

# Appendix A—Treatments To Manage Factors Limiting Restoration

Limiting factor	Potential treatments to compensate	Potential plant types or propagation methods
Extreme heat	<p>Add mulch.</p> <p>Install vertical mulch.</p> <p>Install shade cards.</p>	<p>Favor species with adaptations to survive heat, such as thick or waxy cuticles, light surfaces, etc.</p> <p>Make sure transplants have a high root-to-shoot ratio.</p> <p>Use 1-1 or plug-1 stock.</p>
Extreme cold	<p>Add mulch.</p> <p>Use perforated plastic landscape film to induce germination or protect seedlings.</p>	<p>Favor species with adaptations to survive cold, such as thick or waxy cuticles.</p> <p>Transplant wildlings.</p> <p>Transplant greenhouse-grown plants that are past the tender seedling stage.</p>
Wind or sand blast	<p>Install vertical mulch.</p> <p>Install shade cards.</p> <p>Spray antidesiccant on foliage.</p> <p>Pit and imprint the soil.</p>	<p>Favor species with adaptations to survive cold, such as thick or waxy cuticles.</p> <p>Transplant wildlings.</p> <p>Transplant greenhouse-grown plants that are past the tender seedling stage.</p>
Herbivory	<p>Install wire cages.</p> <p>Install tree tubes.</p> <p>Use repellants.</p> <p>Install row cover.</p> <p>Wrap the stems.</p> <p>Limit watering.</p>	<p>Favor plants that are poisonous, have spines, or are not palatable.</p> <p>Cut back on fertilizing before outplanting greenhouse stock.</p> <p>Make sure transplants have a high root-to-shoot ratio.</p> <p>Use 1-1 or plug-1 stock.</p>
Granivory	<p>Spread cracked wheat before seeding.</p>	
Frost heave or needle ice	<p>Add mulch.</p> <p>Tamp soil firmly around plants when planting.</p> <p>Pit and imprint the soil.</p>	

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Short growing season	Use plastic film to enhance germination and seedling growth.	Transplant wildlings.  Transplant greenhouse-grown stock.
Lack of soil moisture	Sow seed at the onset of the rainy season.  Ensure firm seed-to-soil contact.  Reduce compaction with scarification.  Pit and imprint the soil.  Avoid working the soil when it is excessively wet or dry.  Water when planting.  Water by hand or install an irrigation system.  Use buried clay-pot irrigation.  Increase organic material in the soil or use other soil amendments.  Inoculate the soil with micro-organisms.  Add mulch.	Favor species with adaptations to survive drought, such as those with thick or waxy cuticles, spines, reflective or hairy surfaces, high root-to-shoot ratios, or the ability to drop leaves when stressed.  Transplant greenhouse-grown stock raised in deep containers.
Poor water infiltration	See <i>Increased Soil Compaction</i> below.  Manage physical crust formation after vegetation is reintroduced.	See <i>Increased Soil Compaction</i> below.
Lack of precipitation for germination or seedling establishment	Irrigate seeded areas.	Transplant wildlings.  Reseed if necessary.  Transplant greenhouse-grown stock.
Sun intolerance	Install shade cards.  Install vertical mulch.  Pit and imprint the soil.	Select plants that are growing in full sun.  Plant in cooler or cloudier times of year.  Harden off before planting.

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		Use B-1 fertilizer to reduce transplant shock. Prune back plants by one-third.
Loss of soil layers	Rebuild soil from onsite sources.  Import topsoil.  Inoculate with mycorrhizae.  Import compost or other soil amendments.	Favor species found growing on sites with similar disturbances.
Inadequate soil nutrients	Add local organic matter.  Inoculate with mycorrhizae.  Import compost, other soil amendments, or use fertilizer to correct nutrient and pH levels.	Favor species with a high root-to-shoot ratio.  Favor species that are nitrogen fixers.
Loss of soil micro-organisms	Rebuild soil from onsite sources.  Import topsoil.  Inoculate soil when transplanting nursery stock or after seedlings have emerged.	Inoculate greenhouse soil.
Increased soil compaction	Scarify to compacted depth.  Increase soil organic matter.  Inoculate with mycorrhizae.  Reintroduce large soil organisms.  Avoid recompaction by: <ul style="list-style-type: none"> <li>• Minimizing repeated walking or equipment use</li> <li>• Adding mulch</li> </ul> Allow for cycles of wetting and drying.	Favor species found growing on similar disturbances.  Increase plant cover.  Favor species with a variety of root forms (fibrous roots, taproots, spreading roots).  Favor plants with lots of root biomass.  Avoid plants with dense root mats.

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Physical crust formation (Prevents water infiltration and seedling establishment)	Increase organic matter and break up crust. Add topsoil from the site. Import topsoil. Inoculate with mycorrhizae. Encourage biological crust formation where appropriate. Add mulch.	
Change in soil pH (Soil toxicity)	Add topsoil from the site. Import topsoil. Inoculate with mycorrhizae. Correct with soil amendments. Improve drainage.	Favor species found growing on sites with similar disturbances.
Excess sodium	Apply gypsum and flush with water. Improve drainage.	
Altered slope or drainage	Recontour. Install drainage structures.	Favor species adapted to altered conditions.
Continuing erosion	Avoid use when wet. Prevent further damage to biological soil crusts. Add organic matter. Increase surface residue and roughness. Stabilize with: <ul style="list-style-type: none"> <li>• Checkdams or siltdams</li> <li>• Soil binders</li> <li>• Erosion control blankets</li> <li>• Bioengineering structures</li> </ul> Inoculate with mycorrhizae.	Favor species that will provide cover rapidly. Favor species with a variety of root forms (fibrous roots, taproots, spreading roots). Favor species that lend themselves to propagation with bioengineering techniques.

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Suppression of natural disturbance	Reestablish or emulate natural processes.	Favor species that do not depend on disturbance for survival.
Weed competition	Minimize fertilization, especially with nitrogen.  Minimize irrigation.  Solarize the soil.  Control weeds.  Inoculate with mycorrhizae.  Add mulch.	Select species that will shade weeds.  Select a variety of species to fill in all niches (for instance, shrubs, graminoids, and forbs).
Continued damaging use	Reduce or remove use with: <ul style="list-style-type: none"> <li>• Physical barriers</li> <li>• Information and education</li> <li>• Regulation and enforcement</li> </ul>	Transplant larger plants of species that will deter use, such as larger shrubs, plants with spines or thorns, or poisonous plants.  Favor species that are resistant to damage.

## References

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