Final Report to the Colorado Water Conservation Board: Healthy Rivers Fund
South Platte Watershed Restoration Projects
Wildlands Restoration Volunteers

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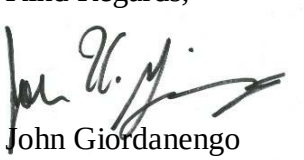
Overview

The Healthy Rivers Fund was instrumental in the design and implementation of three riparian restoration projects and 15 leadership and skills trainings in 2010. Three tributaries to the South Platte River that received restoration work were Tarryall Creek, St. Vrain Creek, and Rock Creek. This work was planned and implemented by Wildlands Restoration Volunteers in partnership with numerous public agencies and private entities within Northern Colorado. Restoration activities were planned and carried out by WRV staff and relevant partners, developed to improve water quality and wildlife habitat. Results and treatment statistics are broken down by project site below.

On behalf of our volunteers, partners, staff and Board of Directors, I want to extend a big thank you for your support of our restoration and stewardship community and these worthy projects.

Kind Regards,



John Giordanengo
Colorado Northern Regional Director
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Rock Creek

Background

Upper Rock Creek is part of the Boulder Creek Watershed, which drains into St. Vrain Creek and the South Platte. This portion of Upper Rock Creek runs through one of the largest undisturbed grasslands in Boulder County and was altered in the late 1960s when an overhead power line was installed. The changes made to the creek as a result of the utilities access road crossing it precipitated a large head cut that continued to worsen over the last ten years, causing substantial degradation/incision of the river channel.

Boulder County contractors re-graded the banks and altered stream sinuosity to approximate a morphology appropriate for the site. The relationship between stream surface water levels, bank grades, and ground water elevation below treated areas appears appropriate to support the development of a diverse and thriving riparian plant community near the eastern edge of the foothills.

Implementation

Eighty-one volunteers contributed approximately 1,100 hours of planning time and implementation labor toward project goals. Over 400 Salix exigua cuttings and 1,100 container plants of native riparian shrubs, trees, and herbaceous wetland plants were installed. Planted species included narrowleaf cottonwood, leadplant, wood's rose, golden currant, Baltic rush, and others. In addition, 700 feet of riparian area was seeded and covered with erosion matting. Overall, 56,000 square feet of riparian area received treatments, along with 5,600 square feet of wetlands.

The seasonality of the channel means the project site only received four months of surface flow before drying up in early August. Refer to technical section notes below for further details.

Monitoring

Boulder County staff are taking the lead on monitoring the site to determine if project goals were met. Preliminary anecdotal observations by county staff in 2010 indicate little to no lateral migration of the regarded stream channel. A set of pre- and post-project photos was taken in 2010 by WRV and it is expected that a second set of photos in 2011 will illustrate first growing season results well. Below are a series of pre- and post-project photos of the rock creek site.

Incised Channel (upstream, 2009)

Denuded Stream Bank, 2009

Re-graded Banks, Seeding, Erosion Matting, Planting, 2010

Willow Bundles, 2010

Stream Realignment, 2010

Volunteer Labor

181 volunteers contributed 1,100 hours of planning time and implementation labor to address project goals. The total value of volunteer labor was $23,375.

Photos

Additional project implementation photos are available at this link: http://www.wlrv.net/colorado/index.cfm?fuseaction=home.photogallery&eventid=522.

Technical Notes for Rock Creek

Plant materials

This project involves planting approximately 15 trees (5-gallon stock), 216 shrubs (1-gallon stock), 239 shrubs (1-quart stock), and 706 rushes and sedges (10-cubic inch stock) along the re-created banks of Rock Creek. The potted plants will be staged along the access road near the creek. In addition, we will be installing about 700 willow stakes. Each stake is a length of willow stem, either coyote willow or blue-stem willow. The blue-stem willow stakes will be installed only by crew 7 upstream of 6+00 and will be staged at the road crossing upstream of 6+00. Coyote willow stakes will be installed in flagged areas in work areas 1 – 6 and will be staged in several pools along the creek. Please note that the bluestem willows actually have green stems this time of year, and the coyote willow stems are brown. The 10-cubic inch rushes, sedges, and bulrushes will be planted in and adjacent to a small existing wetland that is being expanded. If we end up with extra rushes, bulrushes, and sedges, we may plant the leftovers along the banks of the re-created stream channel.

Table 1. Plant species for Rock Creek restoration		
Species	Number	Size
Narrowleaf cottonwood	7	5 gallon
Peach-leaf willow	8	5 gallon
Chokecherry	56	1 gallon
Coyote willow	239	1 quart
Coyote willow	250	Assumes each long stem will be cut in half
Bluestem willow	110	Assumes each long stem will be cut in half
Western snowberry	44	1 gallon
Wood's rose	116	1 gallon
Baltic rush	294	10 cubic inch
Common three-square	196	10 cubic inch
Hardstem bulrush	98	10 cubic inch
Nebraska sedge	118	10 cubic inch

The numbers of plants by species for each 100-foot length of restored stream channel are noted in the Rock Creek Section Notes.

