Research

Integrated Weed Management

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INTEGRATED NOXIOUS WEED MANAGEMENT

Prepared for:

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Integrated Noxious Weed Management

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16. Abstract

The 1942-45 introduction of phenoxy herbicides offered selective weed control with limited manpower and resources. Entrepreneurs identified the profit incentive and created a demand for an increasing number of specific weed control chemicals. As a result an imbalanced weed management system was created. Agriculture and roadside weed management became dependent upon chemicals. A change in environmental legislation and public concern regarding the effects of chemicals has resulted in the development of a more diverse system of weed control: Integrated Weed Management (IPM). This report summarizes Integrated Weed Management as a primary means of minimizing the use of chemicals and determines methods available for control of noxious weeds. The study included online literature searches and telephone interviews to identify model programs and best practices in other states.

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EXECUTIVE SUMMARY

The 1942-45 introduction of phenoxy herbicides offered selective weed control with limited manpower and resources. Entrepreneurs identified the profit incentive and created a demand for an increasing number of specific weed control chemicals. As a result an imbalanced weed management system was created. Agriculture and roadside weed management became dependent upon chemicals. A change in environmental legislation and public concern regarding the effects of chemicals has resulted in the development of a more diverse system of weed control: Integrated Weed Management (IWM). Central to an IWM system is the idea that a full range of weed control techniques should be applied and integrated into a single strategy that recognizes the ecology of the organisms and the environment, and brings down weed populations by depleting the weed seed bank or weakening the plant to the extent that it cannot spread further.

Each year the New Mexico Department of Transportation (NMDOT) Research Bureau hosts a Research Quality Initiative at which persons from the Transportation Department are invited to present research proposals. A diverse committee then selects projects based upon predetermined criteria. Projects are prioritized and assigned to principal investigators.

During Fiscal Year 2002, Mr. Steve Reed of the NMDOT Environmental Section identified a need to successfully control noxious weeds while minimizing the use of herbicides. This report summarizes Integrated Weed Management as a primary means of minimizing the use of chemicals and determines methods available for the control of

noxious weeds. The study included online literature searches and telephone interviews to identify model programs and best practices in other states and Federal agencies.

It is recommended that the New Mexico Department of Transportation Environmental Section work together with the Highway Maintenance Bureau, Field Operations Division to design and establish an Integrated Weed Management system based upon scientific data. Further investigation into the possible use of biological controls is suggested.

INTRODUCTION

The New Mexico Department of Transportation (the Department) is not alone in its search to effectively manage noxious weeds using methodology that is safe to humans and the environment, and that will safeguard the continued existence of native species. The Federal government, states and local agencies throughout the United States of America are interested in becoming knowledgeable in developing policies and best practices for weed management with an emphasis on minimizing the use of chemical herbicides.

New Mexico's Department of Transportation "Vegetation Management Program Overview" identifies its responsibilities in Vegetation Management:

"*Maintain a safe right-of-way by providing clear sight distances, to clear signs and fixtures of vegetation for visibility and functionality, to provide adequate drainage in roadway ditches, to reduce fire hazard and provide snow drift control. It is also necessary to protect the roadway surface from vegetation encroachment and to maintain drainage."*

In May, 2000, the Department's Environmental Section issued "Noxious Weed Management Guidelines" incorporating the following regulatory measures supporting NEPA actions on federal lands, and a state interagency strategic plan.

- Presidential Executive Order, E.O. 13112 on Invasive Species (February 3, 1999)
- Federal weed law
    - 7 USC Chapter 61 Sections 2801-2814 (the Federal Act on Noxious Weeds)

- 7 CFR Part 360 Sections 199-300 – USDA Animal and Plan Health Inspection Services (APHIS)

- FHWA Guidance on Invasive Species (August 10, 1999)
- New Mexico Noxious Weed Management Act of 1998 (76-7D-1 to 76-&D-6 NMSA 1978)
- Federal Agencies

  Guidelines for Coordinated Management of Noxious Weeds

  Development of Weed Management Areas – USDA Forest Service

  USDI Bureau of Land Management, USDI National Park Service

- Interagency

  New Mexico Strategic Plan for Managing Noxious Weeds (draft February 2000 and New Mexico Noxious Weed Summit, June 9-10, 2000)

  The New Mexico Strategic Plan is characterized by guidelines to map the locations of noxious weeds and encourages agencies to contribute to the Southwest Exotic Plant Mapping Program (SWEMP), and the formation of Cooperative Weed Management Programs (CWMP) at local levels.

"Noxious Weed Management Guidelines" also determined that biological controls are "probably not feasible" to be used by the NMDOT, even though they were used by Federal Agencies. The use of herbicides was to be minimized around and adjacent to aquatic areas, and applicators were required to be licensed. Herbicide use was to meet specifications described in New Mexico Highway and Transportation Department, Standard Specifications for Highway and Bridge Construction, 2000, Section 620.

Since that time an increase of regulation and public concern with the chemical treatment of weeds has led federal, state and local agencies to re-examine and research alternative management practices that can replace or minimize the use of chemicals.

Each year the New Mexico Department of Transportation (NMDOT) Research Bureau hosts a Research Quality Initiative at which persons from the Transportation Department are invited to present research proposals. A diverse committee then selects projects based upon predetermined criteria. Projects are prioritized and assigned to principal investigators.

During Fiscal Year 2002, Mr. Steve Reed of the NMDOT Environmental Section, identified a need to successfully control noxious weeds while minimizing the use of pesticides.

The purpose of this research study is to identify best management practices that provide alternative non-chemical solutions to minimize the use of herbicides in the control of noxious weeds, and provide a framework for new weed management policies and procedures.

The report is divided into 7 sections:

1. Introduction
2. Background
3. Weed Management Solutions
4. Developing an Integrated Weed Management Plan
5. Noxious Weed Controls
6. Success Stories
7. Conclusion and Recommendations

APPENDIX A

- Iowa Marketing Materials

BACKGROUND

The management of roadside noxious weeds in New Mexico falls under the auspices of the Department of Transportation, (Prior to July 1, 2003 known as the Department of Highways and Transportation-NMSHTD) Field Operations Division of the State Highway Maintenance Bureau. The state is divided into six districts each with a weed management coordinator. District coordinators follow guidelines published in, "Roadside Vegetation Management Handbook" NMSHTD, 1992. The Handbook provides detailed instructions for roadside management to minimize soil disturbance; seeding (cultural control); mechanical and chemical vegetation control. A list of New Mexico noxious weeds with a description, history and distribution, together with instructions regarding herbicide equipment was published in 1991. Neither the manual nor the list included detailed biological profiles to determine when plants should be treated. At the time of writing districts use chemical, mechanical and cultural controls.

All personnel who work in the vegetation management area are trained and licensed as Public Applicators by the New Mexico Department of Agriculture. Vegetation management is practiced through the summer months. In the winter patrol personnel revert to road maintenance and deicing. Patrol employees are also called upon to assist the Preliminary Design Bureau, Environmental Section of the Engineering Design Division with weed management within specific projects.

In addition, each district maps the location of noxious weeds by mile marker and adds the data to the Southwest Exotic Plant Information Clearinghouse (SWEMP). SWEMP data covers Arizona, Colorado, New Mexico, and Utah.

Several surveys initiated by the University of Minnesota Center for Transportation Studies indicated that some of the greatest challenges of vegetation management are:

- Completing work with weather and time constraints
- Communicating with the public about herbicides and overcoming controversy
- Satisfying conflicting public expectations regarding weed control, mowing and expenditures regarding specific weeds
- Controlling specific noxious weeds
- Keeping farmers/ranchers happy
- Accomplishing goals with limited staff and funding
- Educating maintenance personnel about management practices

Challenges such as those listed are common with many weed management teams, and many feel that they are, “Not winning the war.”

