LATAH SOIL AND WATER CONSERVATION DISTRICT
RIPARIAN REVEGETATION STRATEGIES
Prepared by: Brenda Erhardt, May 2022, version 2022.1

Overview

Latah Soil and Water Conservation District's (Latah SWCD) riparian revegetation efforts are multi-faceted, site-specific, and based off proven revegetation techniques. These revegetation strategies are adapted for efficiency and effectiveness by multi-agency professionals with over 20 years of steelhead habitat restoration experience in the Potlatch River watershed and are continually evolving as new technique are learned and to meet site and project objectives. The National Marine Fisheries Service's (NMFS) steelhead recovery plan lists the following habitat restoration priorities for steelhead habitat restoration projects (NMFS 2017):

1. Restore hydrologic processes to retain surface flow by reducing surface runoff from altered land surfaces, disconnecting artificial drainage systems from natural drainage systems, and modifying water uses. This will contribute to reducing stream temperature problems.
2. Restore channel-forming processes by reestablishing floodplains in incised channels, removing or setting back flood control structures, and rehabilitating stream channels that have been straightened.
3. Reestablish riparian vegetation to improve LWD recruitment and create shade for streams.
4. Reduce fine sediment delivery to streams where it is increased caused by agriculture, road drainage systems (including undersized culverts), or other artificial sources.
5. Inventory, prioritize, and eliminate remaining artificial fish migration barriers.

Revegetation practices are important components to all five of these habitat restoration priorities in varying degrees. For example: see Figures 1 and 2 below showing Latah SWCD's revegetation following a culvert realignment and replacement. A comprehensive revegetation plan is needed to protect these newly installed structures and to prevent excessive weed encroachment.

Figure 1. Nora Creek culvert replacement, August 21, 2017.

Figure 2. Nora Creek culvert replacement, July 25, 2018. Revegetation strategies included seeding and mulching with native species, sedge mat and sedge plug placement, cutting installation, and planting of containerized shrubs and herbaceous plant materials.

In the Potlatch River watershed, many streams have undergone past alteration due to land use practices and the removal of beavers. Channels may have been straightened and subsequently incised, floodplains disconnected, summer flows may be low or absent, and instream habitat simplified. Following these hydrology changes, riparian plant communities have transitioned from wet-adapted to dry-adapted species and many of the woody species that provided shade and future wood recruitment were removed. Latah SWCD uses process-based strategies for the restoration of meadows, wetlands, and riparian zones to restore lateral and vertical connectivity, reestablish stream flow regimes, reduce erosion and sediment delivery, and restore riparian functions. Process-based restoration strategies emphasize addressing “root causes of degradation” by reestablishing “normative rates and magnitudes of physical, chemical, and biological process that create and sustain river and floodplain ecosystems” (Beechie et al. 2010). See Figure 3 below for artist’s representation of a straightened and incised channel and Figure 4 for a restored stream and meadow. Revegetation planning and implementation are necessary components of these habitat restoration projects.

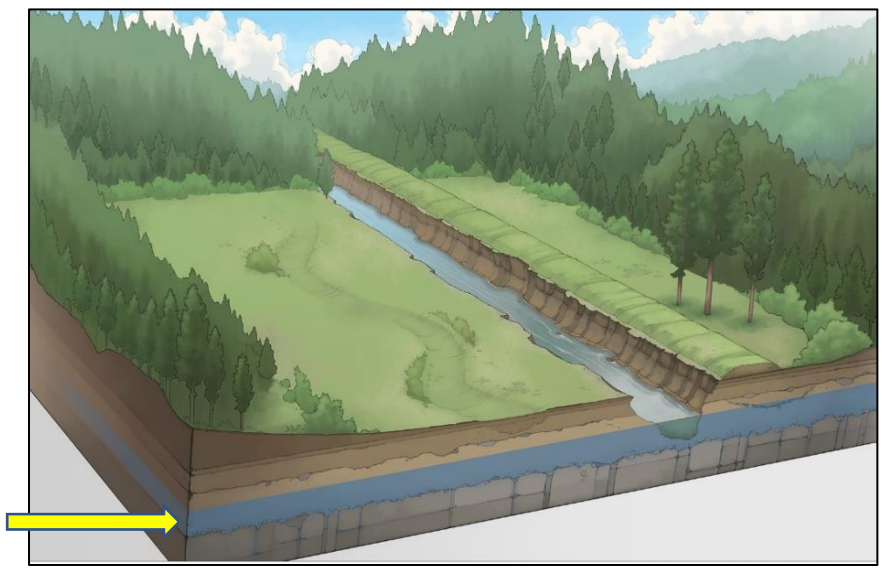

Figure 3. Straightened and incised channels are common throughout the Potlatch River watershed and result in high flow velocities, little to no floodplain interaction, and greater erosion potential. Note the berm on the left bank which further interrupts floodplain access and prevents natural channel movement. This situation results in a dropped water table (see yellow arrow) and exacerbates high stream temperatures and low flow conditions.

Figure 4. A more desirable stream formation is shown here with enhanced floodplain access and a recovering woody riparian plant community. These features encourage meadow saturation which raises the water table and allows for a greater influx of cool, clean water during low flow conditions.

Revegetation strategies should include planning, site assessment, design, site preparation, planting, establishment/maintenance, monitoring, and adaptive management (Cramer 2012), and the extent of the revegetation plan varies depending on project specifics and site conditions.

For example, a large-scale Latah SWCD meadow restoration project revegetation plan usually includes weed control, protection of the existing good quality native plant community whenever possible, salvage and replacement of high-quality native sod when it is unavoidably displaced during project construction efforts, seeding/mulching of all bare and disturbed ground to minimize invasion of weedy and undesirable species, and strategic plantings of a diverse mix of native trees, shrubs, forbs, and grasslikes. Planting efforts are followed by survival checks, replacement of plant mortalities, weed control as needed, and adaptive management. Protective measures to enhance revegetation success include the use of burlap, irrigation, exclusion fencing, and slash placement. Active revegetation efforts will take place for a minimum of 3-5 years post-project implementation with the greatest effort usually occurring in the first 2 years. A diminishing effort is required for subsequent years to maintain new plantings, replace mortalities, and to allow for adaptive management strategies. Planting and protective techniques are discussed in greater detail later in the document.

The extent of the revegetation effort required is site specific and depends largely on pre-project site conditions and the scope of the project disturbance. These factors determine the degree to which active and/or passive restoration may occur.

