U.S. FOREST SERVICE
NATIONAL STREAM AND AQUATIC ECOLOGY CENTER

November 30, 2016

UPPER MILK CREEK: STREAM CONDITION and RESTORATION POTENTIAL

Client: White River National Forest

Location: Milk Creek, Rio Blanco County, Colorado

Date of Visit: 10/18/2016

On-Site Participants: R. Clay Ramey, Fisheries Biologist, West Zone, White River National Forest
Tom Probert, Hydrologist, White River National Forest
Steven Yochum, Hydrologist, National Stream and Aquatic Ecology Center

Summary: Milk Creek, a tributary to the Yampa River between Meeker and Craig, Colorado, is home to a core conservation population of Colorado River cutthroat trout, a subspecies conserved under an agreement that includes the Forest Service. This population of cutthroat trout is uncommon – genetic testing indicates that the population is 99% pure Colorado River cutthroat trout, with 1% introgression from other subspecies of cutthroat trout. This is a valuable population of native trout, with potentially the highest genetic purity in the Yampa River basin. A primary impairment of Milk Creek that is likely inhibiting population increase is excessive summer stream temperatures on the downstream reaches.

A reach on upper Milk Creek, on the White River National Forest, was visited to assess its general condition and develop restoration strategies, if needed. The primary impairments to this reach include: channel incision from past disturbances; high rates of streambank erosion and meander migration, which have potential for cutting off meanders, decreasing sinuosity, and increasing local channel slope and channel incision; overly-wide channel width in some locations; lack of tree canopy for shading, for reducing solar heating during low flow; and a lack of instream large wood due to firewood removal for hunting camps.

The following alternatives are suggested for consideration for this reach of upper Milk Creek:

Alternative 1: No Action
Alternative 2: Vegetation plantings plus management changes
Alternative 3: Introduction of large instream wood, plus vegetation plantings and management
Alternative 4: Channel restoration in selected areas, plus wood introduction, vegetation plantings and management

Recommendation: Considering that this Colorado River cutthroat trout population is a core conservation population, and the situation of excessive downstream stream temperatures, a high rate of warming within this reach, poor canopy cover, and the direct removal of instream large wood for hunting camps, it is recommended that Alternative 3 be implemented.

Prepared by: **Steven E. Yochum, PhD, PE**
NSAEC Hydrologist
970-295-5285, steveneyochum@fs.fed.us

INTRODUCTION

Milk Creek, a tributary to the Yampa River between Meeker and Craig, Colorado, is home to a *core conservation population* of Colorado River cutthroat trout, a subspecies conserved under an agreement that includes the Forest Service and Colorado Parks and Wildlife (CRCT Conservation Team 2006). This population of cutthroat trout is uncommon – genetic testing indicates that the population is 99% pure Colorado River cutthroat trout (Wright 2007), with 1% introgression from other subspecies of cutthroat trout. This is a valuable population of native trout, with potentially the highest genetic purity in the Yampa River basin. Due to its core conservation population status, special Parks and Wildlife management regulations apply.

The reaches of Milk Creek that host this population of native trout are on the White River National Forest, private inholdings within the National Forest, and on the Milk Creek Ranch, immediately downstream of the Forest Service management boundary (Figure 1). A summary of the upper stream reaches is provided in Yochum (2016).

