Appendix B – Botany

Herbicide Effects to Plants by Active Ingredient

Potential Herbicide Effects to SOLI

Determination Statements by Alternative for Each Individual SOLI Location

Revegetation Guidelines Document

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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 sulfonylureas 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 exposured 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-Imazypyr).

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 non-target species particularily sensitive to this chemical 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 ectomychorrhizal 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 Caroxylase (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).

Potential Herbicide Effects to SOLI

Herbicide effects are based on specific characteristics of the chemical, the target families, and restrictions of use based on EPA labe and Regional FEIS guidelines. All methods of application are considered in effects analysis. N = Herbicide would not affect SOLI plant species (reasons explained) Y = Herbicide could potentially affect this species and herbicide related PDF's must be applied.

SOLI	Chlorsulfuron PDFs to protect individual plants from direct spray, drift, runoff, wind erosion. No aerial application	Clopyralid Targets Asteraceae, Fabaceae, Polygonaceae, Solanaceae	Glyphosate Non-selective; PDFs to protect from direct sspray; runoff not a concern	Imazapic Somewhat selective PDFs to protect from direct spray, drift, runoff and timing after use of other herbicides	Imazapyr Non-selective; PDF's to protect plants from direct spray, drift runoff	Metsulfuron methyl Selective for some broadleaf and woody species and can damage conifers PDFs to protect individual plants from direct spray, drift, runoff, wind erosion. No aerial application	Picloram Targets Asteraceae, Fabaceae, Polygonaceae, Apiaceae- also Brassicaceae, Liliaceae, Scrophulariaceae (less affected) PDFs to protect from direct spray drift, runoff, buffers, fall application by TES plants and other special situation	Sethoxydim Selective for annual and perennial grasses and target invasives	Sulfometuron methyl Non-selective; PDFs to protect plants from direct spray, drift, runoff, wind erosion. No aerial application	Triclopyr Selective for broadleaf and woody plants. Selective application methods only spot, wiping, basal bank and cut stump application
Achnatherum wallowaensis	Not sure, assume worst case scenario and apply PDF's and monitoring to determine potential impacts	N Poaceae is not a target and tolerant	Y	Y	Y	Not sure, assume worst case scenario and apply PDF's and monitoring to determine potential impacts	Not sure, assume worst case scenario and apply PDF's and monitoring to determine potential impacts	Y	Not sure, assume worst case scenario and apply PDF's and monitoring to determine potential impacts	N Poaceaw is not a target and is tolerant
Allium geyeri var. geyeri	Y	N Liliaceae is not a target	Y	Y	Y	Y	Y	N Broadleaved plants are tolerant of this herbicide N	Y	Y, if target invasive is nearby
Arabis	Y	N	Y	Y	Y	Y	Y	N	Y	Y, if target

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hastatula		Crucifereaceae is not target						Broadleaved plants are tolerant of this herbicide		invasive is nearby
Botrychium species: B crenulatum, B. minganese, B. montanum, and B. pinnatum	Y	N Ophioglossaceae is not target	Y	Y	Y	Y	Not sure, assume worst case scenario and apply all PDF's	N Broad leaved plants tolerate this herbicide	Y	Y, if target invasive is nearby
Calochortus longebarbatus var. longebarbatus	Y	N Liliaceae not target family	Y	Y	Y	Y	Liliaceae less susceptible to this herbicide, monitoring indicates no effect	N Broadleaved plants tolerate this herbicide	Y	Y if target invasive species is nearby
Carex hystericina	Not likely due to species habitat preference for wetter habitat and herbicide	N Cyperaceae not a target family	Y	Y	Y	Not sure, apply all PDF's	Not sure, assume worst case scenario apply all PDF's	N, Sedges tolerate this herbicide	Not sure, apply all PDF's	Y if target invasive species is nearby

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	use and buffer restrictions. If treatment allowed follow all PDF's.									
Carex interior	Not likely due to species habitat preference for wetter habitat and herbicide use and buffer restrictions. If treatment allowed follow all PDF's.	N Cyperaceae not a target family	Y	Y	Y	Not sure, apply all PDF's	Not sure, assume worst case scenario apply all PDF's	N, Sedges tolerate this herbicide	Not sure, apply all PDF's	Y if target invasive species is nearby
Carex cordillerana	Not likely due to species habitat preference for wetter habitat and herbicide use and buffer restrictions. If	N Cyperaceae not a target family	Y	Y	Y	Not sure, apply all PDF's	Not sure, assume worst case scenario apply all PDF's	N, Sedges tolerate this herbicide	Not sure, apply all PDF's	Y if target invasive species is nearby