WEED MANAGEMENT SOLUTIONS

Noxious and exotic weeds constitute a serious biodiversity issue worldwide. In the United States 2000 noxious weeds are already established. Millions of acres in the West are rapidly undergoing degradation. In California over the past twenty years, starthistle has spread from 1 million acres to more than 20 million acres, 22% of the State's land base. Noxious and exotic plants impact 50% of species that are threatened or endangered by changing habitat and food supply. Fortunately there are solutions that when combined and applied to plants at various stages of their lifecycle, constitute an Integrated Weed Management (IWM) system.

Weeds know no boundaries, be they geographic or political, so it behooves all levels of government to work as a cooperative team within a wide range of jurisdictions. When any of the six transportation districts in New Mexico manage roadside vegetation they are aware of landowners next to the roadside that have weed problems. District coordinators can work with landowners, be they private, federal or business entities to determine cooperative solutions. Wyoming landowners are invited to visit biological control centers of distribution to help them solve a weed problem on their property. Weld County, Colorado, at one time received grants that enabled them to offer funding to landowners for specific weed management solutions.

Federal, state and local agencies have different management policies and plans depending upon their responsibilities and financial base. Many have published policies, strategic plans and handbooks on their Web sites. Several publications identified on Web sites can assist agencies to develop IWM plans.

The National Invasive Species Council *Management Plan: Meeting the Invasive Species Challenge*, 2000, identifies legal references that refer to land, air and water considerations, and identifies links to agencies that can be used as a basis for cooperative efforts. (http://www.invasivespecies.gov)

The Nature Conservancy specializes in open range integrated weed management. *Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas*, April, 2001, updated June, 2003, provides basic control information, and a separate *Fire Management Manual* details fire management considerations, not found in other publications. The Conservancy updates its online handbook periodically. A print version is not available. (http://tncweeds.ucdavis.edu/handbook.html)

The University of Minnesota Center for Transportation Studies, *Best Practices Handbook on Roadside Vegetation Management, 2000*, is essential reading within transportation roadside management departments. Not only are "Best Practices" discussed, it provides a detailed rationale to develop an IWM plan. (http://lrrb.gen.mn.us)

Colorado Parks, Natural Areas Program has made available online and in print, *Creating an Integrated Weed Management Plan: A Handbook for Owners and Managers of Lands with Natural Values. 2000.* This publication is particularly valuable in demonstrating the minimum amount of biological detail and control information that needs to be included in a handbook. (http://parks.state.co.us/cnap/IWM_handbook.IWM_index.htm)

Washington State's *Integrated Pest Management Implementation Handbook, Version 2, 2002*, takes a different approach to other handbooks in that, in its essence, provides a job description for integrated pest management coordinators. It guides the

reader through developing an Integrated Pest Policy (IPM), the process of developing an IPM program, plan and strategies. A proposed selection of forms is incomplete at the time of writing. (http://agr.wa.gov) >Plants and Insects>Integrated Weed Management>IPM Handbook. Note: IWM is part of IPM practices: e.g., San Francisco has a management plan that integrates both pest control and weed control.

On a local agency level, Socorro Soil and Water Conservation District, New Mexico, has two publications: *Socorro County's Integrated Weed Management Plan for the Control and Management of Invasive/Noxious Weeds*, and, *Socorro County's Strategic Plan for Managing Invasive/Noxious Weeds.* Both the Program Manager and the SWCD have won awards for their management of noxious weeds. (http://www.socorroswcd.org)

Information in any one of these publications can make a valuable contribution to the development of a comprehensive integrated weed management plan.

Policies and strategic plans are essential to the efficient eradication of weeds, but the need to take action is self-evident. It is rare that a single control technique can eradicate a particular weed species, particularly if the infestation is widespread. It has, therefore, become general practice throughout the United States to incorporate an Integrated Weed Management System (IWM). When control methods are used in combination and in response to the biological life cycle of plants, they can constitute a weed management program that is cost effective and efficient.

There are five control categories:

1.1 Prevention

Prevention – Methods or management practices that discourage the growth or spread of undesirable plants over desirable plants.

In order for an agency to properly manage noxious weeds it is necessary to identify plant locations and determine the status of infestation, in addition to all the factors that will affect the selection of a control method. Onionweed was first sighted at a road stop, and later on top of a Mesa in the Southern part of New Mexico. At this stage it was a simple matter to bring in a contractor to dig up the plants, and monitor the site to prevent further infestation. Under present practices the location of the infestation would have been mapped and identified by mile marker with the Southwest Exotic Plant Information Clearinghouse (SWEMP). SWEMP data covers Arizona, Colorado, New Mexico and Utah. Contributors include federal and state agencies, tribal governments, universities, private consulting firms, businesses and organizations. The shared data based upon Geographic Information Systems (GIS) format helps to determine policies, long range plans, and collaboration among many agencies, as well as identifying patterns of growth or decline of noxious weeds. The Department is considering changing their

data input from mile markers to GPS coordinates to improve the integrity of the SWEMP database and develop a management process that will more accurately reflect the effectiveness of control methods.

Prevention methods in the State of New Mexico Department of Transportation include specific procedures that control erosion and limit vegetation destruction. Certified seed and weed free mulch are applied wherever possible to reseed treated areas with perennial native grass. Equipment used at noxious weed and construction sites is cleaned before leaving the location. Prior to construction weeds are sprayed twice with herbicides at approximately 4-week intervals to minimize infestation caused by disturbance of the soil.

The Department 2000-2001 Strategic Plan includes educating the public, landowners and businesses regarding noxious weed management. Many of the proposed program actions are reflective of proactive programs such as those found in Colorado and Wyoming that initiate community involvement and contribute to preventive measures.

1.2 Cultural Control

Cultural – Methods or management practices that encourage growth of desirable plants over undesirable plants. (Note: there are other definitions that include "manipulation of the environment through controlled burning, grazing management, or re-vegetation programs.")

In 1992, the New Mexico Highway and Transportation Department published its, "Roadside Vegetation Management Handbook" that is still used by the six district weed management coordinators throughout the state. The manual establishes three management

zones: High: areas with ornamental plantings; Urban: within city limits, near rest areas, or other environmentally sensitive areas; and Rural: areas outside city limits or away from rest areas. Cultural procedures include using weed free seed and mulches, and disturbing vegetation as little as possible. Areas left by the removal of weeds are replaced with native grasses or wildflowers to prevent re-infestation and new infestations of other species. Texas and Oklahoma use wild flowers to replace weeds. Winston-Salem has 53,000 trees lining its rights-of-way and more being planted each year. The benefits of reseeding are numerous:

- "Less money spent on herbicides, fertilizers, and maintenance…native plants are self-sustaining, they require less maintenance, and their dense roots force out competing plants, so the area requires less herbicide use.
- More effective application of herbicide through better use of equipment and spot spraying only the weeds. Using the best products at the right time optimizes chemical use.
- Soil stabilization through the use of native grasses prevents erosion and slope failure.
- Roadside beautification and enhanced wildlife habitat.
- Improved traffic safety, as vegetation screens headlight glare in curved median areas and delineates the roadway for drivers.
- Creation of an inexpensive and low-maintenance snow fence.
- Dramatic reduction in mowing and spraying needs.
- Aesthetic improvements to the road and travel experience, which can reduce drive fatigue and boredom.

