increase in channel length and pool frequency, has probably been beneficial to fish, including Yellowstone cutthroat trout. Follow-up monitoring to evaluate the influence of these actions is warranted.

The presence of rainbow trout and hybrids in Brackett Creek presents a substantial threat to Yellowstone cutthroat trout in the drainage. Priorities for Brackett Creek include determining the source of rainbow trout, which may be coming from the Shields River or a private pond. Results of this investigation will provide the basis of a strategy to protect and restore Yellowstone cutthroat trout in the creek.

FWP considers Brackett Creek to be periodically dewatered, and resulting low flows may be, in part, responsible for the relatively warm temperatures recorded in 2002 (Figure 4-12). The general approach to addressing dewatering is to work with water rights holders on voluntary measures that increase water use efficiency, and potentially to compensate water users financially for water left in the stream.

Recent habitat restoration efforts notwithstanding, eroding banks and riparian degradation remain constraints on the Brackett Creek's fishery. As this stream flows mostly through private lands, conservation activities will involve collaboration among FWP, the SVWG, and private landowners. Likely activities include implementation of agricultural BMPs and stream habitat restoration.

5.5.6 Middle Fork Brackett Creek

Middle Fork Brackett Creek originates in the Bridger Range (Figure 5-11). Most of its 3-mile length is within the GNF. Available information on this stream includes genetic evaluations in 1987 (MFISH database), and fish population and habitat assessments conducted in 2001 (Shepard 2004). In the 1980s, Middle Fork Brackett Creek supported genetically pure Yellowstone cutthroat trout (Leary 1987). In 2001, Shepard (2004) found brook trout to be more abundant than Yellowstone cutthroat trout.

Habitat evaluations from 2001 describe a streambed dominated by smaller-sized particles, no large woody debris, low to moderate frequencies of small woody debris, and relatively low amounts of spawning habitat (Shepard 2004). The assessed section had an elevated width-to-depth ratio that may indicate channel instability. Pool habitats made up about half the section by number, but less than a third by length. Pools were of relatively high quality with good volumes and depths and abundant cover. Stream banks were relatively stable and had a moderately high proportion of undercuts. In-stream and bank cover were both rated as moderately high.

Landownership within the Middle Fork of Brackett Creek sub-watershed is a mixture of private and public lands. Land uses include timber harvest and recreation on developed forest roads. The conservation strategy for this stream will include an evaluation of the influence of forest activities, followed by implementation of appropriate BMPs if necessary. Evaluation of the feasibility of brook trout control or eradication is a conservation need.

5.5.7 North Fork Brackett Creek

North Fork Brackett Creek is a small headwater stream flowing mostly through Forest Service-administered lands (Figure 5-11). Land uses include timber harvest and recreational uses, such as hiking, biking, and motorized trail use. Most of North Fork Brackett Creek flows through undeveloped lands, with a recreational trail being the primary potential influence where several crossings provide sites for channel disturbance and sediment delivery.

Fishes present in North Fork Brackett Creek include Yellowstone cutthroat trout, mountain whitefish, brook trout, and brown trout (Shepard 2004, Carson 2005). Yellowstone cutthroat trout sampled in 1987 tested as genetically pure (Leary 1987). Yellowstone cutthroat trout were the most abundant trout in 1974; however, more recent surveys indicated that brook trout have likely suppressed Yellowstone cutthroat trout (Shepard 2004).

A habitat survey was conducted at mile 1.1 along the North Fork during 2002 (Shepard 2004). Small gravels and sand dominated the streambed. Small and large woody debris were abundant, and about 10% of the larger woody debris crossed the entire channel. Spawning habitat was moderately abundant in this portion of the channel. The width-to-depth ratio of this section was greater than 17, again indicating some over-widening. Rankings of in-stream cover, bank cover, bank stability, and pool quality were all relatively high, while use of the riparian area was ranked as low.

Potential conservation actions for North Fork Brackett Creek should address habitat degradation, sediment delivery, and nonnative fishes. Implementation of BMPs to prevent delivery of sediment from recreational trails should be evaluated. Likewise, the feasibility of suppression or eradication of brook trout should be determined.

5.5.8 South Fork Brackett Creek

South Fork Brackett Creek flows through a patchwork of private and federally owned lands (Figure 5-11). No fisheries information is available for this stream. Investigations of fish community composition and habitat status are needed to guide a specific Yellowstone cutthroat trout conservation approach for South Fork Brackett Creek.

5.5.9 Weasel Creek

Weasel Creek is a small stream flowing nearly entirely through private lands (Figure 5-9). Limited fish sampling in Weasel Creek yielded no fish, although a pure Yellowstone cutthroat trout and a single brook trout were captured in its unnamed tributary (Shepard 2004). Conservation planning for the Brackett Creek drainage should consider Weasel Creek as a potential source of brook trout.

5.5.10 Skunk Creek

Skunk Creek, the next drainage to the south of Weasel Creek, flows mostly through private lands across its 3.5-mile length (Figure 5-11). Fisheries investigations in Skunk Creek yielded Yellowstone cutthroat trout, brook trout, and mottled sculpin (Shepard 2004). Genetic testing of Yellowstone cutthroat trout from Skunk Creek found 10 of 13 fish to display alleles diagnostic of Yellowstone cutthroat trout; whereas the remaining 3 fish were identified as post first generation hybrids between Yellowstone cutthroat trout and rainbow trout (Shepard 2004).

The presence of hybridized fish and nonnative brook trout are considerable concerns for the Brackett Creek drainage. Although brook trout distribution was spotty and their abundance low (Shepard 2004), the tendency of brook trout to displace Yellowstone cutthroat trout in headwaters is well documented. Similarly, the hybridized fish in Skunk Creek pose a threat to pure Yellowstone cutthroat trout in neighboring streams. Identifying the source of rainbow trout genes, and developing an action plan to protect and secure Yellowstone cutthroat trout in Skunk Creek are conservation priorities.

Habitat information on Skunk Creek includes a habitat survey conducted about 1.5 miles from its mouth and observations along the entire length of Skunk Creek (Shepard 2004). In the assessed reach, in-stream cover, bank cover, bank stability, and pool quality ranked high, while use of the riparian area ranked low, indicating grazing and other land use practices were compatible with riparian health and function. Observations of habitat quality and land use in the upstream reaches, within the national forest, indicated relatively poor stream bank stability and high levels of fine sediment. Addressing habitat quality and reducing sediment loading are conservation priorities for the upper portions of Skunk Creek.

5.5.11 Miles Creek

Miles Creek originates in the Bangtail Mountains and flows nearly entirely through private lands before its confluence with Brackett Creek (Figure 5-11). Fisheries investigations in 2001 found genetically pure Yellowstone cutthroat trout and mottled sculpin in this stream (Shepard 2004). Habitat was in relatively good condition. The streambed had relatively high levels of fine sediment was likely natural in origin, although previous grazing practices or logging may have augmented natural loading.

