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

August 16, 2016

ARMSTRONG CREEK RESTORATION: ASSESSMENT

Client: Routt National Forest

Location: Headwaters of Elkhead Creek in California Park, Colorado

Date of Visit: 7/26/2016

On-Site Participants: Liz Schnackenberg, Hydrologist, Medicine Bow-Routt National Forest
Brian Hodge, Fish Biologist, Trout Unlimited
David Merritt, Riparian Ecologist, National Stream and Aquatic Ecology Center
Steven Yochum, Hydrologist, National Stream and Aquatic Ecology Center

Summary: Stream restoration efforts have been implemented on Armstrong Creek in California Park, on the Routt National Forest. A site visit was performed to observe the conditions of the restoration projects constructed in Armstrong Creek. Specifically, projects that were constructed in 2013 (lower Armstrong Creek) and 2015 (upper Armstrong Creek) were observed.

Generally, lower Armstrong Creek was in good condition, with several fish species observed (speckled dace, sculpin, and mountain sucker) and cutthroat trout abundance reportedly increasing in this restoration reach. The riparian vegetation was dense and well-established. The sedge plugs, sedge mats and willow plantings appear to have been very successful. However, an abundance of what appeared to be smooth brome and Canada thistle was observed.

The upper subreach of upper Armstrong Creek was observed to be generally in good condition. However, the restoration performed on the lower subreach of upper Armstrong Creek is faring more poorly and we are concerned about the potential for recapture of the stream channel through the previously-incised but now ponded areas. With respect to this subreach, the following alternatives are suggested for consideration:

Alternative 1: No Action

Alternative 2: Rebuilding of rock grade control structures and reinforcing of existing berms

Alternative 3: Rebuilding of rock grade control structures, regrading and vegetating the pond areas, and repair of other noted geomorphic adjustments

Recommendations: Spot application of glyphosate is recommended for control of smooth brome and Canada thistle on lower Armstrong Creek. Additionally, we recommend alternative 3 for implementation on upper Armstrong Creek. However, if implementing alternative 3 in 2016 is not possible, we recommend alternative 2 be implemented in 2016.

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

David Merritt, PhD
NSAEC Riparian Ecologist
970-295-5987, dmmerritt@fs.fed.us

INTRODUCTION

Stream restoration projects have been implemented on Armstrong Creek in California Park on the Routt National Forest. California Park and its watershed ranges in elevation from 7800 to 10,879 feet (Meaden Peak). Average annual precipitation within the Park varies from 27 to 29 inches (PRISM, Daly et al., 2008), with the watershed receiving up to an estimated 49 inches. California Park has been designated as a special interest area, due to its geological, historical, scenic, and zoological values (USFS 2016). The Park's watershed has been classified as *Functioning at Risk* within the Forest Service Watershed Condition Framework (Potyondy et al. 2009).

California Park contains a population of Colorado River cutthroat trout, with potentially more than 40 miles of stream extent. Impairments to the cutthroat trout population are thought to be primarily excessive peak summer temperatures (Bidelspach 2011). Historically, brook trout were stocked in the Park, but stocking was reportedly discontinued in about 1996 and brook trout are thought to be no longer present.

Other species reportedly of interest present within California Park include sandhill cranes, sharp-tail grouse, leopard frog, and other native fish (dace, sculpin, and mountain sucker). Additionally, sage grouse habitat is present.

A site visit was performed to observe the conditions of stream restoration projects constructed in Armstrong Creek (drainage area = 3.28 mi^2). Specifically, restoration projects that were constructed in 2013 (lower Armstrong Creek) and 2015 (upper Armstrong Creek) were observed. This report details observations collected during the site visits, and provides alternatives and recommended actions given current conditions.