Lime-green pin flags denote the exact locations of 5-gallon **peach-leaf willow**; one pin flag per plant

Yellow pin flags denote the exact locations of 5-gallon n**arrowleaf cottonwood**; one pin flag per plant

Dark green pin flags denote the locations of clumps of 1-gallon **western snowberry** planting; one pin flag per plant

Purple pin flags denote the exact locations of 1-gallon **chokecherry** planting; one pin flag per plant

Pink pin flags denote exact locations of clumps of 1-gallon **Wood's rose** planting; one clump of three plants per pin flag; plants 2 feet apart

Orange-red pin flags denote curved lines parallel to the creek channel where **coyote willow stakes** will be planted; a blue pin flag with "up" written on it denotes the upper end of a line of coyote willow stakes and a pin flag with "down" written on it denotes the lower end of a line of willow stakes; the stakes will be installed in bundles of 5 stakes per bundle; install one bundle every two linear feet.

Blue pin flags will denote curved lines parallel to the creek channel where **1-quart coyote willow** plants will be installed; the pin flags denote the upstream and downstream ends of a line of coyote willow 1-quart plants; install one plant every two linear feet.

It is important to keep the potted plants moist prior to planting. If they are dry, please give them a drink before they are planted. Keep the willow stakes in the creek until you are ready to trim and install them.

Check dams

Check dams are designed to prevent downcutting of small channels and promote infiltration of runoff water. They are not designed to hold large volumes of runoff water. The check dams will hold a small

amount of sediment. We will use existing ponderosa pine logs for the check dams. The logs are about 3 feet long and 1 foot in diameter. The logs are staged at the stock tanks immediately west of the north – south access road at the project site.

To construct a check dam, dig a trench to hold a ponderosa pine log, with the trench extending at least one foot laterally from the edge of the channel (more lateral log extension is ok within reason). The trench needs to be a bit deeper than the lowest part of the channel. Bury about 1/2 of the height of the log. The top of the log should be about 6-7 inches above the bottom of the channel. Keep the final position of the log as level as possible, so water doesn't run around one end, but runs evenly over the entire log. Backfill the removed soil around the log and tamp it in place to eliminate any small holes between the log and the base of the channel. The lateral extensions of the log will end up being buried and, therefore, invisible.

Planting technique

Consult the Rock Creek Section Notes for your work area to determine the number of each species of plant to install. Bring the appropriate plants to the planting site. Make sure the plants are moist, and, if not, water the plants before planting.

We will be planting the potted plants and willow poles through recently installed erosion mat in some locations. At the location where each potted plant will be installed through erosion mat, make two perpendicular cuts with a pair of scissors in the erosion mat just long enough to accommodate the material being planted. Use rocks to hold back the pieces of erosion mat so they don't get in your way. After the plant is installed, use staples to secure the cut ends of the erosion mat.

Tree and Shrub Planting (5-gallon trees, 1-gallon shrubs, 1-quart shrubs)

1. For the 5-gallon trees, 1-gallon shrubs, and 1-quart shrubs, dig a hole that is 1.5 times wider than the diameter of the container. Place the excavated soil and rocks on a brewery blanket next to the hole where the plant will be installed.

2. For 5-gallon trees, 1-gallon shrubs, and 1-quart shrubs make sure the depth of the hole matches the soil level in the plant container. You can check this by placing the potted plant in the hole and seeing if the soil in the pot is level with the soil at the edge of the hole. If not, add or remove soil from the hole.

3. Before removing the plant from its container, check for roots that may be protruding from the bottom of the pot. It may be necessary to trim these roots or to slice the pot itself down the side and across the bottom to free the plant.

4. To free the plant from the container, hold onto the pot, invert the pot slightly downward, and gently shake the pot while GENTLY pulling the plant by its base. Do not yank the plant to free it form the pot, because that will damage the roots.

5. Once removed from the pot, check to see if the plant has a lot of circling roots. Gently pry the roots loose from one another with your hands.

6. The 5-gallon or 1-gallon plants may be root-bound, i.e., a dense tangle of roots will exist in the bottom of the pot. If so, cut the root ball in quarters, cutting from the bottom upwards through the fine roots and soil for several inches, and try to spread ("butterfly") the roots out before planting. If this is

done, be sure to mound the soil at the bottom of the hole so the soil fits inside the butterflied roots thus ensuring good soil-root contact.

7. Quickly place the plant in the hole. Remember, roots can desiccate rapidly, especially in direct sunlight on a hot day.