Active versus Passive Restoration

"The purpose of the vegetation restoration is to set a trajectory for the site to continue to develop into the desired end-state. The designer may also adaptively manage the site to move it incrementally towards its desired end-state during plant establishment" (WSDOT 2017).

"Active restoration is where management techniques such as planting seeds or seedlings are implemented, and passive restoration is when no action is taken except to cease environmental stressors" (Morrison and Lindell 2010). "There is general agreement that true restoration requires not only reestablishment of more desirable structure or composition, but of the processes needed to sustain these for the long term" (McIver and Starr 2001). Process-based restoration "aims to reestablish normative rates and magnitudes of physical, chemical, and biological processes that create and sustain river and floodplain ecosystems" (Beechie et al. 2010). Restoration of the ecological processes of meadows, wetlands, and riparian zones restores lateral and vertical connectivity, stream flow regimes, reduces erosion and sediment delivery, and restores riparian functions.

The extent to which the native plant communities are able to recover passively depends greatly on the extent and duration of the disturbance. For example, in a situation where the stressor removed is livestock grazing, the native plant community may rebound quickly following livestock exclusion. See Figures 5 and 6 for before and after photos from a Latah SWCD livestock exclusion fencing project which showcases a passive restoration response 11 years following livestock exclusion from the site.

Figure 5. Corral Creek livestock exclusion fencing site, pre-construction, May 2009. Note reference tree circled in yellow.

Figure 6. Corral Creek livestock exclusion fencing site, 11 years post-construction, July 2021. Note reference tree circled in yellow.

In the photos above, the woody species on-site were able to release following livestock exclusion and the riparian corridor is on the path to recovery. However, a study in Utah concluded that while the herbaceous plant community (*Carex* spp.) may recover quickly following livestock removal, in some cases woody species lag and would likely require active vegetation manipulation to achieve reestablishment. “We postulate that low woody-species recruitment may affect the potential of the riparian zone to quickly shade stream channels and facilitate undercut bank formation, common riparian restoration objectives. To prevent halted riparian succession, designers should proactively identify potential limitations to woody vegetation colonization” (Hough-Snee et al. 2013).

In a situation where a meadow has been dehydrated for decades due to stream incision resulting from past land use changes, berm construction, ditching and movement of the stream, as was common in the Potlatch River watershed, a comprehensive process-based meadow restoration strategy may be required to restore the hydrologic and channel-forming processes to set the stream on a trajectory towards recovery. These meadow restoration projects often include diverting the flow away from the straightened ditch and back into the historic channel alignment. This is accomplished through the placement of channel diversion structures, and the project often includes additional plugging or filling of the ditch, berm removal, construction of wetland swales and fill areas, design channel construction, beaver dam analog and large wood placement installations, etc. This type of project requires an active restoration strategy throughout the disturbed areas to ensure site stability, prevent structure failures and erosion, and to limit weed encroachment.

In most cases, both active and passive restoration strategies happen simultaneously on a site as there are multiple disturbance regimes and varying levels of native plant presence on the site pre- and post-construction. Following a meadow restoration project and subsequent rehydration of a degraded/dehydrated meadow, wetter meadow conditions commonly drive out many of the dry-adapted species (often non-native grasses and weeds). This has been documented on numerous Latah SWCD meadow restoration project sites and is detailed in the Latah SWCD Vegetation Monitoring Summary (Erhardt 2021).

Following long-term meadow dehydration, propagules of wet adapted species (e.g., sedges and rushes) may either be absent, extremely low in abundance, and/or poorly distributed. Introduction of a diverse native seed and plant mix on all disturbed locations immediately following construction improves the site diversity and coverage, allowing for a quick reestablishment of the native plant community. Native seed placement on disturbed ground also limits the establishment of the opportunistic non-native weeds. Once invasive weeds gain a foothold, the effort needed to remove them increases exponentially.

Seeding and planting specifications will vary depending on site variables. In general, seeding rates and planting density will be higher for more disturbed areas and lower for less disturbed areas. For example, new channel construction typically requires total reestablishment of a woody riparian corridor, while creek realignment with an existing historic channel may only require vegetation enhancement. Figures 7 and 8 below provide an example of a similar case on Corral Creek.

Figure 7. Straightened section of Corral Creek, June 15, 2009, pre-construction. Note lack of floodplain access and woody riparian vegetation in incised and eroding ditch that conveyed most of the flow for Corral Creek before the diversion into the historic alignment.

Figure 8. Realigned section of Corral Creek, June 10, 2010, 1-year post-construction. Following flow diversion from incised ditch shown above in Figure 7 into historic channel alignment. Note the presence of some woody vegetation which allows for the potential for future wood recruitment and for woody riparian vegetation expansion passively.

Figures 9 and 10 below provide an example of a situation where a more active restoration strategy was required on another Corral Creek project site.

Figure 9. A new side channel to Corral Creek was constructed in 2008 and therefore required complete reestablishment of the riparian vegetation. October 24, 2008.

Figure 10. Following an extensive revegetation effort, the site is now resilient and self-sustaining. Corral Creek side channel, June 4, 2021.

Another example is from a tributary to the East Fork Potlatch River (EFPR) which was highly impacted by past logging and land use changes. As a result of significant disturbance required to repair the site, an intensive revegetation program was implemented. See Figures 11 – 13below.

Figure 11. EFPR tributary, pre-construction, May 2012

Figure 12. EFPR tributary during revegetation implementation which included the use of burlap for soil and plant stabilization, October 2012.

Figure 13. EFPR tributary site, 8 years post-construction. June 2020

Revegetation process details:

Every site is unique and requires a specially formulated revegetation plan with the objective of placing the project on a trajectory towards natural resilience. The revegetation process should include 3 phases:

Phase 1 – Design and planning

Phase 2 – Implementation and maintenance

Phase 3 – Monitor and adapt

Phase 1 – Design and planning

The design and planning phase includes site assessment and development of project objectives which will help determine the necessary revegetation components as well as develop metrics for success. A thorough revegetation plan ensures long-term project success by increasing revegetation effectiveness as well as efficiency. Identifying metrics for project success early on makes monitoring and adaptive management strategies more efficient as well. Characteristics of a successful revegetation effort include high presence of desirable plant species, limited erosion and bare ground, limited invasive species encroachment, and enhanced stability of stream banks and new structures. Projects without a comprehensive revegetation plan may see a higher instance of revegetation failures resulting from inappropriate species selection, low seeding rates, and inappropriate seeding/planting timing. As a result, these projects may see higher plant mortality, high levels of erosion, and unchecked invasive species spread.