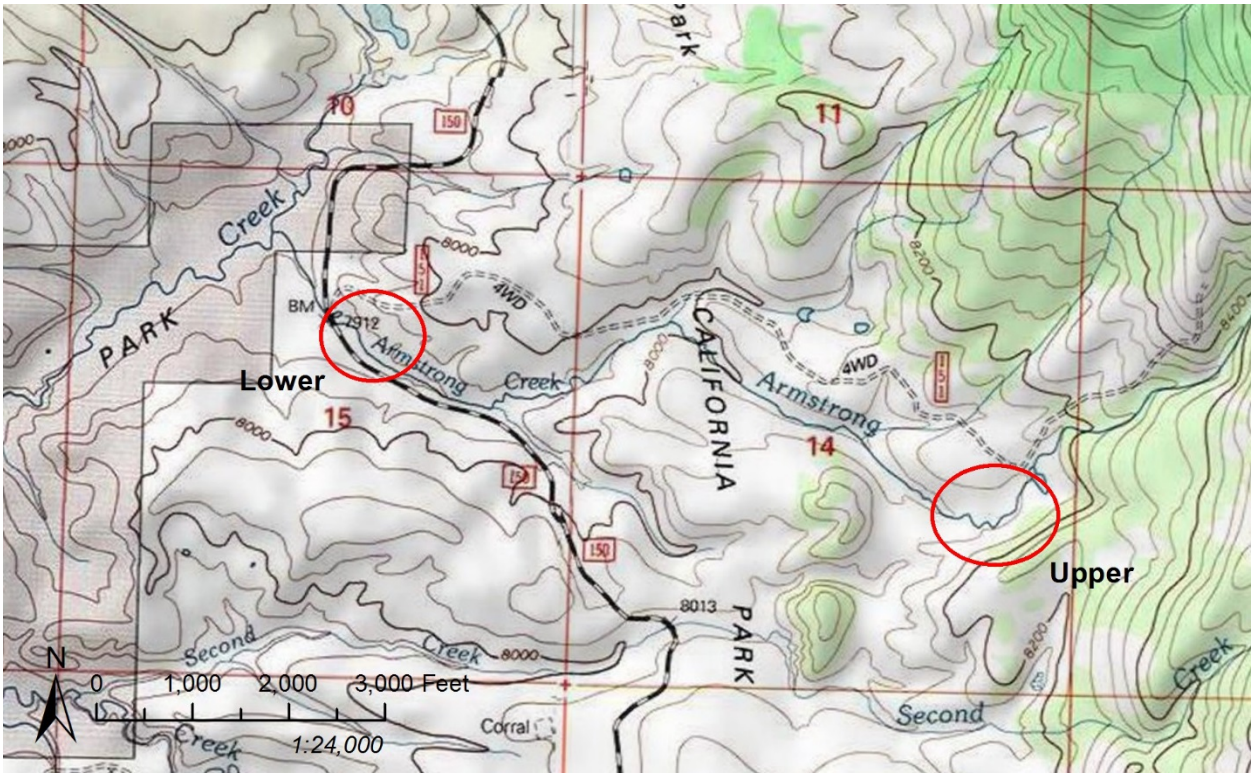

Figure 1: Armstrong Creek, at the lower and upper restoration sites.

CURRENT CONDITIONS

Reaches visited include both lower and upper Armstrong Creek. Generally, lower Armstrong Creek was in good condition. However, substantial impairments were observed within the upper Armstrong Creek restoration reach.

Lower Armstrong Creek

The portion of lower Armstrong Creek inspected during this visit was geomorphically stable (Figure 2, Figure 3), with well-developed riffle-pool bedforms. Portions of this reach were reportedly stabilized in place while another portion was re-channelized to pull the stream back from an eroding terrace. Introduced large wood, with rootwads, were present, as were active beaver dams. Several species of fish were observed including speckled dace, sculpin, and mountain sucker. Cutthroat trout abundance has reportedly increased in this restoration reach since implementation.

The riparian vegetation along this lower reach was dense and well-established along banks and near channel floodplain. The plantings of sedge plugs, sedge mats and willow appeared to have been very successful. There was also an abundance of what appeared to be smooth brome and Canada thistle along the visited reaches of lower Armstrong Creek.

Figure 2: Lower Armstrong Creek channel, with pool and rootwads.

Figure 3: Lower Armstrong Creek channel and riparian zone. Note the dense sedges (*Carex utriculata* and *C. aquatatilis*) and bulrushes (*Scirpus microcarpus*) along the new channel and the natural colonization of bars in the channel.

Upper Armstrong Creek

The upper Armstrong Creek restoration reach consists of three higher-gradient subreaches: an upper reach where the channel was stabilized and aquatic habitat was enhanced in place, a middle reach that was left as is (other than management), and a lower reach that was re-routed, the former gullied channel (Figure 4) partially filled, and a new channel and floodplain reconstructed and planted. An 8-foot high fence was installed in 2015 to exclude all three subreaches from livestock grazing and game browsing.