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	treatment allowed follow all PDF's.									
Erigeron engelmannii var. davisii	Y	Y Asteraceaea family is target	Y	Y	Y	Y	Y	N Broadleaved plants are tolerant of this herbicide	Y	Y, if target invasive is nearby
Leptodactylon pungens ssp. hazeliae	Y	N Polemoniaceaea not a target family	Y	Y	Y	Y	Not sure, assume worst case scenario apply all PDF's	N Broadleaved plants are tolerant of this herbicide	Y	Y if target invasive is nearby
Mimulus clivicola	Y	N Scrophulariaceae is not a target family	Y	Y	Y	Y	Y	N Broadleaved plants are tolerant of this herbicide	Y	Y, if target invasive is nearby
Mirabilis macfarlanei	Y	N Nyctaginaceae is not a target	Y	Y	Y	Y	Not sure, assume worst case scenario apply all	N Broadleaved plants are	Y	Y, if target invasive is nearby

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		family					PDF's	tolerant of this herbicide		
Phacelia minutissima	Y	N Hydrophyllaceae is not a target family	Y	Y	Y	Y	Not sure, assume worst case scenario apply all PDF's	N Broadleaved plants are tolerant of this herbicide	Y	Y, if target invasive is nearby
Phlox multiflora	Y	N Polemoniaceae is not target family	Y	Y	Y	Y	Not sure, assume worst case scenario apply all PDF's	N Broadleaved plants are tolerant of this herbicide	Y	Y, if target invasive is nearby
Platanthera obtusata	Y	N Orchidaceae is not a target family	Y	Y	Y	Y	Not sure, assume worst case scenario apply all PDF's	N Broadleaved plants are tolerant of this herbicide	Y	Y, if target invasive is nearby
Primula cusickiana	Y	N Primulaceae is not a target	Y	Y	Y	Y	Not sure, assume worst case scenario apply all	N Broadleaved plants are	Y	Y, if target invasive is nearby

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		family					PDF's	tolerant of this herbicide		
Rubus bartonianus	Y	N Rosaceae is not a target family	Y	Y	Y	Y	Not sure, assume worst case scenario apply all PDF's	N Broadleaved plants are tolerant of this herbicide	Not sure, assume worst case scenario and apply PDF's and monitoring to determine potential impacts	Y, if target invasive is nearby
Trifolium douglasii	Y	Y Fabaceae is target family	Y	Y	Y	Y	Not sure, assume worst case scenario apply all PDF's	N, broadleaves plants tolerate this herbicide	Y	Y, if target invasive is nearby
Trollius laxus	Y	N Ranunculaceae is not a target family	Y	Y	Y	Not sure, assume worst case scenario and apply PDF's and monitoring	Not sure, assume worst case scenario apply all PDF's	N Broadleaved plants are tolerant of this herbicide	Y	Y, if target invasive is nearby

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						to determine potential impacts				

Determination Statements by Alternative for each individual SOLI location

Site No	GENUS	SPECIES	Invasive Plant Code	Determination statements derived from impacts from invasive plant treatments in combination with treatment effectiveness				Proposed treatment for Alternative B, C and D 1st choice. Other methods also available
				Alt A	Alt B	Alt C	Alt D	
0616020241	*Achnatherum*	*wallowaensis*	CEMA4	MIIH	MIIH	MIIH	MIIH	Chemical
0616020502	*Achnatherum*	*wallowaensis*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616041176	*Allium*	*geyeri*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616041252	*Arabis*	*hastatula*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616041347	*Arabis*	*hastatula*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616012117	*Botrychium*	*crenulatum*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616012102	*Botrychium*	*minganense*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616012103	*Botrychium*	*minganense*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616012118	*Botrychium*	*minganense*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616060138	*Botrychium*	*minganense*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616062224	*Botrychium*	*minganense*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616012115	*Botrychium*	*montanum*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616012124	*Botrychium*	*montanum*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616012126	*Botrychium*	*montanum*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616060178	*Botrychium*	*montanum*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616062223	*Botrychium*	*montanum*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616062225	*Botrychium*	*montanum*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616012104	*Botrychium*	*pinnatum*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616012125	*Botrychium*	*pinnatum*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616012213	*Botrychium*	*pinnatum*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616060158	*Botrychium*	*pinnatum*	SEJA	MIIH	MIIH	MIIH	MIIH	Chemical
0616060016	*Calochortus*	*longebarbatus*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616060115	*Calochortus*	*longebarbatus*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616060131	*Calochortus*	*longebarbatus*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616060943	*Calochortus*	*longebarbatus*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616060952	*Calochortus*	*longebarbatus*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616040513	*Calochortus*	*macrocarpus*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616041078	*Carex*	*hystericina*	CEMA4	MIIH	MIIH	MIIH	MIIH	Manual
0616041364	*Carex*	*hystericina*	CEMA4	MIIH	MIIH	MIIH	MIIH	Chemical
0616012151	*Carex*	*interior*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616062226	*Carex*	*interior*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616020247	*Erigeron*	*engelmannii*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616020248	*Erigeron*	*engelmannii*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616020249	*Erigeron*	*engelmannii*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616020250	*Erigeron*	*engelmannii*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616020251	*Erigeron*	*engelmannii*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616021357	*Erigeron*	*engelmannii*	ONAC	MIIH	MIIH	MIIH	MIIH	Chemical
0616022087	*Erigeron*	*engelmannii*	ONAC	MIIH	MIIH	MIIH	MIIH	Chemical
0616022088	*Erigeron*	*engelmannii*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616022089	*Erigeron*	*engelmannii*	CESO3	MIIH	MIIH	MIIH	MIIH	Chemical
0616022090	*Erigeron*	*engelmannii*	CESO3	MIIH	MIIH	MIIH	MIIH	Chemical
0616040469	*Erigeron*	*engelmannii*	CESO3	MIIH	MIIH	MIIH	MIIH	Chemical
0616040480	*Erigeron*	*engelmannii*	ONAC	MIIH	MIIH	MIIH	MIIH	Chemical
0616040216	*Leptodactylon*	*pungens*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616041141	*Leptodactylon*	*pungens*	CESO3	MIIH	MIIH	MIIH	MIIH	Chemical
0616012134	*Mimulus*	*clivicola*	CYOF	MIIH	MIIH	MIIH	MIIH	Chemical
0616040294	*Mimulus*	*clivicola*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical

