RESTORING NATIVE VEGETATION IN THE ESCALANTE RIVER WATERSHED

GUIDELINES AND RESOURCES FOR LAND OWNERS AND LAND MANAGERS

Headwaters Site near Escalante, Fall 2011 – Photo: Kara Dohrenwend

Prepared for the Escalante River Watershed Partnership
as an appendix to the
Woody Invasives Control Plan

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INTRODUCTION & PURPOSE

Ensuring native plant revegetation in large woody invasive removal areas in the Escalante River Watershed is an important objective of the Escalante River Watershed Partnership (ERWP). Restoring native plant species, either through passive or active measures, provides numerous benefits including: improved shade, shelter and food for aquatic and terrestrial animals; flood control; enhanced soil retention and formation; nutrient regulation; and improved water quality. Revegetation may also aesthetically enhance an area while providing for improved recreational access, expanded pasture or cropland, or provide other land use opportunities.

Passive revegetation, or regeneration, can often be achieved through the mitigation of stressors (e.g. removal of woody invasives, improving water availability, etc.). Active revegetation, on the other hand, requires activities such as planting, soil modification, secondary weed control, targeted grazing, or prescribed fire to achieve desired outcomes. For the purposes of this guide, the terms restoration and revegetation are used interchangeably to refer to desired conditions sought through the replacement of woody invasive species with desired plant species. While the term restoration is sometimes interpreted to mean the return to an "original" state, restoration in this document is used as a catch-all phrase to describe a suite of mitigation activities intended to improve a site's condition.

This document is primarily intended to provide restoration guidance for land owners and land managers. Emphasis is placed on the use of planning, evaluation, and removal techniques that can minimize active revegetation efforts. Information about species and planting methods appropriate to this watershed is also included. In addition, some suggestions about Russian olive removal techniques and/or land management practices that facilitate native plant regeneration are also provided.

Table IV-4. Results of the GIS analysis and expert workshop (combined) for riparian acres in the Escalante River Watershed grouped into land management status, with acres already treated for RO, and high and low density vegetation acres selected for control.

Land Status	Total Acres[1]	Acres Already Treated[2]	Acres Selected for Control[3]	High Density Vegetation Acres[4]	Low Density Vegetation Acres[4]
NPS	2481	851	845	756	89
BLM	8204	851	1500	1328	172
Private	2157	36	1563	880	683
State	131	3	10	7	3
TOTAL	**12,973**	**1664**	**3918**	**2971**	**947**

[1]All derived or surveyed riparian and non-riparian vegetation below 7100' elevation, including ephemeral reaches; excludes US Forest Service lands.
[2]Actual acres of vegetation within 50/15m of stream channels; private and NPS treatments reported as of 1/20/2010; BLM treatments reported as of 7/1/2010.
[3]Acres that met Scenario 2 criteria for high priority basins or are non-riparian vegetation. "Control here means vegetation needing to be inventoried, monitored, treated or re-treated.
[4]Acres selected for control.

Table V-2. Alvey Wash-Harris Wash riparian acres by land management status.

Land Status	Total Riparian Acres[1]	Acres selected for Control[23]	High Density Vegetation Acres[4]	Low Density Vegetation Acres[4]
NPS	138	138	120	18
BLM	1366	1366	922	444
Private	664	664	346	318
State	49	49	23	26
TOTAL	**2217**		**1411**	**806**

[1]All derived or surveyed riparian and non-riparian vegetation below 7100' elevation, including ephemeral reaches; excludes US Forest Service lands.
[2]Portions of this have been treated but already accounted for in Table IV-4.
[3]Acres that met Scenario 2 criteria for high priority basins or are non-riparian vegetation. "Control here means vegetation needing to be inventoried, monitored, treated or re-treated.
[4]Acres selected for control.

TABLES from Woody Invasive Control Plan showing anticipated acres needing invasive removal

LAND MANAGEMENT GOALS & CHALLENGES

The Woody Invasives Control Plan (WICP, Appendix A to the Action Plan of the ERWP) summarizes size and density estimates of the riparian areas targeted for woody invasive control in the Escalante watershed (as shown in the tables to the right). Areas selected for invasive removal efforts over five years total approximately 6135 acres. Approximately 36% of these areas are in Alvey/Harris Wash; the remaining 64% lie along the Escalante River.

Given the free flowing nature of the Escalante River, many targeted removal areas in the active flood plain and adjacent areas are expected to regenerate native plants with little or no active management other than Russian olive removal and resprout/sapling follow up. However, according to the plan, active restoration may be needed to achieve land management goals and objectives established by landowners on at least 185 acres of private land. The exact extent of areas where active restoration activities will be needed is currently unknown.

For publicly owned areas, land management goals and objectives are relatively consistent and are specified in the WCIP, which gives some continuity to public land removal efforts. The WICP states the following goal:

> *Reduce through various control methods Russian olive and other woody invasive species in the watershed to minimal levels, thereby allowing native plants and animals to thrive and natural (historical) riparian processes to function, such that riparian areas become more naturally functioning, sustainable and resilient to change. Over the next five years the Partnership will increase the number of sustainable, healthy riparian and floodplain communities in the watershed while reducing those dominated by woody invasive species.*

The WICP also states that, where feasible, passive restoration should be used over active restoration methods, and when active restoration is necessary, regionally sourced native plant materials should be used. Neighboring plant associations, soil types, and geographic location are used to help determine which species may populate a site naturally and thus indicate which species may be good ones to plant if active restoration is deemed necessary.

On privately owned land, removal and revegetation goals vary widely depending on the land owner's intended uses. Many private landowners may prefer to use their land for grazing or agricultural production. Improved access, wildlife habitat, aesthetics, or enhanced recreational opportunities may be additional goals. Regardless of intended land uses, the introduction of potentially invasive non-native plant species should be avoided. While non-native plants may have their function in certain land use scenarios (e.g. converting a field to desirable pasture grasses or hay production) the use of native plants is highly recommended whenever possible, both to minimize long term maintenance, and to keep new invasive plants from spreading throughout the watershed.

On both private and publicly owned land, erosion control is an important consideration in all invasive removal projects. However, removal in some areas may result in shifting wash /river courses on adjacent or nearby private land. Therefore, communication with neighbors before removal activities begin is very important. Also, phasing removal efforts may help to mitigate potential negative impacts.

SITE EVALUATION

It is important to determine what is possible on a site prior to implementing large-scale invasive tree removal. While the idea of conducting a "site evaluation" may sound laborious or even intimidating, most landowners are familiar with the process of evaluating their land– whether that's finding a good garden spot, determining where to landscape, or where to expand agricultural fields. The following outlines an evaluation procedure to encourage the establishment of desirable vegetation after woody invasive (Russian olive and tamarisk) removal by cataloging site characteristics, including water, soils, and existing vegetation.

Site evaluation is an important and relatively straightforward part of restoration planning, but can also be challenging. The most difficult aspect of the site evaluation process is keeping the process objective, and then using the evaluation to determine how to meet land use goals, or to decide if the goals are obtainable and/or economically feasible. A form similar to the one found on page 10 and in Appendix A can provide a good template for taking field notes during site evaluation visits.

A pre-removal assessment can help direct decisions about where to start, phasing opportunities, how to "open up" native plant areas, as well as to identify areas to avoid because of the presence of other weed species, erosion threats, or other site concerns. It is also important to consider access to the site, and to note the past and intended land use on the site. In addition, because removing large woody invasive species is a long-term commitment, regular reassessment of the site as removal efforts advance is also important. Over time, it becomes easier to determine key site conditions, including the presence and density of both native and invasive plants (both the primary species being removed as well as others that may need attention), and the age of the invasive species. Opportunities for and challenges to the success of the project may become apparent during the site evaluation process.

WEATHER

The months of June, July and August are the warmest months during the year with average maximum temperatures between 85 – 90 degrees Fahrenheit. Monsoonal storms typically occur between July and September and are a

significant precipitation driver in the watershed. With thunderstorms and flash floods common, summer is the wettest season.

Precipitation is highly variable within the watershed, with lower elevation sites typically averaging 6-9" a year. Ground and surface water are also affected by rain and snow in the fall, winter and spring months. Dry winters and springs can lead to low flows and dropping water tables.

These weather patterns suggest that fall can be an ideal time for active restoration activities (such as planting containerized plants or seeding cool season germinating plants). Mid-summer during the monsoons is the ideal time to seed or plant warm season germinating plants. Dormant poles, sprigging, and other salvage activities are generally best done in late winter or early spring.

SOILS AND WATER

When determining a site's condition and its potential for either regeneration or assisted revegetation, it is important to consider local hydrology and soil conditions. A good understanding of these factors helps in determining appropriate plant materials and timelines for planting if active restoration is needed, or how to best treat a site to promote passive restoration. Given its unique and varied geographic features, the Escalante River watershed is difficult to generalize so the following information should be supplemented with site specific observations.

SOILS

In much of central and southeast Utah soils are marginally to poorly developed. This classification is based on soil chemistry and physical properties (including pH, nutrient levels, salinity, and texture). Soil properties can determine which plants will and will not grow on a given site, so it is critical to have some understanding of soils prior to setting revegetation goals. Some soil conditions may require the use of amendments (e.g., compost or addition of mycorrhizal fungi) which can be time consuming and expensive; however, many native species do not need soil amendments and adverse conditions can be addressed through the selection of appropriate plants (such as salt tolerant species). In active flood areas it is also important to note that soil conditions may be significantly change during the next flood.

Removal activities themselves, especially those that change grading and drainage, can also change soil conditions. Soils may become more saline, or less so, if drainage patterns are altered. For example, salts may accumulate in locations where water is collected by changing the site contours to capture rainwater runoff. Conversely, cutting outlets for rainwater runoff can help carry salts off site.

WATER

Russian olives and tamarisk generally colonize areas where ground water is, at least seasonally, available for plant use. These species are seldom found in the most actively flooded areas, but typically grow along streambanks, within floodplains and near and other riparian areas, including springs and floodplains. The transitional zones between riparian corridors and drier upland sites are also common places to find Russian olive in the Escalante area.

It is essential to determine the depth to groundwater prior to any active revegetation activities, since groundwater availability may dictate which plants have a reasonable expectation of long-term establishment and survival, especially when supplemental irrigation may not be an option. Woody riparian species generally require groundwater within 3 to 8′ of the surface, whereas herbaceous riparian species require much shallower groundwater. Transitional zones (areas between the river channel and more upland locations) may have groundwater available only seasonally at 8′. Upland locations in areas that periodically flood may have ground water at depths greater than 10′.