A brook trout invasion may be underway in Miles Creek. In 2009, a brook trout was seen in Miles Creek, along with numerous Yellowstone cutthroat trout. Additional sampling is warranted to determine the extent of the brook trout invasion, and develop a plan to protect the stream's Yellowstone cutthroat trout.

Although habitat in Miles Creek is largely in good condition, an isolated area of eroding banks results in sediment loading and impaired habitat (Endicott 2007b). The landowner has initiated development of grazing management strategy to reduce impacts on the riparian area and stream banks. In addition, a bank restoration project is slated to address habitat degradation and sediment loading to Miles Creek.

5.5.12 Nixon Creek

Nixon is a small creek that flows to the south until its confluence with Brackett Creek Figure 5-11). No fisheries information is available for this stream. A qualitative evaluation of habitat found riparian areas and stream habitat to be mostly in good condition, with exception of the lowest half mile of stream (Endicott 2007c). This landowner has implemented a grazing management strategy that will allow better control of livestock's use of the riparian area. Road crossings were another feature with potential to affect fish. At least one culvert was likely impassable given the steep approach, and length and grade of the culvert. This feature may be beneficial by protecting resident Yellowstone cutthroat trout from invasion of nonnatives. Conversely, the culvert may jeopardize a resident population, if present, by restricting gene flow or preventing recolonization after disturbance.

The conservation strategy for Nixon Creek includes collecting the requisite baseline information on fish species composition and distribution. In addition, evaluating the potential for the culvert to block fish movement is warranted. This information will guide implementation of specific actions to benefit Yellowstone cutthroat trout conservation in Nixon Creek.

5.5.13 Canyon Creek

Canyon Creek is the only perennial stream within the Lower Shields River Watershed that occurs above the Chadbourne diversion. It flows east for 13 miles until its confluence with the Shields River from the Bangtail Range (Figure 5-11). Canyon Creek has two tributaries: Grouse Creek and Bridgman Creek. A small portion of Canyon and its tributaries occur within the GNF. In addition, Canyon and Bridgman creeks flow through some state-owned lands. Nonetheless, most of the drainage is in private ownership.

In 2001, Shepard (2004) conducted fish investigations at regular intervals along the length of Canyon Creek and its major tributaries. Yellowstone cutthroat trout occurred through most of the drainage, and were the most abundant trout. Brown trout and brook trout were present, making interspecific competition a threat to Canyon Creek's Yellowstone cutthroat trout population. The genetic status of Canyon Creek's Yellowstone cutthroat trout is unknown.

The upper reaches of Canyon Creek and its tributaries likely has a low ability to support fish. Reconnaissance investigations in fall of 2010 suggest water availability may be the limiting factor (S.T. Opitz, FWP, personal communication). Despite being a good water year, the headwater reaches were completely dry. Ample water was present in these reaches earlier in the year; however, the seasonal, naturally dewatering likely limits the extent of occupiable habitat.

Conservation needs for Canyon Creek include determination of the genetic status of resident Yellowstone cutthroat trout, and actions to reduce or eliminate competition with brook trout and brown trout. As seen in the upper Shields River HUC, brook trout can rapidly displace Yellowstone cutthroat trout in headwaters streams following initial invasion. Although Yellowstone cutthroat trout were dominant in 2001, this situation could have changed in recent years, and additional sampling is warranted to track the ability of Yellowstone cutthroat trout to persist in sympatry with brook trout and brown trout.

6.0 Additional Information Needs and Adaptive Management

Recent fish surveys have greatly augmented our understanding of distribution and status of Yellowstone cutthroat trout in the Shields River watershed, and support development of a proactive approach to manage this watershed as a metapopulation. Nonetheless, information on some aspects of Yellowstone cutthroat trout ecology is lacking. To facilitate better management of Yellowstone cutthroat trout in the Shields River watershed, FWP seeks to fill a number of informational gaps through cooperative planning with other resource management agencies. This section describes some of the areas where more data are needed to refine the conservation approach through adaptive management.

6.1 Life History, Habitat Use, and Movements

Currently little information describing life history forms present within the Shields River watershed is available. Investigation of seasonal habitat use and movements would be a major asset in identifying key spawning, rearing, and overwintering areas, and would assist in the management of these reaches to promote conservation of Yellowstone cutthroat trout. Identification of favorable habitat features would also guide restoration planning. A study is underway that is examining habitat use and movement of Yellowstone cutthroat trout in the upper Shields River watershed, and the factors that promote successful invasion by brook trout. This project is employing PIT tag technology that allows identification of movements of specific fish. Likewise, advancements in the use of fish genetics may allow studies evaluating habitat use and movement of Yellowstone cutthroat trout. These studies could provide the foundation to formulate a long-term strategy for increasing gene flow among conservation populations, protecting and conserving critical habitats, and promoting in-stream conditions favorable to Yellowstone cutthroat trout.

6.2 Population and Genetics Surveys

Augmenting information on distribution, abundance, and genetic composition of the basin's Yellowstone cutthroat trout population would greatly increase the ability to manage habitat and fisheries to promote Yellowstone cutthroat trout conservation. The upper basin and headwaters areas of most streams have been surveyed at least once since 1989; however, the middle reach of the Shields River and several tributaries in the lower Shields HUC have not been surveyed. Increased monitoring in the upper Shields River main stem and tributaries will assist FWP in assessing population trends in the watershed. Furthermore, a stratified sampling scheme will be developed to ensure that each tributary is sampled at least once every 20 years. More intensive monitoring of population trends and community composition will allow managers to closely track the status and distribution of Yellowstone cutthroat trout and potential competing species and adapt restoration efforts appropriately.

Although the genetic status of many populations has been analyzed, fish populations and interactions are dynamic. Monitoring should include periodic genetic sampling to track hybridization, especially in areas most at risk. The resulting data would guide management decisions relating to fish removals or construction of barriers, if warranted.

6.3 Water Use and In-stream Flows

Late-summer in-stream flow is a prominent factor limiting Yellowstone cutthroat trout in the Shields River watershed. FWP lists several streams as chronically or periodically dewatered. These listings, coupled with the water resources report produced by the SVWG and the well data provided in Table 4-5 and Table 4-6, emphasize how critical water-quantity issues are in the Shields River watershed. Water leasing or irrigation efficiency projects will be an important restoration strategy. Nonetheless, the minimum in-stream flows necessary to protect and restore Yellowstone cutthroat trout have not been established. A systematic analysis of appropriate minimum in-stream flows, by reach, will provide targets for prioritizing and implementing water conservation projects.

The already scarce water supply in the watershed is even more reason to study the effects of well expansion on the surface water supply. The link between surface water use for agriculture and groundwater use for residential development should be brought to the forefront of the water budget discussion in the Shields River. The rate of well drilling has risen dramatically in the past 15 years, and this new level of water use will affect surface water over time as groundwater and subsurface waters are intercepted and prevented from recharging aquifers underlying the Shields

River. A recent study of groundwater use including, a map of the amount of water use in each well concentration area will be helpful in determining how much of an effect this recent development is having on the watershed. Studies in the Gallatin River subbasin prompted DNRC to change some of its rules to ensure groundwater developments will not affect surface water rights.

