Sierra Nevada Meadow Restoration: Best Management Practices for Preventing Introduction and Spread of Invasive Plants

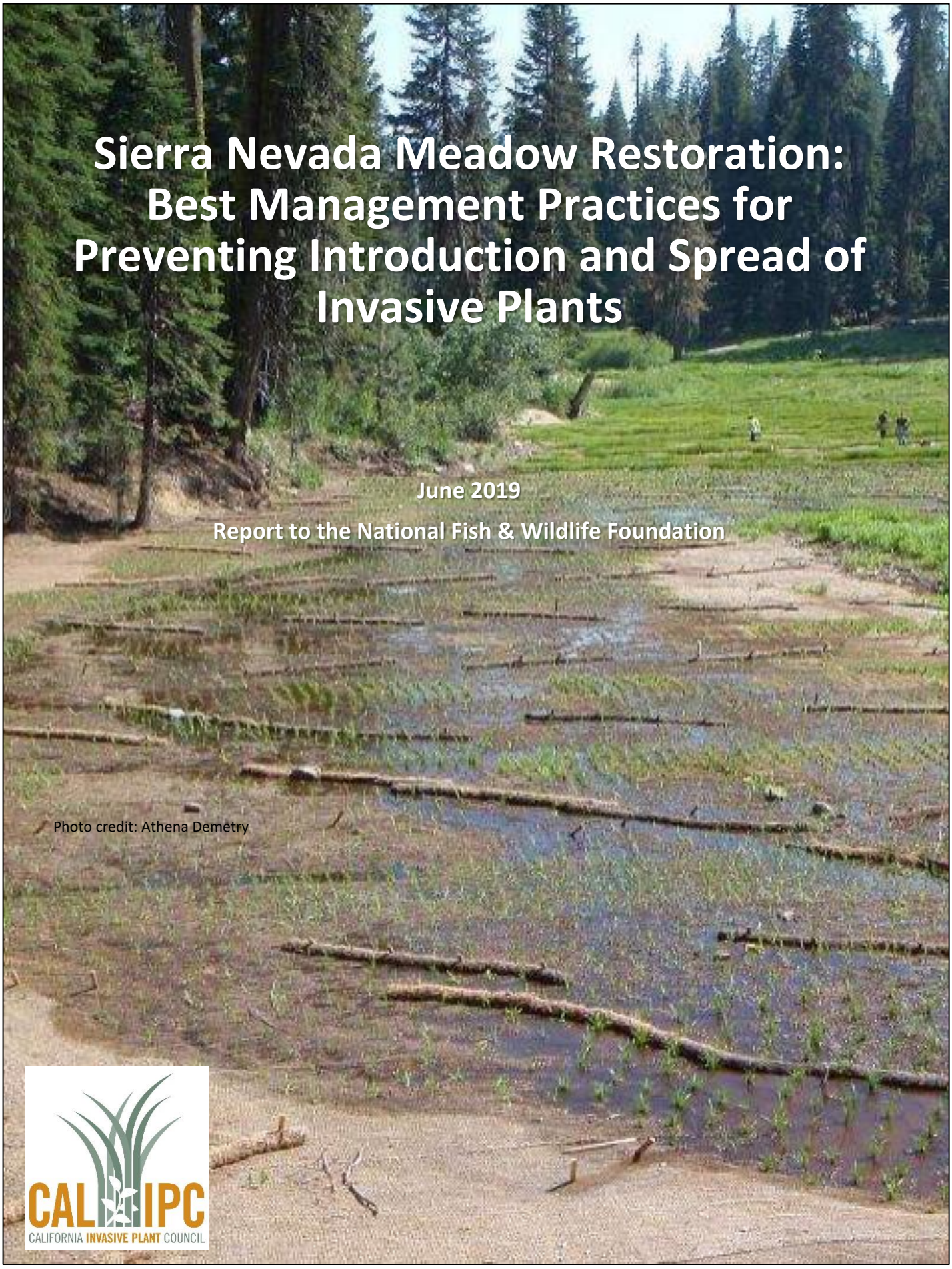

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Photo credit: Athena Demetry

CAL IPC
CALIFORNIA INVASIVE PLANT COUNCIL

Sierra Nevada meadows…

…are vital for upper watershed hydrologic function and wildlife habitat, especially with the impacts of climate change.

