maintain minimum in-stream flows, and reduce entrainment of adults and fry into irrigation systems. In addition, as a significant portion of the Cinnabar Creek sub-watershed flows through range and hay meadows, opportunities may exist to work with private landowners on implementing grazing and forage production practices to improve riparian function and habitat condition, while maintaining agricultural productivity. Fisheries investigations refining the understanding of distribution and status of nonnative salmonids will allow development of more specific strategies to conserve the headwaters population of Yellowstone cutthroat trout in the basin.

6.2.6 Cedar Creek

Cedar Creek (Figure 6-10) originates in the Absaroka-Beartooth Wilderness, and flows to the west until its confluence with the Yellowstone River downstream of Corwin Springs. Cedar Creek lies nearly entirely on the GNF, with less than 0.5 miles of its 8-mile length flowing through private lands. Fisheries investigations have focused primarily on its role as a spawning tributary for fluvial Yellowstone cutthroat trout, with considerably less emphasis addressing the resident fishery. A population survey in 1990 found an estimated 13 brook trout per 1000 feet, but did not report other species being present (FWP unpublished data). Fish surveys conducted by GNF personnel found brook trout to be the most abundant species downstream of the wilderness boundary (S.W. Shuler, GNF, personal communication)

Cedar Creek is an important spawning tributary for fluvial Yellowstone cutthroat trout and had the largest confirmed run of all streams evaluated (Berg 1975). Cedar Creek is among the “high quality” spawning tributaries (Clancy 1988) and has had substantially greater number of adults ascending the stream and correspondingly greater numbers of redds than neighboring Tom Miner or Big creeks (Byorth 1990). This heavy use by fluvial Yellowstone cutthroat trout has resulted in Cedar Creek being the greatest known contributor of fry to the Yellowstone River in the upper Yellowstone River HUC, with fry production substantially exceeding neighboring Mulherin, Big, and Mill creeks (Roulson 2002).

Genetic analyses have examined fluvial spawners, out-migrating fry, and resident fish (Table 6-7). In 1991, of the 13 fry tested, at least 2 individuals were of hybrid origin (Leary 1992). Analyses of tissue collected from 24 fluvial Yellowstone cutthroat trout in 2003 found 23 nonhybridized Yellowstone cutthroat trout, and one Yellowstone cutthroat trout × westslope cutthroat trout hybrid (Martin 2004). A radio-tag study also confirmed nonhybridized Yellowstone cutthroat trout use Cedar Creek, with one of the 44 tagged, nonhybridized Yellowstone cutthroat trout using Cedar Creek (DeRito 2004). In contrast, none of the radio-tagged rainbow trout nor hybrids used Cedar Creek during this study.

Table 6-7: Summary of genetic analyses conducted in the Cedar Creek watershed (MFISH database).

Sample No.	*Sample Size*	*Target Species*	*Percent of Genes*	*Count*	*Collection Date*
2874	24	YCT		23	07/15/2003
2874	24	YCT×WCT		1	07/15/2003
0681	20	YCT	41.2		08/13/1992
681	20	WCT	58.8		08/13/1992
605	13	RBT	3.8		08/19/1991
605	13	YCT	96.2		08/19/1991

A dominance of westslope cutthroat trout genes was present in the resident cutthroat trout near the wilderness boundary (Table 6-7). The occurrence of westslope cutthroat trout genes at such high proportions, nearly 60%, likely relates to fish plants in the early 1930s, when about 44,000 "cutthroat trout" were released in Cedar Creek (FWP fish plants database). Distinctions between subspecies of cutthroat trout were considered irrelevant in those years, and some of these fish may have been westslope cutthroat trout, although additional plants in the 1940s were listed as being Yellowstone cutthroat trout.

Several barriers to fish movement are present in Cedar Creek. Installation of a fish ladder in the culverts under the Highway 89 bridge has allowed spawning Yellowstone cutthroat trout into Cedar Creek since the 1980s (Clancy and Reichmuth 1990). This road crossing is slated to be replaced by the Montana Department of Transportation in the near future, and the new crossing will provide fish passage. The next fish barrier is an irrigation diversion located about 0.5 miles from the mouth. This partial barrier may limit the habitat available to fluvial Yellowstone cutthroat trout to spawning. A natural barrier lies about 0.5 miles above this irrigation diversion.

As the greatest producer of Yellowstone cutthroat trout fry to the Yellowstone River, Cedar Creek has substantial conservation value, and several existing and future projects will preserve this important run. Entrainment of Yellowstone cutthroat trout fry into irrigation canals is minimal, eliminating the stream from the list of streams where a fish screen would be beneficial (P. Byorth, Trout Unlimited, personal communication). FWP has water leases with several irrigators to maintain minimum flows, as well as owning a water right. The USFS holds a water right of 10.02 cfs from 6 water rights that are under a lease agreement with FWP and this water prevents dewatering of prime habitat for fluvial Yellowstone cutthroat trout in the lower 2,700 feet of channel. The lease will expire in September 2015, but will be eligible for renewal as early as 2014. In the interest of securing permanent in-stream flow rights for fish and wildlife habitat, the USFS could convert all owned rights to in-stream flow through DNRC's change of water use application. This action would have substantial conservation benefits and FWP will work with USFS to explore this opportunity.

Reestablishment of a nonhybridized, resident population of Yellowstone cutthroat trout is a possible, future action that would require removing the existing Yellowstone cutthroat trout × westslope cutthroat trout hybrids, and reintroduction of nonhybridized Yellowstone cutthroat

trout. The existing, natural barrier about one mile from the mouth may be sufficient to prevent upstream movement of nonnative salmonids. Alternatively, construction of a barrier may be necessary to protect the reestablished population. Future planning for Cedar Creek will evaluate the feasibility of these options.

6.2.7 Slip and Slide Creek

Slip and Slide Creek (Figure 6-10) originates in the Absaroka Mountains and flows west for just over 4 miles before its confluence with the Yellowstone River. Two unnamed forks of substantial length feed Slip and Slide Creek, and an on-stream impoundment is a significant feature. Approximately 1.8 miles of stream flow through private lands, with the bulk of the remaining stream occurring within the GNF.

Available fisheries information comes from surveys conducted by the GNF in the early 1990s (S.W. Shuler, GNF, personal communication) and again in the 2010s (S.T. Opitz, FWP, personal communication). Slip and Slide Creek does not support a resident fishery, presumably due to low or intermittent stream flow, or lack of connectivity to a population source. Likewise, intermittency in drought years limits this stream's ability to support a fluvial run of Yellowstone cutthroat trout. Nonetheless, recent reconnaissance from the mouth to the Highway 89 crossing found sufficient flow and no obstructions that would impede fluvial fish. The highway crossing is a concrete box culvert installed to grade, with no drop at the outlet, and gravels and cobbles on its bed, which are features conducive to fish passage.

Three impoundments are on privately owned portions of lower Slip and Slide Creek. One private pond was historically licensed for rainbow trout and this species is likely still present (S.T. Opitz, FWP, personal communication). The USFS is currently examining the land and water rights under the Shooting Star Land Exchange. If the USFS acquires the property, an evaluation of the fish assemblage within the ponds, stability of their outlets, and degree of connectivity to the stream would be follow. Establishment of Yellowstone cutthroat trout populations in these ponds would be a possibility, and would meet the conservation objectives of decreasing risk of hybridization, replicating local populations, and providing a recreational fishery. Likewise, establishing a resident population of Yellowstone cutthroat trout in the stream above the ponds may be possible. Another potential opportunity with this land exchange would be conversion of water rights for in-stream flow. This action could benefit fluvial Yellowstone cutthroat trout in the lower reach of Slip and Slide Creek and increase recruitment of fry to the Yellowstone River.

