

## Appendix B – Botany

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## Herbicide Effects to Plants by Active Ingredient

This section summarizes the effects to plants by active ingredient. Effects are grouped by the mode of action (how the ingredient kills a plant).

### Acetolactate Synthase (ALS) Inhibitors

Chlorsulfuron, metsulfuron methyl, sulfometuron methyl, imazapic, and imazapyr work by inhibiting the activity of an enzyme called acetolactate synthase, which is necessary for plant growth. These five active ingredients are very potent herbicides; very low concentrations kill and damage plants. In some circumstances, these ingredients could damage non-target species more readily than the other groups of herbicides proposed. On the other hand, lower concentrations mean smaller amounts of chemical substances are released into the environment.

The active ingredients and commercial formulations could be difficult to use in areas where native plants are a large component of a treatment area. These ingredients could be useful though, in situations where an invasive plant is the dominant cover species, or on some aggressive species that have not been effectively treated by other methods or herbicides.

#### *Chlorsulfuron*

Chlorsulfuron (used in Telar or Glean) is both a pre-emergent and post-emergent herbicide (i.e. it effectively inhibits seed germination and damages fully emerged plants). It could affect annual, biennial and perennial broadleaf species. Drift could cause damage to non-target plants at distances greater than 900 feet from the application site during a ground based broadcast application.

Chlorsulfuron is very potent relative to the application rate. The typical application rate proposed by the Forest Service for chlorsulfuron is greater than 6,000 times higher than the No Observed Effect Concentration (NOEC) in vegetative vigor studies on less tolerant species (sugarbeets and onions) (SERA, 2003-chlorsulfuron). This means that extremely small amounts will cause observable damage in these species. The risk assessment stated that a very broad range of sensitivities could occur, with grasses appearing far more tolerant than most other species.

The NOEC values for soil exposure used for seedling emergence testing were found to be substantially higher than the vegetative vigor studies (i.e. it would take a higher concentration of the ingredient to cause an observable effect on emerging seedlings than on vegetative vigor of older plants). Nonetheless, offsite movement of chlorsulfuron in runoff could damage non-target plants under conditions that favor runoff. In arid regions, wind erosion of treated soil could also result in damage to non-target plants (SERA, 2003-chlorsulfuron).

Chlorsulfuron has been shown to reduce non-target plant reproduction in a study done on cherry trees (Fletcher et al., 1993). The authors asserted that cherry tree reproduction displayed high sensitivity even when exposed to small quantities of chlorsulfuron, such as might be found in airborne particles traveling long distances, without altering vegetative growth. They postulated that drifting sulfonyleureas might severely reduce both crop yields and fruit development on native plants. The same authors in another study compared three herbicides, atrazine, chlorsulfuron, glyphosate at low application rates (within the range of reported herbicide drift levels) to four other crop plants. Only chlorsulfuron was found to cause reduction in the yields of these crops if plants were exposed at critical stages of development (Fletcher et al., 1996).

#### *Metsulfuron methyl*

Metsulfuron methyl (used in Escort XP) is also a potent herbicide. It affects many broadleaf and woody species.

This ingredient could cause damage to non-target plants at distances of up to 500 feet using a ground based broadcast application. For metsulfuron methyl, the typical application rate is greater than 800 times higher than the NOEC for less tolerant plants (onions) (SERA, 2003).

The offsite movement of this ingredient in runoff could damage non-target plants under conditions favorable to runoff, although this is less likely with metsulfuron methyl than chlorsulfuron. In arid regions, wind erosion could also result in damage to non-target species (SERA 2003).

#### *Sulfometuron methyl*

Sulfometuron methyl (used in Oust) is a broad-spectrum pre- and post-emergent herbicide. It is less selective than chlorsulfuron or metsulfuron methyl and is effective against broadleaf and grass species. Sulfometuron methyl drift could cause damage to non-target plants at distances greater than 900 feet from the application site during a ground based broadcast application. Typical application rate is greater than 1875 times higher than the NOEC for less tolerant plants. The offsite movement of this ingredient in runoff could damage non-target plants under conditions favorable to runoff. This kind of offsite movement is more likely with sulfometuron methyl than with chlorsulfuron and metsulfuron methyl. In arid regions, wind erosion could also result in damage to non-target species (SERA, 2003).

#### *Imazapic*

Imazapic (used in Plateau) is a selective herbicide, but even tolerant plants that are directly sprayed at normal application rates are likely to be damaged (SERA 2003). Affected plants include annual, perennial broadleaf and grass species. Many native bunchgrasses are not affected. Less tolerant species can be affected by drift up to 50 feet from ground applications and up to 100 feet from aerial applications. In clay soils in areas of relatively high rainfall rates, conditions in which runoff is favored, there could be a slight risk to some susceptible terrestrial plants. Imazapic is more selective than imazapyr. It is less likely to harm native plants or plant communities.

#### *Imazapyr*

Imazapyr (used in Arsenal, Chopper and Stalker®) is a non-selective herbicide. Tolerant plants that are directly sprayed at normal application rates are likely to be damaged (SERA, 2003-Imazapyr). Less tolerant species can be affected by drift up to 500 feet by imazapyr. Imazapyr can also “leak” out of the roots of treated plants, and therefore can adversely affect the surrounding native vegetation (Tu et al., 2001). When applied in areas in which runoff is favored, damage from runoff appears to pose a greater hazard than drift. Residual soil contamination could be prolonged in some areas. In arid areas, residual toxicity to susceptible plant species could last for several months to several years. Residual contamination could be much shorter in areas of relatively high rainfall (SERA, 2003-Imazapyr).

### **Synthetic auxins**

Picloram, clopyralid, and triclopyr mimic naturally occurring plant hormones called auxins. They kill plants by destroying tissue through uncontrolled cell division and abnormal growth.

#### *Picloram*

Picloram (used in Tordon®) is selective for broadleaf and woody plants. It could impact sensitive species at distances of nearly 1000 feet from the application site (SERA, 2003-Picloram).

In their Pesticide Re-registration Fact Sheet (1995), the EPA noted that picloram poses very significant risks to non-target plants. Estimated concentrations of picloram in the environment are hundreds to thousands of times the “level of concern” at which 25 percent of seedlings fail to emerge. The EPA also noted that picloram is highly soluble in water, resistant to biotic and abiotic degradation processes, and mobile under both laboratory and field conditions. They stated that there is a high potential to leach to groundwater in most soils.

Plant damage could occur from drift, runoff, and distant areas where ground water is used for irrigation or is discharged into surface water (EPA, 1995). Labeling restrictions from these findings were implemented to reduce effects. Because picloram persists in soil, non-target plant roots can take up picloram (Tu et al., 2001) and could impact revegetation efforts. Lym et al. (1998) recommended that livestock not be transferred from treated grass areas onto sensitive broadleaf crop areas for 12 months or until picloram has disappeared from the soil without first allowing seven days of grazing on an untreated green pasture. Otherwise, urine may contain enough picloram to injure susceptible plants. To a lesser degree, this can occur with other active ingredients such as glyphosate and imazapic.

### *Clopyralid*

Clopyralid (used in Transline) is more selective than picloram. As with picloram, clopyralid has little effect on grasses, but also does little harm to members of the mustard family. It is effective on the sunflower, legume, nightshade, knotweed and violet families. It is less persistent than picloram. Off-site drift may cause damage to susceptible plant species at distances of about 300 feet from the application site. Wind erosion of treated soil in arid climates could also cause damages in the range of 200 to 900 feet. Use of clopyralid in a roadside revegetation project had mixed results (Tyser et al., 1988). Native grasses increased while native forbs decreased, which is typical for an ingredient that is selective against forbs. However, non-native annual grasses increased in this study.

### *Triclopyr*

Triclopyr (used in Garlon) is a selective systemic herbicide. It is used on broadleaf and woody species. It is commonly used against woody species in natural areas (Tu et al., 2001). Sensitive species could be impacted by drift from 100 feet (typical Forest Service application rate) to 1000 feet (maximum US Forest Service application rate) (SERA, 2003-Triclopyr). Two forms of triclopyr could be used with differing degrees of effects. Triclopyr BEE (butoxyethyl ester) is more toxic to plants than triclopyr TEA (triethylamine salt). Triclopyr BEE formulations are more apt to damage plants from runoff than other formulations. Both formulations have been found to decrease the relative long-term abundance and diversity of lichens and bryophytes. Newmaster et al. (1999) stated drift from triclopyr could affect the sustainability of populations of lichens and bryophytes, where these ingredients reduced abundance. They found that normal application rates (applied aerially) were found to reduce abundance by 75 percent, variable by species. Colonists and drought-tolerant species were more resistant than the mesophytic forest species, which means that herbicide treatments could essentially push back the successional stage on a non-vascular community. Triclopyr was found to inhibit growth of four types of ectomycorrhizal fungi associated with conifer roots at concentrations of 1,000 parts per million (Estok et al., 1989).

## EPSP Synthase Inhibitors

Glyphosate - preventing plants from synthesizing three aromatic amino acids. The key enzyme inhibited by glyphosate is called EPSP.

### *Glyphosate*

Glyphosate (used in 35 formulations including RoundUp and Rodeo®) is a non-selective systemic herbicide that can damage all groups or families of non-target plants to varying degrees, most commonly from off-site drift. Plants susceptible to glyphosate can be damaged by drift up to 100 feet from the application site at the highest rate of application proposed. More tolerant species are likely to be damaged at distances up to 25 feet (SERA, 2003-glyphosate). Non-target species are not likely to be affected by runoff based on the NOEC for pre-emergent vegetation. Glyphosate strongly adsorbs to soil, and has a low potential to leaching into groundwater systems (SERA, 2003-glyphosate). Because it adsorbs readily to soils, plant roots do not readily absorb it. Non-target species will not be impacted through their roots.

Some field studies have been conducted using glyphosate. Miller et al. (1999) found no effects to plant diversity in an 11-year study on site preparation using herbicides, though the structural composition and perennial species presence were changed. Such differences in overstory and understory vegetation may have ecological implication. For instance, reductions in several species (*Vaccinium* and *Prunus* species) in the understory could affect wildlife species dependent on them for food, and could also affect traditional gathering of these species. As discussed in the effects summary of triclopyr, Newmaster et al. (1999) raised concern that drift from glyphosate as well could affect long term sustainability of populations of lichens and bryophytes.

### Acetyl CoA Carboxylase (ACCase) Inhibitors

Sethoxydim inhibits acetyl CoA carboxylase, the enzyme responsible for catalyzing an early step in fatty acid synthesis. Non-susceptible species have a different CoA carboxylase binding site, rendering them immune to the effects.

#### *Sethoxydim*

Sethoxydim (used in Poast®) kills post-emergent annual and perennial grasses by preventing the synthesis of lipids. Because sethoxydim is water-soluble and does not bind strongly with soils, it can be highly mobile in the environment. Rapid degradation generally limits extensive movement. In water, sethoxydim can be degraded by sunlight within several hours (Tu et al., 2001). For relatively tolerant species, there is no indication that damage from drift would result at distances more than 25 feet from application sites. For susceptible species, there is a possibility of damage no greater than 50 feet from application sites. Runoff could cause damage to susceptible plants in areas of high rainfall (SERA, 2001-sethoxydim).

## Common Control Measures

The Table of Common Control Measures (Table 5) in Chapter 2 of the EIS was derived from the document *Common Control Measures for Invasive Plants of the Pacific Northwest* (Mazzu 2005, botanist for the Region 6 Invasive Plants FEIS Team). This is a working document. It is continually updated as new information is acquired.

This publication is Appendix N of the R6 FEIS, and can be viewed online at the Forest Service Region Six Invasive Plants Website: <http://www.fs.fed.us/r6/invasiveplant-eis>

## Pacific Northwest Region Six White Paper - NEPA for Invasive Plant Biological Controls and Compliance with Standard 14

Desser/Bulkin/Spiegel Update July 26, 2006

**Purpose:** This white paper provides information regarding the use of classical biological control agents as part of integrated invasive plant (noxious weed) management on National Forests in the Pacific Northwest Region. Biological control agents are used when weed eradication is not possible (R6 2005 FEIS Appendix J-9).

**Use of Biological Controls for Invasive Plants in the United States:** USDA - APHIS (Agricultural Plant Health Inspection Service) approves each step in the importation and release of biological control agents in the United States. Biological control agents undergo a rigorous testing procedure prior to being available for release. Initial testing occurs in quarantine laboratories abroad and in the United States. The agents are tested for their effectiveness in controlling the target organism, and for their host specificity. This does not include the release of pathogens for weed control, as they are regulated by EPA as biological pesticides. The International Code of Best Practices for Classical Biological Control of Weeds (Balciunas and Coombs 2004) provides further guidance to reduce the risk that unintentional effects may occur from releases.

APHIS completes NEPA, ESA consultation and other technical analysis assuming that biological controls would be distributed throughout North America, to wherever the target species exists. This satisfies the intent of NEPA for the release and distribution of the agent in the United States (Beard and Carbone 2001).

**Use of Biological Controls for Invasive Plants in Region 6, Oregon, Washington, Idaho and California:** Each state approves releases of biological control agents for invasive plants. Staff from state Departments of Agriculture provides guidance for appropriate releases in each state. The R6 2005 FEIS, including Appendices H and J, compiled up to date information about biological controls in Oregon, Washington, Idaho and California. The R6 2005 FEIS considered the effectiveness, cost and environmental consequences of using biological controls and resulted in the addition of Invasive Plant Treatment/Restoration Standard 14 to all Forest Plans in the Region:

*“Use only APHIS and State-approved biological control agents. Agents demonstrated to have direct negative impacts on non-target organisms would not be released.”*

The ROD states that Standard 14 was adopted because:

*“...it reduces the chances of unintended non-target impacts because of the APHIS testing procedures. It also provides for adaptive management if unexpected non-target impacts are discovered. Adopting this standard will address decision factors 1 and 2 better than No Action (no standard)...”*

To help Forests comply with Standard 14, the Regional Office will annually provide a list of agents that may not be released because they do not meet the standard (2006 list attached) in addition to any new and approved biological control agents for invasive plants. Practitioners are encouraged to coordinate with the state experts regarding the selection of agents.

**NEPA Requirements** have been satisfied by the APHIS and R6 documents. The effects of redistributing biological control agents for invasive plant management according to Standard 14 have been fully



disclosed in APHIS and R6 documents. Release of these agents is not considered a site-specific action because “these agents are expected to occupy invasive plant hosts on National Forests regardless of any action the Forest Service may take (Beard and Carbone 2001).”

**Table 1 – Attachment Table from White Paper – Biocontrol agents meeting standard 14 of the R6 2005 Invasive Plant ROD**

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Aceria <sup>1</sup>	malherbae	Acarina	Eriophyidae	MITE	Field bindweed (may attack Calystegia spp.)	Spotty, isolated sites, Doing well in Wasco County, recommended E of Cascades; warm sites; Not approved in CA due to presence of closely related natives (may infest Calystegia spp.).	Transfer infested leaves/galls during growing season, early season allows mite populations more time to expand.	Stunts plants, reduces flowering, reduces plant density in Texas and Oregon.
Agapeta	zoegana	Lepidoptera	Cochylidae	INSECT	knapweeds (prefers spotted, also diffuse)	Widespread in OR, possible gaps; prefers large plants, scattered density, cooler knapweed sites	Adults with blacklights, early July-September, short adult lifespan; or dig roots.	Reduces biomass and density.
Agrilus	hyperici	Coleoptera	Buprestidae	INSECT	St. Johnswort	Spotty in E OR & WA, disperses well; would use on west side if could establish, established near Medford, use in SW part of region, prefers warm dry with large stems; prone to fungus on wet sites; may want	Sweep adults, June-July; release 100 on well-established plants.	Most infested plants die; will attack plants in shade undamaged by Chrysolina hyperici.

<sup>1</sup> Not approved in CA

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
						to redistribute; found on native H. concinnum in CA; 3e3		
Aphthona	abdominalis	Coleoptera	Chrysomelidae	INSECT	leafy spurge	Failed, never recovered in US	Not needed	
Aphthona	cyparissiae	Coleoptera	Chrysomelidae	INSECT	leafy spurge	Widespread; moist, high humidity and Mediterranean, dry summers with sun, sand, rock; Avoid sites with depressions, N aspects, bare ground; larvae need 4 months cold. Canadian research sug. prefers: flowering plants >51 cm, 50- 125 stems/sq m., 40-60% sand.	Sweep adults June-July.	Less effective than A.lacertosa; when Aphthona spp. establish reductions in cover, density, aboveground and root biomass occur in 3-5 yrs.

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Aphthona	czwalinae	Coleoptera	Chrysomelidae	INSECT	leafy spurge	Widespread; moist, high humidity and Mediterranean, dry summers with sun, sand, rock; larvae need 4 month cold <4 C.	Sweep adults June-July.	Less effective than and frequently occurs with <i>A.lacertosa</i> ;; when <i>Aphthona</i> spp. establish reductions in cover, density, aboveground and root biomass occur in 3-5 yrs.
Aphthona	flava	Coleoptera	Chrysomelidae	INSECT	leafy spurge	Well distributed, spotty establishment; more mesic than <i>A. cyparissiae</i> or <i>A. nigriscutis</i> ; larvae need 4 month cold period; sunny locations.	Sweep adults July.	Very effective near Bozeman, little impact in many other sites.

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Aphthona	lacertosa	Coleoptera	Chrysomelidae	INSECT	leafy spurge	Widespread; more mesic than other Aphthona spp.; do not redistribute from area where parasitic protozoan Nosema is present	Sweep adults June-July.	Most effective agent on leafy spurge. When it establishes, reductions in cover, density, aboveground and root biomass in 3-5 years. Expected to do well in northern US but not southern.
Aphthona	nigriscutis	Coleoptera	Chrysomelidae	INSECT	leafy spurge	Widespread, may want to move within few miles; larvae need 4 month cold period; maximum sun exposure, well-drained, smaller and more scattered spurge, Stipa spp. sites.	Sweep adults June-July.	Particularly effective in Canada.
Aplocera	plagiata	Lepidoptera	Geometridae	INSECT	St. Johnswort	Warm and dry with long summers; common in E OR & WA, recovered near Camp Sherman, disperses 50 miles.	Sweep larvae in summer, 500 indiv. adequate for release.	Variable; appears to need warm, dry areas with summer long enough to allow two full

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
								generations. Effective in BC.
Bangasternus	fausti	Coleoptera	Curculionidae	INSECT	knapweeds (Diffuse, spotted, and squarrose)	Widespread, hot & dry, low elev.	Transfer adults in the summer.	Can consume up to 100% of seeds in a flower head; attacks other insects in the flower head.
Bangasternus	orientalis	Coleoptera	Curculionidae	INSECT	yellow starthistle	Widespread; cool climates unfavorable.	Sweep or hand pick in summer.	Single larva destroys 50- 60% of seeds in a head, but small % of damage at a site.
Botanophila	seneciella	Diptera	Anthomyiidae	INSECT	tansy ragwort	Prefers meadows and openings	Sweep adults in early summer, release 50. Transplant infested plants.	Widespread, along with T. jacobaeae and L. jacobaeae tansy ragwort control attributed to these three agents.
Brachypterolus	pulicarius	Coleoptera	Nitidulidae	INSECT	toadflax	Accidental, widespread on yellow	Collect adult with sweep net or aspirator	effective in reducing seed production of

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
								yellow toadflax
Bradyrrhoa	gilveolella	Lepidoptera	Pyralidae	INSECT	Rush skeleton weed	Recent release, not established; permit issued 5/02.	Unknown	Can kill aboveground parts, general effectiveness unknown.
Bruchidius	villosus	Coleoptera	Bruchidae	INSECT	Scotch broom, French, Spanish, and Portugese	recent intro, limited avail in W OR & WA, accid in Carolinas, OR wrote petition & tested in OR & WA	Collect and redistribute adults after mating, heavy duty sweep nets or beating sheets. Collectible in OR in 2003.	Reduces seed production and may reduce spread.
Calophasia	lunula	Lepidoptera	Noctuidae	INSECT	toadflax	Not est at high elevations, poss due to cold; warmer sites poss better; does not do well where ant pops high.	One to three generations/yr; transfer larvae.	Widespread near Spokane, ineffective, rec ently recovered in OR; strong flier; most common on roadside stands, low density in large stands.

