Lower Deer Creek Barrier Assessment

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Executive Summary

Lower Deer Creek, a tributary of the Yellowstone River downstream of Big Timber, Montana, supports a genetically pure population of Yellowstone cutthroat trout. Recent genetic investigations indicate hybridization with rainbow trout has begun in the lower reaches, presenting an immediate threat to the pure population, and urgent need to intervene to prevent the spread of rainbow trout and hybridized fish. Yellowstone cutthroat trout have declined substantially in both abundance and distribution throughout their range, especially in the lower portion of the Yellowstone River drainage. Legal challenges seeking protection of Yellowstone cutthroat trout under the Endangered Species Act are pending. Loss of the Lower Deer Creek population through hybridization could be used to support the plaintiff's claims by suggesting existing mechanisms are insufficient to protect native fish

Construction of a barrier to prevent invasion of rainbow trout or their hybrids is essential to maintaining the genetic integrity of the cutthroat population in Lower Deer Creek. Barriers are small dams that allow fish to move downstream, but preclude upstream movement. Although barriers prevent infusion of Yellowstone cutthroat trout genes from below, the threat of hybridization outweighs this concern.

Montana Fish, Wildlife & Parks, in collaboration with the US Forest Service, conducted a thorough survey to identify potential barrier sites on Lower Deer Creek. Efforts included analysis of aerial imagery, a helicopter reconnaissance flight, and on-the-ground evaluations of potential sites. Evaluation criteria for potential sites included presence of lateral confinement between bedrock walls, the ability to mobilize and operate heavy equipment at the site, the amount of habitat protected by the barrier placement, and costs associated with materials, transport, and labor.

Of the three sites identified, one emerged as the obvious candidate, if permission to access the site could be obtained. The other two sites are located upstream of the preferred site on US Forest Service land. Both non-preferred sites possessed the lateral confinement required to construct a stable structure; however, other features presented distinct disadvantages. Notably, the length of stream protected upstream of the non-preferred sites is likely insufficient to result in a population that would persist over the long term. Population size correlates with habitat size, and the available habitat protected by non-preferred barriers would not provide a large enough population to prevent inbreeding. Moreover, the relatively small population would be more susceptible to extinction following disturbance such as fire or disease. Accessibility was another key factors reducing their suitability. Each would require either helicopter assistance or multiple trips on ATV to transport equipment and materials.

Limited access increases project costs given the expenses associated with leasing aircraft, and the extended construction period related to mobilizing equipment and materials. Costs at the middle barrier site would be the greatest, as barrier construction would obliterate a trail providing access through US Forest Service lands. To mitigate for the loss of public access, a significant length of trail would need to be constructed and

rerouted through very difficult terrain to bypass the barrier site. The fish barrier project would have to absorb those costs. Moreover, this option would delay construction by several years, as trail obliteration would require considerable review and public comment periods. Delay would increase the risk to the population by allowing invasion of rainbow trout and their hybrids to continue.

The lowermost and preferred site occurs on School Trust Lands managed by the Department of Natural Resources Conservation. Barrier construction at this site would protect considerably more stream length than the other two, giving the Yellowstone cutthroat trout population a substantially better chance of long-term persistence. Likewise, site layout is ideal for barrier construction, mobilization of equipment, including the use of a concrete truck, which would present considerable savings compared to the other two sites. Its only drawback is that it is only accessible over a private road, and permission has not been obtained to access the land by this route. Rectifying this constraint would be in the benefit of Yellowstone cutthroat trout and the public given the biological and economic advantages of barrier placement at this site.

