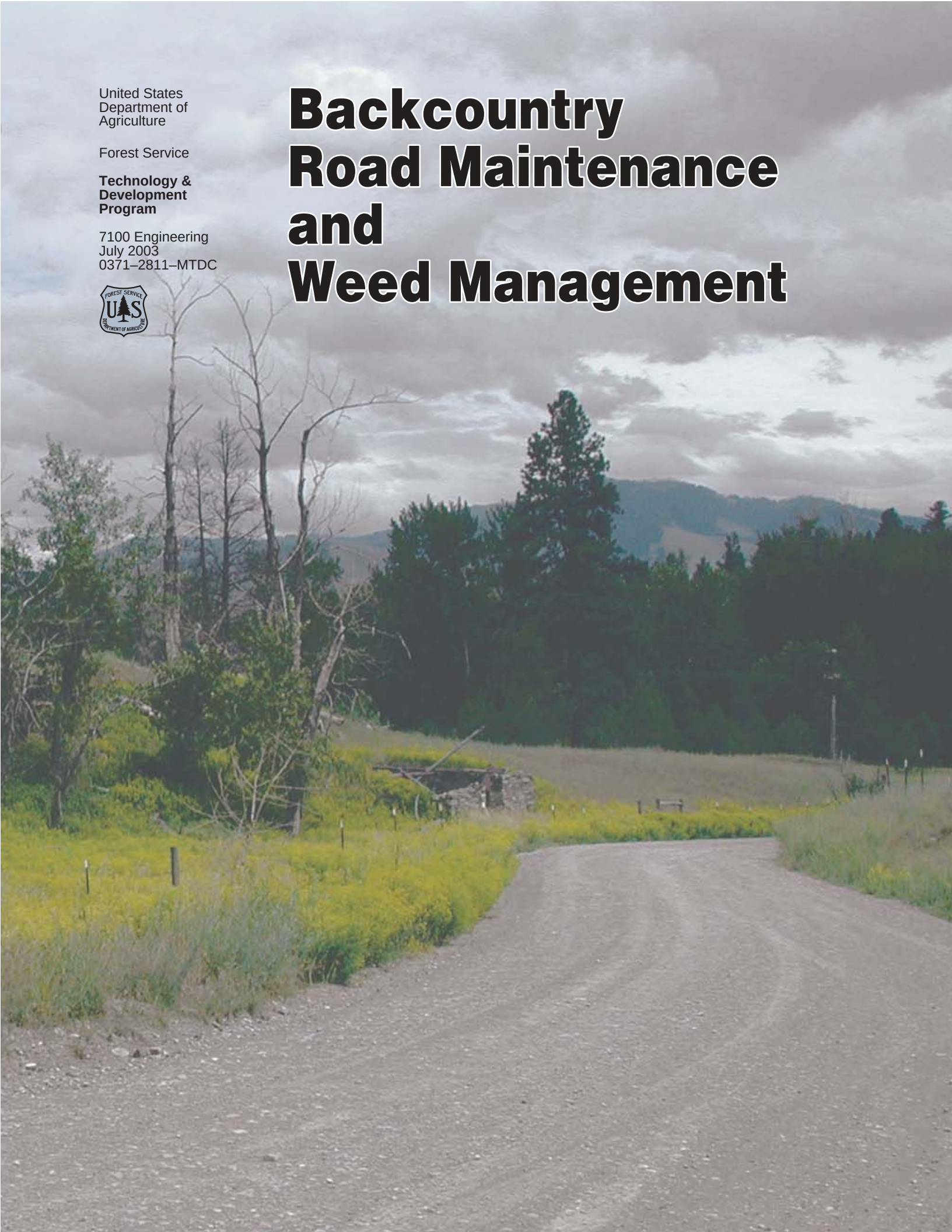
United States
Department of
Agriculture

Forest Service

**Technology &
Development
Program**

7100 Engineering
July 2003
0371–2811–MTDC

Backcountry Road Maintenance and Weed Management



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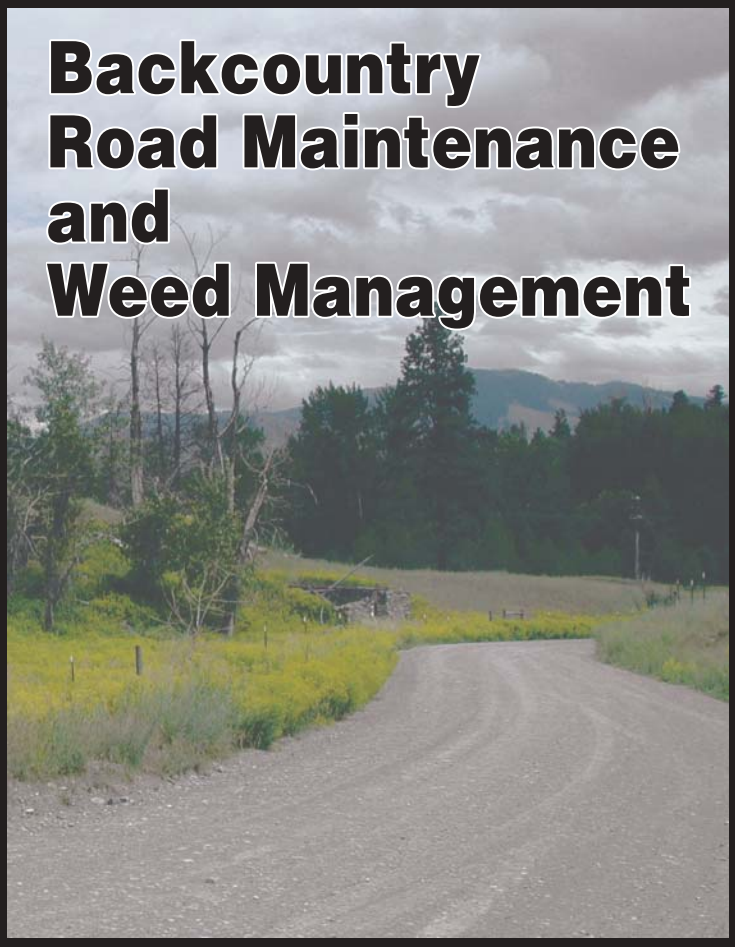

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**USDA Forest Service
Technology and Development Program
Missoula, MT**

2E22H65—Weed Theory

July 2003

Cover photo: Leafy spurge infestation along a road in western Montana.*—Photo by Sara Lustgraaf, USDA Forest Service.*

