length, and importation of spawning gravel to line the new bed. Imprinting of fry obtained from fluvial brood stock is a potential, future conservation action for Kickabuck Spring Creek.

Milligan Slough is a third spring creek with potential to provide spawning habitat. Currently, much of Milligan Slough is overly wide, and fine sediment dominates the streambed (Endicott 2007). Conservation actions appropriate for this stream would include channel restoration, grazing management, and riparian plantings. FWP will seek opportunities to work with landowners on implementation of conservation activities along Milligan Slough.

6.3 Shields River (HUC 10070003)

The Shields River (Figure 6-26) watershed encompasses approximately 289,000 acres and flows into the Yellowstone River, east of Livingston, Montana. The Shields River valley is primarily agricultural, with irrigated crops, pasture, and rangeland being major land uses. Forest occupies the higher elevations, with timber harvest, livestock grazing, and recreation being common in these areas.

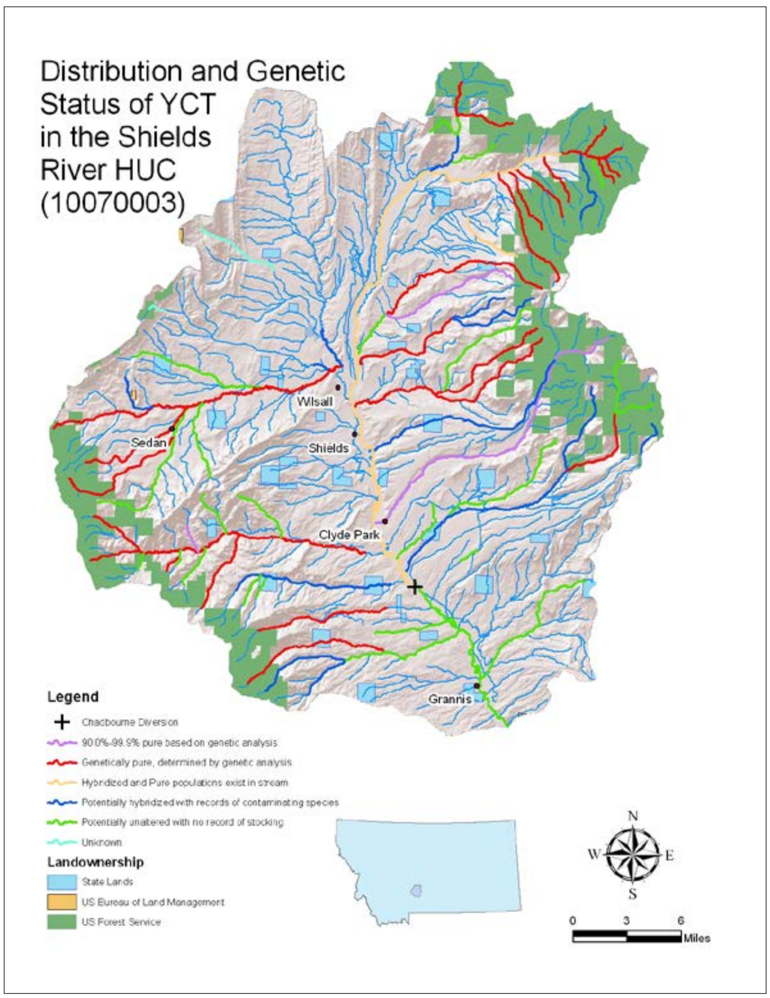

Figure 6-26: Shields River Subbasin (HUC 10020003).

The Shields River watershed (Figure 6-27) provides substantial habitat for Yellowstone cutthroat trout, and this species is still widely distributed throughout the basin's waters. Most of the subpopulations show a high degree of genetic integrity, with nonhybridized populations still occupying a substantial number of stream miles, and hybridized subpopulations having less than 10% rainbow trout alleles.

The spatial focus of this strategy is the Shields River watershed downstream of the Chadbourne diversion (Figure 6-27). The Chadbourne diversion was built in 1908, and was likely an impediment to fish passage historically, although it may not be a complete barrier currently (OASIS 2006). The Chadbourne diversion makes a logical management divider because it has functionally isolated the Yellowstone cutthroat trout upstream from potential genetic introgression with rainbow trout. FWP and its partners have addressed the watershed above this feature in a separate conservation strategy (FWP et al. 2012).

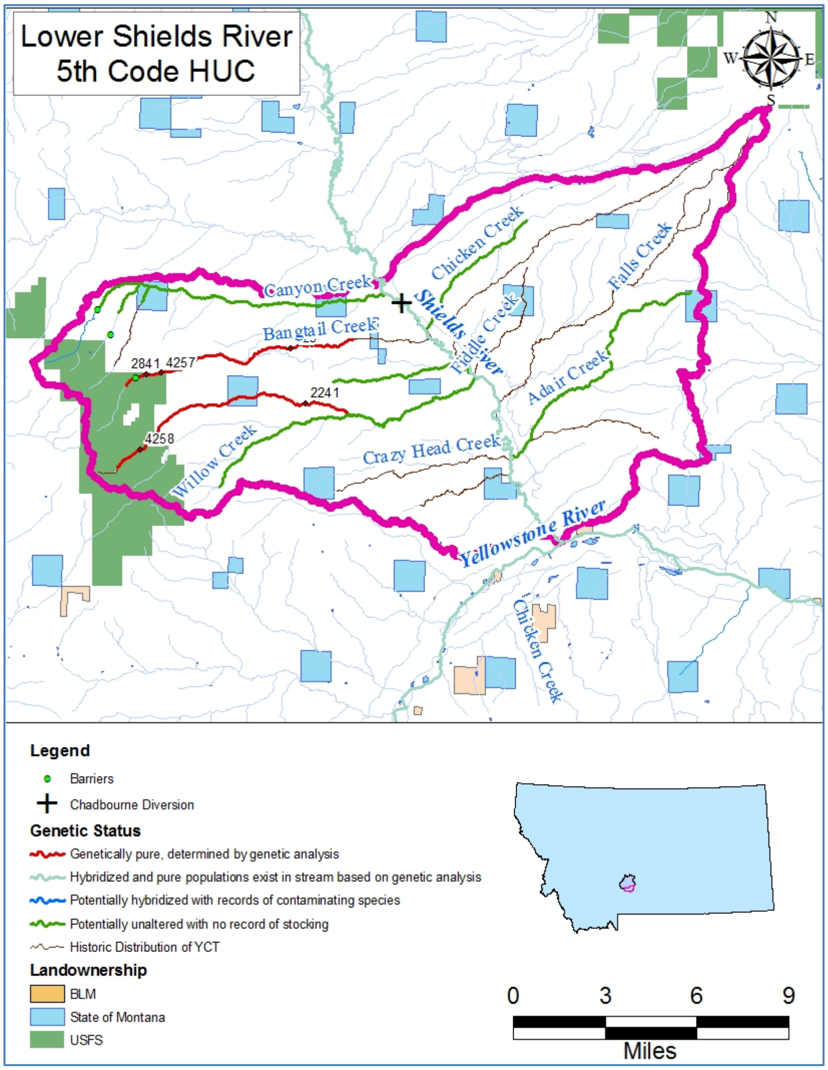

Figure 6-27: Lower Shields River 5th order HUC.