6.2.8 Tom Miner Creek

The headwaters of Tom Miner Creek (Figure 6-10) begin in the Gallatin Range, and it flows through primarily private lands until its confluence with the Yellowstone River. Tributaries include Horse, Skully, Sunlight, Trail, Soldier, Sheep, Ferrell, Wigwam, and Pine creeks. Fisheries investigations on Tom Miner Creek have examined the fluvial Yellowstone cutthroat trout spawning run, and genetic status of resident fish. Yellowstone cutthroat trout are present,

along with other members of the native fish assemblage, and introduced rainbow, brook, and brown trout.

Tom Miner Creek is among the major spawning tributaries for the neighboring reach of the Yellowstone River, and most investigations have focused on fluvial fish. The presence of a run in Tom Miner Creek was confirmed in the early 1970s (Berg 1975), and this run is among the strongest in the area (Clancy 1987; Clancy 1988; Byorth 1990). In the early 2000s, nonhybridized Yellowstone cutthroat trout used Tom Miner Creek during the spawning period (DeRito 2004). Unlike other local streams, dewatering for irrigation was not a factor limiting fry production; however, naturally low flows during drought did reduce fry production (Byorth 1990).

Genetic analyses in the 1980s and 1990s focused on resident fish in the upper half of the watershed. Only nonhybridized Yellowstone cutthroat trout had been detected in the Tom Miner Creek drainage in these efforts (Table 6-8). This apparent lack of hybridization suggests a barrier, either natural or human-made, is preventing invasion of rainbow trout from the Yellowstone River. In 2009, FWP biologists documented a long reach of cascades that may be a partial or total barrier to upstream movement (C.L. Endicott, FWP, personal communication).

Table 6-8: Summary of genetic analyses conducted in the Tom Miner Creek watershed (MFISH database).

Stream	*Sample No.*	*Sample Size*	*Target Species*	*Percent of Genes*	*Collection Date*
Tom Miner Creek	374	25	YCT	100	09/30/1989
	347	25	YCT	100	09/07/1989
	349	17	YCT	100	9/07/1989
	182	25	YCT	100	09/30/1986
Horse Creek	949	7	YCT	100	07/10/1992
Skully Creek	324	25	YCT	100	09/07/1989
Trail Creek	554	25	YCT	100	08/30/1989
Dry Creek	640	5	YCT	100	07/23/1992

In summer of 2010, FWP and the GNF collaborated on an extensive fish survey in the Tom Miner Basin, which is the area encompassing the headwaters to the confined canyon reach (Opitz 2011). The sampling design called for electrofishing Tom Miner Creek and its tributaries at 0.5-mile intervals. Of the 11 tributaries sampled, the fish-bearing reaches yielded only Yellowstone cutthroat trout. Electrofishing efforts on Tom Miner Creek found brown trout, Yellowstone cutthroat trout, one rainbow trout, and an apparent rainbow trout × Yellowstone cutthroat trout hybrid.

A mixture of nonhybridized and slightly hybridized Yellowstone cutthroat trout occur throughout the upper basin (Leary 2011). Analyses of 7 fish from Skully Creek found all but 6 of the fish were nonhybridized Yellowstone cutthroat trout. The presence of a hybrid was an unwelcome find, especially as a sample of 25 fish in 1989 yielded no hybrids. In contrast, an 8 fish sample from Sunlight Creek indicated that all fish were nonhybridized. Of the 29 fish

analyzed in the main stem of upper Tom Miner Creek, all but one were nonhybridized. The 4 fish from Twin Peaks Creek tested as nonhybridized. A hybrid swarm was present in Horse Creek (N=17) and a tributary (N=6), although the majority of the tested alleles were Yellowstone cutthroat trout in origin. A sample of 13 fish from Trail Creek yielded only nonhybridized fish.

The distribution of nonhybridized Yellowstone cutthroat trout and the absence of brook trout were encouraging results (Opitz 2010). Rainbow trout present a threat to the basin's Yellowstone cutthroat trout. Rainbow trout were not found in any tributaries, but as indicated by genetic results, they have been able to hybridize with Yellowstone cutthroat trout. Ongoing assessments have included Soldier, Divide, and Middle creeks, although genetic results are pending. Reed, Pine, and Walsh creeks were fishless.

Future research will be needed to determine the degree of movement of fish from Tom Miner Creek into the tributaries. Protecting this apparent core population of Yellowstone cutthroat trout is a high priority. Actions to prevent spread of rainbow trout or hybrids may include removal or construction of small barriers.

As the majority of the Tom Miner Creek watershed is in private ownership, FWP and its conservation partners should identify opportunities to evaluate stream health and habitat condition. The lower reaches of Tom Miner Creek were subdivided in recent years, and residential development has potential to negatively affect water quantity and quality, as well as fish habitat. Likewise, agricultural uses can have an adverse effect on fish, if not managed in a way compatible with stream health. Development of a collaborative effort with local landowners to evaluate stream condition, and develop solutions as warranted, is therefore a component of the strategy for the Tom Miner Creek basin.

6.2.9 Rock Creek

Rock Creek (Figure 6-11), the next drainage to the north of Tom Miner Creek, flows through the GNF and private lands across its 12.4 miles of length. In the 1980s and early 1990s (Table 6-9), nonhybridized Yellowstone cutthroat trout was the most abundant species upstream of a railroad crossing, with only one brown trout captured in this stream (MFISH database). In 2008, a mixture of brown trout, rainbow trout, Yellowstone cutthroat trout, and apparent hybrids were present upstream of the railroad culvert. A series of cascades followed by a 10-foot-high-waterfall are probable barriers to upstream fish movement, as no hybrids or other species were present upstream of either feature (C.L. Endicott, FWP, personal communication). A landowner reports that a 40-ft waterfall occurs upstream of the 10-foot high waterfall. Although its presence has not been verified, a waterfall of this height would be a certain fish barrier.