Contents

Acknowledgments

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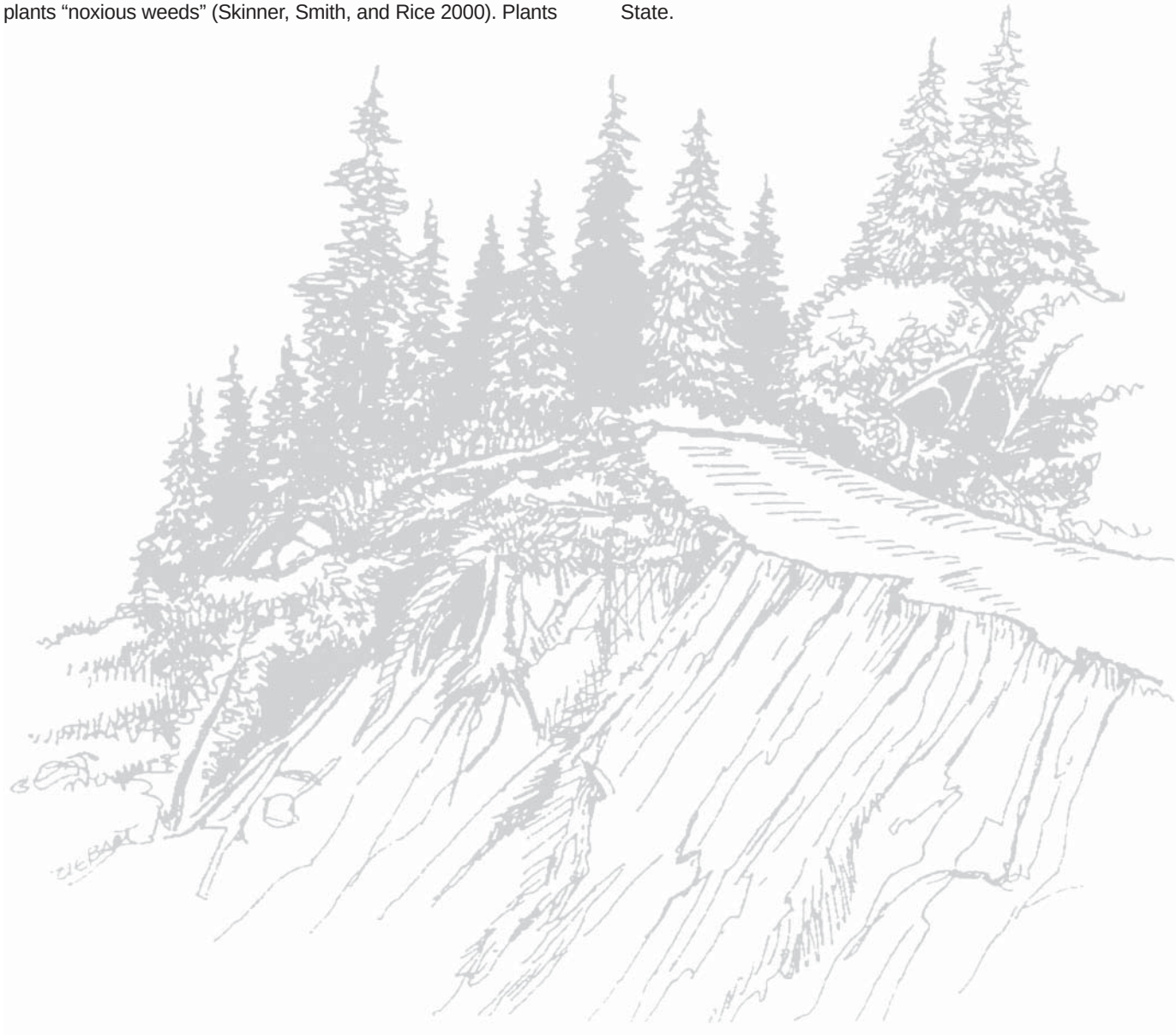
Introduction

Roads and noxious weeds seem to go hand in hand on most public lands in the United States. It is not easy to improve or maintain backcountry roads without spreading noxious weeds. This document includes recommendations for reducing or eliminating the spread of weeds during road maintenance. Recommendations are based on weed biology, road maintenance practices, and observations rather than actual research. Very little research has been conducted on this topic.

State governments have legally declared more than 500 invasive plants "noxious weeds" (Skinner, Smith, and Rice 2000). Plants are defined as noxious weeds if they are carriers or hosts of damaging insects or diseases or if they are overly aggressive, difficult to manage, parasitic, or poisonous. Most noxious weeds are not native to the United States. Many do not create problems in their native environments. For information on species that have been declared noxious in a particular State or area, contact the State's Department of Agriculture noxious weed coordinator, or a county extension agent or noxious weed superintendent. All State noxious weed lists can be accessed through the INVADERS database (*http://invader.dbs.umt.edu/*). Click on *State/Provincial Noxious Weed Lists* and specify the State.



Plant Biology and the Spread of Weeds

Disturbed Ground

Most noxious weeds are early successional species that prefer highly disturbed sites such as areas along rivers and streams, trails, trailheads, roadsides, building sites, wildlife bedding grounds, overgrazed areas, and campgrounds (Baker 1986, Sheley and Petroff 1999). Parendes and Jones (2000) found that the presence of exotic plant species was highly correlated with sunlit soil and frequent, severe disturbances, such as those resulting from road traffic and from road maintenance activities such as grading. In Glacier National Park, exotic plant species showed a continuous distribution along road and trail corridors in the majority of study transects (Tyser and Worley 1992). Chicoine (1984) found that spotted knapweed was readily disseminated along transportation corridors. Managing knapweed required preventing roadside infestations from spreading.

Nutrients

Road construction and maintenance activities mix soil layers, increasing soil microbial activity. Weeds exploit these newly available nutrients efficiently (Best and others 1980, Belcher and Wilson 1989). This may be one reason that the density of weedy plants increases as intensity of disturbance increases (Jensen 1995).

Transport of Seed From Infested to Uninfested Areas

A study in Kakadu National Park in Australia found that weed seed was transported into the park on tourist vehicles and was more likely to be transported by four-wheel-drive vehicles that had been driven off road (Lonsdale and Lane 1994). A study in California found that native plant cover and the number of species were greatest in sites farther than 0.6 mile from roads and least in sites 30 feet or less from roads. Conversely, noxious and invasive plant cover was greatest closer to roads (Gelbard and Harrison 2003). Vehicle undercarriages can trap and transport weed seed (Sheley and Petroff 1999). It is reasonable to assume that maintenance equipment used for work that disturbs the ground will transport weed seed more readily than recreational vehicles.

Soil "Banking" of Seed

Plant biology is an important factor in identifying the road maintenance activities that help weeds become established and spread. Seed of most perennial noxious weeds such as leafy spurge (figure 1), oxeye daisy, rush skeletonweed (figure 2), and spotted knapweed (figure 3) can remain viable longer than 5 years (Liao and others 2000, Davis and others 1993, Wicks and Dersheid 1964, Toole and Brown 1946). For example, 82 percent of buried oxeye daisy seed was viable after 6 years, and 1 percent of the seeds were still viable after 39

Figure 1—Leafy spurge aggressively displaces native vegetation not only by usurping available water and nutrients, but by releasing toxins that prevent other plants from growing.—*Photo by William M. Ciesla. Image 3943076 courtesy of Forestry Images (http://www.forestryimages.org).*

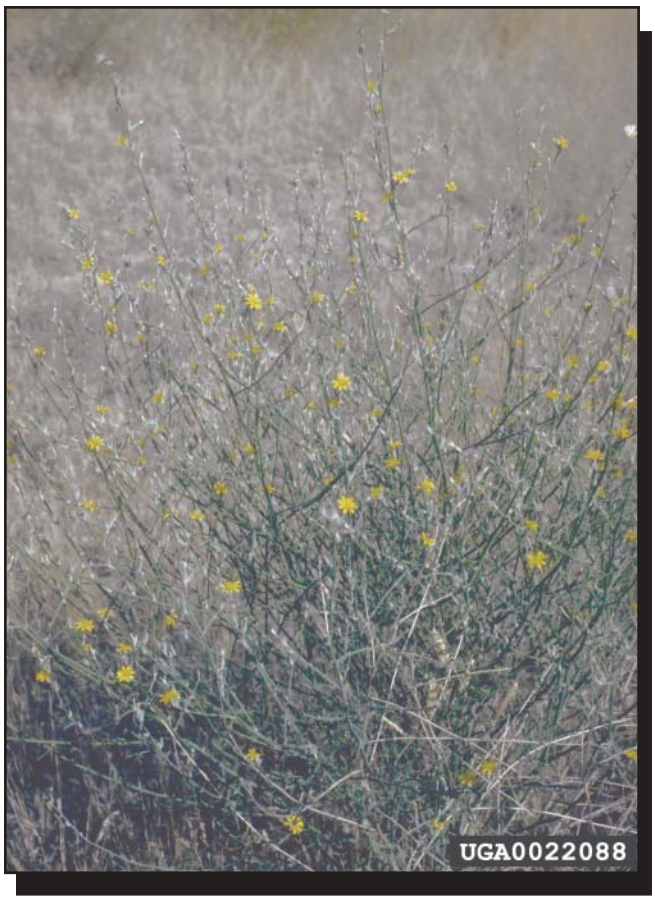


Figure 2—Rush skeletonweed plants have invaded this dry grassland, replacing beneficial forage species grazed by livestock and wildlife. *—Photo by Gary L. Piper, Washington State University. Image 0022088 courtesy of Forestry Images (http://www.forestryimages.org).*