Invasive plants…

…are spreading in the Sierra Nevada and pose a significant threat to meadow function and wildlife.

Meadow restoration…

...is an important investment in future meadow function and wildlife habitat. But it is also a potent source of introduction and spread of invasive plants which can undermine restoration's intended benefits.

Prevention Best Management Practices (BMPs)…

…provide guidance on ways that we can accomplish restoration while avoiding the pitfalls of invasive plant introduction and spread.

For more details on prevention BMPs, see the manual "Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers" in the resources library at cal-ipc.org, including handy checklists for various aspects of project implementation.

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Meadow Restoration Activities

Whether to improve water storage, reduce downstream sediment, or enhance habitat for threatened or endangered wildlife species, meadow restoration in the Sierra Nevada is a top conservation priority. Water courses in meadows degraded by past anthropogenic disturbance (typically from over-grazing) are often deeply incised. These incised channels must be filled in order to recover hydrologic function and prevent further downcutting, erosion and water loss. Channels can be restored in multiple ways and their restoration often involves large equipment, regrading, infilling, and extensive replanting. Each approach carries with it the risk of introducing and spreading non-native plant propagules.

One of the less intrusive restoration techniques uses instream structures to catch sediment and water. These are typically employed when incision depth is less than two times the depth of the active channel under normal flow conditions (the bankfull channel depth, Stillwater 2012). These instream structures are intended to function like beaver dams (there are active conservation campaigns to restock beavers themselves to help maintain meadow function as well). Preferably, local materials are used, such as willow stakes woven into coarse screens and fastened to channel banks. Boulder vanes, rock dams and weirs, and sod mats may also be used. Instream structures are typically combined with bank stabilization actions including physical reinforcements and replanting. Beyond the channel, work may be done upslope on vegetation and trails to reduce concentrated inflow.

For deeply incised channels, restorationists bring in heavy equipment to recontour the meadow. The existing channel can be reconfigured, both in its longitudinal and cross-sectional geometry. Alternatively, flows can be diverted into a new channel with stable hydraulic geometry, while the original incised channel is plugged with earth at multiple points along its length in order to form ponds when the water table rises (such as in the “pond and plug” work in the upper watershed of the Feather River). Some high-investment meadow restorations involve not only recontouring but also the introduction of fill material to replace soil lost from erosion. Active replanting is often needed to replace vegetation that is disturbed or removed during stabilization or recontouring.

Excavators, dump trucks, fill materials from off-site, nursery stock, seed or plugs, and workers moving around the site – these are all potential vectors for introducing and spreading invasive plants at a meadow restoration sites. Seeds and even plant rhizomes can travel on equipment and personnel. Fill

materials and nursery stock can contain weed seed. Restoration work that disturbs the ground provides invasive plants an ideal opportunity to establish themselves and spread.

Fortunately, by paying attention to weed-free practices and performing our work in a conscientious manner we can prevent the introduction and spread of invasive plants. It's worth the time to do it right so that our meadow restoration projects accomplish all that they are designed to do and avoid costly weed control measures later.

Which BMPs do we need for our meadow restoration project?

The table below suggests which BMPs are important for each type of meadow restoration activity.

