

## Part 7: Key Invasive Nonnative Plants

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### Introduction

Invasive, nonnative plant species pose one of the greatest potential threats to long-term ecosystem integrity in the area burned by the 2002 Hayman Fire. In other ecosystems, nonnative invaders have been shown to cause decline of native plant species and pollinators, as well as adverse changes in fire regimes, nutrient cycling, and hydrology. Thus, invasive, nonnative species may be responsible for some of the most serious ecological impacts and the greatest long-term costs (for example, for mitigation) associated with the Hayman Fire. Early detection and subsequent monitoring will be essential for the most cost-effective control and the subsequent reduction of negative effects.

Hobbs and Huenneke (1992), in a review paper, found that disturbances outside of the historic range of variability (that is, more or less disturbance than a system evolved with) led to increased invasibility with examples from grasslands, shrublands, and woodlands (see part 1 in this chapter for a discussion of historic disturbance regimes in the Hayman area). D'Antonio and Vitousek (1992) linked invasive grasses to altered fire cycles, which led to ecosystem deterioration in places where the grasses supported much more frequent fires than had formerly occurred during the evolutionary history of the native biota (for example, *Bromus tectorum*, cheatgrass, in the Great Basin). Many researchers have found that areas rich in native species are highly vulnerable to invasion by nonnative species (for example, Levine and D'Antonio 1999; Stohlgren and others 1999). Perhaps of most concern for the Hayman burn area, studies repeatedly find that riparian systems (for example, Planty-Tabacchi and others 1996; Stohlgren and others 1998; Levine 2000) and roads and trails (for example, Tyser and Worley 1992; Greenburg and others 1997) are particularly vulnerable to invasion. Current research is focusing on predicting where nonnative species are likely to establish based on patterns of native species richness and spatial variables (for example, slope, aspect, elevation, soil type, position relative to drainage or road, and so forth) so that resource managers can prioritize and direct control efforts (for example, Chong and others 2001; Schnase and others 2002). These applied, predictive models require extensive species and plot data as well as remotely sensed data.

## Nonnative Plants of the Hayman Area

Recognizing the importance of managing the nonnative plant species that appear after fires, the Pike National Forest has developed a prioritized list of nonnative plant species within the Hayman Fire area (table 13; D. Bohon personal communication). The highest priority species include: (1) those that are a priority for elimination (*Hieracium aurantiacum*, orange hawkweed, and *Centaurea maculosa*, spotted knapweed); (2) those that are already dominating some areas (*Linaria vulgaris*, yellow toadflax; *Cirsium arvense*, Canada thistle; and *Euphorbia esula*, leafy spurge) to the localized exclusion of native plant species; and (3) one that is currently found along roads and trails (*Centaurea diffusa*, diffuse knapweed). Following the fire, the Priority 1 species (species that are known to occur or are likely to occur) were surveyed (Petterson, unpublished data) but, because of the lateness of the growing season and the overall dry conditions, additional field work will likely be required for the data to be considered complete for the areas surveyed.

Cheatgrass (*Bromus tectorum*) is considered a Priority 2 species because it is a noxious weed on the Colorado State list, but it was not abundant before the burn (table 14). Data on cheatgrass were collected by the contractor, but future monitoring of cheatgrass is important because of its widespread introduction through straw mulch and the subsequent possibility of cheatgrass gaining dominance after the fire. Data resulting from the contract will provide useful input for future monitoring and modeling efforts (for example, to estimate where nonnative species are likely to occur in the future and so direct monitoring and control). Initial maps from the fall 2002 data show nonnative species concentrated along roads and drainages (fig. 28, 29).

In plots established within the Hayman burn perimeter before the 2002 fire, we documented 17 nonnative plant species, six of which are considered noxious in Colorado (table 14; unpublished data from Fornwalt and others 2002). In addition, Dalmation toadflax (*Linaria genistifolia* ssp. *dalmatica*) is known to occur on some State trust lands 7 km east of Cheesman Reservoir within the Hayman burn area (L. Routten, personal communication). Species seeded intentionally (or unintentionally, in the form of contaminated seed lots or hay bales) for rehabilitation include nonnatives and potentially, invasives (table 15).