Escalante River Flood looking up canyon towards Choprock Canyon. Extreme flooding events mean passive revegetation should be encouraged, and active techniques need to be chosen carefully, if used at all, so that efforts are not washed away. From website Escalante Deluge, Neon and Choprock Slots, October 2006. http://www.math.utah.edu/~sfolias/escalante/e.php?i=2

Flash floods can severely impact or completely remove plants, whether established passively or actively. While floods can bring in seeds from desired plant species, scoured areas can also provide an inviting seed bed for invasive plants. Periodic reassessment of restoration areas will be required to assure follow-up treatments are not needed. It may be best to select active restoration sites away from flood prone areas, especially those sites that are flooded on an annual or semi-annual basis, to ensure that expensive planting areas are not damaged by flood events. Passive revegetation is the preferred strategy in flood prone areas, including phasing removal to favor passive native plant regeneration. Deep plantings (also known as longstem planting) may be possible in active flood areas, but should be carefully evaluated before investing resources. Additional planning to minimize bank destabilization in locations where irrigation infrastructure, fields, and buildings may be impacted is also very important.

VEGETATION: NATIVES, NON NATIVES AND WEEDS

When planning a revegetation project it is important to consider what other vegetation may inhabit the site. When Russian olive and tamarisk are removed the nearby presence of native vegetation or weeds will be an important predictor of what sort of vegetation may subsequently colonize the site. A site evaluation should take into account the existence of native plants, desirable non-natives, and other potential weed species, as well as their distribution in and around a project area.

NATIVE PLANTS

Cataloging, and on larger sites mapping, the vegetation on a project site is an important step prior to initiating removal efforts. Any large areas of native plants, such as cottonwoods, willow stands, birch, hackberry trees, or grasses, that may be surrounded by Russian olives and tamarisk or may be adjacent to the project site should be noted. If possible, the site should be walked prior to removal in order to locate and tag these plants as potential starting points for removal activities.

DESIRABLE NON- NATIVE PLANTS

In some areas (e.g. pastures and agricultural fields) there may be species of desirable non-native plants that are worth preserving such as alfalfa or other pasture grass. In such cases it can be helpful to identify these plants prior to large woody invasive removal to assure that they are not damaged by removal activities, or inadvertently spread into areas downstream.

SECONDARY WEEDS AND THEIR CONTROL

Weeds can present a significant challenge once large woody invasive plants are removed. A flush of other weeds often emerges on a site once the existing canopy is opened up. Effectively controlling these emergent weed species typically requires a minimum of two to three years. Sometimes it is necessary to use several different techniques to successfully remove these secondary weeds. Finding the appropriate tool to use at the appropriate time can make all the difference.

Treatments for secondary weeds can be grouped into several categories: chemical control (herbicides), mechanical control, cultural control, and biological control. Often a combination of these methods may be needed for successful weed control. Some weed species (for example Russian knapweed and perennial pepperweed) are best controlled with herbicides. However, it is possible to effectively control many annual weeds through mechanical and cultural methods such as the timing of mowing, or by irrigating deeply but infrequently. Often a combination of all four types of control yields the best results. County Weed Supervisors and University Extension Agents can provide useful information on the best strategy for your site.

Herbicides fall into two broad categories, 'selective herbicides' and 'non-selective herbicides'. Selective herbicides are those that impact only certain kinds of plants (such as broadleaf plants or grasses). Non-selective herbicides will kill both broadleaf plants and grasses. When chemical control is the method of choice it is important to use chemicals safely, in accordance with the label, and timed for the targeted weed species.

Establishing desired vegetation may help prevent secondary weed invasions and can help keep the growth of established weeds at bay. Where selective herbicides are used, seeding of site-appropriate grasses that can tolerate continued herbicide application is recommended. When non-selective herbicides are used, it is important to spot spray or otherwise restrict herbicide application to target plants only. It is possible that an area may revegetate naturally, but the site should be monitored closely.

Mechanical means of weed control include grazing and mowing. These can be very effective control measures, particularly with annual weeds when done at times that minimize seed production. Irrigation may help in the establishment and persistence of desirable vegetation after removal of weed species; however, one must be careful to prevent the spread of herbicides through water movement from sites where herbicide has been used.

Biological control (biocontrol) is available for some weed species. The tamarisk leaf beetle (*Diorhabda carinulata*) is an important biocontrol agent that has become established in the Escalante area. The beetle, which has been active in parts of southeastern Utah for several years, may minimize the infestation of tamarisk into areas along the Escalante River newly cleared of Russian olive.

Appendix B provides a summary of information for common secondary weed species in the Escalante watershed. For additional advice on identifying and controlling other weed species in this area, please contact the local County Weed Supervisor or the local University Extension Office.

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PHASED REMOVAL

A very important aspect of native plant restoration in areas where large woody invasive plants are removed is how quickly an area is cleared. While it can be very satisfying in the short term to remove all the Russian olives in a 10-acre area, it can be equally disheartening to return to a sea of saplings, resprouts, and other weeds a few months or years later. Better long-term results can often be achieved by phasing removal over several years (for example, removing no more than ½, and sometimes starting with as little as ¼ of the project area in a given year, depending on the presence of native plants that can "fill-in" after removal of the woody invasives).

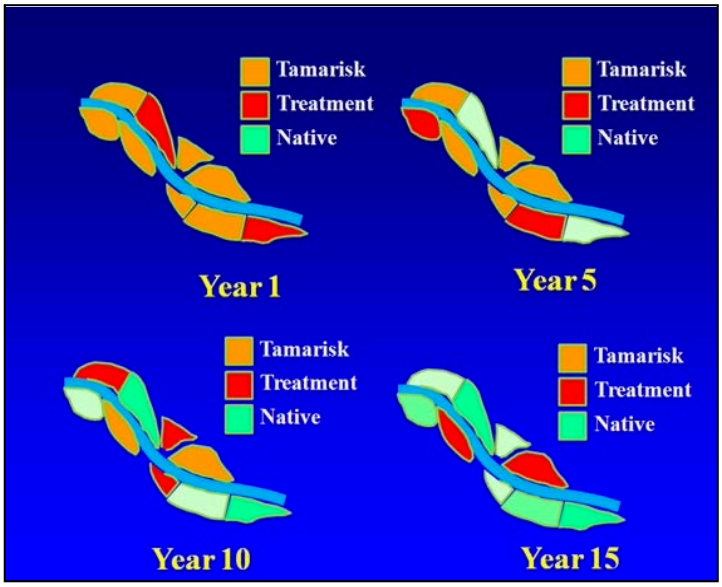


Diagram showing phased removal over 15 year period. From "The Rate and Spatial Extent of Habitat Recovery Following Tamarisk Eradication Efforts has Important Implications for Wildlife Species", Eben H. Paxton, Tad C. Theimer and Mark K. Sogge. Presented by Eben Paxton, 2010 Tamarisk Symposium presentation.

One way to encourage passive regeneration is to begin removal activities in places where healthy native plants are present, thereby providing sunlight, ground moisture, and nutrients for existing native plants, while also mitigating potential wildfire hazards. In addition, the native plants provide seed and other means of regeneration. Newly installed plants or emerging seedlings are also provided a more hospitable growing environment through the shade and wind-break services provided by the remaining plants. By making sure that active clearing is paced to allow for native plant regeneration and site stabilization before additional clearing is done, effort and money can be saved and habitat structures can stay in better balance in the project area.

Phased approaches require project planning to be completed within the context of the surrounding watershed. Removal of woody invasives from sites up to 40-acres or more may be appropriate; however, aggressive removal should be based on site characteristics such as high native plant presence, shallow depth to groundwater, or other considerations that suggest less intensive follow up will be required. Therefore, it may be desirable to retain areas of Russian olive between and within these larger areas until the initial clearings have stabilized with a more native plant mix able to provide wind and solar shelter.

With careful project planning, that balances long-term goals and strategies with short-term action plans, a more gradual approach can work well with the limitations of many funding sources. Close coordination and planning that takes jurisdictional restrictions and deadlines into account are also critical. While funding from a given source may only last one year, or in ideal situations up to 5 years, annual work plans can be implemented such that positive short-term results (e.g. minimal retreatment, vigorous passive native plant regeneration) are also achieved. The cost of repeated mobilization to a site can be balanced by making sure follow-up, resprout treatment, and other actions are done at the same time as further clearing, resulting in a likely reduction in the need for active revegetation efforts. It is vitally important when working in this manner to brief work crews on key locations where work should cease in preparation for future work.

EVALUATION WORKSHEET:

An evaluation worksheet is a useful way to record information about a project site. The following example has been partially filled out to explain what each field means, and to illustrate the kind of information that is useful to collect. A blank copy of this worksheet is provided in Appendix A.

Instructions & Example: Site Evaluation Worksheet for Woody Invasives Removal and Revegetation

Form filled out by:		Robert Heron
Date:		8/15/2012
Location	Watershed:	*Denote watershed where work in occurring; can use smaller watershed name if known* Example: Escalante Watershed
	General Location & Elevation/UTMs:	*Record general location and elevation of project site; if you have a GPS, record UTMs* Example: 3415 Butler Lane, 5751' 12 S 447782.59, E 4181038.40, 5751'
Ease of site access & barriers (river, pack animal needed, etc.); landmarks:		*Note if there are any significant barriers to the site* Example: The site is easily assessable by foot and ATV or 4-wheel drive vehicle. A rough 2-track road leads to the site. A large sandstone outcropping marks the southern boundary of the site.
Ownership/owner; contact info:		*Note who the landowner(s) is/are* Arnie and Karen Butler; 435.590.1234; a_k_butler@yahoo_gmail.com
Conservation easement or equivalent?		*Note if there is an easement or equivalent on the property; if known, record the easement holder* There is a conservation easement on the property. The easement is held by The Nature Conservancy.
General site description (note, if known, soil type, salinity, depth to water table, usage by wildlife or grazing animals, plants present, etc.):		*Record general site observations* The site is adjacent to the house and is primarily used by wildlife traveling along the river corridor. The soil type is unknown; however, a salt crust is visible on the ground along the river. Standing water is present in the winter and late summer. Aside from Russian olives, there is a good patch of willows, a few cottonwoods and some sagebrush towards the house.
Total treatment area (acres), location, and description:		*Record an approximate acreage of site to be worked by year; denote location and overall density* Year one treatment area: The area with the largest Russian olive infestation is about 2 acres; located along the southern perimeter. Trees are dense! Year two treatment area: 1-acre of scattered trees; SW corner of property
Irrigation available?		*Note if there is irrigation available* No. There is no irrigation available.
Landowner objectives; removal and revegetation goals (e.g. what is the desired land use for this site):		*Record the landowner's ultimate goals for the site* The landowner would like to see more wildlife in this area. They are interested in native plants that provide shade and landscaping value. Their son is getting married here next fall (2013) and they'd like to see plants established before then.
Rough scope and timeline of work (if known):		*If known, outline a rough scope of work and timeline for the project* The landowner would like to see Russian olives removed from the 2-acre site this fall, with additional work occurring on the 1-acre site in the spring (2013). As noted above, the landowner would like to see native vegetation growing by fall of 2013.