	BEST MANAGEMENT PRACTICES								
RESTORATION ACTIONS:	**Planning**	**Travel**	**Tools, Eqpt, Vehicles**	**Cloths, Boots, Gear**	**Mat'ls**	**Waste Disposal**	**Soil Disturb-ance**	**Veg Mgmt**	**Reveg**
Channel modifications:									
• *Instream structures*	√	√	√√	√	√		√√		
• *Regrading*	√	√	√√	√			√√		
• *Headcut protection with rocks, etc.*	√	√	√√	√	√		√√		
• *Water flow diversion*	√	√	√	√	√		√		
• *Riffle augmentation*	√	√	√	√	√		√		
• *Channel re-alignment*	√	√	√√	√			√		
Vegetation management:									
• *Active transplanting*	√	√	√	√			√	√	√
• *Seeding*	√	√	√	√			√	√	√
• *Passive revegetation*	√	(√)	(√)	(√)				√	
• *Invasive plant management*	√	√	√	√		√	√	√	
Infrastructure Management:									
• *Road re-alignment*	√	√	√√	√			√√		
• *Road out-sloping*	√	√	√√	√			√		
• *Fill removal at stream crossings*	√	√	√√	√			√		
• *Road surface improvement*	√	√	√√	√	(√)		√		
• *Cross-drains, culverts, bridges*	√	√	√√	√	√		√√		
Fuels and Fire Management:									
• *Grazing*	√	√	√	(√)			√		
• *Manual removal of fuels*	√	√	√	√		√	√		
• *Fire breaks*	√	√	√√	√			√√		
• *Prescribed burns*	√	(√)	(√)	(√)			√√		

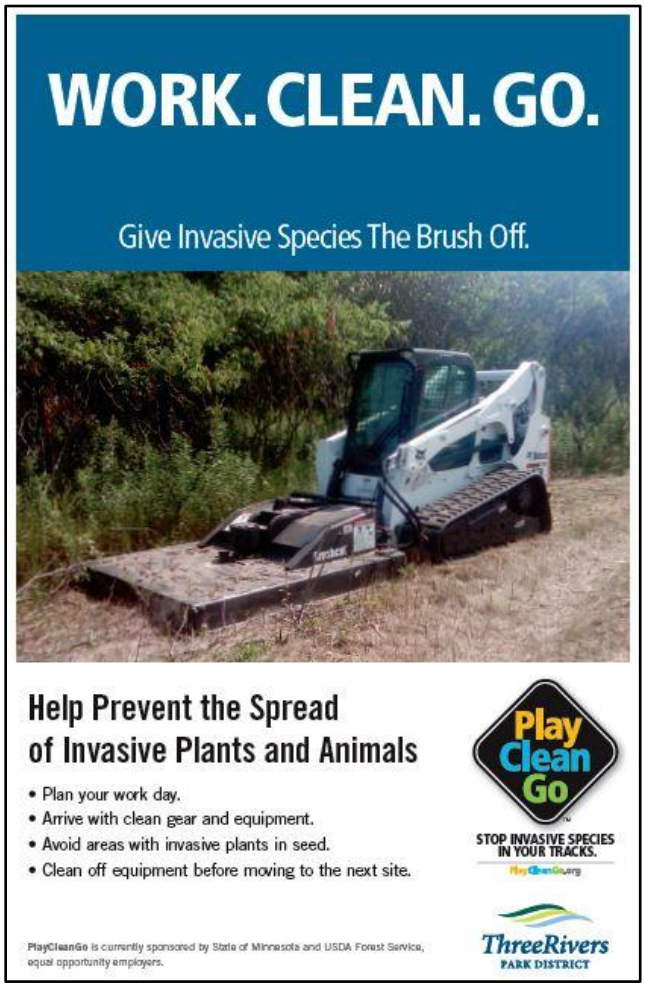
√ = BMP applies
(√) = BMP may apply
√√ = Risk is especially high

Best Management Practices (BMPs) for Meadow Restoration

BMPs have been developed to prevent the inadvertent introduction and spread of invasive plants through land management activities (publications are available for free download in the Resource Library on Cal-IPC's website). The following BMPs are common sense. But there are many potential vectors for invasive plant introduction and it's important to be familiar with all of them. It is also important to understand that to be effective many of these prevention measures need to be thought through in advance. A small investment in prevention can save large expenses later in treatment and potential future unforeseen -- but avoidable -- environmental impact on meadows.