Species selection is an important part of the revegetation planning process. Appropriate species lists and quantities of native grasses, grasslikes, forbs, trees and shrubs should be prepared prior to project initiation. To determine plant species selection, collect a plant inventory from the site and/or a nearby reference site. Also, talk to local plant experts and restoration practitioners for information on specific species selection. See Table 1. for a list of species commonly used on Latah SWCD project sites in the Potlatch River watershed.

	SPECIES COMMON NAME	**SPECIES SCIENTIFIC NAME**	**Latah SWCD Sources**	
			Seed Company or Plant Nursery	**Seed Collection**
Wetland Grass Mix	Spike Bentgrass	*Agrostis exarata*	X	
	American Sloughgrass	*Beckmannia syzigachne*	X	
	California Brome	*Bromus carinatus*	X	
	Mountain Brome	*Bromus marginatus*	X	
	Bluejoint Reedgrass	*Calamagrostis canadensis*	X	
	California Oatgrass	*Danthonia californica*	X	
	Tufted Hairgrass	*Deschampsia cespitosa*	X	
	Slender Hairgrass	*Deschampsia elongata*	X	
	Blue Wildrye	*Elymus glaucus*	X	
	Fowl Mannagrass	*Glyceria striata*	X	
	Meadow Barley	*Hordeum brachyantherum*	X	
	Quick Guard	sterile triticale	X	
Forbs (seed and/or container plants)	Western Yarrow	*Achillea millefolium*	X	
	Nettleleaf Horsemint	*Agastache urticifolia*	X	X
	Grand Agoseris	*Agoseris grandiflora*	X	X
	Western Aster	*Aster occidentalis*	X	
	Red Besseya	*Besseya Rubra*	X	X
	Common Camas	*Camassia quamash*	X	X
	Grand Collomia	*Collomia grandiflora*		X
	Showy Fleabane	*Erigeron speciosus*		X
	Strawberry	*Fragaria virginiana*	X	
	Clustered Gentian	*Frasera fastigiata*		X
	Blanketflower	*Gaillardia aristata*	X	
	Northern Bedstraw	*Galium boreale*	X	X
	Prairie Gentian	*Gentiana affinis*	X	X
	Prairie Smoke	*Geum triflorum*	X	X
	Little Sunflower	*Helianthella uniflora*	X	
	Cow Parsnip	*Heuchera cylindrica*	X	X
	Rocky Mountain Iris	*Iris missouriensis*	X	X
	Lewis Flax	*Linum lewisii*	X	
	Nineleaf Lomatium	*Lomatium triternataum*	X	
	Taperleaved Penstemon	*Penstemon attenuatus*	X	

	SPECIES COMMON NAME	SPECIES SCIENTIFIC NAME	Latah SWCD Sources	
			Seed Company or Plant Nursery	**Seed Collection**
	Globe Penstemon	*Penstemon globosus*		X
	Yampah	*Perideridia gairdneri*		X
	Varileaf Phacelia	*Phacelia heterophylla*		X
	American Bistort	*Polygonum bistortoides*		X
	Tall Cinquefoil	*Potentilla arguta*	X	
	Slender Cinquefoil	*Potentilla gracilis*	X	X
	Fatty Fingers Cinquefoil	*Potentilla gracilis* var. *permollis*	X	X
	Common Selfheal	*Prunella vulgaris*		X
	Western Coneflower	*Rudbeckia occidentalis*	X	X
	Western Groundsel	*Senecio integerrimus*	X	X
	Oregon Checkermallow	*Sidalcea oregana*	X	
	Blue Eyed Grass	*Sisyrinchium idahoensis*	X	
	Canada Goldenrod	*Solidago canadensis*	X	X
	Missouri Goldenrod	*Solidago missouriensis*	X	X
	California False Hellebore	*Veratrum californicum*		X
	Mules Ear	*Wyethia amplexicaulis*	X	X
Trees/Shrubs	Thinleaf Alder	*Alnus incana*	X	
	Red Alder	*Alnus rubra*	X	
	Sitka Alder	*Alnus sinuata*	X	
	Serviceberry	*Amelanchier alnifolia*	X	
	Red-osier Dogwood	*Cornus sericea*	X	
	Douglas Hawthorn	*Crataegus douglasii*	X	
	Pacific Ninebark	*Physocarpus capitatus*	X	
	Lodgepole Pine	*Pinus contorta*	X	
	Quaking Aspen	*Populus tremuloides*	X	
	Black Cottonwood	*Populus trichocarpa*	X	
	Nootka Rose	*Rosa nutkana*	X	
	Bebb Willow	*Salix bebbiana*	X	
	Drummond Willow	*Salix drummondiana*	X	
	MacKenzie Willow	*Salix rigida*	X	
	Douglas Spirea	*Spiraea douglasii*	X	
	Common Snowberry	*Symphoricarpos albus*	X	
Grass-likes	Water Sedge	*Carex aquatilis*	X	
	Lens Sedge	*Carex lenticularis*	X	
	Small-Winged Sedge	*Carex microptera*	X	
	Nebraska Sedge	*Carex nebrascensis*	X	
	Sawbeaked Sedge	*Carex stipata*	X	
	Beaked Sedge	*Carex utriculata*	X	
	Inflated Sedge	*Carex vesicaria*	X	

SPECIES COMMON NAME	SPECIES SCIENTIFIC NAME	Latah SWCD Sources	
		Seed Company or Plant Nursery	Seed Collection
Common Rush	*Juncus effusus*	X	
Daggerleaf Rush	*Juncus ensifolius*	X	
Slender Rush	*Juncus tenuis*	X	
Small-Fruited Bulrush	*Scirpus microcarpus*	X	

Table 1. The species listed above are primarily native species occurring in the Potlatch River watershed. Specific selection varies based on individual site characteristics and site location within the watershed.

Phase 2 – Implementation and maintenance

The implementation and maintenance phase of the revegetation effort is also multi-faceted and depends on project type, site specifics, and objectives as determined in the plan/design phase. Following process-based restoration projects, most sites require augmentation or enhancement to the native plant community as the site adjusts to the new or restored conditions. This phase should be implemented over a 3-to-5-year timeline to spread the risk and to allow time for adaptive management as hydrological conditions change. There are many components to a thorough revegetation effort and some of these techniques and strategies are detailed in the text and Table 2 below.