Site No	GENUS	SPECIES	Invasive Plant Code	Determination statements derived from impacts from invasive plant treatments in combination with treatment effectiveness				Proposed treatment for Alternative B, C and D 1st choice. Other methods also available
				Alt A	Alt B	Alt C	Alt D	
0616040295	*Mimulus*	*clivicola*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616040296	*Mimulus*	*clivicola*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616040297	*Mimulus*	*clivicola*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616040382	*Mimulus*	*clivicola*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616040385	*Mimulus*	*clivicola*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616040539	*Mimulus*	*clivicola*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616041039	*Mimulus*	*clivicola*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616041045	*Mimulus*	*clivicola*	CIAR4	MIIH	MIIH	MIIH	MIIH	Bio-control
0616041109	*Mimulus*	*clivicola*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616041391	*Mimulus*	*clivicola*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616041392	*Mimulus*	*clivicola*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616040488	*Mirabilis*	*macfarlanei*	CESO3	LAA	LAA	LAA	LAA	Chemical
0616040494	*Mirabilis*	*macfarlanei*	ONAC	LAA	LAA	LAA	LAA	Chemical
0616040217	*Phacelia*	*minutissima*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616060123	*Phlox*	*multiflora*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616060149	*Phlox*	*multiflora*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616060150	*Phlox*	*multiflora*	CADR	MIIH	MIIH	MIIH	MIIH	Chemical
0616060151	*Phlox*	*multiflora*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616060152	*Phlox*	*multiflora*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616050462	*Platanthera*	*obtusata*	CEMA4	MIIH	MIIH	MIIH	MIIH	Chemical
0616020286	*Primula*	*cusickiana*	CEMA4	MIIH	MIIH	MIIH	MIIH	Chemical
0616020292	*Primula*	*cusickiana*	CYSC4	MIIH	MIIH	MIIH	MIIH	Chemical
0616020339	*Primula*	*cusickiana*	CYSC4	MIIH	MIIH	MIIH	MIIH	Bio-control
0616040300	*Primula*	*cusickiana*	HYPE	MIIH	MIIH	MIIH	MIIH	Chemical
0616041212	*Primula*	*cusickiana*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616040218	*Rubus*	*bartonianus*	CESO3	MIIH	MIIH	MIIH	MIIH	Chemical
0616040380	*Rubus*	*bartonianus*	LIDA	MIIH	MIIH	MIIH	MIIH	Chemical
0616060859	*Trifolium*	*douglasii*	PORE5	MIIH	MIIH	MIIH	MIIH	Chemical
0616060860	*Trifolium*	*douglasii*	PORE5	MIIH	MIIH	MIIH	MIIH	Chemical
0616060941	*Trifolium*	*douglasii*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616060942	*Trifolium*	*douglasii*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical
0616062299	*Trifolium*	*douglasii*	CIAR4	MIIH	MIIH	MIIH	MIIH	Chemical
0616040210	*Trollius*	*laxus*	CEDI3	MIIH	MIIH	MIIH	MIIH	Chemical

Revegetation Guidelines Document

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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 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 compete)

<u>The current extent and patterns of spread of invasive species</u>: 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.

<u>Grazing and hydrologic issues in riparian systems</u>: Revegetion 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 dominate disturbance process (e.g., in the Blue Mountains) and must be factored into design and cost of revegetation.

<u>Historical range of variability (HRV) and degree of departure:</u> 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 additional 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[1] 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 rational, are as follows:

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[1] 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, 5th 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.