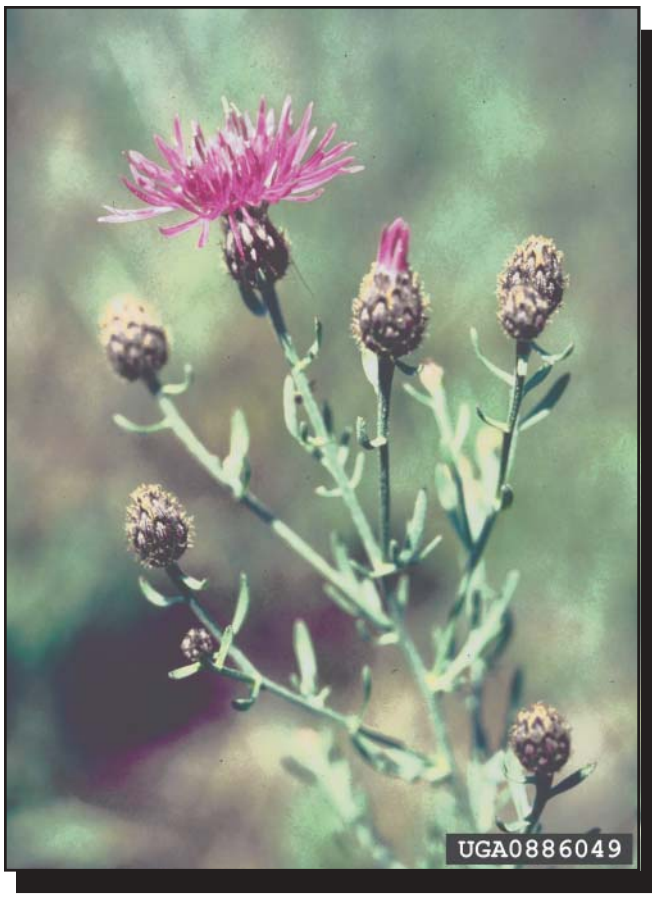


Figure 3—Spotted knapweed has a purple flower that superficially resembles the garden flower, bachelor's button, and several native aster wildflowers.*—Photo by Jim Story, Montana State University. Image 0886049 courtesy of Forestry Images (http://www.forestryimages.org).*

years (Toole and Brown 1946). Studies of Scotch broom (figure 4) have shown that 0.6 percent of seed in dry storage were still viable after 81 years, and that Scotch broom seed may remain viable in soil for as long as 100 years (Turner 1934). Viability of yellow star thistle seed declines rapidly, but 20 to 40 percent are viable after 1 year and 10 percent can remain viable for longer than 10 years (Callihan, and others 1989).

Hard seed coats and burial in soil may extend seed viability in some species. For example, spotted knapweed seed has a hard outer coating that protects it from being degraded in soil, while burial under as little as a ½ inch of soil "banks" the seed and prevents it from sprouting. Davis and others (1993) found that 29 percent of spotted knapweed seed was still dormant 8 years after burial, and 90 percent of the dormant seed was still viable. Because spotted knapweed produces an average of 1,000 seeds per plant per season (Schirman 1984, Story and Anderson 1978, Watson and Renney 1974), the amount of seed stored in soil can be extremely high. After seed production was halted for more than 7 years, spotted knapweed seed in formerly weed-infested soil ranged between 129,500 and 170,000 seeds per acre (Davis and others 1993). A similar study of creeping buttercup (figure 5) indicated that 51 percent of buried seed was still viable after 20 years in undisturbed soil (Lewis 1973). Long-term survival of the seed was attributed to their hard outer coat.

Figure 4—The ancestors of the scotch broom plants that infect this hillside in Oregon were brought to the United States as an ornamental garden plant.—*Photo by Eric Coombs, Oregon Department of Agriculture. Image 0023001 courtesy of Forestry Images (http://www.forestryimages.org).*

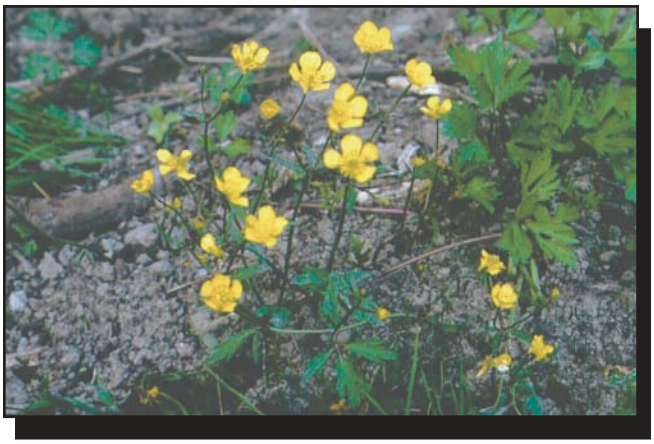


Figure 5—This attractive little creeping buttercup has established itself in gravelly soil similar to a roadway shoulder.—*Photo by Ilkka Korpela, University of Helsinki, Finland.*

The incredibly large quantities of seed produced by weed species can produce extremely high plant densities. Scotch broom was found to produce over 16,000 seeds per square meter in a study in Australia (Smith and Harlen 1991). Yellow star thistle (figure 6) has been recorded at densities of 2 to 3 million plants per acre (Callihan and others 1989) with possible seed production of 24,000 achenes (one-seeded fruits) per square yard (Maddox, Mayfield, and Porits 1985).

Figure 6—The spines on the seed heads of this yellow star thistle show how it received its common name.*—Photo from USDA Animal and Plant Health Inspection Service, Oxford, NC, archives. Image 1148062 courtesy of Forestry Images (http://www.forestryimages.org).*

Vegetative Fragments

Vegetative propagules such as plant root fragments, stolons (runners), and stem fragments can spread weed infestations. Species such as rush skeletonweed, leafy spurge, purple loosestrife (figure 7), kudzu (figure 8), and all varieties of hawkweed can be transported vegetatively. Plant parts moved about during road maintenance can spread weed infestations nearly as effectively as seed.

Shading the Soil

Establishing and maintaining competitive, desirable plants along roadsides and other areas vulnerable to weed colonization helps prevent or slow establishment, growth, and reproduction of noxious weeds (Sheley and Petroff 1999). A study in western Montana determined site factors influencing weed establishment and spread on roadsides. Results showed that shading of the roadway by tree and shrub overstory was a primary factor limiting spotted knapweed establishment on roadsides in forest habitats (Losensky 1989).

