**Candidate Conservation Agreement with Assurances**
**Big Hole River Rapid Assessment Findings Report**

Montana Fish, Wildlife & Parks

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## Acknowledgements

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## Disclaimer

Boundaries depicted in map layers are not intended to replace legal descriptions or those delineated by a professional surveyor. Maps are created for general reference purposes only and are not necessarily an accurate representation of property ownership boundaries.

## Synopsis

The implementation of the Candidate Conservation Agreement with Assurances program in the upper Big Hole River required that Montana Fish, Wildlife, and Parks (MFWP) survey enrolled lands for potential or immediate threats to fluvial Arctic grayling. Due to the fact that no immediate threats were discovered, we documented potential points of interests, such as: potential barriers to grayling migration (beaver dams (N=129), irrigation diversions (N=190), or culverts (N=55)), areas of degraded stream/riparian habitat (N=181) and degraded stream crossings (N=96), irrigation withdrawal structures (headgates (N=181)), automobile rip-rap (N=5) along or in the river, and livestock confinement areas with a river reach flowing through it (N=10). Although no acute threats to grayling were documented on enrolled lands, a multitude of chronic threats exist that may negatively impact grayling survival in the Big Hole River watershed.

## Introduction

This report details findings of the 'rapid assessment' phase of the Candidate Conservation Agreement with Assurances (CCAA) program developed for fluvial (river-dwelling) Arctic grayling (*Thymallus arcticus*) in the upper Big Hole River watershed in southwest Montana (Map 1, *see page 9*). As part of the CCAA enrollment process, landowners who enrolled in the program allowed Montana Fish Wildlife, and Parks (MFWP) to conduct a 'rapid assessment' of their property within 90 days of enrollment. The purpose of these rapid assessment surveys was to identify immediate causes to grayling mortality and to identify potential take issues on enrolled lands should grayling be listed as Endangered or Threatened under the Endangered Species Act. An immediate threat is an object (physical or chemical) or action that causes damage or mortality to aquatic species, including Arctic grayling. Examples of immediate threats to grayling could be: the presence of an unscreened pump that was removing water and grayling from the river, a net left in the river that was entangling fish, or a leaky oil or gas container next to the river. A tangential purpose of these assessments was to identify actions that the landowner could take to benefit grayling, such as the removal or modification of barriers to grayling migration, or the stabilization of streambanks with native vegetation to increase overhead cover and prevent sedimentation. Issues identified in the rapid assessment phase will be addressed in the landowner's site-specific conservation plan. Rapid assessment surveys will continue on newly enrolled lands. Enrollment in the Upper Big Hole CCAA is open to non-federal landowners until 90 days prior to a proposed listing date of Arctic grayling under the Endangered Species Act.

## Methods

Representatives from MFWP assessed enrolled lands during late May through August 2005. Landowners who had enrolled in the CCAA program agreed to allow access to their property as part of the enrollment process. Personnel, either on foot, all-terrain vehicles, or in a canoe, assessed enrolled lands on the Big Hole River and its tributaries. Boundaries of enrolled lands were identified in ArcMAP 9.1 by ESRI using a cadastral layer from the Natural Resource Information System website for Beaverhead County, Montana.

If a point of interest (waypoint) was identified during the assessment surveys, crews recorded the waypoint with global positioning satellite (GPS), took a digital photo, and described the point. Waypoints and data were entered in Excel, projected into ArcMAP as shapefiles, and linked to a corresponding picture such that a picture of the item could be viewed by clicking on the point in ArcMAP. Data points and pictures were later reviewed for accuracy and categorized. Potential points of interest were: **(1)** Immediate threats to grayling, such as pollutants or mechanical devices in or near the river, (**2)** Potential barriers to grayling migration, such as beaver dams, irrigation diversions, or culverts, (**3)** Irrigation withdrawal structures, such as headgates, (**4)** Areas of degraded stream/riparian habitat, **(5)** Debris, trash, or rip-rap along or in the river, (**6)** Livestock confinement areas adjacent to the stream.

## Results

Rapid assessment surveys were conducted on rivers and streams flowing through approximately 215,000 acres of property owned by 39 private landowners enrolled in the CCAA program as of February 2006. Approximately 230 miles of stream were surveyed and 1172 waypoints were collected (Map 2, *see page 10*) (Table 1, Appendix).

## *1) Immediate threats to grayling*

No immediate threats to grayling were found on enrolled lands.

## *2) Potential barriers to grayling migration*

Potential barriers to grayling migration were documented, the majority of which were channel-wide, pin-and-plank irrigation diversions or beaver dams on tributary reaches (Map 3, *see page 13*).