ACTIVE REVEGETATION METHODS & CONSIDERATIONS

Active revegetation uses a variety of methods, including seeding, pole or willow whip plantings, or container plantings to re-establish desired plants. Site characteristics, including depth to groundwater and soil type, texture and salinity, as well as land use can help to determine which species are best adapted to a particular location, and whether seed, poles or grown plants are needed for the site.

Grazing can slow down or completely halt revegetation efforts, which can be particularly devastating when time and money have been invested in active restoration activities. It may be necessary to temporarily exclude wildlife and livestock to allow new plants to become established. Containerized and pole plantings can, in some cases, be individually caged (if larger fencing is not an option) to get the trees and shrubs to a size that can withstand grazing pressures. Heavy hog wire will be needed if beavers are present as they can chew through other kinds of wire easily. Conversely, in some situations, grazing can also be used as a tool to reduce unwanted resprouts, saplings or other weed species.

It is important to consider what equipment will be available for planting. Specialized equipment may be hard to come by; farm equipment, however, can often be modified to achieve comparable results. Site access and conditions will also play a role in what equipment can be used. For example, many tractors may not be effective where cut stumps can damage tires.

A two man auger can be used in areas where equipment cannot reach to deep plant cottonwoods and other riparian species

SOIL AMENDING

Analysis of the physical and chemical characteristics of soils will indicate if amendments may be necessary at a particular site to meet specific restoration goals. Plant establishment may be hampered by nitrogen deficiencies, high salinity, high clay content, low organic matter, and/or poor soil microbial communities. Deficiencies in the soil may be modified by seedbed preparation, but can often be addressed less expensively through proper plant selection. Appropriate soil preparation may play a significant role in the establishment of seeded and planted species. A local Extension Agent can provide information on soil testing and thresholds for these factors in your area.

Soil l amending on a large scale can be expensive and require large equipment. Photo courtesy of GYPSOIL/Ron Chamberlain. Crops & Soils magazine | November–December 2011 American Society of Agronomy

Saline soils can be treated by flooding a site in order to leach salts out of the rooting zone of desirable species. Saline soils can also be improved by creating micro-sites by imprinting or pitting, or by applying surface mulch. To increase restoration success in areas with saline soils, salt tolerant species, such as inland saltgrass, saltbush and/or New Mexico privet, can also be chosen (see Appendix C for additional species).

Soil organic matter deficiencies can be mitigated by incorporating mulch into the soil. However, you will want to check that mulching material does not contain seed of plants that are not wanted on the site.

Soil texture can sometimes be improved by importing quality topsoil. Not only is this costly, but this can be risky because of the potential of importing alien plant, animal, or microbial materials. A common technique used to reduce compaction and increase infiltration is soil ripping, which can be critical in heavily compacted areas. However this technique disturbs the soil surface completely, and should be used carefully and in isolated areas to avoid spikes in annual weed growth or increased wind and water erosion. Soil texture concerns can often be addressed through selecting appropriate plant species or using planting techniques suited to the soil type. Pole plantings, for instance, do not readily establish in fine clays and silts.

Deficient soil microbial communities are common at sites dominated by a single species such as Russian olive or tamarisk. Mycorrhizal fungi are symbiotically associated with many plant species and they assist in the absorption of water and nutrients. The addition of inexpensive mycorrhizal inoculum may favor the establishment and development of desired species. Soil microbial communities can be improved by applying a commercial inoculum and in some situations by importing native soil from nearby areas.

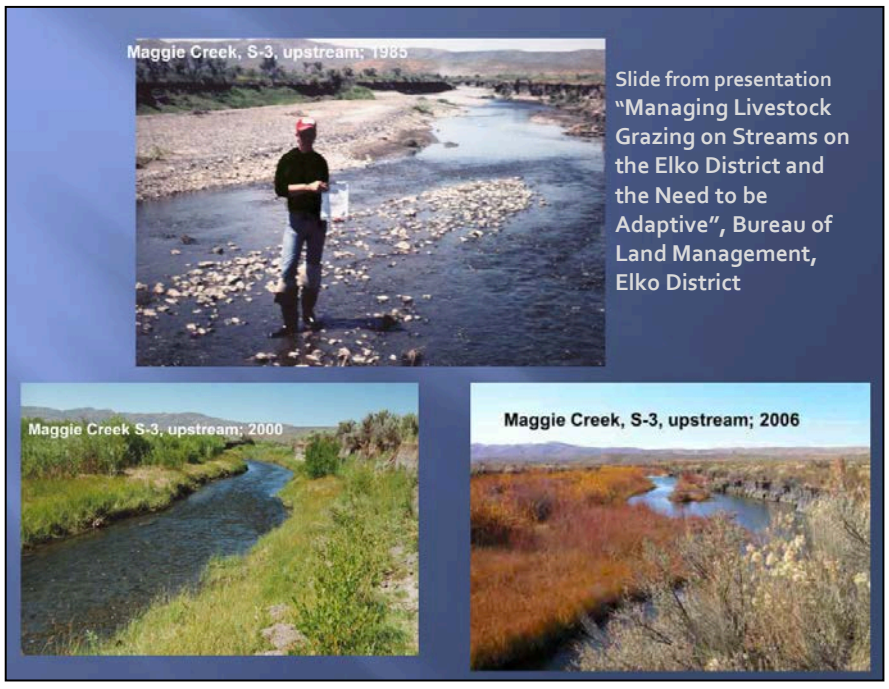
GRAZING & HERBIVORY

A number of grazing strategies promote positive vegetation change in riparian areas that are revegetating. Grazing intensity, frequency, and timing can be modified to reduce secondary weed presence and resprout and to help establish desirable plants. Grazing activities, done properly, can promote plant vigor, regrowth and energy storage, and also minimize soil compaction. Grazing actions in the uplands will likely affect riparian areas. In riparian areas, timing grazing to allow vegetation growth during periods of high flow can help to protect streambanks, dissipate energy, and trap sediment – protecting property and adjacent lands in the process.

Generally speaking, successful grazing plans will encourage vegetation establishment beneficial to livestock through increased forage, which also can increase native plant growth and vigor. Some general principles include:

- Rotate grazing locations annually, avoiding grazing the same place at the same time year after year.
- Allow time for plant development before or plant recovery after the grazing period.
- Move animals before too much defoliation occurs, which will accelerate plant recovery.
- Provide for livestock needs throughout the year, including water in varied locations as natural sources change.
- Manage for maintenance or improvement of the physical functionality of riparian areas by protecting upland areas as well.

A number of different techniques can be used to implement these principals. These techniques can be grouped into tools that 1) attract livestock away from riparian areas, 2) promote herd mobility, and 3) restrict access to riparian areas at critical times.



In certain situations it is necessary to attract livestock away from riparian areas to preserve bank stability, and vegetation vigor. These actions might include:

- offsite water development
- upland seeding
- prescribed fire or other vegetation treatment to enhance upland forage production
- grass reserves
- feed supplementation
- temporary electric fencing

A herd that moves around puts less pressure on riparian and upland soils and plant communities, improving plant establishment and reproduction. Distribution patterns and forage preference may be positively affected by incorporating different kinds of livestock, such as sheep and goats. Some livestock operators have also seen grazing pattern improvements with the use of breeds adapted to more mountainous terrain.

There can be critical times to keep livestock out of riparian areas in order to allow plants to seed, or promote growth and stabilize banks during flooding events. These actions can include:

- hardened crossings and water access points in riparian areas
- providing watering points and mineral supplements (e.g., salt blocks) out of the riparian areas
- locating bedding grounds in upland locations
- strategically placing livestock turnout locations
- active herd management

At times, temporary fencing may be needed for two to three years during and following restoration to allow desirable species time to establish, especially in areas where pressure, from domestic animals or wildlife, is high. Woven wire fencing, the bottom of which is buried two to three inches underground, will exclude most herbivores (e.g. beaver, rabbits, deer and cattle - but probably not elk unless the fence is > 7 feet in height). This type of fencing has worked well in some areas of the Escalante River watershed.

The BLM Technical Reference 1737-20, Grazing Management Processes and Strategies for Riparian-Wetland Areas, provides useful information, case studies, and contact information. Local Rangeland Management Specialists can also provide assistance, with emphasis on strategies that have proven successful in the Escalante watershed.

PLANT SELECTION

Choosing the best plants for a restoration site can be a complicated process. Site evaluation information will give a fairly good idea of what species are on and around a site. This will provide a good indication of what species may be easiest to establish. However, soils, depth to groundwater, and other site conditions must also be considered. Plant selection involves not only choosing what species to introduce, but also how to introduce them to the site – through seed, containerized stock, or other methods.

Cone-tainer and Book flats are a good way to introduce containerized plants to hard to reach areas.

The water jet stinger works well in sandy sites to deeply plant poles that will not wash out in flood events

If feasible, projects should strive to preserve site ecological and genetic integrity by restoring sites with a proper mixture of locally collected, genetically appropriate native plant material. Plant material from as near the restoration site as possible is preferred because this material is the most likely to thrive and reproduce with little or no further assistance. If locally sourced plant materials are not attainable, plant materials from outside the watershed, but of the appropriate species, are also good choices. Appendix D provides a list of nurseries, seed companies, and plant materials centers that offer native plants. The list is limited to facilities relatively close to the watershed (a 250 mile radius).

SPECIES SELECTION

Table B is a short list of suggested native plant species for revegetation and natural landscaping that are commonly found in the Escalante River watershed. A more exhaustive list of trees, shrubs, grass, and forb species that are commonly found in the Escalante River watershed, and may be desirable to encourage in restoration areas, is provided in Appendix C. In areas where agriculture or a naturally landscaped area may be the ultimate desired land use, a native riparian buffer between crop lands and the river or stream can help to stabilize banks, protecting land from erosion and/or flooding. These areas may also attract pollinator species that can be of benefit to crop production. A revegetation project may ultimately use a mix of species to achieve landowner goals.

