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G. Vegetation / Roadside Management

INCORPORATING INVASIVE PLANT ANALYSIS INTO NEPA

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Abstract: One of today's largest ecological problems is biological pollution, or the spread of invasive plant and animal species. We lose 4600 acres daily to new weed infestations. The ecological and economic costs to the nation are staggering (Westbrooks 1996). In response, the Federal Interagency Committee on the Management of Noxious and Exotic Weeds (FICMNEW) helped draft Executive Order 13112. All 16 agencies involved were responsible for the field guidance that followed (NISC 2001). In accordance with the EO 13112 goals of prevention, control, restoration, and education, FHWA sent guidance to all state Departments of Transportation asking that analysis of invasive species be incorporated within the NEPA process. The 1999 guidance was aimed at preventing the spread of weeds on highway projects and through maintenance practices (Harper-Lore 2000). State case studies will demonstrate how this Executive Order was incorporated into national policy and translated to highway construction and maintenance projects.

The Importance of Early Analysis

We all have learned that whenever soil is disturbed, opportunistic plants are likely to fill bare spots. Some of these plants are early successional and short-lived plants, about which we do not worry, i.e. lambsquarters (*Chenopodium berlandieri*) and curly dock (*Rumex crispus*). They do not exist for long. It is the plants that capture a site quickly and tenaciously persist over time that raise concern. Plants like purple loosestrife (*Lythrum salicaria spp.),* yellow star thistle (*Centaurea solstitialis*), spotted knapweed (*C. maculosa*), leafy spurge (*Euphorbia esula*), giant reed (*Arundo donax*), common buckthorn (*Rhamnus carthartica*), multiflora rose (Rosa multiflora), saltcedar (*Tamarix spp*.), Russian olive (*Eleagnus angustifolia*), and tree-of-heaven (*Ailanthus altissima*) that cause economic and ecological harm. Their impacts and costs are well known. How do we then prevent them from pioneering into disturbed sites? How do we minimize the disturbance, especially in highway construction and maintenance projects? Since highway corridors crisscross the nation, how do we minimize the spread of invasive plants through and from the corridors? These are questions we must answer before the disturbance takes place.

Because of EO13112 and its subsequent guidance, all highway construction will be analyzed early in the NEPA process, before highway design or construction specifications are completed. By analyzing the existing site and adjacent lands at this point, modifications can be made to minimize impacts and design management plan to deal with invasive plants already on site. Thus invasives can be prevented and controlled through design, site preparation, construction methods, contract specifications, and project monitoring.

Research is Needed

To identify invasive threats in soils and adjacent lands

Of course, much remains to be learned about prevention of invasive plants on disturbed sites. In order to identify existing and adjacent weeds, we must do more than write a presence list while walking the potential construction limits. Many invasive plants have long seed viability in the soil. Therefore we have a new challenge, to analyze the soils on a project before we disturb them. We need to find a way to field test these soils to identify the problems that are out of sight. A soil analysis, at this time, can only be done through field collection and greenhouse propagation to identify the weeds waiting for the disturbance on which they will thrive. This takes a lot of time and patience, plus excellent botanical skills. How might we identify the seeds themselves?

1. Determine seed and plant identification techniques for field use.
2. Design a soil field test that identifies the extent of threat.
3. Develop an inventory technique that allows mapping of weeds that can be incorporated into geographic information systems (GIS).

To determine cost efficiency
Another cost of weeds is controlling them and/or restoring sites after construction. If we do not eradicate them up front, they will linger as competition for desired plants for decades to come (Curtis 1959). If we are not aware of the invasives on the site, we cannot take appropriate precautions to minimize them, i.e. wash construction equipment before it arrives or departs each segment. Naturally, there is a need to avoid bringing weed seed into the construction zone, through imported soils, mulches, sods and other plants added for purposes of erosion control, mitigation, turf establishment, landscaping, etc. Arranging these specifications with weeds in mind can save time and money later.

To track effectiveness over time
We have no long-term assessments of invasive plants and their control on construction and maintenance maneuvers over time. In the 50's, DOTs used a combination of mowing and spraying to remove existing weeds. In the 70's, they aimed at reducing mowing and spraying. In the 90's, DOTs moved towards being proactive with the weed issue and began looking for ways to prevent weed establishment and movement up front (Harper-Lore 2001). We do need studies to learn if our existing best management practices are effective and cost saving over time.

Existing Practices
The Wyoming Department of Transportation (DOT) has been using an ecological strategy since 1991. They along with other States in their region require the use of weed-free forage to be used as mulching on construction and other planting projects. The State Departments of Agriculture have cooperating in setting up certification of these mulches. Thus one more avenue for weed introduction into a project is closed.