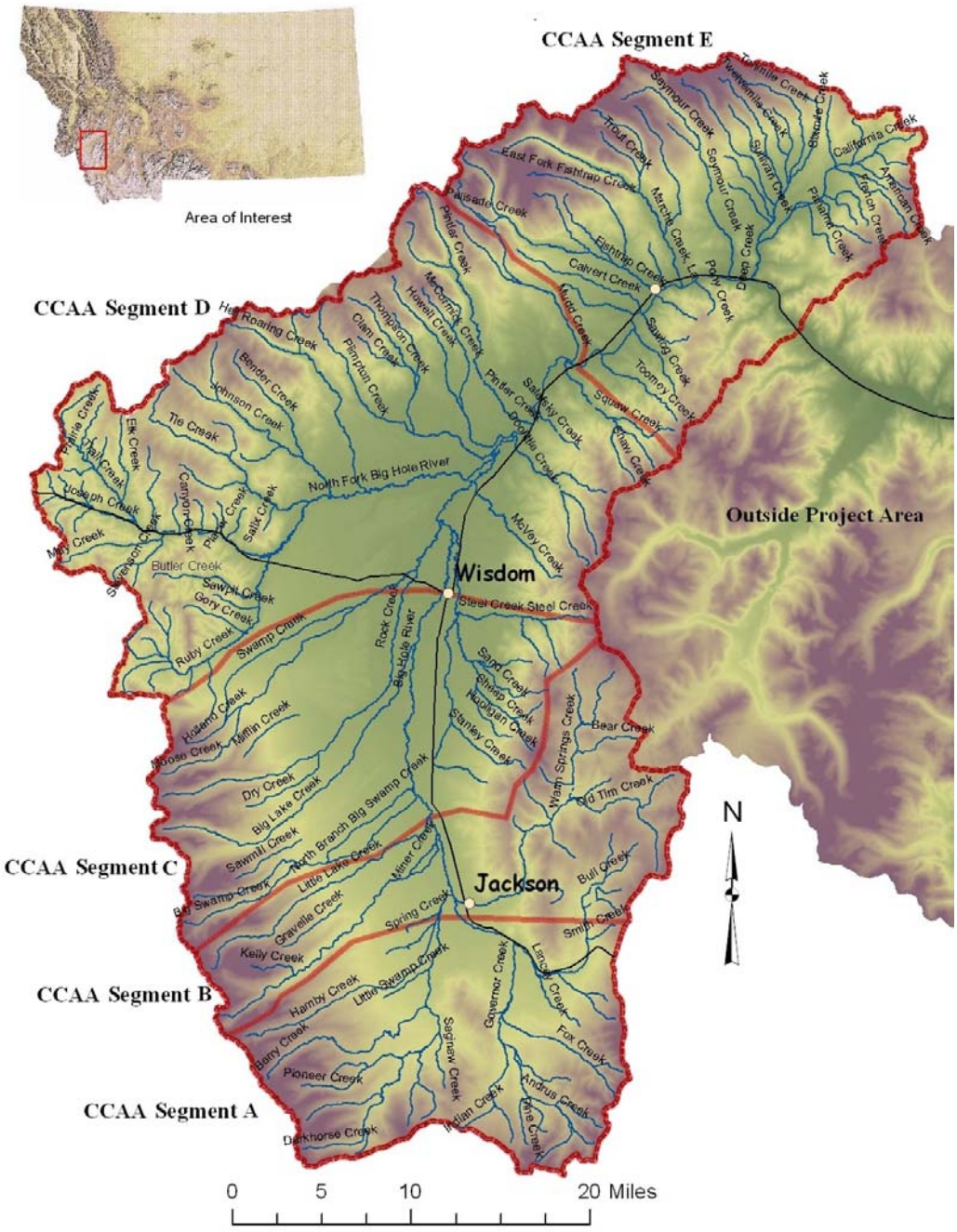
***Irrigation diversions as potential barriers to grayling migration***

The potential for an irrigation diversion to act as a barrier was visually assessed and defined by the condition of the structure at the time of the assessment. Pin-and-plank irrigation diversions were considered barriers when they were channel-wide, boards (planks) were in place across the stream, and a plunge pool was not present on the downstream side. Irrigation diversions were not considered barriers when the diversion was not channel-wide, rocks were used to create the diversion, and/or when boards were not in place on a pin-and-plank structure. A total of 190 irrigation diversions were documented, 54 of which were considered barriers (e.g. Figure 1a), 81 were not considered barriers (e.g. Figure 1b), and 49 diversions may act as potential barriers during certain management and low flow scenarios. Five diversions currently have fish ladders installed to allow fish passage and one diversion has a slot where a fish ladder could be installed.

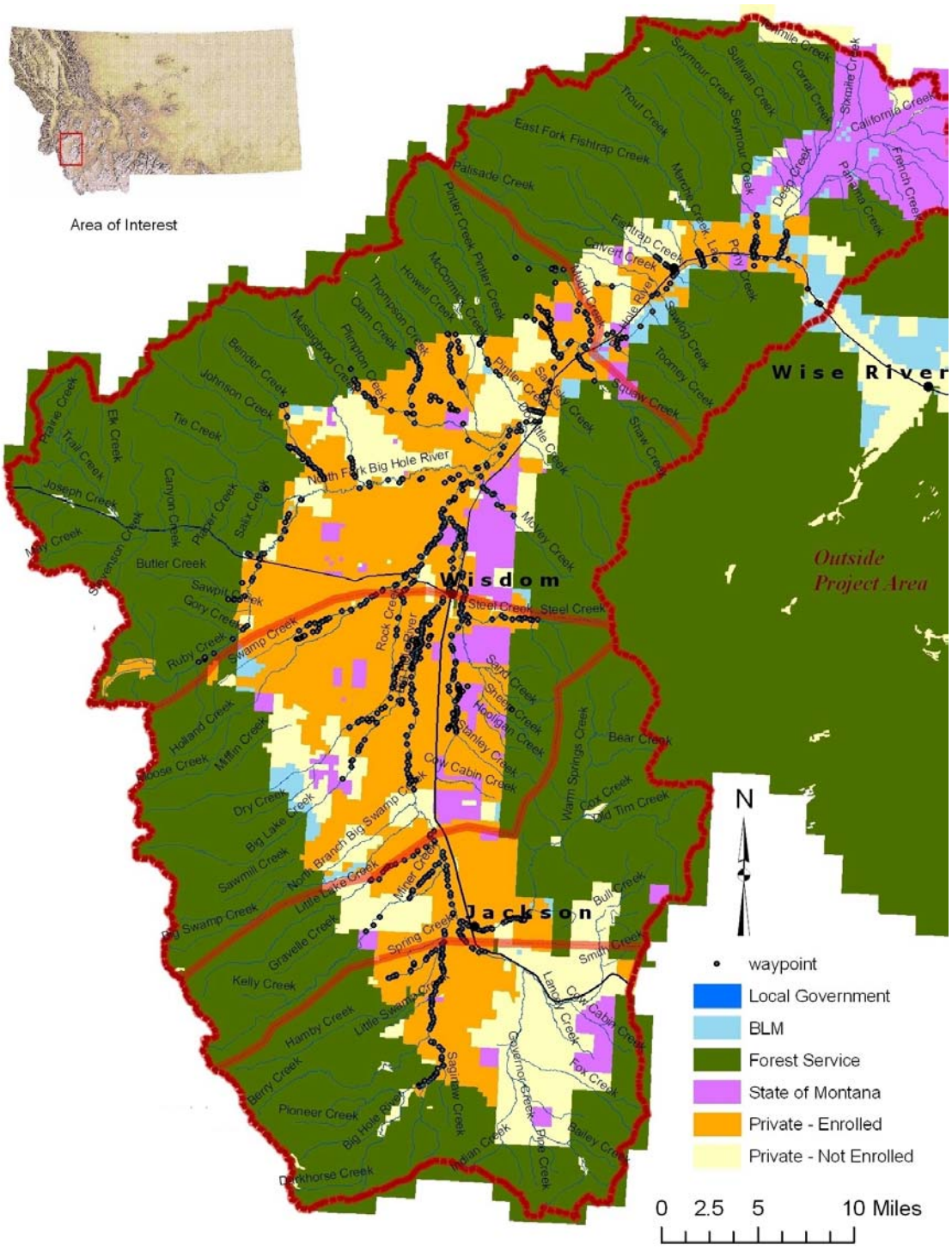
**1a**

**1b**

**Figures 1a.** A channel-wide, pin-and-plank irrigation diversion on a tributary of the Big Hole River that, at times, may act as a barrier to upstream migrating fish, and **1b.** A rock irrigation diversion that directs water to a ditch and does not act as a barrier to upstream migrating fish.