REVEGETATION METHODS	DETAILS
Seeding	Apply native seed to all disturbed areas or bare ground to prevent/limit weed encroachment, reduce soil erosion, protect new structures, and enhance pollinator and wildlife habitat.
Mulching	Apply certified weed-free mulch following seeding to limit seed predation and seed movement (this is especially important on the floodplain and stream banks), increase germination, and provide safe sites for the seeds. For container plants add bark mulch around the base of plants to retail soil moisture and limit weed encroachment during the establishment phase.
Slash placement	Place slash over recently disturbed sites to increase surface roughness, provide safe sites for native plant material establishment, slow and disperse flow, and capture debris and sediment. Slash is a readily available and inexpensive protective measure for new structures and bare ground as the vegetation is establishing.
Sod salvage/replacement	Salvage good quality native sod on areas to be disturbed and replace on-site in vulnerable locations. Cover the newly placed sod with burlap followed by regular irrigation to enhance re-establishment of the sod through the dry summer months.

Table 2. cont.	
REVEGETATION METHODS	**DETAILS**
Supplemental plantings – containerized plants	Add containerized woody and slow growing herbaceous plants strategically throughout the site to speed up the recovery process and stabilize vulnerable locations. Choose a diverse mix of native trees, shrubs, forbs, and grasslikes depending on site specifics. Optimal container size will depend on the species and the planting location.
Supplemental plantings - cuttings	Install cuttings to enhance woody plant diversity, stabilize the stream banks, and add roughness on the floodplain and stream banks.

Table 2. Planting and seeding techniques and rationale.

Seeding and mulching

All bare or disturbed ground is seeded with a mix of native grasses and forbs following construction to stabilize the soil and to minimize invasion of undesirable weedy species. Utilization of native plant materials is the best for the site and is required by some funding and permitting agencies. Locally sourced plant materials are best for site-specific conditions (Cramer 2012). The seed is then covered with a layer of weed-free mulch and the most vulnerable areas are irrigated, when possible, to encourage root development and to achieve surface roughness before seasonal flooding occurs. Burlap may be used to enhance seedling growth during the hot and dry summer months. Additional seed is broadcast in subsequent years in areas with lower germination/coverage. Figures 14-17 below show an example of a new roadside fill area near a meadow restoration project on West Fork Big Bear Creek. To prevent weed encroachment from the roadway, for road protection, and to ensure stability of the new fill area during the first high flow event, it was a high priority to add vegetative roughness. This was accomplished by adding slash, seeding, and mulching as soon as the fill area was completed. The site was then watered weekly or bi-weekly through the hot and dry months of September and October. By late October the new grass seedlings had achieved significant growth prior to the first high flow events.

Figure 14. September 2, 2020

Figure 15. September 2, 2020

Figure 16. October 14, 2020

Figure 17. May 8, 2021

Sod salvage

Sod salvage includes harvesting existing desirable vegetation from construction areas and replacing it in highly vulnerable locations. "Salvaged sod, if available without weeds, is an outstanding type of herbaceous plant material. It has a dense soil/root mass that is relatively resistant to erosion, it establishes quickly, and it uses materials that may otherwise be discarded" (Cramer 2012). Salvaged sod also provides a bank of seed as well as roughness that will trap seed and organic matter for new plant growth.

To ensure survival of the newly placed sod, Latah SWCD covers the sod with burlap if possible and waters it regularly. The burlap keeps the sod shaded and damp and ensures high survival rates. Burlap is removed when the extreme high summer temperatures begin to drop, and the fall rains begin. Note: If burlap placement is not possible due to time and/or funding constraints, placed sod still provides roughness and many species will survive even without the added protection of burlap.

Figure 18. Sod harvest with an excavator

*Figure 19. **Sod harvest scenario A:** When possible, sod is picked up or harvested by the excavator and placed immediately on regraded or newly excavated area. The newly placed sod is then covered with burlap and watered until the onset of cooler temperatures and/or fall rains.*

Figure 20. ***Sod harvest scenario B:*** *When no suitable location is available to place sod directly on the site, the sod is placed on tarps, covered with burlap and watered until ready for placement.*

Slash

Salvaged woody debris and slash is placed over disturbed surfaces to create additional roughness in the finished grade surface (WSDOT 2017). Latah SWCD utilizes slash placement on disturbed areas whenever possible which has ensured greater protection for the project structures, especially through the first season of high flow events. Slash also interrupts flow patterns preventing channelization along construction access roads and other linear features created through the restoration construction process.

Many of the photos throughout the document showcase slash usage for site protection. Large scale projects require large quantities of slash and it has been most useful to pair restoration projects on sites where landowners have access to slash piles from logging operations on site or close by. Slash may also be generated through strategic thinning of crowded conifer stands on-site. Smaller quantities of slash can be secured through tree limbing.

Container plantings

A diverse mix of native trees, shrubs, forbs, grasses, and grass-likes are installed in a range of container sizes to provide a variety of rooting depths for soil stability, increased ground coverage to prevent weed encroachment, and to increase wildlife and pollinator habitat. See Table 3 for an example of some woody/herbaceous species commonly used in Latah SWCD meadow and riparian restoration project sites.

Plant type and site conditions will determine the optimal container size for planting. It is generally best to plant the largest plants that your budget will allow up to tall 1-gallon containers. These larger plants often have better survival and are more resilient given their enhanced root development when faced with browse pressure or drought conditions. However, there are some instances when smaller plants might be the best choice. Water availability, soil compaction (like the top of a ditch plug), or a lack of time and/or labor might necessitate using smaller planting stock. “Planting a variety of species ensures the highest likelihood of project success. Monocultures are susceptible to total failure when exposed to disease or unfavorable site conditions” (Cramer 2012). Applying bark mulch around the base of the plants also increases success rates by reducing competition from other plants and enhancing soil moisture. Latah SWCD conducts spring and fall plantings at project sites for a minimum of 3 years. Planting in both spring and fall for multiple years spreads the risk and allows for adaptive management to take place as the site adjusts to the new conditions created by the project. Staging the implementation reduces the risk of failure due to extreme high flows, drought, and predator cycles (Heekin 2017).

Other Latah SWCD revegetation lessons learned:

- re-plant mortalities right away
- increase effort on difficult sites
- change species if needed due to changing site conditions (i.e., rising water table)
- increase diversity over time following changing site conditions
- add bark mulch around the base of woody and herbaceous plants to prevent weed encroachment, enhance soil moisture and increase survival rates

Supplemental irrigation is often needed to enhance survival of new containerized plantings during spring and fall plantings. The extent of the irrigation needs is variable depending on the site and the season. For example: The 2021 spring and summer seasons were the driest on record for Latah County. Spring plantings that normally would have required 2-3 weeks of irrigation instead needed supplemental watering throughout June and July.