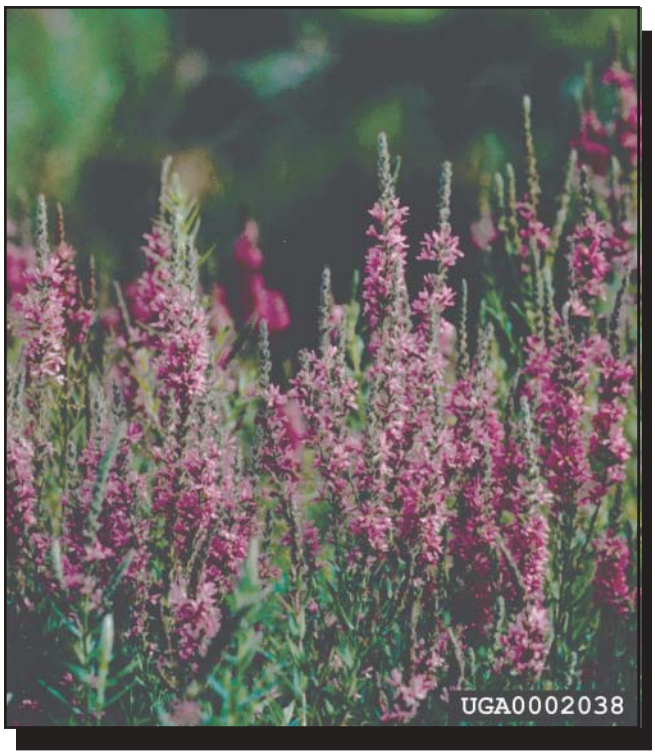


Figure 7—Purple loosestrife has an attractive flower, but it can take over an area, creating a loosestrife monoculture and completely replacing native species.*—Photo by Bernd Blossey, Cornell University. Image 0002038 courtesy of Forestry Images (http://www.forestryimages.org).*

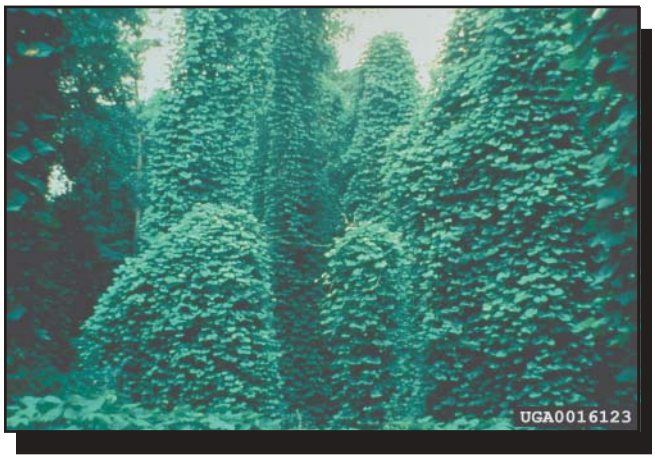


Figure 8—This established kudzu infestation mimics the foliage on the trees it killed and whose trunks it now uses for support.*—Photo by James H. Miller, USDA Forest Service. Image 0016123 courtesy of Forestry Images.org (http://www.forestryimages.org).*

How Road Maintenance Increases Weed Infestations

Road maintenance involves a variety of activities such as road grading; roadside brushing and mowing; installation, maintenance, replacement, and removal of drainage structures; ditch cleaning; maintenance and replacement of structures such as cattle guards, gates, and signs; and crushing, storage, and placement of aggregate. Each of these activities is defined in appendix A.

Roads on public lands are high-risk sites for the introduction and spread of noxious and invasive plants. Transporting seeds and plant parts by vehicles (Lonsdale and Lane 1994), and removing vegetation and mixing soil during road construction and maintenance, provide ideal conditions for the introduction, germination, and establishment of weed seeds. Road corridors are also prolific sources of weed seeds that may be carried to other locations (Tyser and Worley 1992) or that may colonize adjacent vulnerable habitats.

Road grading typically moves road surface material up and down the road system. This process disturbs soil and vegetation on the roadway and shoulders, transporting soil and gravel that may carry weed seeds or vegetative propagules. No published studies of the transport of seeds during grading have been completed, so it is not known how far weed seeds may be transported after they have been picked up by the grader's blade. The freshly graded road provides a disturbed soil seedbed suitable for weed germination when the seeds' moisture and temperature requirements are met. Grading a series of roads without washing the blade may transport weeds from one road to the next.

Cleaning roadside ditches also moves soil from place to place, creating an ideal seedbed by disturbing soil and removing competitive, desirable vegetation.

Equipment used to maintain road drainage structures can spread weeds by transporting soil and weed seeds from one culvert to another. Seeds from equipment can be deposited in stream crossings and washed downstream, creating infestations along the riparian corridor. Treatment of weeds in riparian zones is difficult and may require use of expensive techniques, such as hand removal.

When brush is cut along the roadsides, weed seeds are transported on the mower head. No studies of the relationship between road brushing and weed seed dispersal have been published. It is clear that weeds from other locations can be introduced to a work site on unwashed equipment. Excavators, road graders, ditch diggers, and other road maintenance equipment are often used in highly disturbed settings infested with noxious or invasive plants, providing ample opportunity for seeds to adhere to the machinery.

Since seeds and vegetative fragments are present in the soil at infested locations at all times of the year, road maintenance and other soil-disturbing activities can transport weeds at any time of the year—not just when plants are setting seed.

Stockpiles of crushed aggregate often become infested with noxious weeds, such as spotted knapweed. Weed seeds may be brought in on unwashed rock-crushing equipment and mixed into the aggregate during operations. Weeds from adjacent infested areas may also infest the aggregate stockpile. Seeds produced by infestations on the stockpile are transported with the aggregate when it is hauled and placed on roads.

Weed Management

Strategies for managing noxious weeds depend on the characteristics of the weed species present, the size and configuration of the infestation, the habitat in which the infestation is found, and local attitudes about weed management methods.

In general, managing weeds can be compared to fighting fires (Dewey 1996). In both cases, the work includes prevention, early detection and control, management, and restoration. Prevention is the most effective and least expensive weed management strategy. Once a species has been introduced to a site, early detection and control or eradication is the next best plan of action. When a species has become well established in an area, the strategy must be to contain and control the infestation. This is accomplished using integrated weed management techniques, including biological control agents, herbicides, manual and mechanical techniques, and restoration with desirable vegetation. Small infestations outside the perimeter of the main infestation should be detected early and eradicated, if possible, much as spot fires outside the main fire line are detected and put out.

Linear roadside weed infestations are similar to long, thin wildland fires and should be controlled before they cover large blocks of land.

Introduced as an ornamental from Asia, saltcedar invades riparian habitats throughout the American West. It releases salt into the soil, making the soil unsuitable for native species.—*Photo by Steve Dewey, Utah State University. Image 1624020 courtesy of Forestry Images (http://www.forestryimages.org).*

Minimizing the Spread of Weeds

Some of the following recommendations to reduce or eliminate the spread of weeds during road maintenance will be easy to adopt. Other recommendations may be difficult to implement and could conflict with the customary timing or type of road maintenance practices. Each forest supervisor and district ranger will have to weigh the importance of weed management against the resources and funding available to determine which measures are appropriate for a particular unit. To be successful, road maintenance practices must be part of a comprehensive weed management program implemented cooperatively with all landowners and managers in the area.

Best Management Practices

Forest Service Manual 2080 (*http://fsweb.wo.fs.fed.us/directives/fsm/2000/2080.rtf*) directs the development and coordination of the Forest Service noxious weed program. Each forest and district is directed to appoint a noxious weed coordinator and develop and implement a noxious weed management program. The Northern and Intermountain Regions (1 and 4) have implemented regionwide 2080 direction (*http://fsweb.r1.fs.fed.us/directives/fsm/2000/2080.doc* and *http://fsweb.r4.fs.fed.us/directives/fsm/2000/2080.doc*) in the form of best management practices (BMPs) for reducing or eliminating the spread of weeds through Agency activities. Northern Region road construction and maintenance BMPs are included in appendix A. Intermountain Region BMPs are similar to those of the Northern Region. All units with existing or potential roadside weed infestations should consider following the BMPs for roads and ground-disturbing activities covered by the Northern and Intermountain Region supplements to the Forest Service Manual.