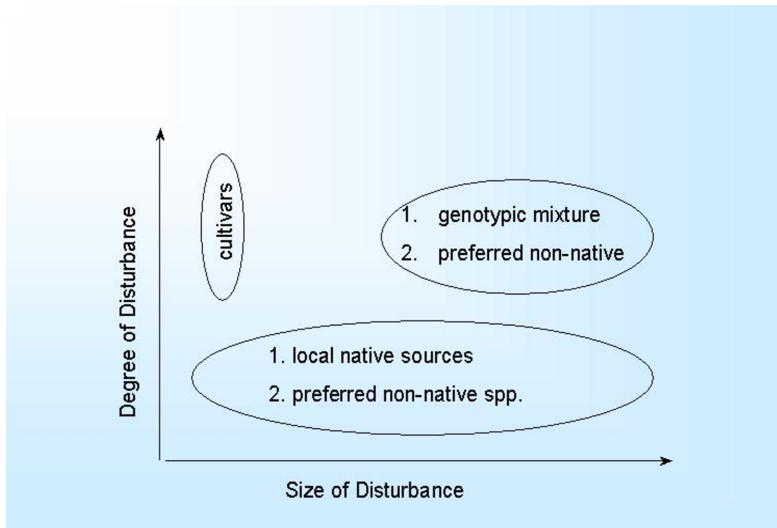

Fig. 1. Relationship between size and degree of disturbance and primary and secondary preferences for plant material for revegetation on National Forests and Grasslands in Region 6. (Adapted from Lesica and Allendorf 1999).

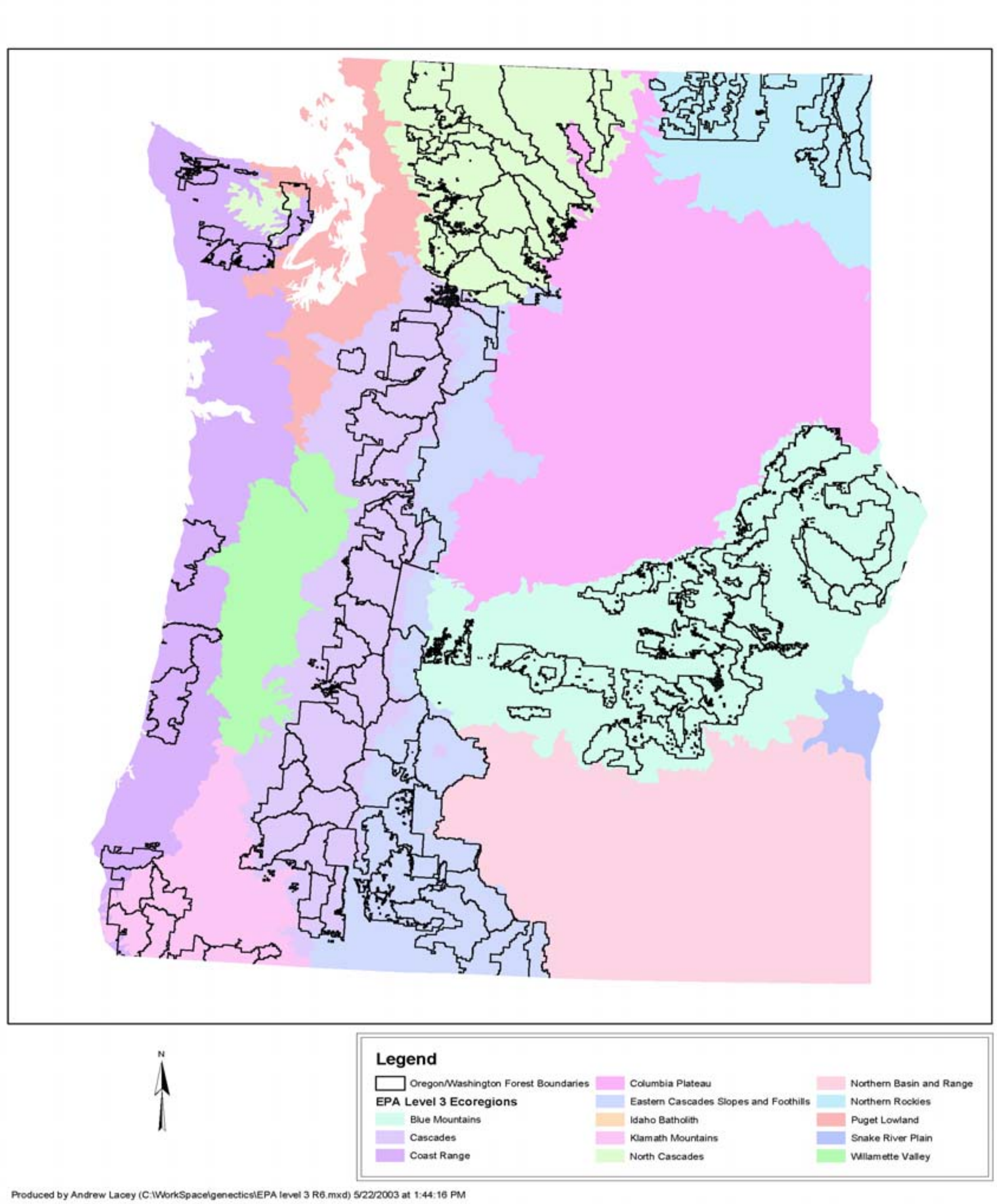

Figure 2. Relationship between Level III ecoregions (in color) and R6 National Forest boundaries (outlined in black).