Planting Season	PROS	CONS
Fall	• Minimize irrigation requirements • Longer planting season • More time for root development before next summer's dry season • Less plant stress during transport and staging prior to planting	• Ground may be hard if planting before fall rains begin • Greater potential for frost heaving • Less time for root establishment before high flow event • Cutting installation is difficult in dry hard ground • Difficult plant placement as ordinary high-water mark and flow paths may not be visible in intermittent streams
Spring	• Better plant placement as flow paths and water levels in streams are present • Better soil moisture • Softer ground allows for deeper installation of cuttings • More time for root development before high flow events • No risk of frost heaving	• Sites not accessible during optimal planting time due to meadow saturation or snow on roads • Increased irrigation needs depending on planting timing • Cutting installation is difficult in deep water conditions • All plants may not be available at nursery in the early spring
Both	• Spreads the risk for the potential for unfavorable planting conditions	• Requires additional resources (labor) to support a multi-season planting effort

Table 3. Pros and Cons for fall versus spring plantings.

Cuttings

Vegetative cuttings (poles) from willow and cottonwood species are also utilized in the revegetation effort for bank stabilization, to rehabilitate riparian corridors, for beaver and wildlife habitat, and to provide roughness to slow flow and capture debris and sediment. Variables determining the success of cutting survival include cutting size, collection time and location, preparation of the cuttings, and planting techniques (Zierke 1994). A detailed account of willow and cottonwood planting methodology can be found in the USDA NRCS Technical Note 23, "How to Plant Willows and Cottonwoods for Riparian Restoration" (Hoag 2007).

Latah SWCD utilizes willow cuttings in a variety of ways including bank plantings and as the base for structures to provide roughness on the floodplain (mini-stick berms or willow gates) which are installed to interrupt flow paths, reduce channelization, and arrest head cutting situations. Incorporating cuttings into habitat structures, beaver dam analogs and other channel structures also may increase cutting survival rates by providing increased protection from ungulate browse and raking as well as increased hydration at the structure sites. Benefits of using cuttings rather than containerized plants include ease of installation, capability of fitting a large quantity of plants into small and tight spots, cost effectiveness, and ability to install into active channels.

Figure 21. Cuttings installed on new channel in Middle Fork Big Bear Creek to stabilize new stream bank.

Cuttings may be installed in both spring and fall planting seasons (Hoag 2007) and there are pros and cons for each. Site conditions and planting objectives will determine which season is optimal for the site. For instance, fall plantings allow for installation of the cuttings at the lowest water line that the site may experience whereas when planting in the spring, the low water line is unknown. Spring planting of cuttings allows for a full growing season for root development before the next high flow event. See Fall vs. Spring planting table (Table 3) for a list of additional risk and benefits.

Seed Collection

Locally sourced native seeds are best to use for seed-based restoration projects. Most of the restoration seed mix is usually acquired from seed producers, but on-site seed collections are another method to enhance the species diversity in the seed mix. Seed collection requires pre-planning and should be conducted in an ecologically sensitive manner.

- Do not take more than 20% of the seed from one location as it is important to leave enough seed on-site for future regeneration.
- Timing is critical. Collecting too early will result in low seed viability and collecting too late may result in low seed quantity.

- Allow the plant material and seed to dry before storing. Plant material that is not thoroughly dried may mold and spoil. To prevent mold growth, collect the plant material when it is dry, store collections in breathable paper bags, or spread the material on tarps and allow to dry thoroughly before placing it into bags.
- Use pest strips to prevent insect damage to the seed during the seed drying process.
- Separate the seed from the chaff and then add the seed to your seed mixes before seed application. There are many methods for cleaning the seed and these will vary depending on the quantity and type of seed collected.

Weed Control

Maintenance

The maintenance portion of Phase 2 is conducted for a minimum of 3 to 5 years post project construction. This time frame allows for site planners, engineers, landowner/land managers and revegetation implementers to regularly assess the site, identify areas of concern, replant mortalities, and adjust the species mix as needed. Invasive species identification is also valuable as small-scale infestations can more easily and efficiently be controlled with early detection.

Short-term maintenance strategies include adding supplemental irrigation through the hot dry months to enhance plant and seed establishment. Once established, native plants do not need supplemental irrigation, but during the first year, watering new plantings generally enhances success rates. Water is typically obtained through on-site sources such as a pond or stream or purchased through municipal sources and stored in water tanks/trucks. On-site sources require temporary water rights permits and stream sources are only utilized if flow can accommodate the level of use without impacting the resource. Figuring out the logistics of having water on-site for construction and revegetation is best done during the plan and design phase.

Annual maintenance may also include the following:

- Spring – debris removal around exclusion fences, identification, and re-planting of washed-out or scoured plants, adding mulch to last year's plantings, replanting and re-seeding as conditions require
- Summer/Fall – equipment and planting materials pick up (remove pin flags, pots, burlap removal, etc.), invasive species scouting and control

Phase 3 – Monitor and adapt

Multiple vegetation monitoring strategies are employed at Latah SWCD riparian, wetland, and meadow restoration project sites (See Table 4). Vegetation monitoring occurs with other project effectiveness monitoring strategies which are not addressed in this document. The monitor and adapt phase may occur simultaneously along with the Phase 2 implementation and maintenance phase and will ideally also continue after the Phase 2 is complete. For vegetation monitoring, all sites are visited multiple times through the first few growing seasons by planners and field crew members to check for seed establishment and mortality of containerized plants and cuttings. Based on the results of these site visits, adaptive management strategies may be employed to replace mortalities, adapt species selection, and re-seed as needed. Vegetation monitoring also includes scouting for invasive and noxious weeds. Continuation of monitoring past the 5-year timeframe can provide details on site progress, and on how to conduct the revegetation process with greater efficiency and effectiveness in the future. While monitoring sites for up to 10 years post-project would be ideal, the actual extent of the monitoring may depend on funding availability and scope of work.