Designing studies to evaluate stream flow throughout the basin is beyond the scope of this conservation strategy; however, a conceptual approach follows. Collection of field data on stream flows, irrigation withdrawals, inputs (precipitation), and groundwater/surface water interactions that could be fed into a water budget model is a valid start. Given the spatial extent of the basin, and the number of diversions present, these efforts should focus on high priority sub-watersheds initially.

Collaborators in water budget evaluations will include a number of entities. Such investigations are consistent with the mission and responsibilities of DNRC and NRCS, who may provide funding, technical expertise, or both. Indeed, DNRC has already contributed substantially to the understanding of water quantity issues in the Shields River watershed (DNRC 2005). FWP, the SVWG, and irrigators are other obvious participants. Future investigations may occur through state or federal agencies, graduate research projects, or private sector scientists.

6.4 Connectivity Investigations

Maintaining connectivity among streams is a primary consideration in managing the Shields River watershed as a metapopulation. Road crossings, irrigation diversions, and dams are the typical features that can block fish movements in watersheds like the Shields River watershed. The Forest Service has inventoried its road crossings, and other crossings en route, and developed a spatial database housing these data. Building on this effort to include all roads in the basin, including private ranch roads, county roads, and state highways, will be a valuable tool in promoting connectivity in the Shields River watershed. Moreover, this activity can be dovetailed with evaluations of irrigation diversions to determine both fish passage and entrainment (see 6.5 Entrainment Investigations).

Components of the diversion and road-crossing inventory will include application of a standard methodology to evaluate road crossings, such as FishXing (Love and Firor 2001), mapping locations of diversions using handheld global positioning system (GPS) units, and photographing each feature. A project GIS database will house the resulting data. FWP has developed a database with known fish barriers that will provide the template for this approach. The Forest Service road crossing data will be added to this database. Overlaying information on potential barriers with fish distribution data and Yellowstone cutthroat trout genetics will allow for prioritization of barriers needing modification or removal to allow for fish passage.

6.5 Entrainment Investigations

The widespread irrigation of lands in the Shields River valley requires an extensive network of irrigation diversions, canals, and returns. The large quantity of water and widespread irrigation network throughout the Shields River basin potentially exposes Yellowstone cutthroat trout to entrainment both during upstream migrations of adults and as fry and juvenile fish are out-migrating.

As discussed in 4.3.5 Entrainment in Irrigation Ditches, an inventory of irrigation diversions, combined with an evaluation of the potential of each to entrain Yellowstone cutthroat trout is a priority research need for the Shields River watershed. This inventory will require a sound data management approach and development of a project GIS to maintain spatial data within the Shields River watershed. Diversions can then be prioritized based on potential to entrain fish, risks to Yellowstone cutthroat trout, and landowner interest. Results of investigations into life history strategies and movements (6.1 Life History, Habitat Use, and Movements) will also inform the prioritization process. Solutions to prevent or reduce entrainment will follow accordingly and include installation of screens, staggered shut down of ditch flows, and ditch maintenance. Given the expense and associated maintenance of fish screens, a substantial loss of Yellowstone cutthroat trout to irrigation systems would be necessary to justify screen installation.

6.6 Water Temperature

Dewatering, riparian degradation, and channel alterations in the watershed likely contribute to stream temperatures that are stressful to cold-water fishes, including Yellowstone cutthroat trout. Data presented in 4.2.2 *Water Temperature* indicate water in the Shields River frequently and substantially exceeds temperatures that are stressful, and sometimes lethal to Yellowstone cutthroat trout. Likewise, water temperatures in valley portions of tributary streams may also be unsuitable for the propagation and support of this native fish.

FWP has monitored water temperature at stations along the main stem of the Shields River on a near-annual basis since the late 1990s. Data management and analysis of these data are conservation needs that will provide additional information on longitudinal and temporal trends in water temperature along the main stem. FWP will ensure these data are properly housed in an accessible database such as the EPA's STORET or the Boise Laboratory Stream Temperature Modeling and Monitoring program[6].

Determination of minimum recommended flows is another research need for the Shields River watershed. Development of a thermal model such as the stream network temperature model

[6] http://www.fs.fed.us/rm/boise/AWAE/projects/stream_temperature.shtml

(SNTEMP; Bartholow 2000) will likely be a component of this conservation action. This model is widely applied and allows determination of the role of channel geometry, stream flow, and shading on stream water temperatures. Likewise, the wetted perimeter method (Leathe and Nelson 1989) provides a means to recommend minimum flows to keep riffles inundated. Although this model does not address temperature considerations, FWP uses this methodology to establish minimum recommended flows, and its application would augment thermal modeling through the SNTEMP model.

Another informational gap limiting the ability to promote a thermal regime favorable to Yellowstone cutthroat trout is a lack of understanding of their thermal optima and tolerances. Laboratory investigations that evaluate thermal tolerances such as upper incipient lethal temperature and optimal temperature range are critical research needs. Bear et al. (2007) and Selong et al. (2001) present appropriate laboratory methodologies. Likewise, field investigations such as Sloat et al. (2005) and Wehrly et al. (2007) will allow field-testing of thermal optima and tolerances. Combined, laboratory and field investigations will support development of conservation practices that provide a suitable thermal regime for Yellowstone cutthroat trout.

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Appendix A: Completed and Ongoing Restoration and Conservation Projects in the Shields River Watershed

Various entities have collaborated on projects aimed at conserving, protecting, and enhancing Yellowstone cutthroat trout in the Shields River watershed. A number of the existing projects are listed in the MFISH database (Table 0-1). The SVWG, private landowners, the Park Conservation District, FWP, Forest Service, and NRCS have contributed to an impressive record of existing projects. These encompass most of the suite of restoration activities likely to be applied throughout the watershed, including implementation of agricultural BMPs, bank stabilization, elimination of fish migration barriers, screening of irrigation diversions, and riparian plantings. The SVWG has maintained a separate list of project completed before 2003 (Table 0-2). Note the number of projects in Table 0-2 that were funded by landowners, and received no public funds.

Table 0-1: Existing restoration and conservation projects benefiting Yellowstone cutthroat trout in the Shields River watershed (FWP files).