Table A: Suggested Short-List of Species for Revegetation & Natural Landscaping in the Escalante Watershed

Type	Common Name	Max. Height	Water Use	Wildlife Value	Growth Rate	Landscape Value	Salinity Tolerance	Approx. Elevation Use
Grasses	Indian ricegrass*	18"	Low	High	Fast	Yes	Low - mod	Below
	Canada wildrye	4'	Low - mod	Mod	Mod	Yes	High	
	western wheatgrass	18 – 24"	Mod	Mod	Mod		High	4000-9000'
Forbs	buckwheat species	Varies	Low - mod	High	Mod	Yes	Low -high	Below 6500'
	globemallow species	12"	Low	Mod	Mod	Yes	Low - mod	Below 7000'
	yellow beeplant	24"	Low - mod	High	Fast	Yes	Low	Below 7000'
Trees	Rocky Mountain maple*	50'	High	Mod.	Mod.	Shade tree	Low	Above 7000'
	thinleaf alder*	20'	High	Mod	Fast	No	Low	Above 7000'
	western river birch*	20'	High	High	Fast	No	Low	Above 5500'
	Fremont cottonwood*	75'	High	High	Fast	Shade tree	Low	Below 6500'
	narrowleaf cottonwood*	60'	High	High	Fast	Shade tree	Low	Above 6000'
	netleaf hackberry	20'	Mod.-Low	Mod.	Slow	Screen	Mod - high	Below 7000'
	box elder*	40'	High	High	Fast	Shade tree	Mod	5000-8000'
Shrubs	bacharris	15'	Mod	Mod	Mod	No	Mod - high	Below 5000'
	silverleaf buffaloberry*	25'	High – Mod.	High	Fast	Screening	Mod - high	Above 4500'
	Gambel's oak*	30'	Low	High	Slow	Screening shade	Low	Below 9000'
	Gooddings willow	50'	High	Mod.	Fast	No	Low	Below 5000'
	peachleaf willow	40'	High	Mod.	Fast	No	Low	Above 5000'
	coyote willow*	20'	High	Mod.	Fast	No	Low	Below 8000'
	yellow willow*	15'	High	Mod.	Fast	No	Low	Above 4500'
	redbud	20'	Mod.	Mod.	Fast	Yes	Low - mod	Below 5000'
	New Mexico privet	15'	Mod.	High	Fast	Yes	Low - mod	Below 6500'
	Utah serviceberry*	15'	Low	High	Mod.	Screening	Mod - high	Below 8000'
	mountain mahogany*	20'	Low	Mod.	Mod.	Screening	Mod	Above 5500'
	rabbitbrush*	6'	Low	Mod.	Fast	Yes	Low - mod	Below 9000'
	three-leaf sumac*	10'	Low	Mod.	Fast	Screening	Low - mod	Below 8000'
	four-wing saltbush*	5'	Low	High	Fast	Fast	Mod – high (depends on variety/cultivar – some prefer non-saline, sandy soil)	Below 7500'

Table A Legend: *Denotes known local source availability for collection. Green: may not do well at or below indicated elevation; Blue: may not do well at or above indicated elevation; Brown: may not occur in area except at lower elevation – or unknown ecology and presence in area.

SEEDING TECHNIQUES AND TIMING

Seeding can be ideal for establishing grasses and forbs, and some shrubs, although it does require patience in areas without irrigation. In arid regions, establishing plants from seed can be challenging, but seeding is often the most cost effective restoration method, especially on large projects. In addition, seeding may be the most effective restoration method on sites with alkaline and saline soils because containerized materials may not adjust well to the soil conditions, even if the plant is a salt tolerant species. Seeding can also be used as a tool in achieving other land use objectives, such as conversion of fields to pasture grasses or other agricultural crops.

METHODS

Seeding techniques used during restoration efforts consist of broadcast, hydro-seeding, or drill seeding, or a combination of the three. Broadcast seeding is the distribution of seed on the soil surface; seed can subsequently be incorporated into the soil. Hydro-seeding includes the application of seeds dispersed in water under pressure, typically followed by a hydro-mulch application. Drill seeding uses a seed drill to place seeds at optimal depth and spacing for germination. The technique used on a given site may depend on the particular plant species chosen, optimal requirements for establishment, and site access, among other considerations.

Broadcast seeder on a tractor

TIMING

Timing of seed application is another important factor to consider, especially in arid regions. The optimal time to seed may be immediately prior to the period of greatest or most consistent precipitation; however, species establishment rates for the same seeding date may vary from year to year, as favorable weather patterns for one species may not trigger germination in another. In the desert southwest, successful grass seedings typically require three to four successive precipitation events separated by four to seven days. It can take some time for seeding efforts to become visible as some seeds may not germinate for several years.

The time of year when a particular plant germinates is also a consideration before seeding. Some plants need a cold or hot period to trigger germination. Most species germinate only at specific soil temperatures. Warm season grasses, which include bluestems and gramas, among others, typically germinate in May, June and July. Cool season grasses, on the other hand, begin to germinate in February or March. Cool season grasses include Indian rice grass and wildryes, as well as various wheatgrasses, bluegrasses and fescues. Winter or early spring plantings for both warm and cool season grasses may also be successful. While optimum soil temperatures will not have been achieved, soil contact may be improved due to the beating action of rainfall, snow weight, and/or soil heaving.

RATES

Seeding rates for restoration projects are hard to generalize due to variations in both site attributes and goals. Seed quality is typically expressed as PLS (Pure Live Seed). PLS represents how pure the seed is (amount of seed vs. amount of chaff, other non-viable plant material, and/or weed seeds) and the germination rate of the seed. To assure success, seeds with a lower PLS are typically applied at higher rates than seeds with higher PLS values.

Seeding rates are sometimes expressed as the number of seeds or weight of seed per unit area (acre, hectare, etc.). In general, seeding rates should be increased for harsh sites (poor soils, steep slopes, low moisture, etc.) where germination and plant survival will be lower due to the harsh conditions; rates should also be increased if competition from weedy species is expected. Foraging by small animals may contribute to seed loss; likewise, some seeds may not germinate if planted at insufficient depths. While mulching may help to mitigate seed loss, wind and water may also remove seeds from the restoration site. In native plant communities, some have found that grasses generally establish more competitively than forbs, forbs more than shrubs, and shrubs more than trees. For more guidance on seed selection and application rates, visit with a representative from one of the native seed companies listed in Appendix D.

PLANTING TECHNIQUES

A number of different techniques and plant materials can be employed to actively re-establish native plants on a site. These range from vegetative installations of poles and whips, or sprigs to containerized plants. Bare-root plants and plants salvaged from areas that will be disturbed are other effective ways to reestablish plant materials. All of these methods are labor intensive, which limits the number of plants that can be installed. The purpose of live plant materials installation is to establish a modest number of plants that will subsequently grow, mature, and produce more plants on the site. For a more detailed comparison of these different techniques, please see Appendix E.

COTTONWOOD POLE & WILLOW WHIP PLANTINGS:

Planting dormant cottonwood poles and willow whip cuttings is an effective way to establish plants in recently cleared areas with local plant materials. Poles and whips plantings are ideal ways to speed up regeneration of willow and cottonwoods on sites with high water tables. If healthy native riparian communities exist near a project site, pole and whips can be harvested nearby and then transplanted on-site, thereby reducing cost. A number of Natural Resources Conservation Service (NRCS) publications, listed in the resources section, describe proper planting techniques for these materials. Generally, poles should be young with smooth bark. Poles can be effectively planted to over 8′ deep, but, in general, are only useful in riparian and wetland areas where the depth to ground water is consistently within 3 to 8′ of the surface.

BARE ROOT PLANTS:

Young trees and shrubs that are dug, stored, and shipped without soil around their roots are considered bare root plants. This type of material is low cost and easy to ship, as well as easier to transport to remote locations. Plants often have more robust root masses than traditional containerized stock. While many tree species can be produced this way, some fare better than others. Bare root plants may be difficult to establish in drier conditions and they do need to be quickly planted upon arrival at a site. Bare root plants do best when deeply watered in at the time of planting.

CONTAINERIZED PLANTS:

Containerized plantings are the most expensive option for introducing plant materials onto a site – and should be done with a firm goal in mind. Plants can be grown in a number of container sizes, ranging from small tubes and "conetainers", up to large 15 gallon pots. Container size should be chosen based on project goals, budget, and transportation to the project site. In a front country site where little revegetation is necessary and more immediate results are desired, larger sized stock may be desirable. In backcountry settings, with difficult access, smaller containers may be more practical.

More recently developed containers are treepot and tallpot containers. These containers promote the development of long root systems. Depending on the depth to the water table, plants grown in this manner can often be installed such that they reach the capillary fringe, the zone of soil directly above the water table, thereby reducing the need for subsequent irrigation. Tallpots are also useful in dry upland sites where installing roots at least 18" to 24" down can help put them into soils with higher moisture content during the critical establishment period.

Another deep planting method employs the use of long stemmed plants. Not all species can be grown in this manner; only those species whose root-crown can survive burial can be grown this way. This includes many riparian species, and some upland plants. Longstem plants can be grown in treepots or tallpots (which promotes long roots, in addition to long stems); they can also be grown in more standard containers. Useful information about this planting technique may be found by contacting the NRCS, Tamarisk Coalition or Rim to Rim Restoration.

SPRIGGING AND SALVAGE:

For rhizomatous species, those plants able to spread through roots and shoots, sprigging is an effective and inexpensive method to establish plant material. Sprigging involves planting rhizomes at depths of 3-4". One species particularly well adapted to this method is inland saltgrass. Saltgrass can be moved nearly any time of year – though fall and winter sprigging has been seen to be most effective. Desert four o'clock is easy to establish this way as well, as is Woods' rose.

Moving a plant from an area slated for development or disturbance to an area where restoration is occurring can be an effective method of gathering local native plant materials. While operators of heavy equipment are often able to avoid native species when removing woody invasives, salvaging is useful in instances where natives are difficult to see or are in danger of being trampled, or if construction of pipelines, roads, or buildings will destroy plant materials. This technique is not often possible unless vegetation disturbances are nearby and at the right time of year.

IRRIGATION

In some locations, irrigation may be used to accelerate plant establishment and development. This is often necessary where forage or crop production is replacing Russian olive and tamarisk dominated areas. Since irrigation is expensive and often not sustainable unless the land is producing crops or feed, it is not an option on many sites.

Irrigation of restoration sites may be particularly useful for plant species that can be difficult to establish. Irrigation in the first several growing seasons (1-3 years) may assist plant establishment and development, but should not be used long term. The need for irrigation should be determined on a site-by-site basis according to onsite water availability and water needs of seeded and planted species.

Drip, micro-spray, watering tubes, sprinklers, and flooding irrigation techniques can all be effective for riparian restoration projects. As a general rule in arid areas, recommended irrigation rates during the growing season for seeded sites are 0.25" per week, and two times the monthly precipitation average for planted sites. Live plantings need to be watered immediately following planting, unless roots are planted directly into the water table or capillary fringe. If onsite plant available water will not support planted riparian vegetation in the long term, the site may eventually be colonized by xeric grasses, forbs, shrubs, and trees after irrigation ceases, so it is critical to choose plant species to match projected water availability.

OTHER PLANT MATERIALS INFORMATION

HOW MANY PLANTS ARE NEEDED ON A SITE?

Just as with seeding, active revegetation that uses live plant materials requires some calculation of plant numbers. In order to provide cover, habitat, and food resources for wildlife, the Tamarisk Coalition calculated, based on prior planning efforts on the Colorado River, that each Russian olive should be replaced by approximately two riparian shrubs or one upland shrub, depending on the site location. As tamarisk provides less wildlife habitat than an equivalent Russian olive, replacement vegetation can be calculated at 50% of the Russian olive rate. Additional plants may need to be planted in order to account for survivability. These calculations suggest that a heavily infested acre in a riparian setting with 100 Russian olives, and 50 tamarisk trees, for instance, may require at least 300 replacement plants to maintain wildlife resources. Such numbers are merely guidelines to help land managers and owners assess their restoration needs.