1.0 Introduction

The Yellowstone cutthroat trout (YCT, *Oncorhynchus clarki bouvieri*) is one of the members of the trout family native to Montana, and a species of special concern. Currently, YCT occupy less than 45% of their historic habitat range wide, and only about 24% of their historic stream miles within Montana (May et al. 2007). The Shields River watershed and upper Yellowstone River hydrologic unit, which extends from the Montana border to Bridger Creek, are the strongholds for YCT in Montana, with 63% and 50% of historic habitat still occupied respectively (Figure 1-1). Downstream of these drainages, YCT become increasingly rare, occupying less than 5% of their historic habitat. Securing the remaining, disjunct populations of YCT is a critical component of YCT conservation (FWP 2000, FWP 2007)

Introduced species are among the causes of the decline of native cutthroat trout, including YCT. The major threat to YCT persistence is hybridization with non-native rainbow trout (Kruse and Hubert 2000). Unlike brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontanalis*) that spawn in the fall, the spring spawning times of rainbow trout (*O. mykiss*) and YCT overlap, resulting in fertile, hybridized offspring. While brown or brook trout may take generations to displace native cutthroat through predation and competition, the invasion of rainbow trout is much more dire because of the immediate and irreversible genetic effects of hybridization.

The disjunct populations of YCT remaining in the lower Yellowstone River watershed are particularly vulnerable to extirpation, or local extinction. Among the conservation measures used in the protection of the populations is construction of barriers that prevent invasion of non-native fishes. Although this approach has tradeoffs in terms of restricting gene flow into secured habitats, the immediacy of the threats from hybridization, combined with the longer term impacts of predation and competition, often justify these actions as one component of conserving the population (Hilderbrand and Kershner 2000).

Reductions in the distribution and abundance of YCT have prompted conservation groups to petition the US Fish and Wildlife Service to include the species on the endangered species list. Although the service has found the petitions to be unwarranted, the groups filed a 60-day notice of intent to sue, meaning legal challenges are pending. Completion of conservation projects aimed at protecting YCT will figure largely in legal decisions, and will reduce the likelihood of including YCT on the endangered species list. Essentially, conservation actions involving collaboration among agencies and private landowners indicate existing mechanisms to protect the fish are sufficient and working, making protection under the Endangered Species Act unnecessary.

Montana Fish, Wildlife & Parks (FWP) has identified Lower Deer Creek as stream where barrier construction is warranted to protect a remnant, genetically pure population of YCT. Rainbow trout have begun to invade the drainage, presenting an urgent need to intervene. The objective of this document is to evaluate locations that may be suitable for barrier construction, and evaluate their suitability for protecting pure YCT in the Lower Deer Creek drainage.