Stream	Year	Actions	Benefits	Contributors
Brackett Creek	2002	Restoration of 4 miles of channel	Reduced sediment	Private landowners
		Elimination of a fish passage barrier	Restored connectivity	Future Fisheries Improvement Program
		Stabilization of > 7000 feet of eroding banks	Improved habitat	Bring Back the Natives
		Transplant of sod mats and riparian shrubs	Improved habitat	
Elk Creek	2005	Off-channel stock water	Reduced sediment	Private landowner
		Bank re-sloping	Improved riparian function	Future Fisheries
		Riparian fencing	Improved habitat	
Fairy Lake	2000	Spawning gravel placement	Improved spawning habitat	Forest Service
		Installation of large woody debris in stream	Improved habitat quality	Trout Unlimited
North Fork Horse Creek	2004	Riparian fencing	Improved riparian health & function	Private landowner

Stream	Year	Actions	Benefits	Contributors
		Installation of fish screen on irrigation diversion	Prevention of fish loss to irrigation diversion	Future Fisheries Improvement Program
		Replacement of flood irrigation with center pivot	Increased in-stream flows	
Daisy Dean Creek	2007	Off-channel stock water	Improved riparian health & function	Private landowner
		Riparian fencing		
		Riparian plantings		
Middle and South Forks Horse Creek	2011	Restoration of eroding banks and terraces	Reduced sediment	Private landowner
		Riparian fencing	Improved riparian health and function	Trout Unlimited NRCS
		Hardened access points for stock water	Improved stream habitat	Future Fisheries Improvement Program
Chadbourne diversion repair and retrofit	2012	Repaired aging diversion structure	Prevent failure of diversion	DNRC
		Made structure impassable	Prevent invasion of rainbow trout	Future Fisheries Improvement Program
		Provided fish ladder for selective passage	Restore connectivity for Yellowstone cutthroat trout	Water Users GNF Western Native Trout Initiative
Brook trout removal & Yellowstone cutthroat trout distribution investigation	2009	Sampled streams in the Shields River headwaters at regular intervals to determine species composition and distribution	Improved understanding of Yellowstone cutthroat trout distribution and evaluated brook trout invasion	Montana Fish, Wildlife & Parks GNF YNP
		Analyzed genetic status of Yellowstone cutthroat trout in project area	Found no evidence of hybridization	

Stream	Year	Actions	Benefits	Contributors
		Mechanically removed brook trout	Reduced threats to Yellowstone cutthroat trout	
Watershed Restoration Plan	2012	Development of a watershed restoration plan that will guide projects aimed at reducing sediment loading to streams from stream banks, roads, and hillslope erosion	Reduced sediment	SVWG DEQ
Yellowstone cutthroat trout movement study	2011	Pit-tagged Yellowstone cutthroat trout and brook to evaluate seasonal movements and habitat movements	Documented Yellowstone cutthroat trout seasonal movements and brook trout invasion	Wildlife Conservation Society US Geological Service

Table 0-2: List of conservation projects completed from 1997 though 2003 by private landowners or facilitated through the predecessor of the SVWG (the Upper Shields Watershed Association) courtesy of the SVWG water quality chair. Some overlap with Table 0-1 is possible.

Stream	*Actions*	*Benefits*	*Contributors*
Shields River bank stabilization	Stream bank restoration on the Shields River	Reduced sediment Improved habitat	SVWG Private landowner Future Fisheries Improvement Program DNRC
Shields River bank stabilization	Stream bank restoration on the Shields River	Reduced sediment Improved habitat	DNRC Future Fisheries Private landowner USFWS
Shields River bank stabilization	Stream bank restoration	Reduced sediment Improved habitat	SVWG Private landowner DEQ
Horse Creek habitat restoration	Habitat restoration	Reduced sediment Improved habitat	DEQ SVWG Private landowner
Shields River habitat	Habitat restoration	Reduced sediment	Private landowner

restoration		Improved habitat	SVWG USFWS DEQ
Antelope Creek	Off-stream stock water	Improved riparian condition	Private landowner SVWG NRCS
Daisy Dean Creek	Off- stream stock water	Improved riparian condition	Private landowner SVWG DNRC Future Fisheries Improvement Program
Unnamed springcreek	Off-stream stock water	Improved riparian condition	DEQ SVWG Private landowner
Cottonwood Creek	Fish friendly irrigation diversion	Improved stream flows Fish passage	Private landowner NRCS Future Fisheries Improvement Program SVWG
Little Indian Creek	Off-stream stock water	Improved riparian condition	Private landowner DEQ SVWG
Antelope Creek	Off-stream stock water	Improved riparian condition	Private landowner DEQ SVWG
Unnamed spring creek	Moved corral off stream	Improved riparian condition, water quality, and in-stream habitat	DEQ Private landowner SVWG
Shields River	Fish friendly irrigation diversion	Fish passage	DEQ Private landowner
Shields River	Irrigation efficiency investigation soil moisture monitoring	Irrigation efficiency planning	Ditch company DNRC

	sprinkler system installation	Improved irrigation efficiency	NRCS SVWG Private landowners
Shields River/Elk Creek	Off-stream stock water/corral movement	Improved irrigation efficiency	Future Fisheries Improvement Program Private landowners NRCS
Stream Habitat Assessment	Evaluation of geomorphic condition of Shields River	Stream habitat assessment Stream restoration planning	FWP DEQ DNRC SVWG
Horse Creek	Off-stream stock water	Improved riparian condition	Private landowner
Porcupine Creek	Off-stream stock water	Improved riparian condition	Private landowner
Shields River	Bank restoration	Reduced sediment Improved habitat	Private landowner
Shields River	Off-stream stock water	Improved riparian condition	Private landowner
Horse Creek	Bank restoration	Reduced sediment	Private landowner
Shields River	Of-stream stock water	Improved riparian condition	Private landowner
Unnamed spring creek	Off-stream stock water	Improved riparian condition	Private landowner
Horse Creek	Fish friendly irrigation diversion	Improved steam flows	Private landowner
Shields River	Irrigation efficiency	Improved stream flows	Ditch users

Appendix B: Responses to Comments on Stakeholder Review Draft

FWP solicited comments from stakeholders on a stakeholder review draft. The official release date was May 18, 2012 and deadline for comments was July 18, 2012. Five people commented on the stakeholder draft. Two watershed residents, representatives of other state conservation agencies, and Trout Unlimited provided insightful comments.

Commenter 1: watershed resident

This commenter thanked the authors for their hard work in preparing the conservation strategy.

Response:

Thank you for the kind words. The authors appreciate recognition for their work.

Commenter 2: watershed resident

If you are finding minimal comments (regarding) the stakeholder draft on the YCT, probably it seems to be a daunting task to absorb the 114 pages of a draft. The research and work that the various scientists put together is readable and applicable in so many cases but to try to see how individuals might be affected takes some time to absorb the findings. I am an individual landowner with property along the Dry creeks; which flow into Flathead Creek outside my property boundary. I am a fairly new resident of this particular area which allows me to view the area with new eyes. This document gives a chance to see how landowners can be identifying how we can improve practices to encourage better use of water for fish and land use and ultimately human health.

A comment I heard not long ago could relate to our trying to comment on the comprehensive coverage of the entire Shields River Valley which is trying to develop an action strategy for our waters - "How can anyone think about making things better for such a vast area when we can't even take care of our own 40 acres (or back yard for that matter)."