LOCATING PLANT MATERIALS and CONTRACTING GROW OUTS

Native plant materials, whether containerized stock or commercially purchased seed, can be challenging to locate. The challenges increase if locally or regionally sourced materials are desired.

Seed companies in Utah generally source seeds collected, grown, or purchased in a given year. Request source information when ordering seed. Sometimes seed companies will have several sources for a given seed, and you can request the source closest to your project. This is particularly true of shrub and forb species, which are often wild collected rather than farm grown.

There are several large nurseries specializing in native plant propagation for revegetation purposes, however, many are not close which increases shipping costs and logistical challenges. Furthermore, many nurseries do not document the sources of their plant materials, or they source their materials from locations close to their propagation fields. When ordering plants, ask if the source seed or cutting is known prior to finalizing the order.

It is possible to send seed to nurseries for contract growing. Nurseries in Utah that specialize in native plant production include Great Basin Natives, Wildland Nursery, High Mountain Nursery, and Wildland Scapes Plant Nursery. Contact information for these nurseries is listed in Appendix D.

PLANT PRODUCTION TIMELINES

It is important to anticipate plant needs long before planting dates arrive. This chart shows the number of months needed to grow some commonly used species from germination to fully rooted plant. The final size of the plant as well as the plant species determines the amount of time needed for a grow-out. The shortest amount of time from germination to rooted material is about 3 months for some grasses and forbs in tubes, or hardwood cutting started cottonwoods.

If longstem or other larger plant materials are needed, germination to finished plant may require up to 21 months. Not only does this make these plants hard to find, but this material also costs more to produce. In locations where used, however, longstem and tall pot plants save money on follow up and in higher survival rates.

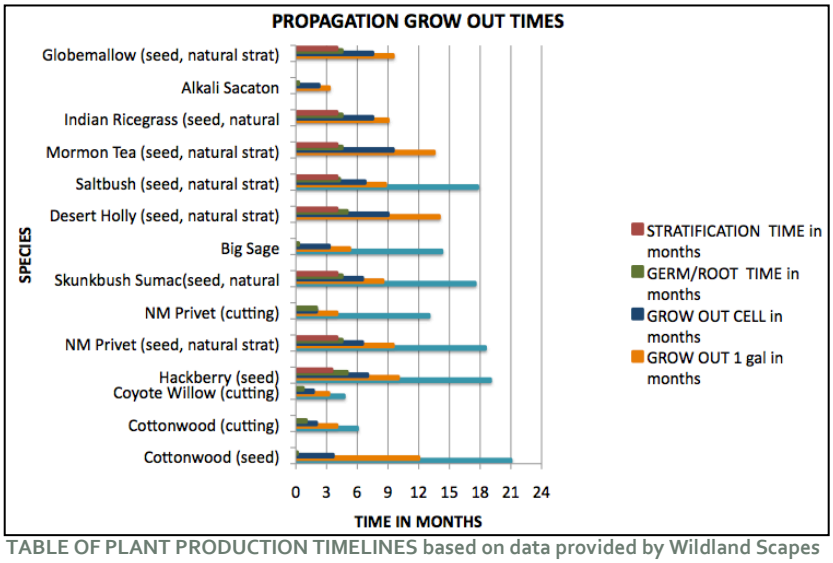


TABLE OF PLANT PRODUCTION TIMELINES based on data provided by Wildland Scapes Plant Nursery, Moab Utah.

MONITORING & MAINTENANCE

Successful large woody invasive removal is a long-term process requiring a long-term commitment to monitoring and maintenance of cleared areas. Ideally, revegetation (whether passive or active) reduces the follow up activities necessary to maintain a healthy riparian area, including but not limited to: resprout and sapling removal, other weed control, and erosion control efforts. Monitoring can be as simple as documented repeat photos or as complicated as vegetation transects coupled with other data collection.

Regardless of the monitoring method, it is critical that each project site is examined several times a year to determine what, if any, follow up activities are needed. During site walkthroughs, landowners should note if plants are regenerating on the site passively; if so, it is important to determine if these plants are desirable plants that meet land owner needs or if they are other weedy species that need further attention. Attachment B of the WICP provides more information on Russian olive retreatment techniques. More information is available about the tamarisk leaf beetle and how it can be used as one tool in the treatment of tamarisk. Detailed monitoring protocols are found in Attachment D of the WICP.

Restoring native vegetation on any site, but particularly in areas cleared of Russian olive and tamarisk, requires commitment and patience. It has been repeatedly shown in other areas of the upper Colorado River watershed that sites do not reach states of equilibrium for at least 5 to 10 years. Repeated monitoring and follow up activities may be required throughout this time. And in those rare sites that recover quickly, repeated monitoring can be a good reminder of why this work is being done.

POSTSCRIPT

Most people begin restoration projects with very practical near-term objectives in mind (e.g., reduction of noxious weeds, expansion of forage for livestock, control of erosion). But as conditions on the land improve and "experiments" work better than expected, some become much more deeply engaged. The process of healing the land can be an extremely rewarding experience. A small project may expand, with goals becoming grander, and may extend to decades. Sharing discoveries, techniques, restoration successes and failures with others engaged in restoration "experiments", or finding additional advice and information that is not locally available is a logical next step.

One extremely valuable resource is the *Society for Ecological Restoration International* (SER). This organization is home to restorationists of all stripes, professional and amateur, as well as academics interested in the scientific basis of successful restoration efforts. Amateur restorationists have been an important part of SER from its beginning. And because ecological restoration (and its academic counterpart, restoration ecology) is among the youngest of the environmental sciences, it is one in which amateurs can still make important contributions. In fact, amateur restorationists on our part of the Colorado Plateau are in a particularly good position to make such contributions because the area is so remote, sparsely populated and little studied. SER's web site (*www. ser.org)* is a good place to begin to explore what's currently happening in ecological restoration in the U.S and around the world as well as an excellent source for connections to various other organizations, individuals, and projects that may provide the additional information you need. SER has also sponsored a series of books (*The Science and Practice of Ecological Restoration*, Island Press) on many aspects of ecological restoration that may be of use.

Finally, and again reflecting the very young nature of this field of study and practice, the first comprehensive textbook devoted to restoration ecology was recently published. *Introduction to Restoration Ecology* (Island Press, 2012) provides an introductory level approach to all the basics of modern restoration planning, implementation and monitoring. It is designed for mid-level college students, but does not assume a strong science background and therefore much of the information in the book should be accessible to interested readers. In addition to explaining the principles of ecological restoration, the book makes them more real by providing examples of actual projects in which these principals are applied.

TABLES AND FORMS

APPENDIX A: EVALUATION FORM

Form filled out by:		
Date:		
Location	Watershed:	
	UTMs:	
Ease of site access & barriers (river, pack animal needed, etc.); landmarks:		
Ownership/owner:		
Conservation easement or equivalent?		
General site description (note, if known, soil type, salinity, depth to water table, usage by wildlife or grazing animals, plants present, etc.):		
Total treatment area (acres), location, and description		Year one treatment area:
		Year two treatment area:
Irrigation available?		
Landowner objectives; removal and revegetation goals (e.g. what is the desired land use for this site):		
Rough scope and timeline of work (if known):		

Circle statement that best characterizes site, or distinct areas of the site:

Presence of natives WITHIN site:	* High native presence within site; easy to spot, located in large groups, of multiple sizes
	* Natives scattered throughout site, plants hard to see but include large shrubs and trees
	* Understory grasses and forbs present
	* Only overstory species present (cottonwood, box elder and hackberry)
	* No native plants visible on site
	Native plants mixed with large woody invasive trees provide opportunities for passive plant regeneration, and can also be important to protect in the event of wildfire. If there are areas of healthy native plants on the site these places can be important locations to clear first to allow plants more access to sun and water, and also to allow them to reproduce.
Presence of natives AROUND site:	* Site surrounded by native plants
	* Site bound by cliff or other barrier; no native plants present
	The presence of native plants around a site is sometimes easier to assess than on-site natives – especially if the area is so thickly grown in that site travel is difficult. Native plants present around a removal area help provide seed source for plant regeneration. Sites that are bounded by no native plants have a higher chance of requiring active plant restoration assistance.
Presence of other invasives plants WITHIN site:	* No invasive plants known on site
	* Scattered patches of understory invasive plants
	* Dense understory of known invasive plants
	* Scattered individual invasive woody tree species
	* Dense areas of other invasive woody tree species
	If there are herbaceous or other large woody invaders on the site, it is important to note this early. Clearing one invader can simply allow others to expand. It may be important to stay out of some areas to allow native plant regeneration first; or one may want to remove all invasives at the same time.
Presence of other invasive plants AROUND the site:	* No invasive plants around site
	* Patches of invasive understory around site
	* Dense invasive understory around site
	* Individual woody invasives nearby
	* Dense woody invasives around site
	Even if there are no visible invasives IN the site, if there is an adjacent population, they do pose a threat. Due to their nature, these plants are likely to move into a newly cleared area faster than desirable plants.
Density and distribution of Russian olive or tamarisk prior to removal:	* 25% of less canopy cover
	* 50% of less canopy cover
	* 75% of less canopy cover
	* 100% of less canopy cover
	Note areas where Russian olive/tamarisk may be less dense; may want to begin work in these areas.
Age and size of invasive trees:	* Saplings, most less than 8' tall
	* Young trees; most less than 15' tall
	* Mature trees, most greater than 25' (in the case of Russian olives, many up to 40')
	Tree size can provide useful planning information when combined with density and distribution information. It is also important note if many sizes of plants are present, this suggests many generations of plants may be on the site.