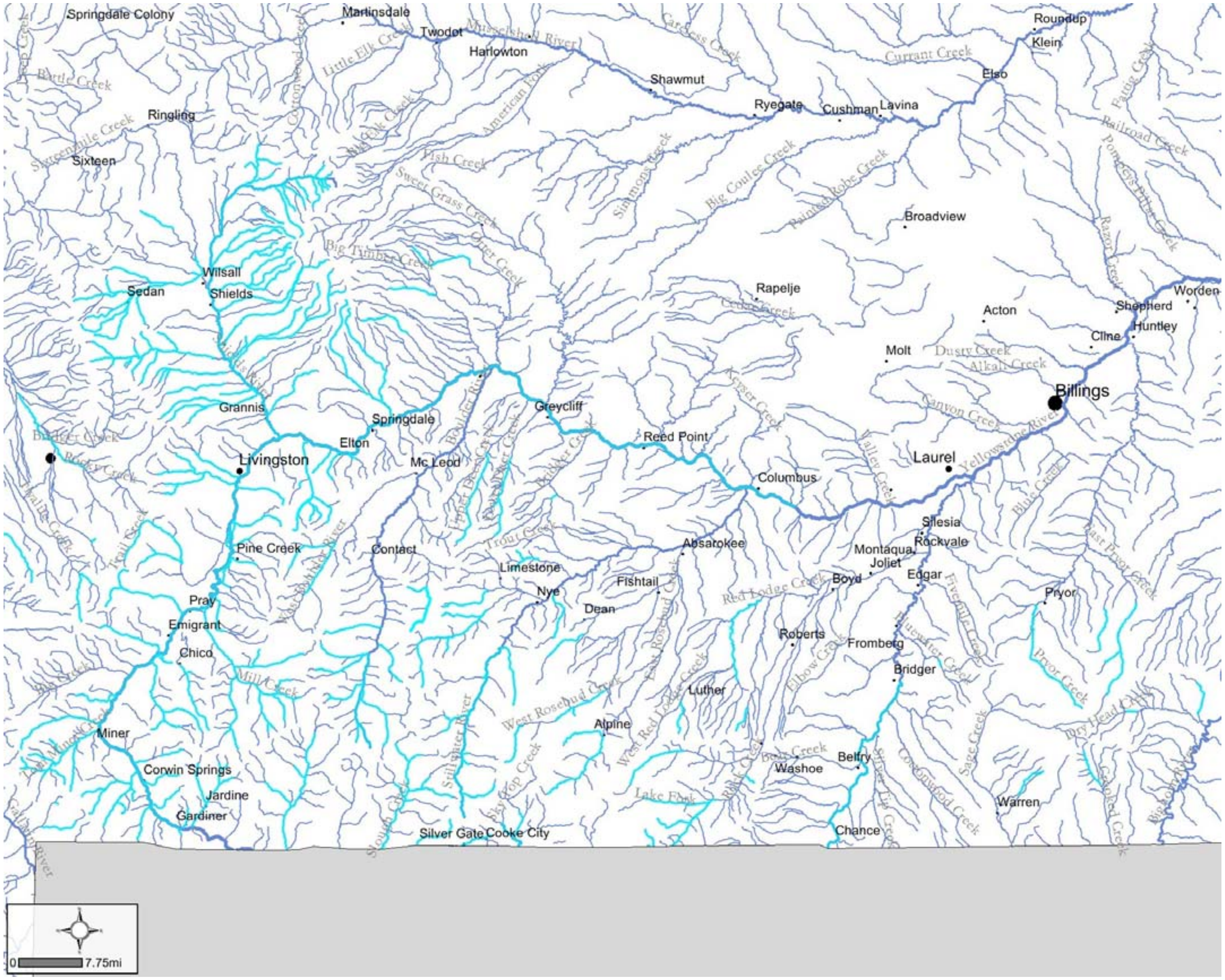

Figure 1-1: Map of the Yellowstone River watershed in Montana showing current distribution of YCT. Streams in aqua support YCT.

2.0 Fisheries Background

Lower Deer Creek is tributary to the Yellowstone River located in Sweet Grass County. It originates on the Gallatin National Forest south of Big Timber, and flows north to the Yellowstone River (Figure 2-1). Lower Deer Creek harbors one of only a few remaining native YCT populations in the lower Yellowstone River basin, along with a sympatric population of brown trout. Unlike most other remaining populations, YCT in Lower Deer Creek have coexisted with brown trout for at least the last 60 years. The relatively long-term persistence of YCT along with brown trout is atypical, as the non-native fish usually displace the native fish through competition, predation, or both within few decades. The YCT in Lower Deer Creek have a very high conservation value because the fish are native, unhybridized, and have proven to be resilient in the presence of non-native brown trout.

Fisheries investigations by FWP biologists describe abundance and longitudinal distribution of YCT and brown trout in Lower Deer Creek (Olsen 2007). The YCT population in Lower Deer Creek extends from near the mouth of the creek, which is dry during most of the year, to the falls shown on Figure 2-1. Although rare near the mouth, the YCT proportion increased farther upstream. Approximately 4 miles downstream of the forest boundary the mix of browns trout to YCT is 5:1 and the mix of trout on the Gallatin National Forest near the Lower Deer Creek Cabin is approximately 2:1. The density of trout in the creek ranges between 787 and 1319 brown trout per mile and between 99 and 399 YCT per mile. The trout density decreases substantially upstream of the West Fork of Lower Deer Creek, because the gradient of the stream increases, while the frequency of quality pools decreases.