Planning and Personnel

Evaluate the extent of existing weed infestations and develop strategies to reduce the size of each infestation, prevent the spread of weeds, and stop the introduction of other weed species. Preventing the introduction of weeds to uninfested sites is the most critical component of a weed management program, and it is one of the most cost-effective methods of management.

➥ Inventory roads for noxious weeds and maintain records of weed species and their locations so planning for road maintenance can include mitigation measures. Road maintenance crews and weed coordinators should collaborate to establish roadside maintenance schedules that will control seed produced by noxious weeds.

➥ Give a high priority to containment and treatment for new invader weeds or those that are not well established in the area.

➥ Train road maintenance personnel to identify noxious weeds and other invasive plants of concern. These should be marked and reported to the noxious weed coordinator.

➥ Use weed crew personnel to assist with road maintenance as scheduling and their skills allow. Weed crew personnel will bring their knowledge of weed species and dispersal mechanisms to the job, helping reduce the spread of weeds during road maintenance.

➥ Herbicide use should be specified in planning documents. Planning staff should become familiar with documents such as FS–2100–2, *Pesticide Use Proposal* (*http://fsweb.wo.fs.fed.is/im/forms/fs_forms/fs-2100-2.rtf*).

Minimizing the Transport of Seed and Vegetative Propagules Within a Road Corridor

Minimizing the transport of seed and plant parts by vehicles, machinery, wildlife, and livestock is the key to preventing the establishment of noxious weeds.

➥ Inspect all gravel pits and material sources annually and keep them weed free. Establish and maintain annually updated records of certified weed-free sources. Inspect gravel pits and material sources before each use to ensure that weeds haven't invaded since the last annual inspection. Record the inspection results. Don't use material from any source that is infested with weeds unless the material can be cleaned of seed and other vegetative matter before use.

➥ Consider using biological-control agents to manage weeds on roadsides adjacent to land infested with noxious weeds. Because biological-control agents do not eradicate their hosts or eliminate seed production, they are not appropriate for use on new invader species or in situations where eradication or complete control is achievable.

➥ Include weed control in the road maintenance appraisal for timber sales. Alternatively, add a special roadside weed management provision to the *C* section of the timber sale contract. Including weed control in timber sales assures funding to complete the work.

➥ Spray noxious weed infestations on or near roads or manage the invaders by other effective means. Controlling weeds near roads will reduce dispersal of weed seed by vehicles and maintenance or construction equipment. Reducing or eliminating the weed infestations will allow better growth of desirable grasses and other plants.

➥ Coordinate weed control and road maintenance so weeds are controlled for several consecutive years before major road maintenance or reconstruction. This will reduce the amount of viable weed seed stored in soil on road shoulders, cut slopes, and borrow sites in the project area.

Minimizing the Transport of Weeds From Infested to Uninfested Areas

Cleaning vehicles and equipment is the least expensive and most effective method of noxious weed control.

➥ Avoid working in weedy areas if possible. Postpone work until weeds have been eliminated from the site.

➥ Perform road maintenance such as road grading, brushing, and ditch cleaning from uninfested to infested areas to the extent possible. This will help prevent moving weed propagules from infested areas into adjacent uninfested areas.

➥ Wash all Agency and contractor off-road vehicles ***before*** entering public lands to minimize transporting weed seed. A standardized method and form for recording vehicle-washing inspections may be needed to promote consistency throughout the Agency. It may also be desirable to require that all stock and stock trailers be inspected and cleaned before entering public lands. This may not be practical unless the public must pass an entrance station or other restricted entry point to access public land.

➥ Wash off-road vehicles and heavy equipment to avoid transporting weed seed ***from*** public lands, and inspect and clean livestock after working in or traveling through weedy areas.

➥ Wash road graders and other equipment immediately after operating in infested areas. Clean all dirt and plant parts from the undersides of mower decks.

The Forest Service Technology and Development program has developed a high-pressure mobile power washer (figure 9) mounted on a trailer that can be towed by a pickup. The

Figure 9—The portable vehicle washer developed by the Missoula Technology and Development Center is being used to clean a fire engine on the Bitterroot National Forest.

washer can be used by two workers to wash vehicles from top to bottom in 5 minutes or less. The system uses oscillating bars with nozzles to wash vehicle undercarriages and hand-directed wands wash more accessible areas. The washer carries 350 gallons of water—enough to wash about 10 vehicles. All wash water is captured on a containment mat for reuse. The water goes through settling tanks and filters to remove mud, weed seeds, plant parts, and even spores. The captured material can be easily removed from the filters for proper disposal. See *MTDC Portable Vehicle Washer* (0234–2836–MTDC), available electronically at *http://www.fs.fed.us/eng/t-d.php?link=pubs/htmlpubs/htm02342836/*. A hard copy of the document can be ordered from:

USDA Forest Service, MTDC
Attn: Publications Distribution
5785 Hwy. 10 West
Missoula, MT 59808–9361

Plans for building the washer will be available through the Missoula Technology and Development Center at the address above. The Technology and Development program is modifying the washer so it will be able to wash large earth-working equipment.

Maintaining Desirable Species

Establishing and maintaining competitive, desirable plants along roadsides and other disturbed areas vulnerable to weed colonization helps prevent or slow the establishment, growth, and reproduction of noxious weeds.

➥ Raise the mower height to at least 4 inches to help retain existing desirable grasses and keep the soil surface shaded on roadsides that are mowed.

➥ Limit brushing and mowing to the minimum road distance and maximum height needed to meet safety objectives.

➥ Reseed after construction, heavy maintenance, and other soil disturbing activities. Where roads are graded once a year or less, seed the roadway's shoulders after grading. Seeding with desirable, rhizomatous grasses will allow faster recovery from disturbances. Consult appendix A for reseeding guidelines. Natural Resource Conservation Service offices can provide recommendations on species suited for your local climate and conditions. Only use seed that has been certified weed-free for your area.

➥ Fertilize desirable roadside vegetation as necessary to maintain plant health. Do not fertilize areas where weeds are present, unless you do so while applying a targeted, compatible herbicide. Where weeds are present, targeted herbicides may eliminate weeds and allow grass and other desirable species to produce lush growth, even without fertilization.

➥ To reduce the effects of grading on roadside grasses, grade roads early in the spring before grasses develop seed heads or late in the season after grasses have set seed and become dormant. Local climate will dictate which season will be more practical and effective for grading. In some climates, fall grading requires watering the roadway, which can be very expensive.

➥ On highly traveled roads, consider paving or using binders to stabilize the road surface. A stable surface will minimize the need for road grading, allowing desirable vegetation to become well established.

Minimizing Soil Disturbance

Because weed species prefer disturbed ground, don't disturb roadbed aggregates or soil along the road unless it is really necessary. In such cases, reestablish desirable species as soon as possible.

➥ Evaluate the need to grade each road or section of road rather than following a set schedule for road maintenance. This is especially important in weedy areas or areas that are susceptible to infestation. Do not grade unless you must do so for road drainage, safety, or function.

➥ Use only clean fill material from a weed-free source rather than borrowing fill from a weed-infested stockpile, road shoulder, or ditch line.

➥ Keep the grader's blade 1 to 2 inches above the road surface when the primary goal is to remove rocks that have fallen onto the road.

➥ Consider paving or treating the roadway surface with soil stabilizers such as Road Oyl, Stabilizer, Soil-Sement, or Pennz-supress D to reduce routine road maintenance. Sources for these products are listed on page 16. Some stabilizer material, such as lignite, tends to kill existing grasses and forbs. Weeds will quickly recolonize treated areas and outcompete desirable vegetation, so use caution when applying stabilizers in infested areas.

Recommended Research and Development

The literature review for this project identified a lack of research on the relationship between road maintenance and noxious weed dispersal. Research should be conducted to identify how specific maintenance tasks influence the establishment and spread of weeds on roadways. This information could be used to determine which types of maintenance should be modified and how much benefit could be achieved. The research should include species, distance, and quantity of weed seeds and other propagules that are spread or transported during each maintenance task.