Wisconsin has joined an interagency, interdisciplinary State association to work on that State's weed issues. Through information sharing and support, Wisconsin's DOT is likely to make great strides in weed control.

State Weed Councils are organizing everywhere. The Wyoming DOT also belongs to a weed council. New Hampshire has also worked with their Department of Agriculture to release biocontrol beetles to reduce purple loosestrife infestations. The Vermont DOT is experimenting with biocontrols also. They used a Minnesota Department of Natural Resources model for rearing the beetles (*Galerucella spp*.). Releases have occurred on 20 sites, which are being monitored. New Mexico Highway and Transportation Department has joined 33 groups in a Memorandum of Understanding (MOU) that draws together all levels of land managers to work on Coordinated Weed Management Areas throughout the state. The MOU should lead to inventory, management, prevention, and eradication of invasives throughout the state.

The Colorado DOT is inventorying all rights-of-ways to identify presence of noxious weed species. Knowing what already exists will lead to improved planning for and management of invasive species on highway upgrades and new projects. Utah's DOT has led the response to the Executive Order 13112. They formed an internal team of design, construction, maintenance and environmental divisions. Along with the Utah FHWA Division Office, they defined how invasives would be included in the NEPA decision-making process. Appropriate Best Management Practices (BMPs) were also defined.

During the concept phase, determine impacts that would spread noxious weeds.
1. Include a Special Provision in contracts for "Invasive Weed control".
2. The Special Provision provides for the following BMPs:
   A. Cleaning all earthmoving equipment before entering a project,
   B. Minimizing disturbance of areas known to be infested with weeds,
   C. Minimizing soil disturbance anywhere in the right-of-way,
   D. Monitoring and controlling disturbed areas and soil stockpiles,
   E. Renegotiating bare soils as soon possible after disturbance,
   F. Controlling weeds with pre-emergent, herbicides,
   G. Including payment for equipment cleaning under mobilization,
   H. And paying for control of weeds as a separate bid item.

Implementation of EO 13112 on invasives will be studied by each state DOT. One by one they will determine their best practices to prevent, control and monitor these weedy species. As new research provides new tools and proves cost and time effectiveness, more Departments of Transportation will be proactive. They are one of many partners needed to wage this war on weeds.

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SETTING REGIONAL ECOLOGICAL GOALS FOR ROADSIDE MANAGEMENT

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Abstract: Native plant advocacy groups have advocated the concept of "natural roadside management". These groups typically press state departments of transportation (DOTs) to incorporate this concept into their roadside management. As a result, many DOTs have since increased emphasis on the use of native plants. Justification for the emphasis on native plants in the roadside typically focuses on the assumed lower maintenance requirements and their hardiness. Experience in Texas Department of Transportation's (TxDOT) roadsides indicates these assumptions are either false or must be carefully qualified. Because most native plant advocates speak from a specific area of concern such as wildflowers, prairies, or simply the broad category of native plants, it is often difficult for these advocates and roadside managers to understand each other. This derives from the manager and advocate having an incomplete understanding of each other's perspective, language, and goals. This paper proposes that more effort needs to be made towards creating measurable connections to regional ecological issues, and then expressing those in terms of accomplishable tasks. Looking outside the right-of-way is the best way to connect to meaningful ecological issues. A three-stage process is proposed that may be used to develop roadside projects that have an ecological focus. These stages are: 1) investigating feasibility, 2) formulating a specific goal, and 3) developing program tasks. The process stresses a connection to the culture and community of the region, as well as to other agencies and organizations.

Introduction

Over the last decade, native plant advocacy groups have urged that the concept of "natural roadside management" be incorporated by state departments of transportation (DOTs) in their roadside management programs (Bassett 1999; Evink 1998; Ritzer 1990). As a result, many DOTs have since increased emphasis on the use of native plants. It is difficult to say exactly how far this concept has come and to what degree actual changes have been implemented in roadside management practice. There has been no comprehensive study that characterizes the nation as a whole regarding this issue, only snippets of information and much of it anecdotal in nature.

Discussions of roadsides within the ecological literature have mostly related to the subject of "conservation corridors" (Saunders and Hobbs 1991; Bennet 1991). This concept recognizes the fragmentation effect of development over long periods and the negative impact it has on many species of animals and birds. Developed as a result of work leading to the theory of island biogeography (MacArthur and Wilson 1967), the approach is considered by many writers to be a valid approach to aiding in the survival of species populations (Rosenberg et al. 1997; McDowell et al. 1991; Bennet et al. 1994). On the other side of the issue, some authors question the viability of such corridors either in terms of their cost of management (Simberloff and Cox 1987) or their possible negative impacts on species health by allowing the spread of disease (Hess 1996).