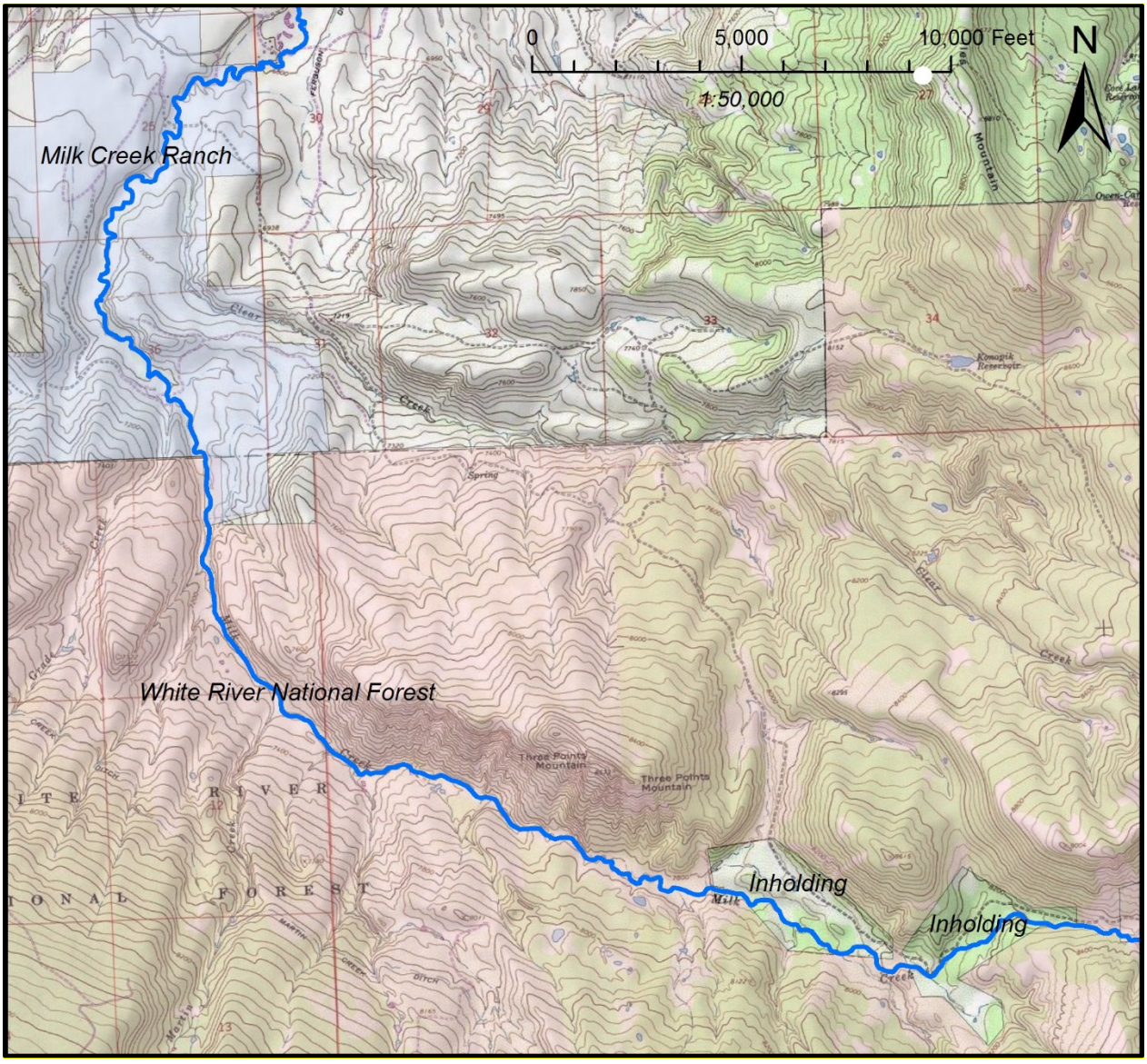

Figure 1: Milk Creek, within the White River National Forest, inholdings on the National Forest, and the Milk Creek Ranch.

Milk Creek near the National Forest boundary and further downstream also contain other native fish species, including speckled dace and mountain sucker.

Excessive summer stream temperatures are likely the primary impairment to Cutthroat trout on the downstream reaches of Milk Creek. To address this issue, substantial effort has been spent on stream restoration on the Milk Creek Ranch, just downstream of the Forest Service management boundary. However, stream temperatures are already warm at the boundary of the National Forest – opportunities for reducing warming within the National Forest and inholdings would benefit and extend the range of this core conservation population as a whole.