8. Hold the plant in place while you backfill with the excavated soil and rocks. Gently pack the soil into the hole, firm it into place as you fill, and eliminate any large air pockets. If the native soil is composed of large clay chunks that will not break apart easily, you can add a little screened topsoil to fill the voids when watered. The screened topsoil is in a pile on the west side of the creek in Section 4. The soil should be packed firmly enough to eliminate root-killing air pockets and to minimize the likelihood of the soil settling, but not compacted so hard that it prohibits the penetration of water and plant roots.

9. If possible, build a small earthen berm a few inches high around the edge of the hole to serve as a water catchment. You may need to secure extra soil to do this.

10. Immediately water the plant to help relieve the stress of planting, to settle the soil, and to eliminate any air pockets. Add more soil to any sinkholes that appear around the transplant such that the soil is level and covers the roots.

Willow Bundles

1. Dig a hole about 6 inches in diameter and 24 inches deep near the edge of the stream bank. A combination of a post-hole digger and a rock bar may work well for this task. Measure the depth of the hole to make sure you have reached 24 inches. Water should accumulate in the hole. Place excavated materials, including soil and rocks, in a white, plastic bucket and add water to make a slurry. Set aside large rocks that will not fit back in the hole.

2. Select 3 willow stems from the pile of willow stems in the stream.

3. Cut each willow stem into one or more (probably two) straight lengths, each 30 – 36 inches long. MAKE SURE THAT THE CUT ON THE BOTTOM END OF EACH WILLOW STEM IS AT AN ANGLE so you later identify which is the top end and which is the bottom end of each willow stem. If the ends of the stems show signs of drying out, make a new cut a few inches from the dried end.

4. Gather 5 of the 30-36-inch long willows stems WITH THE POINTED (BOTTOM) ENDS TOGETHER. Tie the stems into a bundle with two lengths of twine.

5. Place the bundle bottom end down in the hole. THE BUNDLE MUST BE PLACED POINTED (BOTTOM) END DOWN. Otherwise, the willow stems in the bundle will die.

6. Pour the slurry made from the soil (see step 1 above) and smaller rocks excavated from the hole back into the hold.

7. Add additional soil (available in two piles on site) to the hole and around the bundle to eliminate any air pockets.

8. If necessary, trim the tops of the bundle so that no more than 12 inches of the poles are aboveground.

Wetland Plants (10-cubic inch tubes)

1. Make a hole with a Janz dibble (painted yellow) or a hollow-probe dibble. This is accomplished by inserting the dibble into the soil nearly to the level of the foot step. If necessary, move the handle of the dibble in a circular motion to increase the size of the hole. Remove the dibble from the hole.

2. Remove a plant from its plastic tube by inverting the tube and tapping the top of the tube on your hand. The plant should fall out without too much difficulty. If not, try shaking the tube in a downward direction, with the top end of the tube pointing down, rather like a ketchup bottle is shaken when the ketchup does not pour very quickly. You can remove roots protruding from the end of the tube if need be to free the plant. Catch the plant before it falls to the ground. It is bad form to let the plant fall to the ground.

3. Nip off any dead roots at the bottom of the soil plug with your fingers. Place the plant in the hole. Make sure that the top of the soil that contains the plant is level with the top of the planting hole. If not, remove the plant and make the hole deeper or add a bit of soil to make it less deep, as need be. Insert the plant in the hole. If there is an air space between the plant and the side of the hole, add soil to fill the space. When the plant is properly positioned in the hole, water the plant until no more water can be added. Place the empty plastic tube back in the rack. Do not stack the tubes.

St. Vrain Creek

Background & Goals

St. Vrain Creek is the primary drainage in the St. Vrain Watershed, draining over 400 square miles of the Colorado Front Range into the South Platte River. Human activity since 1859 has significantly impacted this watershed, with agriculture and urban development changing the natural composition of streams and surrounding riparian areas. WRV's 2010 project at St. Vrain Creek addressed needs in 0.75 miles of riparian area on Golden Ponds and St. Vrain Creek within the City of Longmont. Currently, the banks along this portion of St. Vrain Creek are dominated by non-native species such as Tamarisk and Russian olive, as well as Siberian elm. The primary goal of this project is to improve the health of the riparian area by removing the non-native trees and shrubs and replacing them with their native counterparts.

Implementation

Contracted sawyers cut down and bucked trees marked for removal by the City. Volunteers walked designated areas of the property in organized teams to locate bucked material and haul it to staging piles for subsequent removal by City of Longmont (COL) personnel.

Over 350 native shrubs and trees were installed and hundreds of tamarisk, Siberian elm, and Russian olive trees were removed and treated. In total, 105,600 square feet of riparian area received treatments. Refer to technical section notes below for further details.

Photos

Photos of this project are available by following this link:
http://www.wlrv.net/colorado/index.cfm?fuseaction=home.photogallery&eventid=511

Volunteer Labor

128 volunteers contributed over 1,750 hours of planning time and implementation labor to address project goals. Using the Colorado volunteer rate of $21.25/hour, the total volunteer labor value of this project was $37,846.21.