Although Yellowstone cutthroat trout still occupy a considerable portion of their historic range in the Shields River watershed, numerous threats to their persistence still exist. Brook trout are invading new streams and in places are rapidly displacing Yellowstone cutthroat trout. Brown trout are also present in many streams and have potential to eliminate Yellowstone cutthroat trout through competition and predation. 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 in the Shields River. In the portion of the watershed downstream of the Chadbourne Diversion, few barriers prevent invasion of rainbow trout, making loss of remaining nonhybridized populations and continued genetic contamination of slightly hybridized populations a significant threat.

Reduced stream flow from irrigation diversion is among the factors limiting suitability of streams to support Yellowstone cutthroat trout in the planning area. Within this planning area, FWP lists three streams as dewatered (Table 6-49). FWP has in-stream flow reservations only for the Shields River. These reservations were based on the percent exceedance approach, which has been replaced by the wetted perimeter approach (Leathe and Nelson 1989). Two key components to the strategy for addressing the effects of dewatering in the basin’s streams will be to determine minimum recommended flows, and identify opportunities to improve water-use efficiency though voluntary implementation of conservation measures.

Table 6-49: FWP’s dewatered stream list for the lower Shields River watershed (MFISH database).

Stream Name	*Tributary To*	*Begin River Mile*	*End River Mile*	*Dewatering Class*
Bangtail Creek	Shields River	0	5	Chronic Dewatering
Shields River	Yellowstone River	0	65	Periodic Dewatering
Willow Creek	Shields River	0	12	Chronic Dewatering

Locally led conservation has been substantial in the Shields River watershed, with the Shields Valley Watershed Group, private landowners, and agencies collaborating on a numerous projects on the main stem and in tributaries. The progenitor of the current watershed group originally organized to address Yellowstone cutthroat trout conservation, as well as other concerns in agricultural watersheds, such as weed control. The group has completed planning efforts that will benefit Yellowstone cutthroat trout, including development of a watershed restoration plan to reduce loading of nonpoint-source sediment from roads, hillslopes, and bank erosion. This sediment reduction plan is part of the total maximum daily load (TMDL) plan developed through the Montana Department of Environmental Quality (DEQ 2009), a requirement of the Clean Water Act.

6.3.1 Shields River

Approximately 16 miles of the Shields River (Figure 6-27) is within the area covered by this conservation strategy. Landownership is almost entirely private, with the exception of small parcels of state-owned land, including a fishing access site. Agriculture, including livestock grazing and production of small grains and forage crops, is the primary land use, although residential development is considerable and is likely to expand.

Fish community composition reflects its connectivity with the Yellowstone River, and includes nonnative brown trout and rainbow trout, in addition to members of the native fish assemblage (Table 6-50). Yellowstone cutthroat trout are rare in this part of the river, and rainbow trout × Yellowstone cutthroat trout hybrids are likely present.

Table 6-50: Distribution and abundance of fishes in the Shields River (MFISH database).

Begin Mile	*End Mile*	*Species*	*Abundance*	*Use Type*	*Life History*	*Genetic Status*	*Data Rating*
0	33	Brown trout	Common	Year-round resident	N/A	N/A	EFMSO
0	21	Longnose dace	Common	Year-round resident	N/A	N/A	NSPJ
0	33	Longnose sucker	Abundant	Year-round resident	N/A	N/A	EFSSO
0	63	Mottled sculpin	Common	Year-round resident	N/A	N/A	EFSSO
0	33	Mountain sucker	Common	Year-round resident	N/A	N/A	NSPJ
0	33	Mountain whitefish	Abundant	Year-round resident	N/A	N/A	EFMSO
0	33	Rainbow trout	Rare	Year-round resident	N/A	N/A	EFMSO
0	2	Rainbow × cutthroat trout	Unknown	Unknown	Unknown	N/A	EFSSO
0	33	White sucker	Common	Year-round resident	N/A	N/A	NSPJ
0	13	Yellowstone Cutthroat Trout	Rare	Unknown	Resident	Potentially unaltered with no record of stocking	EFSSO
0	13	Yellowstone cutthroat trout × rainbow	Rare	Year-round resident	Resident	N/A	NSPJ

FWP regularly monitors fish populations in three sections of the Shields River, and the Convict Grade monitoring reach is within the area covered by this strategy. Yellowstone cutthroat trout have not been especially abundant in the Convict Grade section in the recent past, and their numbers are in decline (Figure 6-28). Yellowstone cutthroat trout were most abundant during sampling efforts in the 1970s through the mid-1980s. During the remainder of the 1980s, Yellowstone cutthroat trout were exceptionally rare to absent. Their numbers have fluctuated since the early 1990s, but have not returned to levels seen in the 1970s and 1980s.