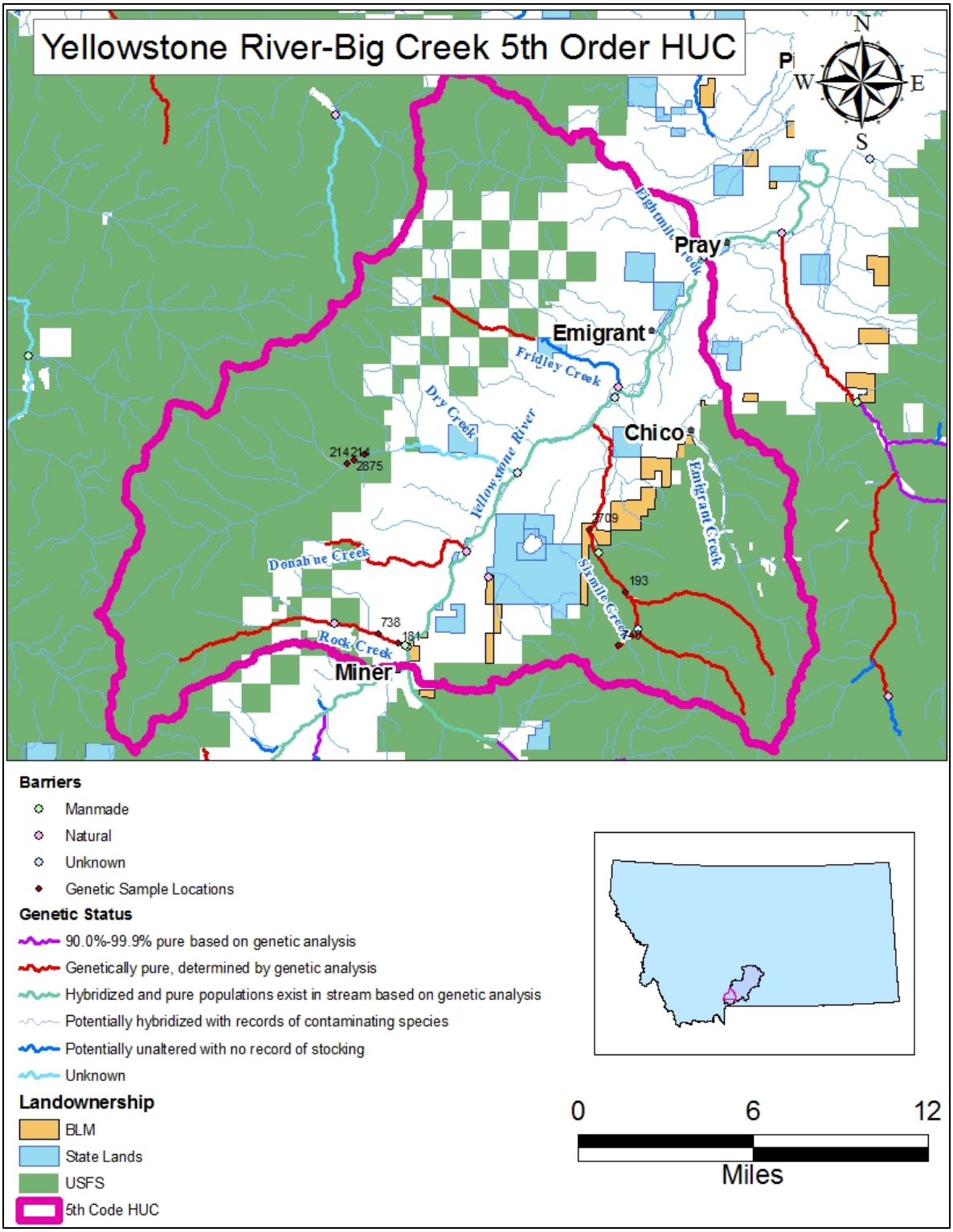

Figure 6-11: Distribution of Yellowstone cutthroat trout in the Yellowstone-Big Creek Watershed (FWP GIS database).

Table 6-9: Summary of genetic analyses conducted in the Rock Creek watershed (MFISH database).

Sample No.	*Sample Size*	*Target Species*	*Percent of Genes*	*Collection Date*
738	5	YCT	100	7/28/1992
181	25	YCT	100	9/30/1986

Previous efforts to increase access for fluvial Yellowstone cutthroat trout had mixed results. A fish ladder installed in the late 1980s provided access for fluvial Yellowstone cutthroat trout, and presumably nonnative salmonids, which now occupy Rock Creek upstream of the culvert. When the fish ladder was in operation, Rock Creek produced relatively large numbers of Yellowstone cutthroat trout fry (Shepard 1992); however, the ladder failed soon afterward. In 2008, no Yellowstone cutthroat trout were found upstream of the culvert and a few fry were present downstream of the culvert. These results suggest the ladder did increase recruitment of Yellowstone cutthroat trout to the Yellowstone River over the short term, but the price was loss of a nonhybridized Yellowstone cutthroat trout population in lower Rock Creek.

Rock Creek presented considerable opportunity to increase recruitment of Yellowstone cutthroat trout fry to the Yellowstone River, while preserving a nonhybridized population in its upper reaches. Irrigation demands on Rock Creek are relatively light, and this stream maintains adequate flow through the incubation and emergence periods, making it an ideal candidate for reestablishing a spawning run. The natural barriers prevent nonnative fishes already present above the railroad culvert from invading the upper watershed. Likewise, these barriers will exclude nonnatives that gain access with elimination of the passage barrier near the mouth.

In 2011, removal of the impassable railroad culvert, and subsequent construction of a series of step pools has opened Rock Creek to fluvial Yellowstone cutthroat trout. Monitoring to evaluate the effect of this project has included implantation of passive inductive transponder or PIT tags in Yellowstone cutthroat trout and rainbow trout in the Yellowstone River. Antennae installed on the nearby county bridge recorded several Yellowstone cutthroat trout ascending the stream in the first and second year following the project. The presence of fry during the Yellowstone cutthroat trout emergence period was another promising observation. FWP will continue to monitor use by fluvial Yellowstone cutthroat trout and fry production in Rock Creek. This project met the conservation objective of conserving Yellowstone cutthroat trout populations and life histories.

6.2.10 Donahue Creek

Donahue Creek (Figure 6-11) originates in the Gallatin Range, and flows through federal and private lands before its confluence with the Yellowstone River. Limited fisheries information (Table 6-10) is available for this stream and the available information is nearly 20 years old. Yellowstone cutthroat trout is the only species identified as present in Donahue Creek and a fish survey conducted near the mouth in 1991 found an estimated nine Yellowstone cutthroat trout per mile. Genetic sampling in 1989 found only nonhybridized Yellowstone cutthroat trout (N = 26; MFISH database).

Table 6-10: Distribution and abundance of fishes in Donahue Creek (MFISH database).

Begin Mile	*End Mile*	*Species*	*Abundance*	*Use Type*	*Life History*	*Genetic Status*	*Data Rating*
0	7	Yellowstone cutthroat trout	Common	Unknown	Resident	Nonhybridized	EBS

Conservation priorities for Donahue Creek include updating information on fish distribution and genetic status. In addition, the presence of only Yellowstone cutthroat trout so low in the watershed suggests a barrier close to the mouth may be preventing encroachment of nonnatives. Severe dewatering may be the barrier. Identifying and protecting any barrier would be vital in protecting the nonhybridized Yellowstone cutthroat trout population, should it still exist. FWP seeks opportunities to work with private landowners in the basin to evaluate stream health, and develop a restoration or stream management strategy as warranted. Private landowners have already contributed to Yellowstone cutthroat trout conservation in Donahue Creek by retrofitting an irrigation diversion to prevent entrainment of Yellowstone cutthroat trout (S.W. Shuler, GNF, personal communication).

6.2.11 Big Creek

The Big Creek watershed (Figure 6-11) is the second largest in the Paradise Valley. Much of this stream, and many of its tributaries, flow through the GNF. Its lowermost 5 miles flow through private lands.

Big Creek has been the focus of fisheries investigations beginning in the 1970s, with an emphasis on evaluating its role in recruiting Yellowstone cutthroat trout fry to the Yellowstone River. Several investigations confirmed that Big Creek supported a small run, with dewatering being the factor limiting the fluvial run (Berg 1975; Clancy 1985; Byorth 1990). Fluvial spawners using Big Creek have tested as being nonhybridized Yellowstone cutthroat trout (Martin 2004).

Beginning in 1999, FWP secured a water lease to maintain in-stream flows in Big Creek through the summer months. The lease calls for a minimum of 11 cfs in Big Creek during incubation, emergence, and out-migration periods. Monitoring use of Big Creek by fluvial spawners and production of fry allowed evaluation of the effect of water leases on fry production. These investigations confirmed the efficacy of water leasing in improving the spawning run into Big Creek. Big Creek went from having a small spawning run, with unreliable recruitment (Byorth 1990), to being the second largest producer of Yellowstone cutthroat trout fry in the upper Yellowstone River HUC (Roulson 2002).

Entrainment of fluvial spawners and fry presents a constraint on reproduction in Big Creek (DeRito 2004; FWP Livingston fisheries files). In 2007, installation of a rotating drum screen on the Mutual Ditch. Internal baffles power the rotation. The baffles and other elements of the screen have broken on several occasions necessitating repairs and retrofits. Although self-powered drum screens may be successful in some situations, other types of screens are available,

and may be more appropriate for a given site. Furthermore, tapping into an external power source such as power lines or solar panels may be possible if a drum screen an appropriate option.