- Reduced environmental impacts from maintenance operations.
- Improved water and air quality.” (Minnesota)

1.3 Mechanical Control

Mechanical - methods or management practices that physically disrupt plant growth including but not limited to, tilling, mowing, burning, flooding, mulching, hand pulling, hoeing, tree ringing.

Mechanical methods are often used in small areas of infestation and on tall vegetation. Since the 1992 New Mexico Handbook was published, new tools and technologies have been developed: thermal weed control that includes hot water spraying, steam spraying, and infrared burning. These methods have shown to be effective but results vary according to reports from a variety of states. Washington State found that infrared burning was more reliable and cost effective than hot water spraying. A detailed study by Oregon Department of Transportation indicated that the technique required fire permits and a source of water control for possible accidental fires. They concluded that infrared burning was more suitable for riparian habitats. In New Mexico the use of blowtorches has been deemed appropriate for small infestations in some situations. Tree ringing has shown to be effective to control Russian Elms. Alternatively, cutting down the trees and coating stumps will minimize the use of chemicals. While tree ringing is labor intensive, it may be appropriate where public pressure to use alternatives to chemicals is applied, or where the area is chemically sensitive as in a riparian setting.

2.1 Biological Controls

Biological - The use of organisms such as goats, sheep, cattle, insects and fungi to disrupt the growth of undesirable plants.

The use of animals to control weeds has been shown to be effective, but in New Mexico has been determined to be costly. As with mechanical controls, using animals to reduce vegetation, involves repetitive action. Where there is competition in this area of control, costs are lower.

Interest in biological controls with insects has seen a hiatus over the past ten years. The first trials were performed in Hawaii at the beginning of the 20th Century, but with changes in legislation and public opinion, research and trials in this mode of control have increased. It is the most cost effective method of control available. Most insects are inexpensive, are gathered by volunteers, or a small number of employees. Maintenance is low as the insects devour the weeds, consequently, labor costs are minimal. Knapweed control agents that attack the weed from the roots, flowers and leaves reflect the value of biological controls.

Wyoming uses biological control as its first line of defense in weed management. Insects are more commonly placed on privately owned lands next to roadways. Occasionally insects are used on rights-of-way. Arizona chooses to use insects directly on rights-of-way. New Hampshire has recently successfully concluded testing (1997-2001) Galerucella spp.leaf-eating beetles to control purple loosetrife in wetlands. They later added beetles along rights-of-way that established “diversity in the introduction of biocontrol of loosetrife over a wider region.” Texas began introducing biocontrols in the early 1960’s. Programs for biological control have centered around puncturevine, musk thistle, field bindweed and salt cedar. Biological control of salt cedar has been under

investigation for ten years. Texas has also provided biological control research for Australia in the control of prickly pear. Subsequently the Cactoblastis moth from South America was released in Australia.

While biocontrol is generally effective, success rates range from 90% to 0%. Pathogens can be accidentally introduced (The pathogen Nosema was accidentally introduced when controlling musk thistle (Carduus nutans) with a biological control." The USDA Agricultural Research Service's Exotic and Invasive Weed Management Research Unit in Albany and the California Department of Food and Agriculture Biocontrol Program has actively been developing a control program for Starthistle in California and other Western states. Three insects were introduced, but the false peacock fly was accidentally released and has become widespread. It is more effective than the original intentionally released controls in that it has been shown to be host specific to the yellow starthistle and does not attack native thistles.

Permits issued by the US Department of Agriculture are required for importing and release of biocontrols. (http://www.aphis.usda.gov/ppq/permits/biological/weedbio.html)

3.1 Chemical Controls

Chemical - The use of herbicides or plant regulators to disrupt the growth of undesirable plants.

While herbicides have been maligned over the years, they have shown to be effective and cost efficient in many cases. Chemical applications often need to be applied annually over as many as ten years to completely eradicate an infestation of specific plants. Chemicals correctly and efficiently applied may be an appropriate control treatment, particularly when used in combination with other controls and applied as spot

treatments. Agencies have determined that chemicals may be used diluted from the original manufacturers recommendation. Higher concentrations of chemicals have been shown to be harmful to desirable plants in some cases. Many treatments are only viable for one year and have to be repeated on an annual basis.

The controversy surrounding herbicides used as controls centers around a number of issues:

- Individuals with serious chemical reactions
- Notification of spraying schedules
- Affect on children who are more susceptible to chemicals than adults
- Negative reactions by pets, fish and wildlife
- Environmental concerns such as residue
- Over spraying and over use
- Toxicity of inert ingredients such as surfactants, that can be more dangerous than the listed and tested chemical
- The cumulative synergistic effects of mixing chemicals
- Safety of highway patrol workers

A number of agencies have “no spray” policies: Trinity, Humboldt and Mendocino in California spent years trying to stop roadside spraying in their counties before they succeeded. Intense pressure from the public has led to “no spray “ policies on county roads from the Golden Gate to the Oregon border. However, Caltrans as a state agency does not actively support this policy according to Californians for Alternatives to Toxics, 1999.

It is possible to use an integrated management approach with or without chemicals. African rue is an example of integrated weed management where pulling or digging the plants before the seed sets, then spot treating with chemicals, followed by reseeding with a desirable species and maintaining a healthy coverage of perennial plants, eliminates the infestation.

When the five control methods are used in correlation to each plant's biological profile, noxious weeds can be at best eliminated, or at least controlled.

A process that is not widely used is biological detailing of noxious plants to be used as an integral part of an IWP. Each profile should include detailed biological information and an analysis of appropriate control methods based on scientific research. Dr. Mark Rentz, Weed Scientist at New Mexico State University has initiated such a project with a view to publishing the information on the Internet.

The University of California has begun a similar project. A sample profile of Starthistle can be viewed at: http://wric.ucdavis.edu/yst/yst/html.

The profile includes:

Introduction and Spread

Impacts

Biology and Ecology

Management

Developing a Strategic Plan

Weed Management Areas

Legislation

References

New Publications

When profiles are placed on the Internet, the information can be updated periodically and be readily available both for Department employees and the general public. New ideas can be developed and shared. Detailed biological profiles and matching controls should be an integral part of an agency's policy and strategic plan.

A summary chart (Fig.1) in which New Mexico Noxious Weeds are identified by the Federal Government, have been matched to controls discussed in literature searches published on the Internet. The chart is reflective of possible solutions for each plant. Information contained therein is not detailed. It is offered as a guide only. Links to Internet pages from which the data originated are listed in "Weed Management References" should the reader need more information.

CONTROL SUMMARY, JUNE 2003 (Fig. 1)

Weed	Chemicals	Alternatives
African Rue (Peganum Harmala) Class B Present throughout New Mexico, Arizona, Texas, Washington, Oregon	Dilute spot application of glyphosate Tebuthiuron Diuron Triclopr 2,4-D	• No available biocontrol agents identified • Mechanical: Pull or dig plants before seed set. Annually, remove any seedlings from the seed bank and dispose of properly.
Comments: • Maintain a healthy coverage of perennial plants. • Re-seed areas with desirable species.		

Weed	Chemicals	Alternatives
Black Henbane (Hyoscyamus Niger) Class A Poisonous to livestock. Found on disturbed or heavily grazed sites, fencerows, roadsides, waste places, and riparian areas. Does well in most soils.	Metsulfuron Picloram Dicamba 2,4-D Escort	• Cutting, hoeing, digging isolated plants before seed production. • Mechanical methods are effective, however, it can be difficult to remove because of its thick stem. • Must be maintained annually. • No available biocontrol agents identified
Comments: • Maintain a cover of perennial plants. • Control methods must be maintained annually. • Preventive measures: Guard against disturbance and overuse. Follow-up visit a month after the first treatment to pickup missed or late bolting plants.		