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 (*Koelaria 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 evapotranspiraation. 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 morality due to limiting environmental factors and competition. Goodwin and Sheley (2003), for example, suggest a seeding rate of 80 PLS/ft^2 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^2 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^2 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^2:

(1 acre) x (43,560 ft^2/acre) x (20 PLS/ft^2) = 871,200 PLS

(131,000 seeds/lb) x (0.83) = 108,730 PLS/lb.

871,200 ÷ 108,730 = 8.01 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.^{2}:

Species	Seeds per pound	PLS	Target Coverage (PLS/ft2)
Blue wildrye	131,000	0.83	10
Mountain brome	81,500	0.86	10
Prairie junegrass [a]	2,300,000	0.80	10
Sandberg's bluegrass	925,000	0.80	10
		Total Coverage:	40 PLS/ft^2

[a] Bluebunch wheatgrass may be substituted on drier sites. Idaho fescue would be a good addition to this mix if available.

Blue wildrye: (1 acres) x (43,560 ft^2/acre) x (10 PLS/ft^2) = 435,600 PLS

(131,000 seeds/lb) x (0.83) = 108,730 PLS/lb.

435,600 ÷ 108,730 = **4.01 lb/acre**.

Mountain brome: (1 acre) x (43,560 ft^2/acre) x (10 PLS/ft^2) = 435,600 PLS

(81,500 seeds/lb) x (0.86) = 70,090 PLS/lb.

435,600 ÷ 70,090 = **6.21 lb/acre**.

Prairie junegrass: (1 acre) x (43,560 ft^2/acre) x (10 PLS/ft^2) = 435,600 PLS

(2,300,000 seeds/lb) x (0.80) = 1,840,000 PLS/lb.

435,600 ÷ 1,840,000 = **0.24 lb/acre**.

Sandberg's bluegrass: (1 acre) x (43,560 ft^2/acre) x (10 PLS/ft^2) = 435,600 PLS

(925,000 seeds/lb) x (0.80) = 740,000 PLS/lb.

435,600 ÷ 740,000 = **0.59 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 x .79 = .67 PLS. Divide .67 into 5 lbs/acre = 7.5 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 [1]

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.

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

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

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 _). 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/and 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/and 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	http://www.crop-net.com/weeds.htm
American Cyanamid Weed Guide	http://www.cyanamid.com/tools/weedguide/index.shtml
UC Pest Management Guidelines - Weed Photo Gallery	http://www.ipm.ucdavis.edu/PMG/r785700999.html
FMC Weed ID	http://ag.fmc.com/ag/weedbug
Idaho Noxious weeds	http://www.oneplan.state.id.us/pest/nw00.htm
University of Illinois Weed ID	http://web.aces.uiuc.edu/weedid.htm
Iowa State Weed ID	http://www.weeds.iastate.edu/weed-id/weedid.htm
Noxious Weeds of Kansas	http://www.ink.org/public/kda/phealth/phprot/weeds.html
Common Weed Seedlings of Michigan	http://www.msu.edu/msue/iac/e1363.htm
Oregon State Weed ID site	http://www.css.orst.edu/weeds/id.html
University of New England Weed ID	http://www.une.edu.au/agronomy/weeds/photo_library/ph_lib.html
Rutgers Coop Extension - Weeds of New Jersey	http://www.rce.rutgers.edu/weeds/index.html
Virginia Tech Weed Identification Guide	http://www.ppws.vt.edu/weedindex.htm
WSSA Photo herbarium	http://ext.agn.uiuc.edu/wssa/subpages/weed/herbarium0.html
Wyoming Noxious Weed Site	http://www.uwyo.edu/plants/weeds/id

Weed Control

ARS Exotic and Invasive Weeds Unit	http://wric.ucdavis.edu/exotic.html
NC Aquatic Weeds (East)	http://www.cropsci.ncsu.edu/aquaticweeds
Yellow Star thistle	http://soils.ag.uidaho.edu/yst
Weeds of No-till Cropping Systems	http://www.btny.purdue.edu/Extension/Weeds/NoTillD/NoTillWeed1.html
North Carolina Cotton Weed Control	http://ipmwww.ncsu.edu/Production_Guides/Cotton/chptr10.html
New York Forage Crops Weed Control	http://wwwscas.cit.cornell.edu/forage/recommends/recindex.html
Weeds of Minnesota Wheat	http://www.smallgrains.org/techweed.htm

Agricultural Companies

Aventis	http://www2.aventis.com
BASF	http://www.basf.com
Bayer	http://www.agro.bayer.com/
Dow AgroSciences	http://www.dowagrosciences.com
DuPont	http://www.dupont.com
FMC Home Page	http://www.fmc.com
Monsanto	http://www.monsanto.com
Novartis	http://www.novartis.com/agri/index.html
Rohm and Haas Home Page	http://www.rohmhass.com

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

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

North Dakota Weed Information	http://www.ext.nodak.edu/extpubs/weeds.htm
Wyoming Weed and Pest Council	http://www.wyoweed.org/