Examining potential weed transport mechanisms during road maintenance would establish more precisely when and how weeds are likely to be spread and how that spread may be reduced or eliminated.

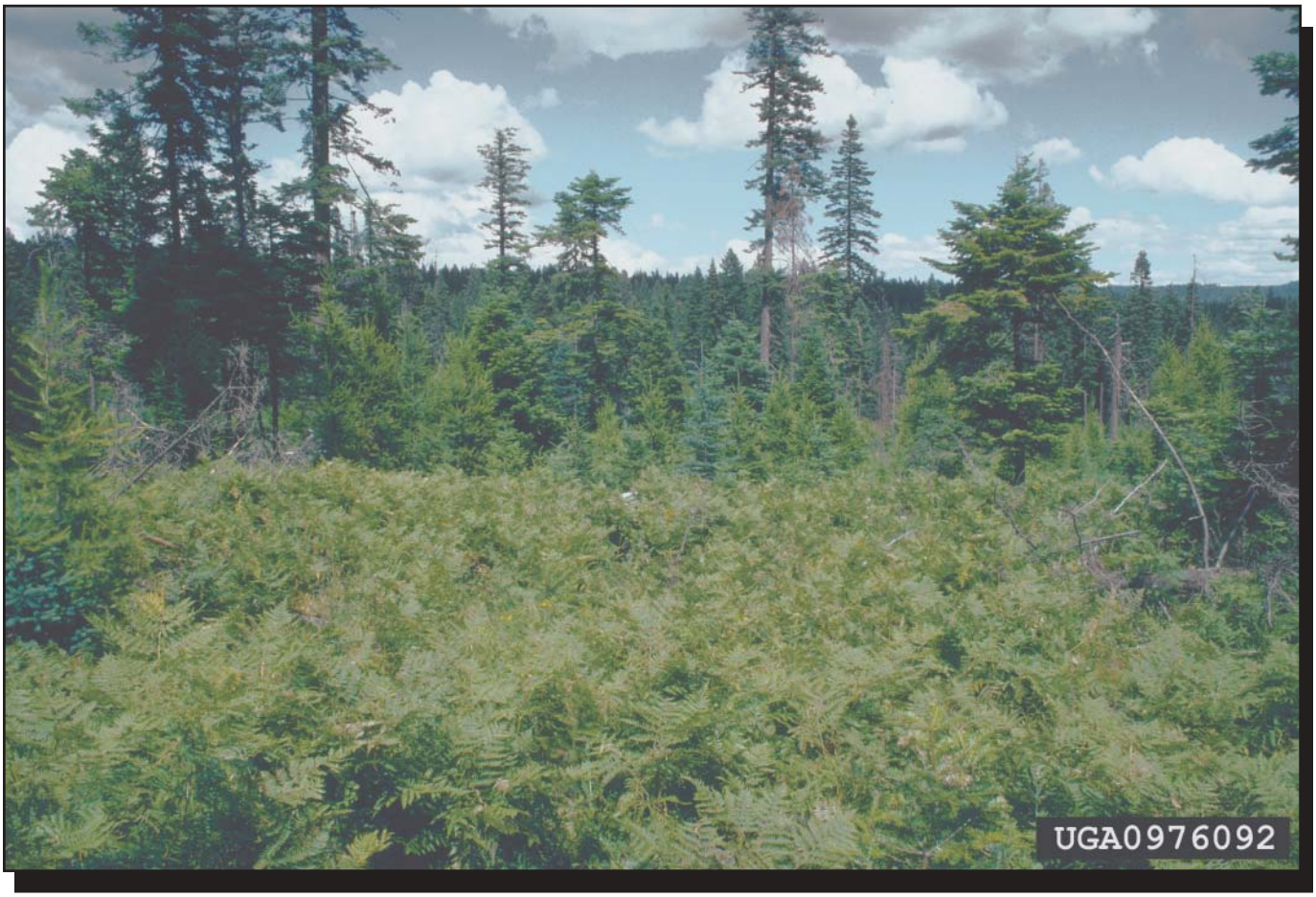
Consider developing grader-mounted technology for "last pass" seeding of desirable grasses along road shoulders. A grader-mounted seeding mechanism would reduce seeding costs and make reseeding more practical, given limited maintenance budgets.

Common gorse is an imported shrub with lovely yellow flowers and impressive thorns that displaces native shrubs and disrupts natural habitat. It is particularly aggressive in coastal scrubland environments.*—Photo by Norman E. Rees, USDA Animal Research Service. Image 0021012 courtesy of Forestry Images (http://www.forestryimages.org).*

Dodder is a parasitic vine that is fed from host plants. It looks like a bright yellow thread among plant stems and leaves.*—Photo by the USDA Animal and Plant Health Inspection Service, Oxford, NC, archives. Image 1149113 courtesy of Forestry Images (http://www.forestryimages.org).*

Conclusions

Road maintenance is essential for safe access to public lands. Noxious weed species frequently colonize roads and are likely to be spread during road maintenance. Road maintenance can be designed to minimize weed spread and reduce weed seed production. The work should not be undertaken without coordination between the maintenance crew and the noxious weed specialist.



Western brackenfern has invaded this old tree harvest unit on the Walla Walla Ranger District in Washington.—*Photo by Dave Powell, USDA Forest Service. Image 0976092 courtesy of Forestry Images (http://www.forestryimages.org).*

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Web-Based Resources

The following are a few of many Web sites that have information about weeds. Readers are encouraged to search other Internet sites or publications that may address their specific interests.

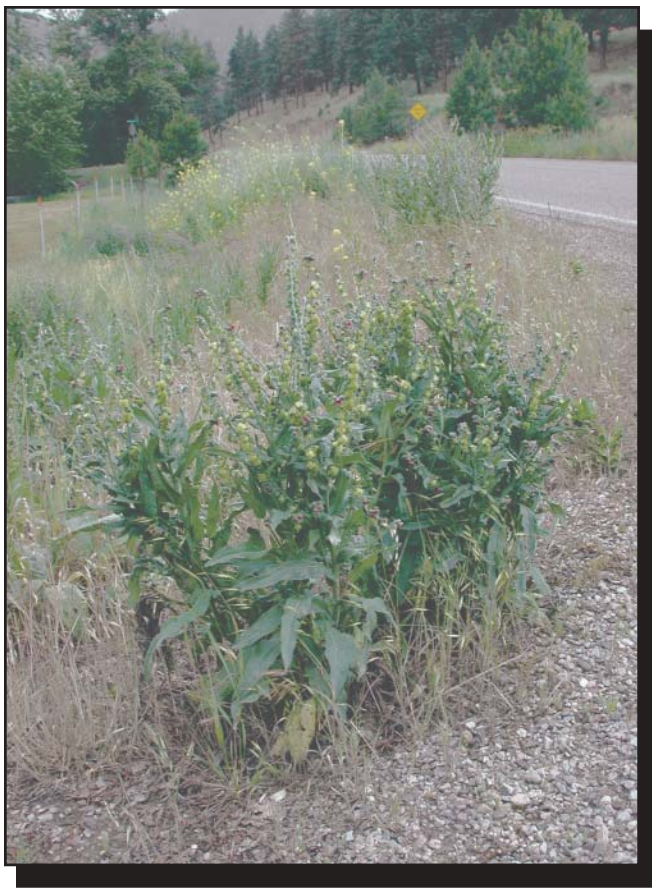
Invasivespecies.gov (*http://www.invasivespecies.gov/*) describes itself as a gateway to Federal and State invasive species activities and programs.

The **INVADERS** database (*http://invader.dbs.umt.edu/*) is a comprehensive database of exotic plant names and weed distribution records for five States in the Northwestern United States.