Maybe it really is about just taking care of our own back yards. So I recite from your draft document on the Flathead Creek area (commenter included text from 5.3.1 *Flathead Creek*). Thanks to all the scientists who developed this tome for seeing our waters in a new light.

Response: We agree that reading and absorbing a document of this size and density is daunting and that the basin residents are likely weary of planning documents, having completed several major planning efforts over the past decade. Mindful of these factors, we chose a 60-day stakeholder comment period over a shorter timeframe. Although we would have preferred more respondents, future opportunities to incorporate landowner concerns will be available, as this document will be updated periodically to reflect implementation of conservation actions and changes in the status of Yellowstone cutthroat trout populations in the watershed. We appreciate that you recognize that this document can be a tool allowing landowners to identify potential projects on their properties.

Your comment regarding “taking care of our own 40 acres” was poignant, as we recognize conservation starts with the individual. We are fortunate to have an active watershed group that places Yellowstone cutthroat trout conservation among its priorities. In fact, conserving cutthroat trout was the impetus for starting a watershed group in the Shields River watershed. Moreover, as detailed in Appendix A: Completed and Ongoing Restoration and Conservation Projects in the Shields River Watershed, landowners have an impressive record of implementing projects that benefit fish and water quality. This local commitment to conservation is among the reasons we separated a portion of the Shields River watershed into its own planning document. Combined with the watershed restoration plan developed to reduce sediment loading (Confluence 2012), this document is among the tools available to landowners to identify opportunities to take care of their own acreage. A number of agencies and entities are available to provide technical and financial assistance including FWP, Trout Unlimited, NRCS, DEQ, and Park County Extension.

Commenter 3: Larry Dolan, Hydrologist, Montana DNRC

Mr. Dolan has considerable expertise in the hydrology of the Shields River watershed and serves as a technical advisor to the watershed group. He provided several pages of comments. Some were minor corrections or suggestions on style. The following are responses to his substantive comments.

1. When I first started to read the report, I was in agreement that limiting the scope of the strategy to the basin above the Chadbourne Diversion was a good idea. After looking over the current Yellowstone Cutthroat Trout distribution and genetic status maps though, (Figure 2.3 and Figure 2.4) I’m not so sure. These maps don’t really show much difference in the status of the populations above and below the diversions. By not including the lower watershed, could the impression be that we are giving up on those populations?

Response: Nonhybridized and potentially hybridized Yellowstone cutthroat trout are indeed present in several streams downstream of the Chadbourne diversion, including the Shields River. The decision to limit this document to the watershed upstream of the Chadbourne diversion relates to the intention to manage this portion of the watershed as a metapopulation to the extent possible (see 1.0 Introduction for the discussion of metapopulations). Exclusion of the remaining streams does not mean we do not find them as less worthy of conservation, or that we are giving up on those populations; they simply are not connected to the watershed upstream of the Chadbourne diversion. FWP and their conservation partners are preparing a separate conservation plan that addresses these streams. Although in draft form, this second document devotes over 15 pages to the streams downstream of the diversion. The overriding conservation goal and the objectives designed to meet this goal are identical, regardless of position in the watershed.

2. The percent column in Figure 2.4 is a little confusing. I wasn't sure if it was the percent purity of the fish or the percent of the fish sampled that were Yellowstone cutthroat.

Response: The percent refers to the estimated percentage of alleles, or genes, in the population that is typical of Yellowstone cutthroat trout and is a measure of the degree of hybridization. A sample scoring 100% means the sample included alleles possessed only by Yellowstone cutthroat trout and no alleles from rainbow trout or westslope cutthroat trout were detected. The heading now reads percent of Yellowstone cutthroat trout genes to clarify what the column denotes. Note that this is an estimate based on statistical probability and the larger the sample size, the more confidence we have in this estimate. A sample of 25 fish gives a 95% confidence interval that the estimate reflects the genetic composition of the population.

3. The discussion on page 22 attributes water temperature increases from irrigation diversions as due to the decrease in the amount of water in the stream. This is true, but there are other factors that come into play. As you know, some of the water that is diverted for most irrigation systems returns to the stream, either through surface returns or delayed groundwater returns. From what I have observed, surface return flows (flow of the end of flood irrigated fields or that which is wasted back to the river at the end of a ditch) usually is significantly warmer than the water in the stream. Groundwater returns typically are cooler. The overall effect of irrigation probably is warmer water, but there could be localized areas where groundwater returns cool the stream some and could provide a refuge for fish during hot weather.

Response: The potential for irrigation return flows delivered as groundwater to cool streams is now within this discussion.

4. Page 37, first paragraph under water quantity. When first referring to the affects of irrigation on stream flows, I would change the initial characterization from "dewatered" to "irrigation altered". I suggest this not to understate the effects of irrigation, but to recognize that irrigation withdrawals can reduce flows without totally or significantly dewatering a stream. Portions of the Shields and its tributaries are dewatered by irrigation, and it is appropriate to refer to the stream as dewatered in these cases.

Response: We agree with these distinctions and have modified the text accordingly.

5. In the water quantity section, it might be helpful to include a table with the DFWP instream water reservations, and possibly to include columns with the reservation compared to senior irrigation demands.

Response: FWP has in-stream flow reservations on a combination of over 170 stream segments and times of year in the Shields River watershed. A table of these reservations would be unwieldy and tracking down senior water rights for these segments would be cumbersome. We modified the text to clarify the priority date for FWP's in-stream flow reservations, which is December 15, 1978 and make clear that these reservations are relatively junior rights, with some water rights dating to the late 1800s. In addition, we included a link to the MFISH database so interested parties could determine FWP's in-stream flow reservations for a given stream segment and compare the date with their water rights.

6. Another point that you might want to consider including in the water quantity section is that, even under the most efficient irrigation scenarios, irrigation demands on the Shields River still would exceed the available water supply during the late summer. I've also observed at least one occasion where the Shields River was dewatered early in May, when the weather warmed quickly at low elevations, everyone wanted to irrigate, but the mountain snowmelt still had gotten into full swing and streamflows were far too low to meet the demand.

Response: These points are now within the water quantity section.

7. On page 43 it is stated that climate change has a tendency to reduce stream flows. I've been involved with some stream-flow modeling for future climate scenarios. Overall our conclusions have been that climate change may not reduce stream flows <u>on an average annual basis</u>. It would be more correct to characterize the effects as a reduction to late summer flows.

Response: We conferred with Dr. Dan Isaak a fisheries research scientist with the US Forest Service Rocky Mountain Research Station in Boise, Idaho. He is a lead researcher on climate change effects on fish in the Rocky Mountains. He stated the following:

> I'd generally concur with Larry's statement. There's lots of uncertainty regarding how/if climate change will affect total annual runoff because there are no clear trends in total precipitation. But, your statements about less snow & earlier runoff are correct. The net effect of the earlier runoff is that there's less left later in the year during the summer, so low flows are getting lower. The attached paper by Leppi et al. 2011 is a good one documenting these

historical trends across the northern Rockies. The other thing that's happening (although no one's sure yet whether climate change is causing it) is that there's more inter-annual variability in runoff. The attached Luce and Holden 2009 paper documents this for the Pacific Northwest, and highlights the fact that extreme low-flow years are becoming more extreme and more common.