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Ceutorhynchus	litura	Coleoptera	Curculionidae	INSECT	Canada thistle	Spotty distribution; in sunny areas with competition and U. cardui reduces density; may be effective at very high densities where thistle populations are stressed.	Collect adults from early spring shoots; release in groups of 30-50.	While it reduces overwintering survival of C. thistle, surviving plants provide source for reinfestation. Needs augmentation with another agent.
Chaetorellia	acrolphi	Diptera	Tephritidae	INSECT	knapweeds (spotted preferred, also diffuse, squarrose, purple starthistle)	Spotty distribution, Lane Co, Hood R.; moist habitats in OR; dry, south-facing slopes, scattered plants in Brit.Col.	Clip larvae-infested seed heads in fall or early spring; best to rear adults and separate from other emerging insects, esp predators.	Establishment in some areas difficult due to competition with seed head weevils and moths.
Chaetorellia	australis	Diptera	Tephritidae	INSECT	yellow starthistle	Widespread, spread 50mi/yr; requires nectar source in same area for first generation that emerges prior to C. solstitialis availability.	Sweep adults or collect infested seed heads in late winter and place in new area in spring.	Larval feeding reduces seed production 80-90%.



Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Chamaesphecia	crassicornis	Lepidoptera	Sessiidae	INSECT	leafy spurge	5 sp.failed in US, not avail.	Unknown	Unknown.
Chamaesphecia	hungarica	Lepidoptera	Sessiidae	INSECT	leafy spurge	not yet established, possible future introductions.	Unknown	May be effective in moist sites.
Chrysolina	hyperici	Coleoptera	Chrysomelidae	INSECT	St. Johnswort	Widespread in mesic; cool moist summers, cold winter w/o snow; does not do well in shade.	Sweep adults early to mid June, release 250+.	Variable; more effective in CA and w OR than ID and WA.
Chrysolina	quadrigemina	Coleoptera	Chrysomelidae	INSECT	St. Johnswort	Widespread in dry; dry summers, mild, moist winters; best in CA climate.	Sweep adults from early flowers, early to mid June, release 250+. Late summer pops female and will not breed w/o males.	Variable, most effective in CA where it was responsible for the weed's removal from the noxious weed list.
Coleophora	klimeschiella	Lepidoptera	Coleophoridae	INSECT	Russian thistle	Widespread, moves on own	Not needed	High parasitism and predation by natives make this ineffective.

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Coleophora	parthenica	Lepidoptera	Coleophoridae	INSECT	Russian thistle	Widespread, moves on own	Not needed	Feeding damage has little effect, also heavily attacked by predators and parasitoids.
Cyphocleonus	achates	Coleoptera	Curculionidae	INSECT	knapweeds (spotted preferred, also diffuse)	Prefers lg stems & monoculture stands, well-drained, low, hot, dry, gravel pits	Collect adults Aug-Sept or rear from roots.	Reduces biomass and density.
Cystiphora	schmidti	Diptera	Cecidomyiidae	INSECT	Rush skeleton weed	Widespread, most attack in open locations, well-drained soil, <16" annual precip, yrly ave temp >63F.	Collect galled stems early July to late September; remove seedheads/flowers, tie stems into teepees, set among uninfested plants.	Native parasitoids greatly diminish effectiveness.
Diorhabda	elongata	Coleoptera	Chrysomelidae	INSECT	tamarix	lots of use in E OR when available: Snake and Owyhee R	All stages, nylon mesh sleeves tied on branches may deter predators and dispersal.	Defoliated plants dieback, severe defoliation for 2 years killed some large

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
								plants.
Eriophyes	chondrillae	Acarina	Eriophyidae	MITE	Rush skeletonweed	Widespread, disperses well, found on isolated plants; undisturbed, well-drained, south- and west-facing slopes.	Transfer galled stems July-mid October, success depends on ambient RH, transfer in evening or damp days.	Most effective agent on this weed so far, impact reduced in CA due to predaceous mites.
Eteobalea	intermediella	Lepidoptera	Cosmopterigidae	INSECT	toadflax	released and recovered in MT, unavail yet for redistribution	Sweep in late summer.	Unknown.
Eteobalea	serratella	Lepidoptera	Cosmopterigidae	INSECT	toadflax, yellow	released and recovered in MT, unavail yet for redistribution	Sweep in late summer.	Unknown.
Eustenopus	villosus	Coleoptera	Curculionidae	INSECT	yellow starthistle	Widespread, spreads well, cool climates unfavorable.	Sweep or hand pick adults in June or July.	Feeding on flower heads and buds can cause 90-100% seed reduction in a head.
Exapion	ulicis	Coleoptera	Apionidae	INSECT	gorse	Widespread W OR & WA, all gorse except where gorse and weevil destroyed by fire.	Not needed	May retard the spread of the plant but does not reduce

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
								established density; 30-95% of seedpods attacked.
Exapion	fuscirostre	Coleoptera	Apionidae	INSECT	Scotch broom	Widespread W OR & WA, mod effect, affect 50% seeds; prefers meadows and hills w/S exposure; damp and cold, N face undesirable.	Adults, April and May; release 100-250 adults.	Reduces seed production up to 60%; stand density reduction is questionable.
Galerucella	calmariensis	Coleoptera	Chrysomelidae	INSECT	purple loosestrife	Apparent synergism between two Galerucella spp.: alone G. pusilla density too low for control, G. calmariensis poss limited by dispersal; G. calmariensis attack transfers nutrients to regrowth, which allows G. pusilla to attain high densities. No direct toxic effect of triclopyr amine.	Small releases tend to remain small, releases of 2000 larvae or adults produce outbreaks. Place larval-infested foliage on plants in the new stand.	Widespread, effective, FS may want; biomass at several sites in Oregon and Washington has been reduced by 90%.

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Galerucella	pusilla	Coleoptera	Chrysomelidae	INSECT	purple loosestrife	As above.	Releases of 2000 produce outbreaks. Place larval-infested foliage on plants in the new stand.	Widespread, effective, FS may want; biomass at several sites in Oregon and Washington has been reduced by 90%.
Gymnetron	antirrhini	Coleoptera	Curculionidae	INSECT	toadflax	Biotype approved intro in WA & MT may want to spread but generally common; does not withstand extreme winter cold; avoid releasing where flower feeding beetle (B. pulicarius) is abundant.	Sweep adults in July and August.	40-60% infested seed heads, limited effect on stand density
Gymnetron	linariae	Coleoptera	Curculionidae	INSECT	toadflax, Dalmatian	Recent release, established in WY in rocky sites	Sweep or hand pick in summer.	Unknown.
Hyles	euphorbiae	Lepidoptera	Sphingidae	INSECT	leafy spurge	Numerous intros, failed in OR, occurs in MT, unlikely to be introduced; warm summers,	Hand pick larvae summer to fall, release 500+ on warm, rocky, sandy sites.	Defoliates in midsummer and spurge later refoliates; not

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
						mild winters.		effective, limited by virus in U.S.
Hylobius	transversovittatus	Coleoptera	Curculionidae	INSECT	purple loosestrife, L. alatum also used during testing but use in field unknown.	Spotty, expensive to rear and collect; stands; may dampen rebound after defoliation by Galerucella, helps reduce root reserves of large plants, appears to shift population to younger cohort.	Cut path through infested stand, collect adults with flashlight for 2 hours after sunset along path. Weevils drop when disturbed. Release 25-100 at sites with large plants.	Feeds on root storage reserves, believed to complement leaf beetle damage.
Larinus	minutus	Coleoptera	Curculionidae	INSECT	knapweeds (diffuse, meadow, spotted, squarrose, C. arenaria, and Calcitrapa spp.)	Widespread, may want to move within few miles; hot, dry areas.	Adult sweep net, hand pick, aspirate in early summer	Heavy defoliation can result in stunting and death; larvae consume entire flower head contents. Dramatic reductions in MT, OR & WA.

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Larinus	obtusus	Coleoptera	Curculionidae	INSECT	knapweeds (spotted and meadow, occ diffuse)	Limited distribution, priority on meadow in E OR; prefers spotted knap.; prefers slightly moist sites.	Sweep at 10% bloom, do not move larvae and pupae in seed heads as this moves different species and biotypes.	Defoliation and seed feeding; populations increase slowly.
Larinus	curtus	Coleoptera	Curculionidae	INSECT	yellow starthistle	Widespread in E OR & WA, does poorly on westside, may need redistribution in spots in E; cool climates unfavorable.	Sweep or hand pick adults at 10% bloom, late June to early August.	Larval feeding can reduce seed production by 100%.
Leucoptera	spartifoliella	Lepidoptera	Lyonetiidae	INSECT	Scotch broom	Widespread	Not recommended	Host density changes not documented; heavily parasitized in OR & WA, may increase susceptibility to pathogens.
Longitarsus	jacobaeae	Coleoptera	Chrysomelidae	INSECT	tansy ragwort	Sunny pastures below 800 meters, survives cold where snow keeps ground from freezing deeply.	Collect adults with vacuum from infested rosettes after first fall rains; sweep net bolted plants; transfer 100-500.	Widespread; one of three agents attributed with ragwort control in OR.

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Mecinus	janthinus	Coleoptera	Curculionidae	INSECT	toadflax	Limited distribution, priority E OR; hot, dry forest and grassland, large stemmed plants; overwinter survival best in s BC or snow-cover.	Light sweep net in May to July, earlier better; release 200.	Sig plant density reduction in BC, OR and WA.
Metzneria	paucipunctella	Lepidoptera	Gelichiidae	INSECT	knapweeds (spotted preferred, also diffuse and meadow)	Widespread; does not tolerate severe winters; bulk storage attracts predatory mites.	Clip larvae-infested seed heads late summer, early fall, early spring. Seed heads often infested with straw itch mites which attack biocontrols and cause severe human itching.	Although larvae destroy other agents in seed heads, greatest reduction in seed production occurs when moth and gall flies are all present. Deer mice cause heavy overwinter mortality.
Microlarinus	lareynii	Coleoptera	Curculionidae	INSECT	Puncturevine, also attacks Tribulus cistoides and some Kallstroemia spp.	Isolated sites, limited by cold winter temps., can use inundative in other areas.	Collect adults from soil litter with vacuum or aspirator or put plants and litter in bag in sun and collect crawling adults.	Very effective in warm climates.



Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Microlarinus	lypriformis	Coleoptera	Curculionidae	INSECT	Puncturevine, also T. cistoides and some Kallstroemia spp.	Same as above.	Collect adults from soil litter, same as above.	Very effective in warm climates.
Nanophyes	marmoratus	Coleoptera	Curculionidae	INSECT	purple loosestrife	Sites without prolonged flooding; tolerates wide range of conditions incl. high tidal exchange, low host density; excellent host-finding ability.	Adults with beating tray and beat stick; release 100-200 adults per site.	Widespread, effective, 1000's per plant;
Oberea	erythrocephala	Coleoptera	Cerambycidae	INSECT	leafy spurge	Limited distribution; larvae bore down stem with large pith >3mm; warm, well- drained sites.	Sweep and hand pick adults at peak flowering, release 100+, may need to cage to establish.	Ineffective in western Canada prob due to small pith; In OR it changed the population from old, large roots to smaller, thinner, less competitive plants; attacks only specific biotypes of spurge.

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Pelochrista	medullana	Lepidoptera	Tortricidae	INSECT	knapweeds (spotted and diffuse)	Just released, difficult to establish, not yet available; prefers dry; damage identical to Agapeta.	Collect infested roots in fall, winter or early spring.	Reduces plant biomass.
Phrydiuchus	tau	Coleoptera	Curculionidae	INSECT	Mediterranean sage, also clary	Widespread, may want to move within few miles if Med sage becomes est around John Day; best on warm, dry sites. Attacks clary sage as well but prefers Med sage.	Sweep adults in late spring and early summer when flowers in 25% bloom; aspirate adults in Oct-Nov when mating and ovipositing.	Effective on sites with strong perennial component and little grazing, little effect on salt-desert scrub or annual dominated.
Prokelisia	marginata	Homoptera	Delphacidae	INSECT	Spartina anglica, S. alterniflora, S. foliosa	approved, not nec on FS lands yet; intertidal areas	Vacuum or sweep adults and nymphs June-Oct	early results promising for S. alterniflora in Willapa Bay
Psylliodes	chalcomera	Coleoptera	Chrysomelidae	INSECT	Musk thistle, also Italian, plumeless, and Illyrian.	Approved, but still unavailable, establishment unknown; found in cold and hot areas of Italy.	Sweep adults.	Unknown.

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Pterolonche	inspersa	Lepidoptera	Pterolonchidae	INSECT	knapweeds (Diffuse, spotted, and squarrose)	Recovered in Mosier, OR in 2005, rare and hard to work with; Mediterranean climate best.	Transfer adults, eggs, larvae, or pupae.	Once infested 20% of plants but now infrequent due to knapweed reduction from seed head weevils (Larinus spp.).
Puccinia	chondrillina	Uredinales	Pucciniaceae	FUNGUS	Rush skeletonweed	Widespread; most effective in mesic sites, less damaging in hot and dry sites.	During summer move infected stems and place in cool evening and when dew period anticipated; misting uninfected plants aids infection rate.	Pathotype available has little effect on SW OR late-flwr or NE WA, N ID early-flwr biotypes. In some CA areas considered more effective than mite or midge.
Sphenoptera	jugoslavica	Coleoptera	Buprestidae	INSECT	knapweeds (diffuse preferred, also spotted and squarrose)	Very widespread; warm, dry areas; females need 5 days > 86F to lay eggs.	Collect adults with sweep net in mid-July early evening.	Reduces biomass, seed production, and density.

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Spurgia	esula	Diptera	Cecidomyiidae	INSECT	leafy spurge	Dense spurge, south-facing slopes in cool climates, some shade okay.	Clip galls late May to October, release 100+ in dense, well-watered, sheltered spurge sites.	Ineffective, attacked by native species, not likely for USFS; galls on leafy spurge too sparse for much impact.
Subanguina	picridis	Nematoda	Tylenchidae	NEMAT ODE	Russian knapweed, diffuse knapweed	nematode, isolated sites, need better dissemination; difficult to establish; does not do well in dry areas, best in moist areas.	Collect galls in fall and place on soil. Nematodes will emerge from disintegrating galls and move to shoots in wet spring.	Disperses very slowly; some sites now have native grasses but if area too small, weed will reinvade from edges.
Terellia	virens	Diptera	Tephritidae	INSECT	knapweeds (spotted preferred, also diffuse)	Prefers spotted knap.; isolated sites, igher elev. than weevils; does not survive well in seedheads with L. minutus, prefers cooler and wetter than weevils.	Collect infested seedheads in fall or early spring; must be kept moist; best to separate out parasitoids.	Reduces seed production; limited availability so effect still not determined.

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Tetranychus	linterarius	Acarina	Tetranychidae	MITE	gorse	Widespread W OR & WA, favors unshaded gorse patches away from the ocean.	Not needed	Now attacked near Bandon, OR by accid pred mite from greenhouse industry; at many other sites attacked by ladybird beetle and rendered ineffective.
Trichosirocalu s <sup>2</sup>	horridus	Coleoptera	Curculionidae	INSECT	Subtribe Carduinae: musk, plumeless, Italian thistles accepted in US; in other areas Canada, and bull thistles are accepted.	Intro everywhere, recovered Klamath R only, not likely for USFS, poss on natives; surveys in Klamath Co have shown no nontarget impacts.	Sweep in July or pick in spring prior to bolt.	Seldom effective by itself. Prohib in CA due to concern for artichokes. Requires 3-5 years to build population. Disperses quite well.

<sup>2</sup>Not approved in CA

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Tyta <sup>3</sup>	luctuosa	Lepidoptera	Noctuidae	INSECT	Field bindweed (also may attack Calystegia spp.)	Recent releases, not established, although moths recovered; unlikely on FS; difficult to establish; recorded to feed on native Calystegia spp.	Transfer larvae and adults, can black light; not approved in CA	Does not significantly damage hedge bindweed (Calystegia sepium), effect on field bindweed unk.
Urophora	stylata	Diptera	Tephritidae	INSECT	bull thistle	Widespread in W OR with gaps, cold-adapted population now est on Umatilla Wildlife Refuge; while most seeds in an area can be killed, not effective due to recolonization by far-flying seeds; similar initial seed reduction as mowing but mowing allows later flowering when flies not available for seed predation.	Collect 20-50 galled seed heads in late fall, keep cool and dry through winter and release newly emerged adults in spring to avoid transferring associated parasites; sweep adults between May and July, transfer 130+ (half female) per release.	Because Bull thistle is transient, it is difficult to maintain fly populations for more than a few years in any location. Flies disperse rapidly.

<sup>3</sup> Not approved in CA

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Urophora	cardui	Diptera	Tephritidae	INSECT	Canada thistle	Widespread, may want to move within few miles; does best in scattered, semi-shaded, moist C. thistle stands.	Locally may transfer 50-100 galls in spring; otherwise collect galls in fall, winter, early spring, rear adults, separate other insects and release onto misted plants. Collect galls from similar habitats as cold-adapted strains have been developed.	Limited effectiveness; provides metabolic sink that reduces vigor.
Urophora	quadrifasciata	Diptera	Tephritidae	INSECT	knapweeds (black, brown, diffuse, meadow, short-fringed, spotted, squarrose, and cornflower)	Widespread; Larvae do not tolerate severe winters	Clip larvae-infested seed heads early spring and fall, sweep adults June to July.	Where both Urophora species are present, seed production is reduced at least 50%. Urophora species freq destroyed by seed head moth and weevils.

Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
Urophora	affinis	Diptera	Tephritidae	INSECT	knapweeds (spotted, diffuse, squarrose)	Widespread; Does best in mesic or wetter years; check for presence prior to redistribution.	Clip larvae-infested seed heads early spring and fall, sweep adults in June.	Where both Urophora species are present, seed production is reduced at least 50%. Urophora species freq destroyed by seed head moth and weevils.
Urophora	solstitialis	Diptera	Tephritidae	INSECT	Musk thistle and plumeless thistle; In Europe assoc with Carduus spp.	Recent release in MD,MT, and OR, not established yet in US, difficult to establish.	Collect thistle heads after galls harden in August-September.	Unknown.
Urophora	sirunaseva	Diptera	Tephritidae	INSECT	yellow starthistle	Widespread in western US, SW OR; does not do well in windy areas, not in NE OR; excellent disperser.	Sweep adults late May and July.	Rarely exceeds 25% attack rate, effectiveness limited.
Zeuxidiplosis	giardi	Diptera	Cecidomyiidae	INSECT	St. Johnswort	Damp, mod to high humidity, high elevations; not suitable for dry summers or continuous wind.	Best to establish plants from new population in pots, infest with midges, and then transplant.	many intro in OR failed, est in So CA but para; high RH, does poorly in dry, windy; best in



Biocontrol Agents Meeting Standard 14 of the R6 2005 Invasive Plant ROD								
Agent Genus	Agent Species	Order	Family	Type	Weed Targeted	Sites/ Recommended	Collection Notes	Effective
								HI.