Until recently, the population of cutthroat trout in Lower Deer Creek was unhybridized; however, new genetic information indicates that Yellowstone cutthroat trout in the lower reaches of the creek (approximately 3 miles downstream of the forest boundary) have been hybridized with rainbow trout (Leary 2006). When additional fish were tested from farther upstream on the National Forest, there was no evidence of hybridization (Leary 2007). Nonetheless, the absence of migration barriers between downstream areas means rainbow trout or hybridized fish from the lower reaches of the creek will eventually colonize the upper creek. As unhybridized populations become hybridized by rainbow trout, they lose their conservation value. Losing more populations through hybridization, competition and predation with non-native fish, will increase the probability that YCT will become listed under the Endangered Species Act.

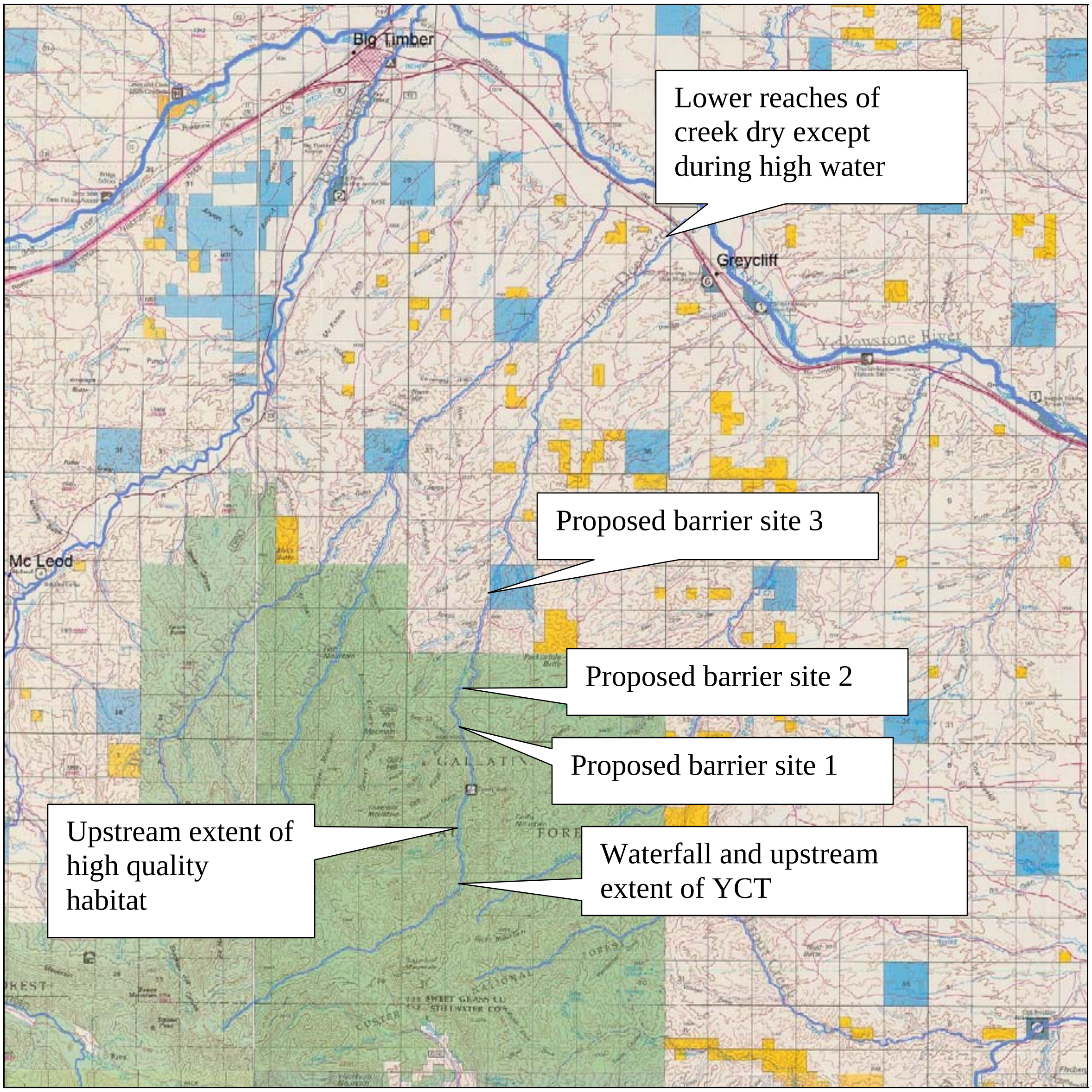

Figure 2-1: Location of Lower Deer Creek, potential barrier sites, and other features.