Figure 4: Gully formed from incision of the now abandoned and filled channel of upper Armstrong Creek (image from PowerPoint presentation provided by Henderson in 2013).

The upper subreach consisted of toe wood, coir soil wraps (Figure 5), and revegetation efforts to narrow the channel, strengthen banks, and decrease solar heating. The toe wood structures were constructed using aspen. A steep portion of this channel (reportedly 4.5%) had a series of rock cross vanes installed (Figure 6) to create drops and spill flow resistance, to dissipate energy. "Rock and roll" structures were also utilized (Figure 7), which were constructed of lodgepole pine. They appeared to be functioning well.

Overall, this upper subreach was generally stable, though erosion along some of the toe wood armored portions of the channel was observed (Figure 8). Considering the structures' reported bank embeddedness, this erosion is not considered a problem to the structural stability and morphological condition of the channel. Some headcutting above the channel, from local drainage, was also observed, which will require monitoring at a minimum and potentially a small amount of earth movement to remedy.

Figure 5: Upper subreach restoration, on upper Armstrong Creek.

Figure 6: Rock cross vanes on upper Armstrong Creek.

Many of the installed sedge mats were observed to have successfully rooted and established. As mentioned, some are being undercut, but may stabilize with time and continued root growth. Some of the sedge plugs had been undermined and uprooted in the channel. This was evident in eroded areas associated with the rock and roll drop structures and the rock cross vanes. Surprisingly, few willow plantings have survived along this reach. Many of the surfaces that were recontoured away from the channel are dominated by weedy non-native plant species such as yellow cress (*Rorippa* spp), timothy (*Phleum pratense*), smooth brome (*Bromus inermis*), Canada thistle (*Cirsium arvense*), and tarweed (*Madia glomerata*).

Figure 7: Rock and roll structures on upper Armstrong Creek.

Figure 8: Undercut coir matting and toe wood armored banks on the upper restored reach of upper Armstrong Creek.

The lower subreach channel and floodplain reconstruction is not faring as well as the upstream portions of upper Armstrong Creek. This subreach restoration consisted of the development of a new channel on an abandoned terrace and the excavation of ponds where the incised channel was located. Gravel and cobble material present within the incised channel were utilized in riffles. The substrate present within this reach is composed of a clay-dominant material that was apparently deposited behind beaver dams that were once present.

A number of problems were observed within this subreach, including:

- The new channel and immediately adjacent floodplain surface appear to be perched above the floodplain and a series of small ponds were established where the incised channel existed prior to construction (Figure 10). Some headcutting of the plugs installed between the ponds, with resulting loss of water holding capability, was observed. This elevation difference may result in recapture of the stream channel.
- The earthen berms separating the new channel from the ponds and location of the previously-incised channel (Figure 9) are narrow and likely too dry for sedge establishment. Willow revegetation efforts were not utilized in these areas. Reportedly, these berms are designed to be overtopped with flows greater than the 5-year return interval.

Figure 9: Earthen berm, with new channel (right) and adjacent ponds and floodplain (left).