This paper will not attempt to settle the issue. In any event, the author cannot find any specific effort in the United States to establish conservation corridors within a highway roadway. A program that may provide a model for U.S. DOTs is in place in Australia (Straker 1998). The Roadside Conservation Advisory Committee of Victoria (RCAC) was established in 1975 to provide a forum for government, agency, and community organizations involved in the natural resource management of linear reserves and the management of the indigenous habitat located within the road reserve. The program promotes conservation of roadside habitats and the protection and enhancement of indigenous vegetation and flora communities as well as providing advice and products to groups working within the road reserve. It should be noted that many of the roadways targeted by this program are very wide, contain a significant amount of land area, and historically used as corridors for driving livestock to markets. However, their program may provide a model for U.S. DOTs at least in their recognition of the need to protect key animal species and plants. However suitable the model may be, it will still need to address a series of basic issues in U.S. DOTs.

Despite the question of viability of linear corridors, it is well documented that highways can contribute to the fragmentation of habitat, sometimes having a severe barrier effect on the movement of some animal species. These include snakes, cougars, amphibians, goats, elk, bear, wolves, and fish, to name only a few. The response has been to incorporate crossings into highway projects to mitigate their effect as a barrier. These have been incorporated in many states and are now an accepted practice within the transportation industry (FHWA 2000).

The acceptance of crossings as a viable technique to improve the environmental fit of a highway is due to its clear benefit to an ecological issue of significant ecological merit that extends well beyond the confines of the highway itself. It should also be noted that crossings are feasible in terms of design, fit within maintenance capabilities, and do not represent an unreasonable demand for extra funding. Crossings do not require difficult monitoring or upkeep nor are they likely to generate unfavorable responses from nearby landowners. They also photograph well and demonstrate a proactive initiative by the DOTs.

Crossings and corridors are examples of the scale of design that should be considered when looking to the roadside as a contributor to ecological health. Restoration of even small sites can be labor and cost intensive. It is very hard to justify large expenditures of money and energy simply for the sake of a preferred landscape aesthetic that occurs on a strip of land that is only a small fraction of the larger landscape. Despite the small relative size of the roadway, it should be made to support whatever ecological function for which it is best suited. The thesis of this paper is that the nature of this function must derive from the larger landscape and that with careful selection and planning, some roadsides may be able to contribute to the ecological health of the region.

Fig. 1. Restoration within the roadside should be rooted in large-scale ecological issues.

Assumptions Regarding the Promotion of Native Plants

Many DOTs have been urged to change their programs to utilize only native plants in roadside planting design. This may be appropriate in many cases but not all. Native plants are typically promoted because they are native rather than for any specific ecological function. Justification for the emphasis on native plants in the roadside typically focuses on the assumed lower maintenance requirements and their hardiness. Experience in TxDOT roadsides indicates these assumptions are either false or must be carefully qualified. Native plants evolved as part of a system of interrelated organisms and processes. Any qualities of hardiness or vigor must be referenced to those conditions.

Selecting a preferred plant out of such a system and inserting it into a completely different set of environmental parameters will likely not be successful. An example of this phenomenon in Texas illustrates this very well. Yaupon (*Ilex vomitoria*) is a common, small, evergreen tree in Texas. They are widely available either as collected plants or raised in containers and typically occur as understory plants within the canopy of larger trees. Their root system is very shallow and suckers develop easily. They live through the toughest drought and coldest winters, and female trees sport red berries in the winter.

Despite the ubiquitous nature of this plant in the wild, planting success on the roadside has been dismal. Plants were installed in rows within turfed areas of the roadside; completely exposed to the elements. Soil temperatures in the sparse grass can easily reach 120 degrees F, the slopes drain quickly, and there is little or no organic matter in the roadside soils. On the other hand, when this plant is installed as part of a community of native plants with proper attention to soil improvement and surface mulching, success can be dramatic. This has been the case at a TxDOT project in Austin, Texas.