Sampling in the Big Creek occurred in the 1980s and 2012. The efforts in the 1980s were not spatially expansive, but provided information on species composition and genetic status. Species presumed present include brook trout, brown trout, mottled sculpin, rainbow trout, and mountain whitefish (Table 6-11). Yellowstone cutthroat trout × rainbow trout hybrids also reside in Big Creek. Genetic investigations in the 1980s found variability among sampling locations in terms of proportions of rainbow trout genes present (Table 6-16). These data suggest presence of nonhybridized Yellowstone cutthroat trout higher in the watershed, with an area of mixing near the downstream boundary of USFS lands (Leary 1987).

Table 6-11: Distribution and abundance of fishes in Big Creek (MFISH database).

Begin Mile	*End Mile*	*Species*	*Abundance*	*Use Type*	*Life History*	*Genetic Status*	*Data Rating*
0	4	Brook trout	Unknown	Unknown	N/A	N/A	NSPJ
0	4	Brown trout	Common	Year-round resident	N/A	N/A	NSPJ
4	8	Brown trout	Rare	Year-round resident	N/A	N/A	NSPJ
0	4	Mottled sculpin	Unknown	Year-round resident	N/A	N/A	NSPJ
0	4	Mountain whitefish	Common	Year-round resident	N/A	N/A	NSPJ
0	4	Rainbow trout	Common	Both resident and fluvial/adfluvial populations	N/A	N/A	EBS
5	8	Rainbow trout	Common	Both resident and fluvial/adfluvial populations	N/A	N/A	EBS
5	6	Rainbow × cutthroat trout	Unknown	Unknown	Unknown	Unknown	EBS
3	4	Westslope cutthroat trout	Unknown	Unknown	Unknown	Unknown	EBS
5	8	Yellowstone cutthroat trout × rainbow	Unknown	Year-round resident	N/A	N/A	EBS

Table 6-12: Summary of genetic analyses conducted in the Big Creek watershed (MFISH database)

Sample No.	*Sample Size*	*Target Species*	*Percent of Genes*	*Collection Date*
215	11	YCT	10.5	7/02/1987
215	11	RBT	89.5	7/02/1987
2875	18	YCT (fluvial)	100	7/15/2003
214	14	YCT	57.1	7/02/1987
214	14	RBT	42.9	7/02/1987

The fish survey conducted in 2012 followed a systematic approach, with100 meters of stream sampled at 0.5-mile intervals. Similar to the 1980s effort, a mixed fishery of Yellowstone cutthroat trout, rainbow trout, and hybrids were present up to a waterfall located about 9 river miles from the confluence with the Yellowstone River. Upstream of the 20-ft falls, apparently nonhybridized Yellowstone cutthroat trout were present, although genetic analyses to confirm this assumption are pending. Conservation actions for resident Yellowstone cutthroat trout populations include protecting core or conservation populations and evaluation of opportunities to expand distribution of nonhybridized fish.

The conservation strategy for Big Creek includes measures to protect the fluvial spawning run, and to identify and protect any remaining conservation populations of Yellowstone cutthroat trout higher in the drainage. The water leases in Big Creek have been phenomenally successful in increasing recruitment of fry to the Yellowstone River, and these should be continued. Similarly, preventing entrainment of fry at the Mutual Ditch, and potentially other diversions, would protect spawners and increase recruitment of fry to the Yellowstone River.

Improving spawning habitat in lower Big Creek is a potential activity, although the strength of the spawning run suggests habitat alterations may be unwarranted. Much of lower Big Creek has been channelized, and consists of an entrenched channel with limited gravel available for spawning (Byorth 1990, Endicott 2007a). Adding structure to this uniform and entrenched channel would promote deposition of gravel. Nonetheless, any habitat project occurring in Big Creek should be undertaken with caution to not jeopardize the existing, strong run of Yellowstone cutthroat trout.

6.2.12 Dry Creek

Dry Creek (Figure 6-11) lies to the north of Big Creek, and flows through mostly private lands over its seven-mile length. Little fisheries information is available for Dry Creek, and no survey data are available for its resident fishery. Presumably, Dry Creek has a naturally low potential to support a Yellowstone cutthroat trout spawning run. As its name implies, a lack of water availability may limit its potential as a spawning stream, although a Yellowstone cutthroat trout × rainbow trout hybrid has been documented ascending Dry Creek during the spring (DeRito 2004).

Although its potential to support resident or fluvial Yellowstone cutthroat trout populations may be limited, local landowners have inquired about potential projects to promote a spawning run by using water savings from a proposed pipeline conveying irrigation water in the Mutual Ditch, which is fed by Big Creek (Endicott 2007a). Over 0.5- miles of habitat is available before the Mutual Ditch intercepts Dry Creek, and if sufficient flow could be maintained during the summer months, Dry Creek has potential to provide some recruitment of Yellowstone cutthroat trout to the Yellowstone River. Evaluation of the feasibility of siphoning the ditch under the stream is among the informational needs for Dry Creek.

In summary, Dry Creek has some potential to support a resident cutthroat trout fishery, and a spawning run of fluvial fish. Fisheries surveys to determine the status of its resident fishery would guide development of a specific conservation strategy for Dry Creek. In addition, working collaboratively with landowners and irrigators, FWP should evaluate the feasibility of increasing stream flow in Dry Creek during summer months to support a Yellowstone cutthroat trout spawning run.

6.2.13 Sixmile Creek

Sixmile Creek (Figure 6-11) originates in the Absaroka-Beartooth Wilderness on the east side of the Paradise Valley, and flows through the GNF, before entering private land four miles from its mouth. Major tributaries include the North Fork Sixmile Creek and Big Pine Creek. The Sixmile Creek watershed supports nonhybridized Yellowstone cutthroat trout, mottled sculpin, and nonnative brown trout and rainbow trout (Table 6-13).

Table 6-13 : Distribution and abundance of fishes in Sixmile Creek (MFISH database).

Begin Mile	*End Mile*	*Species*	*Abundance*	*Use Type*	*Life History*	*Genetic Status*	*Data Rating*
0	5	Brown trout	Rare	Year-round resident	N/A	N/A	EBS
5	7	Brown trout	Common	Year-round resident	N/A	N/A	EBS
7	14	Brown trout	Rare	Year-round resident	N/A	N/A	EBS
0	5	Mottled sculpin	Rare	Year-round resident	N/A	N/A	EBS
5	7	Mottled sculpin	Common	Year-round resident	N/A	N/A	EBS
7	14	Mottled sculpin	Rare	Year-round resident	N/A	N/A	EBS
4	5	Rainbow trout	Rare	Unknown	N/A	Nonhybridized	EBS
0	11	Yellowstone cutthroat trout	Common	Unknown	Resident	Nonhybridized	EBES

Table 6-14: Summary of genetic analyses conducted in the Sixmile Creek watershed (MFISH database).

Stream	*Sample No.*	*Sample Size*	*Target Species*	*Percent of Genes*	*Collection Date*
Sixmile Creek	2709	1	RBT	100	09/19/1999
	193	25	YCT	100	10/10/1986
Big Pine Creek	740	5	YCT	100	08/14/1992

The presence of sympatric brown trout, and confirmation of rainbow trout occurring in Sixmile Creek, presents concerns for the persistence of the nonhybridized Yellowstone cutthroat trout residing in this stream. Moreover, electrofishing surveys suggest brown trout densities have increased in Sixmile Creek and its north fork over the past 15 years (S.W. Shuler, GNF, personal communication). Potential options include mechanical suppression of nonnatives, or chemical removal, with Yellowstone cutthroat trout being reintroduced. Construction of a barrier to prevent reinvasion by nonnatives would be a potential action, if chemical removal is the preferred option.