Monitoring & Maintenance

City of Longmont is doing monitoring on this project with seasonal staff to determine survival rates of installed plants and effectiveness of weed treatments. Transplanted vegetation is being watered throughout the year for the first two growing seasons.

Technical Section Notes for St. Vrain Creek Restoration

Target Woody Invasive Plants

This project is a follow-up to prior Russian olive and Siberian elm removal projects dating back to 2004. Our task is to locate, cut, and treat the stumps of ALL individual plants found. With the success of past projects, we are now attempting to eradicate these two species entirely from the this section of the Creek.

Woody Invasive Plant Removal Technique

Please note, Russian olives do have long, sharp thorns so great care is necessary to avoid scrapes or puncture injuries. It is imperative that all volunteers performing this work wear protective eyewear and sturdy gloves.

Three easy, but **essential,** steps to killing invasive woody plants using the cut-stump method:

1. Cut all of the stems of the target plant as close to the surface of the soil as possible. For shrubs with many trunks, it may not be possible to cut the stems closer than 6 inches from ground level. Cutting is usually best accomplished with a pair of loppers, but a hand saw is essential for larger trees (over 2" caliper).
2. As soon as possible (ideally within 30 seconds of cutting), apply herbicide to all of the freshly cut trunks. Apply herbicide until excess herbicide runs down the trunks but cease application before herbicide hits the soil. Thorough application of herbicide to all stems is essential to kill the plant. Do not apply herbicide where it will drip into standing water. (Wear latex or nitrile gloves whenever handling herbicides.)
3. Haul the cut stems to the nearest roadway or parking area and stack in piles. Park staff will load and haul away branches – assist staff with loading onto trailer, if in proximity.

Crew members cutting trees should work in a fairly compact area so that the herbicide applicator doesn't have to run around finding the stumps. However, crew members need to work far enough apart to maintain safe working distances. A safe distance is generally 1-1/2 times the height of the tree being cut.

Two volunteers may be needed to drag heavy and/or awkward trees and branches. Drag trees to their final destination, rather than intermediate destinations, because it's harder to separate branches already piled up once. Stack trees and branches facing the same direction, with stump ends facing the trail and branches facing back toward cutting area. Since the material will be removed with a grapple, individual tall piles are preferable to a continuous, long pile.

Larger trees will be cut with chainsaws prior to and during the workday by Longmont staff. Crews will assist staff by dragging branches and smaller logs across the creek (in some cases) and up the slope where accessible to stockpile the material to be picked up later by Longmont staff.

If seedlings are found (probably under 18" in height), do not cut – attempt to pull out with roots intact. If seedlings do not pull out intact easily, leave in place and apply herbicide to entire plant, taking care to avoid spraying nearby plants.

Do not worry about Russian olive seeds as they are not feasible to collect. They have a short period of viability.

Native Plantings

We will be planting approximately 264 native treesn and shrubs to continue riparian restoration efforts along St. Vrain Creek. They will vary in size and species:

- 24 balled and burlapped (B&B) trees
- 40 5-gallong native trees and shrubs
- 200 1-gallong native shrubs

Longmont staff will acquire plant materials and determine final plant list, but anticipated species may include:

Trees	
Populus sargentii	Plains Cottonwood (mesic/wetlands)
Populus angustifolia	Narrowleaf Cottonwood (mesic/wetlands)
Shrubs	
Atriplex sanescens	Fourwing Saltbush (uplands/xeric)
Chrysothamnus nauseosus	Rubber Rabbitbrush (uplands/xeric)
Prunus americana	Wild Plum (mesic)
Punus viginiana	Western Chokecherry (mesic)
Salix exigua	Coyote willow (wetlands)

Planting Technique – Container plants

Park staff will supply potted trees and shrubs and stage them on a trailer. Some holes will be pre-dug – if so, please skip Step 1. A Technical Advisor will select locations for each plant.

1. When preparing to dig the hole, measure the circumference of the hole at 1 1/2 times that of the container (use a shovel handle or stick to measure)

2. Make sure the depth of the hole matches that of your plant container (again, you can measure with a shovel handle or stick).

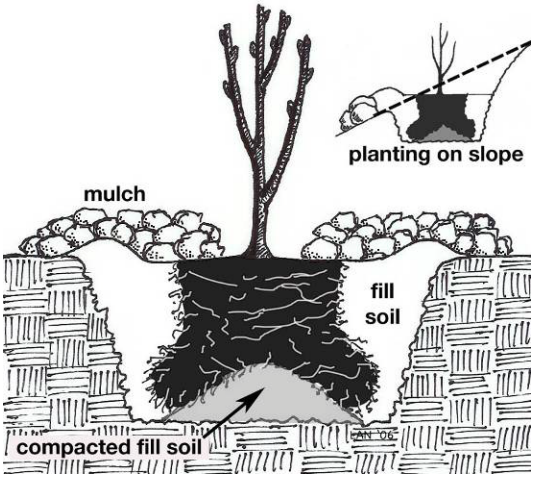
3. Place the excavated soil next to the hole.