In 1993, the author, working with a team of landscape architects, engineers, and managers, developed a replanting program for a new urban interchange (http://tti.tamu.edu/enviro_mgmt/projects/mopac/) (Figure 2) that focused on native plant community establishment. The design mimicked the native plant associations from the surrounding landscape, arranging these in large groups throughout the site. The plant pallet included over sixty species along with seeding of a dozen more. Plant diversity ranged from grasses and forbs to canopy trees planted in a variety of sizes. Composted tree trimmings from the area were used to recreate the moist, high-organic litter typically found in native plant communities. Vegetation management in the 95-acre site is focused on improving erosion control and water quality. At the end of two growing seasons the plant groups were beginning to close in and create the beginnings of a micro-habitat for birds and small mammals. The development process has continued with species being lost and gained as competition, invasion, and climate shape the groups. Today, viewers would think the landscape had always looked that way and that the DOT did a great job of gently placing the bridges among a native landscape. Amid the context of a highly developed urban area, this site now contains a diversity of vegetation that can support some of the bird life that would be missing in a park-like planting.

Fig. 2. Urban interchange with native plant community establishment.

This example illustrates the difference in approach that offers a more viable and logical approach to roadside planting. The perceived benefits of native plants will in almost every instance be the result of the aggregation of a diverse set of species. Rather than the aesthetic character of a single plant being the goal, the ecological process becomes the focus. As a system, these processes and interactions may then provide real benefit to ecological health by enabling a wide range of subsidiary interactions related to the formation of a viable microhabitat.

Support for this radical (at the time) departure from past planting design approaches was achieved by highlighting the importance of connection to the significant issues of water quality and avian habitat restoration. Focusing on ecological process and demonstrable improvements in environmental health is a better justification for more careful planning, more funding, added training, and public/private partnerships. Any meaningful effort will necessarily compete for funding with many other roadway issues. To garner a share of these funds, the initiative must be saleable both to and by those responsible for making those decisions. Focusing on tangible benefits, even if they cannot be fully quantified in economic terms, is both appropriate and much more likely to result in long-term improvements to native plant populations as well as an improvement in aesthetic appearance.

Can the linear character of highway roadsides be connected to broader ecological issues that might warrant special design and management? The answer of course depends on a lot of issues, some which may be daunting. Most of these will be related to the following issues.

- Scope and merit of the project
- Nature of the roadway
- DOT management resources
- Funding
- Communication

Understanding these will help determine the viability of a proposed project.

Scope and Merit of the Project

The proposed improvement should be developed in relation to an issue outside the right-of-way. This may be in the form of a strong connection to the landscape immediately adjacent to the roadway or to wider ecological issues that are more regional in scale. Regardless of the scale, the connection must be substantive. Due to the size of the areas being considered for development, the expense will be substantial. In order to merit this type of expenditure, the need must be real and widely perceived as being worth the effort. The effort cannot be simply a mere gardening exercise or be "something that would be nice" only in terms of aesthetic character.

The goals of the project must have wide support and be clearly recognizable as a worthwhile initiative. This allows decision-makers to feel confident about supporting the goals despite their cost or other accommodations. This is especially true when the program will be unique and sure to gather wide attention. State bureaucracies such as DOTs tend not to suffer gladly those individuals who attempt to stretch the envelope and fail. Notable or extensive programs that require significant funding will have the best chance of moving forward when enough individuals are involved so that 1) the shear weight of numbers of persons involved reinforces the validity of the effort and 2) enough persons are involved that no single person could be singled out for blame if the effort fails.

Nature Of The Roadside Environment

The character of roadways is virtually identical across the United States (Figure 3), the result of design standards developed and shared through the Federal Highway Administration (FHWA) and the American Association of Highway Transportation Officials (AASHTO). Most roadways are placed on re-consolidated soils compacted to near maximum density. Areas of cuts may expose deep parent material that is very different in character from undisturbed soils outside the right-of-way. These slopes, some approaching a 3:1 gradient or steeper, may be covered with a layer of "topsoil". Drainage to protect the foundations of pavements is engineered to be positive, usually in the form of a v-shaped swale. These are collectors of eroded soils and frequently have a soil profile different than other areas in the roadside but areas outside the excavated areas may retain the original soil profile, plant community, and seed-bank. The corridor or sites must be suitable in terms of soils, slopes, and moisture regimes relative to the intended goal or at least be realistically capable of being restored. In many cases, this will be very difficult.