Regarding stream temperature trends & climate change, I've also attached two papers that document these trends for the northwest. Interestingly, the rates of warming often vary by season of the year, but things appear to be warming fastest during the summer season.

We amended the text to coincide with your modeling and Dr. Isaak's concurrence, and clarified that climate change was likely to cause water shortages in warmer temperatures during late summer. Citations for the papers provided by Dr. Isaak are as follows:

Isaak, D. J. C. H. Luce, B. E. Rieman, D. E. Nagel, E. E Peterson, D. L. Horan, S. Parkes, and G. L. Chandler. Ecological Applications 20:1350-1371.

Isaak, D. J., S. Wollrab, D. Horan, and G. Chandler. 2012. Climate change effects on stream and river temperatures across the northwest U.S. from 1980-2009 and implications for salmonid fishes. Climate Change 113:499-524.

Leppi, J.C., T. H. DeLuca, S. W. Harrar, and S.W. Running. 2010. Impacts of climate change on August stream discharge in the Central-Rocky Mountains. Climate Change 112:997-1014

Luce, C. H. and Z. A. Holden. 2009. Declining annual streamflow distributions in the Pacific Northwest United States, 1948-2006. Geophysical Research Letters 36.

8. Are Yellowstone cutthroat "rare" in the upper Shields River (see table 4-7) and rainbow trout abundant? While working on the Shields River above the Big Ditch diversion for several seasons, I observed quite a few cutthroat and brown trout, but can't ever recall seeing a rainbow trout. It could be that the cutthroat population starts to drop off significantly below the Big Ditch.

Response: You are correct and thanks for catching that error. The upper Shields River, especially upstream of Smith Creek remains a stronghold for Yellowstone cutthroat trout, although nonnative species are cause for concern.

9. Are main-stem barriers on the upper Shields River a good idea at this time, as is discussed on page 57? Adult fish may move up and down the stream quite a distance. On

page 90, you discuss the possibility of doing a study on cutthroat migration patterns in the watershed. Maybe the installation of the fish barriers should be contingent on the findings of this type of a study.

Response: A study of habitat use and movements began in 2011 with efforts focusing on the upper Shields River watershed. Dr. Brad Shepard with the Wildlife Conservation Society and Dr. Robert Al-Chokhachy with the USGS are the primary investigators. I posed your question to Dr. Shepard and here is his response:

> The preliminary findings of the movement studies and additional sampling in the upper Shields basin have indicated that: 1) brown trout are moving up into the upper basin and are now within a few miles of the streams where these temporary barriers are proposed; and 2) brook trout invasion into additional streams in the upper basin have been occurring very rapidly in recent years. In addition, I plan to analyze the YCT movement data in more detail within the next couple months, so will have a better idea of YCT movements, but preliminary information suggests that movement out of Lodgepole Creek in the upper basin is limited and we consistently see all age classes of YCT in the tributary streams, including adults, which suggests these streams support resident YCT. Lastly, the proposed barriers are "temporary" in that if additional data finds YCT need more connectivity or when we can install a more permanent barrier in the Shields River, these barriers can be removed.

As discussed in 5.1 Shields River and 5.4 Upper Shields River Watershed (5th Code HUC): Data Review and Conservation Strategies, the ongoing brook trout invasion is rapidly displacing the headwaters populations of Yellowstone cutthroat trout. Temporary barriers are our potential interim measures to prevent extirpation of Yellowstone cutthroat trout, such has nearly happened in the Smith Creek watershed, where Yellowstone cutthroat trout are now exceptionally rare. Movement and habitat use studies using PIT tags will continue for a few years to guide the adaptive approach to conserving the upper watershed Yellowstone cutthroat trout.

Regarding long-distance movements of Yellowstone cutthroat trout in the Shields River main stem, we have insufficient data to determine if this occurs. All Yellowstone cutthroat trout captured in the annual spring sampling receive a Floy tag; however, the relative rarity of the fish in the lower river means this is an exceedingly small sample size. Although Yellowstone cutthroat trout in the lower river have been tagged for years, no anglers have reported capturing tagged in the Upper Shields River Watershed (5^{th} code HUC). Extensive electrofishing in the upper watershed in 2004, 2009, 2011, and 2012 have not found any Yellowstone cutthroat trout tagged in the lower river. Nonetheless, given the small sample size of tagged fish, we cannot rule out long migrations of main stem Yellowstone cutthroat trout. Therefore, permanent barrier construction will consider maintaining connectivity to the greatest extent possible and protection of migratory life-history patterns as is consistent with the objectives of the Agreement to conserve cutthroat trout in Montana.

10. Under 6.3 on page 91 you discuss determining minimum flows to protect and restore cutthroat trout. I know that portions of the upper Shield River can be entirely dewatered during much of the summer in dry years. I've also observed dead cutthroat trout that apparently became stranded when the stream was dewatered. Working with the irrigators to maintain simple stream conductivity and minimal survival flows in these reaches might be a good starting point to consider.

Response: Your experience monitoring flows along the Shields River makes you uniquely qualified to identify critical areas for maintaining in-stream flows and we appreciate your recommendations. As the water use efficiency and associated planning proceeds in the watershed, we hope to collaborate with DNRC on flow management and efficiency to the greatest extent possible.

Commenter 4: Christina Staten, DEQ
Ms. Staten has been working with the Shields Valley Watershed Group on nutrient monitoring in the Shields River and tributaries near Wilsall, MT. Her comments included mostly clarifications of 303(d) list status and identification of typographical errors. We address the substantive comments below, but we do appreciate the detection of those errors.

Comment: Ms. Staten identified a repeated error in the in-text citation for the Shields River watershed TMDL plan.

Response: We have corrected the citation from DEQ 2008 to DEQ 2009, which refers to the TMDL plan for the Shields River Subbasin (4^{th} code HUC).

Comment: "Other habitat alterations" is not a probable cause used by DEQ. Potter Creek was not listed for "other habitat alterations" in 2008. Potter Creek is included in the 2012 Integrated Report with the following probable causes of impairment: low flow alterations, sediment/siltation, and solids (suspended/bed load).

Response: DEQ did use other habitat alterations in its suite of causes of impairment as recently as 2006, as DEQ listed other habitat alterations among causes of impairment for streams in the

Shields River watershed in its data assessment sheets updated 6/19/2006. (FWP has archived several of these spreadsheets.) Data compilation for this document began in 2008, when the 2006 list was the most current list, as the 2008 list was not available until well into 2009. Because we had not noticed any other modifications to the data assessment records among the 2006, 2008, and 2010 reviews, we missed the altered impairment categories, if the change occurred within one of those reviews. The only modification we have noticed in the assessment records over the years is that the 2012 database reverts to the data review completed in 1999 for streams in the Shields River watershed. We have modified the text to use the current nomenclature.