3.0 Barrier Site Selection Rationale

Selection of an appropriate site for barrier placement requires consideration of a number of factors. A fish migration barrier is essentially a small dam that creates a vertical drop between 5 and 6 feet. Fish from downstream cannot ascend the barrier, although fish can move downstream over the barrier. Site suitability involves a variety of geologic, biological, and logistical considerations.

Several geologic features increase the efficacy of such a barrier at precluding upstream fish migration. Bedrock control of the stream channel is a primary requirement. Sites fortified by bedrock prevent the stream from migrating around the structure in high water. The second feature is stream gradient. High gradient lessens the backwater effect downstream of the dam that can occur during high water. The backwater effect occurs when flows are great enough to cause the stream to leave its banks. As it does this, the depth of the water downstream of the dam increases, lessening the jump distance for a fish to clear the dam. The higher the gradient of the stream the less backwater effect is present at the barrier structure. In other words, relatively high gradient maintains the impassibility of the barrier at higher flows.

Consideration of a number of fisheries concerns is essential in identifying appropriate barrier locations. Long-term persistence of fish populations is directly related to population size, and population size is often directly related to the length of stream occupied by the fish (Hilderbrand and Kershner 2000). In other words, the larger the population is, and the more miles of habitat it occupies, the less likely it will be to go extinct over time. Smaller populations are more vulnerable to inbreeding and random events, such as fire, drought, and disease. Further, migration barriers may also isolate important habitats such as spawning areas from fish that are either upstream or downstream of the barrier. The possibility of excluding fish from important habitat is reduced by maximizing the amount of habitat located upstream of the barrier.

The importance of large population size has become evident in Lower Deer Creek following recent wildfires. Ash and sediment washed into the stream in 2006-2007 from the Derby Fire caused complete mortality of age-0 brown and cutthroat trout in the lower reaches of the stream (Olsen 2007). Fortunately, heavy precipitation did not follow the intense burn in 2006; however, had substantial rain or snow fallen on the burned area immediately following the fire, it could have resulted in the complete elimination of fish in the drainage. This occurred in Crooked Creek of the Pryor Mountains in 2002, where over 1/2 of a native YCT population was lost, and only a remnant population of 200 individuals survived in 1.5 miles of the unburned headwaters (USDI BLM 2007). Similarly, in 1991, the West Fork of Lower Deer Creek burned and was followed by a heavy rain (Poore 1994). Subsequent electrofishing in 1992 suggested fish population levels were severely depleted near the Lower Deer Creek cabin on the Gallatin National Forest (Poore 1995). However, because the large amount of habitat occupied by the fish, and the interconnectedness of the main creek with small fish bearing tributaries, the fishery quickly recovered.

A final critical factor influencing barrier location in the Lower Deer Creek drainage is accessibility. To construct a barrier, the site must be accessible to heavy equipment. An excavator large enough to move and or lift boulders is necessary to prepare the site for the pouring of concrete. Accessibility for a concrete truck is also helpful, because large amounts of concrete can be delivered at one time resulting in accelerated construction time. If a particular site is not accessible to equipment, it does not preclude the construction of a fish barrier; however, the price of the project greatly increases because equipment has to be either flown into a site or transported by other means.

4.0 Methods

Evaluations of potential barrier sites involved several components. First, review of aerial photos allowed preliminary identification of potential sites based on apparent bedrock confinement. Next, a helicopter flight of the entire stream permitted closer examination of sites found through aerial imagery and identification of other potential sites. FWP and USFS fisheries biologists visited each site to evaluate suitability based on bedrock confinement, local gradient, and accessibility. Finally, a USFS fisheries biologist, who is also a heavy equipment operator, examined the logistics associated with mobilizing and using equipment at each site.