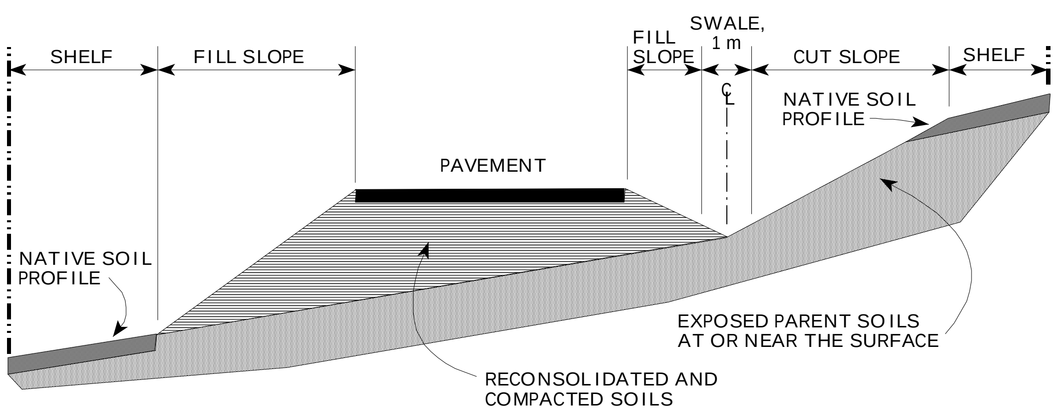

Fig. 3. Typical roadway section profile.

The highway roadside is a very dynamic environment. It is often used by a number of agencies such as electric, gas, water, sewer, and communications. Adjacent landowners often appropriate the roadside in front of their properties and treat it as their own by simply mowing it or in some cases, using it as retail display space. In rural areas, roadsides are often used to move farm equipment between parcels resulting in impromptu dirt lanes. The author's experience in roadside research confirms that long-term control will require physical barriers to prevent disturbance and that in some cases, such as fire, even this will not be guaranteed.

The corridor or the selected sites though a corridor must be able to be physically controlled to prevent unwanted disturbance. Two characteristics are needed: stability and consistency of management.

Stability. Most areas in need of ecological healing became that way due to some sort of disturbance or even destruction. The restoration of an ecological process that once existed in a stable system logically implies that stability is one of the end-result characteristics of the restored function. Most ecological functions include a complex set of relationships of myriad components that may take a long period of time to become present and functioning.

Consistency. Rather than stability, a project or program may call for a particular type of management to maintain a set of conditions. In such cases it may be desirable to perform a special treatment(s) to attain a certain ecological state and to prevent any other activity from occurring on the site.

DOT Management Resources
A key issue is the skill level of managers responsible for overseeing the project. In this regard, DOTs are usually woefully lacking. Vegetation management is an important department of DOTs whose focus is usually limited to controlling vegetation height and weed control. These activities are well codified and training is widely available. Their functions can easily be contracted and are sometimes performed by fairly low-wage employees. This is in contrast to the specialized knowledge needed to develop and manage what may amount to an ecological restoration or reclamation effort. Very few DOTs have this type of skill available on-staff. Even when present they may have responsibility for an entire state, based in a division-level office. In most cases, the critical management oversight will be carried out at the local “area office” level. In TxDOT, maintenance supervisors perform this task. They are responsible for monitoring roadway construction projects, maintenance projects such as resurfacing and repair, as well as vegetation management tasks such as mowing and herbicide application. Typically, less than ten percent of their time may be devoted to vegetation related issues. With this focus for their job duties, it is easy to see the justification for their lack of training in environmental management. Even with basic familiarity of such issues, ecological restoration often requires complex judgment in the face of changing conditions, a difficult task to ask of someone with limited training.

Added Costs for Ecological-based Projects
The cost of ecological restoration can be considerable. Items such as soil rehabilitation, seeding, mowing, burning, weed control, etc., can add up to hundreds of dollars per acre, even thousands. A few miles of roadway corridor can quickly add up to significant expenditures. It is likely that the majority of environmentally concerned activists are unfamiliar with the details of these costs, even if they understand them to be high. Some may feel that these costs can more easily be met by getting a large state agency to foot the bill. This may not be an unreasonable point of view. The presence or absence of a responsible party determines who pays the costs of restoration (Holl and Howarth 2000). An offending party may be required by law to pay the costs of restoration either through fines or bonds. When no responsible party can be identified, funding must come either from taxes, voluntary contribution of labor or money, or private sources. These are represented as coming together in the form of public/private partnerships for the actual work of restoration. This model is certainly relevant in this case since we are seeking ways to assist the healing of damage that may have accumulated over many years and through many people. Under their model, additional funding for a legitimate ecological goal may be considered as a reasonable use of tax dollars. The key may lie in whether or not the efficiency of the agency is suitable to accomplishing the program. It may be that in some cases, other agencies or organizations may be better equipped.

Communication
Through discussions at conferences and individual contacts within the DOTs, as well as persons within advocacy groups, the author has found a general dissatisfaction and confusion on issue of when and where to use native plants. DOT managers have expressed frustration due to a lack of specific information about how to apply what they consider vague notions about “natural roadside”. Many also feel they are unfairly criticized for the work they do. Advocacy groups are dissatisfied with what has been accomplished so far and are confused as to why these principals have not been eagerly and more quickly adopted by DOT roadside managers.