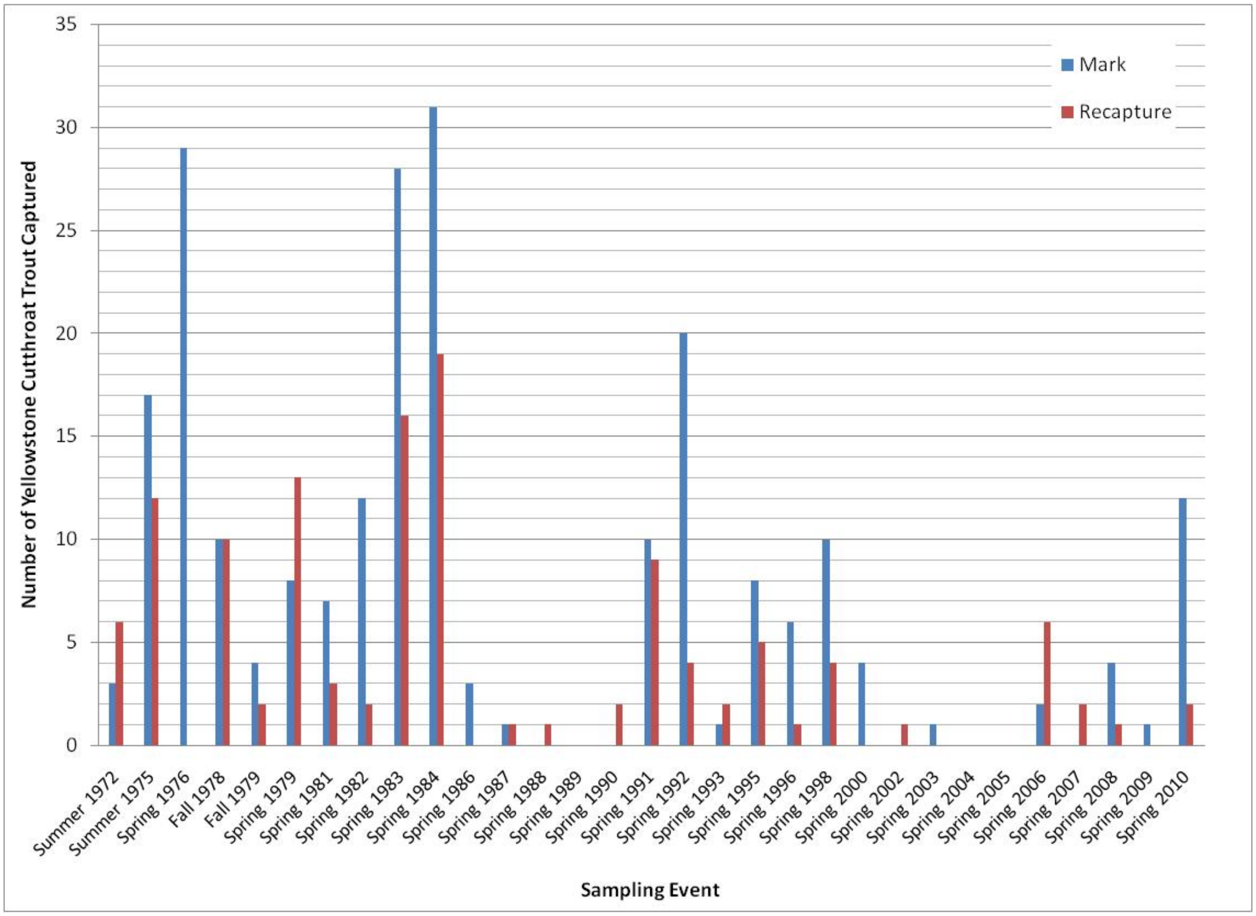

Figure 6-28: Number of Yellowstone cutthroat trout captured during mark-recapture sampling events in the Convict Grade monitoring section, Shields River (data from FWP, Livingston Fisheries Office files).

Comparison of abundance of Yellowstone cutthroat trout in the Convict Grade section to other games species underscores their rarity in the lower Shields River (Figure 6-29). Population estimates reported in MFISH indicates mountain whitefish is the numerically dominant species, with a median population estimate of about 2,650 fish per mile for the 3 years with a reported population estimate. Brown trout ranged from an estimated 164 to 875 fish per mile, and averaged nearly 360 fish per mile over 13 years. Rainbow trout population estimates were similar to those for brown trout, averaging about 420, and ranging from 127 to 852 fish per mile for the 8 years with reported population estimates. Low numbers of Yellowstone cutthroat trout precluded calculation of a population estimate in most years. In 1984, sufficient Yellowstone cutthroat trout were captured to allow calculation of a population estimate, which yielded an estimate of fewer than 70 fish per mile.

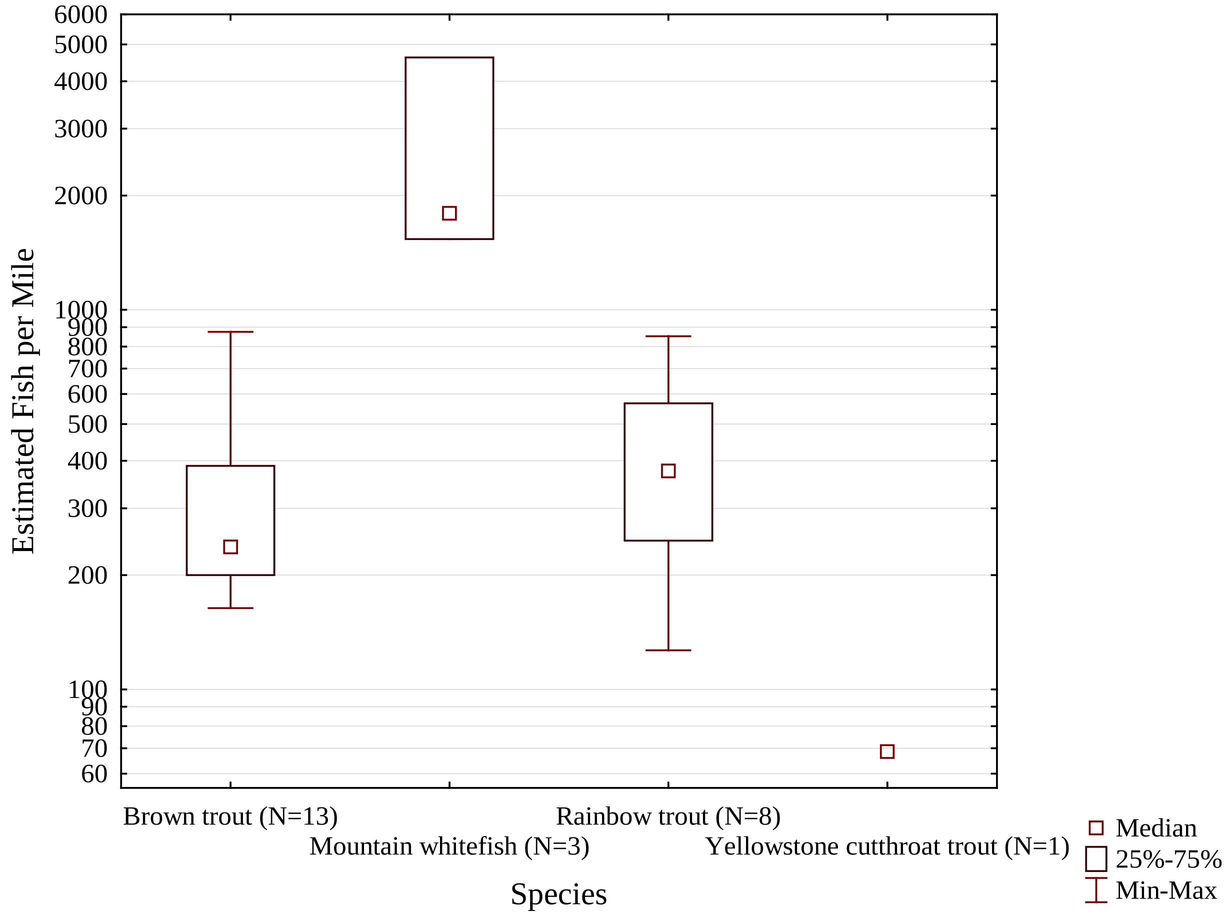

Figure 6-29: Comparisons of estimated fish per mile for salmonids captured in the Convict Grade monitoring section (MFISH database).

Probable causes for the low numbers of Yellowstone cutthroat trout in the lower Shields River include presence of nonnatives and potentially a lack of suitable spawning habitat in the adjacent tributaries. Low stream flows through the summer months likely have negative effects on habitat availability and water temperature, although irrigation return flows may mitigate thermal loading associated with dewatering.

Temperature data from the USGS provide a means to evaluate thermal regime in this reach of the Shields River. The USGS has been monitoring daily temperatures at their gage station since the late 1990s. This gage is about 1 mile from the mouth of the Shields River, within the area covered in this conservation strategy.