4. In clay soils, use the point of a shovel, pick mattock, or sharpshooter to rough up the sides and bottom of the hole. This helps with root penetration. If the soil is loam or sand this is unnecessary.

5. Before removing plant from container, check for roots that may be protruding from the bottom of the pot. It may be necessary to trim these back, or slice the pot itself down the side and across the bottom to free the plant.

6. To free the plant from the container, hold onto the pot, turn slightly downward and gently pull the plant by its base.

7. If the plant doesn't release, roll the pot on the ground and squeeze the sides in with your hands or knees, and again gently try to work it free. Avoid forcefully pulling the plant out of the pot since this can damage the root system.



8. Once removed from the pot, check to see if the plant has a lot of circling roots (root bound). Gently pry the roots loose, or run a knife across them to break them apart. (Note: for this project, we will NOT split or 'butterfly' the rootballs.)

9. Quickly place the plant in the hole, making sure the top of the potted soil lines up with the top of the ground surface. Remember, roots can desiccate rapidly, especially in direct sunlight on a hot day.

10. Make sure the roots are spreading outward - NOT bent upward, all kinked to one side, or circling the root ball.

11. Hold the plant in place while you backfill with the excavated soil. Gently pack the soil into the

hole, firm it into place, and avoid any large air pockets.

12. Build a small earthen berm (minimum 2 feet in diameter and 3 inches high) around the edge of the hole.

13. If the plant was planted on a slope or in a drainage, the uphill end can be left open to allow water to flow into the catchment. Use this as a catchment for watering.

14. Immediately water the plant to help with the stress of planting, and to settle the soil and eliminate any air pockets. Replace any sinkholes around the transplant with new soil to cover up the roots.

15. Install wire cage around trunk of trees to prevent browsing damage, taking care not to damage the bark.

16. Apply wood chip mulch approximately 3 to 4 inches deep, extending about 1 foot from the base of the plant (2 foot total diameter), then clear mulch from a 4 inch circle at the base of the plant so that mulch does not contact the plant itself.

Planting Technique –Ball and Burlap

Because of their size, balled and burlapped (B&B) trees will be 'half-planted' by Longmont staff prior to the workday. This means that the holes will be dug, the bottom half of the wire cage removed, and the tree properly placed in the hole.

1. Verify that the tree is planted at the proper depth and is plumb (vertical as viewed from all sides). Adjust tree if necessary to make plumb. If the tree appears to be planted at an incorrect depth relative to surrounding grade, contact your TA.
2. Carefully remove the remaining wire cage with bolt cutters. Use care to not disturb the root ball. Cut wire will be sharp – be careful to avoid puncture wounds and scrapes. Cut and remove of any plastic twine.
3. IF the root ball is solid and intact (firmly attached to tree), cut off and remove the burlap wrap with a utility knife. Look for short nails that hold the burlap together – carefully remove them by hand if possible (not rusted). Dispose of nails and wire cage to avoid injury.
4. If the rootball is NOT intact (chunks of soil are loose in ball or tree wobbles), keep the burlap wrap in place but cut away the portion on the top of the ball. This will prevent the burlap from wicking water and desiccating the tree.
5. Backfill the hole 1/3 of the way and water. With a stabbing action, use a shovel to settle the soil and remove air pockets. Do not stomp on wet soil.
6. Backfill the hole 2/3 of the way and water. Repeat process to remove air pockets.
7. Backfill the remaining hole and install a small earthen dam (minimum 5 feet in diameter and 4 inches high/6 inches wide). Water tree again with 10 gallons of water. Dam should be large enough/firmly built to hold this much water.
8. Once water has soaked in, place wood mulch and install cage as previously described for container plantings.

Tarryall Creek

Background & Goals

Tarryall Creek is located within the Upper South Platte watershed near the town of Tarryall, seven miles upstream of Lake George, and was historically characterized by a meandering meadow riverine system. The 3,000-foot section (6,000 total, including both sides of stream) of Tarryall Creek included in the scope of this project is located in a narrow, terraced alluvial valley (type VIII) on the Puma Hills River Ranch. The beaver population had likely been trapped out of the area as early as 1820 and this section of the watershed was settled in the mid-1800s, at which point the willow shrub communities were cleared for agricultural purposes. Currently, the Puma Hills Ranch operates livestock grazing and hay farming along most of the stream bank. The overall channel stability of this section of stream will be improved in part through restoring a native community of willows and other native shrubs in a buffer area along the stream. Current restoration goals at Tarryall Creek include the establishment of a healthy native riparian shrub community to provide short-term and long-term protection of stream banks and freshly graded areas that were hardened with log veins and buried physical structures. Upon completion, this project will enhance ecological conditions and recreational fishing in this section of the Upper South Platte Watershed while preserving agricultural operations.