**Table 2 - Attachment Table from White Paper - Biocontrol Agents Not Meeting Standard 14 of the R6 2005 Invasive Plant ROD**

Agent Genus	Agent Species	Weed targeted	Aphis Status	Reason Not to Use	Effectiveness
<i>Aceria</i>	<i>centaureae</i>	Diffuse knapweed	Not approved	Not approved	
<i>Aceria</i>	<i>malherbae</i>	Field bindweed (may attack <i>Calystegia</i> spp.)	approved, not approved in CA	Spotty, isolated sites, Unlikely on USFS, doesn't do well in R6 climate, poss on Admin or Grasslands; warm sites; Not approved in CA due to presence of closely related natives (may infest <i>Calystegia</i> spp.).	Stunts plants, reduces flowering, reduces plant density in Texas.
<i>Agonopterix</i>	<i>nervosa</i>	gorse	Not approved	Not approved, Accidental Release	
<i>Agonopterix</i>	<i>alstroemeriana</i>	poison hemlock	Not approved	Not approved, Accidental Release	
<i>Altica</i>	<i>carduorum</i>	Canada thistle	Not approved	Not approved, may attack natives	
<i>Cassida</i>	<i>rubiginosa</i>	Canada thistle	Not approved	Not approved, Accidental Release	
<i>Chaetorellia</i>	<i>succinia</i>	yellow starthistle	Not approved	Not approved, Accidental, spreads well on own.	Appears more effective than <i>C. australis</i> . Will feed on <i>Centaurea americana</i> , a native.
<i>Chrysolina</i>	<i>variens</i>	St. Johnswort	Not approved	failed 50 yrs ago, will not be rereleased	unknown.
<i>Gymnetron</i>	<i>tetrum</i>	common mullein	Not approved	Not approved, Accidental	
<i>Larinus</i>	<i>planus</i>	Canada thistle	Not approved	Not approved, Accidental, known on <i>Cirsium calolepsis</i> on Wside	
<i>Nanophyes</i>	<i>brevis</i>	purple loosestrife	?	Not introduced in US, all females contaminated with parasitic nematode, no current plans for introduction in US	
<i>Phrydiuchis</i>	<i>spilmani</i>	Mediterranean sage	Requires reapproval	Introduction into U.S. failed, unlikely to be reintroduced.	

Agent Genus	Agent Species	Weed targeted	Aphis Status	Reason Not to Use	Effectiveness
<i>Puccinia</i>	<i>canaliculata</i>	yellow nutsedge	Not approved	not released in US, considered for bioherbicide use	Unknown.
<i>Pythium</i>	<i>rostratum</i>	knapweed	Not approved	Not approved	
<i>Rhinocyllus</i>	<i>conicus</i>	Canada thistle, Italian thistle	approved	No longer approved, widespread, no longer used, attacks natives	
<i>Selenophoma</i>	<i>juncea</i>	Scotch broom	Not approved	Not approved, widespread, no longer used, non-target effects	Suspected of killing plants in late spring.
<i>Trichosirocalus</i>	<i>horridus</i>	Subtribe Carduinae: musk, plumeless, Italian, Canada, and bull thistles are accepted.	approved, not approved in CA	Introduced everywhere, recovered Klamath R only, not likely for USFS.	Seldom effective by itself. Prohib in CA due to concern for artichokes. Requires 3-5 years to build population. Disperses well.
<i>Tyria</i>	<i>jacobaeae</i>	tansy ragwort	approved	Widespread, attacks natives ( <i>Packara sedaris</i> , <i>S. triangularis</i> ) but no population effect known, do not use east of Cascades	Works best in conjunction with <i>L. jacobaeae</i> .
<i>Tyta</i>	<i>luctuosa</i>	Field bindweed (also may attack <i>Calystegia</i> spp.)	approved, not approved in CA	Recent releases, not established, although moths recovered; unlikely on FS; difficult to establish; recorded to feed on native <i>Calystegia</i> spp.	Does not significantly damage hedge bindweed ( <i>Calystegia sepium</i> ), effect on field bindweed unk.

Source: Lia Spiegel, Entomologist  
Blue Mountains Pest Management Service Center  
401 Gekeler Lane  
La Grande, Oregon 97850 - ph. 541.962.6574 FAX 541.962.6504

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## Implementation Planning

This section outlines the process that would be used to ensure the selected alternative is properly implemented. The method follows Integrated Weed Management principles (R6 2005 FEIS, 3-3) and satisfies pesticide planning requirements at FSH 2109.14. It applies to currently known and new sites found during ongoing inventory.

### **1. Characterize the invasive plant infestation to be treated. This includes:**

- Map and describe the target species, density, extent, treatment strategy, and site type.
- List any resource of concerns and determine if additional surveys are needed. Coordinate with resource specialists to get additional information or new information about specific locations. Identify and perform pre-treatment surveys for species of local interest and/or their habitats.

### **2. Develop site prescriptions**

- Use Integrated Weed Management principles to identify possible effective methods of treatment using the Treatment Decision Tree described in section 2.2.6 above. Non-herbicide treatments should be considered when sites are small or target plant densities are low, particularly after several years of herbicide treatments. Prescribe herbicides as needed based on the biology of the target species and size of the infestation (for instance, manual treatment alone cannot effectively eradicate rhizomatous species). Determine that the prescribed treatment is within the scope of those analyzed in the EIS. If treatments would not be effective once Project Design Features are applied, further NEPA would also be required to authorize the effective treatment.
- Apply appropriate Project Design Features from Table 7 of the EIS.
- Determine that the prescribed treatment is consistent with the ESA consultation.
- Review compliance criteria for the Forest Plan and any other environmental standards indicated by the label or state regulations. Develop an Invasive Plant Prevention Plan, a public notification plan, and coordinate with local Tribes.
- Complete Form FS-2100-2, Pesticide Use Proposal. This form lists treatment objectives, specific herbicide(s) that would be used, the rate and method of application, and Project Design Features that apply. Apply for any herbicide application permits when needed for treatments in Riparian Areas.
- Confirm that acceptable plant or mulch materials are available for passive restoration. If the prescription includes extensive site preparation, additional NEPA is required.
- Coordinate with adjacent landowners, water users, agencies, and partners.

### **3. Accomplishment and Compliance Monitoring**

- Develop a project work plan for herbicide use as described in FSH 2109.14.3. This plan presents organizational and operational details including treatment objectives, the equipment, materials, and supplies needed; the herbicide application method and rate; field crew organization and lines of responsibility, and a description of interagency coordination. The plan will also include a job hazard analysis to assure applicator safety.
- Ensure contracts and agreements include appropriate prescriptions and that herbicide ingredients and application rates meet label requirements, Standards 16 and 18, and site specific Project Design Features.
- Document and report herbicide use and certify applicator information in the National Pesticide Use Database, via the Forest Service Activity Tracking System (FACTS).
- Document the implementation of the public notification plan.

#### **4. Post Treatment Monitoring**

- Post-treatment reviews would occur on a sample basis or when required by a Project Design Feature to determine whether treatments were effective, if damage to non-target species occurred, or whether or not passive restoration occurred as expected.

Post-treatment monitoring would also be used to detect whether Project Design Features were appropriately applied and effective. Contract administration and other existing mechanisms would be used to correct deficiencies.

# Revegetation Guidelines Document

United States  
Department  
Agriculture

Forest Service

Pacific  
Northwest  
Region

2003



## **Guidelines for Revegetation of Invasive Weed Sites and Other Disturbed Areas on National Forests and Grasslands in the Pacific Northwest**

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## Introduction

This document provides methods and guidance for revegetation of invasive weed sites and other disturbed areas on National Forests and Grasslands in the Pacific Northwest (Region 6). Steps are outlined for assessing existing and potential site conditions, and for developing long-term revegetation strategies that are effective, affordable, and consistent with the ecological context and land management objectives of the site and surrounding landscape. The need for this document was driven by relatively new policies and programs that promote the use of native plant materials in revegetation projects (Appendix A,B). Historically, resource managers in the western United States have relied on introduced species (e.g., smooth brome, orchardgrass, timothy, crested wheatgrass) that have been selectively bred for characteristics that, at least in the short-term, made them logical choices for revegetation projects. Although some introduced species will continue to play an important role in site restoration, it has become increasingly clear that the widespread and excessive use of highly competitive and persistent non-native species has had adverse impacts on the diversity and health of our native forest, rangeland, and aquatic ecosystems (Detwyler 1971; Covington and Moore 1994; Kaufmann *et al.* 1994; Kay 1994; Mills *et al.* 1994; Brown 1995, Lesica and DeLuca 1996; Bartos and Campbell 1998; Schoennagel and Waller 1999; Brown and Rice 2000) As a consequence, new direction for revegetation projects strives for a balance between rapid establishment of high levels of competitive plant cover, and broader, more long-term objectives aimed at restoring inherent ecosystem properties (e.g., genetic and species diversity, vegetation structure) and processes (e.g., disturbance regimes, succession patterns, hydrologic regimes, and nutrient cycles).

Revegetation with carefully selected plant materials is a critical component of integrated weed management strategies. Commonly used control tactics, such as manual or chemical treatments, may eliminate or suppress invasive species in the short term, but the resulting gaps and bare soil create open niches that are susceptible to further invasion by the same or other undesirable plant species (Westman 1990; Jacobs *et al.* 1999; D'Antonio and Meyerson 2002). On degraded weed sites where reproducing individuals of desirable species are absent or in low abundance, revegetation with well-adapted and competitive grasses, forbs, and legumes can be used to direct and accelerate plant community recovery, and achieve site management objectives in a reasonable timeframe (Hobbs and Mooney 1993; Sheley *et al.* 1996, Brown and Amacher 1998). This document incorporates a landscape ecology approach to revegetation that first considers and prioritizes individual projects in the context of watershed scales. More fine-scale elements of a successful revegetation design are also addressed, including evaluation of existing and potential site conditions, identification of realistic site goals, and development and implementation of appropriate action strategies. Because the science and practice of restoration is rapidly evolving, and the potential and most effective usage of many native species has not been fully explored, an experimental approach to revegetation is advocated. Sections and references on monitoring principles and techniques are therefore included to provide tools for resource specialists to evaluate the efficacy of alternative revegetation treatments, and gain insights into how methods may be refined to better achieve desired outcomes (i.e., adaptive management).

The recommendations in this document follow National and Regional Forest Service authorities and policy guidelines (see Appendix A, B), and are intended to provide a conceptual framework from which site-specific revegetation prescriptions can be developed. A number of sections, including the Decision Matrix and Site Prescriptions, were initially developed by resource specialists on the Siuslaw National Forest (Region 6), and refined and augmented by multi-Forest revegetation teams in Region 2 in cooperation with the National Park Service (<http://fsweb.arnfpng.r2.fs.fed.us/>). Detailed treatment descriptions and management scenarios are beyond the scope of this document, and specialists including District and Forest botanists, silviculturists, geneticists, ecologists, soil scientists, and range conservationists should be consulted as necessary to refine revegetation prescriptions and identify the



most appropriate plant materials (species and seed sources) and revegetation methods for a particular site. Restoration of disturbed sites should be approached as a multi-disciplinary effort, and will be most successful when local knowledge and expertise are fully utilized and integrated into comprehensive revegetation strategies.

### **Revegetation in a Landscape Context**

Revegetation programs and strategies should be developed using a landscape ecology approach that considers individual projects in the context of watershed scales. Thus, revegetation of invasive weed sites should fit into broader ecological strategies that address other major restoration issues of a given watershed, including departures from historical vegetative conditions, at-risk aquatic/wildlife/plant species, hydrology, uncharacteristic wildfire risks, etc.. Projects can then be designed and prioritized so that they contribute to the overall goals for the particular watershed or landscape planning area. In addition, efforts should be taken to ensure that revegetation projects are fully integrated with the suite of other ongoing resource management projects, both spatially and temporally. One obvious example is that weed control operations must be tightly linked and coordinated with post-removal revegetation plans. A landscape ecology approach to revegetation also requires a thorough understanding of the underlying problems contributing to the need for revegetation, and how they interact with other processes within the watershed. This may be accomplished through assessments of the larger landscape area and its connection to the problem site. A key question is whether the site problem is unique, or symptomatic of other problems within the watershed that need to be addressed at a larger scale. Finally, in an era where the extent and intensity of management is declining and more aligned with natural processes, revegetation projects must be compatible with the dominant disturbance processes of the site and surrounding area (e.g., wildfire cycles, herbivory).

Some of the major issues to consider during the development of landscape-scale revegetation strategies for invasive weed sites include:

*(the following section is not complete)*

The current extent and patterns of spread of invasive species: Design projects to cut off or slow the spread paths and corridors using spatial strategies similar to those of wildfire management. Interrupt dominant vectors to minimize the degree and rate of propagule spread. Identify recurring points of invasion (e.g., roads/trails); revegetate the sites with highly competitive species. Tier revegetation to control prioritization scheme. Because funding for invasive spp. management efforts is typically limited, it is essential to prioritize revegetation of sites occupied by species and populations that are most important to control. Prioritization should be based on impacts of invader species, site characteristics, and potential for success.

Grazing and hydrologic issues in riparian systems: Revegetation species should be chosen based on consideration of site and landscape level aquatic strategies and goals. Utilize the Rosgen or other hydrologic classification schemes to determine succession on the stream and physical site characteristics to help select species for revegetation that will be compatible with the dominant hydrologic disturbance processes. Design projects with hydrologic disturbance in mind. Ungulate herbivory can be the dominant disturbance process (e.g., in the Blue Mountains) and must be factored into design and cost of revegetation.

Historical range of variability (HRV) and degree of departure: Quantify historical range and variability of landscape pattern dynamics to assess current landscape conditions and define limits of acceptable change. Design appropriate landscape vegetation treatments consistent with overarching ecosystem management goals. In upland settings, consider implications of fire regime (e.g., low intensity, frequent return interval versus infrequent high intensity). In high intensity fire areas, for example, revegetation efforts may

emphasize use of species that disperse and spread rapidly, have high seed production, and are tolerant of fire.

### Site Assessment

Following the development of larger scale landscape strategies, site assessment is the next critical phase in the design of a successful revegetation project. There are 3 primary steps in determining whether a given site requires active revegetation. These include:

- Evaluation of site history and existing conditions
- Defining land management and site goals
- Determining the need for action

#### *Site History and Existing Conditions:*

The evaluation of existing site conditions involves first determining what resources or values are at risk from degradation of the site. Example of site risks to be considered include: (1) erosion and soil loss potential, (2) the likelihood of invasion or re-invasion by undesirable plant species, (3) loss of cultural, visual, or social values, and (4) potential effects on threatened, endangered, or sensitive (TES) species, and their forage and habitat.

Site dominated by invasive weed species may have an increased risk of surface run-off and soil erosion due to the loss of vegetative cover and native plants that have inherent soil stabilizing growth habits (e.g., extensive fibrous root systems). Risk of erosion will be higher on steep slopes (>40-50%) and sites with crusted, shallow, compacted, or highly erodible soils. Erosion can have negative effects on “downstream” ecosystem processes and species through sediment transport and deposition. On site, loss of the soil surface layer may strongly affect the degree and speed of revegetation due to depletion of organic matter, water holding capacity, and critical nutrient reserves.

Risk of noxious weed invasion or re-invasion on a site is largely dependent on the abundance of undesirable species in the seed bank, the size and proximity of surrounding weed populations, the ease of seed movement to the site, and the growth and spread characteristics of any adjacent weed species (D’Antonio and Meyerson 2002). For example, a population of an aggressive knapweed less than a quarter mile down a well-traveled road renders a site highly susceptible to invasion. In contrast, a site surrounded by several miles of dense forest that separates it from a population of a rhizomatous weed species such as white top is at fairly low risk of invasion. Loss of native vegetative cover may negatively impact the availability and abundance of culturally important medicinal or food species. Artifacts present in the soil also may be at risk of being disturbed or transported by soil erosion accompanying the loss of vegetative cover. Aesthetics and recreational quality are diminished by patches of bare soil, as well as by unattractive invasive plants that have sharp spines or thorns. Wildlife species have co-evolved with native plant species and are highly dependent on them for food, or cover, or both. Of special concern are TES species that may be directly or indirectly affected by degraded vegetative conditions resulting from weed invasions. For example, listed fish species may be adversely affected by altered seasonal water flows or by increased sediment loads in streams due to erosion of disturbed weed sites. Propagules from weed sites in close proximity to special management areas of high social or ecological value can disperse and become established in the pristine habitats that often harbor TES plant species. Finally, revegetation of invasive weed sites with aggressive non-native cover species may unintentionally introduce equally invasive, though not officially designated as noxious, plants into the vicinity of TES plant populations resulting in excessive competition with rare native species that are already in decline or at risk of extirpation.

In addition to risk assessment, it is also important to determine the causes of site degradation. Broad categories include soil disturbance, loss of native species, and loss of whole plant communities whose structure normally regulates the processes of nutrient cycling and water retention. Within these broad categories, the agents contributing to disturbance and their relationship to ecosystem degradation should be identified and evaluated in terms of their continued presence and ongoing effects. For instance, if road construction has disturbed soils in the past, is the road still maintained (bladed annually, subject to ditch cleaning, sprayed annually to control existing weed infestations), or has it been closed or even obliterated? Or, if native plants have been lost due to heavy grazing pressure by domestic or wild ungulates, do those animals still have access to the area? Revegetation, especially with native species, is difficult to impossible in the face of continuing disturbance. Passive restoration (the removal of the disturbing agent so that unassisted site recovery can take place) will be the simplest and most cost-effective step towards revegetation of some sites, and is requisite to the success of active revegetation methods.

### Desired Future Condition:

Defining revegetative goals, or desired future condition, for a given site is a crucial step in site assessment. In many cases, the recovery of natural ecosystem processes and pre-disturbance conditions, or some close approximation, will be assumed as the preferred state. This suggests a plant community that is structurally diverse, fully functioning in all ecosystem processes, and consisting of locally adapted native species. A knowledgeable botanist or a plant ecologist should be consulted at this stage to help in identifying realistic goals for site revegetation. In some cases, such as in the presence of ongoing degradation or large-scale infestations, complete recovery to pre-disturbance conditions may not be an appropriate objective. Revegetation goals must also be realistic, both in the sense that they may actually be achieved, and that they are affordable. Some common and overarching goals for revegetation of National Forests and Grasslands include:

Contribute to the restoration of ecosystem structure and function.

Minimize or contain surface erosion, particularly if the project or downstream area is susceptible to impacts of erosion and/or sedimentation.

Maintain or re-establish nutrient cycling as quickly as possible through establishment of desirable vegetative cover for nutrient uptake, and placement of woody debris or mulch for nutrient input.

Avoid or minimize stream or riparian area sedimentation

Exclude noxious weeds and undesirable non-native species by revegetating sites with local native species or non-persistent cover crops that will not be overly competitive with native vegetation in the target area.

Give special consideration to sites of high ecological or social value, and areas containing TES species or habitat. Revegetation with local native species (local ecotypes) is a high priority within intact and pristine ecosystems, core conservation areas, and their buffers and connecting corridors.

### Need For Action:

Determining the need for action on a specific site requires consideration of the potential for natural recovery. For example, is there adequate moisture available to support natural regeneration, sprouting, and establishment of native vegetation within a reasonable period of time? The degree of disturbance, as indicated by the proportion of the existing plant cover that consists of desirable native species, will also affect revegetation outcome. Ten to twenty percent native cover is considered a minimum required to facilitate natural recovery of a site (James 1992, Sheley *et al.* 1996, Goodwin and Sheley 2003). The

diversity, abundance, and viability of plant propagules of desirable species in the seed bank or within the immediate vicinity are additional important determinants in natural recruitment and recovery. A novel method for quantifying site disturbance and the potential for natural recovery based on the plant cover of individual species, and their longevity and native/non-native status is described in McArthur *et al.* (1995). The formula<sup>1</sup> could easily be modified to incorporate information on additional life history traits such as root morphology (e.g., rhizomatous vs. non-rhizomatous) and seral status. Sites dominated by propagule pools of early seral (pioneering) native species are predicted to have the greatest likelihood of natural colonization and recovery, while those reliant on late seral species for regeneration or dominated by undesirable rhizomatous species will generally be less successful.

The size of the invasion and the length of time that weeds have been present may strongly influence revegetation strategies and the need for active manipulations. Very small sites are the most easily re-colonized by the extant seed bank and by plant propagules dispersed from surrounding sources. Depending on the ecological setting, it is reasonable to allow revegetation to occur on its own on sites less than about 0.25 acres, or to possibly assist natural recovery through the redistribution of seed from surrounding plants by hand. The longer the site has been occupied by invasive plants, the greater the potential for the seed bank to become dominated by undesirable species, and for chemical or physical changes in soil conditions (e.g., shifts in nitrogen pools and pH) and associated microbial communities that may adversely affect species replacement dynamics and natural site recovery (Evans *et al.* 2001; Svejcar and Sheley 2001; D'Antonio and Meyerson 2002).