After the Yochum (2016) publication was submitted, the inholdings (reaches A & B; Figure 2) were visited by representatives of the U.S. Fish and Wildlife Service (Bob Timberman) and Trout Unlimited (Brian Hodge). Their conclusions (Timberman 2016) were that:

> *While the upper end of Allan's* (Jones reach) *has some rough banks, the vast majority is in nice shape with quality pools, shading, and a narrow low flow channel with a healthy riparian zone throughout the properties. Grazing has been minimal, and it sounds as though it will remain that way for the foreseeable future. From a fishery standpoint, we agree that little could be improved upon. That stated, Allan mentioned how much better it was when beaver were present and prior to the Timber Creek slide. He also alluded to entertaining a beaver reintroduction plan if one was ever proposed, as would I. In short the stream reach is not perfect, but I wouldn't want to bring in heavy equipment there. Nor do I see a need for an overstory planting project.*

To compliment this basic assessment of reaches A and B, this report details the observations and restoration potential of reach C, on the National Forest.

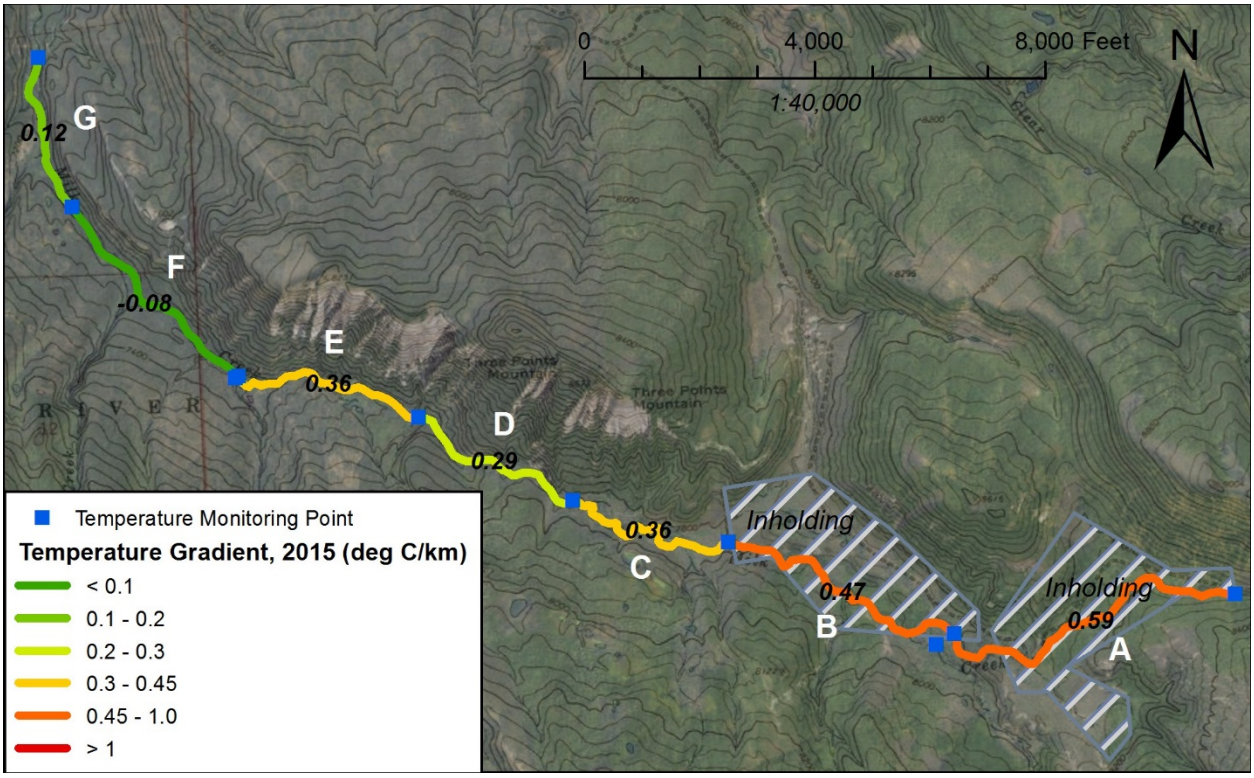

Figure 2: Stream reach designations and average July temperature increase gradients (degrees C per km of stream length) of the primary Colorado River cutthroat trout reaches, on National Forest and inholdings. The flow direction is from right to left.