Because most native plant advocates speak from a specific area of concern such as wildflowers, prairies, or simply the broad category of native plants, it is often difficult for these advocates and roadside managers to understand each other. This derives from the manager and advocate having an incomplete understanding of each other perspective, language, and goals. Advocates frequently have a poor understanding of the goals and priorities of highway design and management, or of the political and budgetary constraints involved. Similarly, roadside managers are often unfamiliar with the overall goals of the advocacy group, and often have less of a background in the environmental sciences and the terms used.

The lack of communication between these two sides makes it difficult to meld two fundamental points of view. The environmental advocate tends to look at the broadest implications of an ecological issue. For them, the issue of plant or animal diversity is clearly perceived in terms of the long-term effects on the human condition. The magnitude of the potential downside provides all the necessary incentive and urgency, becoming a generally accepted assumption. While the assumption may be valid, it does not carry with it any obvious, specific guidance on how to deal with the situation within any specific field of human activity. Roadside managers find their days concerned with site-specific issues that are governed by long established practices. Communications within their sphere is based on scheduled, measurable tasks that form the basis for a legally enforceable contract or that meet statutory requirements. Details on how to meet these requirements are not just convenient; they are indispensable. These basic viewpoints are as two wheels to the same cart but lacking a good horse. The horse in this metaphor is a common goal that is both specific in its ecological intent and also measurable in terms of its application as a management practice. Doing so provides specific tasks that can be developed, taught, enacted, monitored, and evaluated.

Application of an Ecologically Based Approach

Applying this approach will be very site and issue specific, as all are ecological restorations. However, the process used may vary only slightly. A suitable model (Figure 4.) should include at least the following phases.

- Investigating feasibility
- Formulating a specific goal
- Developing program tasks

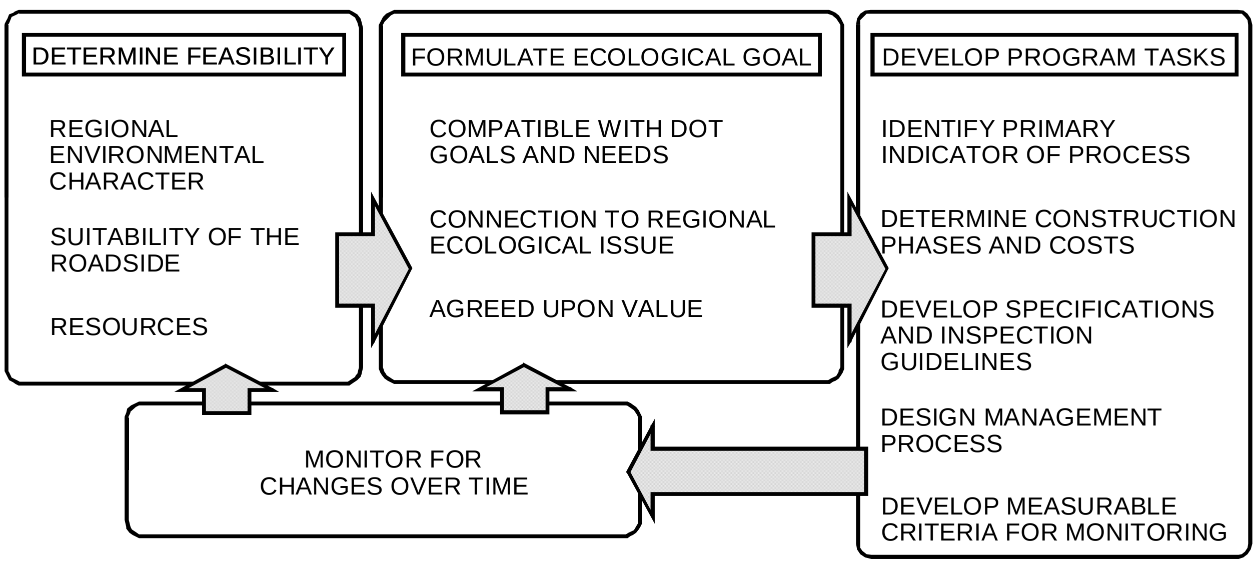

Fig. 4. Process chart for developing ecological goals for roadways.