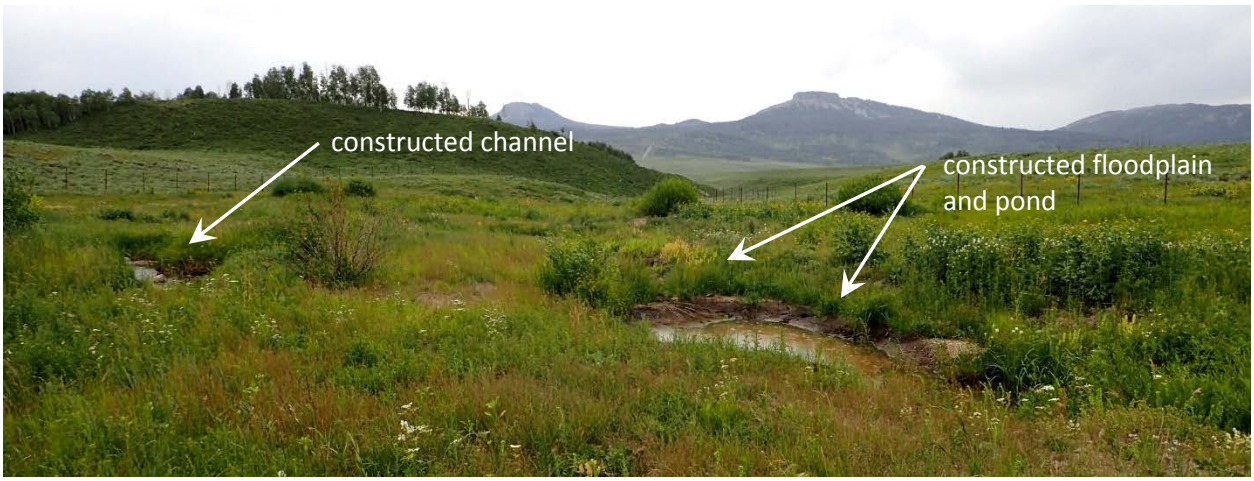

Figure 10: Perched constructed stream channel, with adjacent floodplain and ponds constructed where the incised channel was located prior to restoration.

- The constructed gravel and cobble riffles shifted downstream into the excavated pools (Figure 11). This may be due to lack of embeddedness into the clay-dominated substrate.

Figure 11: Shifted riffle bed material.

- Rock cross vanes installed to prevent incision have partially failed (Figure 12), with adjacent bank loss and piping through the structure. No geotextile material was installed along the upstream face of these structures.

Figure 12: Piping through left arm of cross vane, with adjacent bank failure.

- At least two constructed meander bends have headcuts propagating across the constructed floodplain surface. These floodplains do not have substantial vegetation recruitment or plantings and are susceptible to erosion.

- An active headcut was observed within the channel at the site of a lost riffle (Figure 13). This location is just above the two most downstream cross vanes grade control structures (Figure 12).

Figure 13: Active headcut, at location of lost riffle.

Downstream from the cross vanes, rock and roll structures were installed. These are generally faring well, though at least two were constructed improperly (downstream logs placed parallel, rather than stacked with a footer and header log). Also, some erosion was noted just downstream from some of the structures (Figure 14), though this erosion is likely not endangering the stability of the structures.

Figure 14: Erosion at downstream end of rock and roll structure.

CONDITION SUMMARY

The channel rerouting, vegetation restoration, and overall effort along lower Armstrong Creek appears to have been effective. Banks are stable, vegetation mortality appears to have been low, vegetation is shading the channel, and there are deep pools. The goals and objectives of this project were not made clear, though with an assumption that the goals are similar to the First Creek restoration further south in California Park, specifically to improve stream and riparian health, improve habitat for and expand the range of sensitive species, and increase the resilience and resistance of native fishes and aquatic habitats to the effects of climate change (USFS 2016), then the inspected reach of the lower Armstrong Creek restoration is considered to be generally successful at this point in time.

An issue noted within lower Armstrong Creek is the presence of weeds. It is recommended that control measures be taken to counter the noted smooth brome and Canada thistle. Spot application of glyphosate (Roundup) would likely be an effective means of control. This would enhance the spread of native desirable riparian species. The formation of monospecific stands of Canada thistle should be avoided, as this would be detrimental to native riparian vegetation and the restoration efforts.

Upper Armstrong Creek has had less time for recovery since construction of the restoration project, though mixed results were observed. Generally, the upper reach is faring well, with relatively minor undercutting of coir-wrapped soil lifts and toe wood (Figure 8). This erosion does not appear to be fundamentally destabilizing, and may stabilize over time with root growth.

However, the lowest subreach of upper Armstrong Creek is not faring as well, with some of the adjustments that have occurred during and since this year's spring melt potentially threatening overall stability and leading to general failure. The specific issues of greatest concern are:

- The grading of the valley bottom and constructed channel (Figure 10) is likely not sustainable, with the pond area (where the former incised channel was located) and floodplain being at a lower grade than the channel. Fundamentally, floodplains slope up from a channel and adjacent bankfull surface. When the berms separating the channel from these pond areas are overtopped (>5-year return interval flood), there is high risk of this resulting in channel capture of the new channel by the old. This would result in a straightening, steepening, bypassing of the constructed grade-control structures, headcutting and incision, and the likely reformation of the pre-restoration gully (Figure 15).

Figure 15: Pre-restoration condition of the lower subreaach of upper Armstrong Creek.

- The rock grade control structures that are piping, scouring and being undermined (Figure 12) will likely fail, potentially this coming snowmelt season.
- The observed headcut (Figure 13) will likely continue migrating upstream.
- The shifting of coarse material placed on the clay material from riffles into the downstream pools (Figure 11), as well as a general lack of coarse material that could

serve to armor the fines that the channel is carved into and would provide better habitat for aquatic invertebrates and fish spawning habitat, is problematic and should be addressed.