Weed	Chemicals	Alternatives
Camelthorne (Alhagi maurorum medik) Class A Found in New Mexico, Texas, Washington State, highways	2,4-D Touchdown 600 Tordon 22K/Tordon 101	None identified.

Weed	Chemicals	Alternatives
Dalmation Toadflax (Linaria damatica/ Linaria genistifolia) Class A Toxic to livestock. Rapid colonization. Heavy water user.	Picloram Picloram + 2,4-D Phenoxypropionic herbicides (diclorprop more effective than phenoxyacetic herbicides (2,4-D)) Champion Extra if less than 15cm tall, May or early Fall (root and tips affected). Estaprop/Turboprop 600/dicholorprop (Translated systemic herbicide absorbed by leaves) Ks if less than 15cm tall. (Moves rapidly to growing point of plant. Inhibits cell elongation.)	Biocontrol: • Toadflax moth Feeds on leaves and flowers
Comments:		

Weed	Chemicals	Alternatives
Dyer's Woad (Isatis tinctoria) Class A Intermountain states habitat. Steep hillsides, dry rocky soils, disturbed sites, rights-of-way, waste areas.	Metsulfuron and Chlorsulfuron or in combination with 2,4-D in rangelands where grasses and not broad-leaf plants are appropriate. 2,4-D at rosette stage to early blossom.	• Puccinia Thlaspeos (Rust fungus) prevents or reduces seed production. • Pulling when plants have bolted and begun to flower. • Taproot must be removed below the crown.
Comments: • Typically is spread along highways, railways or canals and then to adjacent areas. • Eliminate seed production. • Maintain a healthy cover of perennial plants to discourage infestation and spread.		

Eurasian Watermilfoil (Myriophyllum Spicatum) Class A Found in 33 states.	Fluridone 2,4-D Diquat Diquat and complex copper Endothall dipotassium salt Endothall and complex copper	• Large harvesting equipment to mechanically remove milfoil in larger areas. • Manipulation of water level (higher or lower) and chemical control. • Harvest before early summer. • In swimming areas cover sediment with opaque fabric. • Mow twice during growing season.
Comments:		

Weed	Chemicals	Alternatives
Field Bindweed **aka European morning glory** (Convolvulus arvensis) Class C	Perennial grasses sprayed with 2,4-D amine provides good competition for bindweed.	• Two years of extensive tillage for complete removal. • Sheep grazing keeps from spreading.

Comments:

- Combine cultural and chemical controls.
- Start cultivation in Spring
- Cultivate re-growth each time plants reach 7.5-10 cm long.
- Mid-July allow the bindweed to grow undisturbed to the bud stage and then apply either:
- (1) Banvel alone 3.0L product ha mixed with 2,4-D amine at 2.2 L product/ha. Resume cultivation as required if re-growth occurs. Plant only cereal crops the following year and treat with 2,4-D or Banvel and 2,4-D mixtures as recommended for cereal crops.
- (2) Roundup at 7.0-12.0 L product/ha in 100 L of water/ha. Immediately after harvest cultivate or treat with 1.4-1.86 L/ha (600 g/L formulation of 2,4-D and Banvel or Roundup mixture in the summerfallow year if patches still persist. Cultivation or spraying must be thorough and at the right time.

Weed	Chemicals	Alternatives
Haltogen (Haltogen glomeratus) Class B Poisonous to sheep and cattle. Seen in railroad beds, roads, sheep trails and where the soil has been disturbed. Thrives in saline soils of colder semi-arid regions, particularly where soil coverage is thin. Also found on burned-over areas, overgrazed range, dry lakebeds, abandoned dry farms.	2,4-D Ester will kill approximately 98% of plants when applied in late May or early June, but is not selective. Repeated treatments are necessary for control. 2,4-D + Triclopyr Glyphosate Tricloyr Chlorsuluron Herbicide control of established stands on saline soils and low-precipitation is not recommended.	• No biological control has been identified • Hand grubbing • Do not use fire. Haltogen rapidly colonizes.
Comments: • Minimize disturbance and seed dispersal, eliminating seed production. • Maintain healthy native communities.		

Weed	Chemicals	Alternatives
Johnson Grass (Sorghum halepense) On BLM list Occurs in crop fields, pastures, abandoned fields, rights-of-way, forest edges, stream-banks. Thrives in open, disturbed, rich bottom ground, particularly in cultivated fields.	Roundup in June, prior to seed maturity. Spray lightly. Treat for several years to ensure good control. No currently registered herbicides will selectively control jointed goatgrass. Hoelon Sonalan Treflan applied preplant-incorporated at commercial rates in Montana reduced density by less than 60%.	• In light infestation, hand pull during June just after rain. All parts of the plant should be removed. • Till where practical and leave exposed roots to winter kill. Repeated tillage 6 times at 2-week intervals reduces population.
Comments: • More effective to spot treat with herbicide than to pull plants. Large clumps can be sprayed with 2% Roundup. • On buffer and disturbed sites, repeated and lose mowing kills seedlings		

Weed	Chemicals	Alternatives
Jointed Goatgrass (Aegilops cylindrical) Class C	Chemical controls have been minimally effective.	• Mainly controlled by cultural practices: summer fallow one season followed by deep plowing, burning stubble, long-term crop rotations. • Hasten depletion of viable seed in soil. • Mowing after spikes emerge from the boot and flower occurs, but before the seed reaches "soft dough" stage. • Biological controls have been inconsistent.
Comments: • Prevention: Use weed-free seed, clean machinery before leaving site; destroy localized areas growing along roadsides, waste areas or field borders before seeds reach the soft dough state. • Cultural techniques: burning, flooding.		

Weed	Chemicals	Alternatives
Diffuse Knapweed (Centaurea diffusia/ Acosta diffusia) Class A Plains, rangelands, forested benchlands.	Chemicals kill Knapweeds with many repeat treatments. Picloram – most widely recommended Clopyralid Dicamba 2,4-D – by itself is effective in early Spring. Glyphosate-ammoninium is more effective than glyphosate Tordon Arsenal Picloram/Dicama Picloram/2,4-D Clopyralid/2,4-D Dicamba/2,4-D –effective if applied to roots before bolting. Mixes reduce grass injury.	Biological Controls: • Sulphur knapweed moth • Broadnosed knapweed weevil • Knapweed peacock fly • Knapweed root weevil • Lesser knapweed flower weevil • Blunt knapweed flower weevil • Spotted knapweed seedhead moth • Toricidae moth • Grey-winged root moth • Bronze knapweed root-borer • Green Knapweed Clearwing Fly Mechanical Controls: • Seed control-cut or mow before seed is set. • Mow followed by herbicide • Pulling in Spring when soil is moist, second pulling in June focusing on bolted plants.
Comments: Eliminate seed production. Stress the plant's nutrient reserves as well as the soil seed bank. Re-seed infested area with desirable species and manage them to produce a vigorous stand of plants.		