The **Center for Invasive Plant Management** (*http://www.weedcenter.org/index.html*) is a joint effort of a coalition of agencies, organizations, and individuals interested in managing invasive plants and maintaining healthy ecosystems in Western North America. Site contents include invasive plant information, invasive plant management, fire and drought early warnings, invasive plant education, grants, and restoration.

The **Montana Weed Control Association** noxious weed information site (*http://www.mtweed.org/*) provides information on weed identification, the dangers of noxious weeds, and recommendations for control.

The **National Roadside Vegetation Management Association** (*http://nrvma.org/index.html*) is a network of Federal, State, county, city, university and industry personnel dedicated to providing expertise, solutions and networking opportunities to personnel involved in integrated roadside vegetation management and in providing safe, beautiful roadsides.



Houndstongue—sometimes called gypsy flower—is a drought-resistant weed introduced from Europe in the early 1800s in contaminated crop seed. It prefers open, disturbed ground, such as that created by road construction and maintenance.*—Photo by Sara Lustgraaf, USDA Forest Service.*

Manufacturers of Soil Binders

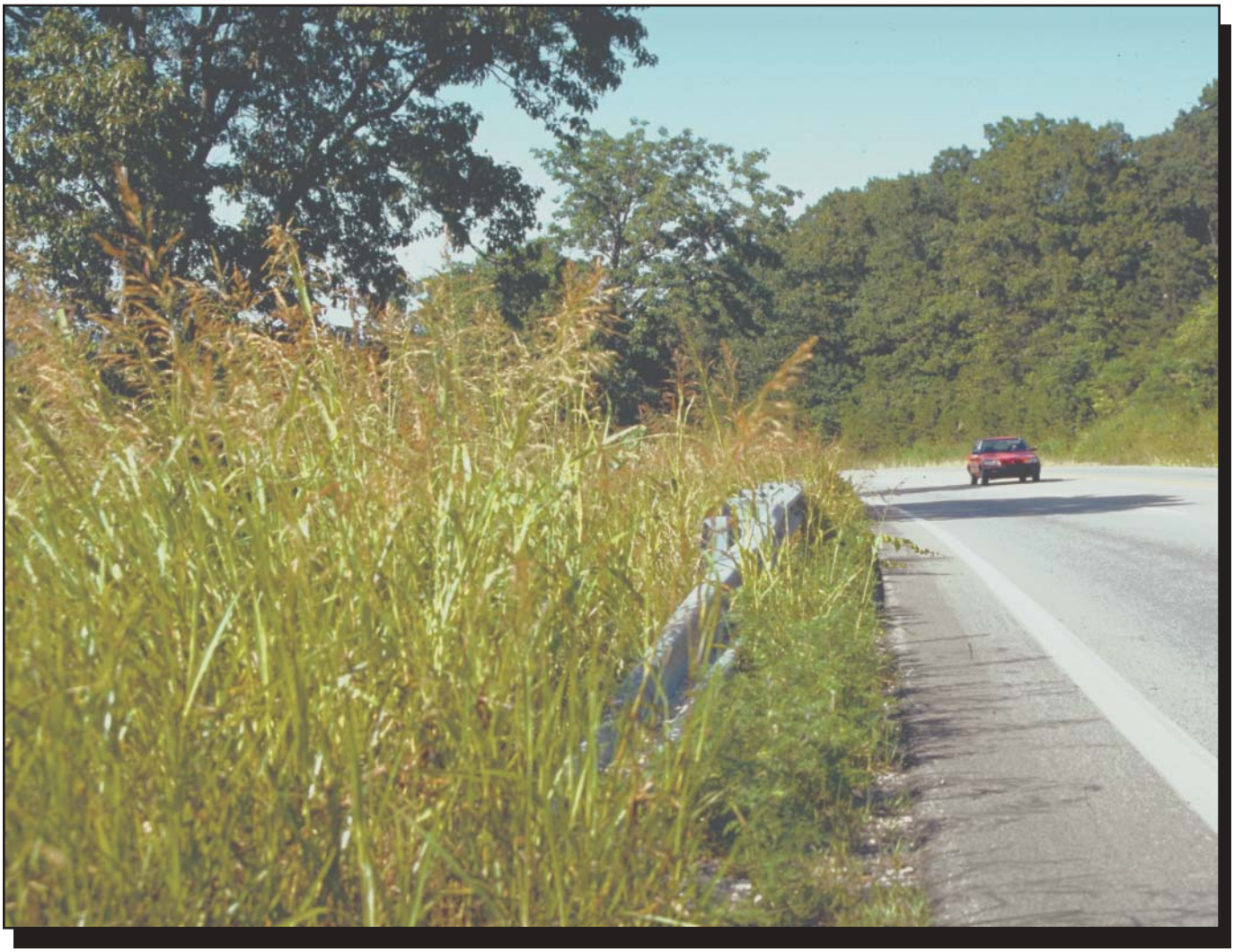
Road Oyl (Road Products Corp.)
P.O. Box 22044
Knoxville, TN 37933
Phone: 800–685–0539

EMC SQUARED system (Soil Stabilization Products Co., Inc.)
P.O. Box 2779
Merced, CA 95344–0779
Phone: 800–523–9992

Stabilizer (Stabilizer Solutions, Inc.)
4832 East Indian School Rd.
Phoenix, AZ 85018
Phone: 800–336–2468

Soil-Sement (Midwest Industrial Supply, Inc.)
P.O. Box 8431
Canton, OH 44711
Phone: 800–321–0699

Pennzsuppress D (Pennzoil Products Co.)
John Snedden, National Sales Manager
100 Pennzoil Dr.
Johnstown, PA 15909



Johnsongrass was introduced into Alabama in the 1830s as a pasture grass from eastern Europe. It has become a roadside safety hazard that obscures visibility and increases the intensity of roadside fires.*—Photo by Bonnie Harper-Lore, U.S. Federal Highway Administration. Image 1624081 courtesy of Forestry Images (http://www.forestryimages.org).*

Appendix A—Descriptions of Road Features and Maintenance Activities

Aggregate—Crushed aggregate or mined gravel is used to provide a reasonably smooth and maintainable roadway travel surface, reduce erosion, and improve surface drainage of roads. The surfacing material must be replaced at intervals because of mixing with the subsoils, degradation of the rock, and loss of surfacing material as traffic and maintenance gradually moves it off the roadway. Aggregate is quarried at commercial or forest-owned sources. It may be crushed within or outside the forest with portable or stationary equipment and hauled to the roadway. Portable rock crushing equipment is used in many locations, both within and outside the forest boundaries. Aggregate may be stockpiled in centralized locations.

Road grading—A road grader with a 12- to 14-foot-wide blade removes surface irregularities, restores surface drainage features, and smooths the roadway surface to improve safety and user comfort. Grading is typically completed by making three to four passes over the entire road surface from beginning to end. Aggregate and native surface material is moved back and forth across the road surface during this operation.

Ditch cleaning—Roadside ditches are installed to intercept overland or underground water flow, drain road surfaces, and guide water away from the roadway and shoulders. Ditches become overgrown with vegetation over time, which hinders ditch performance. Ditches are periodically maintained by removing vegetation using a grader or rubber-tired backhoe.

Drainage Structures—Enclosed culverts, open-top culverts, underdrains, and diversion structures guide water over, beside, or under roadways and protect the roadway from erosion. They also protect waterways from traffic-associated degradation and may allow for aquatic organisms to pass from one side of the roadway to the other. They must be cleaned regularly and eventually must be replaced. Heavy equipment is usually required for this job, disturbing large areas of soil.