Figure 3: Reach *C* (10/13/2016). The red ovals highlight hunting camps present at the time of the field visit on 10/18. Image: DigitalGlobe.

REACH C CONDITION

The Milk Creek watershed consists of 21.4 mi^2 (55.4 km^2) at the National Forest boundary, with 6.6 miles (11 km) of mainstem stream length as well as several tributaries available to cutthroat trout as habitat. Average annual precipitation is estimated to vary from 21 to 40 inches on the National Forest (PRISM, Daly et al. 2008). The stream valley varies from relatively wide and lower-gradient meadows to narrow and well-forested canyons. Outcrops of steep shale slopes are present along portions of the north banks of this reach, most prominently below the ridge to the west of Three Points Mountain (Figure 1). These shale layers are likely the primary source of turbidity in Milk Creek.

Reach *C* (Figure 3) is a 3600 ft (1100 m) reach between the inholdings and a shift to a narrower valley form. It is relatively low gradient, with an average channel slope of 0.020 ft/ft. It had a temperature gradient of 0.36 C/km in July of 2015 (Figure 2). This reach is tied for the third-highest rate of July heating in 2015, though lower than the two upstream reaches that are within inholdings (reaches A and B). This lower-gradient riffle-pool channel in located in a relatively wide park-like setting.

This reach is substantially impacted by hunters that set up relatively-elaborate camps during the hunting season. Two camps present at the time of the site visit are highlighted by red ovals (Figure 3). The camp on the left was setup immediately adjacent to Milk Creek, without a buffer.

The stream reach was walked, photographs collected, and condition discussed by the three participating practitioners. Observations are provided in the following sections.

Figure 4: Aerial image detail of upstream portion of reach C (10/13/2016). Note the shadows and limited shading by tree canopy. The red numbered circles indicate streambank erosion locations of possible concern, with the numbers indicating the figures. Flow direction is from right to left.

Shading

Reach C has a very limited amount of tree canopy shading the channel, as is evident in Figure 4. Note the low areal coverage of shade from the existing trees. Alders and willows are generally present along the channel banks and in portions of the active floodplain, though this woody vegetation provides much less effective canopy for channel shading. Cottonwoods have minimal presence along this reach, with only a few relatively-young narrowleaf observed. On the downstream Milk Creek Ranch reach, livestock exclusion is resulting in the development of new cottonwoods stands from the remnant population of mature trees.

Floodplain Connectivity

This stream reach varies in connectivity with its floodplain, with a few remnant portions of the channel directly connected to its historic and wide floodplain surface within a meadow, and numerous other portions of the reach that appear to be incised and disconnected with its former floodplain (Figure 5). These latter subreaches typically still have floodplains, though they are much narrower than the former wet meadow extent.

Figure 5: Incised portion of reach C, with poor connectivity with the former floodplain and meadow.

Streambank Erosion

Relatively-high rates of streambank erosion is occurring along a few portions of reach C. These eroding banks are along both the valley margins (Figure 6) and within more central portions of the valley bottom as downstream meander migration.

The three observed locations where it appears that relatively-high rates of streambank erosion is occurring and could lead to meander cutoffs are illustrated in Figures 7 to 9. The locations are

indicated in Figure 4 by the red circles, with the numbers referring to the figure numbers. Aerial imagery was utilized to measure the average rate of bank erosion at these three sites (1993 compared to 2016). The measured average bank erosion rates are indicated in the figure captions. However, these rates can be greatly exceeded during future large floods.