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 stage (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 relatively 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 among 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.

Another 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 2007). 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 (Figure 6-30) at the USGS gage station record suggests the lower main stem has a thermal regime potentially unfavorable to the of Yellowstone cutthroat trout in most summers. 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. 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, during this exceptionally dry and warm year, water temperatures were likely less suitable for support of cold-water fisheries, especially sensitive Yellowstone cutthroat trout. The 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.

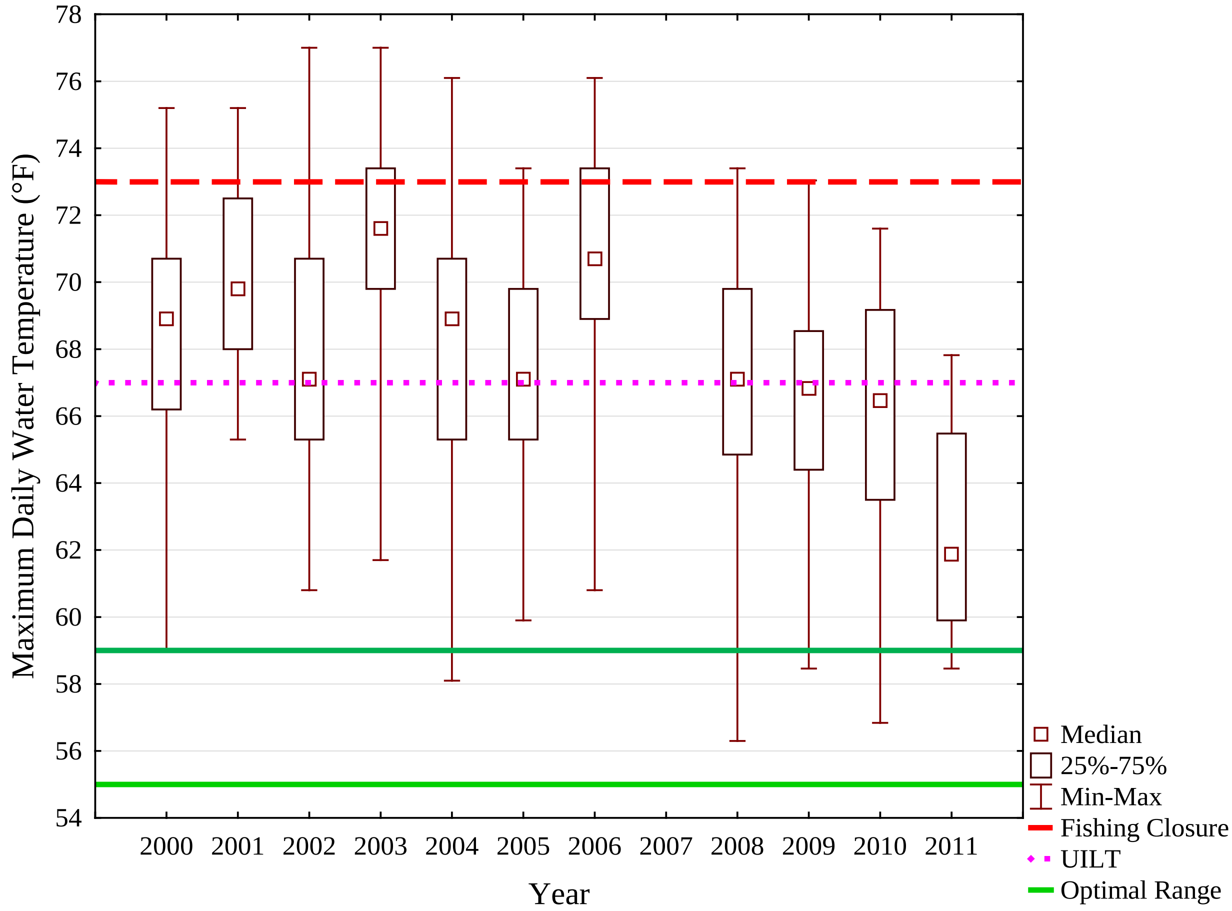

Figure 6-30: Distributional statistics for maximum daily water temperatures measured at USGS gage station 6195600 during July and August for the period of record, and comparison to thermal optimum (55 °F to 59 °F) and UILT (67 °F) of westslope cutthroat trout and drought closure criteria (> 3 days at 73 °F).

Mean daily temperatures (Figure 6-31) reflect maximum temperatures and cooling in the evening and nighttime hours. 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 possibly 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.