Weed	Chemicals	Alternatives
Spotted Knapweed (Centaura Maculosa/ Acosta diffusia) Class A Well-drained, light to course-textured soils that receive summer rains. Not shade tolerant. Prefers wetter sites than Diffuse Knapweed (12-30" rain).	See Diffuse Knapweed	• Biological Controls: Banded knapweed gall fly Seadhead gall fly • Cattle and sheep will graze spotted knapweed, although sheep appear to be more effective. Animals reduce spotted knapweed seedlings and rosettes when associated grasses are dormant. Goats can also reduce knapweed production.
Comments: • Eliminate seed production • Stress the plant's nutrient reserves as well as the soil seed bank • Re-seed infested area with desirable species and manage them to produce a vigorous stand of plants		

Weed	Chemicals	Alternatives
Russian Knapweed (Centaurea repel/ Acroptioln repens) Class B	See Diffuse Knapweed	• Biological Controls: See Diffuse Knapweed.
Comments: • Eliminate seed production. • Stress the plant's nutrient reserves as well as the soil seed bank. • Re-seed infested area with desirable species and manage them to produce a vigorous stand of plants.		

Weed	Chemicals	Alternatives
Kochia (Kochia scoparia) Class B Aggressive in semi-arid regions across the USA, cultivated fields, roadsides, and waste places up to 8,500 feet. Can be toxic to cattle when more than 50% used in feed.	Vista – (fluroxypyr) Good results in Washington State where they used 1,200 gallons of Vista. Spray early.	• Biological controls are the primary method of control in the Great Plains: Leafy spurge stem boring beetle Brown dot leafy spurge beetle Copper leafy spurge beetle Black dot spurge flea beetle (established in Colorado, Idaho, Montana, Nebraska, North Dakota, Oregon and Washington) Black leafy spurge flea beetle Hungarian clearwing moth Spurge hawk moth Leafy spurge stem boring beetle Leafy spurge gall midge
Comments:		

Weed	Chemicals	Alternatives
Onionweed (Asphodelus fistulosus) Class A		• Hand pulling
Comments: • Small infestations noted.		

Weed	Chemicals	Alternatives
Perennial Pepperweed **Aka Tall whitetop, Broad-leafed peppergrass, Virginia pepperweed** (Lepidium latifolium) Class A Most often found in riparian areas, marshy floodplains, valley bottoms, and seasonally wet areas from 5,500-9,000 feet.	Metsulfuron Dicamba Glyphosate+2,4-D Chlorusulfuron Imazapyr	• Treat new infestations as soon as they are found • No biological control identified • Periodic mowing and spring burning have reduced perennial pepperweed in Utah.
Comments: • A combination of mechanical (cutting or pulling) and herbicide application. • Pull or cut during flower and bud stage • Herbicides should be applied to the recovering stems when they return to flower bud stage later the same year.		

Weed	Chemicals	Alternatives
Poison Hemlock (Conium Maculatum) Class B Poisonous to humans, cattle and sheep. All parts of the plant are poisonous. Common in riparian areas or irrigation ditches.	Easy to control with chemicals but riparian location precludes their widespread use. Excellent control with: Glyphostate Picloram Dicamba 2,4-D	• Deep taproot makes manual control somewhat difficult. • Biological controls being tested in Prineville District, BLM lands.
Comments:		

Weed	Chemicals	Alternatives
Purple Loosetrife (Lithrum salicaria) Class A Found in wetlands, construction sites. A vigorous plant.	Must be approved for aquatic setting. Roundup has no soil residue. Monitor for several years. Eliminating entire vegetative cover will promote seed germinations. For seed prevention use 2,4-D formulation for use near water. Rodeo – needs nonionic surficant added to the spray solution. Garlon – can only be used to the water's edge. Cannot be used in water. Apply in the pre- to early flower or late flower growth stages. Apply herbicide to foliage of intact plants. Spray basal bark with triclopyr	• Not tolerant of shade. • Remove above ground stems by burning or mechanical means. • Dig or pull plants. Biological Control: • Golden loosestrife beetle • Black-margined loosestrife beetle • Root boring weevil • Seed weevil
Comments: • Cut stems close to the ground followed by herbicide		

Weed	Chemicals	Alternatives
Salt Cedar (Tamarix ramosissima/ Amarix parviflora) Class C Grows well on moist sandy soil, sandy loam, loamy and clay soil textures. Tolerant of highly saline habitats, and concentrates of salt in its leaves. Found in flood plains, riverbanks, stream courses, saltflats, marshes and irrigation ditches in arid regions of the Southwest and Southern Great Plains.	After fire when re-sprouts appear and grow to 1-2 m tall, use: Imazapyr, or, Imazapyr plus glyphosate, or Triclopyr	• Saltcedar leaf beetle No widespread releases have been permitted.
Comments:		

Weed	Chemicals	Alternatives
Siberian Elm (Ulmus pummila) Class C Tolerates a variety of conditions.	Cut to stump and apply Roundup.	• Girdling trees is the preferred method where practical. • Girdle in late spring to mid-summer when sap is flowing and the bark easily pulls from the sapwood. • Annual mowing may be appropriate when nearby seed sources cannot be removed. • No biological controls are known that are feasible •
Comments: Remove seedlings by hand.		

Weed	Chemicals	Alternatives
Silver Nightshade (Solanum elaegnifolium) Class A Found in semi-arid regions with 12-23" annual rainfall. Coarse-textured sandy soils. Used in the manufacture of steroidal hormones, as a cheese additive, and tanning hides. Negatives: lowers crop yield. Toxic to livestock.	Glyphosate Picloram	• Biological control: nemotode – Orrina phyllobia, causes leaf and stem galling.
Comments:		

Weed	Chemicals	Alternatives
Teasels **Common Teasel** (Dipsacus fullonum) Class B **Cut-leaved Teasel** (Dipsacus laciniatus) Class B Grows in sunny habitats from wet to dry. Can take over savannas and prairies.	Glyphosate – Use sparingly during growing season to avoid killing monocots. 2,4-D Triclopyr	• Mechanical-digging, cutting flower heads before seeds set. • Mowing is ineffective. • Prescribed burns are ineffective. • No biological controls feasible.
Comments: • It takes several years to totally eradicate teasel from a natural community. • Remove all seed production.		

Weed	Chemicals	Alternatives
Thistles **Bull Thistle** (Cirsium vulgare) Class C There are many Cirsium species, some common and some rare. The natives do not generally have leaves clasping the stem all the way from node to node, and may have hairy upper and lower leaf surface and are blue-green or gray in color. Found in dry to moist habitats, nitrogen-rich soil and gravelly to clay-textured soils. Pastures, overgrazed rangeland, roadsides, and logged areas.	Chlorsulfuron Dicamba Dicamba+2,4-D Picloram+2,4-D Metsulfuron methyl	Biological Controls • Bull thistle seedheaded gall fly can reduce seed by 80%. Established in Colorado but not available for redistribution from the Division of Plant Industry's Biological Pest Control section. • Rosette weevil feeds on the rosette. Extensively studied by the USDA to insure it would not damage other plants. Mechanical Controls • Cutting, mowing and/or severing the taproot just below the root crown before seed set will eliminate current year seed production. If continued annually, will eliminate infestation. Mow with a rotary cutter. Dig at least two inches below ground level.
Comments: • Kill Bull thistle plants after they have bolted, but before plants have flowered. • Repeat control for several years to deplete the bank of thistle seeds in the soil.		

Weed	Chemicals	Alternatives
Canada Thistle (Cirsium arvense Breea arvensis) Class A Found in crops, pastures, rangeland, roadsides and riparian areas.	Chemical control of Canada thistle in Spring or Fall depending upon local conditions. Clopyralid+2,4-D Canada thistle tends to grow in wet areas and may restrict the use of herbicides.	• Hand pulling is most effective on small populations, and most effective prior to development of seeds.
Comments:		

Weed	Chemicals	Alternatives
Musk Thistle (Carduus nutans) Class B Found in prairies, grassy balds, and open areas that are subject to invasion. Grows at sea level to 8,000 feet in neutral to acid soils.	Folier spraying is effective. Glyphosate Triclopyr Chlopyralid	Biological Controls: • Thistlehead feeding weevil (not recommended due to unanticipated impacts) • Rosette weevil • Musk thistle flower fly • Musk thistle leaf beetle
Comments:		

Weed	Chemicals	Alternatives
Scotch Thistle (Onopordum acanthium/ O. tauricum) Class A Found at roadsides, irrigation ditches, waste areas, rangelands, adjacent to riparian or sub-irrigated deeper soils along stream courses, lower alluvial slopes and bottomlands.	Picloram Dicamba Clopyralid Clopyralid+2,4-D	None identified.