Sixmile Creek is a dewatered stream, with water diverted to Dailey Lake and downstream water uses. Determination of the sufficiency of flows in lower Sixmile Creek during the irrigation season is warranted to evaluate the potential for this stream to support a run of fluvial Yellowstone cutthroat trout. Partnerships with irrigators and adjacent landowners would be valuable in promoting greater in-stream flow and habitat improvements, as feasible.

6.2.14 Emigrant Spring Creek

Emigrant Spring Creek is a small, unmapped spring creek originating in the floodplain of the Yellowstone River downstream of Sixmile Creek. This stream supports a resident fishery composed of native and nonnative species (Table 6-15). In 2004, Emigrant Spring Creek was the subject of a restoration project aimed at restoring habitat and increasing in-stream flows. The goal of these efforts was to establish a Yellowstone cutthroat trout spawning run into Emigrant Spring Creek. Whirling disease was detected in 2007, and monitoring the effect of this infestation on recruitment and infection would be informative.

Table 6-15: Distribution and abundance of fishes in Emigrant Spring Creek (MFISH database).

Begin Mile	End Mile	Species	Abundance	Use Type	Life History	Genetic Status	Data Rating
0	0.4	Brook trout	Rare	Year-round resident	N/A	N/A	EBS
0	0.4	Brown trout	Abundant	Both resident and fluvial/adfluvial populations	N/A	N/A	EBS
0	0.4	Mottled sculpin	Common	Year-round resident	N/A	N/A	EBS
0	0.4	Mountain whitefish	Rare	Year-round resident	N/A	N/A	EBS
0	0.4	Rainbow trout	Common	Both resident and fluvial/adfluvial populations	N/A	N/A	NSPJ
0	0.4	Yellowstone cutthroat trout	Common	Unknown	Resident	Nonhybridized	EBS

Redd counts conducted in 2007 confirmed use by fluvial spawners (Endicott 2007b). Nine redds were observed, and several of these were of sufficient size to suggest they consisted of several, superimposed redds. This level of use, so soon after completion of habitat restoration, is promising, and confirms the value of habitat restoration in conserving native fish.FWP will continue monitoring to evaluate species composition of spawners and fry production.

6.2.15 Fridley Creek

Fridley Creek (Figure 6-11) originates in the Gallatin Range on the west side of Paradise Valley. It flows through a patchwork of federal, private, and state lands before entering the valley, where landownership is solely private. About 3 miles from its mouth, Fridley Creek separates into two forks. The North Fork of Fridley Creek was disconnected from the Yellowstone River in the 1930s with construction of the Park Branch Canal. A project reconnecting the north fork to the Yellowstone River occurred in 2003. On the south fork, replacement of an existing irrigation diversion with a structure outfitted with a fish ladder has restored connectivity. The goal of this project was to establish a fluvial Yellowstone cutthroat trout spawning run. The previous pin-and-plank structure blocked upstream movement when the diversion was in use, which coincided with the Yellowstone cutthroat trout spawning run.

Fisheries data include several surveys over the past few decades. MFISH indicates this stream supports members of the native fish assemblage including nonhybridized Yellowstone cutthroat trout (Leary 1992) and introduced brook trout and rainbow trout (Table 6-16), although electrofishing surveys in the mid-1990s found only Yellowstone cutthroat trout, with no nonnative species (S.W. Shuler, GNF, personal communication). A waterfall presumably presents a barrier to upstream movement into the forested portion of the watershed. In 2012, Yellowstone, rainbow, brown and brook trout were present throughout Fridley Creek.

Table 6-16: Distribution and abundance of fishes in Fridley Creek (MFISH database).

Begin Mile	*End Mile*	*Species*	*Abundance*	*Use Type*	*Life History*	*Genetic Status*	*Data Rating*
0	9.1	Brook trout	Common	Year-round resident	N/A	N/A	EBS
0	9.1	Mottled sculpin	Common	Year-round resident	N/A	N/A	EBS
0	9.1	Mountain whitefish	Common	Year-round resident	N/A	N/A	EBS
0	9.1	Rainbow trout	Rare	Year-round resident	N/A	N/A	EBS
0	9.1	Yellowstone cutthroat trout	Abundant	Unknown	Resident	Nonhybridized	EBES

The survey in 2012 will fill several data gaps; however, these data were not available in time for this report. The survey employed the statistically sound sampling design required by the agreement and will provide information on longitudinal species composition and abundance. Genetic samples will update information on genetic status along Fridley Creek.

Conservation priorities for Fridley Creek include protecting remaining nonhybridized fish, and reestablishing a fluvial run into the lower reaches of both forks.FWP will seek partnerships with private landowners to implement conservation practices to ensure the agricultural and residential uses are compatible with native fish. Major landowners in the basin have already been valuable partners in Yellowstone cutthroat trout conservation efforts, and these relationships will facilitate continued work towards conservation goals.

6.2.16 Emigrant Creek

Emigrant Creek (Figure 6-11) arises in the Absaroka- Beartooth Wilderness on the east side of Paradise Valley. About five of the nine stream miles within the montane reaches of the stream are within private ownership. The valley portion flows entirely through private lands. The lowest two miles of Emigrant Creek are listed as chronically dewatered. A diversion on Emigrant Creek intercepts a substantial amount of stream flow and conveys it into the Mill Creek watershed.

Little fisheries information is available for Emigrant Creek. A survey in 1986 reported brook trout in the lower 0.2 miles (MFISH database). Fish surveys in 1996 found only brook trout present in headwater reaches upstream of the Huckleberry Gulch confluence (S.W. Shuler, GNF, personal communication). This same effort found no fish in East Fork Emigrant Creek, presumably due to poor water quality from acid mine discharge. Species presumed present lower in the drainage include brook trout, mottled sculpin, rainbow trout, and Yellowstone cutthroat trout (Table 6-17). No genetics data are available to evaluate the genetic status of any cutthroat trout occupying Emigrant Creek.

Table 6-17: Distribution and abundance of fishes in Emigrant Creek (MFISH database).

Begin Mile	*End Mile*	*Species*	*Abundance*	*Use Type*	*Life History*	*Genetic Status*	*Data Rating*
0	2	Brook trout	Rare	Year-round resident	N/A	N/A	EBS
0	2	Mottled sculpin	Common	Year-round resident	N/A	N/A	EBS
0	2	Rainbow trout	Rare	Year-round resident	N/A	N/A	EBS
0	2	Yellowstone cutthroat trout	Rare	Unknown	Resident	Potentially hybridized	EBS
7	17	Brook trout	Rare	Year-round resident	N/A	N/A	EBS
7	17	Mottled sculpin	Common	Year-round resident	N/A	N/A	EBS
7	17	rainbow trout	Rare	Year-round resident	N/A	N/A	EBS
7	17	Yellowstone cutthroat trout	Rare	Unknown	Resident	Potentially hybridized	EBS

As the lower 2 miles of Emigrant Creek is regularly dewatered, flow may be no longer sufficient to support a spawning run, and none of the studies of Yellowstone cutthroat trout spawning has reported Yellowstone cutthroat trout using Emigrant Creek. The feasibility of restoring connectivity would be contingent on voluntary participation of water rights holders. Review of aerial photos indicate the canal transferring water from Emigrant Creek travels nearly 4 miles before connecting with the irrigation system off of Mill Creek. Seepage and evaporation losses are unknown; however, some opportunity may be available to increase conveyance efficiency. Conversely, much of the area along the ditch is subdivided. Substantial demands on water and the large number of landowners may make Emigrant Creek a lower priority in reestablishment of a fluvial run of Yellowstone cutthroat trout.