Implementation

About 38 volunteers contributed 1,530 hours to plan and implement riparian restoration treatments along approximately 1.75 miles of riparian corridor along Tarryall Creek on the Puma Hills Ranch.

Approximately 9,000 willow cuttings of *Salix planifolia, S. monticola*, *S. exigua,* and other *S. spp.* were harvested and installed using a combination of hand-operated willow probes, a backhoe-mounted stinger, and a water stinger. Willows were installed so 3 to 6 inches of the cutting were below the existing ground water level and 18 inches remained above ground. *Populous angustifolia* and *P. balsamifera* were installed on the south bank of a river backwater to shade that area for juvenile trout and other aquatic life.

BioHabitats and EcoMetrics, which provided the primary technical design work prior to WRV's involvement in the project, also provided volunteers during the WRV project week. Thanks to Mark Beardsley's water stinger, WRV was able to install more willows in the frozen soil conditions than would have otherwise have been possible. The backhoe-mounted stinger was able to penetrate ice and helped get willows installed on the flood terrace. WRV has since obtained the specifications for the water stinger and is developing that technology internally in order to gain greater efficiencies in future willow installation efforts.

The owner of Puma Hills Ranch installed a cattle exclusion fence around the entire riparian corridor, and three cattle crossings, to create a 20 foot wide riparian buffer area on each side of the creek.

We believe the overall channel stability of this section of stream will be improved by the restoration of a native willow community in the 20 foot buffer area along each side of the stream. Wildlife habitat will be vastly improved as this portion of the hay meadow is converted to a more structurally diverse riparian corridor to benefit birds, fish, reptiles, amphibians, and mammals. A primary goal of the project was to reduce the rate of bank migration by providing a combination of soft (i.e., bank stabilization by roots) and hard (i.e., log veins and rock armoring) engineering techniques. According to early monitoring results, we believe this project is on track to meet those goals, but continued evaluation monitoring will be necessary to determine the exact degree of success.

Photos

Photos of the project are available at this link:
http://wlrv.net/colorado/index.cfm?fuseaction=home.photogallery&eventid=558

Volunteer Labor

38 volunteers contributed over 1,530 hours of planning, technical design and labor. At the Colorado volunteer rate of $21.25/hour, the total volunteer labor value of this project is $32,512.50.

Monitoring

Monitoring is being undertaken by EcoMetrics, who is using a combination of repeat photography and physical measurements to document stream width, depth, and channel migration over time, as well as riparian area revegetation success.

A detailed monitoring plan from EcoMetrics is attached. The plan describes the monitoring philosophy, metrics of interest, and the agreed criteria for evaluation of immediate and long-term success for each objective and goal.

Monitoring Results: Evaluation of goals and objectives

Using the approved monitoring plan, EcoMetrics prepared a table for each of the six primary project goals to outline the specific objectives for each and the individual metrics that were used to evaluate them. Tables 1-6 in the attached monitoring report summarize monitoring and appraisal results including pre-project values, as-built values, and immediate- and long-term targets for goals 1-6, respectively. Goals one and two were most relevant to the phase of the Tarryall Creek restoration project undertaken by WRV under the scope of this grant. First-year results are presented here.

Goal 1: Improve vegetation along stream banks and throughout riparian area
Monitoring has revealed that the immediate success towards improving streamside and riparian vegetation is fair. The number of willow cuttings exceeded the amounts specified in design plans. While the volunteer-installed cuttings met design criteria for size and quality, the mechanical plantings (i.e., large shrub transplants with an excavator) generally did not, and these plants all had to be pruned to help survival. For this reason, the immediate benefits of instant large shrubs were not realized right away. On the other hand, the survival and growth of all installed willow cuttings has been very good through the first season. If these trends continue, there is strong reason to believe this goal will be met or exceeded in the short- and long-term.

There are a large number of "volunteer" willow sprouts and newly-planted willow shrubs along the stream. For these young shrubs to successfully survive and grow, they must be protected from harmful activities such as intensive livestock grazing and haying which had been common on this site. Since the project has successfully implemented a riparian protection fence (see Goal 2), we fully expect a rapid increase in the amount of shrub cover both on the greenline and throughout the riparian area in general. In general, it appears the project is on track for meeting riparian vegetation goals as long as the channel treatments perform well, the willow stakes survive, and (most importantly) the RPA buffer is maintained. Ongoing monitoring will continue to evaluate this response.