Figure 6: High **e**roding channel bank along the valley margin.

Figure 7: Active bank erosion and downstream meander migration. A hunting camp is shown in the background. Average erosion rate (1993 to 2016): 1.8 ft/year. The location is indicated in Figure 4.

Figure 8: Active bank erosion and downstream meander migration. Average erosion rate (1993 to 2016): 0.6 ft/year. The location is indicated in Figure 4.

Figure 9: Active bank erosion and downstream meander migration. Average erosion rate (1993 to 2016): 1.8 ft/year. The location is indicated in Figure 4.

Channel Widths

Work performed downstream on Milk Creek, on the Milk Creek Ranch, has indicated that the bankfull channel width in well-vegetated reaches can be as narrow as 22 to 24 feet. Generally, reach C has bankfull channel widths that are not excessive but, in places, the channel is overly wide. This is especially the case towards the downstream limit of reach C (Figure 10). As shown by historic aerial imagery (Figure 11), the current straight form of the downstream limit of reach C is a recent development. It appears that a more complex channel existed in 1993, though the upper portion of this reach was still relatively straight.

Figure 10: Overly-wide portion of reach C.

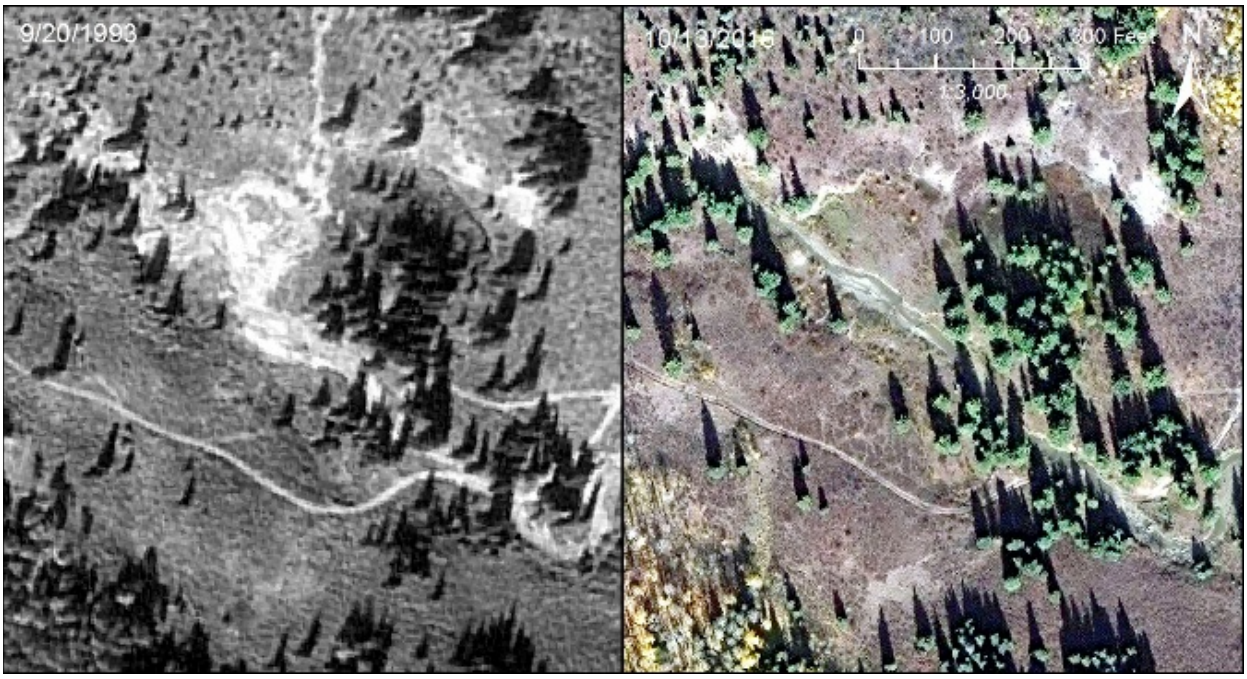

Figure 11: Aerial imagery of the downstream portion of reach C, from 1993 (left) and 2016 (right). This reach has decreased in complexity, with a current straightened form with excessive channel widths.