### Short-Term Expectations

Areas most vulnerable to nonnative plant invasion are generally those areas that are most favorable for native plant species recovery (Stohlgren and others

**Table 13**—Nonnative plant species prioritized by the Pike National Forest (D. Bohon, personal communication). Priority 1 species are known or likely to occur within the Hayman burn area. Priority 2 species were not common before the 2002 fire, but they are likely to become more common.

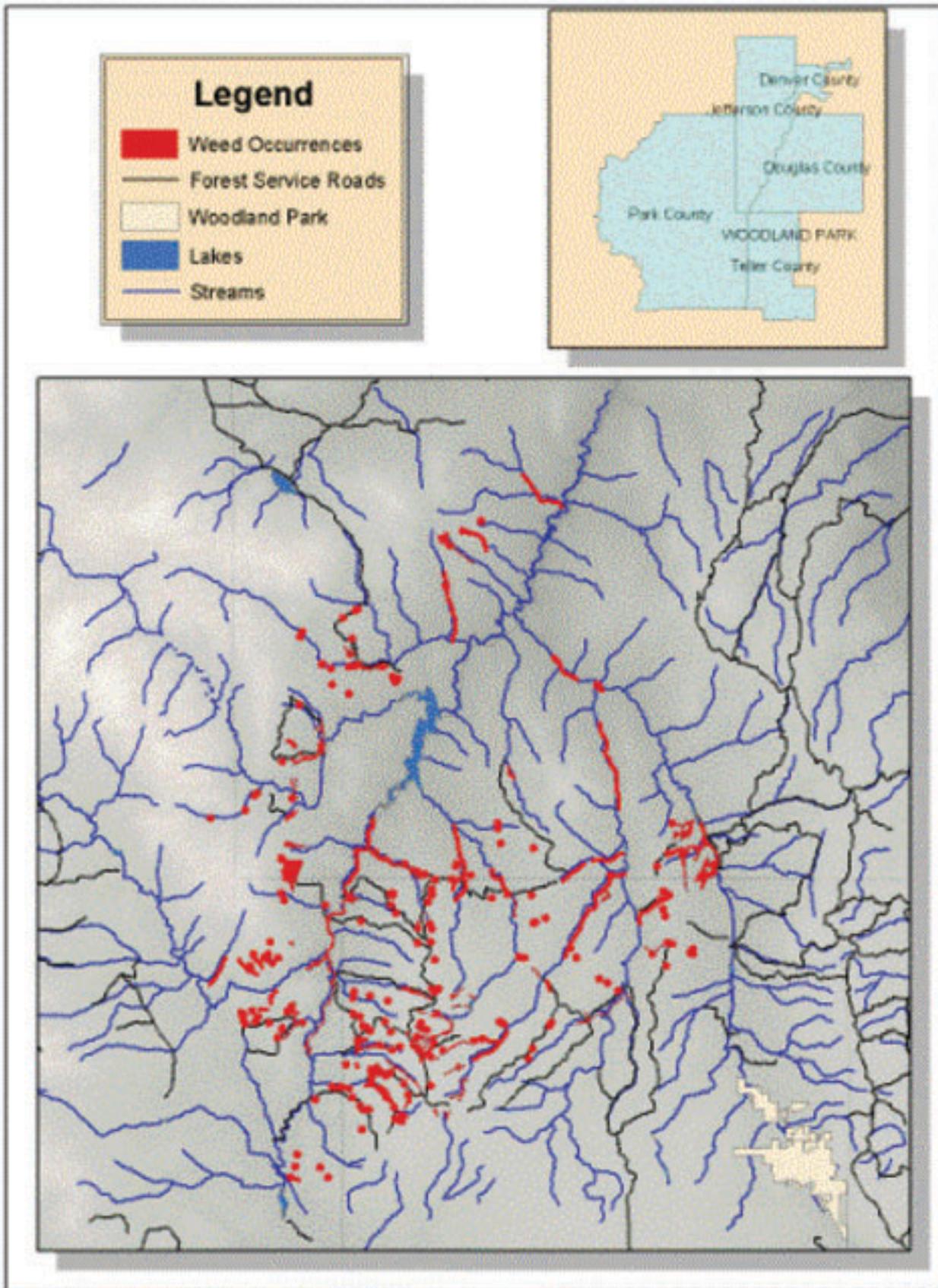
Rank	Scientific and common names
<b>Priority 1 species</b>	
Known to occur:	<i>Hieracium aurantiacum</i> , orange hawkweed <i>Centaurea maculosa</i> , spotted knapweed* <i>Linaria vulgaris</i> , yellow toadflax* <i>Euphorbia esula</i> , leafy spurge* <i>Centaurea diffusa</i> , diffuse knapweed* <i>Cirsium arvense</i> , Canada thistle*
Likely to occur:	<i>Cardaria draba</i> , hoary cress* <i>Centaurea repens</i> , Russian knapweed* <i>Chrysanthemum leucanthemum</i> , oxeye daisy* <i>Cirsium vulgare</i> , bull thistle* <i>Clematis orientalis</i> , Chinese clematis <i>Cynoglossum officinale</i> , houndstoungue* <i>Hesperis matronalis</i> , Dame's rocket* <i>Hyoscyamus niger</i> , black henbane <i>Lepidium latifolium</i> , perennial pepperweed* <i>Linaria dalmatica</i> , dalmation toadflax* <i>Lythrum salicaria</i> , purple loosestrife* <i>Onopordum acanthium</i> , scotch thistle* <i>Salsola collina/iberica</i> , Russian thistle*
Not expected, but possible:	All species included on the State's Noxious Weed List, Part 2.00C
<b>Priority 2 species</b>	<i>Bromus tectorum</i> , cheatgrass*