Additional monitoring examples:

- To measure and document changes in the plant community following wet meadow restoration activities, Latah SWCD may implement a cover plot vegetation monitoring strategy for selected project sites (Erhardt 2015). The focus here is on riparian vegetation abundance (as reducing bare soil can increase infiltration and reduce surface movement of fine sediment) and composition (a higher proportion of wetland species are indicative of soil that is wetter for longer which suggests that the floodplain is functioning more effectively). See the Latah SWCD vegetation monitoring summary for monitoring results on multiple past Latah SWCD meadow restoration projects in the Potlatch watershed.
- Herbaceous plant community monitoring is also achieved through photos, drone flights, and regular site visits.
    - Bare ground must be revegetated immediately following the disturbance to prevent weed encroachment and to limit erosion. On these bare sites, the herbaceous component (grasses and forbs) is monitored through regular site visits throughout the growing season. Paying close attention to plant establishment especially in the first and second years following the disturbance allows for quick adaptive management. If some areas are not establishing well, adjustments to the seed mix and seeding timing are made until satisfactory revegetation has occurred.
- Woody survival monitoring

- Woody species plantings occur over multiple seasons and multiple years with the field crew replacing mortalities as needed.
- Annual spring site assessments as the woody species begin to bud provides insight into plant survival and to plan for the spring and fall planting efforts.
- Fencing and other protective measures are utilized to prevent ungulate browsing on select species or in select areas, and regular site visits can determine the effectives of these protective measures.

Vegetation Monitoring Type	Details
Site visits	Regular assessment of planting successes and failures multiple times throughout the growing season. Results will trigger replacement of mortalities, species changes if needed, increasing protective measures, and other adaptive management strategies.
Drone flights	Aerial site reviews showcase site functionality and shows vulnerable locations where new plantings would be beneficial/optimal.
Scouting for weeds	Scouting and weed identification followed by flagging/mapping weed locations will increase weed control efficiency. Targeting small infestations has a higher success rate than attempting eradication following broad weed spread.
Cover plot methodology	Vegetation monitoring to measure changes to the plant community resulting from shifts to the meadow hydrology following process-based meadow restoration.

Table 4. Examples of revegetation site review and monitoring techniques.

There are many revegetation strategies and techniques that may be utilized for successful riparian restoration projects. New methods are being developed annually and as more is leaned and strategies shift, this document will be updated to capture these successes and lessons learned. The Frequently Asked Questions section below captures additional information on Latah SWCD revegetation process and methods.

Frequently Asked Questions – The Latah SWCD Perspective

Water Sources – What goes into deciding where to access water and how does one decide?

- As discussed in the Vegetation monitoring section above, supplemental irrigation is utilized on a short-term basis to enhance survival of the new plantings. Water is also required for dust abatement and compaction needs during the initial construction phase on some larger scale projects.
- Planting in spring and fall seasons is necessary and the scale of water needs is dependent on the seasonal site conditions and the type and quantity of species to be planted. Determining the best source for water for these irrigation needs is nuanced and care is taken to determine the best, most ecologically sensitive, and most efficient water source for these short-term needs.
- Water source options
    - On-site pond
        - Pros – efficient if pond is located near the project site; does not deplete creek or aquifer; water value can be counted towards in-kind match for the landowner for some funding sources.
        - Cons – if the pond is located far from the project, it will require a water truck to fill water shuttles for storage near planting locations, which increases the cost of the project and for labor; water rights permit sometimes required depending on type of pond.
    - Creek
        - Pros – efficient; doesn't deplete aquifer; the water stays in the system as planting locations are within the meadow systems and the majority of the pants are installed within a 15- to 30-foot buffer of the creek; this temporary use to establish vegetation provides long-term benefits to the creek such as sediment reduction and shading; water value can be counted towards in-kind match for the landowner for some funding sources.
        - Cons – Water rights permitting use out of the creek will depend on timing and flow requirements in the Potlatch, therefore, water may not always be available from this source and other options will need to be prepared.
    - Wetland cells
        - Pros – efficient; doesn't deplete aquifer; water is going directly back onto the meadow; temporary use to establish vegetation for long-term benefits to the site; water value can be counted towards in-kind match for the landowner for some funding sources.
        - Cons – short-term minor depletion of water in cells which have the benefit of providing meadow rehydration benefits during the dry season.

- Purchase water from municipal sources
  - Pros – no IDWR temporary water rights permit required.
  - Cons – depletes the aquifer; more expensive; less efficient than using water on-site; raises the costs of the project for water purchase, delivery, and crew labor; added logistics for figuring out water storage on-site; no landowner match opportunity.

Spring versus fall plantings – Which is better for herbaceous and woody containerized plants and woody cuttings?

Spring AND fall plantings can be beneficial times for seeding and planting a diverse mix of native grasses, grass-likes, forbs, trees, and shrubs.

Rationale for conducting plantings in spring **and** fall:

1. Volume of work – numerous project sites with varying planting, seeding, weeding, and vegetation management needs require multi-season effort.
2. Site accessibility – site access is variable in the spring and Latah SWCD field crews are available April-November. Strategic planning in the off-season increases planting efficiency as more accessible sites are focused on in early spring and work can be continued in the fall as the weather cools and fall rains begin.
3. Priorities - planting and seeding in the fall immediately after construction and the following spring are imperative for multiple reasons.
   a. It is necessary to achieve native plant establishment before significant invasive and non-native plants can establish. If the site is left unvegetated, the weeds move in. Weeds that have established require more time, effort, and funding to remove when compared with the up-front cost of seeding.
   b. Plantings and follow-up seeding in the spring following the construction year is also an important year for assessing the site and planting adaptively based on site changes following the first high flow events. Again, this first spring is one of the last chances to occupy and diversify the site with natives prior to weed encroachment that inevitably occurs when bare ground is left unplanted.
4. Spread the risk – every year and every season are different. Planting success rates are highly variable by year and season and are unpredictable. We also ameliorate these seasonal risks by mulching, watering, utilizing burlap as needed, and minimizing or pausing planting efforts through the hottest and driest weeks. The Latah SWCD field crew constantly adapts to the changing conditions year-to-year as well as season-to-season.

Why spend so much time, energy, thought on revegetation (in this case, the seeding)?

Simple answer – to set the site on the trajectory to becoming a self-sustaining ecosystem following restoration implementation. To protect new structures, reduce weed invasions, improve site biodiversity, and fulfill commitments to the landowners.

Following rehydration of a degraded/dehydrated meadow system, wetter conditions will drive out many of the drier-site adapted species (often non-native grasses and weeds); however, if the site has been dehydrated for decades (typical in the Potlatch River Watershed meadows), propagules of wet-site adapted species may be absent, extremely low in abundance, and/or poorly distributed. Introduction of a diverse native mix immediately following construction improves the site diversity and coverage, putting the development of the plant community on the right trajectory for recovery.