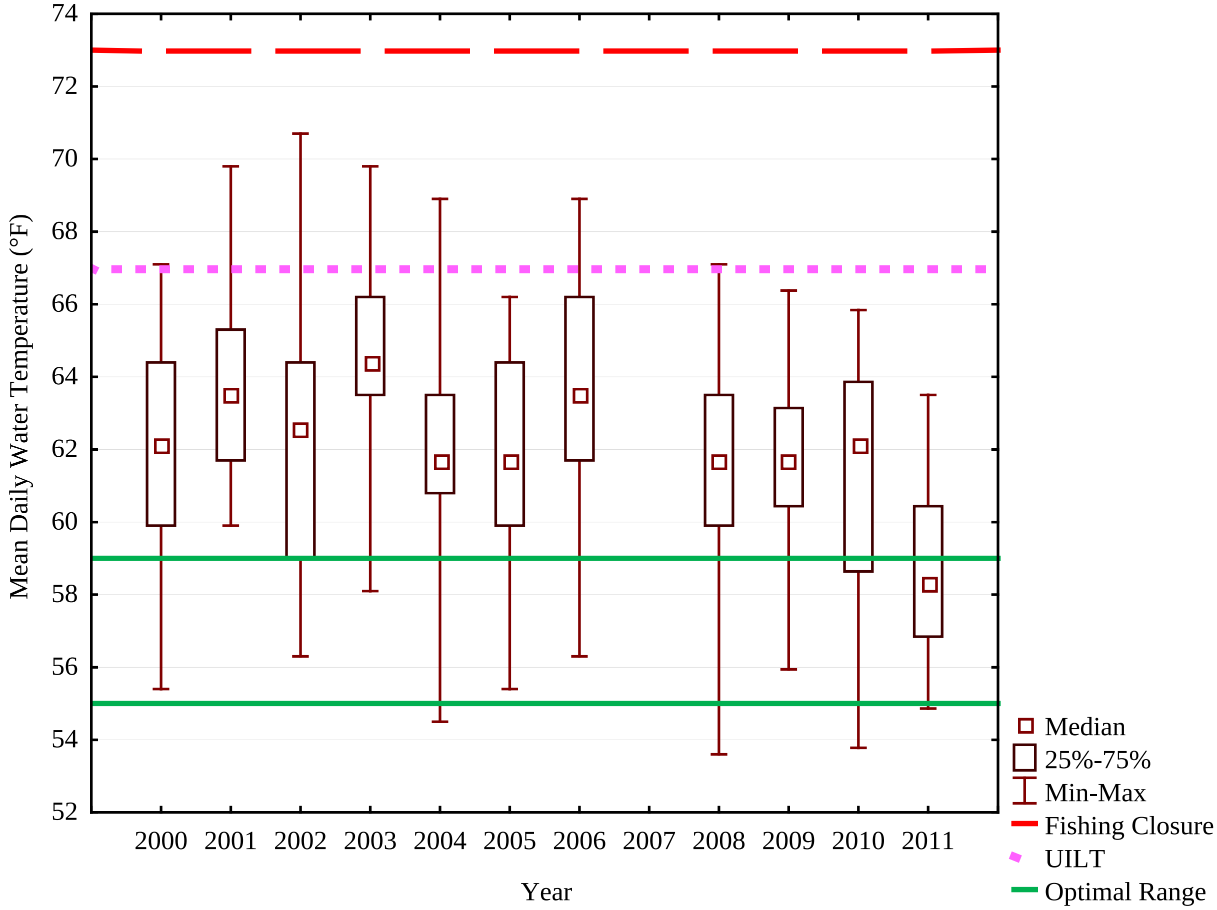

Figure 6-31: Distributional statistics for mean daily water temperatures measured at USGS gage station 6195600 during July and August, from 2000 through 2011, and comparison to thermal optimum and tolerances of westslope cutthroat trout.

Comparisons of average and maximum daily temperatures (Figure 6-32) at the gage station near the mouth of the Shields River indicate they were highly correlated, with a correlation coefficient of 0.93. 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.

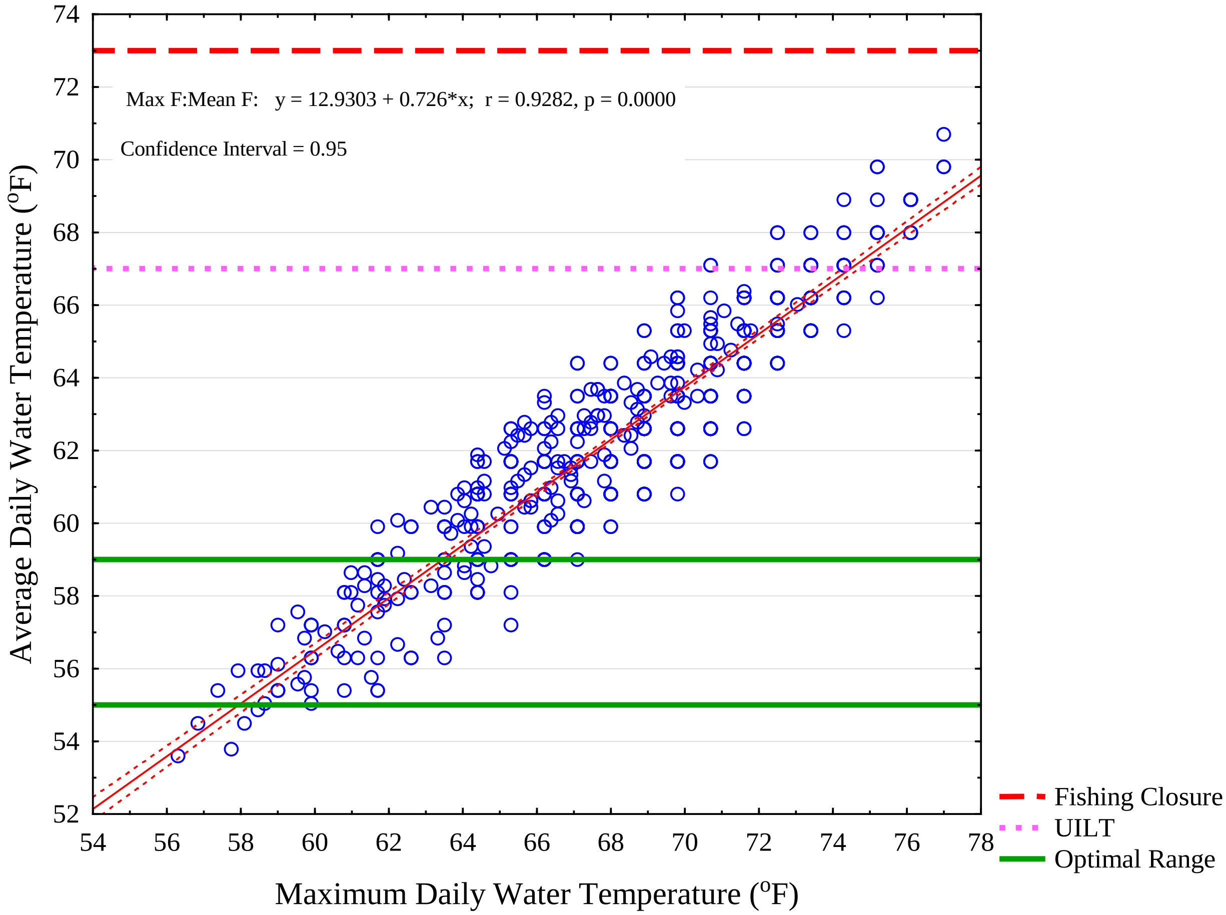

Figure 6-32: Comparison of average and maximum daily temperatures from USGS gage station 6195600.

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 6-51). The number of periods with temperatures exceeding the threshold was variable, from 1 to 4. In some years, maximum daily temperatures 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 6-51: 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

Water demands for irrigation and other agricultural uses in the Shields River are considerable, and water reservations to support fisheries are typically junior rights. Nonetheless, opportunities may exist to increase in-stream flows through implementation of voluntary improvements in water-use efficiency and potentially compensating water rights holders for contributing to in-stream flows.

One of the goals of Yellowstone cutthroat trout conservation agreement (MCTSC 2007) includes maintaining the diversity of life histories represented by remaining cutthroat trout populations. Although information on habitat use and movements of Yellowstone cutthroat trout occupying the lower Shields River is lacking, these fish are likely fluvial migrants that move between the Shields and Yellowstone rivers (S.T. Opitz, FWP, personal communication). Fluvial migrants are especially vulnerable to dewatering in tributary streams, and efforts that maintain in-stream flows through the incubation and drift periods provide enormous benefit. Efforts to conserve this life history strategy should be similar to actions for the Yellowstone River, with an emphasis on identifying potential spawning streams, and working towards solutions that are compatible with agricultural production while increasing the efficiency of water use.

6.3.2 Bangtail Creek

Bangtail Creek (Figure 6-27) is the only named stream in the Bangtail Creek drainage, and joins the Shields River downstream of the Chadbourne diversion. Bangtail Creek originates in the GNF, but most of its length flows through privately owned lands.

Bangtail Creek supports native Yellowstone cutthroat trout and mottled sculpin, and nonnative brook trout (Table 6-52). Brook trout have been present in the creek for decades. According to fish stocking records maintained by FWP, over 15,000 brook trout fry have been stocked in Bangtail Creek, beginning in the 1920s and extending through the 1960s. Efforts to establish a brown trout

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2004	1	4
2005	0	1
2006	2	10
2008	0	1
2009	0	1
2010	0	0
2011	0	0

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Table 6-52: Distribution and abundance of fishes in Bangtail Creek (MFISH database).