Riparian Vegetation and Beaver Activity

Alders along the channel banks are common throughout this reach (Figure 12). Willows are also present, with some portions of the reach having dense stands (Figure 13), while other portions having sparse coverage (Figure 12). A few narrowleaf cottonwoods (*Populus angustifolia*) were also observed, though they are young and sparsely present throughout the reach. Weeds were also observed, including houndstongue (*Cynoglossum officinale*) and plumeless thistle (*Carduus acanthoides*).

Beaver activity was observed within this reach, including browsing, burrowing, and the building of small dams. In places, the beaver population may be a bit excessive for the current willow population.

Sheep grazing occurs on this reach, with this livestock appearing to be negatively impacting the riparian vegetation. The willows are being browsed, likely from sheep, deer, and elk. A comprehensive assessment of livestock and game utilization may be advisable.

Figure 12: Low beaver dam and impoundment, with alders along the channel banks and a sparse willow population.

Figure 13: Dense willow stands along the Milk Creek channel, on the upper portion of reach C.

Large Instream Wood

Large instream wood is often observed to be associated with deep pools that are maintained by local flow acceleration around the obstacles. These pools are important trout refugia from high summer temperatures and winter ice. They also serve as cover. Large wood is also associated with increased channel complexity that is considered beneficial to aquatic species.

Large wood is present to an extent within reach C and are contributing to pool development. However, due to the limited tree canopy within this reach (Figure 3), and the limited potential for this stream scale to transport larger wood with rootwads during typical spring snowmelt runoff events, the potential for large wood recruitment is limited. Furthermore, substantial amounts of large wood are being harvested (for firewood) directly from the stream channel (Figure 15) or from dead standing trees that would have likely became instream wood (Figure 16). This disturbance is being caused by hunting camps (Figure 14) that are frequently established at the same locations each season. These relatively-elaborate camps are common on federal public land throughout Colorado during the autumn. Harvesting firewood from and alongside the stream channels is having a substantial impact on large wood presence in the stream, with a likely consequential reduction in pool frequency, extent, and depth, as well as cover and bed material size variability.

Figure 14: Hunting camp along the banks of Milk Creek reach C.

Figure 15: Relatively large (about 18" diameter) instream wood harvested as firewood for nearby hunting camps.

Figure 16: Firewood harvesting for nearby hunting camps.

CONDITION AND RESTORATION POTENTIAL SUMMARY

Milk Creek just downstream of the inholdings, on the White River National Forest, appears to be in a transitional form that is, generally, recovering from past disturbances. However, current activities and possibility legacy from historic impacts are still contributing to deficient conditions that may be negatively impacting this core conservation population of Colorado River cutthroat trout (Figure 17).

Figure 17: Colorado River cutthroat trout (photo courtesy of the Bureau of Land Management).

Currently, the channel is predominantly incised between 1 to 3 feet and is frequently disconnected from its former floodplain, which was likely a wet meadow. This incision is due to past disturbances or the loss of beaver dam building activities, and is considered an impairment. The incised channel during annual high flows has, in consequence, higher shear stress ($\omega = \gamma hS$, due to deeper flow depths [h]), higher unit stream power ($\omega = \gamma QS/w$, due to substantially narrowed floodplain widths [w]), and increased sediment conveyance capacity. However, while this condition is considered impaired, mechanical restoration through reconnection of the channel with its former floodplain is not recommended for consideration due to the reasonable extent of existing riparian vegetation, large amount of needed borrow material, difficult access for heavy machinery, and the existing population of cutthroat trout present within this reach. Instead, beaver dam building activities throughout this reach could be encouraged, which can reestablish channel-floodplain connectivity while also providing deep pools for cutthroat refugia from summer heat and winter ice.