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 bioshpere…enrich…understanding of the ecological systems and natural resources important tot 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, invetebrate, 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:**April14, 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.SHAFFER: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 [a]	AVERAGE GERM/PURITY	AVG YIELD YEAR 1 [b]	AVG YIELD YEAR 2	AVG SEED/POUND	COST PER POUND [c]
Bluebunch Wheatgrass (*Pseudoroegneria spicata*)	10	80/90	300	300	140,000	$10.00-$12.00
Blue Wildrye (*Elymus glaucus*)	8	80/95	450	200	110,000	$7.00-$9.00
Bottlebrush Squirreltail (*Elymus elymoides*) or Big Squirreltial *(Elymus* multisetus)	8	80/90	0	125	110,000	$25.00-$30.00
California Oatgrass (*Danthonia californica*)	10	80/90	24	246	125,000	$15.00-$17.00
Great Basin Wildrye *(Leymes cinereus)*	8	80/95	27	160	130,000	$10.00-$12.00
Idaho Fescue (*Festuca idahoensis*)	5	80/95	300	350	450,000	$11.00-$13.00
Lemmon's *Needlegrass (Achnatherum* lemmonii)	8	50/95	150	750	150,000	$15.00-$18.00
Mountain Brome (*Bromus carinatus*)	10	80/95	800	800	70,000	$7.00-$9.00
Needle and Thread Grass *(Hesperostipa* comata)	8	50/95	0	150	115,000	$25.00-$30.00
Pinegrass (*Calamagrostis rubescens*)	2	80/95	0	132	2,500,000	$27.00-$30.00
Prairie junegrass (*Koelaria macrantha*)	2	80/95	150	500	2,315,000	$12.00-$14.00
Sandberg's Bluegrass (*Poa secunda*)	2	75/95	700	900	1,314,000	$8.00-$10.00
Slender Wheatgrass (*Elymus trachycaulus*)	8	80/90	50	350	130,000	$6.00-$8.00
Thurber's Needlegrass (*Achnatherum thurberiana*)	7	50/95	0	150	225,000	$12.00-$14.00
Tufted Hairgrass (*Deschampsia cespitosa*)	2	80/90	109	509	2,500,000	$14.00-$16.00
Western Needlegrass (*Achnatherum occidentalis*)	8-10	50/95	103	189	275,000	$6.00-$8.00
Common Yarrow (*Achillea millefolium*)	2	85/95	165	165	3,000,000	$7.00-$9.00
Pearly-everlasting (*Anaphalis margaritacae*)	1	60/85	No Data	No Data	8,000,000	$20.00-$25.00

[a] Quantity of Government furnished seed will need to be increased if germination and/or purity of seed are lower than recommended values.
[b] Yield figures assume a late summer or fall sowing in year 0.
[C] 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%.

Oregon State Standards					Washington State Standards				
Factor	**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%b
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%a	0.3%a	0.3%a	0.3%a
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).
[a] 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%.
[b] 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
Website: www.css.orst.edu/seedlab

Washington State Department of Agriculture
21 N. 1st 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 Pseudoroegneria spicata	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 Elymus glaucus	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 Elymus elymoides	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 Danthonia californica					
Great Basin Wildrye Leymus cinereus	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 Festuca idahoensis	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 Achnatherum lemmonii					
Western needlegrass Achnatherum occidentale		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 Achnatherum thurberiana		6 inches	6-8 lbs.	Fall/Spring	Short, cool season bunchgrass. Drought tolerant.

Species	Preferred Soil Type	Minimum Precipitation	Pure Stand PLS Rate Per Acre	Time of Seeding	Comments
Mountain brome Bromus carinatus	Silt loam to claay	16 inches	19 lbs.	Fall/Spring	Tall, cool season, short-lived perennial bunchgrass adapted to a wide 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 Koelaria 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		20	0.5	Fall/Spring	Requires full sun/shade intolerant

Species	Preferred Soil Type	Minimum Precipitatio n	Pure Stand PLS Rate Per Acre	Time of Seeding	Comments
Anaphalis margartiacae					
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	*Comments*
Regreen	*Agropyron* X *Triticum* wheatgrass x wheat hybrid	• 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). • Recommended seeding rate pure live seed (PLS) pounds per acre is 10 - 40 pounds (Granite Seed 1996). • 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). • 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). • 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). • 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). • Revisited test plots last summer (1 season after seeding); ZERO Regreen in the plots. (Segotta 1997). • 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). • Seeded in spring and fall, germination >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 years with native veg established (Lewis 1997).

Common or Trade Name	Scientific Name	Comments
		• 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). • 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). • 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). • Fremont NF (Paisley/Silver Lake RD?) seeded with REGREEN after 2002 wildfires. Results pending. • Willamette NF has not had good results with REGREEN, and no longer recommends its use (Lippert 2003).
Pioneer	***Sterile triticale***	• 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, infertilse soils, acid and alkaline soils (Landmark Seed Co.). ,
White oats, domestic oats, cultivated oats, white horse feed oats	**Avena sativa**	• 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). • 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). • 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). • 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). • Quick, one year cover. Good for cool wet sites, but does well on dry sites too once it is established. Wayne Hamilton has be using it extensively on roadsides on MBRD and DRD [Mount Baker-Snoqualmie NF] with great results if sowed in spring, fair in summer, poor in fall.