Begin Mile	*End Mile*	*Species*	*Abundance*	*Use Type*	*Life History*	*Genetic Status*	*Data Rating*
0	13	Brook trout	Common	Year-round resident	N/A	N/A	EFMSO
0	13	Mottled Sculpin	Common	Year-round resident	N/A	N/A	NSPJ
3	12	Yellowstone cutthroat trout	Common	Unknown	Resident	Nonhybridized	EFMSO

A fisheries investigation conducted in 2001 (Shepard 2004) provides information on species composition and abundance at regular intervals along the length of Bangtail Creek (Figure 6-33). Brook trout were present at each sampling station. Yellowstone cutthroat trout were not captured in the lower 3 miles of Bangtail Creek, but were present at the next six sampling reaches. Brook trout outnumbered Yellowstone cutthroat trout at each location where they were sympatric, although some of these differences may not be statistically significant. GNF biologists sampled near river mile 8 in 2006 and river mile 10 in 2010, and found Yellowstone cutthroat trout were more abundant than brook trout (MFISH database).

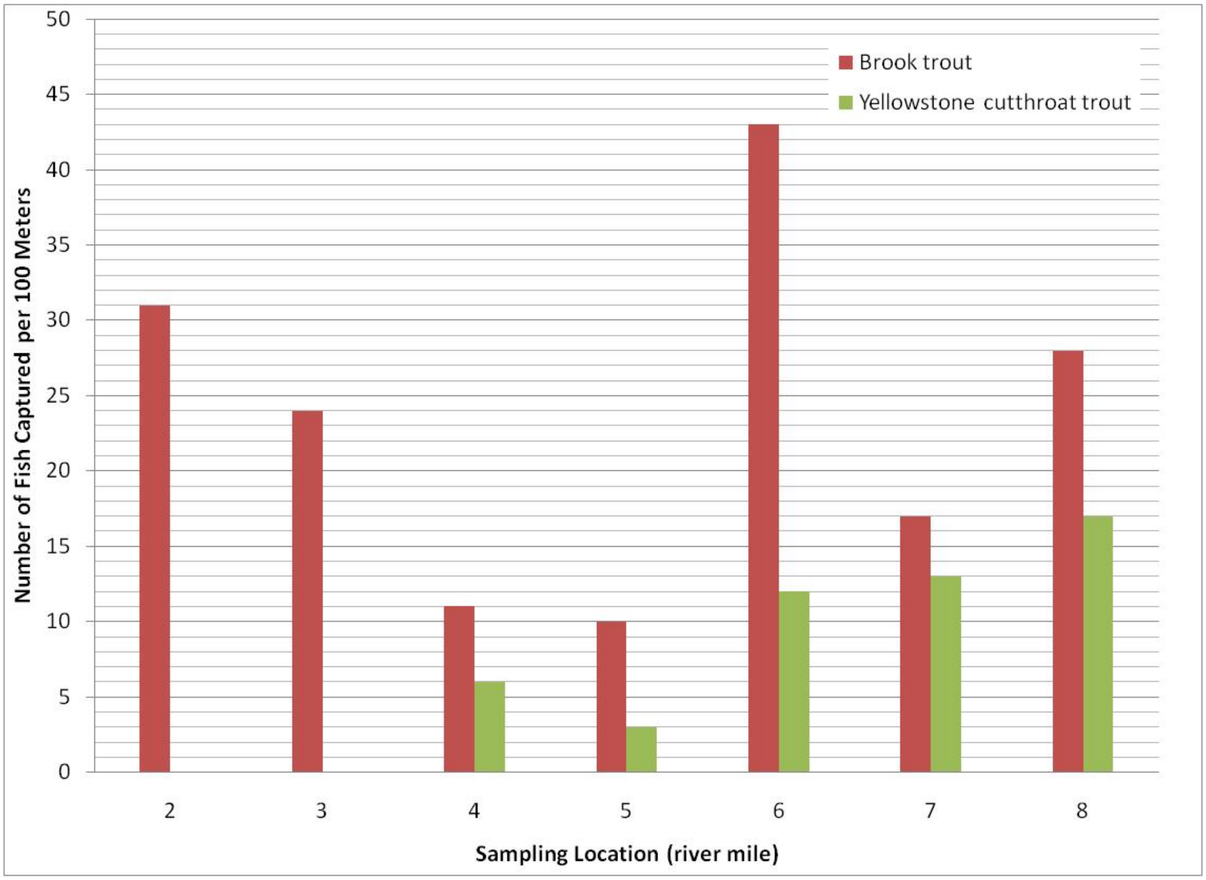

Figure 6-33: Population estimates for Yellowstone cutthroat trout and brook trout for sampling stations on Bangtail Creek (MFISH database).

Fish sampling near river mile 5 has occurred several times, beginning in the 1970s (MFISH database). Methods varied among these events, making comparisons of population estimates problematic. The proportion of the catch comprised by each species does allow inference on temporal trends. In 1974, Yellowstone cutthroat trout were the most abundant, and accounted for nearly 70% of trout captured (Figure 6-34: Percent of catch comprised by Yellowstone cutthroat trout and brook trout in fisheries investigations near river mile 5 on Bangtail Creek.