Rapid re-establishment of the native plant community is crucial to:

- Ensure diversity of the plant community. "The biological diversity of the plant communities on a site is important because plant ecosystems support animal ecosystems" (WSDOT 2017).
- Prevent erosion, thereby preventing delivery of sediment to the stream in next season's high flow events.
- Ensure sustainability of expensive newly constructed structures, which can be lost or damaged due to erosion.
- Prevent invasion by weeds, including noxious weeds, which LOVE bare ground, can quickly dominate a site, and take years to eliminate. The seed source of native species is often diminished by decades of dehydration, whereas the seed source of the invasive, non-native species is abundant due to years of drier conditions that favor them.
- Ensure ongoing good relations with landowners by preventing weed invasions they will have to deal with in future years.

Why use native plants?

1. "To maximize benefits to native fish and wildlife species, use only native plant species. Native plants are adapted to local climates and disturbance regimes (e.g., fire, flood, landslides), compete well for survival on native soils, are adapted to local insect and disease infestations, and provide food and habitat for native wildlife. Make sure the species you are considering are local to your area, not just native to the state" (Cramer 2012).
2. Permitting agencies (Idaho Department of Water Resources (IDWR), Idaho Department of Environmental Quality (IDEQ) / U.S. Army Corps of Engineers 401/404 permits,

Bonneville Power Administration (BPA) Fish and Wildlife Habitat Improvement Program (HIP) III, Endangered Species Act (ESA) consultation) require using native species for revegetation (both seed and plants) on these types of riparian and wetland restoration projects to benefit steelhead by restoring hydrology and improving habitat.

How does one develop a seed mix for and what are the best methods for seed establishment?

There are multiple steps to develop project seed mixes and the considerations Latah SWCD takes throughout this process are detailed in the bullets below. In short, Latah SWCD seed mixes are locally or regionally sourced, diverse, and adapted for specific site and project conditions.

- To develop the restoration seed mixes, Latah SWCD incorporates both native grasses and forbs with different characteristics. These characteristics include:
    - early to late successional
    - annuals, short- and long-lived perennial species
    - rooting diversity
    - full sun to part-sun requirements
    - different moisture regimes
    - variable bloom times for pollinator benefits
    - availability on the local seed market or present on-site for seed collection
- “Restoration practitioners often choose to sow a seed mix across a site and include a variety of species with different flooding and drought tolerances as a bet-hedging strategy within sites and between years” (Kettenring and Tarsa 2020).
- Latah SWCD uses native species in seed mixes with one exception. QuickGuard, a sterile triticale hybrid, is typically added because it establishes quickly adding to the first-year site protection from erosion and weed invasion. Because it is sterile, the QuickGuard diminishes after the first year, allowing the slower-developing native species to emerge and establish over time. In a seed mix, QuickGuard is usually added at 10 lbs. per acre or 5% of the mix.
- Latah SWCD has three custom mixes that are utilized as base mixes on most meadow and riparian projects. These mixes are customized as needed to accommodate specific site characteristics.

1. Channel mix – a diverse mix of native grass species adapted to the wettest conditions. The channel mix is used in constructed channel banks and swales.

Project	LATAH SWCD - EXAMPLE CHANNEL MIX	
Date	2022	
Scientific Name	**Common Name**	**Percent of mix**
Beckmannia syzigachne	American Sloughgrass	20 %
Calamagrostis canadensis	Bluejoint Reedgrass	20 %
Deschampsia cespitosa	Tufted Hairgrass	5 %
Deschampsia elongata	Slender Hairgrass	5 %
Fowl Mannagrass	Glyceria striata	20 %
Western Mannagrass	Glyceria occidentalis	20 %
Hordeum brachyantherum	Meadow Barley	10 %
Triticum aestivum x Secale	QuickGuard	

Table 5. Sample channel mix for regularly inundated locations.

2. Wetland Mix – a diverse mix of native grasses with a diverse range of adaptability from wet to drier conditions. The wetland mix is used for revegetating a wet meadow following construction.

Project	LATAH SWCD - EXAMPLE WETLAND MIX	
Date	2022	
Species Scientific Name	**Species Common Name**	**Percent of Mix**
Agrostis exerata	Spike Bentgrass	5 %
Bromus carinatus	California Brome	10 %
Bromus marginatus	Mountain Brome	10 %
Clamagrostis canadensis	Bluejoint Reedgrass	10 %
Danthonia californica	California Oatgrass	10 %
Deschampsia cespitosa	Tufted hairgrass	10 %
Deschampsia elongata	Slender Hairgrass	10 %
Elymus glaucus	Blue Wildrye	20 %
Hordeum brachyantherum	Meadow Barley	10 %
Triticum aestivum x Secale	Quickguard	5 %

Table 6. Sample wetland mix for seasonally wet locations.

3. Woodland mix – a diverse mix of native upland grasses used to revegetate roads and roadsides following access route development, road decommissioning, and spoils areas.

	Project	LATAH SWCD EXAMPLE - WOODLAND MIX
	Date	2022
Species Scientific Name	**Species Common Name**	**Percent of Mix**
Bromus carinatus	California Brome	15 %
Bromus marginatus	Mountain Brome	20 %
Elymus glaucus	Blue Wildrye	20 %
Festuca idahoensis	Idaho Fescue	15 %
Poa ampla	Sherman Big Bluegrass	15 %
Pseudoroegneria spicata	Bluebunch Wheatgrass	15 %

Table 7. Sample woodland mix for upland forested sites adjacent to project sites.

- Forbs are incorporated in the above seed mixes at variable rates depending on seeding timing, budgets, site conditions, and previous seeding efforts. Native forbs are ordered individually from local native seed sources or are hand-collected on-site. Most native forb species require cold stratification; therefore, most forbs are applied in fall seedings. Specific forbs species are selected given the site's conditions.

Example list of forbs to add to mix: *Blanketflower (Gaillardia aristata), Western Aster (Symphyotrichum spathulatum), Missouri goldenrod (Solidago missouriensis), Canada goldenrod (Solidago missouriensis), Western Yarrow (Achillea millefolium), Little sunflower (Helinathella uniflora), Oregon checkermallow (Sidalcea oregana), Montana goldenpea (Thermopsis montana), Common Camas (Camassia quamash), Prairie gentian (Gentiana affinis), Western groundsel (Senecio integerrimus), Cow parsnip (Heracleum lanatum), Willowherb (Epilobium brachycarpum), Northern bedstraw (Galium boreale), Western iris (Iris missouriensis), Lewis Flax (Linum lewisii), Silky Lupine (Lupinus sericeus), Slender cinquefoil (Potentilla gracilis), Nineleaf Lomatium (Lomatium triternatum), Oregon sunshine (Eriophylllum lanatum), Globe Penstemon (Penstemon globosus), Taperleaf Penstemon (Penstemon attenuatus), Nettleleaf Horsemint (Agastache urticifolia)*

Forb seed notes: Keep in mind that some of these forbs may not be appropriate for the conditions or for season of seeding. If seeding in the spring, this list should be abbreviated and only include those species that do not require fall stratification such as western yarrow, blanketflower, western aster, etc. These are just some examples and can be included if they are appropriate or available.