Background information and guidance for the incorporation of beavers into stream restoration projects include:

- Pollock et al. 2015 The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains
- Macfarlane et al. 2014 The Utah Beaver Restoration Assessment Tool: A Decision Support and Planning Tool
- Cheap & Cheerful Stream Restoration – With Beaver Webinar on techniques and research surrounding partnering with beaver in restoration design, from Utah State University (Joe Wheaton and Jeremy Christensen)
- Cramer 2012 Washington State Stream Habitat Restoration Guidelines
- Burchsted et al. 1010 The River Discontinuum: Applying Beaver Modifications to Baseline Conditions for Restoration of Forested Headwaters

Generally, the high, eroding banks along the valley margins (Figure 6) are not a concern other than with respect to their fine sediment contribution to the channel and potential impacts to cutthroat trout spawning. However, three locations where faster than typical lateral and downstream meander migration is occurring (Figures 7 to 9) may have repercussions to the channel form by cutting off meanders, decreasing sinuosity, and increasing local channel slope. This increased slope leads to higher stream power and shear stress, and can lead to additional incision and loss of floodplain connectivity, lowering of groundwater table levels, and associated loss of riparian vegetation extent. This can in turn lead to impairment to beaver communities that can eventually reverse the incision that has already occurred. Generally, the rates of erosion are not of imminent concern, but they are steadily progressing, and the erosion rate during a large flood could be dramatically higher. Action is warranted to reduce the erosion rate and prevent meander cutoffs.

Reach C generally has reasonable bankfull channel widths and frequently has relatively-narrow low flow channels, though overly-wide conditions are prevalent towards the downstream limit and, in places, the low flow channel is overly wide. An overly-wide low flow channel results in excessive solar heating during critical

post-snowmelt summer periods. The noted downstream reach (Figure 11), which has been simplified over the last 23 years, could be a candidate for engineered manipulation. However, mobilization of heavy machinery to this reach could be challenging. An alternative to consider is the introduction of large wood, with attached rootwads, to increase complexity within this subreach.

The lack of consistent shading of the channel within by spruce and cottonwoods (Figure 4) is considered a fundamental impairment. The lack of canopy and shade directly impacts stream temperature through solar radiation increasing water temperature, leading to higher rates of temperature increase in the downstream direction (Figure 2). Restoration action to dramatically increase the population of canopy-providing trees is likely warranted. Management changes and direct restoration may likely be needed for vegetation along this reach. A comprehensive assessment of vegetative condition and livestock and game utilization may be advisable, to have greater understanding of status and trends. Tom Probert has recommended the following as options: White River Stream Monitoring Protocol; a greenline assessment (Winward 2000); or the National Riparian Vegetation Monitoring Core Protocol.

Large wood is present to an extent within reach C and are contributing to pool development. However, the recruitment potential within this reach is limited and wood is being actively removed for firewood collection by hunting camps. These campers are untraditional with respect to other Forest users since they set up sites for weeks at a time, have high demand for firewood due to multiple burning needs (wood stoves and fire pits), and have chainsaws and axes for harvesting larger wood sizes. Direct harvesting of wood from stream channels needs to be curtailed for the sake of the cutthroat trout population. Additionally, the introduction of large wood (with rootwads) should be considered. Windthrow emulations (Figure 18) may be most feasible and effective. It's very feasible for a skidder to negotiate the access road to the site.