Investigating the feasibility of a program or project site is necessary to determine early if the basic necessary components are present and suited to the general goal of restoration. This includes the character of the surrounding environmental quality, roadway suitability, and the degree of DOT support that can be expected. Surrounding landscape issues include:

- Water quality issues – determine location, flow courses, and quality of surface and subsurface water
- Plant communities – characterize present and historical vegetation patterns and condition
- Cultural issues – present land use types, historical land use patterns, anticipated future development or changes, and landowner attitudes

Formulating a specific goal involves identifying the ecological issues or conditions that might reasonably be addressed as part of a roadside program. If a realistic and substantive ecological issue cannot be developed into a stated measurable goal, developing long-term support and funding will be nearly impossible. Decision makers will not support an effort that has no demonstrable benefit. The task considers:

- Compatibility with DOT goals and needs – ideally the program would address issues the DOT is required by statute to deal with.
- Significance of ecological goal – the goal must be connected to a significant ecological process or condition.
- Value of program is agreed upon – all participants must understand the expected outcome and agree that it is worthwhile to pursue.

Developing program tasks involves detailed planning to determine the specific tasks necessary to accomplish the project goal. The detail must be specific enough to allow designers to develop meaningful criteria to be used in the construction, installation, management and evaluation phases. It includes:

- Identify the primary indicators relative to target ecological processes.
- Determine the construction needs and scheduling phases with cost estimates.
- Develop detailed specifications and contracting guidelines, including inspection guidance.
- Design a preliminary, long-term management process.
- Develop measurable criteria to be used to monitor site(s).

Developing Connections to Ecological Issues

The range of possible environmental needs that might be addressed within the roadway is understandably more limited than in remote, unused, secure sites. The basic nature of the roadside and its diversity of activities is a severely limiting factor for the great majority of possible goals. However, this will also be affected by the scope and nature of the ecological goal. For most goals, a rural corridor will likely be most appropriate but even smaller sites, such as those found in urban interchanges, may offer the opportunity for a meaningful ecological enhancement.

An ecological goal may not need to provide overwhelming improvement to broad scale environmental problems or issues. In some cases, the benefit only needs to be a fairly obvious and largely unarguable and sensible thing to do. In such cases, other benefits such as improved public relations may carry the necessary weight to achieve agreement to proceed. Of course all this will be balanced and colored by budget and long-term resource needs.

Fig. 5 Potential roadside sites can be identified for conservation as well as maintenance practices.

Even the obvious benefits of a particular goal must be rooted in sound science. This serves to confirm in everyone's mind that support is well justified as well as providing the basis for design and management procedures. This may also identify different ways of thinking about the possibilities for a site. For example, because of the many disturbances that roadsides commonly receive, weedy forbs are usually a prominent component of the vegetation matrix. Some of these, even non-native species, may have value if insect populations were a principal part of the ecological goal.

Insects form the base of an intricate food web that supports small mammals, reptiles, amphibians, and birds. This group in turn, supports larger mammals in addition to aiding in seed dispersal, pollination, and nutrient recycling. Together, all of these contribute to the general health and diversity of the ecosystem as a whole. Areas where crops or grazing have removed much or all of the native grass communities may benefit from increased insect habitat (Dyer and Landis 1997). Research has documented the importance of vegetated strips to crop farming (Lewis 1969; Varchola and Dunn 1999). It has been shown that even small patches, strips, and hedges can shelter many different species of insects (Fahrig and Jonsen 1998). Many of these are insects such as wasps, beetles, and spiders that prey on agricultural insect pests (Wathern 1977). The strips provide shelter, summer aestivation sites, over-wintering sites, and breeding areas (Bhar and Fahrig 1998). Grasslands have been shown to have better properties than forests for many species of insects (Sotherton 1985). Research also shows that native plant communities and many typical roadsides share some of the characteristics of productive insect habitat. Native grassland communities that are in a state of middle-succession seem to offer a higher quality habitat than mature, less diverse communities (Dyer and Landis 1997). The disturbances typical of many roadsides provide more flowering food plants as well as open soil for some insect species, conditions that enhance insect habitat (Wratten 1998; Jansen 1992).

These studies suggest that workable criteria could be developed to identify potential roadside sites (Figure 5) for conservation, as well as maintenance practices for results that are highly site-specific. Mowing or other disturbance activities, usually considered negative, might be desirable if it were found to be compatible with certain flowering, weedy plants that a desirable insect can use as habitat. Using the previous process chart (Figure 4), designers (both public and private) can determine if such an initiative is likely to succeed. Local agricultural agents and landowners could aid in identifying and characterizing the nature of the issues. Land management practices can be identified. Pest and beneficial insect populations can be explored in vegetation communities of the area. Once the nature of the insect populations is described, an appropriate plant pallet can be developed. The type of insects in question will determine the optimal time for appropriate management practices. Fundamental criteria using simple measurements of vegetation structure and diversity (particularly the presence of potential food source plants) would be needed.