- An average seeding rate for riparian restoration seedings is approximately 40-80 lbs. per acre with the higher rate being applied to the most highly disturbed locations. This rate has been highly effective on Latah SWCD seedings.
- Seeding method – given the site conditions, small size of disturbed zones, uneven ground, presence of slash and other conditions, most meadow and riparian restoration projects are not accessible with large-scale seeding equipment. Therefore, most of Latah SWCD riparian restoration seedings are broadcast seeded. Note that broadcast seeding rates are higher than drill seeding rates to accommodate the greater potential for seed predation and seed movement on the floodplain and in the stream channels.
- Seeding Timing
    - Fall – following initial construction or disturbance during the summer dry season, sites are seeded and mulched in disturbed areas right away. The goal is to achieve germination in the coming weeks to add surface roughness and protection on the site prior to the late winter/early spring high flow events. Most forbs require fall stratification and therefore most forb seeds are applied during a fall seeding event.
    - Spring – native grasses and a few select forbs (e.g., western yarrow and blanketflower) may be seeded in early spring to achieve germination during this season. Spring seedings are used to fill in areas that did not establish as well following the previous year's fall seeding event and to enhance establishment at newly disturbed areas following high flow events.
- A certified weed-free straw mulch is always applied following broadcast seeding efforts.
- Watering – at highly disturbed/vulnerable sites (new structures, heavily traveled areas followed by decompaction) the contractor or the field crew will water newly seeded/mulched areas to stimulate germination and establishment in late summer and early fall. Grass germination in fall equals less erosion potential in the late winter/spring of the following year.
- Burlap – at the most vulnerable areas burlap may be used to cover a seeded and mulched area followed by watering through the hot and dry weeks. The burlap provides shading and moisture retention during the hottest and driest periods, which results in grass germination and growth both above and below ground. This technique is utilized strategically as needed. Achieving early grass germination limits erosion and weed encroachment and protects newly installed structures, but it is also labor intensive and requires additional purchase of disposable materials (burlap). See Figures 22-24 below for an example of achieving significant grass germination on new project construction during the dry season.

Fig. 22. August 9, 2017

Fig. 23. August 24, 2017

Fig. 24. September 25, 2017,

In Summary:

Plan for

- Right species (native, site-suitable)
- Right place (soils, hydrology, sun exposure)
- Right time (fall, immediately following construction, remember cold stratification requirements for many native forb species)
- Right rate (heavier for highly disturbed; lower for less disturbed; average 40-80 pounds per acre)

Why spend so many years revisiting and planting on a site? Can't one just walk away if the processes have been restored?

The timeline for revegetation is variable and dependent on the level of project disturbance and the type of restoration required. Process-based projects aim to restore the function of the ecosystem so that the site is resilient and self-sustaining in the future. However, weed invasion, changing hydrology, and the need for adaptive management with species selection, and plant placement all require an investment of time through the first 3 (minimum) – 5 years. Latah SWCD has found that the largest revegetation effort typically occurs in year 1 and 2 following project implementation. The effort is diminishing in years 2 through 5, but continued presence, and adjustments made early in the process ensure better long-term outcomes.

Additional rationale for making a long-term revegetation commitment include:

- Year to year weather events (drought/floods) and depredation – some years/seasons are more or less optimal for planting efforts and having the ability to return to the site for multiple years spreads this risk out over multiple seasons.
- From Stream Habitat Restoration Guidelines (Cramer 2012):

  "Planning and carrying out a restoration activity must include the activities listed below. Notice that planting, which many people think of as the culmination of a project, is actually in the middle. Many projects fail due to lack of proper follow-up after planting, as well as a lack of careful planning and design. Even on a very small project, each of these steps must be considered to ensure no important piece of the puzzle is missed.

- Planning
- Site assessment
- Design
- Site preparation, including weed control
- Planting
- Establishment/maintenance
- Monitoring
- Adaptive management"

What are some other novel methods to improve survival and germination?

1. Sedge mats on new structures – pre-vegetated sedge mats are utilized to stabilize new structures such as channel diversion structures and ditch plugs, and sedge mats may also be strategically placed in new channel construction zones. Steelhead habitat construction takes place during the fish-window in July-October which leaves a short period for revegetation prior to the first high flow events in winter and early spring. The sedge mats are staked heavily and provide protection for these otherwise vulnerable structures during the first year. Areas with sedge mats are enhanced with native seed, cuttings, and other woody plantings in subsequent years.
2. Ground Protection Mats – meadows and riparian areas sensitive areas and heavy equipment is occasionally needed during the construction implementation phase. Utilizing ground protection mats (GPM) is one protective strategy that Latah SWCD employs to minimize damage and compaction to the most sensitive areas and vegetation during construction. GPM can be placed by hand or with equipment as needed to provide a driving surface so that repeated trips through one area don't cause erosion and harm to the existing vegetation.

Figure 25. Ground protection mats (GPM) laid down to protect sensitive wet meadow vegetation from heavy equipment, example from July 2009, Corral Creek project.

Figure 26. GPM laid down to protect sensitive wet meadow vegetation from heavy equipment, example from July 2009, Corral Creek project.

Figure 27. Example of GPM placed over small shrub. Following removal of GPM, shrub is resilient and bounces back.

3. Burlap – burlap is occasionally used to shade new plantings during the hot dry summer months. The burlap retains moisture provided by irrigation and creates a growing season throughout the hot dry summer months. Examples for typical burlap use on Latah SWCD project sites includes covering newly installed sedge mats and salvaged sod and to protect and encourage newly seeded areas where quick seedling establishment is needed. Burlap is used strategically in the most vulnerable locations to occupy the bare ground as quickly as possible in newly constructed areas.
4. Irrigation (including pre-watering) – "Watering at planting will help eliminate air pockets and will ensure that the soil around the root system is at or near capacity. Plants that are not rooted in moist soils will need to be watered regularly throughout their first dry season until the fall rains are consistent" (Cramer 2012).
5. Matching plant container sizes to site conditions – generally, the use of larger containerized plants (up to 1-gallon pots) is optimal for survival and overall plant resiliency. However, there are situation where smaller plants will be better suited for the planting effort. For example, smaller plants may be preferable if the substrate is thin or difficult to plant into.

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