\*Species on the Colorado Noxious Weed List were "identified by individual counties as problem weeds in the county's area or have been recommended for management through public testimony." (<http://www.ag.state.co.us/DPI/rules/noxious.html>)

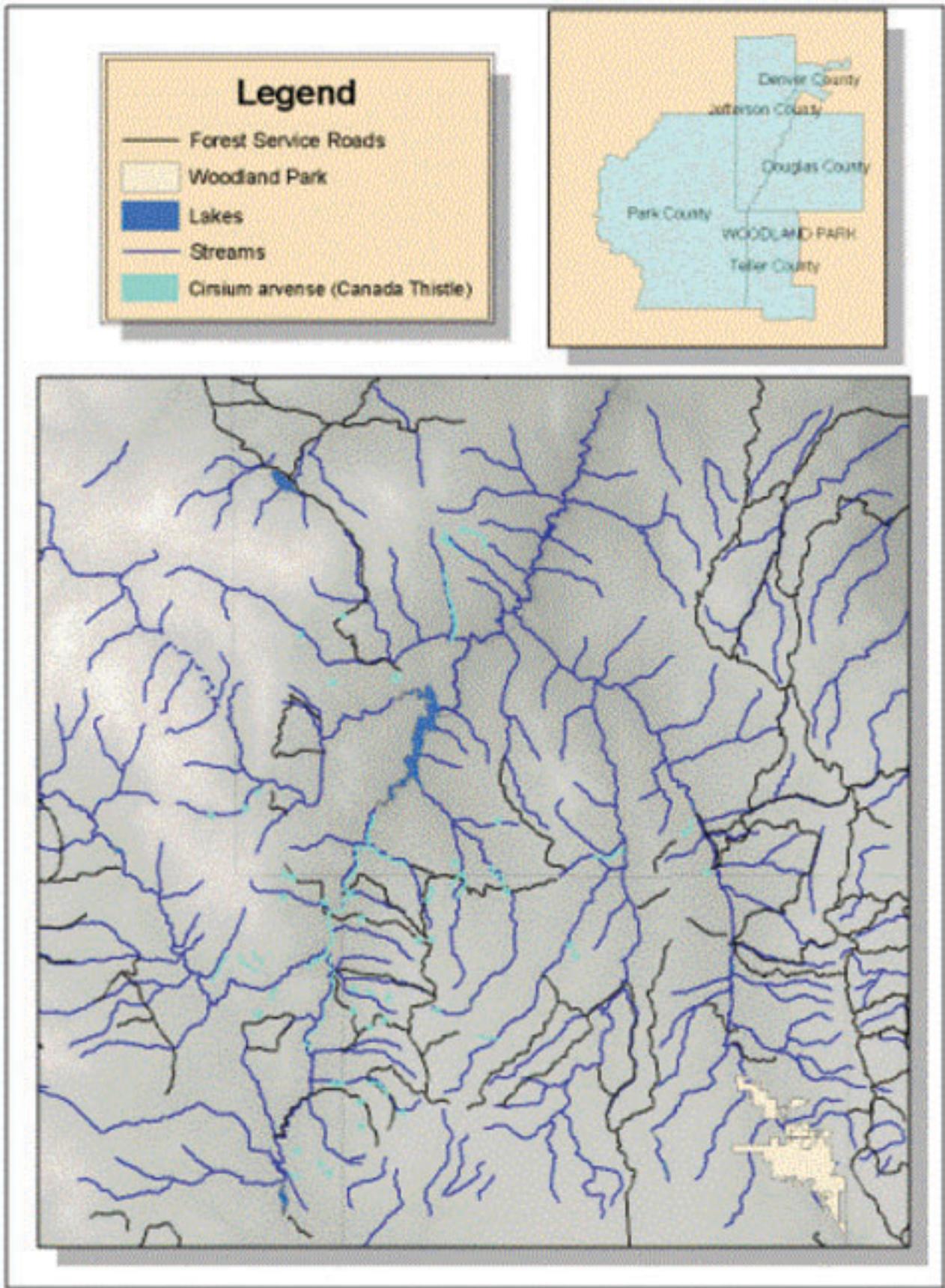
**Table 14**—Nonnative plant species encountered on plots (N = 96) within the Hayman Burn perimeter (sampled before the burn).