**Map 1**. Location of the Big Hole River watershed and CCAA management segments in southwest Montana.




**Map 2**. Location of the 1072 waypoints collected during rapid assessment surveys by MFWP.

***Beaver dams as potential barriers to grayling migration***

Beaver dams were visually assessed and considered potential barriers to fish migration when they were channel-wide, the deposition of fines had filled interstitial spaces, side channels were blocked, and one of the following conditions applied at the time of the assessment: (1) flow through the beaver dam was impeded to a considerable degree, and/or (2) a plunge pool was not present on the downstream side, and/or (3) the crown elevation (height) and cross-sectional profile of the dam (width) were large enough to create a structure that likely prevented fish passage.

A total of 129 beaver dams were documented, 89 of which were considered likely barriers to fish migration (e.g. Figure 5a), 24 were likely not barriers to fish migration (e.g. Figure 5b), and 16 could have been barriers during low streamflows. Beaver dams were typically distributed on smaller tributary reaches with intact riparian areas dominated by overhanging vegetation.

**2a**

**2b**

**Figure 2a.** A large beaver dam complex on a tributary reach of the Big Hole River that impedes flow and likely acts as a barrier to upstream migrating fish, and **Figure 2b**. A beaver dam on a tributary reach that is likely not acting as a barrier to upstream migrating fish because of flow through the dam and the presence of a plunge pool below the dam.

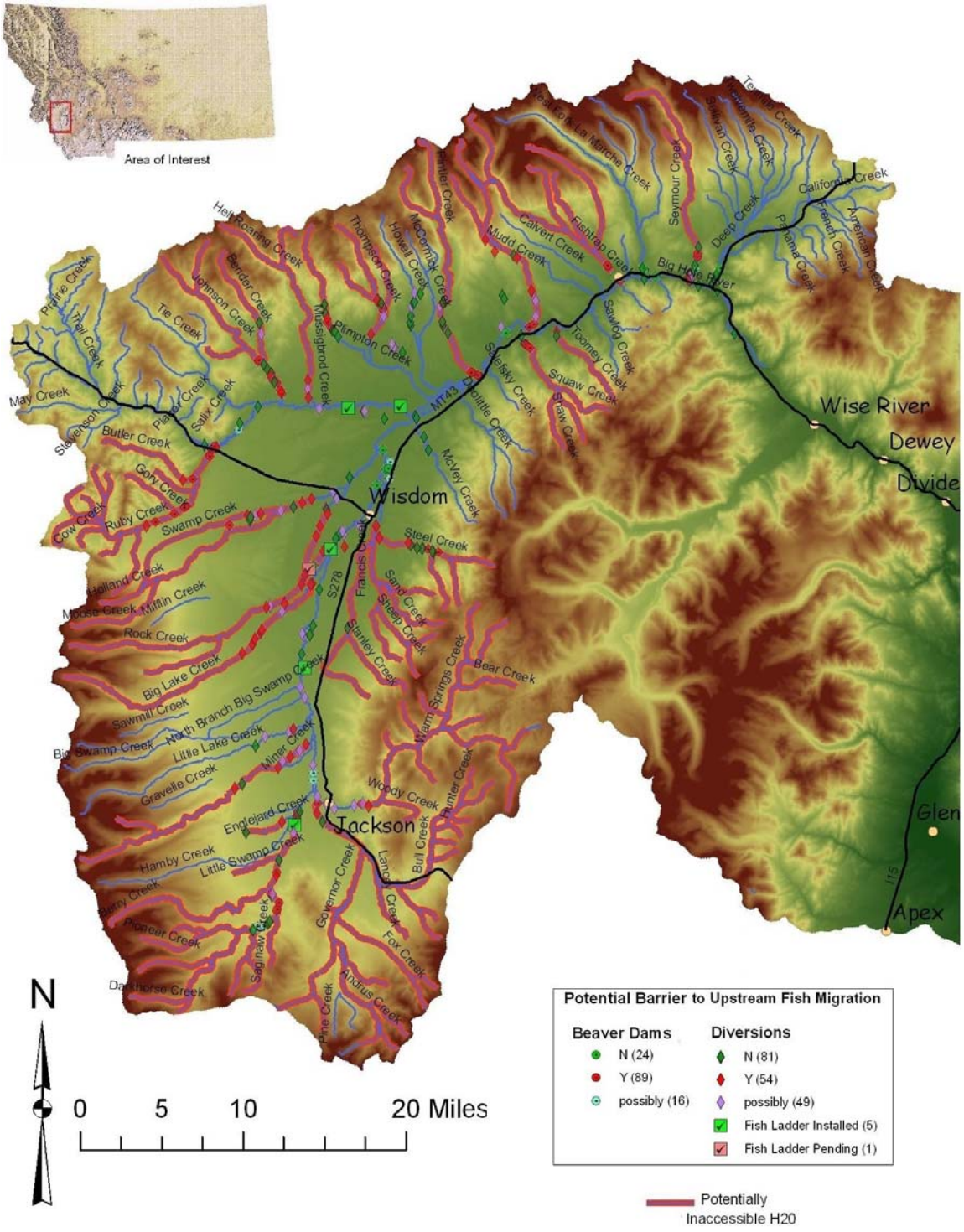
***Culverts as potential barriers to grayling migration***

Culverts are considered barriers to fish when: (1) a disconnect or vertical drop exists between the culvert outlet and stream, or (2) streamflow velocity through the culvert exceeds that of the fishes' ability to swim upstream (Gibson et. al, 2005). Although we did not measure streamflow velocity through culverts, cylindrical culverts under roadways were considered barriers to fish migration because culvert structures under roadways have been shown to be velocity barriers to salmonid migration (Gibson et. al, 2005). Open bottom and bottomless arch culverts are not considered barriers to fish migration in most circumstances (Gosse et. al, 1998) and were therefore not considered barriers during surveys.