Other soil conditions influencing outcome include the degree of substrate disturbance (loss or mixing of soil horizons) and seedbed physical characteristics, including the extent of crusting and compaction. As fertility and water holding capacity are lost with the A and B soil horizons it becomes increasingly difficult to establish vegetation. Regardless of the method of regeneration, cultural amendments and manipulations may be required on highly degraded sites to help decrease the competitive advantage of exotic species, and improve the number and condition of regeneration sites available for germination and root extension of desired species. Examples include topsoil replacement, incorporation of organic matter, mulching, seedbed disking and imprinting to aid water infiltration and soil aeration, liming to adjust pH, and nutrient enhancements/manipulations. An experimental technique of great promise in *Bromus tectorum* dominated communities is the application of sucrose to reduce plant-available nitrogen and create a soil environment more conducive to the establishment of native perennial vegetation (McLendon and Redente 1992; Young *et al.* 1999; Paschke *et al.* 2000).

### **Selection of Plant Materials**

#### **Regional Priorities and Guidelines:**

When site assessment indicates a need for active revegetation, the next critical step is to determine the species and seed sources that will establish and perform well on the site without impeding natural community recovery and succession, or compromising the diversity, genetic integrity, and long-term viability of resident wild populations. The potential risks and impacts of revegetation treatments are greatest for seeding and planting projects that involve large acreages, or that occur in or near management areas of high social or ecological value. In 1994, Region 6 formulated revegetation policy that set general guidelines and priorities for plant material usage in disturbed areas on national forests and grasslands, including sites occupied by invasive exotic plants (see Appendix B). Regional priorities, as well as definitions and rationale, are as follows:

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<sup>1</sup> Disturbance value = Sum[Cover\*(Longevity-Origin Scores)]/Number of Species. Longevity: 1=annual, 2=biennial, 3=biennial to perennial, 4=perennial. Origin: 1=native to local area, 2=exotic to the area, but native to North America, 3=exotic to North America.

**Priority 1 - Local Native:** Plant materials of native species that originate from genetically local sources. Benefits of use include high adaptation to spatial and temporal extremes, and low input requirements (e.g., supplemental water, fertilizer). Local native plant materials are recommended for projects of all sizes (Fig. 1, adapted from Lesica and Allendorf 1999), especially in and around pristine or relatively intact habitats and ecosystems such as designated or proposed wilderness, roadless areas, wild and scenic river corridors, Research Natural Areas (RNAs), Special Interest Areas (SIAs), riparian areas, wetlands, cultural use areas, TES species habitat and connecting corridors, etc. For severe and large-scale disturbances, a mixture of genotypes or seed sources from ecologically different populations has been suggested as a strategy for maximizing genetic variation and enhancing the likelihood of plant establishment and persistence in stressful environments (Fig. 1, adapted from Lesica and Allendorf 1999).

The ecological and geographic boundaries that define a local population are determined primarily by the heterogeneity of the climate and habitat, the genetic structuring of the populations, the extent of local adaptation, and the consequences of mixing distant gene pools (Fenstar and Dudash 1994; Knapp and Rice 1994; Linhart 1995; Montalvo *et al.* 1997; Lesica and Allendorf 1999; Hufford and Mazer 2003). Although seed zones and transfer guidelines have been developed for most Pacific Northwest conifer species (USDA 1973; Randall and Berrang 2002), such information is generally lacking for other native plant species. As a consequence, elevational restrictions along with existing spatial frameworks such as EPA ecoregions, 5<sup>th</sup> field watersheds, and conifer seed zones are frequently used to guide seed movement in native shrubs, grasses, and forbs (Erickson *et al.*, submitted). In the absence of supporting genetic data, the spatial scale of seed mixing and movement in the Pacific Northwest should be limited to geographic areas on the order of Level III ecoregions (Fig. 2; Omernik 1987, 1995), with additional restrictions based on elevation, cold hardiness, and local precipitation patterns. Area geneticists should be consulted for guidance in determining the most appropriate genetic sources of plant material for a particular restoration site.

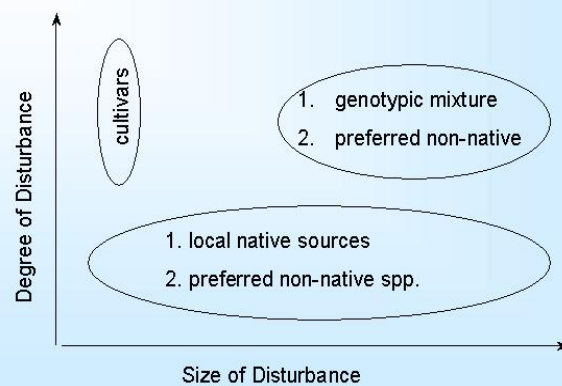
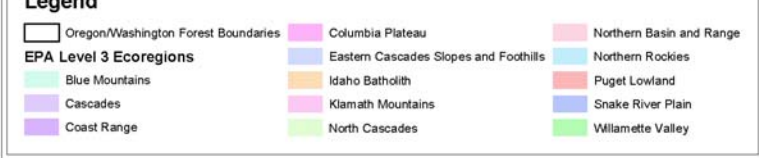


Fig. 1. Relationship between size and degree of disturbance and primary and secondary preferences for plant material for revegetation on National Forests and Grasslands in Region 6. (Adapted from Lesica and Allendorf 1999).



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Figure 2. Relationship between Level III ecoregions (in color) and R6 National Forest boundaries (outlined in black).

Use of local sources of native seed requires carefully coordinated and integrated programs to ensure adequate quantities of suitable seed are available at critical times for project work. A new 5-year Regional contract for native grass and forb seed production (53-04R3-03-14, <http://www.fs.fed.us/r6/uma/native/>) will help facilitate this process at reasonable cost. Table C-1 (Appendix C) contains seed yield and cost figures for native grass and forb species included in the contract. Table C-2 (Appendix C) describes ecological attributes and suggested seeding rates for a broad array of native species that have successfully been used in revegetation projects in the Pacific Northwest.

Priority 2 - Preferred Non-Native: The volume of seed needed for large-scale restoration may at times preclude the use of local native seed, particularly for unplanned events such as wildfires, or other disturbances where it is critical to quickly establish vegetation in order to protect basic resources values and prevent weed invasions. In these instances, a second choice would be sterile hybrids or annuals/biennial/perennial introduced plant species that are non-persistent and non-invasive (Fig. 1, adapted from Lesica and Allendorf 1999). Preferred non-native species are those that will not aggressively compete with the naturally occurring native plant community, will not invade plant communities outside the project area, persist in the ecosystem over the long term, or exchange genetic material with local native plant species. Appendix D includes recommendations for non-native species that may be seeded as temporary ground cover for both erosion control and as noxious weed competitors until native species can become established and occupy the site. The list includes sterile hybrids, such as REGREEN and annuals such as white oats (*Avena sativa*) and winter wheat (*Triticum aestivum*). A more complete list of perennial non-natives that are suitably non-persistent may be developed on Districts/Forests by examining past revegetation efforts where the seeded species are known. Exotic species that have not already been introduced into the area, or that have been found to be aggressive and/or persistent, should be avoided. Table E-1 (Appendix E) provides a listing of non-native species that, although commonly used in the past, are generally no longer recommended due to their highly aggressive nature that has resulted in widespread loss or displacement of native species and plant communities in western wildlands. These include Kentucky bluegrass (*Poa pratensis*); smooth brome (*Bromus inermis*); crested wheatgrass (*Agropyron cristatum*); orchard grass (*Dactylis glomerata*); yellow and white sweetclover (*Melilotus officinale* and *M. albus*); alsike clover (*Trifolium hybridum*) and alfalfa (*Medicago sativa* to name a few. As a last resort, some of these “species-to-avoid” may play a limited role in revegetation of small, highly degraded sites where there is poor potential for native plant community recovery, or in settings where there is little risk of spread beyond the original site of introduction (e.g., seeding around buildings on administrative sites).

Priority 3 - Non-local Native: This category includes native species that do not occur naturally in the local ecosystem, or native plant material that does not originate from genetically local sources. These types of plant materials, including most commercial cultivars (Table E-2, Appendix E), are generally not preferable for wildland use due to concerns over adaptability, genetic diversity level, and the potential for genetic contamination or “swamping” of local native gene pools, including those of TES plants (Millar and Libby 1989; Knapp and Rice 1994; Linhart 1995; Montalvo *et al.* 1997; Lesica and Allendorf 1999; Hufford and Mazer 2003). Because commercial cultivars are typically selected for agronomic traits such as high fecundity, vegetative vigor, and competitive ability, their use may also adversely impact resident natural populations through direct competition and displacement. Moreover, cultivars of native species (and introduced look-alikes such as sheep fescue, *Festuca ovina*) can be very difficult to distinguish from native germplasm, which could severely complicate efforts to collect and propagate local material and waste valuable economic resources. Because of these concerns, cultivars are recommended for use only on small, highly disturbed sites (Fig. 1, adapted from Lesica and Allendorf 1999) that are not in close proximity to areas of high social or ecological value such as designated or proposed wilderness areas; Research Natural Areas (RNAs); Special Interest Areas (SIAs), TES species habitat or corridors, and riparian/wetland areas. Where cultivars have been used, it is important to document and map their locations so these areas can be avoided during seed harvesting activities.

## Designing Seed Mixes

The design of an effective seed mixes incorporates a number of factors, including land-use objectives and site characteristics such as existing and potential vegetation, weed density and biomass, precipitation/temperature regimes, soil characteristics, and shade conditions. In addition, short-term objectives of quick establishment of competitive plant cover must be balanced with more long-term goals of restoring fully functioning and self-sustaining plant communities that will be resilient to further disturbances (i.e., will not degrade to pre-treatment, weed-dominated conditions). This may be achieved by devising seed mixes containing compatible species that (1) maximally occupy available niches (enhance functional diversity), and (2) possess physiological and growth characteristics that facilitate their establishment, competitiveness, and tolerance of stress.

Researchers have found that sites with high functional group diversity, especially with respect to native forbs, are more competitive and resistant to weed invasion and establishment because site resources are fully utilized (Carpinelli 2000; Symstad 2000; Pokomy 2002). Although the full spectrum and diversity of the desired plant community rarely will be achieved during revegetation, niche occupation and resources use can be enhanced by combining key species that vary in their seasonal growth pattern, seral status, reproductive mechanisms, and growth form and root morphology (e.g., fibrous-rooted grasses and forbs with deep taproots) (Panetta and Groves 1990; Jacobs *et al.* 1999; Goodwin and Sheley 2003). Example of native cool-season grasses (grow in the early spring/summer and utilize soil resources in the upper soil profile) that can be competitive against invasive weeds include blue wildrye (*Elymus glaucus*), squirreltail (*Elymus elymoides*), mountain brome (*Bromus carinatus*), thickspike wheatgrass (*Elymus lanceolatus*), slender wheatgrass (*Elymus trachycaulus*), bluestem or western wheatgrass (*Pascopyrum smithii*), and prairie junegrass (*Koeleria macrantha*), Sandberg bluegrass (*Poa secunda*) (Borman *et al.* 1991; Brown and Amacher 1999; Goodwin and Sheley 2003). Idaho fescue (*Festuca idahoensis*), a cool-season bunchgrass, can also be a strongly competitive once mature stands are established. Competitive native forbs and legumes include blue flax, (*Linum lewisii*), common yarrow (*Achillea millefolium*), pearly everlasting (*Anaphalis margaritacea*), fireflower (*Epilobium angustifolium*) and various lupine (*Lupinus*) and vetch (*Vicia*) spp.

Native grass-like species, such as sedges, spikerushes, rushes, and bulrushes, may be useful in revegetating riparian and wetland areas. Under these conditions, containerized seedlings often show better survival and establishment than seeding. Deep-rooted shrubs may also be seeded or planted to more fully utilize resources from the lower soil profile, especially late in the growing season. Shrub vegetation can facilitate the establishment of understory species by increasing water availability and reducing understory temperatures and evapotranspiration. Over the long term, perennial shrubs will also enhance soil fertility and structure and increase nutrient cycling (West 1989).

A more complete list of native species suitable for revegetation activities should be developed on Districts/Forests by knowledgeable plant resource specialists (i.e., range specialists, botanists, ecologists, etc.) through examination of target sites and nearby undisturbed reference areas. There's a broad array of competitive native species that may be useful in revegetation; however, research efforts have not fully explored their potential or the conditions under which they would be most effective. In general, characteristics that make a species well-suited for revegetation include broad ecological amplitude, rapid germination and early seedling growth, and aggressive root systems. Such species are often early seral natural colonizers of disturbed sites. Late seral species often have lower growth rates than colonizers, but still can be an important component of a seed mix because they tend to be highly competitive and often have high root/shoot ratios (Brown and Amacher 1999). Combining native and non-native species in seeding or planting mixes, however, is generally not recommended due to incompatible growth and life history strategies. An exception would involve the mixing of one or two long-lived perennial native



species with a non-native temporary cover crop type species (e.g., from the list in Table D-1, Appendix D) that will rapidly colonize and occupy the site until the slower perennial species become established.

### *Seed Labeling and Testing*

The genetic origin of all native seed used in restoration should be known; purchased seed should be certified as to source identity. Purchased seed, both native and non-native, must have documented and recent (<1 year old) germination, purity, and “All State’s Noxious Weed” test results. The more recent the test, the more likely it is to reflect the true condition of the seed. Testing should be conducted by a National Association of Official Seed Certification Analysis (AOSCA) approved seed testing laboratory (Table C-2, Appendix C). Copies of seed test results should be retained in associated project files.

Purity testing verifies the proportion of pure seed contained in the seed lot and identifies contaminants, including other crop seed, weed seed, and inert matter (e.g. stems, chaff, small stones). Graminoid seed with more than 10-15 percent inert matter will be difficult to apply through a rotary seeder or rangeland drill. Germination tests provide information on how well the pure seed portion of the seed lot will perform under favorable field conditions. The percentage of pure live seed (PLS), calculated as the percent purity multiplied by the percent germination, is commonly used as a standardized indicator of seed quality. See Table C-2, Appendix C, for suggested minimum acceptable germination and purity standards for grass and forb seed.

Many native species produce seeds that are dormant and won’t germinate without afterripening (time) or special germination enhancement treatments (stratification, scarification, gibberellic acid, etc.). In these cases, seed viability may be estimated using other procedures. Most widely used is the fast and inexpensive tetrazolium (TZ) test, which involves a biochemical staining technique with tetrazolium chloride that visibly stains live, germinable seed (Young and Young 1986).

Seed test results should verify that the seed lot contain no “Prohibited” noxious weed seed, and that seed meets or exceed standards for “Restricted” or “Other Weed Seed” content according to Oregon and/or Washington State standards for Certified Seed (Table C-2, Appendix C). Because each state has different lists of prohibited and restricted noxious weeds, request that the seed be tested with an “All-States Noxious Weed Exam”. The name and number of seeds per pound of weed and other crop seed will be listed on the seed label. Be on the alert for aggressive nonnatives that, although not prohibited or restricted by the State, may still pose a threat to native plant communities.

### Determining Seeding Rates

Seeding rates for grasses and forbs can vary greatly depending on site condition, species, and methods of application. Recommended seeding rates for pure grass seed mixtures are generally in the range of 20-50 viable seeds per square foot (Goodwin and Sheley 2003); pure forb and shrub mixes will be lower (you wouldn’t want 10 Elderberry shrubs in every square foot for example). Higher rates are often recommended for severely disturbed sites to compensate for high seedling mortality due to limiting environmental factors and competition. Goodwin and Sheley (2003), for example, suggest a seeding rate of 80 PLS/ft<sup>2</sup> for perennial grasses in severely burned areas, and doubling or tripling rates when seeding to prevent weed invasions, or if broadcast seeding or hydroseeding. Brown and Amacher (1999) recommend 250-350 PLS seeds per ft<sup>2</sup> on severe disturbances. Increasing the seeding rate, however, will never make up for poor seedbed preparation, poor seeding methods, or improper timing of seeding.

Seeding rates are calculated using the following information:

total number of seeds per pound

percentage of each pound that is pure, live seed (PLS)

number of acres to be treated

target PLS /ft<sup>2</sup> after considering site conditions and seeding method

Example calculations for a single species seed mix: seed 1 acre with blue wildrye which has 131,000 seeds per pound and is 83% PLS to get a result of 20 PLS /ft<sup>2</sup>:

$$(1 \text{ acre}) \times (43,560 \text{ ft}^2/\text{acre}) \times (20 \text{ PLS}/\text{ft}^2) = 871,200 \text{ PLS}$$

$$(131,000 \text{ seeds}/\text{lb}) \times (0.83) = 108,730 \text{ PLS}/\text{lb.}$$

$$871,200 \div 108,730 = 8.01 \text{ lb.}$$

Example calculations for a multi-species seed mixture: seed 1 acre with 4 species at different rates (to equalize competition) to obtain a coverage of 40 PLS/ft.<sup>2</sup>:

Species	Seeds per pound	PLS	Target Coverage (PLS/ft <sup>2</sup> )
Blue wildrye	131,000	0.83	10
Mountain brome	81,500	0.86	10
Prairie junegrass <sup>a</sup>	2,300,000	0.80	10
Sandberg's bluegrass	925,000	0.80	10
		Total Coverage:	40 PLS/ft <sup>2</sup>

<sup>a</sup> Bluebunch wheatgrass may be substituted on drier sites. Idaho fescue would be a good addition to this mix if available.

Blue wildrye:  $(1 \text{ acres}) \times (43,560 \text{ ft}^2/\text{acre}) \times (10 \text{ PLS}/\text{ft}^2) = 435,600 \text{ PLS}$   
 $(131,000 \text{ seeds}/\text{lb}) \times (0.83) = 108,730 \text{ PLS}/\text{lb.}$   
 $435,600 \div 108,730 = \mathbf{4.01 \text{ lb/acre.}}$

Mountain brome:  $(1 \text{ acre}) \times (43,560 \text{ ft}^2/\text{acre}) \times (10 \text{ PLS}/\text{ft}^2) = 435,600 \text{ PLS}$   
 $(81,500 \text{ seeds}/\text{lb}) \times (0.86) = 70,090 \text{ PLS}/\text{lb.}$   
 $435,600 \div 70,090 = \mathbf{6.21 \text{ lb/acre.}}$

Prairie junegrass:  $(1 \text{ acre}) \times (43,560 \text{ ft}^2/\text{acre}) \times (10 \text{ PLS}/\text{ft}^2) = 435,600 \text{ PLS}$   
 $(2,300,000 \text{ seeds}/\text{lb}) \times (0.80) = 1,840,000 \text{ PLS}/\text{lb.}$

$$435,600 \div 1,840,000 = \mathbf{0.24 \text{ lb/acre.}}$$

Sandberg's bluegrass:  $(1 \text{ acre}) \times (43,560 \text{ ft}^2/\text{acre}) \times (10 \text{ PLS}/\text{ft}^2) = 435,600 \text{ PLS}$

$$(925,000 \text{ seeds}/\text{lb}) \times (0.80) = 740,000 \text{ PLS}/\text{lb.}$$

$$435,600 \div 740,000 = \mathbf{0.59 \text{ lb/acre.}}$$

**Total****Mix = 11.05 lb/acre**

**How to use PLS:** If the plan calls for a certain amount of pounds of PLS seed per acre, how much bulk seed is needed? To calculate the corresponding bulk amount, divide the PLS percentage into the number of pounds recommended. Example: You want to plant 5 PLS pounds of Idaho Fescue per acre. The analysis label indicates 85% purity and the germination is 79%.  $.85 \times .79 = .67 \text{ PLS}$ . Divide  $.67$  into  $5 \text{ lbs/acre} = 7.5 \text{ lbs of BULK seed/acre}$ .

## Plant Material Establishment

### Site Preparation: to be written

SAVE TOPSOIL (if weed-free) by stockpiling for later use (see Appendix \_\_, for topsoil guidelines).

Prepare seed bed by "roughing up" or terracing exposed soil surfaces so that broadcasted seed is caught and held on the slope.

Where transplanting is a viable option, prepare a capillary bed for storage of transplants. Capillary beds are used to maintain the moisture of the salvaged plants for extended periods of time, minimizing labor and water usage. (See Appendix \_\_, for more information of construction and use).