Comments:

- Scotch thistle is best contained at the rosette stage. Combine mechanical with other methods. Sever taproot 1-2" below the ground. Follow-up with herbicides to the surviving rosettes. Reseed treated ground with competitive desirable plants in fall after spraying. Follow-up with spot cutting of entire plans when first flowers appear. Repeat annually for several years to deplete seed bank.

Weed	Chemicals	Alternatives
Starthistles **Yellow Starthistle** (Centaruea solstitialis) Class A Poisonous to horses. Range: semi-arid to sub-humid rangelands in the West. A winter annual. **Malta Starthistle** (Centaurea Melitensis**)** Class B	2,4-D	• Mechanical work for small stands. • Add chemical pellet application after pulling. • Yellow starthistle bud weevil reduced 60%. • Yellow starthistle seed eating fly • Urophora sirunaseua (fly) • Yellow starthistle hairy weevil (cooler elevations) • False peacock fly (only feeds on Yellow starthistle) • "Tualatin" tall oatgrass or "Paiute" orchard grass with Picloram effectively controls Star thistle.
Comments: • Replace with competitive native perennials. • Malta starthistle management techniques are the same as Yellow starthistle.		

Weed	Chemicals	Alternatives
Woollyleaf Bursage (Ambroisia Grayi) Tap root system can reach to 15 feet. Prefers good water source.	Chemical control needs to be applied over several years. Tordon Banvel 2,4-D Roundup Arsenal	None identified.
Comments:		

Weed	Chemicals	Alternatives
Whitetop/Hoary Cress (Cadaria draba)) Class A Typically found on generally open, unshaded, disturbed ground. Prefers moderate amounts of rainfall.	Whitetop is usually controlled with herbicides. Multiple applications are required May and June or before flowering. Use with nonionic surfactant. 2,4-D very effective when applied during the early bud stage. Glyphosate – apply during flower stage. Spraying followed by spring mowing controls Whitetop by up to 90%.	• Mow 2-3 times a year to slow seed production. • Mow at the bud stage and repeat when plants rebud. • Plant competitive legumes such as alfalfa in crop-pastures. Legumes can compete for soil moisture and shade the weeds. • No biological controls identified.
Comments: • Prevent encroachment by limiting seed dispersal. • Wash equipment and vehicles before leaving infested area. • Minimize water availability.		

SUCCESS STORIES

Success stories abound around the world. Solutions reflect international cooperation, a willingness to try new practices, and the value of public pressure. Success stories reflect how policies and best practices can reduce the use of herbicides.

- Seattle, Washington State – eliminated use of the most hazardous herbicides and insecticides on city property, and set a goal of reducing overall pesticide use by 30 percent by 2002. Seattle also has 14 pesticide-free parks, where landscapes are maintained using no toxic chemicals at all, and alternatives are being utilized. Several departments have done a good job reducing pesticide use to meet or exceed their overall reduction goal, including Seattle Transit, the Seattle Center, and Seattle City Light.
- Thurston County, Washington State – Adopted in 1993, Thurston County's Pest and Vegetation Management Policy sets clear guidelines for the use of non-toxic pest and vegetation controls by all county departments, and eliminates the use of high hazard pesticides on county property. The policy also establishes record-keeping, requires IPM "prescription" for any problem, requires IPM plans for aquatically sensitive areas, and calls for public education.
- Jefferson County, Washington State – roadside policy. Twenty-three years ago Jefferson County implemented a "no-spray" policy for controlling roadside vegetation, and hasn't looked back. Their practices have become a model for the state and region, and several other counties have since followed in adopting "no-spray" policies, including Snohomish and Island counties in Washington.

Jefferson County uses a combination of preventive measures, such as mowing and brushing practices, as well as encouraging low-growing native plants, to keep roadsides well maintained.

- Eugene 4J School District, Oregon – has one of the strongest IPM policies in the Northwest. Passed in 1986, the policy does not allow pesticide use for solely aesthetic reasons, requires 24-hour prior posting before any application, and established a committee to manage the policy and approve any pesticide use. With any outdoor broadcast application of pesticides during school session it is required that notices be sent home with every student 14 days prior to application.
- Arcata, Humbolt County, California – officially banned all use of pesticides on city-owned or managed land in 2000 after 15 years of using alternatives. According to Arcata's Park Superintendent, they have found it is easier not to use pesticides. Changing cultural practices, such as a regime of aerating, mowing, and thatching for lawns, can be as effective as use of chemicals for weed control. Alternatives also save time on paperwork and training necessitated by pesticide use. The city has a semi-pro baseball team whose field is maintained without the use of any pesticides.
- Fairfax, Marin County, California – uses no pesticides on city lands, and in 2001 passed an unprecedented neighbor-notification ordinance. The ordinance required that individuals using pesticides outside on private property to post notification signs for 48 hours before and after spraying, and notify in writing 48 hours prior to pesticide use, all neighbors within 150 feet of the property.

- San Francisco, California – Passed in 1996, the IPM policy of the city and county of San Francisco affects the city's 35,000 employees and more than 80 departments. San Francisco has reduced its use of pesticides by more than 50 percent, eliminated its use of the most hazardous pesticides, and employs a wide variety of alternative techniques (goats, corn-meal mulch)
- Victoria, B.C. Canada – Since 1992 Victoria's IPM program has successfully reduced chemical use by more than 97%. The main focus of the program is monitoring pest levels and following threshold levels to determine, what if any action, will be taken.
- Some agencies have determined that herbicides can be used at a reduced rate. This is possible with some herbicides because the spread between the dose response of the weed and the desirable plant is wide. Therefore, some herbicides are over labeled. (Entz and Martins).
- South Africa has a terrain similar to that of New Mexico and has had success with biological controls in areas that are difficult to access.
- Australia is proactive in roadside management and shares some characteristics with New Mexico. In Victoria, BSV delivers its specialized biological control expertise and services to private and public land managers by working through CNR's regionalized structure. This is done by training appropriate CNR staff and community group representatives so that they become the local experts in biological control and its integration with other weed management techniques. This strategy assists BSV to plan the long-term rearing and distribution of proven

biological control agents and ensure that biological control of target weeds is implemented in the shortest possible time.

For more success stories see: *What Departments of Transportation (DOTS) are Doing about Weeds*. Greener Roadsides, Fall 2001. FHWA, USDOT. http://fhwa.dot.gov////environment/greenroadsides/fa01p9.htm.

CONCLUSION AND RECOMMENDATIONS

Integrated Weed Management has proven to be a more effective, cost efficient and versatile enough to meet the demands of controlling weeds from Alaska to South Africa. Implementation of an IWM program requires direction, teamwork and a clear vision of results. Research to determine a scientific basis for actions, and adequate record keeping are additional components to achieve IWM goals. The plan needs support both philosophically and financially from management. An existing plan can be transformed to IWM as long as there is dedication to the program. It requires support for staffing and procedures that permit employees to perform their duties efficiently.