Key references for the introduction of large wood include:

- USBR and ERDC 2016 National Large Wood Manual: Assessment, Planning, Design, and Maintenance of Large Wood in Fluvial Ecosystems: Restoring Process, Function, and Structure
- Cramer 2012 Washington State Stream Habitat Restoration Guidelines
- ODF ODFW 2010 Guide to Placement of Wood, Boulders and Gravel for Habitat Restoration
- NRCS 2007, TS14J Use of Large Woody Material for Habitat and Bank Protection

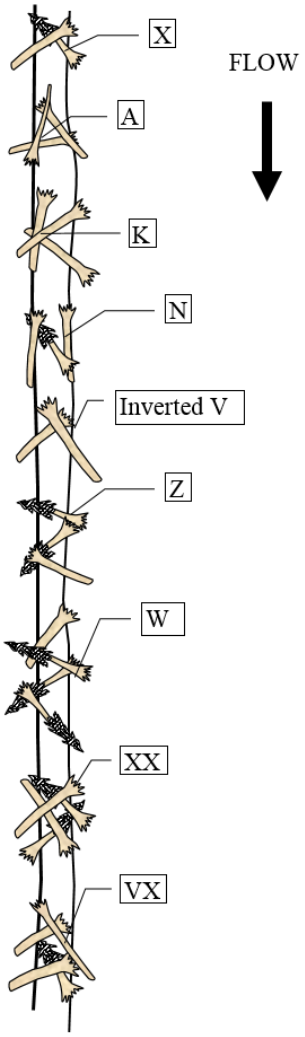

Figure 18: Plan view illustrations of possible windthrow emulations orientations (Graphic from ODF ODFW 2010).

RESTORATION ALTERNATIVES

Four alternatives are proposed for Milk Creek reach C. The alternatives are summarized within each following paragraph.

Alternative 1: No Action

The no action alternative will likely result in continued low levels of shading along reach C, with associated higher rates of temperature increase, as well as continued lower levels of instream large wood due to low recruitment and firewood harvesting from the channel.

Alternative 2: Vegetation plantings plus management changes

An aggressive program of narrowleaf cottonwood plantings could eventually constitute a cottonwood gallery that would provide shade and reduce the rate of temperature increase within this reach. This activity could also counteract the negative impacts of climate change to this core conservation population of cutthroat trout. These plantings would need to be protected from browsing from beaver, sheep, deer, and elk. Additionally, the trout population would likely benefit from an increased beaver population. Assessment of the vegetative condition and livestock and game utilization may likely be needed to develop a plan for increasing willow extent, for increasing the beaver populations. Willow plantings may also be needed in areas. Additional willows along streambanks could narrow the channel at overly-wide locations, reducing solar radiation heating of the stream during low flow.

Alternative 3: Introduction of large instream wood, plus vegetation plantings and management

In addition to the vegetation plantings and management activities of alternative 2, to increase the willow and cottonwood populations, this alternative would harvest local trees (with rootwads) for strategic placement in the channel. This large wood introduction could increase the channel complexity, reduce the rate of meander migration and cutoffs (Figure 4), provide cover, and add to the pool frequency, depth and extent, and increase bed material size variability This alternative would also counteract the negative impacts of firewood harvesting of large wood from the stream channel by hunters for hunting camps.

Alternative 4: Channel restoration in selected areas, plus wood introduction, vegetation plantings and management

This alternative would include actions from alternatives 2 and 3 but would also include the engineered installation of bank stabilization structures to narrow the channel in such locations as the downstream subreach (Figure 11), and to reduce the bank erosion rates associated with meander migration (Figure 4) that will likely lead to meander cutoffs, higher local gradients, and additional channel incision. This alternative would require fairly difficult mobilization of construction equipment and materials.

RECOMMENDED RESTORATION STRATEGY

Due to this Colorado River cutthroat trout population being a core conservation population, and considering the key impairment of excessive summertime stream temperatures, it is recommended that proactive action be taken to reduce solar radiation input and increase habitat quality. Hence, Alternative 3 is recommended.

Alternative 4 is not recommended due to expected substantial effort and cost for mobilizing equipment and materials to the site. Alternative 3 proposes the use of a skidder, which should be able to easily access the site, as well local trees as instream wood material to be installed.

ACKNOWLEDGEMENTS

Appreciation is expressed to David Levinson and Tom Probert for their reviews of this report.

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