### Seed Treatments : to be written

e.g., seed priming; germinator enhancers (GERMINATE)

### Seeding Techniques: to be written

### Bareroot and Containerized Planting Stock: to be written

### Planting Techniques: to be written

## **Mulching**<sup>1</sup>

A mulch is a non-living material placed on the soil surface primarily to protect the soil from wind and water erosion, facilitate infiltration, reduce evaporation and moderate soil temperatures. Mulching generally can improve overall germination and seedling establishment and protect the soil resource. Specific site conditions need to be examined to determine the potential effectiveness of a mulch. On shallow sites where soils are not highly erodible, soil moisture and organic matter are present, high winds are not a problem and no soil crusting is expected to occur, then mulching may not be necessary. Mulch, especially if applied at too high a rate, may inhibit germination and establishment of at least some native species by reducing temperature and light at the soil surface.

Straw mulches consisting of wheat, barley and/or oats are the most common mulches. Application rates can vary, but average 2 tons per acre. Care must be taken to use certified (if available) weed free straw to prevent the introduction of noxious weeds onto the site. Stems need to be as long as possible to increase its life expectancy as a mulch. Straw can be placed on the site by hand or with a blower for large areas. Straw mulch often needs to be anchored to prevent being blown away or washed away by overland water flow. The use of tackifiers, plastic, or biodegradable netting is an effective way to retain the straw on the site. Mechanical crimpers have also been used to push the straw into the soil surface on sites where the use of heavy equipment is feasible.

Native hay mulches have also been used but often contain high levels of noxious weed seed or other non-desirable plant species. Great care must be exercised when using native hay; if the introduced species are desirable, then native hay can result in increased diversity of the resulting plant community.

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<sup>1</sup> Taken in part from National Park Service, USDI, Revegetation and reclamation training workshop, April 1993, and from the R1 and R4 Native Plant Handbooks.

Hydromulching with wood fiber or paper in a water slurry is another form of mulching. This requires the use of a machine called a hydromulcher or hydroseeder, and equipment access to the site. Wood fiber mulches are usually more effective than paper mulches because the longer wood fibers adhere to the soil and are more resistant to wind and water erosion. Hydromulch is often applied at average rates of 1500 lbs to the acre and a tackifier can be used to help it stay on the slope. Incorporation of seed and fertilizer in the mix is not a good idea because much of the seed will not be in contact with the soil and can be lost to desiccation. Fertilizer in the slurry can create a high salt concentration that can reduce water adsorption and kill the seed.

Woodchips, sawdust and bark can also be used as a mulch. These can be quite inexpensive if local sources are present. Wood residues are very long lasting compared to other mulches. However nutrients like nitrogen can get tied up and immobilized in the wood during the decay process. The addition of fertilizer can help offset nitrogen deficiencies during decomposition.

The use of pre-made erosion control mats are also effective for revegetation and rehabilitation projects. These mats come in a variety of types, sizes, strengths and can be expensive. Mats made from straw and/or coconut fiber with biodegradable netting are rolled onto the site and secured with metal staples. Stronger mats, either pure coconut fiber or synthetic fibers, need to be used on sites with high erosion hazards, high velocity overland flow rates, or steep slopes.

Mulching after seeding can improve the success of the revegetation by keeping the seed in contact with soil, moderating temperatures, and reducing water loss necessary for the seed to germinate. Mulching around planted seedlings can also improve water availability and provide protection from the environment.

Fertilizing: to be written

Fertilizer should be used only in exceptional circumstances. Generally, exotic species respond more vigorously to added nutrients. Where fertilizer is used, its composition may favor particular groups of species (Panetta and Groves 1990).

Fertilizer application is not recommended when:

Soil does not show evidence of nutrient deficiency

Seed or seedlings of locally native species, especially nitrogen-fixers (e.g. legumes), are introduced onto the site

Seeding with sterile hybrids such as REGREEN

Site is adjacent to a non-native or noxious weed seed source

Site is adjacent to a waterway (e.g. culvert removal projects)

Fertilizer application may be appropriate on sites in which biological indicators (e.g. chlorotic plants) and soil tests show a nutrient deficiency. Fertilizer has been found to increase growth of weedy annuals, which in turn inhibits the growth of slower growing perennial species (McLendon and Redente 1991, 1992, 1994; Redente *et al.* 1992)

## Monitoring and Evaluation

This section is not complete

Monitoring is necessary to assess if proposed treatments were properly implemented, if actual treatments were effective and if additional treatments or maintenance are needed to make the revegetation project successful in the long-term.

The following information should be recorded as part of revegetation monitoring and evaluation:

Species seeded, planted, or transplanted onto the project site; source and cost of species used (if applicable).

Seed application rates; method of application (e.g. hydroseeding).

Type of mulch and/or erosion control blanket used (if any), mulch application rate (percent cover).

Fertilizer application rate (if applicable).

Other site treatments used, including terracing and irrigation.

Environmental conditions at the time of implementation.

Results - what worked and what did not work.

A Basic Monitoring Form has been included in Appendix \_ as a starting point for recording and sharing information about the success (or failure) of treatments.

## Decision Matrix

**The Decision Matrix and associated Revegetation Prescriptions are being revamped**

The following decision matrix recommends revegetation options based on site characteristics, erosion potential, and presence/absence of noxious weeds.

Site Characteristics

Riparian [Group I](#)

Upland

Erosion potential high (see guidelines, item 2A) [Group II](#)

Erosion potential low (see guidelines, item 2A) [Group III](#)

Wilderness, RNA or Botanical Special Interest Area [Group IV](#)

### Group I: Riparian

#### **Erosion potential high**

**Surface area of disturbance >0.25 acre; site forested** (relatively cool and moist; receives some shading from adjacent stands) and has seed source of locally native woody species (e.g. red alder) available, or **non-forested** (open and relatively dry due to lack of shading; includes large forest openings, road projects (e.g. culvert removal), areas adjacent to clear-cuts, wet and dry meadows, and wetlands). **Noxious weeds present or absent.** [Prescription A](#), pg. \_\_

**Surface area of disturbance (project area) <0.25 acre; site forested or non-forested**

Noxious weeds present [Prescription A](#), pg. \_\_\_

Noxious weeds absent [Prescription B](#), pg. \_\_\_

**Erosion Potential low**

Noxious weeds present; site forested or non-forested; surface area of disturbance (project area) variable  
[Prescription C](#), pg. \_\_\_

Noxious weeds absent; site forested or non-forested; surface area of disturbance (project area) variable  
[Prescription D](#), pg. \_\_\_

**Group II: Upland, high erosion potential**

Noxious weeds present; site forested or non-forested; surface area of disturbance (project area) variable  
[Prescription A](#), pg. \_\_\_

Noxious weeds absent; site forested or non-forested; surface area of disturbance (project area) variable  
[Prescription B](#), pg. \_\_\_

**Group III: Upland, low erosion potential**

Noxious weeds present; site forested or non-forested; surface area of disturbance (project area) variable  
[Prescription C](#), pg. \_\_\_

**Noxious weeds absent**

Surface area of disturbance (project area) >0.25 acre; site forested or non-forested  
[Prescription D](#), pg. \_\_\_

**Surface area of disturbance (project area) <0.25 acre**

Site non-forested [Prescription D](#), pg. \_\_\_

Site forested [Prescription E](#), pg. \_\_\_

**Group IV: Wilderness, RNAs and Special Interest Areas**

All types of sites, from forested to non-forested, low to high elevation, noxious weeds may be present, good native seed source in the area. [Prescription F](#), pg. \_\_\_

**Revegetation Prescriptions***Prescription A*

**Conditions:** Forested and non-forested riparian and upland sites with steep slopes and high erosion potential. Noxious weeds present or absent. Surface area of disturbance variable.

**Objectives:** Minimize surface erosion; stabilize slopes; minimize invasion by noxious weeds; maintain integrity of native plant communities.

*Prescription:*

Consult with Forest/District Soil Scientist on soil erosiveness and erosion control.

Seed with local native grasses if available or nonpersistent annual grass or sterile wheat.

Apply erosion control materials (see Appendix [C](#)). In very critical areas, consider salvaging and replanting displaced woody species onto project site. Consult with Forest Ecologist, Botanist, or Range Conservationist.

Do not fertilize.

Plan for future planting of native species on the site; i.e., for each project area, outline (a) acreage and approximate dimensions requiring further revegetation with native stock, (b) dominant native species present, and (c) provide a map of project locations. Submit native revegetation needs to Forest Ecologist, Botanist, or Range Conservationist.

### Alternatives:

#### [Prescription B](#) (*erosion control materials only*)

Erosion control materials and transplants

Woody Species:

**Forested Sites.** On forested sites where seed source of locally native woody species is abundant, site should fill in naturally with trees and shrubs. Given that establishment of woody species may be delayed on these sites, especially if the project area is large, seedlings of woody species occurring within the vicinity of the project area may be collected and transplanted.

**Non-forested Sites.** On non-forested sites where seed source of locally native woody species may be lacking, seedlings of woody species occurring within the vicinity of the project area may be collected and transplanted. Seed of locally native grasses and herbs may be collected and sent to a nursery to be increased for use on the site in the following years.

### Rationale:

Seeding with non-persistent annuals or sterile wheat. Seeding of project area with a nonpersistent annual or sterile wheat is recommended to (a) provide short-term erosion control, and (b) discourage invasion by noxious weeds and other aggressive non-native species until native species can become reestablished.

**Seeding/transplanting native species:** Seeding and transplanting of locally native herbaceous and woody species is recommended as needed in the future in order to provide native cover as quickly as possible, to discourage invasion by exotic species, and to maintain the integrity of native plant communities, structural and biological diversity, and wildlife values.

**Fertilizer** is not recommended because application may facilitate invasion by noxious weeds and/or undesirable, persistent non-natives. Additionally, fertilizer can change the soil (microbiotic) ecosystem

### Advantages/Disadvantages:

**Advantages.** Erosion control blankets are shown to be highly effective; seeding with non-persistent, non-native grass (Regreen) provides quick vegetative cover & soil binding mechanism; [Prescription A](#) offers the greatest degree of erosion control.

**Disadvantages.** High cost of erosion control blanket; possible inhibition of natural colonization created by presence of annuals or hybrids.



*Prescription B*

**Conditions:** Forested riparian and upland sites with steep slopes and high erosion potential. Sites are small (disturbed area <0.25 acre), relatively moist, and have a good locally native, woody species seed source nearby. Noxious weeds are absent.

**Objectives:** Minimize surface erosion; stabilize slopes; maintain integrity of native plant communities.

**Prescription:**

- Consult Forest/District Soil Scientist for soil erodibility/hazard analysis
- Determine seeding needs
- Do not fertilize.
- Plan for future revegetation needs; see [Prescription A](#).

**Alternatives:**

[Prescription A](#): (*erosion control materials & seed*).

Bioengineered erosion control structures (e.g. using hardwood cuttings).

Erosion control materials plus transplants.

Woody Species:

**Forested sites-** on forested sites where seed source of locally native woody species is available, site should fill in naturally with trees and shrubs. Given that establishment of woody species may be delayed on these sites, especially if the project area is large, seedlings of woody species occurring within the vicinity of the project area may be collected and transplanted as funding becomes available.

**Rationale:**

**Erosion control blanket:** Erosion control materials alone should suffice in small, forested areas where a native seed source is readily available. Site may be sown with a nonpersistent annual or hybrid grass (see Appendix C) in critical areas.

**Fertilizer** is not recommended because application may facilitate invasion by noxious weeds and/or undesirable, persistent non-natives. Additionally, fertilizer can change the soil (microbiotic) ecosystem

**Advantages/Disadvantages:**

**Advantages-** Less expensive than [Prescription A](#) due to elimination of seeding; absence of non-persistent annual grass or REGREEN on site may facilitate colonization by native species.

**Disadvantages-** Less effective erosion control than [Prescription A](#), lower aesthetic value for 1-3 years (depending on moisture), especially in visible areas (e.g. roadcuts), than Prescription A.

*Prescription C*

**Conditions:** Forested and non-forested riparian and upland sites with low erosion potential. Size of disturbed area variable. Noxious weeds present.

**Objectives:** Minimize surface erosion; minimize invasion by noxious weeds; maintain integrity of native plant communities

**Prescription:**

- Seed with nonpersistent annual or sterile wheatgrass (see [Appendix A](#)) as soon as possible after ground disturbance.
- Do not fertilize.
- Mulch with clean, weed-free wheat, oat, or barley straw/**local native hay**; crimp in mulch, if desired.
- Consult with Forest Noxious Weed Coordinator regarding site-specific control of noxious weeds.
- Plan for future revegetation needs; see [Prescription A](#).

*Alternatives:* n/a

**Woody Species:**

**Forested sites.** On forested sites, seeding and outplanting of locally native herbaceous and woody species should be accomplished as soon as possible to discourage invasion by noxious weed species..

**Non-forested sites.** On non-forested sites, seed of locally native grasses and forbs may be sown as early as possible, contingent on seed availability. Seedlings of locally native woody species adapted to drier sites should be collected and outplanted as soon as bare rootstock becomes available (see [Prescription A](#)).

NOTE: Sites with low erosion potential should be given lower priority in revegetation projects than sites with high erosion potential; seedlings should not be allocated for low priority project sites until all high priority sites have been planted. Consult with Forest Noxious Weed Coordinator, Oregon or Washington State Weed Programs, or Forest Weed Strategy for site-specific control of noxious weeds.

**Rationale:**

**Seeding with annual or REGREEN:** Seeding of project area with a nonpersistent, annual or wheatgrass hybrid grass is recommended to (a) provide immediate erosion control in the short-term, and (b) discourage invasion by noxious weeds and other aggressive non-aggressive species until native species can become reestablished.

**Seeding/outplanting native species:** Seeding and outplanting of locally native herbaceous and woody species is recommended as needed in order to provide native cover as quickly as possible, to discourage invasion by exotic species, and to maintain the integrity of native plant communities.

**Weed-free wheat, oat, or barley straw or weed-free local native hay:** Any of these should effectively control surface erosion on relatively flat surfaces, and will be significantly less expensive than erosion control blanket/matting.

Fertilizer is not recommended because application may facilitate invasion by noxious weeds and/or undesirable non-natives.

**Advantages/Disadvantages:**

**Advantages.** Non-native, non-persistent annuals or sterile wheat grass (see Appendix C,) provide quick, effective erosion control, less expensive than erosion control blanket.

**Disadvantages.** Weed-free wheat, oat, or barley straw or weed-free local native hay plus non-persistent annuals or sterile wheat grass (see Appendix C) may inhibit colonization of site by native species; straw/hay and/or annuals and REGREEN may have mild allelopathic properties.

### *Prescription D*

**Conditions:** Forested and non-forested upland, and riparian sites with low erosion potential. Size of disturbed area variable. Noxious weeds absent.

**Objectives:** Minimize surface erosion; maintain integrity of native plant communities

Prescription:

- If site <0.25 acres, **rake in or collect plant materials from edges** or mulch with weed-free wheat, oat, or barley straw or local native hay. Crimp in mulch, if desired. Let site revegetate on its own. Early seral plant species will recolonize these sites.
- Do not seed with introduced species.
- Plan for future revegetation needs; see [Prescription A](#).

Alternatives:

### [Prescription C](#)

### [Prescription E](#)

Wheat, barley, or oat straw plus transplants

Woody Species:

**Forested sites.** On forested sites where seed source of locally native woody species is available, site should fill in naturally with trees and shrubs. Given that establishment of woody species may be delayed on these sites, especially if the project area is large, seedlings of woody species occurring within the vicinity of the project area may be collected and transplanted if possible.

**Non-forested sites.** On non-forested sites where seed source of locally native woody species may be lacking, seedlings of woody species occurring within the vicinity of the project area may be transplanted as soon as bare rootstock and/or plugs are available. Seed of locally native grasses and herbs may be sown, contingent on seed availability.

NOTE: Sites with low erosion potential should be given lower priority in revegetation projects than sites with high erosion potential; seedlings should not be allocated for these low priority sites until all high priority sites have been planted.

Rationale:

**Wheat or oat straw mulch:** Wheat or oat straw mulch should effectively control surface erosion on relatively flat surfaces, and will be significantly less expensive than erosion control blanket or matting.

**Fertilizer:** Fertilizer application is not recommended.

Advantages/Disadvantages:

**Advantages.** Least expensive erosion control treatment; facilitates colonization of site by native species to a greater extent than does [Prescription C](#).

**Disadvantages.** Lower aesthetic value than Prescription C- may be a concern in highly visible areas. Potentially less effective erosion control measure than [Prescription C](#).

Prescription E

**Conditions:** Forested upland sites on relatively flat ground and with low erosion potential. Sites are small in area (less than 0.25 acre), relatively moist, and have a good native seed source nearby. Noxious weeds are absent.

**Objectives:** Allow for natural recolonization of project site by native species; maintain integrity of native plant communities; determine natural, unimpeded rate of recovery of the site.

**Prescription:**

No treatment (control)

**Alternatives:**

[Prescription D](#)

No mulch, plus transplant

No treatment (control):

Monitor site recovery; i.e., record species present; percent cover by species or canopy class; and mean stem height of tree seedlings/saplings by species (if applicable).

**Rationale:**

A no treatment control is required to determine the relative effectiveness of other treatments. In small, upland areas with low erosion potential, the “*no treatment alternative*” should not have significant adverse impacts on the surrounding environment. The no treatment alternative should be applied carefully, however, and only after all potential effects are considered.

**Advantages/Disadvantages:**

**Advantages.** Least expensive alternative. Under appropriate conditions, presents the least impact to the surrounding environment and permits unimpeded, natural recovery of the native community to proceed.

**Disadvantages.** May be difficult to justify politically. May demand that public be educated about restoration alternatives. If not utilized under appropriate conditions, presents risk of surface erosion, and invasion by non-native species and noxious weeds.

*Prescription F*

Wilderness, RNA's, and Special Interest Areas

**Conditions:** All types of sites ranging from forested to non-forested, low elevation to high elevation, and steep to flat. Sites have a good native seed source in the area. Noxious weeds may be present.

**Objectives:** Allow for natural recolonization of project site by native species; maintain integrity of native plant communities and native plant gene pools; determine natural, unimpeded rate of recovery of the site (see *Authorities and Agreements*, Appendix A).

**Prescription:**

- If low potential for erosion, no treatment or rake in/collect native plant materials from the edges of the disturbance to spread on the bare soil.
- If high potential for erosion, work with Forest/District Soil Scientist to stabilize soils with erosion control materials.

- Check area for noxious weeds and contact Weed Coordinator if present.
- Last option – “avoid persistent or invasive exotic plants” and “choose a short-lived ground cover that will not hybridize with local species, displace native species permanently, or offer serious long-term competition to recovery of local plants”. See Appendix B, R6 Revegetation Policy.

### Alternatives:

#### [Prescription D or E](#)

No erosion control materials, plus local transplants from surrounding area

No treatment:

Monitor site recovery; i.e., record species present; percent cover by species or canopy class; and mean stem height of tree seedlings/saplings by species (if applicable).

### Rationale:

A no treatment control is required to determine the relative effectiveness of other treatments. In small, upland areas with low erosion potential the “*no treatment alternative*” should not have significant adverse impacts on the surrounding environment. The no treatment alternative should be applied carefully, however, and only after all potential effects are considered.

### Advantages/Disadvantages:

**Advantages.** Least expensive alternative. Under appropriate conditions, presents the least impact to the surrounding environment and permits unimpeded, natural recovery of the native community to proceed.

**Disadvantages.** May be difficult to justify politically. May demand that public be educated about restoration alternatives. If not utilized under appropriate conditions, presents risk of surface erosion, and invasion by non-native species and noxious weeds.