Policy and Planning

Weed prevention should be included as a key aspect of your meadow restoration goals and to incorporate BMPs into your initial program planning. Some elements to consider:



a. Know about existing policies that may apply, like Forest Service Manual 2900. If none apply, adopt an official policy that preventing the introduction and spread of invasive plants is a goal of the project. Leverage existing campaigns, like WorkCleanGo that promotes the issue and provides resources.

b. Identify key invasive plant species of local concern (see calweedmapper.cal-ipc.org).

c. Build awareness of invasive plant impacts among project personnel. Cal-IPC's website has resources that can support this.

   Establish a process for all parts of your team to coordinate their activities in ways that address weed prevention. Consider having a dedicated invasive plant contact person. Establish a cleaning area(s) on site for equipment and personnel.

d. Integrate invasive plant prevention into your NEPA/CEQA compliance.

e. In designing your project, study the weed prevention aspects of project alternatives and conduct

assessments of risk for each planned activity.

f. Conduct site surveys to understand what weeds are already present and where they may be spread by planned restoration activities. Consider seeds in the soil seed bank.

g. Survey for invasive plant populations upstream of the site to minimize local introductions through stream flow down the watershed.

h. Mark blueprints and other documents that will be used by workers with known invasive plant occurrences and include any special instructions (for instance, "don't drive or walk through this area"). Develop mitigation plans for areas where avoidance of invasive plants is not possible.

i. Develop incentive programs among staff and volunteers to encourage invasive plant detection and reporting.

j. Include invasive plant prevention measures as part of contract notes and specifications.

k. Coordinate with your county's Weed Management Area partners for regional expertise and coordination with existing efforts.

l. Monitor the site regularly for signs of weed growth, have protocol for addressing weeds detected, and have implementation capacity ready to go.

Travel

Travelling to and from the site can move invasive plants to the site and from the site. Travel BMPs aim to minimize transport of invasive plants by moving equipment, vehicles and people.

a. Clear parking and staging areas of invasive plants

b. Leave tools, equipment, gear, and clothes at project site when possible to minimize potential for moving seeds and reduce cleaning needed.

c. Allot travel time for cleaning as required.

d. Moving from an uninfested area to an infested area is not a problem; moving from an infested area to an uninfested area is, so avoid this whenever possible.

e. Make sure the key locations like access roads and staging areas are maintained free of weeds.

Tools, Equipment, Vehicles

Tools, equipment and vehicles used for restoration are potential vectors for invasive plant spread. A D6 dozer used to move and grade soil at a site infested with velvetgrass is virtually guaranteed to trap seeds and rhizomes and deposit them at the next location where it's used—unless it is cleaned thoroughly.

a. Inspect tools, equipment, and vehicles before entering the worksite. Make cleaning part of routine maintenance for tools, equipment and vehicles.

b. Maintain weed-free tool and equipment storage sites.

c. Clean soils and plant materials from tools, equipment, and vehicles before entering the worksite. For complicated vehicles and equipment, use a checklist that specifies all the areas to be cleaned. Flashlights and under-carriage mirrors may be needed.

d. Designate one or more cleaning areas for tools, equipment, and vehicles, with all implements needed to conduct thorough but time-efficient cleaning. These areas should be:
   - easily accessible for monitoring and control
   - located away from waterways
   - located away from areas of sensitive habitats or species
   - near areas already infested with invasive plants

   If water will be used, the area should be:
   - contained with silt fences or soil berms
   - paved or have sealed surfaces to avoid re-accumulation of soil and plant material on cleaned vehicles and equipment

e. For cleaning without water use bristle brushes, brooms, scrapers, and other hand tools to remove soils and debris. High-pressure air nozzles and vacuum cleaners are a good addition to hand removal.

f. When water is available, use a portable cleaning station with undercarriage washers and pressure hoses where possible. Wash on paved or sealed surface and contain wastewater and splash with berms or silt fences.

g. Store equipment and tools on-site when possible. Encourage personnel to store gear and boots on site.