We documented 55 culverts in the Big Hole River drainage, most of which (N=51) were not considered barriers to fish migration because of their construction (e.g. Figure 3a), however, four culverts were considered potential barriers (e.g Figure 3b).

**3a**  **3b** 

**Figure 3a**. A bottomless arch culvert on a Big Hole River tributary that is likely not a barrier to upstream migrating fish. and **Figure 3b**. A double cylindrical culvert on a tributary reach of the Big Hole that may act as a velocity barrier to upstream migrating fish during periods of increased streamflow.




**Map 3**. Locations of potential barriers (beaver dams and irrigation diversions) to fish migration in the upper Big Hole River watershed.

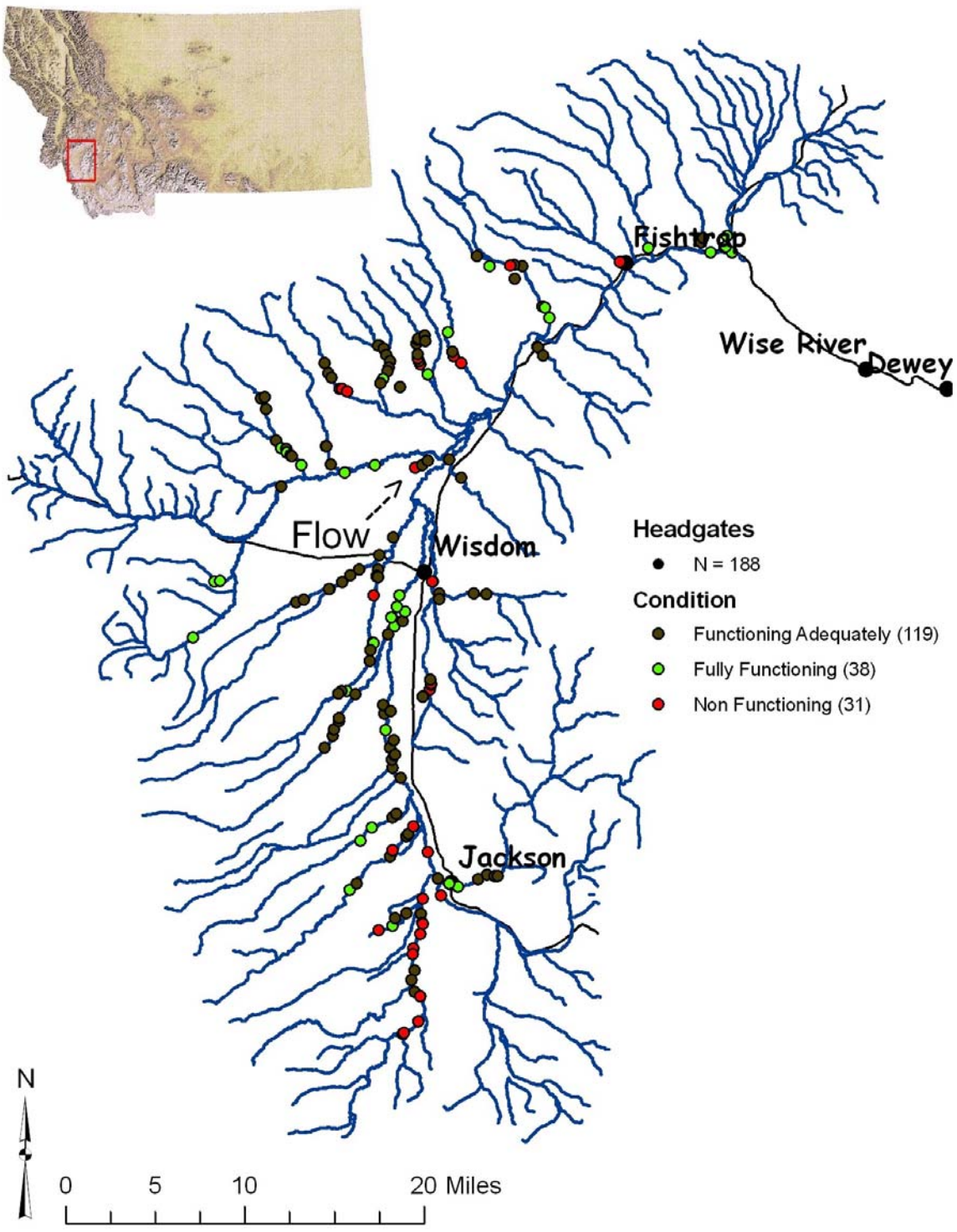
## *3) Irrigation water regulation structures (Headgates)*

Of the 181 headgates mapped (Map 4, *see page 15*), 37 were considered 'fully functioning', in regards to their ability to regulate water withdrawals from the river (e.g. Figure 4a). Most fully functioning headgates appeared to be newly constructed and/or had the ability to prevent water from entering a ditch when closed. The majority of headgates (N=113) were considered to be 'functioning adequately' in regards to their ability to regulate water withdrawals. Headgates categorized as 'functioning adequately' appeared to have a reduced ability to regulate water withdrawals and prevent the input of water into ditches when closed, relative to 'fully functioning' headgates. Some headgates (N=31) appeared to have limited control of irrigation withdrawals and/or their condition was deteriorating (e.g. Figure 4b). These headgates were considered 'non-functioning' in regards to their inability to regulate irrigation water withdrawals and prevent water from entering ditches when closed.

**4a**


**4b**

**Figures 4a**. A functioning headgate that has the ability to control water withdrawals, and **4b.** A non-functioning headgate with limited ability to prevent water from entering an irrigation ditch when closed.