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## Internet Resources for the Revegetation Guidelines

### Weed Related Websites

Weed ID Sites	
CropNet – Weeds	<a href="http://www.crop-net.com/weeds.htm">http://www.crop-net.com/weeds.htm</a>
American Cyanamid Weed Guide	<a href="http://www.cyanamid.com/tools/weedguide/index.shtml">http://www.cyanamid.com/tools/weedguide/index.shtml</a>
UC Pest Management Guidelines - Weed Photo Gallery	<a href="http://www.ipm.ucdavis.edu/PMG/r785700999.html">http://www.ipm.ucdavis.edu/PMG/r785700999.html</a>
FMC Weed ID	<a href="http://ag.fmc.com/ag/weedbug">http://ag.fmc.com/ag/weedbug</a>
Idaho Noxious weeds	<a href="http://www.oneplan.state.id.us/pest/nw00.htm">http://www.oneplan.state.id.us/pest/nw00.htm</a>
University of Illinois Weed ID	<a href="http://web.aces.uiuc.edu/weedid.htm">http://web.aces.uiuc.edu/weedid.htm</a>
Iowa State Weed ID	<a href="http://www.weeds.iastate.edu/weed-id/weedid.htm">http://www.weeds.iastate.edu/weed-id/weedid.htm</a>
Noxious Weeds of Kansas	<a href="http://www.ink.org/public/kda/phealth/phprot/weeds.html">http://www.ink.org/public/kda/phealth/phprot/weeds.html</a>
Common Weed Seedlings of Michigan	<a href="http://www.msu.edu/msue/iac/e1363.htm">http://www.msu.edu/msue/iac/e1363.htm</a>
Oregon State Weed ID site	<a href="http://www.css.orst.edu/weeds/id.html">http://www.css.orst.edu/weeds/id.html</a>
University of New England Weed ID	<a href="http://www.une.edu.au/agronomy/weeds/photo_library/ph_lib.html">http://www.une.edu.au/agronomy/weeds/photo_library/ph_lib.html</a>
Rutgers Coop Extension - Weeds of New Jersey	<a href="http://www.rce.rutgers.edu/weeds/index.html">http://www.rce.rutgers.edu/weeds/index.html</a>
Virginia Tech Weed Identification Guide	<a href="http://www.ppws.vt.edu/weedindex.htm">http://www.ppws.vt.edu/weedindex.htm</a>
WSSA Photo herbarium	<a href="http://ext.agn.uiuc.edu/wssa/subpages/weed/herbarium0.html">http://ext.agn.uiuc.edu/wssa/subpages/weed/herbarium0.html</a>
Wyoming Noxious Weed Site	<a href="http://www.uwyo.edu/plants/weeds/id">http://www.uwyo.edu/plants/weeds/id</a>
Weed Control	
ARS Exotic and Invasive Weeds Unit	<a href="http://wric.ucdavis.edu/exotic.html">http://wric.ucdavis.edu/exotic.html</a>
NC Aquatic Weeds (East)	<a href="http://www.cropsci.ncsu.edu/aquaticweeds">http://www.cropsci.ncsu.edu/aquaticweeds</a>
Yellow Star thistle	<a href="http://soils.ag.uidaho.edu/yst">http://soils.ag.uidaho.edu/yst</a>
Weeds of No-till Cropping Systems	<a href="http://www.btny.purdue.edu/Extension/Weeds/NoTillID/NoTillWeed1.html">http://www.btny.purdue.edu/Extension/Weeds/NoTillID/NoTillWeed1.html</a>
North Carolina Cotton Weed Control	<a href="http://ipmwww.ncsu.edu/Production_Guides/Cotton/chptr10.html">http://ipmwww.ncsu.edu/Production_Guides/Cotton/chptr10.html</a>
New York Forage Crops Weed Control	<a href="http://wwwscas.cit.cornell.edu/forage/recommends/recindex.html">http://wwwscas.cit.cornell.edu/forage/recommends/recindex.html</a>
Weeds of Minnesota Wheat	<a href="http://www.smallgrains.org/techweed.htm">http://www.smallgrains.org/techweed.htm</a>
Agricultural Companies	
Aventis	<a href="http://www2.aventis.com">http://www2.aventis.com</a>
BASF	<a href="http://www.basf.com">http://www.basf.com</a>
Bayer	<a href="http://www.agro.bayer.com/">http://www.agro.bayer.com/</a>
Dow AgroSciences	<a href="http://www.dowagrosciences.com">http://www.dowagrosciences.com</a>
DuPont	<a href="http://www.dupont.com">http://www.dupont.com</a>
FMC Home Page	<a href="http://www.fmc.com">http://www.fmc.com</a>
Monsanto	<a href="http://www.monsanto.com">http://www.monsanto.com</a>
Novartis	<a href="http://www.novartis.com/agri/index.html">http://www.novartis.com/agri/index.html</a>
Rohm and Haas Home Page	<a href="http://www.rohmhass.com">http://www.rohmhass.com</a>

Zeneca Main page	<a href="http://www.zeneca.com">http://www.zeneca.com</a>
Herbicide Company Geneology	<a href="http://www.css.orst.edu/herbgnl/tree.html">http://www.css.orst.edu/herbgnl/tree.html</a>
<b>Educational Resources</b>	
American Society for the Advancement of Science	<a href="http://www.aaas.org">http://www.aaas.org</a>
1998 Weed Science Compendium	<a href="http://www.agsci.kvl.dk/weedsci/teaching/weedbk98.htm">http://www.agsci.kvl.dk/weedsci/teaching/weedbk98.htm</a>
BLM environmental Education	<a href="http://www.blm.gov/education/fire_and_weeds.html">http://www.blm.gov/education/fire_and_weeds.html</a>
K-8 Weed Projects	<a href="http://www.sped.ukans.edu/~unitest/explorer-db/html/835851687-81ED7D4C.html">http://www.sped.ukans.edu/~unitest/explorer-db/html/835851687-81ED7D4C.html</a>
National Science Foundation	<a href="http://www.nsf.gov">http://www.nsf.gov</a>
<b>Miscellaneous</b>	
Council for Agricultural Science and Technology	<a href="http://www.cast.science.org">http://www.cast.science.org</a>
The Environmental Weeds Home Page (Australia)	<a href="http://weeds.merriweb.com.au">http://weeds.merriweb.com.au</a>
Sustainable Agriculture Network	<a href="http://www.sare.org/san">http://www.sare.org/san</a>
University of New England, Australia	<a href="http://www.une.edu.au/agronomy/weeds">http://www.une.edu.au/agronomy/weeds</a>
WeedJobs (Jobs in Weed Science)	<a href="http://www.NRCan.gc.ca/~bcampbel">http://www.NRCan.gc.ca/~bcampbel</a>
<b>University Weed Science Sites</b>	
Auburn University	<a href="http://www.ag.auburn.edu/dept/ay">http://www.ag.auburn.edu/dept/ay</a>
University of California, Davis	<a href="http://veghome.ucdavis.edu/weedsci/WWW/Welcome.html">http://veghome.ucdavis.edu/weedsci/WWW/Welcome.html</a>
Colorado State University	<a href="http://www.colostate.edu/Depts/IPM/nipm/agwee.html">http://www.colostate.edu/Depts/IPM/nipm/agwee.html</a>
University of Georgia Weed Science	<a href="http://mars.cropsoil.uga.edu/fac_weed.htm">http://mars.cropsoil.uga.edu/fac_weed.htm</a>
University of Illinois, Urbana-Champaign	<a href="http://w3.aces.uiuc.edu/CropSci/weed-lab">http://w3.aces.uiuc.edu/CropSci/weed-lab</a>
Iowa State Weed Science	<a href="http://extension.agron.iastate.edu/extweeds/Default.htm">http://extension.agron.iastate.edu/extweeds/Default.htm</a>
University of Maryland Weed Science	<a href="http://www.agnr.umd.edu/users/weed">http://www.agnr.umd.edu/users/weed</a>
University of Missouri-Columbia Weed Science	<a href="http://www.psu.missouri.edu/agronx/weeds">http://www.psu.missouri.edu/agronx/weeds</a>
University of Nebraska Weed Science	<a href="http://ianrwww.unl.edu/ianr/agronomy/ws.htm">http://ianrwww.unl.edu/ianr/agronomy/ws.htm</a>
New Mexico State University Weed Science	<a href="http://taipan.nmsu.edu/weeds/">http://taipan.nmsu.edu/weeds/</a>
North Dakota State University	<a href="http://ncweeds@ndsuext.nodak.edu/extnews/weedpro/">http://ncweeds@ndsuext.nodak.edu/extnews/weedpro/</a>
Oregon State University	<a href="http://www.css.orst.edu/weeds/">http://www.css.orst.edu/weeds/</a>
Rutgers University	<a href="http://www.rce.rutgers.edu/weeddocuments/index.htm">http://www.rce.rutgers.edu/weeddocuments/index.htm</a>
Southern Illinois University	<a href="http://www.siu.edu/~weeds/">http://www.siu.edu/~weeds/</a>
Texas A&M	<a href="http://aggie-horticulture.tamu.edu/plantanswers/turf/publications/weed2.html">http://aggie-horticulture.tamu.edu/plantanswers/turf/publications/weed2.html</a>
Virginia Tech Weed Science	<a href="http://www.ppws.vt.edu/">http://www.ppws.vt.edu/</a>
University of Wyoming	<a href="http://www.uwyo.edu/plants/weeds/">http://www.uwyo.edu/plants/weeds/</a>

<b>U.S. Government Weed Related Sites</b>	
BLM Weed Site	<a href="http://www-a.blm.gov/weeds/">http://www-a.blm.gov/weeds/</a>
BLM Weed Hall of Shame	<a href="http://www.blm.gov/education/weeds/hall_of_shame.html">http://www.blm.gov/education/weeds/hall_of_shame.html</a>
Federal Interagency Committee FICMNEW	<a href="http://bluegoose.arw.r9.fws.gov/FICMNEWFiles/FICMNEWHomePage.html">http://bluegoose.arw.r9.fws.gov/FICMNEWFiles/FICMNEWHomePage.html</a>
National Agricultural Pests Information System	<a href="http://www.agnic.nal.usda.gov/agdb/napis.html">http://www.agnic.nal.usda.gov/agdb/napis.html</a>
National Biological Control Institute	<a href="http://www.aphis.usda.gov/nbci/">http://www.aphis.usda.gov/nbci/</a>
National Park IPM of Weeds	<a href="http://www.colostate.edu/Depts/IPM/natparks/natpark.html">http://www.colostate.edu/Depts/IPM/natparks/natpark.html</a>
USDA ARS Southern Weed Science	<a href="http://msa.ars.usda.gov/la/srrc">http://msa.ars.usda.gov/la/srrc</a>
USDA ARS Weed Science Laboratory (Beltsville, MD)	<a href="http://www.barc.usda.gov/psi/wsl/wsl.htm">http://www.barc.usda.gov/psi/wsl/wsl.htm</a>
<b>Weed Science Societies and Organizations</b>	
American Crop Protection Association	<a href="http://www.acpa.org">http://www.acpa.org</a>
Colorado Weed Management Assoc	<a href="http://www.fortnet.org/CWMA">http://www.fortnet.org/CWMA</a>
European Weed Research Society	<a href="http://www.ewrs.ac.uk">http://www.ewrs.ac.uk</a>
Herbicide Resistance Action Committee	<a href="http://www.PlantProtection.org/HRAC">http://www.PlantProtection.org/HRAC</a>
International Weed Science Society	<a href="http://www.css.orst.edu/weeds/iwss">http://www.css.orst.edu/weeds/iwss</a>
International Weed Science Congress	<a href="http://www.sercomtel.com.br/ice/plantas">http://www.sercomtel.com.br/ice/plantas</a>
North American Weed Management Association	<a href="http://www.nawma.org">http://www.nawma.org</a>
North Central Weed Science Society	<a href="http://www.ncwss.iastate.edu">http://www.ncwss.iastate.edu</a>
Northeastern Weed Science Society	<a href="http://www.ppws.vt.edu/newss.htm">http://www.ppws.vt.edu/newss.htm</a>
Southern Weed Science Society	<a href="http://www.weedscience.msstate.edu/swss">http://www.weedscience.msstate.edu/swss</a>
Weed Science Society of America	<a href="http://ext.agn.uiuc.edu/wssa">http://ext.agn.uiuc.edu/wssa</a>
Weed Science Society of Victoria, Australia	<a href="http://home.vicnet.net.au/~weedsoc">http://home.vicnet.net.au/~weedsoc</a>
Western Society of Weed Science	<a href="http://www.wsweedscience.org">http://www.wsweedscience.org</a>
<b>Individual State Weed Sites</b>	
Arizona Rangeland Weeds	<a href="http://ag.arizona.edu/OALS/agnic/weeds/home.html">http://ag.arizona.edu/OALS/agnic/weeds/home.html</a>
Colorado's 10 Most Wanted Weeds	<a href="http://www.ag.state.co.us/commish/press/1999/weedweek.html">http://www.ag.state.co.us/commish/press/1999/weedweek.html</a>
Control of Invasive Exotic Plants in the Great Plains	<a href="http://www.npsc/nbs.gov/resources/literatr/exotic/exotic.htm">http://www.npsc/nbs.gov/resources/literatr/exotic/exotic.htm</a>
Kansas Noxious Weeds	<a href="http://www.ink.org/public/kda/phealth/phprot/weeds.html">http://www.ink.org/public/kda/phealth/phprot/weeds.html</a>
Michigan	<a href="http://mel.lib.mi.us/science/weeds.html">http://mel.lib.mi.us/science/weeds.html</a>

North Dakota Weed Information	<a href="http://www.ext.nodak.edu/extpubs/weeds.htm">http://www.ext.nodak.edu/extpubs/weeds.htm</a>
Wyoming Weed and Pest Council	<a href="http://www.wyoweed.org/">http://www.wyoweed.org/</a>

## ***Appendices for the Revegetation Guidelines Document***

### **Appendix A for the Revegetation Guidelines Document Authorities, Policy, and Agreements Guiding Use of Native Species in Revegetation**

1. **National Environmental Policy Act of 1969:** “Prevent or eliminate damage to the environment and biosphere...enrich...understanding of the ecological systems and natural resources important to the Nation...”.
2. **Endangered Species Act of 1973 as Amended:** “...Encouraging the states and other(s) ...to maintain conservation programs...to better safeguard the Nation’s heritage in fish, wildlife, and plants”.
3. **Federal Land Policy Management Act of 1976:** “protect the quality of scientific...ecological, environmental...values, (and) where appropriate will preserve and protect certain public lands in their natural condition...”
4. **FEMAT (July, 1993):** “Maintain and restore the species composition and structural diversity of plant communities in riparian zones and wetlands...”; “Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian –dependent species”.
5. **NFP ROD SEIS (April 1994):** “Another goal of forest management on federal lands is to maintain the biological diversity associated with native species and ecosystems in accordance with laws and regulation.”; ACS Objective 9 “Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.
6. **NFP ROD SEIS Standards and Guidelines (April 1994):** “In general, non-native species (Plant and animal) should not be introduced into LSR’s.”; “Evaluate the impacts of non-native species (plant and animal) currently existing within the reserves, and develop plans for eliminating or controlling non-native species that are inconsistent with LSR objectives.”
7. **ICBEMP – Eastside Draft Environmental Impact Statement (May 1997):** For Alternatives 3-7, Terrestrial Strategies TS-01 Objective: “Maintain and promote healthy, productive and diverse native plant communities as appropriate to soil type, climate, and land form.”; Terrestrial Strategies TS-03 Objective:” Rehabilitate disturbed areas to restore native species, maintain productivity, and prevent soil loss”; Tribal Rights and Interests TI-03 Objective: “Recognize native plant communities as traditional resources that are important to tribes...”.
8. **Executive Order 11990 Protection of Wetlands (May 24, 1997):** “Maintenance of natural systems, including conservation and long-term productivity of existing flora and fauna, species, and habitat diversity and stability...”.
9. **Executive Order 13112: Invasive Species (February 3, 1999):** Directs actions to prevent introduction and spread of invasive species and restore native species. Revokes Executive Order 11987.
10. **Emergency Fire Rehabilitation Manual FSM2523 (May, 2000):** “...Natural recovery by native species is preferred...(When action is required) include native plant materials when possible to meet the objectives of the burned-area emergency rehabilitation. When practicable, use seeds and plants in burned-area emergency rehabilitation projects that originate from genetically local sources of native species. When native materials are not available or suitable, give preference to non-native species that meet the treatment objectives, are nonpersistent, and are not likely to spread beyond the treatment area.”

11. **Native Plant Conservation Initiative National Strategy (1995):** Ensure conservation and restoration of native plants and natural plant communities through ecosystem-based management. Educate the public, policymakers, and land managers about native plant conservation.
12. **36 CFR 219.27; 42 U.S.C. 4321; 36 CFR 219.1, 5; 16 U.S.C. 1601 – 1614; 36 CFR 219.26, Part 219:** Preserve, maintain, and enhance the diversity [including genetic diversity] of plant communities.
13. **7 CFR 650.23, Part 650:** Preserve examples of land and water ecosystems [in RNA's] with their full range of genetic diversity of native plants.
14. **FSM 2323.52:** “[In wilderness] permit ecological processes to operate naturally. Allow wherever possible, the natural process of healing in handling disturbed communities. Consider structural or vegetative assistance only as last resort”.
15. **FSH 2509.13-95-3, 26.6:** “[In wilderness] design treatments as temporary, short-lived actions that provide immediate protection but maintain wilderness integrity. Protect the genetics of endemic [*confined geographically to a certain area*, (Hitchcock, et al., 1969)] plants in wilderness. Choose a short-lived ground cover that will not hybridize with local species, displace native species permanently, or offer serious long-term competition to recovery of local plants”
16. **7 CFR 650.23, Part 650, Subpart B, Sec. 650.23:** “[Research] natural areas are established and maintained for...serving as a genetic base for native plants and animals. Natural areas may be established to preserve examples of land and water ecosystems with their full range of genetic diversity of native plants and animals including threatened and endangered species”
17. **Region 6 Policy on Use of Native and Nonnative Plants on National Forests and Grasslands, (April 12, 1994):** Use local native plants as feasible; avoid persistent or invasive exotic plants (see Appendix B, this document).

## ***Appendix B for the Revegetation Guidelines Document***

### **Regional and Forest Policy on Use of Native and Nonnative Plants on National Forests and Grasslands**

**Reply to:** 2600

**Date:** April 14, 1994

**Subject:** Use of Native and Nonnative Plants on National Forests and Grasslands

**To:** Directors and Forest Supervisors

Sound vegetation management is the key to achieving many important objectives of ecosystem management, which include maintaining and enhancing biological diversity, sustaining long-term site productivity, and having healthy ecosystems. Successful vegetation management is dependent on: (1) Clearly defined objectives, (2) availability of adapted plant materials to achieve the objectives, and (3) knowledge of the soil and other environmental conditions where the plant material is to be used.

Revegetation objectives must also be guided by law. For example, it would not be appropriate to respond to natural disturbance processes in wilderness with revegetation projects unless life or property outside of wilderness is jeopardized.

The following direction is intended to guide the use of native and nonnative plant species to meet stated objectives of revegetation prescriptions and projects. Native plant vegetation has an intrinsic value as a component of forest and rangeland ecosystems. Nonnative plant species, although useful at times, have the potential to displace natural plant and animal communities, either through aggressive competition or through disease or insect introductions.

**POLICY:** Use local native plant species to meet management objectives. Follow appropriate seed and plant movement guidelines. Nonnative plant species may be used when: (1) Needed to protect basic resource values (site productivity), (2) as an interim, nonpersistent measure designed to aid in the re-establishment of native plants, or (3) local native plant species are not available. For example, massive soil loss can change sites so that native plant species cannot become established without interim ameliorating measures. As costs, availability, and technical knowledge permit, use of local native plant materials should become a more standard practice. Undesirable plants will not be used.

INTENT: The long-term goal is to use local native plant species as much as possible to meet management objectives. Areas that have the highest priority for using native plant species are those sites in and adjacent to wilderness (but only for restoration of unnatural disturbances), Research Natural Areas, National Parks, streams, wetlands, around documented sightings of sensitive plants, and in Native American cultural use areas. In areas that are in a permanently disturbed condition such as landing strips, powerline corridors, seed orchards, base areas in ski areas, or road cut and fill slopes, use of native plant species is a long-term goal but a lower priority.

Enclosed are DEFINITIONS as further clarification of intent.

/s/Robert Jacobs (for)

JOHN E. LOWE  
Regional Forester

Enclosure

I CONCUR:R.SHAFER:04/05/94

cc:

Dean Longrie, F&W  
Gene Silovsky, F&W  
Bob Meurisse, ERW  
Fred Hall, ERW  
Bernie Smith, Rec  
Susan Sater, Rec  
Margaret Peterson, Rec  
Jerry Beatty, FPM  
Fay Shon, FPM  
Sheila Martinson, TM  
Fred Zensen, TM  
Richard Shaffer, TM



Native: Plant species present in Oregon and Washington prior to European arrival, circa 1800.