Application of a model developed to predict extinction risks of isolated cutthroat trout populations (Peterson et al. in press) provided a quantitative means to compare conservation benefits of potential barrier sites. The Bayesian belief network model (BBN) was developed for the closely related westslope cutthroat trout. Westslope cutthroat trout are also native to Montana, and face the same risks of extirpation under isolation and presence of non-native fishes. The model output is a probability of the persistence of cutthroat trout after 20 years given the length of stream afforded by each potential barrier location. Although the model is not calibrated to YCT, its provisional use here is meaningful in assessing barrier site suitability.

A stream length guideline developed by Hildebrand and Kershner (2000) is another approach in determining whether stream length is sufficient. This study predicted the long-term persistence of isolated cutthroat trout and the feasibility of erecting barriers to prevent invasion of non-native salmonids. The results indicated a minimum of 5 miles of stream was required to maintain a viable fishery. Therefore, barrier placement protecting less than 5 miles of habitat has an unacceptable risk of failure to perpetuate a population.

The final assessment in determination of the most suitable location was a decision-making matrix, which ranked each site according to key site characteristics. These features were the amount of habitat secured for YCT, accessibility for equipment and materials, and potential costs associated with materials and transport.

A major consideration in costs relates to the need for helicopter to transport personnel, materials, and equipment. Preliminary quotes from Billings Helicopter for medium and heavy helicopters indicate helicopter costs would greatly increase overall project costs compared to road access (Table 4-1). A heavy helicopter would be required to move the excavator and other heavy equipment, although a medium helicopter would be sufficient for other needs. Nonetheless, considering a 3-week construction period, these expenditures may double to quadruple costs.

Table 4-1: Hourly rates for helicopters need to transport materials and equipment to remote sites.

Aircraft	*Transport Capacity (pounds)*	*Hourly Rate*
Medium (Huey)	4,000	$2,000
Heavy	11,000	$4,000

5.0 Results and Discussion

Aerial and on-the-ground evaluations identified three potential locations for a fish barrier (Figure 2-1). Each site had bedrock walls on either side of the creek and acceptable gradient. Site 1 is located approximately 100 yards downstream of the confluence of Placer Gulch (Figure 5-1) and had the best hydrological features for a barrier. It has the highest gradient and bedrock walls constrain the stream to the greatest extent of all potential sites. The narrowness of the stream would mean a smaller structure could be constructed to preclude fish passage, which decreases materials costs.

Figure 5-1: Barrier site 1 located 100 yards downstream of the confluence with Placer Gulch.

A significant drawback to site 1 is that it limits the miles of stream habitat upstream of the barrier to only 3 stream miles. This length is substantially less than the 5-mile minimum stream length proposed by Hilderbrand and Kershner (2000). The BBN model gives a 54% chance of persistence of this location, which is considerably lower than the other two potential sites, and reduces the likelihood that the resident Yellowstone cutthroat trout population would persist. The chances of another fire, flood, disease or other factor eliminating the population dramatically increases, because of the reduced number of fish upstream of the barrier, and the inability of fish from downstream to recolonize the upper reaches.

Another shortcoming of site 1 relates to its limited accessibility. Notably, according to the heavy equipment operator, excavator access to site 1 is most likely infeasible. Although it may be possible to walk a mini-excavator down the Placer Gulch trail, crossing Lower Deer Creek with the excavator is problematic. Water depths are too high to cross with a mini-excavator at most locations. Although suitable locations may exist, the risk of damage to the excavator is substantial. This consideration effectively eliminates site 1 as a potential site.

Table 5-1: Results of the BBN model (Peterson et al. in press) predicting persistence of cutthroat trout above each barrier.