APPENDIX B : OTHER WEEDS COMMON IN THE ESCALANTE RIVER WATERSHED

Common Name	Latin Name	Description	Best Time to Survey for Presence	Herbicide Treatment Method and Timing	Non-Chemical Control Methods	Typical Length of Seed Viability	Legal Status in Garfield County***	Other Notes
STATE NOXIOUS WEEDS								
Russian knapweed	***Acroptilon repens***	Perennial forb, 2 - 3'tall,	Rosettes visiblke early summer; Purple flowers through summer into fall	Milestone, Transline or Roundup may be used. Tordon is also labeled for knapweed control but cannot be used in riparian areas.	Two mowings eight weeks apart (first at bud growth stage) have been shown to suppress and prevent seed spread, but it will return the following year. A biocontrol insect is also currently being tested.	Reported to range from 2-3 years, up to 9 years	Listed as a problem noxious weed in Garfield County	Toxic to horses. Older stands may accumulate allelopathic residues in soil. Reproduces by seed and roots.
camelthorn	***Alhegi maurorum***	Perennial shrub, 1.5- 4 feet tall,	Flowers in early to mid-summer. It is greenish and hairless and recongnizable by spiny and intricate branching.	Roundup can provide some control, though multiple applications will be needed. Tordon is effective, but is limited in where it can be used.	Chemical control is likely most effective control strategy. Difficult to address extensive root system with non-chemical methods.	vegetative reproductio n is more common than by seed	Listed as noxious in Arizona, but not in Utah	reproducing by seed and or vegetatively via spreading roots/ rhizomes, and can reach watertables over 40' deep. Care needs to be taken in controling this weed in riparian areas
perennial pepperweed aka perennial peppergrass aka tall whitetop	***Lepidium latifolium***	Perennial forb, 1 to 6 ' tall,	White lowers from summer to early fall	(Telar) is an herbicide reported to be very effective, although there are other options.	Young first-year seedlings can be controlled by handpulling,	Reported to be at least 2 years	Not reported as present in Garfield County	There have been reports of horses becoming ill after eating hay contaminated with this weed
hoary cress aka whitetop	***Cardaria draba***	Perennial forb, up to 2 feet tall,	Flowers late spring	Escort XP, chlorsulfuron, and imazapic are three options for chemical treatment.	Complete digging up of entire plant and all others in area throughout the growing season, for 2 to 4 years, may provide adequate control.	Reported to be 3-4 years	Listed as a problem noxious weed in Garfield County	Grows particularly well on somewhat saline soils
WEEDY ANNUAL SPECIES								
Russian thistle	***Salsola kali***	Annual forb, 0.5 to 3 feet tall	mid-summer to find it before it matures, breaks off, and becomes 'tumbleweed'	Round up or 2,4-D are effective when platns are small	Handpull from moist soil	Reported to remain viable for approximate ly 1 year		One of the most common and troublesome weeds in the drier regions of North America
puncturevine aka goathead	***Tribulus terrestris***	Annual forb, less than 4" tall, 0.5 to 5 feet long	Flowers late spring to early summer	Round up can be effective if applied before flowers start	easy to hand pull or hoe if caught without flowers;	Not reported		The hard, spiny burs produced by this plant injure livestock, are undesirable in hay, and can damage wool.
cheatgrass aka downy brome	***Bromus tectorum***	Annual grass, 4 to 30 inches tall	Can germinate in fall or spring; generally goes to seed in mkid spring	Roundup will kill current year's growth, but should be applied in winter or early spring to ensure is applied before sets seed.	Handpull from moist soil. Mowing is generally not considered useful without multiple mowings	reported to last approx 2 to 3 years		After maturity can become a fire hazard. Also known to provide early spring forage for livestock.
ripgut brome	***Bromus diandrus***	Annual grass, 1 to 3 feet tall	Can germinate in fall or spring; generally goes to seed in mkid spring	Similar to B. tectorum	Similar to B. tectorum	Not reported		At maturity, the long stiff awns of this plant can cause injury to the nose and eyes of grazing animals
NEW AND INVADING SPECIES								
ravenna grass	***Saccharum ravennae***	Perennial grass, up to 7 feet tall	Flowers mid-summer to fall	Roundup will work	Glen Canyon National Recreation area utilizes bulldozing, manual removal, and controlled burns as non-chemical control methods.	Not reported	Not included on State of Utah Noxious Weed List	Ravenna grass is often mistaken for Pampas grass, a less cold hardy cousin. Grass takes over stream banks and can be very hard to remove
purple loosestrife	***Lythrum salicaria***	Perennial forb, growing up to 6 to 8 feet tall,	Flowers mid-summer	Garlon 3A , Rodeo	Young first-year seedlings can be controlled by handpulling; older plants are hard to remove by digging	Reported to be at least 2 years		Infestations can become dense and block flow of water in ditches and canals. It is commonly reported that wildlife habitat is reduced with invasion of this weed.

APPENDIX C: POTENTIAL PLANT SPECIES FOR AREAS IMPACTED BY WOODY INVASIVE SPECIES

SHER ET AL. 2010, NISSEN ET AL. 2010, SHAFROTH ET AL. 2008, NRCS- LOS LUNAS PUBLICATION #2.

Scientific Name	Common Name	Available Cultivars for this Region (if any)	Probable Planting Zone	Mycorrhizal Status	Salinity Threshold dS/m	Max Salinity dS/m	Origin/Life History	Seral Status
Grasses								
Achnatherum hymenoides	Indian rice grass	Nezpar, Paloma, Rimrock	Riparian arid, non saline	M - En	4	6	N - P	E, M, L
Bothriochloa barbinodis	cane bluestem	Saltillo	Riparian arid	M - En	4	8	N - P	NA
Bouteloua curtipendula	sideoats grama	Vaughn	Moderately alkaline flats	M - En	<4	<4	N - P	NA
Bouteloua gracilis	blue grama	Hachita, Vaughn	Riparian arid, non saline	O - En	4	8	N - P	L
Distichlis spicata	saltgrass	Local ecotype	Riparian, saline swales, salt meadow	F - En	6	12	N - P	E, M, L
Elymus canadensis	Canada wildrye	Mandan	Streambank, riparian mesic	O - En	6	12	N - P	P, E, M
Elymus elymoides	bottlebrush squireltail	Sand Hollow, Toe Jam Creek, Fish Creek	Riparian arid, riparian mesic, saline	M - En	4	8	N - P	E, M, L
Elymus lanceolatus	thickspike wheatgrass	Bannock	Riparian arid	M - En	<4	<4	N - P	NA
Elymus trachycaulus	slender wheatgrass	Pryor, San Luis	Swales	O - En	10	22	N - P	P, E
Hesperostipa comata	needle and thread	Local ecotype	Mesic to upland	M-En	4	8	N-P	E,M
Muhlenbergia asperifolia	scratchgrass	Local ecotype	Riparian mesic	NA	>12	>12	N - P	NA
Pascopyrum smithii	western wheatgrass	Rosana, Rodan, Arriba, Walsh, Barton	Meadow	M - En	6	16	N - P	M, L
Pleuraphis jamesii	Galletta grass	Viva	Riparian arid	M - En	6	12	N - P	M, L
Poa secunda	Sandberg bluegrass	Canbar, Sherman, Opportunity, Mtn. Home	Riparian arid	O - En	4	6	N - P	E, M
Panicum obtusum	vine mesquite	Local ecotype	Riparian mesic, swales	M - En	8	12	N - P	NA
Panicum virgatum	switchgrass	Alamo	Riparian mesic	M - En	4	8	N - P	NA
Schizachyrium scoparium	little bluestem	Local ecotype	Riparian arid	M - En	<4	<4	N - P	NA
Spartina gracilis	alkali cordgrass	Local ecotype	Riparian mesic	NA	>12	>12	N - P	NA
Sporobolus airoides	alkali sacaton	Salado, Saltalk	Meadow	O - En	14	26	N - P	P, E, M
Sporobolus cryptandrus	sand dropseed	Local ecotype	Riparian arid, Salt Desert Scrub	F - En	6	8	N - P	E, M
Sporobolus giganteus	giant dropseed	Local ecotype	Riparian arid	M - En	<4	<4	N - P	NA
Forbs								
**Cleome lutea*	yellow bee plant	Local ecotype	Riparian arid	NA	<4	<4	N - A	P,E
**Eriogonum* spp.	buckwheat	Local ecotype	Riparian mesic, riparian arid	NA	<4	<4	N - P	NA
Gaillardia pinnatifida	blanketflower	Local ecotype	Upland, desert shrub	NA	<4	<4	N - P	NA
Heliotropium curassavicum	heliotrope	Local ecotype	Riparian mesic, riparian arid, saline swales	N	8	15	N - P	M, L
Mentzelia spp.	blazing star	Local ecotype	Riparian arid	NA	<4	<4	N - A, B, P	NA
Oenothera spp.	evening primrose	Local ecotype	Riparian mesic, saline swales	N	4	6	N - P	P, E, M
Penstemon eatonii	firecracker penstemon	Local ecotype	Upland	obligate	<4	<4	N - P	P, E

APPENDIX C CONTINUED:

Scientific Name	Common Name	Available Cultivars for this Region (if any)	Probable Planting Zone	Mycorrhizal Status	Salinity Threshold dS/m	Max Salinity dS/m	Origin/Life History	Seral Status
Forbs (Continued)								
Penstemon palmeri	Palmer's penstemon	Local ecotype	Upland	NA	<4	<4	N - P	P, E
Plantago patagonica	woolly plantain	Local ecotype	Riparian arid, saline swales, alkaline flats	FAC - En	2	6	N - P	M, L
Sphaeralcea spp.	globemallow	Local ecotype	Riparian arid, saline swales	FAC - En	4	8	N - P	E, M
Shrubs								
Alnus tenuifolia	thinleaf alder	Local ecotype	Riparian mesic		<4	<4	N - P	P, E, M
**Amelanchier alnifolia*	Saskatoon serviceberry	Local ecotype	Riparian	M - En, EC	8	12	N - P	M, L
**Amelanchier utahensis*	Utah serviceberry	Local ecotype	Mesic		<4	<4	N - P	P, E
Artemisia filifolia	sand sagebrush	Local ecotype	Riparian arid	M - En	2	4	N - P	L
Artemisia tridentata ssp. *tridentata*	basin big sagebrush	Local ecotype	Riparian arid	M - En	4	6	N - P	L
Artemisia tridentata ssp. *wyomingensis*	Wyoming big sagebrush	Gordon Creek	Riparian arid	M - En	4	6	N - P	M, L
Atriplex canescens	fourwing saltbush	Wytana, Rincon	Riparian arid, saline swales, alkaline flats	N	6	10	N - P	P to L
Atriplex confertifolia	shadscale saltbush	Local ecotype	Alkaline flats	N	12	20	N - P	M, L
Atriplex gardneri	Gardner's saltbush	Local ecotype	Riparian arid, saline swales, alkaline flats	N	6	10	N - P	M, L
**Baccharis salicifolia*	mule fat	Local ecotype	Streambank, riparian mesic	FAC - En	8	12	N - P	E, M
**Baccharis salicina*	willow baccharis	Local ecotype	Streambank, riparian mesic	FAC - En	8	12	N - P	E, M
Cercocarpus montanus	mountain mahogany	Local ecotype	Mesic to upland	FAC - En			N - P	E, M, L
Dasiphora fruticosa	shrubby cinquefoil	Local ecotype	Mesic to upland	M - En	4	8	N - P	E, M, L
**Ericameria nauseosa*	rubber rabbitbrush	Local ecotype	Riparian mesic, riparian arid	M - En	4	6	N - P	E, M
Krascheninnikovia lanata	winterfat	Hatch	Riparian arid	N	6	10	N - P	M, L
**Lonicera utahensis*	Utah honeysuckle	Local ecotype	Mesic	N	2	4	N - P	
**Lycium andersonii*	wolfberry	Local ecotype	Riparian arid	M - En	8	12	N - P	M, L
Pluchea sericea	arrowweed	Local ecotype	Riparian mesic	NA	8	12	N - P	NA
**Prunus virginiana*	chokecherry	Local ecotype	Mesic	M - En, Ec	8	10	N - P	P to L
**Quercus gambelii*	Gambel oak	Local ecotype	Mesic	M - En, Ec	4	6	N - P	E, M
**Rhus trilobata*	three-leaf sumac	Bighorn	Riparian mesic, riparian arid	M - Ec	4	8	N - P	E, M
**Ribes aureum*	golden current	Local ecotype	Mesic	M - En	2	4	N - P	E, M
**Rosa woodsii*	Woods' rose	Local ecotype	Riparian mesic	M - Ec	2	4	N - P	E, M, L
**Salix amygdaloides*	peachleaf willow	Local ecotype	Riparian	M - En, Ec	2	4	N - P	P, E, M
**Salix exigua*	coyote willow	Local ecotype	Riparian mesic	M - En, Ec	2	4	N - P	P, E, M