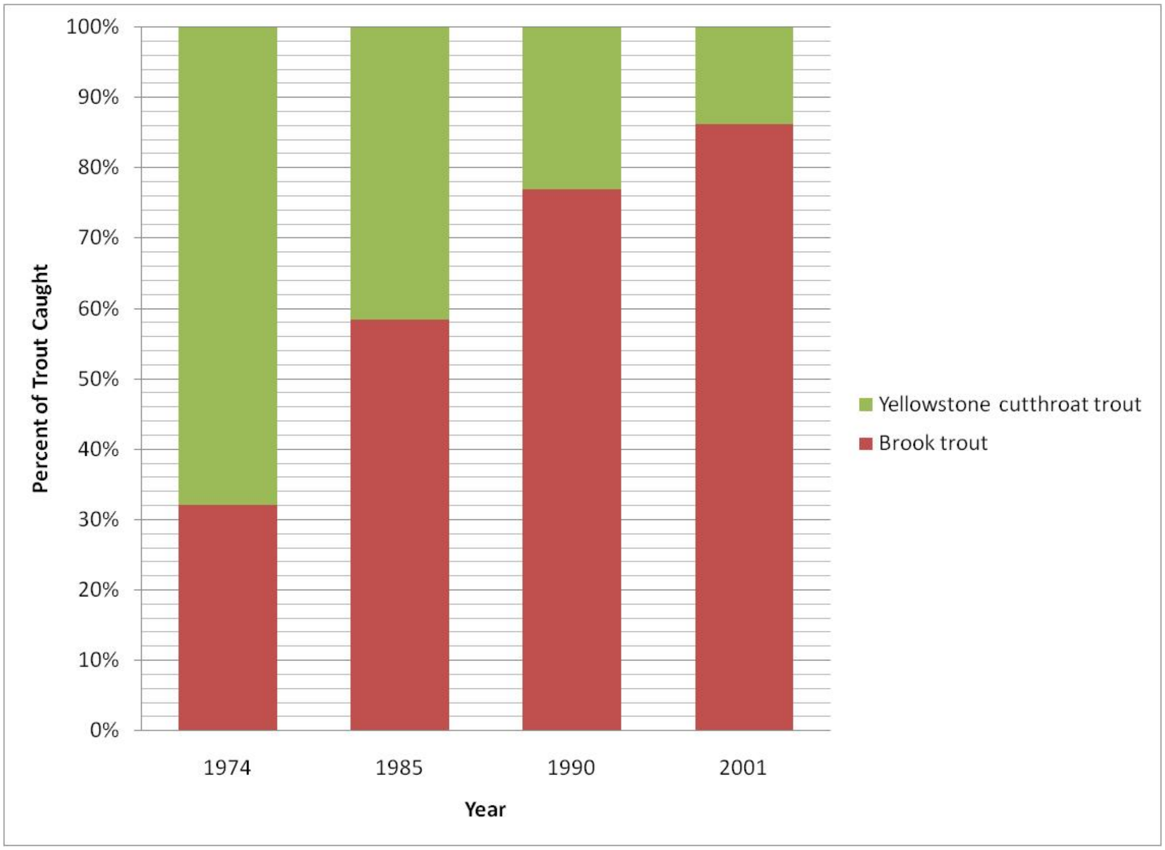

Figure 6-34: Percent of catch comprised by Yellowstone cutthroat trout and brook trout in fisheries investigations near river mile 5 on Bangtail Creek.

Genetic sampling of Bangtail Creek's Yellowstone cutthroat trout (Table 6-53) suggests slight hybridization, which may be of relatively recent origin. Samples collected in 1990 and 1999 showed no evidence of hybridization. In 2001, tissue from fish captured from several locations along Bangtail Creek tested as slightly hybridized, with 97.6% of alleles being Yellowstone cutthroat trout in origin. These samples also indicated first generation hybridization with rainbow trout was likely occurring at that time. Additional longitudinal genetic sampling throughout the stream would be useful to determine if hybridization is continuing and to document the distribution of hybridization along the stream. Depending on the results from the longitudinal genetic sampling, installation of a barrier to prevent spread of hybridization may be advisable.

Table 6-53: Summary of genetic analyses collected in Bangtail Creek (MFISH database).

Sample No.	*Sample Size*	*Target Species*	*Percent of Genes*	*Collection Date*
2841	22	YCT	100	7/07/1999
423	12	YCT	100	8/07/1990
	24	YCT	97.6	7/16/2001

An on-stream reservoir presents the likely feature protecting Bangtail Creek's Yellowstone cutthroat trout population from a greater degree of hybridization. The dam is about 3 miles from the confluence with the Shields River, and sampling in 2001 found no Yellowstone cutthroat trout downstream of the barrier. Maintaining the structural integrity of this feature is a conservation priority for Bangtail Creek. Its failure or removal would allow the abundant rainbow trout in the lower Shield Rivers access to this refuge for native fish.

Fisheries investigations in 2001 (Shepard 2004) included observations of habitat quality, and factors that may limit fish populations. In the privately owned portions of Bangtail Creek, willows and grasses dominated the riparian vegetation, although some disturbance associated with livestock management were apparent. Fine sediment may be limiting fish recruitment in portions of the creek.

Temperature monitoring suggests relatively warm summer temperatures for a small stream (Shepard 2004). Average daily temperatures near river mile 5 were above the optimal range for westslope cutthroat trout (see Bear et al. 2007), and maximum daily temperatures often exceeded 68 °F, which may result in sublethal to lethal stress to cutthroat trout. As the lower five miles of Bangtail Creek experience chronic dewatering, low stream flows may be contributing to these relatively warm temperatures. Restoring riparian shrub canopy and increasing water use efficiency may be among the potential actions employed to improve this component of water quality.

The presence of nonhybridized and slightly hybridized Yellowstone cutthroat trout gives Bangtail Creek considerable conservation value, and protecting this population ranks as a high priority. Hybridization presents an immediate threat to the population, and additional investigation should guide development of specific actions to secure the nonhybridized fish. Brook trout present another threat to Yellowstone cutthroat trout, although cutthroats have been able to persist for several decades in sympatry with brook trout. Nonetheless, the available data suggest brook trout are displacing native cutthroat, indicating a need to intervene. Other potential actions to conserve Bangtail Creek's Yellowstone cutthroat trout relate to promoting compatibility of agricultural production with fisheries needs. FWP will seek opportunities to work with agricultural producers on voluntary practices that maintain economic viability while supporting these native fish.

6.3.3 Chicken Creek

Chicken Creek (Figure 6-27) originates in the Shields River valley near the foothills of the Crazy Mountains. Chicken Creek has no named tributaries, and flows for about eight miles before its confluence with the Shields River. Adjacent land uses include irrigated crop production and livestock grazing.

Fisheries information for Chicken Creek is limited to a single survey in 2002 (Shepard 2004). Low numbers of Yellowstone cutthroat trout were present in a reach about four miles from the mouth. No genetic data are available for this stream.

Habitat observations made during the fisheries investigation indicated relatively poor condition relating to extremely high levels of fine sediment covering the streambed, and little riparian cover. Factors contributing to degraded habitat include naturally erosive soils and incompatible livestock management. Aerial imagery for Chicken Creek indicates reduced riparian cover occurs along considerable portions of the creek. Implementation of grazing BMPs, along with development of off-channel sources of stock water, would likely be beneficial for much of Chicken Creek.

Chicken Creek has been the subject of several projects aimed at improving fish habitat and water quality. Two projects addressed corrals where heavy livestock use had greatly reduced riparian cover and the quality of in-stream habitat. These projects moved corrals off Chicken Creek, and provided alternative sources of stock water to reduce pressure on the stream, while providing essential water for livestock. Within a year after installation of fences and off-channel water, these reaches had recovered remarkably from the pre-project condition.

A third project involved elimination of a passage barrier that blocked upstream movement of fish from the Shields River into Chicken Creek. The effectiveness of this project has not been evaluated. Note that strategies to conserve Yellowstone cutthroat trout in tributaries have changed from the early 2000s, when opening passage was the emphasis. Growing concerns regarding hybridization and invasion of brook trout now make opening passage a viable option only when it does not jeopardize existing populations of Yellowstone cutthroat trout.

6.3.4 Willow Creek

Willow Creek (Figure 6-27) originates in the Bangtail Range, and flows east for twelve miles until its confluence with the Shields River. Its extreme headwaters are in the GNF, and the remainder flows through private lands. Willow Creek has three headwater forks, and a lack of agreement exists among maps for names of streams in this watershed. The USGS 1:100,000 maps and the NHD hydrology coverage designate Willow Creek as extending upstream past its confluence with Middle Fork Willow Creek. Other maps consider this reach South Fork Willow Creek, and fisheries investigations followed this convention (Shepard 2004).