Barrier	***Miles Protected***	***Probability of Persistence***	***Relative Increase Between adjacent Scenarios***	***Relative Increase Between Scenarios 1 and 3***
1	3	0.54		
2	4	0.75	0.21	
3	6.5	0.87	0.16	0.33

The ability to transport materials (concrete, rebar, etc.) would also be difficult and expensive. Ideally, the site would be accessible by a concrete truck; however, vehicle access to the stream at this location is most feasible from the Placer Gulch four-wheeler trail, which will not accommodate a large truck. Access to the site from areas downstream would be very difficult, because of narrow areas of the trail around Site 2 (Figure 5-2). Because of limited access, all equipment and materials would have to be transported to the site by ATVs on the four-wheeler trail or by helicopter. (A large meadow suitable to land a helicopter is present approximately 0.25 miles upstream of site, so helicopter transportation of materials would be possible, although expensive.) Even if mobilization of the mini-excavator was feasible here, site features make transporting equipment and supplies necessary to construct the barrier down the Placer Gulch trail expensive and time consuming.

The second site is located 0.6 miles downstream of the Placer Gulch site. At this location, bedrock walls confine the stream on both sides, although the stream width is approximately 1.5 times of site 1, which increases materials costs compared to site 1 (Figure 5-2). The stream is lower gradient than site 1, which would result in more water being impounded upstream of the dam, making its hydrological features slightly less suitable than site 1. Nonetheless, this gradient is still within the acceptable range for barrier site suitability.

Figure 5-2: Barrier site 2 approximately 0.6 mi downstream of Site 1.

Similar to site 1, the relatively small extent of habitat protected substantially reduces its suitability. According to the BBN model, the YCT would have a 75% chance of persisting, which is 12% less than site 3 (Table 5-1). Likewise, this site would protect only four miles of habitat, which is less than the minimum stream length of 5 miles recommended by Hildebrand and Kershner (2000).

Limited accessibility for heavy equipment is a major drawback. An access trail near the confluence of Tomato Can Gulch and Lower Deer Creek is steep, and would be difficult to traverse with equipment. The US Forest Service designates this as a foot trail to be used by hikers or horses. Moreover, unlike site 1, site 2 lacks helicopter access (Figure 5-2). All materials would need to be transported by ATV down the Placer Gulch Trail, which would be time consuming, and therefore, expensive.

A substantial drawback of installing a barrier at this site is that it will completely block the trail going downstream from Placer Gulch, as the trail goes down the creek bed. Given the steepness of the canyon at this location, there is no feasible location to relocate the trail immediately around the barrier site; therefore, the trail would have to be closed going downstream. The USFS will not allow closing a public access trail, unless a suitable reroute is available. Preliminary evaluations (Scot Shuler, USFS, personal communication) indicate the trail reroute would require construction of considerable length of new trail and the fish barrier project would be responsible for trail construction costs, which may reach $100,000.

Programmatic issues are also a significant factor with trail relocation. Under federal law, the project would require preparation of an environmental assessment (EA) or environmental impact statement (EIS), along with a mandatory public comment period.

This component will increase project costs by an estimated $17,000 (Scot Shuler, USFS personal communication), and will delay project implementation by several years. Increased project costs decreases site suitability. Likewise, delays in project implementation place the remaining YCT population at greater risk of hybridization.

Site 3 is located on school trust land managed by the DNRC (Figure 1-1). Bedrock constrains the stream on both sides, but is about twice the width of site 1 (Figure 5-3). Because of the greater width, a larger structure would need to be constructed to completely block fish passage, which increases materials costs. The gradient in the reach is slightly less than the other sites, but still within an acceptable range.

Figure 5-3: Barrier site 3.

A primary advantage to this site is the amount of stream habitat upstream of the barrier. A barrier at site 3 would protect 6.5 miles of stream, which is twice the habitat above site 1 and 1.6 times the habitat above site 2. Moreover, this length of habitat is greater than the 5-mile minimum stream length proposed by Hildebrand and Kershner (2000). According to the BBN model, the probability of persistence over 20 years is also greater than the other sites, resulting in a 12% increase in the probability the population would persist (Table 5-1). Compared to the other sites, barrier placement here would result in a biologically significant increase in habitat under protection, and would result in a much larger fish population, which would increase the probability of its long-term persistence.