Example: fireweed (Epilobium angustifolium).

Local Native: A population of a native plant species which originated, i. e., grew from seeds or cuttings, from genetically local sources. The geographic and elevational boundaries that define a species' genetically local source are determined by plant movement guidelines.

Example: Douglas-fir (Pseudotsuga menziesii) seedlings grown from seed collected from the local seed zone.

Non-local Native: This term has two meanings: (1) A population of a native plant species which does not occur naturally in the local ecosystem, and (2) plant materials of a native species that does not originate from genetically local sources.

Examples: (1) black cottonwood (Populus trichocarpa) planted on an alpine ridge. (2) Douglas-fir (Pseudotsuga menziesii) seedlings originating from east of the Cascades planted in western Oregon or Washington.

Non-local native should NOT be used because planting them can affect existing plant communities, plant-animal relationships, and the local gene pool.

Acceptable Non-Native: Annual or short-lived perennial that is not persistent or competitive with native vegetation. These species are useful for erosion control or as noxious weed competitors.

Example: Sterile wheat.

Naturalized species: Nonnative species that were introduced by humans to Oregon and Washington and have "gone wild" or become a part of natural communities.

Example: Foxglove (Digitalis purpurea)

Exotic species: Nonnative species that are not known to occur in Oregon or Washington except possibly in landscape plantings or botanical gardens.

Example: Southern magnolia (Magnolia grandiflora)

Undesirable Plant Species: Either one of the following:  
Plant species on the Oregon or Washington Department of Agriculture noxious weed list.

Example: Hairy cats-ear (Hypochaeris radicata)

\*Horticultural varieties of native plant species.

## Appendix C for the Revegetation Guidelines Document

### Native Species Production and Revegetation Information

**Table C-1. Number of pounds of wild-collected seed needed to establish a 1-acre production field for select native grass and forb species, estimated first and second year yields, and anticipated seed costs.**

SPECIES	RECOMMENDED GOVT.- FURNISHED LBS/ACRE <sup>a</sup>	AVERAGE GERM/PURITY	AVG YIELD YEAR 1 <sup>b</sup>	AVG YIELD YEAR 2	AVG SEED/POUND	COST PER POUND <sup>c</sup>
Bluebunch Wheatgrass ( <i>Pseudoroegneria spicata</i> )	10	80/90	300	300	140,000	\$10.00-\$12.00
Blue Wildrye ( <i>Elymus glaucus</i> )	8	80/95	450	200	110,000	\$7.00-\$9.00
Bottlebrush Squirreltail ( <i>Elymus elymoides</i> ) or Big Squirreltail ( <i>Elymus multisetus</i> )	8	80/90	0	125	110,000	\$25.00-\$30.00
California Oatgrass ( <i>Danthonia californica</i> )	10	80/90	24	246	125,000	\$15.00-\$17.00
Great Basin Wildrye ( <i>Leymus cinereus</i> )	8	80/95	27	160	130,000	\$10.00-\$12.00
Idaho Fescue ( <i>Festuca idahoensis</i> )	5	80/95	300	350	450,000	\$11.00-\$13.00
Lemmon's Needlegrass ( <i>Achnatherum lemmonii</i> )	8	50/95	150	750	150,000	\$15.00-\$18.00
Mountain Brome ( <i>Bromus carinatus</i> )	10	80/95	800	800	70,000	\$7.00-\$9.00
Needle and Thread Grass ( <i>Hesperostipa comata</i> )	8	50/95	0	150	115,000	\$25.00-\$30.00
Pinegrass ( <i>Calamagrostis rubescens</i> )	2	80/95	0	132	2,500,000	\$27.00-\$30.00
Prairie junegrass ( <i>Koeleria macrantha</i> )	2	80/95	150	500	2,315,000	\$12.00-\$14.00
Sandberg's Bluegrass ( <i>Poa secunda</i> )	2	75/95	700	900	1,314,000	\$8.00-\$10.00
Slender Wheatgrass ( <i>Elymus trachycaulus</i> )	8	80/90	50	350	130,000	\$6.00-\$8.00
Thurber's Needlegrass ( <i>Achnatherum thurberiana</i> )	7	50/95	0	150	225,000	\$12.00-\$14.00
Tufted Hairgrass ( <i>Deschampsia cespitosa</i> )	2	80/90	109	509	2,500,000	\$14.00-\$16.00
Western Needlegrass ( <i>Achnatherum occidentale</i> )	8-10	50/95	103	189	275,000	\$6.00-\$8.00
Common Yarrow ( <i>Achillea millefolium</i> )	2	85/95	165	165	3,000,000	\$7.00-\$9.00
Pearly-everlasting ( <i>Anaphalis margaritacea</i> )	1	60/85	No Data	No Data	8,000,000	\$20.00-\$25.00

<sup>a</sup> Quantity of Government furnished seed will need to be increased if germination and/or purity of seed are lower than recommended values.

<sup>b</sup> Yield figures assume a late summer or fall sowing in year 0.

<sup>c</sup> Estimated range of prices expected for task orders issued against R6 2003 grass and forb seed production contract (R6-14-03-14)

**Table C-2. Oregon and Washington State seed standards for Source Identified (SIA) class of seed. Where no standard exists, Kentucky bluegrass standards are frequently used for native grass seed, except *Achnatherum* and *Hesperostipa* species for which a minimum reasonable germination standard is 50.0%.**

Factor	Oregon State Standards			Washington State Standards				
	Kentucky bluegrass	ELGL	BRCA5	Kentucky bluegrass	ELGL	BRCA5	FEID	PSSPS
Pure Seed, Min.	92.0%	96.0%	90.0%	97%	90%	95%	97%	95%
Other Crop, Max.	0.25%	0.50%	0.50%	0.5%	0.5%	1.0%	0.5%	0.5% <sup>b</sup>
Inert, Max.	8.0%	4.0%	10.0%	3%	10%	5%	3%	5%
Weed Seed*, Max.	0.30%	0.50%	0.30%	0.3%	0.3% <sup>a</sup>	0.3% <sup>a</sup>	0.3% <sup>a</sup>	0.3% <sup>a</sup>
Weed Seed Max.**, Group A	45/LB	27/LB	27/LB					
Germination, Min.	75%	65%	85%	80%	80%	85%	90%	85%
Max. seeds of other crop grass species				0.25	0.25	0.25	0.25	0.25

\* None of prohibited weeds in Section V, General standards, nor St. Johnswort, is allowed (Oregon).

\*\* Group A: Buckthorn plantain, docks, sheep sorrel, bedstraw (Oregon).

<sup>a</sup> A tolerance of 0.5% may be allowed for samples containing weedy Bromus spp. provided the total of all other weed seeds does not exceed 0.3%.

<sup>b</sup> A tolerance of 0.8% may be allowed in certified wheatgrass containing small grain seed provided the total of all other crop seed does not exceed 0.5%.

## **AOSCA Approved State Seed Testing Laboratories:**

Oregon State University Seed Testing Laboratory  
Oregon State University  
Campus Way  
Corvallis, OR 97331  
Telephone: 541-737-4464  
Fax: 541-737-2126  
Email: [Seedlab@orst.edu](mailto:Seedlab@orst.edu)  
Website: [www.css.orst.edu/seedlab](http://www.css.orst.edu/seedlab)

Washington State Department of Agriculture  
21 N. 1<sup>st</sup> Ave. #201  
Yakima, WA  
Telephone: 509-225-2630  
Fax: 509-454-4395

**Table C-3. Examples of some native grass and forb species useful for revegetation of disturbed sites on National Forests and Grasslands in the Pacific Northwest.**

Species	Preferred Soil Type	Minimum Precipitation	Pure Stand PLS Rate Per Acre	Time of Seeding	Comments
Bluebunch wheatgrass <i>Pseudoroegneria spicata</i>	Silt loam to clay	10 inches	6-12 lbs.	Fall/Spring	Medium tall, tufted, cool season, long-lived perennial bunchgrass with deep roots and late phenology. Moderate establishment, adapted to droughty and harsh sites with poor soils..
Blue Wildrye <i>Elymus glaucus</i>	Sand to silt loam	12 inches	10 lbs.	Fall/Spring	Cool season, tall, perennial bunchgrass. Adapted to a wide range of sites, moderately drought tolerant; productive on poor sites. Rapid establishment; excellent for erosion control.
Bottlebrush squirreltail <i>Elymus elymoides</i>	Rocky/sandy	6 inches	8-10 lbs.	Fall	Medium tall, early to mid-seral, short-lived cool season perennial bunchgrass. Very drought tolerant; good establishment on highly disturbed sites
California oatgrass <i>Danthonia californica</i>					
Great Basin Wildrye <i>Leymus cinereus</i>	Silt loam to clay	8 inches	9-11 lbs.	Fall/Spring	Very tall and robust, long-lived cool season bunchgrass; often spreads by short rhizomes. Adapted to a wide range of sites; moderate-to-very drought tolerant, but can also withstand periodic flooding. Slow to establish.
Idaho Fescue <i>Festuca idahoensis</i>	Silt loam to clay	10 inches	8 lbs.	Fall/Spring	Short-medium, long-lived cool season bunchgrass. Moderately drought tolerant. Slow to establish, but mature stands are strongly competitive.
Lemmon's needlegrass <i>Achnatherum lemmonii</i>					
Western needlegrass <i>Achnatherum occidentale</i>		8-14 inches			Strongly tufted, long-lived, cool season perennial bunchgrass. Deep and extensive fibrous root system. Strong seedling vigor; does well in harsh and arid environments. Very good for erosion control.
Thurber's needlegrass <i>Achnatherum thurberiana</i>		6 inches	6-8 lbs.	Fall/Spring	Short, cool season bunchgrass. Drought tolerant.
Mountain brome	Silt loam to	16 inches	19 lbs.	Fall/Spring	Tall, cool season, short-lived perennial bunchgrass adapted to a wide

Species	Preferred Soil Type	Minimum Precipitation	Pure Stand PLS Rate Per Acre	Time of Seeding	Comments
Bromus carinatus	clay				range of sites. Rapid establishment; productive on poor sites. Very good for erosion control..
Needle and Thread Grass Hesperostipa comata	Sand to silt loam	10 inches	8-14 lbs.	Fall/Spring	Tall, long-lived (?) cool season bunchgrass. Very drought tolerant.
Pinegrass Calamagrostis rubescens					
Prairie junegrass Koeleria macrantha	Sandy	12 inches	1-2 lbs.	Fall/Spring	Medium tall, cool season perennial bunchgrass. Drought tolerant and easy to establish; starts growth in very early spring..
Sandberg's Bluegrass Poa secunda	Sand to clay	8 inches	2-4 lbs.	Fall/Spring	Short, cool season perennial bunchgrass with shallow roots and early phenology. Drought tolerant and productive on poor sites. Slow to establish, but mature stands are strongly competitive.
Slender Wheatgrass Elymus trachycaulus	Sand to clay	16 inches, or wetland/riparian habitats	12 lbs.		Tall, cool season, short-lived perennial bunchgrass with very short rhizomes. Adapted to a wide range of sites; moderate drought tolerance; saline tolerant. Establishes easily and quickly. Very good for erosion control.
Tufted Hairgrass Deschampsia cespitosa	Silt loam to clay	20 inches, or wetland/riparian habitats	1-2 lbs.	Fall	Medium tall, densely tufted cool season perennial bunchgrass adapted to moist or riparian sites, but occurs on drier sites at higher elevations. Performs well in standing water or periodic flooding.
Slender hairgrass Deschampsia elongata	Silt loam to clay	20 inches, or wetland/riparian habitats	1-2 lbs.	Fall	Medium tall, cool season perennial bunchgrass.
Mannagrass Glyceria spp.	Clay	18 inches, or wetland/riparian habitats.	12 lbs.	Fall/Spring	Medium tall, cool season, rhizomatous. Perennial. Good for streambank stabilization.
Purple three-awn Aristida purpurea	Sandy	10 inches	6 lbs.	Fall/Spring	Short-medium, warm season perennial bunchgrass. Drought tolerant. Rapid establishment.
Sand dropseed Sporobolus cryptandrus	Sand to sandy	10 inches	1-2 lbs.	Late summer	Medium tall warm season perennial bunchgrass. Drought tolerant and easy to establish. Very good for erosion control and in a mix with slow establishing species.
Western Yarrow Achillea millefolium	Sand to sandy	8 inches	1 lbs.	Fall/Spring	Mid-to-late seral, rhizomatous perennial forb. Drought tolerant, aggressive. Shade intolerant.
Pearly -everlasting Anaphalis margaritacea		20	0.5	Fall/Spring	Requires full sun/shade intolerant

Species	Preferred Soil Type	Minimum Precipitation	Pure Stand PLS Rate Per Acre	Time of Seeding	Comments
Lupine spp. Lupinus spp.	Silt loam to clay	>10 inches	8-24 lbs.	Fall/Winter	Adapted to dry, open and shaded areas. Nitrogen fixer.



## *Appendix D for the Revegetation Guidelines Document*

### Non-native Species for Use in Revegetation

**Table D-1. Information on non-persistent non-native annuals and sterile hybrids that may be useful in revegetation/restoration in certain ecological settings. The level of persistence of these plant materials may vary depending on local climate and site conditions, and seedings may slow or impede natural recovery to some degree. Check with your Forest Botanist, Geneticist, Soil Scientist, Ecologist, Range Conservationist, or seed supplier for their appropriateness, and for the variety that will perform best given the elevation, climate, and moisture conditions of the planting site. Some species and varieties are best planted in the fall, while others do better when seeded in the spring/summer.**

Common or Trade Name	Scientific Name	<i>Comments</i>
Regreen	<i>Agropyron X Triticum</i> wheatgrass x wheat hybrid	<ul style="list-style-type: none"> <li>• Synthetic inter-species hybrid, 1/4 wheatgrass and 3/4 wheat, male sterile, but can set seed if pollinated from a source of wheat pollen, annual, under good growing conditions can persist 3 seasons (Kratz 1995).</li> <li>• Recommended seeding rate pure live seed (PLS) pounds per acre is 10 - 40 pounds (Granite Seed 1996).</li> <li>• cheap and available in commercial quantities, use for reveg of disturbed logging sites in western Washington has not been very promising, seeds are large, difficult to stabilize on slopes, germination so-so, erosion cover not very dense (Crowder 1995).</li> <li>• Due to the large size and weight of this seed, the recommended lbs/acre (usually 12 lbs/ac) appears not to be adequate, due to low germination, or predation (Sandoval 1997).</li> <li>• All I can say is that we didn't get very good results [from Regreen] at all in tractor cut fire lines, we're not using anymore (Yates 1997).</li> <li>• High predation, the Regreen distributor told us to not put the seed out until the rains came to cut down on this problem. Apparently, when the seed gets wet it is less palatable (Grenier 1997).</li> <li>• Revisited test plots last summer (1 season after seeding); ZERO Regreen in the plots. (Segotta 1997).</li> <li>• Not impressed, tough to compare because we used the Regreen on firelines mostly and the wheat in burned areas; typically poor results on firelines (Lillybridge 1997).</li> <li>• Seeded in spring and fall, germination &gt;85% for both seasons, worked well on road prisms and skid trails for reducing surface erosion/runoff, (grades not exceeding 10%...usually 4-5%). Regreen dying out in 2</li> </ul>

Common or Trade Name	Scientific Name	<b>Comments</b>
		<p>years with native veg established (Lewis 1997).</p> <ul style="list-style-type: none"> <li>• Regreen used on lime pit mine restoration project seeded heavy (30-50 lbs/ac), germination low (10-30%), but at high elevation substrate was lime, where soil was mixed with the lime by the cat, germination and cover was good, uniform (Finch 1997).</li> <li>• Not much success with Regreen, one problem was seeding too late in the fall so it sprouted, then frost killed; high bird predation, all our seeding more successful w/a thin layer of mulch is used (Potash 1997).</li> <li>• Poor germination (3-5%) with REGREEN under hydromulch on gentle to steep slopes in timber sale above 9,600' in elevation. Rocky poor soils on upper end of sale may have been part of the problem (Austin, 2000).</li> <li>• Fremont NF (Paisley/Silver Lake RD?) seeded with REGREEN after 2002 wildfires. Results pending.</li> <li>• Willamette NF has not had good results with REGREEN, and no longer recommends its use (Lippert 2003).</li> </ul>
Pioneer	<i>Sterile triticale</i>	<ul style="list-style-type: none"> <li>• May be used in plantings for short term erosion control by itself, or with slower to establish native species. Adapted to a wide range of soil and moisture conditions; advertised to perform better than wheat on dry and sandy soils, infertile soils, acid and alkaline soils (Landmark Seed Co.). ,</li> </ul>
White oats, domestic oats, cultivated oats, white horse feed oats	<i>Avena sativa</i>	<ul style="list-style-type: none"> <li>• The Federal Highway Administration seeded 20-seeds/square foot [100#/s/acre] of Cayuse oats [variety of oats] and mulched with rice straw and tackifier along the edge of over a mile of Forest Highway 7 last fall, and it provided a good ground cover (Isle 1996).</li> <li>• On the 83,000 acre Fork Fire, found the oats that were sowed on steep chaparral slopes were growing well and uniformly, native seed sowed was much smaller and sparser, best erosion control where rice straw mulch, oats were sowed, and straw check dams and wattles in drainages (Isle 1997).</li> <li>• Oats germinate in fall but, if timed for a nurse crop for dormant natives it does not have an opportunity to obtain much growth before winter killed, not providing the best protection cover during the winter, advantage is no worry about competition from the oats the next spring; oat cover crop should be planted at 1 to 1 1/2 bushels per acre (Hodges 1996).</li> <li>• Cool season, moderately drought tolerant annual, low competition to establishing perennials. Fall planted varieties not suitable for the northern temperate zones with long winters. In areas with long winters, oats should be planted in spring and in fall or spring in more temperate climates (Granite Seed 1996).</li> <li>• Quick, one year cover. Good for cool wet sites, but does well on dry sites too once it is established. Wayne Hamilton has been using it extensively on roadsides on MBRD and DRD [Mount Baker-Snoqualmie</li> </ul>

Common or Trade Name	Scientific Name	<b>Comments</b>
		NF] with great results if sowed in spring, fair in summer, poor in fall.
Barley or cereal barley	<i>Hordeum vulgare</i>	<ul style="list-style-type: none"> <li>• Disappeared the 2<sup>nd</sup> year except where salvage logging had occurred (Arch Rock Fire 1990). Barley plots had less erosion than unseeded plots in half the monitored areas, barley provided significant cover in many areas after 1<sup>st</sup> year on wildfire site (Cleveland Fire 1991), does not seem to persist beyond 1<sup>st</sup> year w/out disturbance (Beyers 1997).</li> <li>• Observations (Crystal Burn, Toiyabe NF, 1994) seeding with cereal barley inhibited the return of native plant species in some areas in the short term, was still in evidence in areas that were disturbed by logging and areas that were not disturbed, in 1995-1996. In 1997, the amount of barley that was present on the site considered minimal. Those transects did not show native vegetation was inhibited. (Van Zuuk 1997).</li> <li>• (The Eldorado NF) used [cereal] barley on a burn on 10/92. Where tractor logging has disturbed the seed heads, a 2<sup>nd</sup> crop of barley is coming up. Elsewhere, 2<sup>nd</sup> year germination is poor, in some moist sites, annual flora took a hit, In 1995 the 1992 seeding of barley is now barely evident. Less than 0.1% of the ground cover is from barley and despite earlier concerns about the annuals; there was little long-term impact on the flora, not sure barley was cost-effective, not sure it really accomplished much other than providing forage, barley may have some value on a very small scale on a case-by-case basis, but otherwise would be reluctant to use it on future fires (Foster 1995).</li> <li>• Sow winter barley or winter wheat, since it germinates in the cooler fall and gets better growth prior to spring (Isle 1999).</li> <li>• Barley worked very well for us seeded in June/July along roadsides with no noxious weeds present. Native plants such as fireweed began recolonizing the sites the same year we planted the barley. Some barleys have deeper root systems than others and some are better planted in the spring/summer than fall. Also, some barleys are treated with a fungicide. Check with your local supplier before purchasing (Austin 2000).</li> <li>• The Willamette commonly uses fall barley as a non-persistent annual with good results. They often mix with 1-2 local native species (Lippert 2003).</li> <li>• Used on 2002 Bisquit fire, Umpqua NF (Wayne.Rolle). Results pending.</li> </ul>
Cereal rye, common rye, or winter rye	<i>Secale cereale</i>	<ul style="list-style-type: none"> <li>• Seeding rate is 55 lbs per acre, introduced, annual, but may occasionally act as biennial, widely grown as a crop, can contaminate wheat fields. Rye can be found throughout eastern CO in wheat fields and disturbed areas, major problem in the wheat fields in Colorado (CWMA 1997). Used for reveg, often along roads, and Dr. Weber says it is expanding its range in CO (Kratz 1995).</li> <li>• 9,000-acre fire from 1992 seeded with cereal rye, competed with the natives as well as conifers planted the</li> </ul>