Common or Trade Name	Scientific Name	Comments
Barley or cereal barley	*Hordeum vulgare*	• Disappeared the 2nd 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 1st year on wildfire site (Cleveland Fire 1991), does not seem to persist beyond 1st year w/out disturbance (Beyers 1997). • 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). • (The Eldorado NF) used [cereal] barley on a burn on 10/92. Where tractor logging has disturbed the seed heads, a 2nd crop of barley is coming up. Elsewhere, 2nd 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). • Sow winter barley or winter wheat, since it germinates in the cooler fall and gets better growth prior to spring (Isle 1999). • 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). • 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). • Used on 2002 Bisquit fire, Umpqua NF (Wayne.Rolle). Results pending.
Cereal rye, common rye, or winter rye	*Secale cereale*	• 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). • 9,000-acre fire from 1992 seeded with cereal rye, competed with the natives as well as conifers planted the 2 years after the fire and STILL persists [1997] (Stubbs 1997).

Common or Trade Name	Scientific Name	Comments
		• 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). • Rye should **not** 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). • For the Mount Baker-Snoqualmie NF, the jury is still out on this species. Persists longer than wheat or barley. • Can be highly persistent in certain settings. Cures out early and is a high fire hazard.in late summer in drier regions.
Triticale	*Triticum aestivum* X *Secale cereale*	• 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). • 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).
Winter wheat, soft white winter wheat, sterile wheat, common commercial wheat	**Triticum aestivum**	• 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). • 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). • Spring and winter varieties suitable for different climates. Seeding rate 60 - 100 (PLS) lbs/acre recommended (Granite Seed 2000). • Recommended in certain recreation and wildlife areas for soil protection and erosion control if seeded at 20 -25 pounds per acre (NRCS 1988). • UMA seeded after Tower and Wheeler fire, but at much reduced rates (20-30lb/acre)
Lolium perenne		• Can be persistent in mesic environments.

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Appendix E for the Revegetation Guidelines Document

Invasive Plant Species to Avoid or Minimize in 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 desireable 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	RMN P	NE & GP	WISC	C A	CoNPS	C D	PCA	R6	COMMENTS
Canada bluegrass	*Poa compressa*	X				X			X		X	
Crested wheatgrass	*Agropyron cristatum* *A. desertorum*							X	X		X	
Hard fescue or sheep fescue	*Festuca ovina var. ovina*								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	**Agropyron intermedium**								X		X	
Kentucky bluegrass	**Poa pratensis**	X		X	X	X			X	X	X	
Red fescue	**Festuca rubra**										X	
Meadow fescue	*Festuca pratensis*								X	X	X	
Meadow foxtail	*Alopecurus pratensis*								X		X	
Orchardgrass	*Dactylis glomerata*	X		X	X			X	X	X	X	
Quackgrass	*Agropyron repens (Elytrigia repens or Elymus repens)*	X	X	X	X	X				X	X	
Reed canarygrass	*Phalaris arundinacea (Phalarioides arundinacea)*	X		X	X	X			X	X	X	
Smooth brome or Hungarian brome grass	*Bromopsis inermis (Bromus inermis)*			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	*Phleum pratense*	X						X	X	X	X	
Tall fescue	*Festuca arundinacea (Lolium arundinaceum)*	X					X				X	
Italian ryegrass common rye or annual ryegrass	*Lolium perenne* ssp. *Multiflorum*	X					X				X	May be persistent in mesic environments or maritime climates
Crab grass	*Digitaria sanguinalis*										X	
Dogtail grass	*Cynosurus echinatus*										X	
Alfalfa	*Medicago sativa*										X	
Sanfoin											X	Persistent
Burnet											X	
Birdsfoot trefoil	*Lotus corniculatus*										X	
Downy brome or cheatgrass	**Bromus tectorum**	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	**Avena fatua**										X	Common contaminant in commercial seed and hay/straw
Tumbleweed mustard	**Sisymbrium loesellii**										X	Common contaminant in commercial seed and hay/straw
	Conyza Canadensis										X	
Babysbreath	**Gypsophila paniculata**	X	X	X						X	X	Sold in nurseries and/or wildflower seed mixes
Bouncing bet or soapwort	*Saponaria officinalis (Lychnis saponaria)*	X			X		X	X			X	Sold in nurseries and/or wildflower seed mixes
Common yarrow (European variety)	**Achillea millefolium *(European variety)***	X			X						X	Note: there is a European and a native variety of this – if in doubt, avoid this species.
Corn chamomile	*Anthemis arvensis*	X									X	Sold in nurseries and/or wildflower seed mixes