Scientific and common names	Frequency
<i>Bromus briziformis</i> , rattlesnake brome	7
<i>Bromus inermis</i> , smooth brome	25
<i>Bromus tectorum</i> , cheatgrass*	1
<i>Carduus nutans</i> , musk thistle*	3
<i>Cerastium fontanum</i> , common chickweed	1
<i>Chenopodium album</i> , lamsquarters	NA
<i>Cirsium arvense</i> , canadian thistle*	25
<i>Crepis capillaris</i> , smooth hawkbeard	2
<i>Festuca ovina</i> , sheep fescue	28
<i>Kochia scoparia</i> , common kochia*	9
<i>Lactuca serriola</i> , prickly lettuce	2
<i>Linaria vulgaris</i> , yellow toadflax*	42
<i>Poa annua</i> , annual bluegrass	4
<i>Poa pratensis</i> , Kentucky bluegrass	NA
<i>Thlaspi arvense</i> , pennycress	NA
<i>Tragopogon dubius</i> , yellow salsify	34
<i>Verbascum thapsus</i> , common mullein*	80

\*Species on the Colorado Noxious Weed List were "identified by individual counties as problem weeds in the county's area or have been recommended for management through public testimony." (<http://www.ag.state.co.us/DPI/rules/noxious.html>)



**Figure 28**—All nonnative plant species found within the Hayman Fire area.



**Figure 29**—All occurrences of Canada thistle (*Cirsium arvense*) found within the Hayman Fire area.

**Table 15**—Information on species seeded on the Hayman burn area. All information from Denny Bohon, personal communication October 9, 2002, Pike National Forest, South Platte Ranger District.

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Hand scarified and seeded area: 13,800 acres. Aerial seeding used the same mix.

Approximately 2,026,000 lb of seed were applied.

Seed was purchased from three vendors:

The majority of the seed came from Sharp Brothers Seed Company: (<http://www.sharpbro.com/>)

A small amount of seed came from Arkansas Valley Seed Solutions: ([http://www.seedsolutions.com/Wildfire\\_Reseeding\\_Options.cfm](http://www.seedsolutions.com/Wildfire_Reseeding_Options.cfm))

And a small amount of seed came from Star Seed:

(<http://www.starseed1.com/>)

Mix:

70% barley (*Hordeum vulgare*)

30% triticale: (*Triticosecale rimpaii* Wittm.) [cross: *Triticum aestivum* \_ *Secale cereale*](some white oats in early mixes: *Avena* sp.)