Goal 2: Protect riparian area from livestock and haying damage
Over this first season, the landowner has demonstrated that he can effectively manage a cattle and hay operation while protecting the stream and riparian area using exclusionary fencing, crossings, and a riparian buffer. The exclusionary fencing and buffer regularly exceeds the minimum 15 ft width. A written agreement is in place to help guarantee this level of commitment in the future. So far, the project meets all targets for immediate-term and short-term success towards limiting damage from livestock and haying.

The Bigger Picture
This project has been successful at producing a number of immediate quantifiable outcomes. A partial list of immediate measureable gains includes:
- 13 acres of protected riparian area buffer (livestock and haying damage removed)
- 5% more shrub cover on treated portions of the riparian area
- 3 water crossings and several miles of fencing that facilitate ranching while minimizing environmental damage
- 255 tons less sediment from bank erosion per year

These immediate gains are important and valuable initial returns on the investment. And while the net initial returns are less than we had hoped, it may be more important to look at the bigger picture which involves long-term improvement and sustainability.

Equally or more important than immediate gains or initial returns is the restoration of processes that will allow the system to function naturally. To this end, the outlook for project success is particularly encouraging. Most importantly, an RPA buffer has been established and the restoration of ecological components within it, primarily the reestablishment of shrubs, appears to be on track for success. Bank erosion and lateral migration rates appear to be significantly reduced, and this should give time for the restored riparian condition to take effect on the channel. If the chain of events continues on this

positive track, aquatic habitat factors should eventually improve naturally and trend towards a reference condition.

Addressing riparian improvement and protection first and foremost, this project focused chiefly on the primary causes of impairment, and by most accounts it appears to be on track for success in this regard. By effectively restoring a natural riparian vegetation community within a protected buffer and removing the harmful effects of livestock grazing and haying, the Puma Hills Ranch project on Tarryall Creek is restoring the capacity of the system to function naturally, which means that there is promise for success in meeting most or all of the long-term goals. In the future, ongoing monitoring will be able to appraise long-term success by repeatedly measuring the change in conditions and comparing results to pre-established longterm expectations.

NOTE: A full monitoring report from EcoMetrics (courtesy of Mark Beardsley) is attached.

Technical Protocol for Willow Establishment on Tarryall Creek

Selecting the Right Willows and Willow Stems

1. **Locate a collection site** near the project site with similar willow species, comparable site conditions (e.g., hydrology, landscape position, elevation), and abundant, vigorous willow stands.
2. **Obtain landowner permission** to collect from the site.
3. **Choose healthy stems** (i.e., "green" wood in cross section) that are**:** relatively straight, covered in smooth bark (i.e., not furrowed or damaged), and free of insect/pathogen damage.
4. **Follow ethical harvest guidelines** to conserve health of the donor stand:
   - Remove no more than 1/3rd of the branches from any single willow.
   - Never remove more than 40% of the overall willow canopy cover.
   - Harvest stems evenly through the stand (e.g., not from one side of the willow only).

Harvesting and Preparation of Willow Cuttings

Tools: Lopping shears, hand pruning shears, small wood saws or brush cutters, twine, labels, buckets.

1. **Harvest willow cuttings** during the dormant season (between leaf fall and bud break):
   - **Select stems ½ to 1¼ inches in diameter** for most willow cutting projects. However, some projects may require stems that are 1 to 3 inch in diameter or even 3 to 6 inches in diameter (i.e., *posts*) where longer or stronger poles are needed. In general, smaller diameter cuttings are appropriate for shrub willows (i.e., *Salix exigua*, sandbar willow) while larger diameter cuttings are more appropriate for tree willows (i.e., *Salix amygdaloides*, peachleaf willow).
   - **Cut stems to length,** as determined by specific project needs (e.g., depth to late-summer water table, severity of erosion and flood damage). Cuttings can range from 18 inches to 5 feet long depending on depth to groundwater. Remove the cutting with a clean diagonal cut at the base of the stem. The diagonal cut is used to differentiate the rooting-end from the above ground end, and to aid installation.

   - **Prepare cuttings** by clipping the terminal bud (unless a tree-like form is desired) with a horizontal cut and removing all lateral (i.e., side) branches along the stem, as close to the stem as possible. Use caution and avoid damaging the stem while clipping the lateral branches. Removing lateral branches helps maintain an appropriate root-to-shoot ratio, reduces transpiration, and creates a cutting that is easier to install. Cut the top end of the stem horizontally to create a flat pounding surface if necessary.
2. **Bundle and tag cuttings** by species, size, date, and site. Keep bundles cool, moist, and shaded during transportation and on-site storage.
3. **Prior to planting, soak willows** in water for 5-14 days to increase speed of adventitious root formation. Willows can be soaked in buckets, a stream, or a lake with well-oxygenated water. Roughly 50 to 80% of the length of the cutting should be in contact with water while soaking. For disturbance-adapted willows (i.e., sandbar willow, *Salix exigua*), and under hydrologic conditions that are highly favorable to the establishment of willow cuttings, pre-soaking may not be necessary.