Brushing—Woody vegetation is pruned from road cut and fill slopes to improve the sight distance and stop the encroachment of brush and trees into the road prism. Brushing is normally done every 3 to 10 years, depending on how quickly the brush grows back. Brushing is usually accomplished using a machine with heavy-duty rotary or flail-type blades on an adjustable boom.

Mowing—Roadsides are mowed where needed for esthetic or safety reasons, or to keep flammable grasses and forbs away from the road shoulder. A sickle- or rotary-type mowing machine is used. The frequency of mowing varies, depending on how quickly the vegetation grows, the length of the growing season, and the flammability of the vegetation. Commonly, mowing is done once a year during the latter half of the field season.

Fences, gates, cattle guards, guardrails, signing, and delineators—These auxiliary structures improve safety and separate vehicles from other traffic and animals. Like all structures, they must be maintained, and they must be replaced when they are damaged or worn out. Soil is disturbed when these structures are anchored in place.

Appendix B—Northern Region Noxious Weed Best Management Practices

2081—MANAGEMENT OF NOXIOUS WEEDS.

2081.2—Prevention and Control Measures.

Roads.

A. Required Objectives and Associated Practices.

(1) Incorporate weed prevention into road layout, design, and alternative evaluation. Environmental analysis for road construction and reconstruction will include weed risk assessment.

(2) Remove the seed source that could be picked up by passing vehicles and limit seed transport.

(a) Remove all mud, dirt, and plant parts from all off-road equipment before moving into project area. Cleaning must occur off National Forest lands. This does not apply to service vehicles that will stay on the roadway, traveling frequently in and out of the project area.

(b) Clean all equipment prior to leaving the project site, if operating in areas infested with new invaders as determined by the forest weed specialist. Reference *Contract Provision C/CT 6.626*.

(3) Reestablish vegetation on bare ground due to construction and reconstruction activity to minimize weed spread.

(a) Revegetate all disturbed soil, except the travel way on surfaced roads, in a manner that optimizes plant establishment for that specific site, unless ongoing disturbance at the site will prevent weed establishment. Use native material where appropriate and available. Use a seed mix that includes fast, early-season species to provide quick, dense revegetation. To avoid weed contaminated seed, each lot must be tested by a certified seed laboratory against all State noxious weed lists and documentation of the seed inspection test provided.

(b) Use local seeding guidelines for detailed procedures and appropriate mixes. Use native material where appropriate and available. Revegetation may include planting, seeding, fertilization, and weed-free mulching as indicated by local prescriptions.

(c) Monitor and evaluate success of revegetation in relation to project plan. Repeat as indicated by local prescriptions.

(4) Minimize the movement of existing and new weed species caused by moving infested gravel and fill material. The borrow pit will not be used if new invaders, defined by the forest weed specialist, are found on site.

(5) Minimize sources of weed seed in areas not yet revegetated. If straw is used for road stabilization and erosion control, it must be certified weed-free or weed-seed free.

(6) Minimize roadside sources of weed seed that could be transported to other areas.

(a) Look for priority weed species during road maintenance and report back to district weed specialist.

(b) Do not blade roads or pull ditches where new invaders are found.

(c) Maintain desirable roadside vegetation. If desirable vegetation is removed during blading or other ground-disturbing activities, area must be revegetated according to section (3) (a), (b), (c) above.

(d) Remove all mud, dirt, and plant parts from all off-road equipment before moving into project area. Cleaning must occur off National Forest lands. (This does not apply to service vehicles that will stay on the roadway, traveling frequently in and out of the project area.)

(e) Clean all equipment prior to leaving the project site, if operating in areas infested with new invaders, as determined by the forest weed specialist. Reference *Contract Provision C/CT 6.626*.

(f) Straw used for road stabilization and erosion control will be certified weed-free or weed-seed-free.

(7) Reduce weed establishment in road obliteration/reclamation projects. Revegetate according to section (3) (a), (b), (c) above.

B. Recommended Objectives and Associated Practices.

(1) Retain shade to suppress weeds. Consider minimizing the removal of trees and other roadside vegetation during construction, reconstruction, and maintenance, particularly on southerly aspects.

(2) Consider reestablishing vegetation on bare ground due to construction and reconstruction activity to minimize weed spread. Road maintenance programs should include scheduled fertilization to maintain vigor of competitive vegetation (3-year period suggested).

(3) Minimize the movement of existing and new weed species caused by moving infested gravel and fill material. All gravel and borrow sources should be inspected and approved before use and transport. The source will not be used if the weeds present at the pit are not found at the site of intended use. If weeds are present, they must be treated before transport and use.

(4) Minimize roadside sources of weed seed that could be transported to other areas. Weed infestations should be inventoried and scheduled for treatment.

(5) Ensure that weed prevention and related resource protection are considered in travel management. Consider weed risk and spread factors in travel plan (road closure) decisions.

(6) Reduce weed establishment in road obliteration/reclamation projects. Consider treating weeds in road obliteration and reclamation projects before roads are made undriveable. Monitor and retreat as indicated by local analysis and prescription.

(7) Evaluate and prioritize noxious weeds along existing Forest Service access roads leading to project area and treat as indicated by local analysis and prescriptions, before construction equipment moves into project area. New road construction must be revegetated as described in *Weed Prevention* measure see section (3) (a), (b), (c) above.

Itchgrass was introduced to Florida from the Philippines in the 1920s as a pasture grass. The tall, aggressive grass has infested roadsides throughout the southeastern United States, displacing native plants.*—Photo by the USDA Animal and Plant Health Inspection Service, Oxford, NC, archives. Image 1149131 courtesy of Forestry Images (http://www.forestryimages.org).*

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About the Authors

Leslie Ferguson is a botanist on the Three Rivers Ranger District of the Kootenai National Forest. Leslie has worked for the Kootenai National Forest since 1982. Other work assignments include interdisciplinary team membership on many environmental assessments and impact statements, team leader on the Cibola National Forest invasive plant management environmental impact statement, two district staff details, and field experience in timber marking, cruising, and stand exams. She graduated from Pennsylvania State University in 1984 with a degree in forest science. Other published work includes an article on Eurasian watermilfoil in *Montana Outdoors* (July/August 2000).

Celestine Lacey Duncan is the owner of Weed Management Services in Helena, MT. She received a bachelor's degree from New Mexico State University in agronomy and soil sciences and a master's degree in weed science with a minor in range science from Montana State University in 1985. She worked for Montana State University as a research associate and at the Montana Department of Agriculture as State weed coordinator from 1985 to 1988. Since 1988, she has been owner and operator of Weed Management Services, a private consulting company specializing in noxious weed research and management in the Pacific Northwest. Celestine served for 2 years as vice-chairperson of the National Invasive Species Advisory Committee.

Kathleen Snodgrass came to the Missoula Technology and Development Center as a project leader in 2001 from the Nez Perce National Forest. She had been the facilities architect for the Nez Perce National Forest for about 7 years and had worked in facilities, landscape architecture, land line, and general engineering on the forest for about 10 years before that. Kathleen spent 10 years in highway design and construction with the Idaho Division of Highways after graduating from Washington State University in 1974 with a bachelor's degree in architectural studies.

Library Card

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Provides recommendations for reducing or eliminating the spread of weeds during road maintenance. Noxious weed species frequently colonize roads and are likely to be spread during road maintenance. Roadway maintenance should not be undertaken without coordination between the maintenance crew and the noxious weed specialist. Recommendations in this report are based on weed biology, observations, and road maintenance practices rather than actual research. Included is a list of references, links to a few Web-based resources, and addresses for manufacturers of soil binders (that can reduce the need for road maintenance), and an appendix containing the U.S. Department of Agriculture, Forest Service Northern Region's *Noxious Weed Best Management Practices*.

Keywords: best management practices, brushing, grading, invasive species, mowing, noxious weeds, road grading, roadsides, seed, soil binders

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