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

COMMON NAME	SCIENTIFIC NAME	NRCS	INV	RMNP	NE & GP	WISC	C A	CoNPS	C D	PCA	R6	COMMENTS
Wild carrot	*Caucus carota*										X	
Foxglove	*Digitalis purpurea*										X	
Wild radish	*Raphanus sativus*										X	
Red sorrel	*Rumex acetosella*										X	
Curly dock	*Rumex crispus*										X	
Dandelion	*Taraxacum officinale*										X	
Salsify	*Tragopogon spp.*										X	
Red clover	*Trifolium pratense*										X	
Veronica	*Veronica serphyllifolia*										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
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", http://plants.usda.gov/plants/cgi_bin/invasive_all.cgi
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Table E-2. Grass cultivars historically used on USDA National Forest Lands in Oregon and Washington [1]						
Release Name	**Scientific Name**	**Common Name**	**Release Year**	**Plant Type**	**Origin**	**Genetic Background and Selection Methods**
Bromar	*Bromus marginatus* Nees ex. Steud	mountain bromegrass	1946	Short-lived perennial bunchgrass	Pullman, WA	Mass selection from seed, tested over 10 years.
Canbar	*Poa secunda*J. Presl	Canby bluegrass	1979	Perennial bunchgrass	Blue Mts, WA	
Covar	*Festuca ovina* L.	sheep fescue	1977	Perennial bunchgrass	Konya, Turkey	
Critana	*Elymus lanceolatus* (Scribn. & J.G. Sm.) Gould ssp. *lanceolatus*	streambank wheatgrass	1971	Perennial sod-former	Havre, Montana	
Durar	*Festuca trachyphylla*(Hack.) Krajina	hard fescue	1949	Long-lived perennial bunchgrass	Introduced plants from Ashkhabad, Turkmenistan grown near Union, Oregon	
Elkton	*Elymus glaucus* ssp. *Jepsonii*	blue wildrye	1997	Short-lived perennial bunchgrass	Elkton, Oregon	1 population from 400 ft.elev

[1] 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.

Appendix B-Botany

Table E-2. Grass cultivars historically used on USDA National Forest Lands in Oregon and Washington [1]						
Release Name	**Scientific Name**	**Common Name**	**Release Year**	**Plant Type**	**Origin**	**Genetic Background and Selection Methods**
Goldar	*Pseudoroegneria spicata* (Pursh) A. Love ssp*. Spicata*	bluebunch wheatgrass	1989	Long-lived perennial bunchgrass	Malley Ridge, Umatilla National Forest, Asotin, WA	Diploid (2n = 14)
Greenar	*Thinopyrum intermedium*	intermediate wheatgrass	1945	Sod-former	USSR	
Joseph	*Festuca idahoensis*	Idaho fescue	1983	Perennial bunchgrass	Idaho	20 clones from plants interpollinated in greenhouses for 3 one-year cycles
Latar	*Dactylis glomerata*	orchardgrass	1957	Long-lived perennial sod-former	USSR	
Luna	*Thinopyrum intermedium*	intermediate wheatgrass	1963	Perennial wheatgrass	Ashkhabad, Turkmenistan	
Magnar	*Leymus cinereus*	basin wildrye	1979	Perennial bunchgrass	Saskatchewan, Canada	
Manchar	*Bromus inermis*	smooth brome	1943	Long-lived sod-former	Manchuria, China	
Oahe	*Thinopyrum intermedium*	intermediate wheatgrass	1961	Perennial sod-former	Russia	4 clones from self- and open-pollinated plants

Table E-2. Grass cultivars historically used on USDA National Forest Lands in Oregon and Washington [1]

Release Name	Scientific Name	Common Name	Release Year	Plant Type	Origin	Genetic Background and Selection Methods
Primar	*Elymus trachycaulus* (Link) Gould ex Shinners ssp. *trachycaulus*	slender wheatgrass	1946	long-lived perennial	Beebe, MT	Selected from original collection.
Schwendimar	*Elymus lanceolatus* (Scribn. & J.G. Sm.) Gould ssp. *lanceolatus*	thickspike wheatgrass	1994	Long-lived perennial sod-former	The Dalles, OR	
Secar *	*Pseudoroegneria spicata* (Pursh) A. Love ssp. *spicata*	bluebunch wheatgrass	1980	perennial bunchgrass	Lewiston, ID	Tetraploid (2n = 4x = 28)
Sherman	*Poa secunda* J. Presl	big bluegrass	1945	Long-lived perennial bunchgrass	Moro, OR	
Sodar	*Elymus lanceolatus* (Scribn. & J.G. Sm.) Gould ssp. *lanceolatus*	streambank wheatgrass	1954	Long-lived perennial sod-former	Canyon City, OR	
Whitmar	*Pseudoroegneria spicata* (Pursh) A. Love ssp. *Inermis* (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

TYPE	DESCRIPTION	REQUIRED EQUIPMENT	APPLICATION RATE	CONSIDERATIONS	COST (in 1995)	USEFUL LIFE
Straw	Certified Weed-free Straw	Hand applica-tion; 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, usu-ally 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