Although physically accessible by heavy equipment, the adjacent landownership may present an obstacle to selecting this site. The site is accessible through a maintained road leading to the Holman home site; however, this is a private road and would require permission to access the School Trust Land. If permission were obtained, a large excavator could be transported to within 0.25 mi of the site and walked up the valley to the site with little difficulty. Furthermore, a concrete truck could be backed up to the edge of the canyon (Figure 5-4) and concrete could be slurried or pumped to the barrier site. These factors present substantial advantages in terms of time and expense of transporting equipment and materials.

Figure 5-4: Aerial photo of site 3 showing location where concrete truck could pump concrete to the stream below.

Material costs for site 3 will be greater than sites 1 and 2 owing to the greater stream width at this site. Nonetheless, the considerably lower transportation costs, if access to the road is granted, more than offsets increases in purchasing concrete and other materials. In comparison, the need for helicopters or requirements to reroute the road on sites 1 and 2 would substantially increase project costs.

Rough cost estimates for barrier construction at each site are informative. For sites 1 and 2, greater transport costs, increased construction period relating to size of excavator possible and transport logistics, would greatly increase costs compared to site 3.

Construction costs would likely be between $150,000 and $300,000 for sites 1, and over $400,000 for site 2 given trail construction and NEPA related costs. In contrast, a barrier at site 3 would cost between $75,000 and $125,000. This presents a considerable savings for taxpayers, as public funds, in the form of grants, will likely pay for most of the project.

Examination of the relative advantages of the three barrier sites indicates site 3 is the obvious choice if permission to access the site over a private road is granted (Table 5-2). Site 3 ranked first in all three categories affecting suitability. Site 1 ranked third owing to the short amount of stream protected and poor accessibility. Furthermore, the inability to mobilize an excavator at this site is potentially insurmountable. Site 2 would support a slightly longer length of stream, but is still below the minimum prescribed stream length of 5 miles. Moreover, a barrier at site 2 would be the most expensive given construction logistics and the requirement to construct trail to mitigate for obliteration of the existing trail.

Table 5-2: Ranking of potential barriers sites based on key factors affecting suitability (1 = best, 3 = worst).

Site	*Amount of Habitat Protected*	*Accessibility*	*Cost*	*Total*
1	3	3	2	8
2	2	2	3	7
3	1	1	1	3

6.0 Summary

Three potential barrier sites are present on Lower Deer Creek, which would provide a refuge for pure YCT, a species that is increasingly rare in the Yellowstone River watershed downstream of Livingston. Conservation projects of this type are an essential tool in the conservation of native fishes. The outcomes of this project will be a secured population of YCT and reduced justification for listing the fish under the Endangered Species Act.

The lowermost site emerged as the best candidate based on all three measures of suitability; however, the accessibility rating is contingent on receiving permission to gain access to the site over the private road. Site accessibility, the amount of habitat protected, and costs were less suitable at the other two sites. Moreover, mobilizing an excavator at the uppermost site is likely infeasible, which presents a significant obstacle to barrier placement.

Although a barrier will address the immediate need of protecting the resident YCT from hybridization, brown trout will remain as long-term threat to the population’s persistence. Once a barrier is established in the drainage, an effort to remove brown trout from the stream upstream of the barrier would likely follow. Removing brown trout would increase the abundance of YCT in the basin’s waters and decrease risks of extinction associated with competition and predation. This would create a unique fishery in the creek where brown, cutthroat, and hybridized rainbow-cutthroat could exist downstream of the barrier site, and unhybridized cutthroat would remain upstream of the barrier. The YCT in the creek would continue to provide angling opportunities and opportunities to harvest fish downstream of the barrier. Protecting the Lower Deer Creek population of YCT, and expanding its size in the drainage would result in an important step to the overall conservation of the species within its native range.

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