Heavy metals and acid mine drainage have apparently extirpated Yellowstone cutthroat trout from the upper reaches of Emigrant Creek. Reclamation would be a significant and expensive undertaking and would not open up much habitat given channel steepness and the velocity and volume of spring runoff. Although mine reclamation would be desirable for human health and wildlife, it rates low as an opportunity to reintroduce Yellowstone cutthroat trout.

6.2.17 Eightmile Creek

Eightmile Creek (Figure 6-11) lies on the west side of the Paradise Valley, and originates in the Gallatin Range. Eightmile Creek begins at the confluence of its north and south forks, and flows for nearly 3 miles through the GNF, before entering private lands. Rangeland is the dominant land use in the valley portion of this stream, although the lowest mile has been subdivided into residential development.

Limited fisheries information is available for Eightmile Creek. A survey conducted in 1987 found brook trout and cutthroat trout (MFISH database). Subsequent surveys near the National Forest boundary in the late 1990s found low densities of brook trout and Yellowstone cutthroat trout (S.W. Shuler, GNF, personal communication). No fish were found in the South Fork of Eightmile, presumably due to low stream flows and high gradients. Species presumed present throughout lower reaches include brook trout, mountain whitefish, rainbow trout, and Yellowstone cutthroat trout (Table 6-18). The record of westslope cutthroat trout is likely an error.

Table 6-18: Distribution and abundance of fishes in Eightmile Creek (MFISH database).

Begin Mile	*End Mile*	*Species*	*Abundance*	*Use Type*	*Life History*	*Genetic Status*	*Data Rating*
0	9	Brook trout	Rare	Year-round resident	N/A	N/A	EBS
0	9	Mountain whitefish	Abundant	Year-round resident	N/A	N/A	EBS
0	9	Rainbow trout	Rare	Year-round resident	N/A	N/A	EBS
4	5	Westslope cutthroat trout	Unknown	Unknown	Unknown	Unknown	EBS
0	9	Yellowstone cutthroat trout	Rare	Unknown	Resident	Potentially hybridized	EBS

Eightmile Creek has potential to support a fluvial spawning run, and nonhybridized Yellowstone cutthroat trout have been documented ascending this stream during the spawning period (DeRito 2004). Dewatering is a likely constraint on potential recruitment, as the lower 2 miles are chronically dewatered during the irrigation season. FWP will explore opportunities to work with irrigators on increasing water use efficiency, which could allow water savings to be left in the stream. Likewise, working with private landowners to manage streamside activities in ways compatible with fish habitat may also be beneficial.

A priority for Eightmile Creek is to collect information on fish composition, distribution, and genetic status of any Yellowstone cutthroat trout present. An apparent absence of natural or human-made barriers within and downstream of the forest boundary (S.W. Shuler, GNF, personal communication) means nonnative fishes have access to invade the headwaters of Eightmile Creek. Moreover, two private ponds downstream of the GNF boundary were formerly on-stream, and were potentially a source of nonnatives. Determining fish composition and genetic status of Eightmile Creek's resident fishery would guide development of specific restoration activities to secure or reestablish a Yellowstone cutthroat trout population.

6.2.18 Mill Creek

Mill Creek (Figure 6-12) is the largest sub-watershed in the upper Yellowstone HUC, encompassing over 160 square miles. Its headwaters originate in the Absaroka-Beartooth Wilderness on the east side of the Paradise Valley. The majority of the watershed lies within the GNF. The valley portions are under private ownership.

Mill Creek supports native and introduced fishes, including Yellowstone cutthroat trout, and nonnative brook, rainbow, and brown trout (Table 6-19). Nonhybridized Yellowstone cutthroat trout dominate in the watershed within the GNF, as a barrier was constructed to protect this population in the mid-1990s, although hybrids have been found upstream of the barrier. Their presence is a significant concern for the genetic integrity of this resident population. Nonhybridized and slightly hybridized Yellowstone cutthroat trout have been found in lower Mill Creek (Table 6-20).

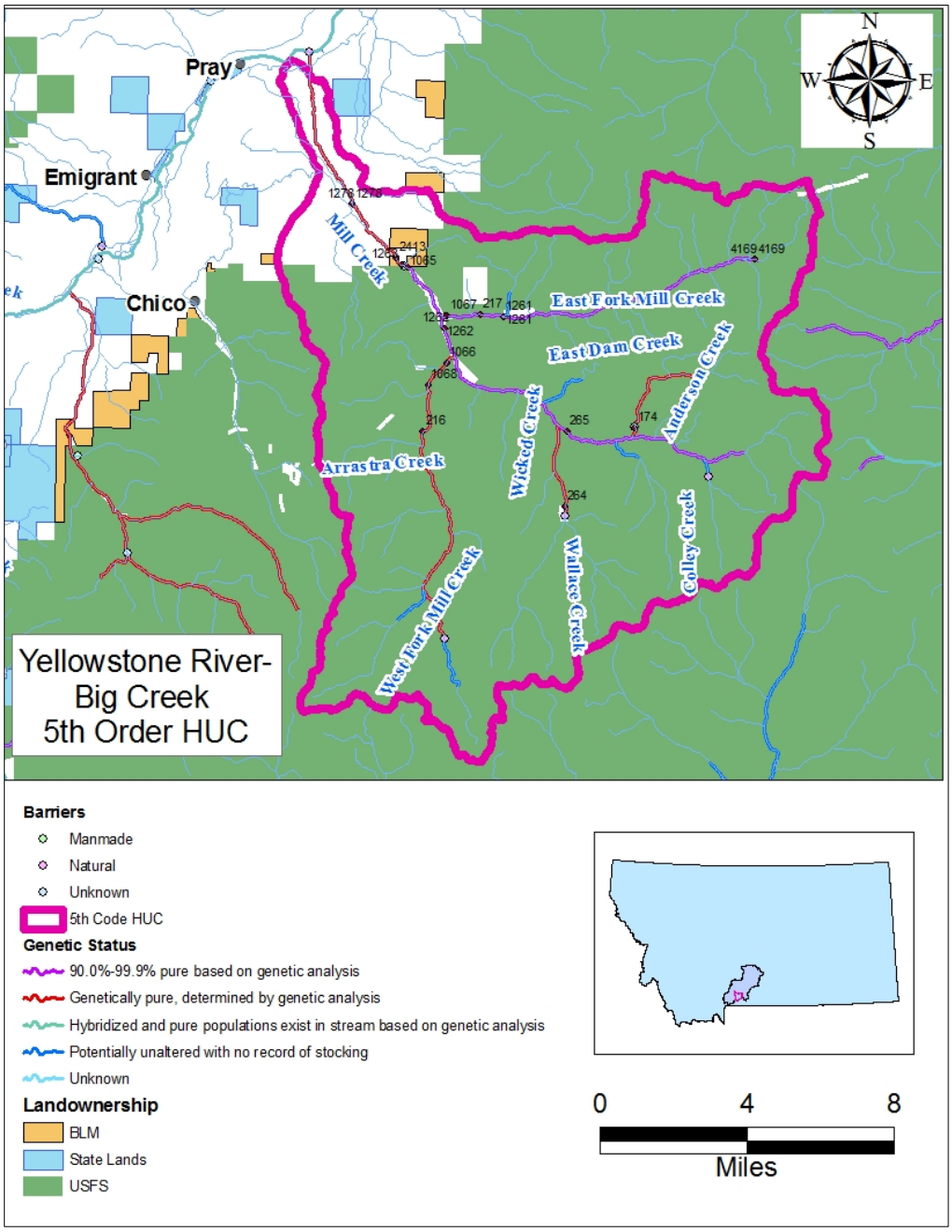

Figure 6-12: Distribution of Yellowstone cutthroat trout in the Mill Creek Watershed (FWP GIS database).