Fishes present in the Willow Creek drainage include Yellowstone cutthroat trout and nonnative brown trout, in addition to other members of the native fish assemblage (Table 6-54). Below the confluence of the middle fork, fish surveys yielded only brown trout and suckers; however, sampling was inefficient because of beaver dams. Upstream of the confluence of Middle Fork Willow Creek, Willow Creek (designated South Fork Willow Creek in Shepard 2004), supported low numbers of Yellowstone cutthroat trout and mottled sculpin (Shepard 2004). Genetic testing of three of these fish found no evidence of hybridization (Shepard 2004).

Table 6-54: Distribution and abundance of fishes in Willow Creek (from MFISH database).

Begin Mile	*End Mile*	*Species*	*Abundance*	*Use Type*	*Life History*	*Genetic Status*	*Data Rating*
0	5	Brown trout	Common	Year-round resident	N/A	N/A	EFSSO
0	8	Longnose sucker	Rare	Year-round resident	N/A	N/A	EFSSO
0	8	Mottled sculpin	Rare	Year-round resident	N/A	N/A	NSPJ
0	8	Mountain sucker	Rare	Year-round resident	N/A	N/A	NSPJ
6	10	Surveyed; no fish captured	Unknown	Unknown	Unknown	N/A	EFMSO
0	5	White sucker	Rare	Year-round resident	N/A	N/A	EFSSO
0	5	Yellowstone cutthroat trout	Common	Unknown	Resident	Potentially unaltered with no record of stocking	EFMSO
5	8	Yellowstone cutthroat trout	Rare	Unknown	Resident	Potentially unaltered with no record of stocking	EFMSO
8	11	Yellowstone cutthroat trout	Unknown	Unknown	Resident	Potentially hybridized	EFMSO

The North Fork Willow Creek has been the subject of several investigations that document Yellowstone cutthroat trout as being present in this stream. In 1995, GNF biologists found only Yellowstone cutthroat trout in surveyed sections within the national forest (MFISH database). Likewise, Shepard (2004) sampled fish at seven locations, and captured Yellowstone cutthroat trout in all reaches except the uppermost, which was fishless. In 2008, GNF biologists sampled another reach within the forest boundary and found healthy numbers of Yellowstone cutthroat trout. Genetic analyses of fish in the North Fork Willow Creek found no evidence of hybridization in two sampling events (Table 6-55). Given the apparent lack of introgression, this population is a core population, and has substantial conservation value.

Table 6-55: Summary of genetic analyses conducted in North Fork Willow Creek (MFISH database). .

Sample No.	*Sample Size*	*Target Species*	*Percent of Genes*	*Collection Date*
2241	19	YCT	100	1/01/2002
771	17	YCT	100	7/23/1993

Fisheries investigations in the Middle Fork Willow Creek suggest this stream has reduced potential to support a fishery. Sampling in two reaches found no fish of any species (Shepard 2004). Additional surveys upstream of sampled reaches would be useful in confirming the status of this stream.

Information on habitat quality includes qualitative observations and habitat surveys on the north fork. Shepard (2004) notes Willow Creek is aptly named given the dense stand of willows that occupies much of the riparian zone. Nonetheless, changes in grazing management would be beneficial in some areas to restore and maintain shrub cover and its function. The GNF has made such changes in its grazing permit in the upper drainage. An on-stream impoundment in lower Willow Creek is another feature with potential to affect fisheries. Investigation into its potential to block upstream movement of nonnative salmonids would be informative.

Two habitat surveys conducted on the North Fork Willow Creek (Shepard 2004) found fine sediment was a constraint to the quality and quantity of spawning habitat available in both reaches. Spawning habitat was extremely limited in the lower habitat section and moderately low in the upper section. Spawning gravels in both sections contained lots of silt that reduced its quality. Domestic livestock accounted for most of the riparian use in the lower section, while logging-related use in the upper basin appeared to cause channel alterations at the upper habitat site.

Dewatering is among the potential constraints on the resident fishery, and may limit Willow Creek's ability to support a spawning run of fluvial Yellowstone cutthroat trout from the Shields River. FWP will work with interested water rights holders on identifying potential projects to increase water use efficiency and increase in-stream flows.

As the Willow Creek drainage supports an apparently nonhybridized population of Yellowstone cutthroat trout, conservation priorities include securing the population. Projects to restore and maintain habitat quality are among potential actions. Likewise, preventing encroachment of brown trout into the upper watershed is an important goal. Their absence in the upper basin suggests a passage barrier, and identification of this barrier is a conservation priority.

6.3.5 Fiddle Creek

Fiddle Creek (Figure 6-27) is a small stream that emerges within the Shields River valley. No fisheries data are available for this stream. Baseline investigations on its potential to support fish and factors affecting this potential are conservation needs.

6.3.6 Falls Creek

Falls Creek (Figure 6-27) originates in the foothills of the Crazy Mountains, and flows for eight miles until its confluence with the Shields River. In 2002, FWP biologists surveyed three reaches, none of which yielded fish. Although these results suggest a low potential to support a fishery, further investigation should evaluate limiting factors and the potential for a passage barrier to preclude fish from Falls Creek.

6.3.7 Adair Creek

Adair Creek (Figure 6-27) originates in the foothills of the Crazy Mountains, and flows through private lands until its confluence with the Shields River. The only fisheries data available for this stream is a survey in 1975 that reported capture of seven cutthroat trout in a 250-ft-long section of stream (Berg 1975).

Baseline investigations to determine species composition and distribution of fish are the primary conservation need for Adair Creek. This information would provide the basis for developing specific recommendations for cutthroat trout conservation.

6.3.8 Crazy Head Creek

Crazy Head Creek (Figure 6-27) originates on the west side of the Shields River valley, and flows for about 7 miles before its confluence with the Shields River. The only available fisheries data comes from a survey in the 1970s that found lake chub (Berg 1975). As Crazy Head Creek flows entirely through rangeland and lacks headwaters in a montane environment, it may not have habitat or thermal regime suitable for support of a cold-water fishery. Determining Crazy Head Creek's potential to support salmonids is a conservation need.

6.4 Upper Yellowstone-Lake Subbasin (HUC 10070004)

The Upper Yellowstone-Lake Subbasin begins downstream of Bridger Creek, and extends past Billings, Montana. The majority of the basin is in private ownership, although numerous state-owned sections are present. This watershed lies within the Northwestern Great Plains Ecoregion, and has the characteristically gentle topography and low elevations typical of Montana prairies.

This historic distribution of Yellowstone cutthroat trout in this HUC was likely limited, as most streams possessed prairie stream affinities such as warmer water temperatures, fine streambed materials, and relatively high dissolved solids. The Yellowstone River and several of its tributaries are the only streams predicted to have supported Yellowstone cutthroat trout historically (Figure 6-35).