Inclusion of low flow alterations as a cause of impairment is an inaccurate description of impairment in Potter Creek. As described in 5.2.1 *Potter Creek*, disturbance in Potter Creek is largely the result of *augmented* flows, as Potter Creek is the route of delivery for irrigation water stored in Cottonwood Reservoir. The extent to which this still happening is unknown, as several of the water users relying on this water have changed irrigation practices. DNRC and the SVWG will be investigating whether these releases are still altering channel morphology in Potter Creek and will develop a delivery strategy that is compatible with channel form and function, and agricultural needs and water rights. DEQ should consider modifying this impairment category in its next 303(d) list review.

Comment: Please clarify this statement. Rice Creek is not included in Montana's Integrated Report, and is not currently part of DEQ's TMDL planning efforts. I do not think Rice Creek was included in the sediment assessment work for the sediment TMDLs, but am not certain. If the SVWG is including Rice Creek in their WRP, please make this clarification.

Response: We checked with Mike Sanctuary with Confluence, who did the aerial photo analysis for the sediment modeling, and he said he evaluated riparian condition and stream morphology on every stream in the National Hydrographic Dataset (NHD) layer, except first order streams. As Rice Creek is in the NHD and is not a first order stream, it was among streams included in the aerial photo analysis and the sediment model. We clarified these points in the text. The aerial photo analysis and sediment model may provide a useful screen in identifying potential projects. We do not know if the SVWG is planning to include Rice Creek in their WRP. If Yellowstone cutthroat trout conservation opportunities exist in Rice Creek, the SVWG would be welcome partners in restoration planning and implementation should they choose to participate.

Comment: Elk Creek was not listed for either of these impairment causes in the 2008 Integrated Report. Elk Creek is included in the 2012 Integrated Report with a single probable impairment cause of "Alteration in stream-side or littoral vegetative covers." The probable source is"Grazing in Riparian or Shoreline Zones."

Response: The probable causes of impairment were obtained from the 2006 303(d) list, when Elk Creek was listed for riparian degradation and other habitat alterations. As stated above, the data compilation for this plan began in 2008 and the 2006 list would have been the most recent list. As DEQ had not conducted a review on any stream in the Shields River watershed since 2000, as evidenced by the presence of blank data matrix sheets across all years, nor were the dates of review changed between the 2006 to 2008 assessment records, we were not aware that DEQ changed the impairment categories. We have updated the categories to reflect the causes of impairment from the 2012 integrated report.

Comment: TMDLs are only required for pollutant causes of impairment. Antelope Creek is included in the 2012 Integrated Report with only one pollutant cause of impairment: "Solids (Suspended/Bedload)." This impairment requires a TMDL, but will not be addressed until after 2014. Antelope Creek also has an "Excess Algal Growth" probable cause of impairment, however this is not a pollutant cause of impairment and does not require a TMDL.

Response: We edited the text to reflect the distinction between pollutants and pollution, and reiterated that DEQ develops TMDLs only for pollutants. Finding the impairment type of solids (suspended/bedload) to be an awkward label, we note that DEQ lists Antelope Creek with a sediment-related cause of impairment that requires a TMDL. Of course, excess algal growth, although categorized as pollution, is usually the consequence of high levels of nutrients, with few exceptions. One exception would be blooms of the diatom *Didymosphenia germinata*, which thrives in cold, oligotrophic waters. Likewise, some cyanobacteria may be capable of substantial blooms in otherwise nutrient poor water, as these taxa can fix atmospheric nitrogen, and are not reliant on dissolved nitrogen. Neither scenario appears to be the case in Antelope Creek. Should the ongoing nutrient monitoring in the Shields River and its tributaries indicate anthropogenic nutrient loading is causing nuisance algal blooms, we encourage DEQ to address nutrient loading in its next round of TMDL development starting 2014. We also encourage DEQ to review their own data from the early 2000s, which include several synoptic sampling events across seasons along the Shields River and includes some of the tributaries.

Comment: Dewatering is neither a probable cause or probable source used by DEQ. Several streams in the Shields River watershed are included in the 2012 Integrated Report for "Low flow alterations," however.

Response: We changed that sentence to refer to FWP’s list of dewatered streams, which was the primary reference used in identifying dewatered streams during the 2000 303(d) list compilation.

Commenter 5: Patrick Byorth, Staff Attorney, Trout Unlimited

Comment: Mr. Byorth's first comment addresses his appreciation at being included as a co-author.

Response: Your appreciation is noted and welcome. As you started the process of preparing this plan in your former employment with FWP, listing you as a co-author seemed appropriate. We are thankful that you do not want your name removed from the list of authors.

Comment: I found the strategy to be detailed, comprehensive and an excellent tool for conservation actions in the Shields. I'm not sure we could expect a better foundation for native trout conservation for any watershed of its size.

Response: Thank you for your kind words.

Comment:
As to the thermal tolerance, you qualify the use of Beth Bear's work on WCT, but the analysis still paints a dismal picture of prospects for restoring YCT. While I do not question the validity of Beth's work, I am less certain about the utility of using the WCT UILT as a benchmark for comparisons to in situ water temperatures and suitability for trout. I ran into this when studying thermal tolerances of grayling in the Big Hole. I am even less comfortable with using WCT UILT and the optimal range as a measure of suitability for YCT. I'd be willing to bet that the YCT UILT is closer to 72 or 74 F, rather than 67. Stressing the optimal range of WCT, which seems overly narrow in comparison to Sloat's work, seems to lead the reader to presume that the optimal range somehow represents the range of suitability. In fact, the suitable range for YCT probably rises as high as 72 F. As you mention, the UILT has limitations when comparing to natural conditions. UILT is more a measure of the ability of a species to acclimate to higher and higher temperatures. Trout, and most fish, actually acclimate in a typical diurnal range to a temperature somewhere around the median temperature between the mean daily and max daily temperature. Which is a better comparison for UILT than maximum temps. In this sense the Critical Thermal Maximum compared to the max daily might be more useful. Although I wouldn't necessarily recommend a rewrite of the section, I might suggest dropping the use of the optimal range from your box and whisker graphs. The UILT provides a more realistic benchmark, even with its limitations, and comparison with the median between the mean and max daily might be more informative. The reason I think this deserves attention is that it can easily lead a reader skeptical of YCT restoration to misinterpret this section as meaning restoration is hopeless, so why bother? While the important message you deliver is that water temperatures are high in late summer and that we can do something about it, the underlying message is that YCT are toast in most the Shields. I have a tough time buying into that message after working on coldwater fisheries throughout SW MT that typically reach the high 70's between mid July and mid August every year and still support high densities of trout. I also

worked enough around the Shields to have seen YCT thriving in tribs reaching the mid-70s. I'd be glad to chat about this if you have any questions. My recommendation is to remove the "optimal range" altogether from graphs, but leave as a point of reference in the text. I would emphasize the limitations of Beth's work as well in both the introductory matter of the section as well as the conclusion. I've heard enough misuse of Selong's work on bull trout by folks who want to cut big chunks of actually occupied bull trout habitat as unsuitable habitat, to be comfortable using WCT for YCT in this context.