Table 6-19: Distribution and abundance of fishes in Mill Creek (MFISH database).

Begin Mile	End Mile	Species	Abundance	Use Type	Life History	Genetic Status	Data Rating
7	10	Brook trout	Unknown	Unknown	Unknown	Unknown	EBS
8	10	Brown trout	Unknown	Unknown	Unknown	Unknown	EBS
0	22	Mottled sculpin	Rare	Year-round resident	N/A	N/A	EBS
9	22	Mountain whitefish	Rare	Year-round resident	N/A	N/A	EBS
0	9	Rainbow trout	Rare	Year-round resident	N/A	Tested conservation	EBES
7	10	Rainbow × cutthroat trout	Unknown	Unknown	Unknown	Unknown	EBS
0	7	Yellowstone cutthroat trout	Rare	Unknown	Resident	Nonhybridized	EBES
7	20	Yellowstone cutthroat trout	Abundant	Unknown	Resident	Tested conservation	EBES

Table 6-20: Summary of genetic analyses conducted in the Mill Creek watershed (MFISH database).

Stream	*Sample No.*	*Sample Size*	*Target Species*	*Percent of Genes*	*Count*	*Collection Date*
Mill Creek (below barrier)	2711	1	YCT	100		03/18/1999
	2712	32	YCT × RBT		1	04/20/1999
	2712	32	RBT		31	04/20/1999
	1278	9	YCT	96.80		04/02/1997
	1278	9	RBT	3.2		04/02/1997
	2413	29	YCT	100		07/29/2002
	1263	2	YCT	100		09/25/1997
Mill Creek (above barrier)	1065	11	YCT	100		04/24/1995
	1262	10	RBT	02		11/06/1997
	1262	10	YCT	98		11/06/1997
	265	23	YCT	100		09/29/1988
East Fork Mill Creek	1067	05	YCT	100		04/24/1995
	217	20	YCT	100		07/22/1987
	1261	19	YCT	94		11/06/1997
	1261	19		0.70		11/06/1997
West Fork Mill Creek	1066	10	YCT	100		04/24/1995
	1068	16	YCT	100		04/24/1995
Anderson Creek	74	25	YCT	100		08/01/1986

Mill Creek has been the subject of considerable study, with most focusing on its role as a spawning tributary for fluvial Yellowstone cutthroat trout, and on evaluation of the effect of leasing water rights on improving fry survival and recruitment. Numerous investigators have documented fluvial Yellowstone cutthroat trout using Mill Creek to spawn (Berg 1975; Clancy 1984; FWP unpublished data; and DeRito 2004). Water leases intended to maintain minimum in-stream flows, and a flushing flow to transport fry, were unsuccessful in contributing fry to the

Yellowstone River in most years (Roulson 2002), and were not renewed. In some years, dewatering is severe enough to result in dessication of redds or stranding of fry and adult fish. Likewise, entrainment of fry into irrigation diversions presents another loss of potential recruitment (FWP, unpublished data). Brook trout were found concentrated in a spring-fed, unnamed tributary to Mill Creek in a meadow within private land just above the Forest Service boundary. In 1997, 560 brook trout were removed from this spring creek by electrofishing (FWP, Livingston, Montana, unpublished data).

Until recently, less effort has been focused on tributaries upstream of the constructed barrier, although East Fork Mill Creek has received some attention. Hybridized and nonhybridized fish have been sympatric in East Fork Mill Creek for at least 13 years. This mixture of hybridized and nonhybridized fish was first documented in 1997 (FWP unpublished data). In 2010, analysis of 15 fish found a similar mixture of nonhybridized and hybridized fish, indicating these sympatric fish have not formed a hybrid swarm over the intervening years (Leary 2011). These results suggest some factor is segregating their spawning in East Mill Creek.

In 2012, an extensive sampling effort focused on tributary streams in the Mill Creek watershed. Streams sampled included Lambert Creek, Anderson Creek, Mill Creek near its headwaters, Colley Creek, Passage Creek, and East Dam Creek. Putative Yellowstone cutthroat trout were present and sometimes abundant in all streams except East Dam Creek, which was apparently fishless. East Dam Creek has a culvert barrier preventing connection at its confluence with Mill Creek. Genetic analyses are pending for these streams.

The Mill Creek watershed has experienced wildfire over the past decade. Wildfire is a natural and necessary component of the ecosystem; however, streams may suffer adverse effects over the short-term. Sediment loading, debris jams, and channel alterations often reduce the quality of the in-stream habitat. Although wildfire can eliminate a population, if a local source of fish is nearby, these fish will eventually recolonize disturbed streams. The Yellowstone cutthroat trout population in Anderson Creek is of particular concern relating to these fires. Anderson Creek supports a nonhybridized population of Yellowstone cutthroat trout upstream of a barrier falls. The GNF will monitor fish populations in Anderson Creek and other streams affected by fire in the Mill Creek watershed.

Conservation priorities for the Mill Creek watershed include maintaining the fluvial run, and protecting the genetic integrity of fish upstream of the USFS boundary. Recently, landowners and irrigators have organized to explore means to maintain in-stream flows, while protecting agricultural values. FWP will provide technical assistance and aid in procurement of grant funds to promote the success of these efforts.

Protecting the genetic integrity of the resident fish population is challenging, as the source of the hybrids is unknown. FWP has tagged rainbow trout downstream of the constructed barrier, and none have been captured above. Alternatively, some fish may be escaping from private

fishponds. FWP will not issue fishpond permits for species other than Yellowstone cutthroat trout in this drainage. Identifying any remaining ponds with rainbow trout, and educating the public about the consequences of illegal introductions, are among the actions needed to address threats to Yellowstone cutthroat trout in the upper drainage.

6.2.19 Elbow Creek

Elbow Creek (Figure 6-13) is the next drainage to the north of Mill Creek. No recent fish data exist for Elbow Creek, although a fish survey in 1984 found brown trout, rainbow trout, and mountain whitefish (Table 6-21). Yellowstone cutthroat trout may be present; however, occurrence of nonnatives is a constraint to persistence of Yellowstone cutthroat trout. Fish surveys to update information on species composition and distribution are warranted. Genetic testing of trout species in Elbow Lake is also a conservation need. Elbow Lake was stocked with Yellowstone cutthroat trout and “cutthroat trout” (subspecies unknown) in the 1930s and 1940s.