**Map 4**. Locations of surveyed headgates and their condition in the upper Big Hole River watershed.

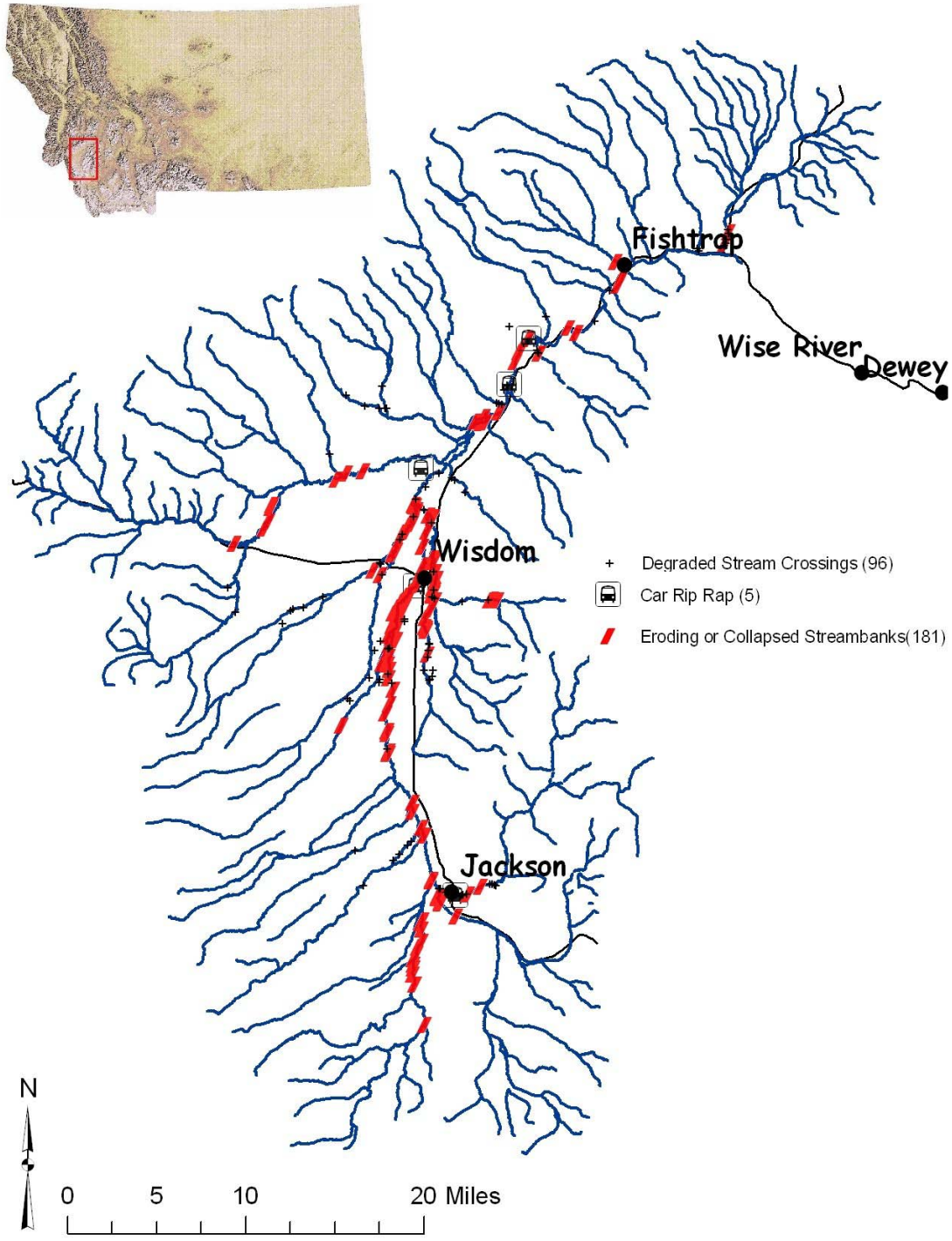
## *4) Riparian and stream habitat condition*

Stream reaches with degraded habitat conditions (N=181) were documented on both the main stem of the Big Hole River and its tributaries (Map 5, *see page 17*). Degraded riparian reaches could generally be characterized as having eroding and unstable streambanks and few willows in the riparian zone (e.g. Figure 5a).

We also documented degraded riparian areas that were used as stream crossings (N=96) by wildlife, livestock, or vehicles (Map 5). Degraded stream crossings could generally be characterized as slow-moving, shallow reaches of stream with high width-to-depth ratios and eroding streambanks that lacked vegetative cover (e.g. Figure 5b).

**5a**  **5b** 

**Figures 5a**. Degraded stream and riparian habitat along the Big Hole River, and **5b**. A degreded stream crossing along the Big Hole River exhibiting eroding streambanks, high width-to-depth ratios, and a lack of vegetative cover along the streambank .




**Map 5**. Stream reaches with degraded riparian habitat, locations of degraded stream crossings, and areas with automobile rip-rap along the Big Hole River and tributaries.

## *5) Miscellaneous findings: Debris and automobile rip-rap*

Four excavation piles containing loose gravel and fine sediment were located along the Big Hole River and its tributaries (e.g. Figure 6a). Excavation piles were likely debris left from the construction of irrigation diversions, ditches, or headgates. Excavation piles were documented during surveys because during precipitation and high runoff events, these debris can act as a point source for fine sediments.

Several areas (N=5) with automobile rip-rap (e.g. Figure 6b) were also documented along streambanks (Map 5), none of which appeared to be installed recently.

**6a**


**6b**


**Figures 6a**. A gravel pile along the Big Hole River that may act as a potential point source for sediment, and **6b**. automobile rip-rap along the Big Hole River.

## *6) Livestock confinement areas in riparian zones*

Ten livestock confinement areas of varying sizes were documented adjacent to river reaches in the upper Big Hole River watershed. We defined 'livestock confinement areas' as places where livestock were fenced, little to no vegetative cover was present, and a reach of river flowed through or adjacent to the fenced area. The term 'livestock confinement area' was used because we lacked the information necessary to define them as feedlots and/or confined animal feeding operations (e.g. 100 animal units corralled for 45 days and sustained solely by means other than grazing (Tyson, 2000)). Of the ten livestock confinement areas, most were located on braids or side channels of tributaries.

## Discussion

The intent of the rapid assessment surveys was to identify and remove immediate threats to Arctic grayling and to identify potential issues of 'take' should grayling be listed under the Endangered Species Act. Although no immediate threats to grayling were documented, a multitude of other potential threats exist that may negatively impact grayling survival in the Big Hole River. Potential threats and potential impacts are discussed below.

### *Potential barriers to grayling migration*

When culverts, beaver dams, and/or irrigation diversions act as barriers to grayling migration, productive habitat may become inaccessible. Adult and juvenile grayling need to move freely up and downstream to access suitable spawning sites, rearing areas, thermal refuges, feeding grounds, and overwintering habitats. Preventing access to seasonally important habitats may have a seriously negative impact on Arctic grayling in the Big Hole River. Grayling in the Big Hole River have been known to migrate in excess of 50 miles, as they move between spawning, feeding, and wintering areas within the watershed (Shepard and Oswald 1989, Lamothe and Magee, 2003). As such, grayling need access to all habitat types (i.e. spawning, rearing, summer feeding, and overwintering habitat) during all life stages, and interruptions to these patterns may be detrimental to their survival.