Additionally, it was noted that surprisingly few willows have survived from the plantings along this reach. Replanting would be advisable, particularly adjacent to grade control structures and the constructed berms (Figure 9).

REMEDIATION ALTERNATIVES

No additional action is warranted on lower Armstrong Creek at this time. However, remediation action on the lowest subreach of upper Armstrong Creek is very likely needed to prevent failure.

The following alternatives are suggested for consideration, primarily of the lowest subreach of upper Armstrong Creek:

Alternative 1: No Action

This alternative would likely result in partial or complete failure of the restoration, potentially as early as the 2017 snowmelt runoff season.

Alternative 2: Rebuilding of rock grade control structures and reinforcing of existing berms

The chinking approach for preventing piping through the rock grade control structures has not worked, resulting in piping and partial failures. Reconstruction of these cross vanes with geotextile fabric along the upstream edge should be more successful for preventing piping.

The existing berms (Figure 9) could be partially reinforced through aggressive vegetative plantings (such as willow clumps). Raising the elevation of these berms to greater than the 5-year return interval flood should also be considered.

Alternative 3: Rebuilding of rock grade control structures, regrading and vegetating the pond areas, and repair of other noted geomorphic adjustments

As with alternative 2, reconstruction of the cross vanes with geotextile fabric along the upstream edge should be more successful for preventing piping. Additionally, borrow material from a nearby source would be used to fill and regrade the pond areas (Figure 10) so that an increasing floodplain slope away from the channel results. This area would be then revegetated with sedges and willows, to provide long-term stability and ecological value. Additionally, with the mobilization of heavy machinery to the site, patching and revegetating other ongoing geomorphic adjustments should be performed, including the headcuts propagating across the floodplain surfaces, lost riffle bed material (Figure 11), resulting headcutting (Figure 13), and local erosion occurring downstream from the rock and roll structures (Figure 14) and the upstream coir and toe wood structures (Figure 8).

RECOMMENDED STRATEGY

The restoration performed on the lower subreach of upper Armstrong Creek fared poorly during the 2016 snowmelt runoff period. Additionally, we are concerned about the potential for recapture of the stream channel through the previously-incised pond areas. Failure of the cross vanes and loss of grade control may likely occur during snowmelt runoff in 2017. Recapture of the stream channel by the ponds has a substantial chance of occurring for flows of sufficient magnitude and duration to overtop the berms and erode headcuts to the point of breach. By nature of the restoration design, this could occur with flows as low as a 5- to 10-year flood, which has a 10 to 20% chance of occurring in 2017.

To address these concerns, **we recommend alternative 3 for implementation**. However, if implementing alternative 3 in 2016 is not possible, due to logistical restraints, we recommend alternative 2 for implementation in 2016.

In general, preventing meander cutoffs should also be a priority in mitigation efforts as shortening the channel and increasing the gradient will lead to further headcutting and incision (Merritt and Scott 2013).

With any of the alternatives and in addition to this recommended strategy, livestock and elk grazing should be prevented through maintenance of the exclosure on upper Armstrong Creek.

ACKNOWLEDGEMENTS

Appreciation is expressed to David Levinson for his review of this report.

REFERENCES

Bidelspach, D.A. 2011. Final Conceptual Plan Report: Integrated Management Plan for the California Park Special Interest Area. Stantec, February 2011.

Daly, C., Halbleib, M., Smith, J.I., Gibson, W.P., Doggett, M.K., Taylor, G.H., Curtis, J., and Pasteris, P.A. (2008). Physiographically-sensitive mapping of temperature and precipitation across the conterminous United States, International Journal of Climatology, 28: 2031-2064.

Merritt, D., Scott, J. 2013. Review of Armstrong Creek Proposed Restoration Actions – April 2013. Report provided to the Routt National Forest by the Applied Freshwater Science Center, Watershed, Fish, Wildlife, Air and Rare Plants Staff, Fort Collins, CO, June 27th, 2013.

Potyondy, J.P. 2011. Watershed Condition Framework. United States Department of Agriculture Forest Service FS-977, Washington, D.C.

USFS 2016 First Creek Restoration PIL, Memo by Chad Stewart, District Ranger Hahns Peak/Bears Ears Ranger District, Medicine Bow – Routt National Forest, May 3, 2016.