Response:
Dr. Bradley Shepard of the Wildlife Conservation Society was kind enough to review Mr. Byorth's comments regarding temperature and provided the following response (with minor edits and additions). Dr. Shepard is researching brook trout invasion, Yellowstone cutthroat trout habitat use and movements, thermal regime, and climate change in headwater streams in the Upper Shields River Watershed, upstream of the confluence with Smith Creek. Given this research focus and other research on cutthroat trout and temperature, he seemed best prepared to respond to Mr. Byorth's comments. Dr. Shepard's response is below:

Although I agree with Mr. Byorth's reluctance to apply thermal criteria tested for westslope cutthroat trout (WCT; Bear et al. 2007) for indicating potential thermal habitats for Yellowstone cutthroat trout (YCT), I think the YCT strategy did an adequate job of explaining the limitations of this application. I believe, as Mr. Byorth does, that we need to develop thermal criteria specifically for YCT and have tried to get funding to conduct this research. (The strategy identifies this as a research need in several locations.) If Mr. Byorth and TU would like to help support this type of research, we have a research study all set up to conduct this research in collaboration with MSU, USGS, and the Bozeman Fish Technology Center. However, without a specific study, I believe the application of thermal criteria for WCT to YCT is the best we can do for now. Ironically, we ran into the same criticism for the Sloat et al. (2005) paper, where we applied bull trout thermal criteria (Selong et al. 2001) to indicate suitable habitats for WCT in the Madison River drainage. It turned out that the bull trout thermal criteria we used for the Madison analysis was very similar to the subsequent WCT thermal criteria that Bear et al. (2007) documented.

I support leaving in the "optimal range" references in the box and whisker graphs; however, we may need to indicate better that YCT will likely thrive in areas outside of these ranges. In the Sloat et al. (2005) paper we used the annual predicted potential growth (computed daily and summed over the growth season) based on stream temperatures and we subsequently applied this type of analysis to YCT throughout their range (Al-Chokhachy et al. in review). I believe this is a much better way to integrate the likely influence of temperature on suitability of particular habitats and I plan to work with the USGS Northern Rockies Science Center, Montana FWP, MSU, and the Gallatin National Forest to apply this type of analysis to the Shields basin.

I believe this will present a better and finer-scale picture of habitat suitability related to water temperature. However, until that is done, the box and whisker graphs that indicate that some waters are becoming marginal for YCT in the Shields is probably reasonable, although definitely biased. We should probably clarify that in the text. I also think it might be worthwhile to actually include the graph of Bear et al. (2007) that shows the full picture of growth to temperature relationship for WCT. It should also be noted that negative growth does not necessarily translate to mortality, but that annual growth predictions are probably a better indicator of thermal suitability.

I agree with Mr. Byorth's concern about using the daily maximum temperatures as the measure of each stream's thermal condition (suitability for YCT). I suggest either changing these graphs, which would require considerable work, or providing a table or regression graph showing comparisons of maximum temperatures versus mean and median daily temperatures. The text should then be modified to indicate that median or mean daily temperatures are probably a better indicator of a stream's suitability to support YCT. (See 4.2.2 *Water Temperature*) for the regression analyses and alterations of text.) In Sloat et al. (2005) we used mean daily water temperatures. The other extremely important way that fish adapt to changing thermal conditions is by moving into either sites where water is more suitable due to groundwater influences (micro-sites with different thermal conditions), or moving longer distances to find suitable thermal refuges. This probably needs to be explicitly stated.

Lastly, I agree with Pat that we do not want to indicate that YCT have no suitable habitat in the Shields because are temperatures too warm. I think we want to indicate that water temperatures are currently marginal for YCT in some places, particularly within the lower Shields River, and that they may become even more unsuitable in the future unless action is taken to mediate (mitigate) warmer air temperatures.

The text has been modified to reflect Dr. Shepard's suggestions to the extent feasible.

Comment:
Finally, the last issue is one you may not be able to resolve, but should be mentioned. While you cite some solid reports on brook trout displacement of YCT, the text seems to equate brook trout invasion equally with brown trout invasion. While I haven't followed the literature closely for several years, I do not recall any studies on browns displacing cutthroats that remotely approached the literature on brook trout invasions. I didn't see any citations to reports studying brown trout effects on YCT or CT in general. I do remember doing some literature review to

that effect, but don't recall finding much. While the tendency might be to assume brown trout are powerful forces of evil on a par with brook trout, we should at least provide some scientific basis for the assumption. I recall "everyone knows" assumptions that brook trout directly displace grayling in the Big Hole wilting after a few summers of research.

Response:
We reworked the discussion in 2.3 Distribution of Other Fish Species in the Shields River Subbasin to clarify the relative differences in threats posed by brook trout and brown trout. Included in this discussion is the role of longitudinal gradient in invasion success and cutthroat trout displacement. Certainly, brook trout are rapidly invading and displacing Yellowstone cutthroat trout from headwaters strongholds and are the biggest threat at this time.

Although investigations of interactions between brown trout and Yellowstone cutthroat trout are lacking, brown trout appear to have followed their typical pattern of displacing, or nearly displacing the native cutthroat from lower elevation reaches, and we cite studies finding this pattern. The main stem of the Shields River and the lower reaches of Brackett Creek may be examples of this lower elevation displacement by brown trout, as brown trout are abundant and Yellowstone cutthroat trout are relatively rare. Hanzel's (1959) and Berg's (1975) studies indicate the displacement of Yellowstone cutthroat trout by brown in the lower river happened decades ago, as Yellowstone cutthroat trout were relatively rare then and brown trout were comparatively abundant. The extent to which this relates to competitive exclusion, predation, or some other biotic or abiotic factor is unknown.

That said, we do have examples of sympatry between Yellowstone cutthroat trout and brown trout in headwaters streams in Montana and Yellowstone cutthroat trout varied in their ability to persist. Lower Deer Creek is one example, and Yellowstone cutthroat trout were holding their own for at least 6 decades of sympatry with brown trout, although at lower numbers than brown trout. In contrast, Yellowstone cutthroat trout vastly outnumbered brown trout in East Fork Duck Creek in the 1980s, by up to sevenfold. By 2007, relative abundances reversed with brown trout being three times more abundant than Yellowstone cutthroat trout. The cause of this reversal is unknown, but suggests we be cautious against underestimating the potential for brown trout to displace Yellowstone cutthroat trout from headwater streams.