We identified barriers that could prevent seasonal access to many tributaries in the watershed. However, the suitability of this potentially unavailable habitat for grayling is unclear. Some of the tributary reaches that are potentially unavailable are either high gradient, seasonally dewatered, or lack suitable high quality habitat for grayling. In some circumstances, however, maintaining a permanent connection through barrier removal/modification may benefit grayling by allowing access to historically important tributary reaches with intact or rehabilitated riparian/stream habitat.

Although many potential barriers were identified on tributary reaches, the permanence and persistence of these structures is also questionable. Many potential barriers identified in the Big Hole River watershed are not likely persistent, or long-term barriers to migration because of changes in streamflow and/or management scenarios. However, some barriers may prevent migratory activity during certain seasons or during certain years, thereby potentially negatively affecting localized populations.

The condition of irrigation diversions as potential barriers to grayling migration may change with season, stream flows, and management scenarios. For example, the management of irrigation withdrawal structures will determine if a structure is a potential barrier. A channel wide pin-and-plank diversion structure will not act as a barrier if boards are not in place. However, if left in place during grayling migration periods, boards left in a pin-and-plank diversion structure may function as a barrier. Several of the major irrigation diversions that were likely barriers have been retrofitted with a denil-

style fish ladder to allow fish passage. Efforts to install more fish ladders on channel wide, pin-and-plank structures, or to modify diversion structures to allow for fish passage are ongoing, and will be accomplished on a site-specific basis through efforts associated with the CCAA program.

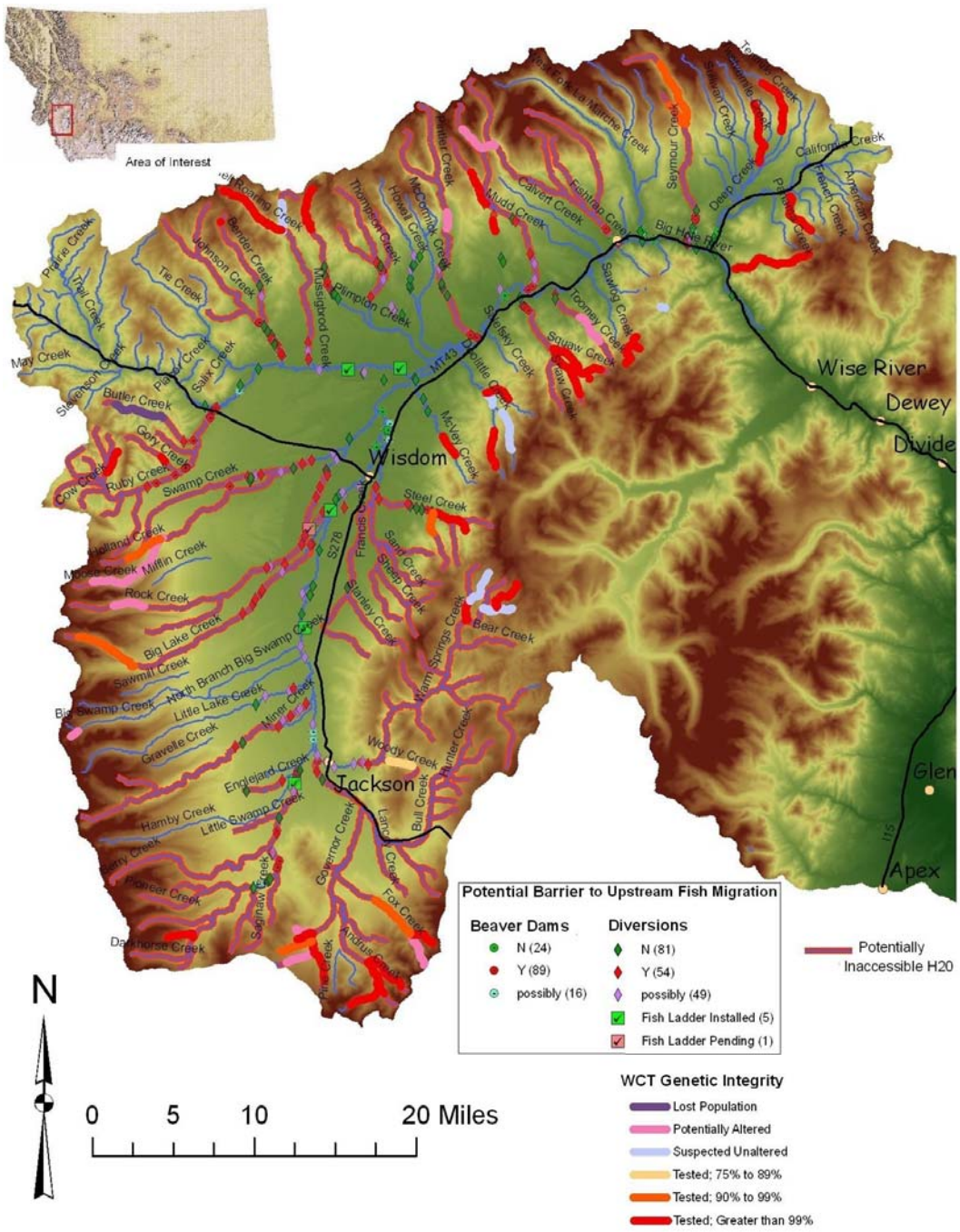
In areas where beaver (*Castor canadensis*) have access to healthy riparian habitats characterized by vigorous willow communities (*Salix spp*.), beaver can become established and build dams that impede the upstream movement of salmonids (Avery, 1992), and alter the hydrology, channel geomorphology, biogeochemistry, and productivity of a stream ecosystem (Naiman et al., 1988). The potential for beaver dams to act as barriers to grayling migration may also change with seasonal grayling migration patterns, and stream flows, much the same as irrigation diversions. During high flow events, for example, a beaver dam on a tributary reach may be compromised, allowing fish passage. That same beaver dam may function as a fish barrier several months later, however, when flows are reduced and/or the dam is repaired.

Beaver dam removal in the Big Hole River watershed is considered on a case-by-case basis, with higher priority given to the removal of beaver dams that prevent grayling from moving into high quality seasonal habitats. Efforts to manage beaver and remove barriers to grayling migration have been ongoing over the past several years and will continue into the future. Several beaver dam complexes in lower reaches of important tributaries, such as Steel Creek and Fishtrap Creek, may impede grayling migration. MFWP and the landowners are actively managing these beaver dams to allow fish passage.