Clothes, Boots and Gear

Restoration workers can be vectors for seed dispersal through what they wear and what they carry into the field. The tendency for a fabric to attract and hold seeds and other plant material varies significantly depending on its texture.

a. Wear clothing, boots and gear that do not retain soil and plant material, for example: cotton duck (canvas), nylon, leather, Para-aramid Kevlar®, Meta-aramid Ripstop Nomex®, leather laces, and leather or rubber boots. Avoid brushed cotton, netting, Velcro, bulky knits, wool, and fleece.

b. Use special gear as appropriate, such as nylon gaiters. Consider dedicating a pair of shoes or boots for use only in the restoration site.

c. Clean clothing, boots and gear before entering restoration site and before moving from an infested part of the site to an un-infested part of the site.

d. Designate cleaning areas for clothing, boots and gear. This can be in the same area as equipment cleaning.

e. Carry appropriate equipment to remove soil, seed, and plant parts: wire brushes, small screwdrivers, boot brushes, hoof picks, water in a spray bottle, and bags for plant material.

f. Remove soil, mud, seeds, and any plant material from clothing, boots and gear before leaving a worksite infested with invasive plants.

Restoration Materials

Meadow restorations may require gravel infill, straw wattles, transplants, sod, seed—these are all especially common vectors. Because project materials are often managed by different entities or departments, developing a procedure for procuring, storing, and inspecting materials at critical control points will streamline materials management and minimize contamination. Consider developing strong business relationships with suppliers who can dependably supply weed free materials.

a. Use certified weed-free sources for all project materials. Develop a procedure for procuring and storing weed-free materials and inspecting material sources. Cultivate relationships with suppliers to streamline sourcing of weed-free materials. See www.cal-ipc.org/prevention for a list of suppliers. Inspect supply sites to confirm weed-free status. When feasible, include penalties, performance standards, or withholding provisions in contract specifications by which a contractor is assessed monetary damages for importing invasive plants as a result of non-compliance with contract specifications.

b. Limit material brought in from off-site. If material excavated from areas containing invasive plants is used, the site will need supplemental management to contain future spread. Stockpile any unused contaminated material in an area on-site that can be monitored.

c. Perform follow-up inspections at sites where erosion control materials have been used to ensure that any invasive plant introductions are caught early and treated.

d. Frequently monitor stockpiles, materials storage areas and borrow pits. Treat new invasive plant populations prior to seed production.

e. Make sure that your restoration planting palette does not include any invasive plants.

f. Use local seed wherever possible to avoid inadvertent introductions of novel weed species.

g. Ensure that the grower is producing the plants in conditions where the stock will not be contaminated with weed seeds or pathogens. Where possible, use local growers to avoid introductions of novel weeds.

h. Inspect (and reject as needed) plants prior to and after installation to insure there are no unwanted interlopers.

i. Purchased seed should be labeled as having no invasive plants present. (Some seed is certified to be "noxious weed free" referring to state noxious weed lists but this may still contain seeds of wildland invasive plant species not included on noxious weed lists.) Have all commercial seed lots tested. Seed test should follow Association of Seed Technologists and Analysts (AOSTA) standards. Tests should Include purity, germination, weed seed, and noxious weed seed.

Waste Disposal

After removing invasive plants, land managers need to decide what to do with the resulting plant biomass, seeds and contaminated materials such as soil and mulch. These materials may spread invasive plants if they are left viable and uncovered or are transported without containment.

a. Designate waste disposal areas where viable invasive plant materials will be contained, buried or destroyed.

b. Develop a monitoring plan for waste disposal areas, including burn piles, to prevent the introduction and spread of invasive plants.

c. Invasive plant material can usually be rendered unviable by sealing it in plastic and keeping covered or bagged materials in the sun, preferably on a dark surface such as asphalt to accelerate the decomposition process. Once material is nonviable, it can be disposed of in a landfill or brush pile. Monitor bagged or covered material to ensure that propagules do not escape through rips, tears or seams in the plastic.

d. When disposing of invasive plant material off-site, contain it securely during transport. Do not dispose of it at a facility that produces mulch or chip products.