APPENDIX C CONTINUED:

Scientific Name	Common Name	Available Cultivars for this Region (if any)	Probable Planting Zone	Mycorrhizal Status	Salinity Threshold dS/m	Max Salinity dS/m	Origin/Life History	Seral Status
Shrubs (Continued)								
**Salix lutea*	yellow willow	Local ecotype	Riparian mesic	M - En, Ec	2	4	N - P	P, E, M
**Sambucus nigra*	blue elderberry	Local ecotype	Mesic to riparian	M - En, Ec	2	4	N - P	E, M
Sarcobatus vermiculatus	greasewood	Local ecotype	Alkaline flats, saline swales	N	6	10	N - P	M, L
**Shepherdia argentea*	sliverleaf buffalo berry	Sakakawea	Arid	M - Ec	8	12	N - P	P to L
Suaeda moquinii	seepweed, seablite	Local ecotype	Alkaline flats, sinks, pools	N	12	30	N - P	M, L
**Symphoricarpos longiflorus*	desert snowberry	Local ecotype	Riparian mesic	M - En	4	8	N - P	M, L
**Symphoricarpos occidentalis*	western snowberry	Local ecotype	Riparian mesic	M - En	4	8	N - P	M, L
Trees								
**Acer glabrum*	Rocky Mountain maple	Local ecotype	Riparian mesic	M - Ec	4	6	N - P	E, M, L
**Acer grandidentatum*	big tooth maple	Local ecotype	Mesic to riparian	M - En, Ec	4	6	N - P	E, M, L
Acer negundo	box elder	Local ecotype	Riparian				N - P	P to L
Betula occidentalis	water birch	Local ecotype	Streambank, riparian mesic	FACW	4	6	N - P	M, L
Celtis reticulata	netleaf hackberry	Local ecotype	Mesic	M - En	4	6	N - P	E, M, L
**Cercis orbiculata*	redbud	Local ecotype	Riparian	NA	<4	<4	N - P	P to L
**Forestiera pubescens*	New Mexico olive	Jemez	Riparian arid	M - En	4	6	N - P	M, L
Fraxinus anomala	single leaf ash	Local ecotype	Riparian mesic, riparian arid	NA	<4	<4	N - P	NA
Populus angustifolia	narrowleaf cottonwood	Local ecotype	Riparian	M - En, EC	2	4	N - P	P to L
Populus fremontii	Fremont cottonwood	Local ecotype	Streambank, riparian mesic	M - En, Ec	2	4	N - P	P to L
**Salix gooddingii*	Goodding's willow	Local ecotype	Riparian mesic	M - En, Ec	2	4	N - P	P, E, M

***Appendix C legend listed below:**

Mycorrizal status (O = obligate mycorrhizal, M = strongly mycorrizal, F = facultative mycorrizal, N = nonmycorrhizal, Type En = endomycorrihiza, and NA=not available, EC = ectomycorrhizal);

Threshold salinity refers to soil salinity levels at which plant performance noticeably decreases;

Maximum salinity refers to soil salinity levels at which plant establishment, development, and growth is severely affected;

Origin (N = Native to Continental U. S.) and Life History Status (A = annual, B = Biennial, and P = Perennial);
Seral status (P = pioneer, E = early seral, M = mid seral, L = late seral, and NA=not available)
* Denotes good species for pollinators

Native Plant Nurseries*						
	Name of Nursery	**Contact**	**Location**	**Phone #**	**Website**	**Types of Materials Produced**
AZ	Flagstaff Native Plant and Seed		Flagstaff	928.773.9406	http://www.nativeplantandseed.com	provide ecotype specific native plants, specialize in propagule collection and growing for Colorado Plateau projects
	Glen Canyon National Recreation Area	Lonnie Pilkington	Page			
	Warner's Nursery and Landscaping		Flagstaff	928.774.1983	http://www.warnercompanies.com	
CA	Greenheart Farms	Rodney Thurman	Arroyo Grande	805 481 2234	http://www.greenheartfarms.com/reclamation/reclamation.htm	riparian revegetation materials; custom-grows; will propagate locally collected seed
CO	Aquatic & Wetland Co.		Ft. Lupton	303.857.6157	http://www.aquaticandwetland.com	wholesale ONLY; grow more than 50 species of wetland and riparian plants native to the Rocky MT region and SW US; bare-root and potted plants; specialize in contract growing
	Chelsea Nursery	Stacey Stecher	Clifton	970.434.8434	http://www.chelseanursery.com/	specialize in xeric and native plants
	Rocky Mountain Native Plants	Tom Glass	Rifle	970.625.4769	http://www.rmnativeplants.com/	specialize in native plants; can do custom grows for a variety of projects; seed collection services
UT	Great Basin Natives		Holden	435.795.2303	http://www.greatbasinnatives.com	specialize in plants native to the Great Basin and surrounding areas
	High Mountain Nursery		Draper	435.731.0107	http://www.highmtnnursery.com	grow native plants from identified seed sources; can do custom grow outs
	Progressive Plants		Copperton	888.942.7333	http://www.progressiveplants.com/	native and water-wise plants; acquire plants from other growers
	Wildland Nursery	Janette Warner	Joseph	435.527.1234	http://www.wildlandnursery.com/	native plant materials; can do custom grows for reclamation projects
	Wildland Scapes	Kara Dohrenwend	Moab	435.259.6670	http://www.revegmoab.com/	regionally grown native plants; contract grows for revegetation projects

*Several other nurseries exist; this sheet provides info for nurseries, relatively near the Escalante River Watershed, with natives as their primary focus.

APPENDIX D CONTINUED:

Seed Companies**						
	Name of Seed Company	**Contact**	**Location**	**Phone #**	**Website**	**Types of Materials Produced**
CO	Pawnee Buttes Seed, Inc.		Greely	800.782.5947	http://www.pawneebuttesseed.com/	native grass, forb, shrub seed
	Sharp Bros. Seed Co.		Greely	800.421.4234	http://www.sharpseed.com/	native grass and forb seed
	Southwest Seed		Dolores	907.565.8722	http://www.southwestseed.com/	native grass, forb, shrub seed
	Western Native Seed		Coaldale	719.942.3935	http://www.westernnativeseed.com/	native grass, forb, shrub seed
UT	Granite Seed		Lehi	801.768.4422	http://graniteseed.com/	native grass, forb, shrub seed; can order source-identified seed
	Stevenson Intermountain Seed		Ephraim	435.283.6639	under construction	native grass, forb, shrub seed
	Utah Seed	Orson Boyce	Clearfield	801.774.0525	http://www.utahseed.com/	land reclamation and restoration, pasture and range

**Several other seed companies exist; provided info for larger companies with natives as their primary focus

APPENDIX D CONTINUED:

Plant Material Centers***						
	Name of Plant Materials Center	**Contact**	**Location**	**Phone #**	**Website**	**Types of Materials Produced/Focus Area**
CO	Upper Colorado Environmental Plant Center	Steve Parr	Meeker	970.878.5003	http://plant-materials.nrcs.usda.gov/copmc/	native grass, forb, and shrub seed releases, limited production of longstem/tallpot products; may help with contract grow
ID	Aberdeen Plant Materials Center	Loren St. John	Aberdeen	208.397.4133	http://plant-materials.nrcs.usda.gov/idpmc	native grass, forb, and shrub seed releases; published extensively on cottonwood/willow pole planting techniques
NM	Los Lunas Plant Materials Center	Greg Fenchel or Dave Dreesen	Los Lunas	505.865.4684	http://plant-materials.nrcs.usda.gov/nmpmc/	native grass, forb, and shrub seed releases, leaders in production of longstem/tallpot products; may help with contract grow
UT	Mayberry Native Plant Materials Center	Kara Dohrenwend	Moab	435.259.6670	under construction	locally sourced plant propagation and seed increase facility

***Escalante River Watershed near the service area boundary for these three plant materials center.

This table represents, to the best of ERWP's knowledge, known suppliers of native plant materials. If you would like to be added to the list, please contact the ERWP. ERWP does not recommend one supplier over another. If you have questions about a particular supplier, please contact them directly.

APPENDIX E: PLANT MATERIALS COMPARISONS

PLANT MATERIAL	DESCRIPTION	USES	APPLICABLE SPECIES	SIZE	LIMITATIONS	CONSIDERATIONS	EQUIPMENT NEEDS	BEST TIME TO PLANT	TYPICAL COST*
Poles	dormant cuttings of young, robust, smaller diameter cottonwood trees	help to armor & stabilize banks; typically used on upper-banks and floodplains	cottonwood (Fremont or narrowleaf), larger willow species; may work with bacharris, New Mexico olive	10-16' long; >3/4" diameter - best to use cuttings 2-3" diameter	*may need to protect from beaver *may be difficult to install in soils with high % of cobble; holes may collapse in sandy soil; soils w/ high % of silt/clay may prevent aeration	*need to plant in water table to ensure hydration; *works best when water w/in 10' of surface and w/in 40' of active flows *plant deeply in alluvium to resist extraction by flood	*for cutting* - sharp lopping shears, pruning shears, wood saw or chain saw *for planting* - water jet stinger/auger for planting	late fall (after dormancy) or early spring (before bud break); typically Dec - March	$8-$15 - may be charged by the foot; can collect poles for free in some areas - may need to obtain permits from land mgmt. agency
Whips	dormant small diameter cuttings of willow and other woody spp.	help to armor & stabilize banks; typically used from water line to mid-bank	willow spp., water birch, thin-leaf alder, redoiser dogwood	varying height - typically around 8' long; stems should be >3/8th" diameter; can be planted in clumps	same as poles	*need to plant in water table to ensure hydration throughout year *plant deeply in alluvium to resist extraction by flood	*for cutting* - sharp lopping shears, pruning shears, wood saw or chain saw *for planting* - rotary hammer drill, water jet stinger (fine-textured soils), or auger	late fall (after dormancy) or early spring (before bud break); typically Dec - March	can typically harvest near restoration sites; may need permit on public land
Bare Root	1-3 year old trees and shrubs that are dug, stored, and shipped without soil around their roots	same uses as other products; may be advantageous due to lower cost and ease of shipping; plants also have more robust root masses than traditional stock	most trees can be produced this way, however, some fare better than others	depends on species and age; can be shipped in bundles	*not applicable to all species *not all nurseries produce bare root stock *may be difficult to establish in drier conditions	need to plant bare root products quickly upon arrival	traditional planting tools (shovel, etc)	early spring (before bud break) or late fall (after leaf drop)	~$1-5/each; typically 40-70% less than containerized stock
***Tubes/ Conetainers**	individual plastic cells used to start plants	good for starting seedlings; easy to re-fill, transport	most	typically around 1" diameter; range from ~5-8' height	*plants need to be planted or up-potted so they don't become root-bound *shorter plants often difficult to find in outplanting (to assess survivability)	*may need more frequent irrigation *smaller plants may need protection from browse	traditional planting tools (shovel, hoedad, etc)	Fall	$.75-2.50 depending on species
***#1-#15 Containers**	plastic containers that can be used to grow plants in a variety of conditions; easy to move and transport	can be used to grown variety plants to maturity; larger sizes more applicable to tree species	all	ranges; #1 (or gallon) hold 3 quarts of soil, size is 6" wide X 7" deep	*shorter root systems often incapable of reaching soil moisture during drought *shorter plants often difficult to find in outplanting (to assess survivability)	inspect nusery stock to ensure healthy root growth (i.e. not root bound or under-developed)	traditional planting tools (shovel, hoedad, etc); for larger sizes, mechanized equipment useful	Fall	varies widely depending on species and size
***Treepots**	plastic containers that hold ~1 gal of soil	good for the growth of larger seedlings and longstem plants; robust root development	species with roots capable of lateral, downward growth	varies; one-gallon treepots are 4'X4'X14'	*may be difficult to install in soils w/ high % cobble	*may be beneficial to use watering tubes for supplemental irrigation *do not submerge plant in water table	soil auger	September-March	$10-15 each