Other barriers, such as culverts, were noted during rapid assessments. Culverts may act as a velocity barrier during high-flow events (Warren and Pardew, 1998) and can also act as a physical barrier to grayling when plugged with debris or vertically offset from the river channel (Gibson et. al, 2005). Although streamflow velocities through a culvert will vary with season and by culvert design (Gibson, et. al, 2005), the upstream movement of grayling through culverts has been shown to be a function of culvert length, stream temperature, life history stage, and fork length (MacPhee and Watts, 1976). To allow salmonid passage, bottomless culverts are preferred over cylindrical culverts (Gosse et. al, 1998). Although most culverts documented during assessments were considered benign in regards to blocking upstream grayling passage, four road crossings with culverts could be modified to improve fish passage and allow access to potential grayling habitat. Further information on streamflow velocities through these particular culverts will be needed prior to their potential replacement. MFWP will work with landowners to address the modification or removal of culverts on a case-by-case basis through efforts associated with the CCAA.

## *Considerations for barrier removal*

Although some barriers may prevent the upstream movement of Arctic grayling, not all barriers should be considered negative features in the Big Hole River basin. Barriers can function as important management tools for protecting populations of native fishes from encroaching nonnative species (Thompson and Rahel, 1998). Genetically pure westslope cutthroat trout populations exist in the headwater reaches of some tributaries in the Big Hole (Map 6). The upstream movement of rainbow trout into these tributaries may negatively impact westslope cutthroat trout populations through hybridization and a subsequent loss of genetic diversity. Preventing nonnative trout from ascending those river reaches where pure populations of westslope cutthroat trout exist is therefore of prime concern when considering barrier removal in the Big Hole River watershed. The removal of barriers to fish migration will be considered on case-by-case basis, with higher priority given to the removal of barriers that may open the most amount of high quality grayling habitat while at the same time ensuring that rainbow trout and other nonnatives are blocked farther upstream by artificial and/or natural barriers.




**Map 6.** Condition of westslope cutthroat trout genetic integrity in Big Hole River tributaries (courtesy of US Forest Service) and the location of potential barriers to fish migration.

## *Irrigation withdrawal structures (headgates)*

In conjunction with irrigation diversions, headgates provide irrigators the ability to regulate water withdrawals from the river and/or prevent water from entering irrigation ditches when closed. Over time, the condition of headgates may deteriorate, at which point the irrigator's ability to regulate water withdrawals and prevent the inflow of water into irrigation ditches is reduced. We identified approximately 31 headgates on enrolled lands that could be improved, replaced and/or upgraded to improve the control of irrigation water withdrawals. Upgrading and/or replacing these headgates may give irrigators improved ability to regulate and improve instream flows.

## *Degraded stream and riparian habitat*

Habitat degredation and habitat loss is considered partially responsible for grayling declines in the Big Hole River (Kaya, 1992; Lamothe and Magee, 2003). Big Hole River grayling presence and abundance is closely correlated with physical habitat parameters such as overhead vegetation, high quality pools, and a lack of streambank erosion (Lamothe and Magee, 2003). We noted a lack of suitable rearing and adult grayling habitat, such as deep pools with overhead cover throughout the mainstem Big Hole River and its tributaries. Reaches with suitable habitat also appear fragmented. These data are consistent with data from a 1994 habitat inventory conducted by OEA Inc. that showed a lack of diverse, high quality stream habitat in reaches of the upper Big Hole River (Lamothe and Magee, 2003). Many of the degraded reaches documented during rapid assessments were considered homogoneous, shallow, slow-moving runs with unstable streambanks that had little to no overhead cover. Increasing streambank stability, the amount of overhead cover, and the number of high quality pools through both passive and active restoration techniques is expected increase grayling abundance in the affected reaches of the upper Big Hole River watershed.

Drought conditions in southwest Montana have likely exacerbated the problem of stream habitat oversimplification and degredation in the Big Hole River. In years with normal peak streamflows, the river is able to move sediment that has been deposited in slow moving pools. However, in drought years with low peak flows, sediment cannot be displaced from pools, so pools continue to fill with sediment. The end result is a dynamic wherein high quality, diverse stream habitat continually degrades as drought persists. If drought persists, restoration and improvement of degraded riparian habitat, and ultimately, degraded stream habitat, will likely be accomplished through both passive and active restoration techniques such as pool excavation, willow planting, and the creation of well-managed riparian pastures. MFWP will work with landowners who have enrolled in the CCAA program to develop site-specific conservation plans aimed at improving riparian and stream habitat conditions in the Big Hole River watershed. The water conservation measures identified in the CCAA are anticipated to offset the cumulative effects of drought on habitat oversimplification and are expected to restore seasonal channel maintenance flows that can flush sediments, thereby increasing habitat quality and diversity.

## *Miscellaneous debris and rip-rap along riverbanks*

Of the four sediment piles mapped along the river, two of the bigger gravel/sediment piles were removed with permission from the landowner. High sediment loads negatively impact fish and macroinvertebrate communities (Bruton, 1985; Waters, 1995; Newcombe and Jensen, 1996), reduce water clarity, and make surface waters less attractive for recreation. Removing these sediment piles from streambanks will likely prevent fine sediments from flowing into the river during runoff events and filling in high quality pools utilized by grayling.

Automobile rip-rap may act as a point source for heavy metals and hydrocarbons. However, given the age of most automobile rip-rap in the Big Hole River, it is likely that fuels, oils, hydrocarbons, and other fluids have washed away. Automobile rip-rap may still threaten water quality by contributing heavy metals to waterways, however. The Big Hole River was listed as an impaired waterway for heavy metals, including copper and lead, from Pintlar Creek to Divide Creek in the 2002 US Environmental Protection Agency's List of Impaired waterways (USEPA, 2005). Cadmium, copper, lead, and zinc are also listed as impairments in the Big Hole River downstream of Divide Creek to the Jefferson River (USEPA, 2005). Heavy metals are also listed as impairing some tributary reaches of the Big Hole River (USEPA, 2005). Removing automobile rip-rap may lead to reductions in heavy metal contaminations, however, more water quality data are needed to justify this claim.