New Mexico has a sound foundation of weed documentation, with a Strategic Plan that identifies solutions to weed management problems within the existing system. To their credit the six state districts won an award in 2000 for making great strides in improving the noxious weed program. The handbook used by the districts as a guide is credible and well thought out. The districts are responsive to changes that can to be made in order to use GPS coordinates instead of mile markers in order to validate the SWEMP database, and are encouraged to go forward with the necessary purchase of GPS transponders for each district. It appears that there is an excellent basis to move forward and grow in a spirit of cooperation and dedication to achieve the stated goal of this research to minimize the use of chemicals within a framework of policy and best practices.

To this end we offer the following recommendations:

- That the NMDOT Environmental Section work cooperatively with the NMDOT Field Operations Division to design an Integrated Weed Management program.
- Design an Integrated Weed Management program that is scientifically based with a weed scientist on the team.
- Identify areas of the present program that can be improved within existing resources.
- Reconsider biological forms of control to determine if they are feasible in New Mexico.
- Develop a public relations plan, and a public outreach program that includes incentive programs for landowners to cooperate with the districts.
- Determine the amount of funding required to manage the program, and identify alternative funding sources, but do not rely on funding as the only criteria to develop the IWM system.
- Re-examine the Strategic Plan 2001-2002 as a base upon which to develop an IWM system.
- Determine if further research is needed for the teams to be able to complete the IWM.

Developing a successful Integrated Weed Management program would be a positive environmental, ecological, and cost saving move for the long term. It is likely to produce a positive reaction from the general public.

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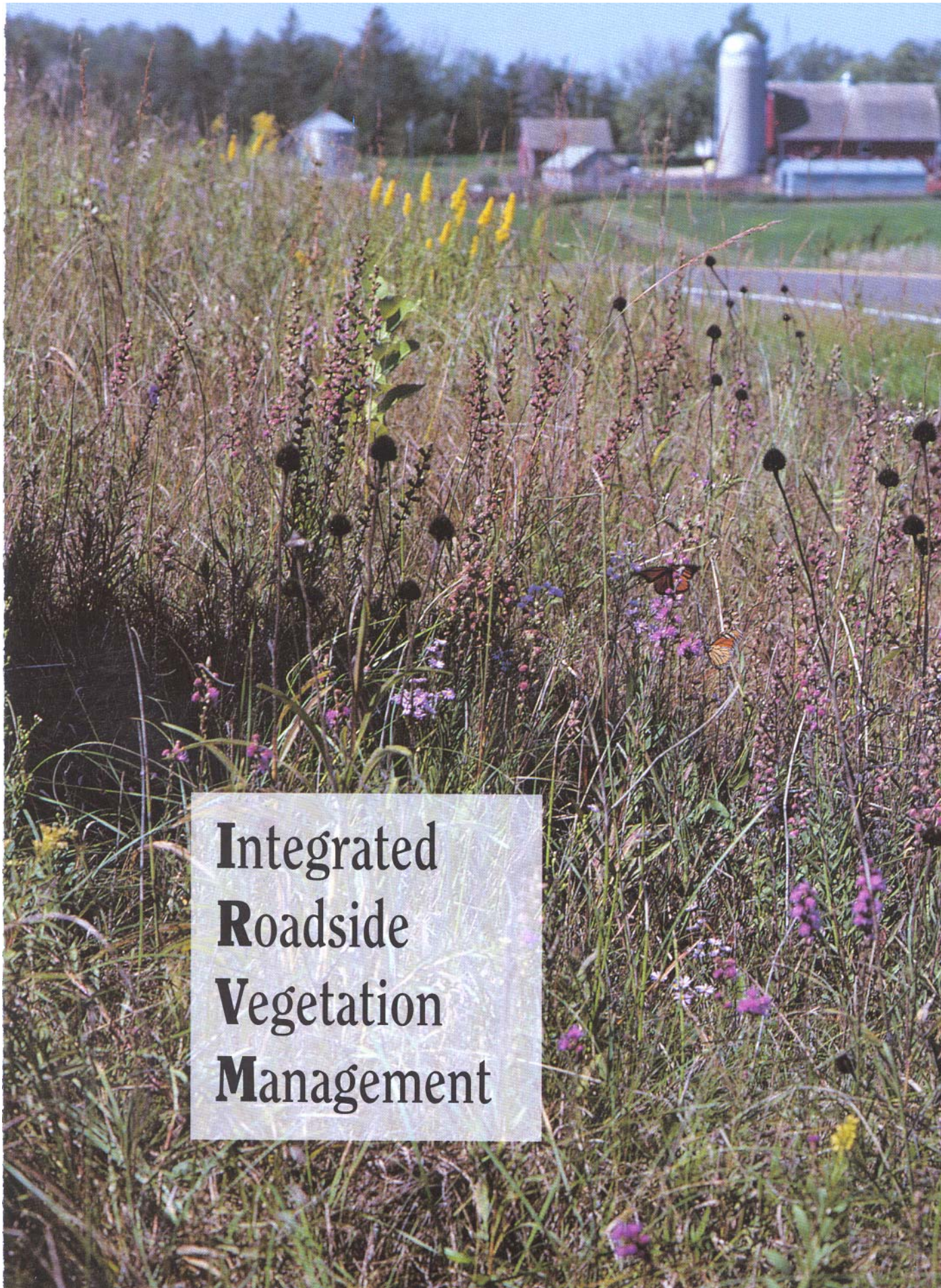
APPENDIX A


Integrated
Roadside
Vegetation
Management

Objective

Using sustainable management practices to establish and maintain a safe, stable, low maintenance roadside that is attractive and healthy for humans and wildlife.

Iowa's roadsides
border an extensive network of federal, state and county paved and gravel roads. Averaging about six acres of roadside per mile of road, we have a potential resource base of almost 600,000 acres of roadsides across Iowa.

When man is aware of beauty and the worth of his resources, he will naturally work to keep what he has and improve what is damaged. Then conservation becomes a way of life.

—Gerald Lyons

Traditional roadside management

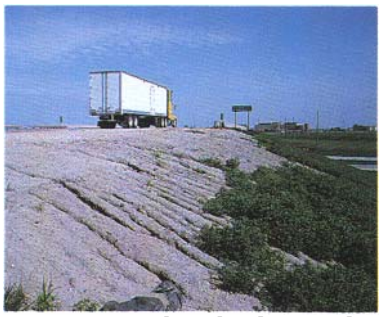
Due to the availability and knowledge of planting and growing grasses from Europe, our early roadsides were seeded with non-native grasses of brome, fescue, timothy or red top. Legumes, such as alfalfa, clover or trefoil may have been included with the seeding. These types of plants are commonly referred to as "cool season" grasses and flowers. They are not native to Iowa, but rather developed in the climate and soils of Europe. Typically they grow during the cool seasons of spring and fall, but go dormant in the hot, dry summer weather of Iowa.

Weed invasion

Over a period of several years, cool season vegetation may lose vigor and begin to die back. When this happens in a roadside, annual and perennial weeds invade and begin to compete with the existing grasses. Before the mid-1980's, roadside crews would spend thousands of dollars every year spraying herbicides to eradicate the weeds that would invade our roadsides. Spraying chemicals did not solve the problem, and in many cases actually resulted in more weeds, not less.

Soil erosion problems

As shallow-rooted, cool season grasses lose vigor, openings develop in the vegetative cover. These openings, especially on steep slopes can be subject to soil erosion problems. Small gullies form in the sloping roadside. Within a short time, roadside



structures such as bridges, culverts, field entrances and the foundation of the road can be seriously damaged.