APPENDIX E CONTINUED:

PLANT MATERIAL	DESCRIPTION	USES	APPLICABLE SPECIES	SIZE	LIMITATIONS	CONSIDERATIONS	EQUIPMENT NEEDS	BEST TIME TO PLANT	TYPICAL COST*
Tallpot (or deep pot) Plants	4" X 30" plastic or pvc pots that allow for rapid root extension into the capillary fringe ; plants have an extensive root system	useful when irrigation is unavailable as the root ball of plant can be placed in contact with capillary fringe; esp. useful in areas with fluctuating water tables	species with roots capable of lateral, downward growth	typically pots measure around 4" X 30"	*may need to protect from beaver *may be difficult to install in soils with high % of cobble	*may be beneficial to use watering tubes for supplemental irrigation *do not submerge plant in water table *despite depth of planting, can still be affected by high salinity	need soil auger that can reach water-table (in some cases >8' deep)	September-March	$25 each
Longstems	woody plants grown such that they have a long stem that can be partially buried into the capillary fringe; can be grown in tallpots, treepots, or other containers	useful when irrigation is unavailable as the root ball of plant can be placed in contact with capillary fringe	box elder, four-wing saltbush, netleaf hackberry, New Mexico olive, three-leaf sumac, golden current, willow spp., silverleaf buffaloberry, bacharris spp.; root crown of species must tolerate burial	stem heights reach up to 6', with total plant height reaching 9'	Same as tallpots/deep pots	*plants take between 3-4 years to reach maturity upon propagation; need to plan ahead if interested in purchasing * may be difficult to plant if soil has high % of cobble	need soil auger or larger diamter stinger bar that can reach water-table (in some cases >8' deep)	September-March	$15 each
Sprigging	sprigging is the practice of planting stolons or rhizomes at a depth of 3-4"	useful to establish plants in soils w/ higher salinity levels; rhizomes more salt tolerant that seedlings	saltgrass or other warm season grasses	good to plant rhizomes in groups of 5 15	practice limited to certain grasses	may need to prepare soil to ensure good survival	just need to dig small furrow or pit, depending on length of sprig	late spring to early summer for warm season grasses	can typically harvest for free
Salvage	transplanting whole plants from their native habitat; typically salvage plants taken from an area slated for development or disturbance	esp. useful if restoration site near area to be developed; i.e. housing development, road widening	common woody restoration species	*works best when plants are isolated; not connected by intertwining roots or runners *best to choose plants under 3' tall	may need to build storage bed for plants if unable to plant directly	*best to salvage on overcast days	sharp shovel, pruning shears, wet burlap bag lined with mulch or wet leaves	late fall through winter when plants are dormant	free,gain permission before collecting on private lands

ESCALANTE RIVER WATERSHED PARTNERSHIP (ERWP) – RESTORATION PLAN RESOURCES & REFERENCES

The following is a list of resources that can be used by land managers and landowners to help inform restoration planning and implementation. Documents provided in hard-copy to Boulder Community Alliance are denoted with a *.

Hyperlinks to documents are also provided when available.

RESTORATION MANUALS:

- Bradley, J. 1997. Bringing back the bush. The Bradley method of bush regeneration. Lansdowne Publishing Pty. Ltd. 18 Argyle Street , The Rocks, New South Wales, Australia.
- Colorado Natural Areas Program, Colorado State Parks, and Colorado Department of Natural Resources. 1998. Native plant revegetation guide for Colorado. 258p.
- Dorner, J. 2002. An introduction to using native plants in restoration projects. Center for Urban Horticulture, University of Washington. 66p.
- Nissen, S., A. Norton, A. Sher, and D. Bean. 2010. Tamarisk best management practices in Colorado watersheds. Joint publication of Department of Bioagricultural Sciences and Plant Pathology, Colorado State University, Fort Collins, CO; Department of Research and Herbaria, Denver Botanic Gardens, Denver, CO; Colorado Department of Agriculture, Denver, CO; and Department of Biological Sciences, University of Denver, Denver, CO. 79p. (see: Tamarisk: BMPS to order)*****
- Sher, A., K. Lair, M. DePrenger-Levin, and K. Dohrenwend. 2010. Best management practices for revegetation after tamarisk removal in the Upper Colorado River Basin. Joint publication of Department of Research and Herbaria, Denver Botanic Gardens, Denver, CO; Department of Biological Sciences, University of Denver, Denver, CO; and United States Department of the Interior. 49p.(see: http://www.anna.sher.com/ to order)*****
- U. S. Department of Agriculture (USDA). 2007. A guide for planning riparian treatments in New Mexico. Joint publication of U.S. Department of Agriculture, New Mexico Natural Resources Conservation Service, New Mexico Association of Conservation Districts, and NRCS Los Lunas Plant Materials Center. 41p. (see: A Guide for Planning Riparian Treatments in New Mexico to download)

PLANS FROM OTHER WATERSHEDS/ASSESSMENTS:

- Arkansas River Watershed Invasive Plants Plan (ARKWIPP) (2008)
- Colorado Headwaters Invasive Partnership (CHIP) (2008)
- Colorado River Basin tamarisk and Russian olive assessment (2009)***(Disk)**
- Dolores River Restoration Action Plan (2010)
- Glen Canyon National Recreation Area and Rainbow Bridge National Monument Integrated Pest Management Plan (2007)
- South East Utah Tamarisk Partnership (SEUTP)- Woody Invasives Species Management Plan (2007)

NATURAL RESOURCES CONSERVATION SERVICE (NRCS) PAMPHLETS, BOOKLETS AND TECHNICAL NOTES)

LOS LUNAS PLANT MATERIALS CENTER PUBLICATIONS:

- Deep-planting techniques to establish riparian vegetation in arid and semi-arid regions. (PDF; 492K) David R. Dreesen and Gregory A. Fenchel. 2010. Native Plants Journal, Indiana Press. 11(1):15-18, 20-22 2010. 7p. (ID# 9703) *****

- Guidelines for Planting Dormant Whip Cuttings to Revegetate and Stabilize Streambanks:Deep Planting - The Ground Water Connection. (PDF; 478 KB) Los Lunas Plant Materials Center. 2007. Los Lunas PMC, Los Lunas, NM. 2007. 2p. (ID# 7105) *
- Guidelines for Planting Longstem Transplants for Riparian Restoration in the Southwest: Deep Planting-The Ground Water Connection. (PDF; 475 KB) Los Lunas Plant Materials Center. 2007. Los Lunas PMC, Los Lunas, NM. 2007. 2p. (ID# 7106) *
- Revegetating Riparian Areas in the Southwest "Lessons Learned". (PDF; 170K) David R. Dreesen, Gregory A. Fenchel. 2010. Plant Materials Technical Note, New Mexico NRCS Website, Los Lunas, NM. LLPMC Technical Note No. 70. 5p. (ID# 9431)
- Seeding Native Grasses in the Arid Southwest. (PDF; 302 KB) David Dreesen. 2009. NRCS New Mexico Website, Los Lunas, NM. November 2008. 8p. (ID# 8352)*
- Seeding Xeric Riparian Sites Following Removal of Invasive Phreatophytes. (PDF; 47 KB) David Dreesen, Greg Fenchel, Danny Goodson, and Keith White. 2006. Handout for Riparian Management Course for NRCS New Mexico employees, Los Lunas, NM. June 5-9, 2006. 8p. (ID# 6608)*
- Selecting the Appropriate Native Plants for Revegetation and Restoration Purposes in the Southwest. (PDF; 649K) David R. Dreesen. 2010. Plant Materials Technical Note, New Mexico NRCS Website, Los Lunas, NM. LLPMC Technical Note No. 69. 16p. (ID# 9432)*

ABERDEEN IDAHO PLANT MATERIALS CENTER:

- How to plant willows and cottonwoods for riparian restoration. (PDF; 1.7 MB) Hoag, JC. 2007. IDPMC, Aberdeen, ID, Aberdeen, ID. Tech Note 23 revision 1/2007.22p. (ID# 7064)*
- Field Guide for the Identification and Use of Common Riparian Woody Plants of the Intermountain West and Pacific Northwest Regions. (PDF; 9.8 MB) Hoag, C, D. Tilley, D. Darris, and K. Pendergrass. 2008. Plant Materials Programs of Idaho and Oregon, Aberdeen, ID. February 2008. 196p. (ID# 7428)
- Technical Note 39: Waterjet Stinger - A tool to plant dormant unrooted cuttings of willows, cottonwoods, dogwoods, and other species. (PDF; 2.5 MB) Hoag, J.C., B. Simonson, B. Cornforth, and L. St. John. 2001. USDA-NRCS, Boise, ID. ID-TN39, Feb. 2001. 13p. (ID# 1083)
- Vertical Bundles: a streambank bioengineering treatment to establish willows and dogwoods on streambanks. (PDF; 1,036k) Hoag, JC. 2010. Aberdeen Plant Materials Center, Aberdeen, ID. January 11, 2010. 6p. (ID# 9299)

LITERATURE, SORTED BY TOPIC:

COTTONWOOD AND WILLOW RECRUITMENT/ESTABLISHMENT

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