Prior to the removal of automobile rip-rap, the potential benefits and cost of removing and replacing the rip-rap should be considered. Automobile rip-rap was historically placed along riparian areas to protect streambanks from eroding near bridges, houses, and other important structures. Removing automobile rip-rap may require that a substitutive rip-rap or some form of streambank stabilization be used to further protect streambanks from eroding. These efforts may be costly, although they may provide some benefits to the watershed by improving water quality and the attractiveness of riparian areas to recreation.

## *Livestock confinement areas*

We documented ten livestock confinement areas on enrolled lands. However, other confinement areas are also known to exist on unenrolled lands. Some livestock confinement areas may no longer be in use because many ranchers have switched from utilizing creek water to using stock water wells when cattle are penned or corralled during winter and/or calving periods.

Although many livestock confinement areas may no longer be actively used, it is likely that inactive livestock confinement areas impair water quality in the Big Hole River to a certain degree because livestock confinement areas (confined animal feeding operations and feedlots) are recognized as a point source for fecal coliform and nutrients (USEPA, 1999). The extent of water quality impairment caused by livestock confinement areas is unclear, however, because little water quality data exist regarding fecal coliform and

nutrient impairments in the Big Hole River watershed (Table 2, Appendix). The Big Hole River is listed as an impaired waterway for thermal modifications and flow and habitat alterations above Pintlar Creek to the Jefferson River (USEPA, 2005). Livestock confinement areas may contribute to this impairment, and removing them would likely improve stream habitat, riparian health, and water quality in the Big Hole River.

## Summary and Conclusions

The goal of the rapid assessment surveys was to identify immediate threats and potential take issues associated with Arctic grayling on approximately 215,000 acres of non-federal lands enrolled in the Candidate Conservation Agreement with Assurances program for the Big Hole River in southwest Montana. No immediate threats to Arctic grayling in the Big Hole River watershed were documented on CCAA enrolled lands. As such, it is likely that a multitude of other factors in concert with Montana's persistent drought conditions, are responsible for reductions in grayling abundance over the past ten years. Montana Fish, Wildlife, and Parks and cooperating agencies are working with private landowners who have enrolled in the CCAA to develop a site-specific conservation plan that will address issues identified in the rapid assessment phase.

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# Appendix

**Table 1**. Description of waypoints collected during rapid assessment surveys of CCAA enrolled lands.

| Area | **Approx # River Miles Assessed** | **Eroding / collapsed streambanks** | **Degraded stream crossings** | **Car rip-rap** | **Livestock confinemtn area** | **Potential Barriers to fish migration** | | | | | | | | **Headgates** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Irrigation Diversions | | | Beaver Dams | | | Culverts | | | | |
| | | | | | | Likely | Possibly | Not likely | Likely | Possibly | Not likely | Likely | Not likely | Fully Functioning | Functioning Adequately | Non functioning |
| **CCAA segment A** | 23 | 8 | 0 | 0 | 0 | 2 | 3 | 11 | 15 | 6 | 3 | 1 | 5 | 1 | 7 | 10 |
| **CCAA segment B** | 24 | 56 | 18 | 1 | 0 | 7 | 12 | 1 | 2 | 2 | 0 | 0 | 5 | 5 | 11 | 4 |
| **CCAA segment C** | 61 | 93 | 33 | 1 | 2 | 28 | 13 | 17 | 3 | 0 | 1 | 2 | 12 | 11 | 40 | 6 |
| **CCAA segment D** | 104 | 11 | 34 | 3 | 6 | 16 | 20 | 40 | 45 | 6 | 9 | 1 | 27 | 15 | 51 | 10 |
| **CCAA segment E** | 17 | 14 | 11 | 0 | 2 | 1 | 1 | 12 | 24 | 2 | 11 | 0 | 6 | 6 | 2 | 1 |
| **CCAA Project Area** | 230 | 181 | 96 | 5 | 10 | 54 | 49 | 81 | 89 | 16 | 24 | 4 | 55 | 38 | 119 | 31 |

**Table 2.** List of impaired waterways in the project area and sources of impairment, as listed by the US Environmental Protection Agency (USEPA, 2005).

| ***Waterbody Name*** | ***Source of Impairment*** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***Flow Alteration*** | ***Thermal Alteration*** | ***Fish Habitat Modification*** | ***Riparian Habitat*** | ***Copper*** | ***Lead*** | ***Other Habitat Modication*** | *Cadmium* | ***Zinc*** | ***Arsenic*** | ***Sediment / Siltation*** | ***Suspended Solides*** | ***Nutrients*** |
| ***Big Hole River*** *(Upstream of Pintlar Creek)* | X | X | | | | | X | | | | | | |
| ***Big Hole River*** *(Pintlar Creek to Divide Creek)* | X | X | X | X | X | X | X | | | | | | |
| ***Big Hole River*** *(Divide Creek to Jefferson River)* | X | X | X | | X | X | X | X | X | | | | |
| ***Governor creek*** | X | | X | X | X | | X | | | | | | |
| ***Warm Springs Creek*** | X | | | | | | | | | | | | |
| *Rock Creek* | X | | X | X | | | X | | | | X | | X |
| ***Steel Creek*** | X | | X | X | X | | X | X | | | | | X |
| ***Swamp Creek*** | X | | | | | | | | | | | | |
| ***Pintlar Creek*** | X | X | X | | | | X | | | | | | |
| ***North Fork of the Big Hole River*** | X | | | | | | | | | | | | |
| ***Trail Creek*** | | | X | | | | X | | | | X | | |
| ***Tie Creek*** *(trib of N. Fork)* | | | | | X | | | | | | X | | |
| ***Ruby Creek*** | X | | X | X | | | X | | | | X | | |
| ***Johnson Creek*** *(trib of N. Fork)* | X | | X | X | X | X | X | | | | | | |
| ***Mussigbrod Creek*** *(trib of N. Fork)* | X | | X | X | | X | X | | | | | | |
| ***Doolittle Creek*** | X | | X | | | | X | | | | X | X | |
| ***Deep Creek*** | X | | | | | | X | | | | X | | |
| ***Corral Creek*** *(trib of Deep Cr)* | | | | | | | X | | | | X | | |
| ***Sevenmile Creek*** *(trib of Deep Cr)* | | | | | | | X | | | | X | | |
| ***Oregon Creek*** *(trib of Deep Cr)* | | | X | X | X | X | X | | | X | X | | |
| ***Sixmile Creek*** | | | | | | | X | | | | X | | |
| ***French Creek*** *(trib of Deep Cr)* | | | | | | | | | | X | | | |
| *California Creek* | X | | X | X | | | X | | | X | X | | |