Soil Disturbance

Soil disturbance provides an opportunity for invasive plants to establish and spread and should be minimized to the extent practical.

a. Minimize ground disturbance, as increased bare ground creates suitable habitat for invasive plant germination.

b. Retain soil and desirable vegetation in and around the activity area as much as possible to prevent the introduction and spread of invasive plants.

c. Consider the impacts of different types of equipment. Choose equipment that minimizes soil disturbance.

d. Limit the number of roads and access points used to help minimize soil disturbance, and to limit the risk of unintentionally transporting invasive plants into uninfested areas.

e. Promptly revegetate after ground-disturbing activities. This will stabilize soils and reduce the likelihood of invasive plant establishment.

f. Contain and manage water runoff, which may carry soil, seeds and plant material. Silt fences installed along perimeters of worksites can aid in preventing the spread of infested materials.

g. Save local existing topsoil for reuse. Plan topsoil management prior to soil disturbance. When excavating topsoil, minimize handling of the material to reduce detrimental impacts to soil microorganisms.

Vegetation Management

Vegetation management, including mowing, manual clearing, trimming, mechanized clearing and trimming, herbicide application, prescribed grazing and burning, should be performed in a way that minimizes the introduction and spread of invasive plants.

a. Consider the timing of invasive plant control efforts based on the plant's life cycle (prior to seed release for herbaceous species) and schedule vegetation management activities to maximize the effectiveness of control efforts and minimize introduction and spread of invasive plants.

b. Manage vegetation with methods and timing favorable to desirable vegetation.

c. Retain existing desirable vegetation to the degree possible. Identify and protect desirable vegetation on site to increase competition with invasive plants.

d. Train vegetation management personnel to identify invasive and non-invasive plants on-site. Provide identification guides to field staff.

e. Consider the potential impacts on vegetation of different types of equipment employed for your meadow restoration and choose equipment that minimizes vegetation disturbance

Revegetation

Revegetation is often an integral part of meadow restoration and involves replanting and rebuilding a plant community on disturbed or degraded land. Creating weed-resistant plant communities requires planning and a thorough understanding of site ecology. Planting in meadow systems may include seeding but more commonly uses plant plugs or meadow sod.

a. Develop revegetation and landscaping plans that optimize resistance to invasive plant establishment.

b. Identify areas where revegetation or landscaping is needed to improve invasive plant resistance of plant communities. Beyond the immediate meadow restoration, this may include, for instance, adjacent disturbed roadsides

c. Determine the coverage goal for revegetation and monitor regularly to gauge effectiveness in meeting the goal.

d. Evaluate existing soil type, texture and health to determine vegetation selection. Develop a plant palette that will occupy various planting zones/ecological niches in order to create a weed-resistant landscape.

e. Provide necessary irrigation for establishment of outplantings.

f. Acquire plant materials locally and verify that materials are weed-free.

g. Use local native ecotypes when feasible. Native species grown outside of the region may not establish well. Consider contract growing of local native plants.

h. Confirm that only selected plant species are used in the planting, especially when naming inconsistencies are possible.

i. Have extra plant materials on hand. Plan for mortality of 20-30% percentage of container plants.

j. Use horticultural practices to promote healthy root and foliage growth that will aid in the vegetation's ability to withstand adverse conditions and to compete with invasive plant growth. Consider soil inoculation with mycorrhizal fungi that help with moisture retention and soil/root relationships in the first year of establishment.

k. Sheet mulching (e.g., with jute) can protect bare ground from weed seed and help retain moisture in revegetated areas. Use only weed-free mulch.