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Two species need mention as possible future concerns. Straw bales were found contaminated with cheatgrass (*Bromus tectorum*), one of the species on the State noxious weed list. Although cheatgrass is not currently a Priority 1, nonnative species in the Hayman Burn area, it should continue to be included in future monitoring efforts because of its invasive and ecosystem-altering potential. Based on seed purity tests conducted by the Forest Service, approximately 6 lb of wild oats (*Avena fatua*) could have been seeded. Future monitoring of wild oats is important because this invasive annual does well along roads and on disturbed areas and, once established, can be difficult to eliminate because the seeds can remain dormant in the soil for up to 10 years (Whitson and others 1996).

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1998, 1999, 2002) – areas with relatively high light, moisture, and soil nutrient availability. Over the short term (next approximately 5 years), riparian areas are likely to be the most vulnerable to invasion. Many of the invasive, nonnative plant species (for example, Canada thistle, fig. 29) were already concentrated in riparian areas and along roads, which are often located along streams (fig. 28, 29). Postfire flooding will provide disturbance as well as deliver seed to riparian areas, and additional disturbance may result from hazard tree removal and road and trail rehabilitation. Proximity to roads and trails may also provide avenues for introduction of other nonnative species.

The areas next most vulnerable to invasion are the staging areas for the rehabilitation effort. There were five staging areas for the straw bales, and these should be monitored over time to provide early warning of what nonnative species were present in the mulch. Roads, trails, areas that received ground-disturbing treatments (for example, ATV traffic, hazard tree removal, straw bale placement), and areas that received other potentially contaminating treatments (for example, seeding, straw mulching) complete the list of priority areas at risk for nonnative species establishment or invasion. Interacting factors in all cases include proximity to roads, staging grounds, and riparian/drainage areas, burn severity, and prefire disturbance (for example, logging, fuel treatments, grazing, and so forth).

Areas that experienced prefire disturbances, such as those mentioned above, may be at increased risk for nonnative invasion following wildfire because those areas may already have nonnative species present in their seed banks as was found in ponderosa pine forests in northern Arizona (J.E. Korb, personal communication). Areas that experienced higher burn severities may also be at increased risk for nonnative species establishment if, for example, the native seed bank is effectively destroyed and the majority of seeds available postfire are nonnative (for example, seeded intentionally or unintentionally). Higher burn severities also deplete mychorrhizae fungal propagules that may be required for native species establishment (Korb and others 2003). All of these scenarios may be expressed in the short term, but their effects are expected to continue into the long term as nonnatives continue to occupy sites and contribute to seed banks.

## Long-Term Expectations

Over a longer term (approximately 50 to 100 years), without control measures, nonnative plant species would be expected to persist or dominate in relatively more mesic areas, open-canopy areas, and along disturbance corridors such as roads (fig. 28). In many cases, the areas where nonnative species persist are also the areas that contain the most native species such as along streams (Stohlgren and others 1998,

2001). Smaller patches of nonnative plants may be expected to persist but not dominate less favorable sites (drier, farther from roads, trails, and riparian areas) and thus provide additional, dispersed seed sources that could be expected to aid in the establishment of new patches of invasive species following future fires, treefall events, or other disturbances. Areas that experienced high burn severity and areas that had prefire disturbances that introduced nonnative species could also continue to maintain populations of nonnative species. Many of the areas at especially high risk may be predicted using spatial models that incorporate GIS maps (for example, roads, trails, drainages, burn severity, and prefire activities) and point/plot field data.

## Conclusion

Decisions can be informed by knowing what kind of weed expansion to anticipate following the passage of time, future fires, droughts, wet periods, or other disturbances, given current locations and types of nonnative and native species. Moreover, effective inventory and monitoring combined with spatial data analysis can provide specific predictions with stated levels of accuracy as to the amount and location of nonnative as well as native species (Chong and others 2001; Schnase and others 2002). Data collected during the summer of 2003 for a Federal interagency Joint Fire Science Program project examining the interactions between fuels, wildfire, and nonnative plants will contribute directly to future spatial modeling capabilities (Omi and others 2000).

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