Integrated roadside vegetation management

Native grasses and wildflowers

More than 30 years ago biologists recognized the value of native plants for roadside vegetation. The grasses, legumes and wildflowers that once comprised our vast prairie landscape are naturally adapted to local growing conditions. With their deep, fibrous root systems and unique photosynthetic pathway, these plants grow vigorously during the hottest months of an Iowa summer. Iowa Department of Transportation and many Iowa utilities now use these plants when reseeding the right-of-way. These plants are the key to reducing maintenance costs and beautifying our roadways.

Prevent weeds and control soil erosion

Integrated Roadside Vegetation Management (IRVM) is a state and county roadside program designed to reduce maintenance expenses and, at the same time, beautify the right-of-way; A community of native grasses and wildflowers is established to protect our roadsides with a dense vegetative cover. Without vegetative openings and dead spots, weeds will not be able to invade and soil erosion will be prevented. Using a variety of grasses and wildflowers provides a better defense against damaging diseases, ravaging insects and uncommon weather conditions. Roadside stability is dramatically improved with a simple change in vegetative covers. As we establish and maintain native grasses and wildflowers in our roadsides, more sustainable management techniques can be implemented.

Seeding native grasses and wildflowers

To develop a plant community, a mixture of native grass and wildflower seed needs to be planted. A typical mixture consists of 4 or 5 grasses and hopefully several legume and wildflower species. The seed mix should match the unique qualities of the specific roadside being seeded. A cover crop of oats, rye or some quick growing vegetation is planted along with the native seed mix. A good cover crop will protect the soil from erosion and shade out competing weeds while the native grasses and wildflowers become established.

Spot spraying

Using herbicides is an **important** part **of** an **IRVM program.**

Plants requiring control should be identified and specific herbicides used during the plant's most vulnerable growing time. Plants; should be sprayed individually to prevent disturbance of the surroundjng vegetation, hence the term "spot spraying." .Most counties implementing IRVM spot spray half their county's roadsides one year and the other half the following year: It may take two or three applications in one year to adequately control a problem weed. Large patches of weeds should be sprayed to eliminate
potential weed seed. The area should then be reseeded with. native vegetation to establish a good permanent vegetative cover.

Mowing shoulders and low visibility areas

Periodic mowing of road shoulders, visually unsafe field and farmstead entrances, and hazardous intersections is a necessary part of IRVM.

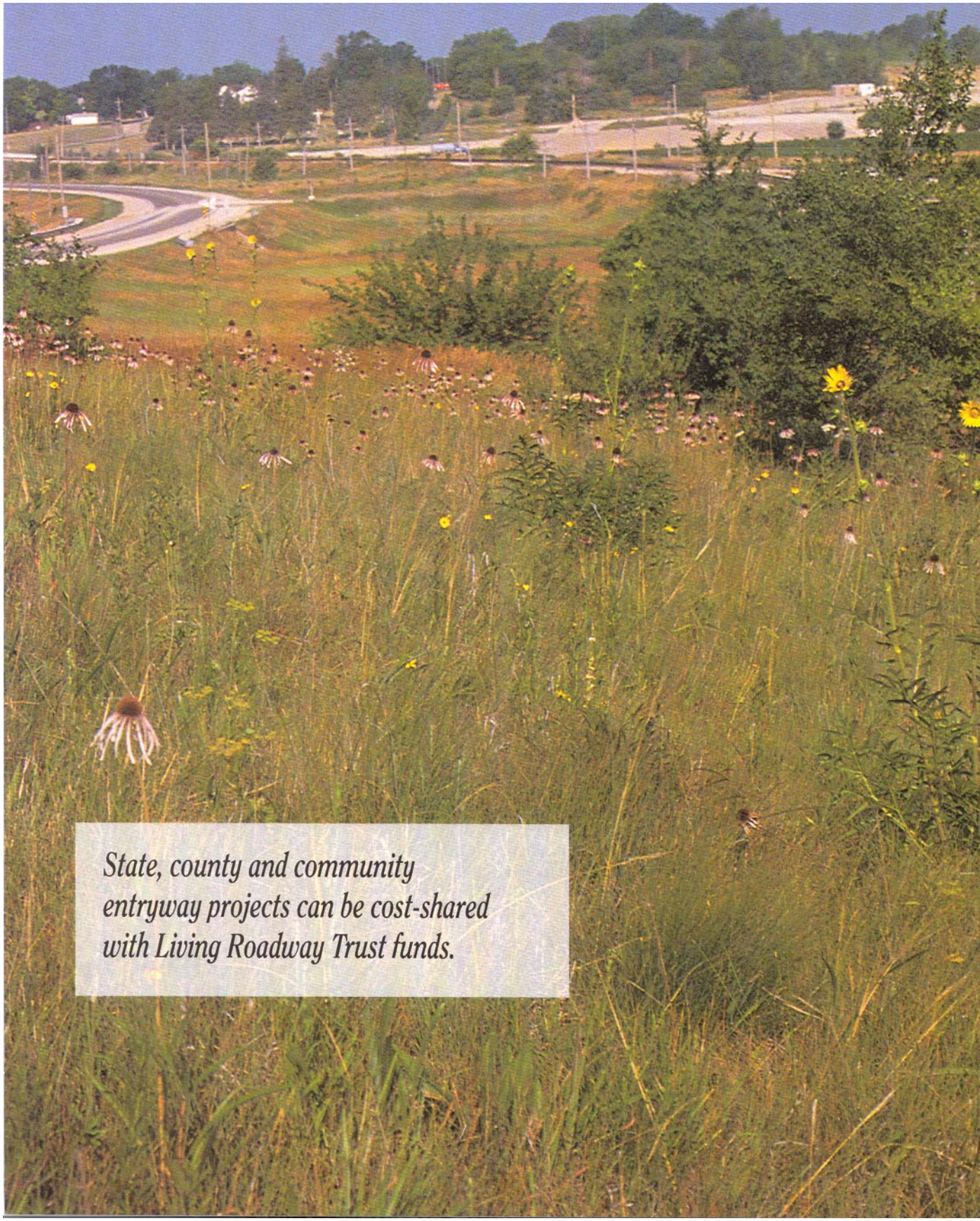
Roadside vegetation should **not** contribute to road dangers and jeopardize traffic safety. Frequent mowing of native grasses and wildflowers will rob the plants of energy and may cause death. Areas requiring frequent mowing should be planted to vegetation tolerant of close clipping. Annual mowing of tall native grasses will not reduce plant vigor if conducted in the fall of the year, especially after the first frost. Mowing the entire right-of-way from fencerow to fencerow is very costly in terms of personnel, equipment and fuel. Maintenance crews should be instructed to resist

public to carry out such excessive mowing campaigns. Heavy mowing equipment easily tears up roadside slopes. Therefore unnecessary mowing should be avoided.

Roadside burning

Every county in the state has roadsides containing actual remnants of Iowa's lost, prairie ecosystem. These native plant sanctuaries deserve our best restoration efforts.

For this reason, safe and properly timed roadside burning is an essential part of a successful IRVM pro- gram. Iowa's native grasses and wildflowers developed plant characteristics that enable them to thrive under periodic burning. Late spring burns will retard the growth of competing vegetation and give native grasses and wildflowers a head start. A roadside burn every three to five years should be sufficient to maintain a healthy plant community. Traffic safety is the most important consideration in roadside burning. Proper weather conditions along with a prescribed burn plan, sufficient fire equipment, water and manpower are essential. Signs alerting approaching vehicles of roadside burning are part of a safe roadside burn.


State, county and community entryway projects can be cost-shared with Living Roadway Trust funds.