Common or Trade Name	Scientific Name	<b>Comments</b>
		<p>2 years after the fire and STILL persists [1997] (Stubbs 1997).</p> <ul style="list-style-type: none"> <li>• Have used on our district for 10+ years. The Sandhills soil tends to blow, especially in the winter, permittees hand sow around windmills, seeding rate high (55 lbs of seed/acre) we do NOT have a problem with any invasion of the rye into the native population of grasses, greens up really early in spring and pronghorn seem to appreciate it (Emly 1995).</li> <li>• Rye should <b>not</b> be used as temporary cover crop unless it can be mown prior to seed maturity- plants reseed themselves and inhibit the germination of native perennials (Colorado Natural Areas Program et al. 1998).</li> <li>• For the Mount Baker-Snoqualmie NF, the jury is still out on this species. Persists longer than wheat or barley.</li> <li>• Can be highly persistent in certain settings. Cures out early and is a high fire hazard.in late summer in drier regions.</li> </ul>
Triticale	<i>Triticum aestivum</i> X <i>Secale cereale</i>	<ul style="list-style-type: none"> <li>• Use as cover crop in certain recreation and wildlife areas to provide temporary soil protection, add organics to soil, and improve infiltration and aeration, use 25 - 40 pounds per acre (NRCS 1988).</li> <li>• Cool season, drought tolerant, annual grass. Hybrid cross between common wheat and cereal rye. Both spring and winter varieties available. Seeding rate 60 - 100 pure live seed (PLS) pounds per acre recommended (Granite Seed 2000).</li> </ul>
Winter wheat, soft white winter wheat, sterile wheat, common commercial wheat	<b>Triticum aestivum</b>	<ul style="list-style-type: none"> <li>• Triticum aestivum strain 'madsen' used here with success, comes in thick the first year, making for great pheasant and chukar food. Make sure it is sterile wheat (Brooks 1996).</li> <li>• Winter wheat continues to grow throughout the winter during any warm-ups, provides good cover but can also compete against the natives in spring, and later shade out seedlings, the secret is to plant a lower rate than you would for a commercial crop. 40 to 60 lbs/acre is recommended; helpful tool is to mow at or before the boot stage. This helps open the canopy, and stops volunteers (Hodges 1996).</li> <li>• Spring and winter varieties suitable for different climates. Seeding rate 60 - 100 (PLS) lbs/acre recommended (Granite Seed 2000).</li> <li>• Recommended in certain recreation and wildlife areas for soil protection and erosion control if seeded at 20 -25 pounds per acre (NRCS 1988).</li> <li>• UMA seeded after Tower and Wheeler fire, but at much reduced rates (20-30lb/acre)</li> </ul>

<b>Common or Trade Name</b>	<b>Scientific Name</b>	<b><i>Comments</i></b>
Lolium perenne		<ul style="list-style-type: none"><li>• Can be persistent in mesic environments.</li></ul>

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## ***Appendix E for the Revegetation Guidelines Document***

### **Invasive Plant Species to Avoid or Minimize in Revegetation and Landscaping Plantings**

Table E-1 contains a listing of non-native plant species that have commonly been used for decades in revegetation, landscaping, and wildflower/grass seed mixes. These species are no longer recommended for general use, however, because they are now known to be highly persistent and aggressive when introduced into native plant communities. In general, exotic species that have high reproductive output and are mid-to-late successional are among the most threatening and difficult to remove or control.

Table E-1 was developed based on recommendations and findings from a variety of sources. On-line resources, including the Natural Resource Conservation Service's PLANTS database and the USDA Agricultural Research Service's INVADERS database, were searched for information on the invasiveness on each plant species (see Legend for web sites). Plant species marked with "CD" were chosen by 13 USFS botanists and range ecologists from 5 western states in the "Top 10 Intentionally-sown Persistent Exotics" survey (Craig Dremann, 1998). They were noted for being especially aggressive in displacing native plant species and native plant communities throughout the western states. Species marked with "RMNP" were identified as "species of concern" (have the greatest potential for ecological impact) by researchers studying non-native vegetation the Rocky Mountain National Park. The Colorado Native Plant Society also developed a list of plants NOT recommended for use in revegetation, restoration, or gardening.

On sites dominated by large populations of one or more of these aggressive exotics, plant materials of more desirable species may be extremely difficult to establish unless efforts are first taken to reduce or eliminate the unwanted species. In addition, some of the species listed in Table E-1 may continue to play an appropriate but limited role in revegetation of noxious weed sites in settings where more desirable species (native and non-native) are not anticipated to establish or compete well against the target weed species. These aggressive exotics should be used only after their risk to TES plant species and other components of biological diversity has been carefully evaluated.





**Table E-1. Grass and forb species to avoid or minimize in revegetation/restoration projects.**

COMMON NAME	SCIENTIFIC NAME	NRCS	INV	RMNP	NE & GP	WISC	C A	CoNPS	C D	PCA	R6	COMMENTS
Canada bluegrass	<i>Poa compressa</i>	X				X			X		X	
Crested wheatgrass	<i>Agropyron cristatum</i> <i>A. desertorum</i>							X	X		X	
Hard fescue or sheep fescue	<i>Festuca ovina var. ovina</i>								X	X	X	Becoming naturalized in the Willamette Valley and very difficult to distinguish from native fescues; not recommended for use (B.Wilson) .Used in SW OR on weed sites in disturbed forest settings – not expected to persist once trees become established and shade it out (S. Bulkin)
Intermediate wheatgrass	<i>Agropyron intermedium</i>								X		X	
Kentucky bluegrass	<i>Poa pratensis</i>	X		X	X	X			X	X	X	
Red fescue	<i>Festuca rubra</i>										X	
Meadow fescue	<i>Festuca pratensis</i>								X	X	X	
Meadow foxtail	<i>Alopecurus pratensis</i>								X		X	
Orchardgrass	<i>Dactylis glomerata</i>	X		X	X			X	X	X	X	
Quackgrass	<i>Agropyron repens</i> ( <i>Elytrigia repens</i> or <i>Elymus repens</i> )	X	X	X	X	X				X	X	
Reed canarygrass	<i>Phalaris arundinacea</i> ( <i>Phalarioides arundinacea</i> )	X		X	X	X			X	X	X	
Smooth brome or Hungarian brome grass	<i>Bromopsis inermis</i> ( <i>Bromus inermis</i> )			X	X	X		X	X	X	X	

COMMON NAME	SCIENTIFIC NAME	NRCS	INV	RMN P	NE & GP	WISC	C A	CoNPS	C D	PCA	R6	COMMENTS
Timothy	<i>Phleum pratense</i>	X						X	X	X	X	
Tall fescue	<i>Festuca arundinacea (Lolium arundinaceum)</i>	X					X				X	
Italian ryegrass common rye or annual ryegrass	<i>Lolium perenne ssp. Multiflorum</i>	X					X				X	May be persistent in mesic environments or maritime climates
Crab grass	<i>Digitaria sanguinalis</i>										X	
Dogtail grass	<i>Cynosurus echinatus</i>										X	
Alfalfa	<i>Medicago sativa</i>										X	
Sanfoin											X	Persistent
Burnet											X	
Birdsfoot trefoil	<i>Lotus corniculatus</i>										X	
Downy brome or cheatgrass	<i>Bromus tectorum</i>	X		X	X		X				X	Common contaminant in commercial seed and hay/straw
Rattail fescue											X	Common contaminant in commercial seed and hay/straw
Wild oats	<i>Avena fatua</i>										X	Common contaminant in commercial seed and hay/straw
Tumbleweed mustard	<i>Sisymbrium loesellii</i>										X	Common contaminant in commercial seed and hay/straw
	<i>Conyza Canadensis</i>										X	
Babysbreath	<i>Gypsophila paniculata</i>	X	X	X						X	X	Sold in nurseries and/or wildflower seed mixes
Bouncing bet or soapwort	<i>Saponaria officinalis (Lychnis saponaria)</i>	X			X		X	X			X	Sold in nurseries and/or wildflower seed mixes
Common yarrow (European variety)	<i>Achillea millefolium (European variety)</i>	X			X						X	Note: there is a European and a native variety of this – if in doubt, avoid this species.
Corn chamomile	<i>Anthemis arvensis</i>	X									X	Sold in nurseries and/or wildflower seed mixes
Dalmation	<i>Linaria dalmatica ssp.</i>	X	X	X						X	X	Sold in nurseries and/or wildflower seed

COMMON NAME	SCIENTIFIC NAME	NRCS	INV	RMNP	NE & GP	WISC	C A	CoNPS	C D	PCA	R6	COMMENTS
toadflax	<i>Dalmatica</i>											mixes
Dame's rocket	<i>Hesperis matronalis</i>	X			X	X		X		X	X	Sold in nurseries and/or wildflower seed mixes
European wand loosestrife or Purple loosestrife	<i>Lythrum virgatum (see Lythrum salicaria)</i>	X	X					X			X	Sold in nurseries and/or wildflower seed mixes
Klamath weed or St. John's wort	<i>Hypericum perforatum</i>	X	X	X	X	X	X			X	X	Sold in nurseries and/or wildflower seed mixes
Mayweed chamomile	<i>Anthemis cotula</i>	X			X						X	Sold in nurseries and/or wildflower seed mixes
Oxe-eye daisy	<i>Leucanthemum vulgare (Chrysanthemum leucanthemum)</i>	X	X			X	X	X		X	X	Sold in nurseries and/or wildflower seed mixes
Perennial sweetpea or perennial peavine	<i>Lathyrus latifolius</i>	X						X			X	Sold in nurseries and/or wildflower seed mixes
Purple loosestrife	<i>Lythrum salicaria</i>	X	X		X	X	X	X		X	X	Sold in nurseries and/or wildflower seed mixes
Scentless chamomile, wild chamomile, or scentless mayweed	<i>Matricaria perforata (Matricaria inodora, Matricaria maritima, Tripleurospermum inodorum)</i>	X	X					X			X	Sold in nurseries and/or wildflower seed mixes
Toadflax or butter & eggs	<i>Linaria vulgaris</i>	X	X	X	X			X			X	Sold in nurseries and/or wildflower seed mixes
Sweet clover, white	<i>Melilotus alba</i>	X		X		X		X	X	X	X	Sold in nurseries and/or wildflower seed mixes
Sweet clover, yellow	<i>Melilotus officianalis</i>			X	X	X		X	X	X	X	Sold in nurseries and/or wildflower seed mixes
Bachelor button	<i>Centurea cyanus</i>										X	Sold in nurseries and/or wildflower seed mixes
Forage kochia	<i>Kochia</i>										X	Sold in nurseries and/or wildflower seed mixes
Wild carrot	<i>Caucus carota</i>										X	

COMMON NAME	SCIENTIFIC NAME	NRCS	INV	RMN P	NE & GP	WISC	C A	CoNPS	C D	PCA	R6	COMMENTS
Foxglove	<i>Digitalis purpurea</i>										X	
Wild radish	<i>Raphanus sativus</i>										X	
Red sorrel	<i>Rumex acetosella</i>										X	
Curly dock	<i>Rumex crispus</i>										X	
Dandelion	<i>Taraxacum officinale</i>										X	
Salsify	<i>Tragopogon spp.</i>										X	
Red clover	<i>Trifolium pratense</i>										X	
Veronica	<i>Veronica serpyllifolia</i>										X	

**Legend for Table E-1:**

**NRCS** --- Natural Resource Conservation Service's PLANTS database, Invasive and/or noxious weed list, <http://plants.usda.gov/plants/>

**INV** --- USDA Agricultural Research Service's INVADERS database for ID, MT, OR, WA, and WY, [http://invader.dbs.umt.edu/Noxious\\_Weeds](http://invader.dbs.umt.edu/Noxious_Weeds)

**RMNP** --- Rutledge, *et al.*, "An assessment of exotic plant species of Rocky Mtn National Park".

**NE & GP** - PLANTS database, "Invasive weeds of Nebraska and the Great Plains",

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**WISC** --- PLANTS database, "Invasive weeds of Wisconsin, WI",

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**CA** --- California Exotic Pest Plant Council, CalEPPC list, "Exotic pest plants of greatest ecological concern in California", (<http://www.caleppc.org/info/plantlist.html>, October 19, 1999).

**CoNPS** --- Colorado Native Plant Society, Boulder Chapter, 1997. Plant species not to use in gardening, reclamation and restoration. Handout from the Colorado Native Plant Society.

**CD** --- Craig Dremann, 1999. Survey of Forest Service Botanists in the West,

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**PCA** --- Plant Conservation Alliance, 2000. Invasive plants, <http://www.nps.gov/plants/alien/>

**R6** – Recommendations for invasive plant species to avoid in seed mixes. Compiled by Forest Botanists botanists on Willamette and Umatilla National Forests .

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**Table E-2. Grass cultivars historically used on USDA National Forest Lands in Oregon and Washington <sup>1</sup>**

Release Name	Scientific Name	Common Name	Release Year	Plant Type	Origin	Genetic Background and Selection Methods
<b>Bromar</b>	<i>Bromus marginatus</i> Nees ex. Steud	mountain brome grass	1946	Short-lived perennial bunchgrass	Pullman, WA	Mass selection from seed, tested over 10 years.
<b>Canbar</b>	<i>Poa secunda</i> J. Presl	Canby bluegrass	1979	Perennial bunchgrass	Blue Mts, WA	
<b>Covar</b>	<i>Festuca ovina</i> L.	sheep fescue	1977	Perennial bunchgrass	Konya, Turkey	
<b>Critana</b>	<i>Elymus lanceolatus</i> (Scribn. & J.G. Sm.) Gould ssp. <i>lanceolatus</i>	streambank wheatgrass	1971	Perennial sod-former	Havre, Montana	
<b>Durar</b>	<i>Festuca trachyphylla</i> (Hack.) Krajina	hard fescue	1949	Long-lived perennial bunchgrass	Introduced plants from Ashkhabad, Turkmenistan grown near Union, Oregon	
<b>Elkton</b>	<i>Elymus glaucus</i> ssp. <i>Jepsonii</i>	blue wildrye	1997	Short-lived perennial bunchgrass	Elkton, Oregon	1 population from 400 ft.elev
<b>Goldar</b>	<i>Pseudoroegneria spicata</i> (Pursh) A. Love ssp. <i>Spicata</i>	bluebunch wheatgrass	1989	Long-lived perennial bunchgrass	Malley Ridge, Umatilla National Forest, Asotin, WA	Diploid (2n = 14)

<sup>1</sup> This table is part of an internal white paper and journal article being prepared by Forest Service geneticists and researchers to describe the geographic origins and genetic constitution of cultivar releases that have been used on federal lines in the Pacific Northwest.

<b>Greenar</b>	<i>Thinopyrum intermedium</i>	intermediate wheatgrass	1945	Sod-former	USSR	
<b>Joseph</b>	<i>Festuca idahoensis</i>	Idaho fescue	1983	Perennial bunchgrass	Idaho	20 clones from plants interpollinated in greenhouses for 3 one-year cycles
<b>Latar</b>	<i>Dactylis glomerata</i>	orchardgrass	1957	Long-lived perennial sod-former	USSR	
<b>Luna</b>	<i>Thinopyrum intermedium</i>	intermediate wheatgrass	1963	Perennial wheatgrass	Ashkhabad, Turkmenistan	
<b>Magnar</b>	<i>Leymus cinereus</i>	basin wildrye	1979	Perennial bunchgrass	Saskatchewan, Canada	
<b>Manchar</b>	<i>Bromus inermis</i>	smooth brome	1943	Long-lived sod-former	Manchuria, China	
<b>Oahe</b>	<i>Thinopyrum intermedium</i>	intermediate wheatgrass	1961	Perennial sod-former	Russia	4 clones from self- and open-pollinated plants
<b>Primar</b>	<i>Elymus trachycaulus</i> (Link) Gould ex Shinners ssp. <i>trachycaulus</i>	slender wheatgrass	1946	long-lived perennial	Beebe, MT	Selected from original collection.
<b>Schwendimar</b>	<i>Elymus lanceolatus</i> (Scribn. & J.G. Sm.) Gould ssp. <i>lanceolatus</i>	thickspike wheatgrass	1994	Long-lived perennial sod-former	The Dalles, OR	
<b>Secar *</b>	<i>Pseudoroegneria spicata</i> (Pursh) A. Love ssp. <i>spicata</i>	bluebunch wheatgrass	1980	perennial bunchgrass	Lewiston, ID	Tetraploid (2n = 4x = 28)

<b>Sherman</b>	<i>Poa secunda</i> J. Presl	big bluegrass	1945	Long-lived perennial bunchgrass	Moro, OR	
<b>Sodar</b>	<i>Elymus lanceolatus</i> (Scribn. & J.G. Sm.) Gould ssp. <i>lanceolatus</i>	streambank wheatgrass	1954	Long-lived perennial sod-former	Canyon City, OR	
<b>Whitmar</b>	<i>Pseudoroegneria spicata</i> (Pursh) A. Love ssp. <i>Inermis</i> (Scribn. & J.G. Sm.) A. Love	bluebunch wheatgrass	1946	Long-lived perennial bunchgrass	Whitman County, WA	Mass selection from wild seed Diploid (2n = 14)



## **APPENDIX F for the Revegetation Guidelines Document**

### MULCH TYPES

<b>TYPE</b>	<b>DESCRIPTION</b>	<b>REQUIRED EQUIPMENT</b>	<b>APPLICATION RATE</b>	<b>CONSIDERATIONS</b>	<b>COST (in 1995)</b>	<b>USEFUL LIFE</b>
Straw	Certified Weed-free Straw	Hand application; blown on or applied by helicopter	4000 lbs/ac (4") on north slopes; 5000 lbs/ac (5") on south slopes	Tough to put on extremely steep slopes except by helicopter. Inexpensive; effective	\$1000/ac by hand; \$3000/ac by helicopter	2 years
Hydroseed Wood Cellulose Mulch	Hydro mulch with wood cellulose mulch	Applied with hydroseeding machine	\$2000 lbs/ac	Hydroseeders are expensive to move in and are in short supply in the fall. Seeding cannot be kept current with construction. Very effective	\$1000/ac by hand; \$3000/ac by helicopter	1 year
Hydroseed Paper Mulch	Hydro mulch with paper mulch	Applied with hydroseeding machine	\$2000 lbs/ac	Same as above	\$1000/ac plus mobilization	1 year
Blankets (some come impregnated)	Various types of premade erosion control blankets	Rolled out and staked or pinned down	By the square foot	Netting decomposes at a different rate than mulch. Effective; expensive	\$ .49-3.50/sq yd for material only; add labor	2 years
Netting	Various types of biodegradable & non degradable netting	Rolled out and staked or pinned down	By the square foot	Can trap animals; decomposes slowly; used over mulch; bio-degradable types available	\$.20-.50/sq yd for material only; add labor	2 years
Channel Liners	Various width heavy-duty blankets	Rolled out and staked or pinned down	By the square foot	Usually left in place. Effective; very expensive	\$3.00-3.50/sq yd for material only; add labor	1 year
Tackifiers	Sprayed on material used to hold soil in place	Sprayed on, usually with a truck mounted sprayer	By the square foot	Short term	\$800/ac plus mobilization	3 years
Sodding	Grass sod	Rolled out and pinned down	By the square foot	Used when instant plant establishment is important	\$.17/sq ft; add delivery and labor	indefinite

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