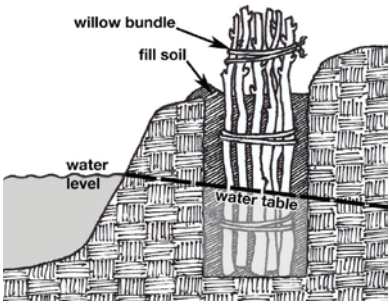
Pre-soaking willow cuttings. USDA-NRCS, Aberdeen Plant Materials Center.

STORAGE OF WILLOW CUTTINGS

Cut willows were stored no more than 24 hours before installation. This treatment was allowed due to the naturally high water table anticipated while cuttings would be producing adventitious roots in May and June.

PLANTING WILLOW CUTTINGS

Tools: planting bars (dibbles), rebar, rubber or wooden mallet, post-hole diggers, electric hammer-drills, soil augers, pick mattocks, power stingers, shovels, buckets, lopping shears.



1. **Locate and flag planting sites, and determine planting densities** based on knowledge of hydrology, location of existing willow populations, and specific site objectives. Areas where the water table drops more than 3 ft during the growing season or with large fluctuations in water-table depths are problematic for survival of willow cuttings. In areas with low erosion potential, space cuttings 1-3 feet apart for creeping rhizomatous willows (e.g., sandbar willow) and 3-8 ft for "clumpy" willows (e.g., Drummond's willow) apply generally on mild slopes. On steeper slopes, or where there is a greater threat of soil erosion, denser plantings may be appropriate.
2. **Optimal time of willow planting** varies by region. Typically, willow cuttings are installed after spring thaw but before bud break, or in fall after leaves change color and/or fall. If planting in fall, be sure to install cuttings deep enough (at least 2 feet deep) to avoid them from being lodged out of the ground by winter freeze-thaw cycles.
3. **Prepare pilot holes,** if necessary, for willow cuttings by pounding in rebar, using a pick mattock or other appropriate tools. Mechanical devises (i.e., stingers or augers) can also be used to prepare deeper holes in difficult soils. Pilot holes allow for easier installation without damaging the cuttings. In soft soils, pilot holes may not be necessary.
4. **Plant willow stakes** into prepared "pilot" holes or directly into substrates by hand-pressure or tapping with a rubber mallet. The bottom 6-8 inches of the cutting should be installed below the expected dry-season water table. Generally, 50-80% of the cutting is buried and at least 4 to 6 inches should remain above ground, or enough to overtop competing herbaceous vegetation. At least 2 lateral stem buds (and preferably 3 or 4) should be present on the above-ground portion of the stem. Be sure that pointy tips on lateral buds point sky-ward and that the diagonally cut end, usually the thicker end of the cutting, is inserted into the ground. Multiple stakes may be placed in a single hole. If the tops of the cuttings were damaged (cut or mangled) during installation, trim the top cleanly with a horizontal cut at least one inch below the longest split.
    - Cracked or heavily damaged tops can hasten drying of the stem and increase susceptibility to pest damage, decreasing survival rates. If tops are damaged from installation, cut them cleanly to remove the cracked portion without greatly reducing the amount of stem that remains above ground.
    - If the stems dry out during transportation, remove the bottom 2 to 3 inches of the cutting to recreate a "fresh" end just before installation.
5. **Backfill around cuttings,** when necessary, and tamp soil around cuttings to insure good soil to stem contact (i.e., without air pockets). Alternatively, pour a syrup-like slurry of soil and water into

the hole, allowing sediment to displace any air pockets as water leaches into underlying soil.
NOTE: Poor soil-to-stem contact is a leading cause of willow stake death!

Volunteer Training

Trained and experienced leaders are integral to the success of all restoration projects. WRV held 16 leadership and technical skills trainings in 2010. Of these 16 trainings, the trainings below are more pertinent to the projects supported by the Healthy Rivers Fund grant.

2010 Trainings: number of trainees
- Crew Leader Trainings in Ecological Restoration (one in Boulder and one in Fort Collins): 36
- Project leader Trainings (one in Longmont): 11
- Technical Advisor Orientation (one in Boulder and one in Fort Collins): 16
- Willow Restoration Skills Training (one in Fredrick, CO at St. Vrain State Park): 11
- Project Support Crew Training (one in Boulder and one in Fort Collins): 33
- Tool Manager Orientation (one in Boulder and one in Fort Collins): 15
- Seed Collection Crew Leader Training (one in Boulder and one in Estes Park): 39
- Wilderness First Aid Training (one in Boulder): 18

In all, 211 volunteer trainings occurred, and we recognize that some individuals took more than one training course. Of these 211, over half went through a mentoring process to gain on-the-job experience in various leadership roles. Training such a high number of volunteers in a leadership capacity is essential to maintaining a sustainable pool of able leaders to help plan and implement future restoration projects.