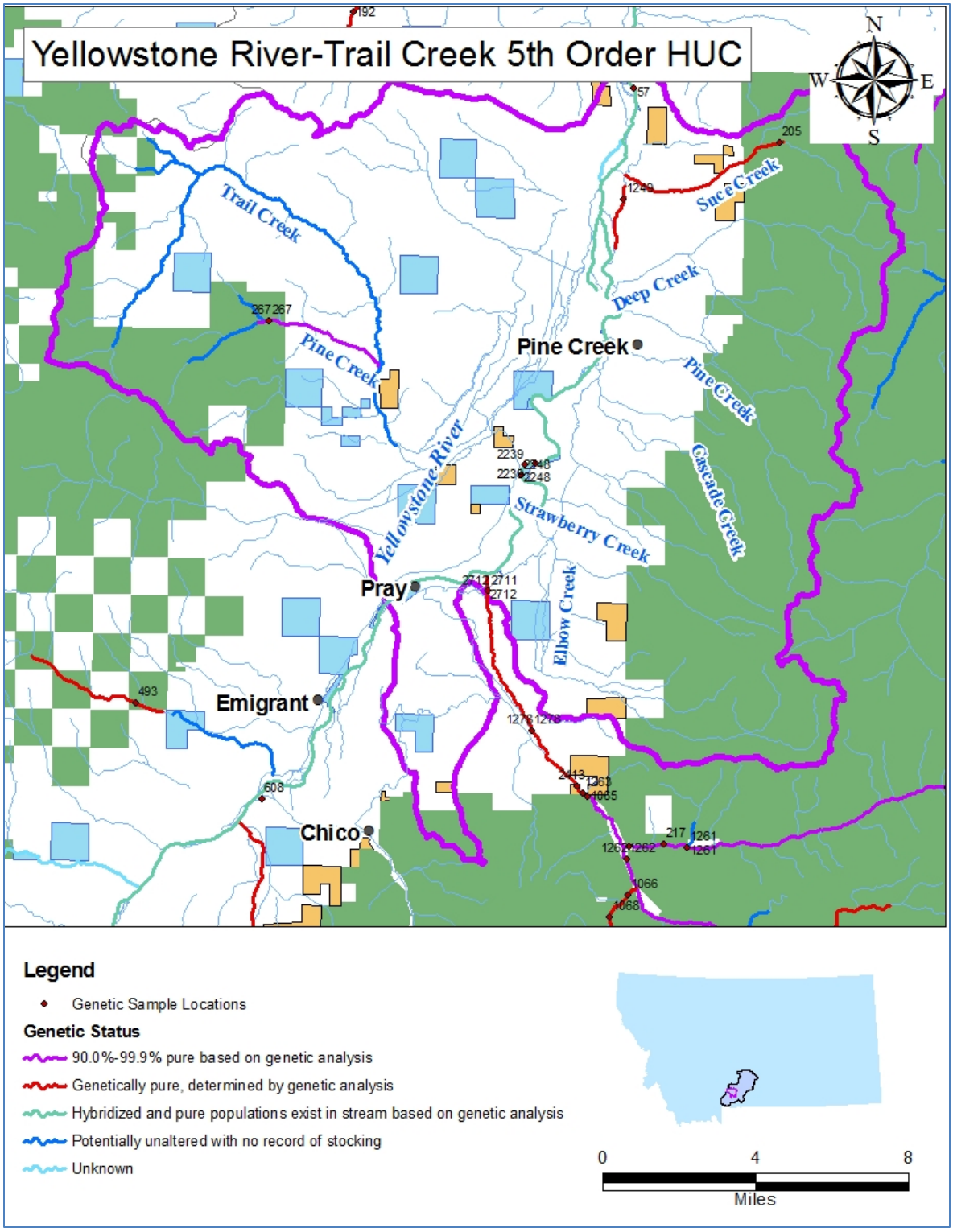

Figure 6-13: Distribution of Yellowstone cutthroat trout in the Yellowstone River – Trail Creek Watershed (FWP GIS database).

Table 6-21: Distribution and abundance of fishes in Elbow Creek (MFISH database).

Begin Mile	*End Mile*	*Species*	*Abundance*	*Use Type*	*Life History*	*Genetic Status*	*Data Rating*
1	11	Brown trout	Rare	Year-round resident	N/A	N/A	EBS
1	11	Mountain whitefish	Unknown	Year-round resident	N/A	N/A	EBS
1	11	Rainbow trout	Rare	Year-round resident	N/A	N/A	EBS
0	6	Yellowstone cutthroat trout	Unknown	Unknown	Resident	Potentially hybridized	NSPJ

Although Elbow Creek is a chronically dewatered stream, nonhybridized Yellowstone cutthroat trout have been documented ascending this stream during the spawning period (DeRito 2004). Working with irrigators on voluntary measures to increase irrigation efficiency and maintain in-stream flows is a potential conservation option for Elbow Creek. Likewise, implementing grazing management strategies compatible with riparian health and function may also be beneficial.

6.2.20 Strawberry Creek

Strawberry Creek (Figure 6-13) originates in the Absaroka Mountain range and flows for about four miles through the GNF before entering private lands in the Paradise Valley. No recent fisheries data are available for Strawberry Creek. Species presumed present include mottled sculpin and mountain whitefish (Table 6-22).

Table 6-22: Distribution and abundance of fishes in Strawberry Creek (MFISH database).

Begin Mile	*End Mile*	*Species*	*Abundance*	*Use Type*	*Life History*	*Genetic Status*	*Data Rating*
0	6	Mottled sculpin	Rare	Year-round resident	N/A	N/A	EBS
0	6	Mountain whitefish	Rare	Year-round resident	N/A	N/A	EBS

Conservation priorities for Strawberry Creek include collection of fisheries information on species composition and distribution. Consistent with the second conservation priority of the Agreement, fish surveys, especially in the stream's montane reaches, may identify a remaining conservation population of Yellowstone cutthroat trout.

The lower mile of Strawberry Creek rates as a chronically dewatered stream, suggesting it provides little to no recruitment of Yellowstone cutthroat trout to the Yellowstone River. Moreover, no radio-tagged cutthroat trout, rainbow trout, or hybrids have been documented ascending Strawberry Creek during the spawning period (DeRito 2004). Nonetheless, opportunities to work with irrigators on increasing water use efficiency, and maintaining in-stream flows may arise, which could benefit the Yellowstone River fishery.

6.2.21 Cascade Creek

The Cascade Creek watershed (Figure 6-13) is the next drainage to the north from Strawberry Creek. Major tributaries include McDonald Creek and Barney Creek. Fisheries information is limited for streams in this watershed. A fish survey in McDonald Creek, conducted in 1984, yielded an estimated 92 brown trout per 1,000 feet of stream. Other species presumed present include mottled sculpin, mountain whitefish, rainbow trout, and Yellowstone cutthroat trout (Table 6-23). As with other streams lacking current fish surveys, a conservation objective for the Cascade Creek watershed is determining species composition, distribution, and genetic status of any Yellowstone cutthroat trout present.

Table 6-23: Distribution and abundance of fishes in Cascade Creek (MFISH database).

Begin Mile	End Mile	Species	Abundance	Use Type	Life History	Genetic Status	Data Rating
0	1	Brown trout	Abundant	Both resident and fluvial/adfluvial populations	N/A	N/A	EBS
0	1	Mottled sculpin	Abundant	Year-round resident	N/A	N/A	EBS
0	1	Mountain Whitefish	Rare	Year-round resident	N/A	N/A	EBS
0	1	Rainbow trout	Common	Both resident and fluvial/adfluvial populations	N/A	N/A	EBS
0	1	Yellowstone cutthroat trout	Common	Unknown	Resident	Potentially hybridized	EBS

Although Cascade Creek and its tributaries are not listed as dewatered streams, the amount of neighboring irrigated agriculture evident in aerial photos suggests irrigation withdrawals are substantial. FWP will seek opportunities to work with irrigators on voluntary measures to increase water use efficiency, and maintain in-stream flow.

6.2.22 Trail Creek

Trail Creek (Figure 6-13) originates in the Gallatin Range, and flows through private lands for most of its 30-mile length. Pine Creek is a major tributary of Trail Creek, and a considerable portion of its length flows through the GNF. An irrigation system intercepts Trail Creek as it flows into Paradise Valley, and the stream no longer has connectivity to the Yellowstone River.

A number of disturbances have had pronounced influence on stream morphology and habitat quality in the upper portions of the Trail Creek watershed. Timber harvest in the 1980s included several large clear cuts, which likely increased water yield and sediment loading over the short term. In 2000, the Fridley fire burned the entire Pine Creek drainage, which has resulted in increased water yield, sediment loading, and flooding. In addition, failure of a large earthen dam in 1997 had pronounced effect on Trail Creek. The dam impounded a 12-acre pond, and the resulting flood exerted tremendous erosive force on the channel downstream of the dam. The