The entire process suggests that a multi-disciplinary team will be needed, significant fieldwork may be required, and meetings with landowners must be held. It has been the author's experience that these are requisite aspects of a viable program if it is to endure and actually make a meaningful contribution to the environmental health of our communities.

Conclusions

Improving the ecological fit of our highways includes and requires developing meaningful ecological goals for the roadside. This paper proposes that more effort needs to be made towards creating measurable connections to regional ecological issues, and then expressing those in terms of accomplishable tasks. Looking outside the right-of-way is the best way to connect to meaningful ecological issues. It also implies a connection to the culture and community of the region, as well as to other agencies and organizations.

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WHERE THE FOREST MEETS THE ROADSIDE: WHY STATE DEPARTMENTS OF TRANSPORTATION MANAGE FOR GRASSLAND COMMUNITIES

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Abstract: Through a sampling of State highway maintenance practices, this paper explores how over 10 million acres of State highway rights-of-way can be converted to conservation acres. States plant and preserve native grasses and forbs, and hold back forest succession to create clear zones for the safety of highway users. This paper explains the clear zone's importance to the traveling public's safety and the evolution of policy towards the use of native plants, specifically grasslands, in clear zones. Incorporating grassland management to those rights-of-way, can result in additional conservation acres and safe travel.

Where the Forest Meets the Roadside Highway Safety Will Always be the First Consideration

Because highway safety is the number one priority of highway agencies, highway authorities are required to provide a safe and comfortable ride to all highway users. Because safety is job number one, all other practices are influenced. For example, guaranteeing good visibility along the road and at intersections, requires maintenance of low-growing or mowed vegetation. To offer a recovery area for errant vehicles or pull-off zones for mechanical failures, a shoulder and clear zone are maintained free of woody vegetation. To prevent fatalities, obstacles, including trees of 4-inch caliper or greater, are not allowed within 30 feet of the road's edge. All that is done in the name of safety could be achieved by installing native grasses and forbs or grassland communities. They require less maintenance, allow pull-offs, and slow down errant vehicles. Since every State has a naturally occurring grassland community, every State can look to its meadows, prairies, etc. for vegetation models.

Forest edges next to roadsides conflict with safety objectives. When trees grow near the pavement edge they reduce visibility, allow wildlife to intrude, create crash obstacles, shade pavements increasing icy conditions, and fall into traffic lanes during inclement weather events. Trees are considered safety hazards for many reasons. However, the traveling public regards trees near the road as sources of shade, comfort, and beauty. Arching trees that create a shady tunnel effect, such as those on the winding roads of New England, are expected by tourists. Groves of old oaks that represent strength, history, and natural beauty in the Midwest entice travelers along rolling roads through hills and valleys. A mix of pines and palmettos lining roadways in the Southeast evoke memories of past vacations. The aspens, firs and spruce stand out against clear, blue Western skies beckoning travelers upwards or beyond towards the seashore.

In order to maintain practical grassland, especially where the forest edge meets the road, we must manage the grassland vegetation to avoid encroachment of the forest and/or discourage natural, old-field succession of the grassland. The result is highly visible to the highway user. The trimming or removal of any trees along highway systems is likely to evoke complaints. Thus for safety and public acceptance, maintaining grasslands and holding forest succession makes sense. Add the resulting seasonal diversity and color of native wildflowers to the mix and the public discovers another kind of roadside beauty, with forests serving as a backdrop, out of harms way.

Roadside Management History

In 1936, J.M. Bennett wrote the book, *Roadsides, the Front Yard of the Nation.* My observation of roadside history is that the title of this book became an unwritten policy as roadside development became a goal of State highway agencies. Intense roadside maintenance was common (Bennett 1936). The 1950's saw a mow-spray method of vegetation management across the country, which maintained our highway rights-of-way as front-yard looking turfs. Americans came to expect this level of care.

The 1970's brought an end to this fuel-using, air-polluting, labor-intensive, and costly use of highway resources. The energy crunch forced many DOTs to find alternatives that were more holistic, using less resources. An ecological approach began to emerge.

Some twenty years later, in the 1990's, conservation became a "driving" force in roadside care thanks to the continued efforts of each State's DOT and new guidances from the FHWA. It was as if the conservation ideas of 1950-70 were rediscovered. The Executive Memorandum of 1994 called for the increased use of native plants as much as practicable. The EO13112 suggested unprecedented cooperation and communication about weed control. Subsequent guidance recommended the early analysis of weed potential on highway projects through the NEPA analysis. States became increasingly proactive (Harper-Lore 2000).

Research Needed

Much remains to be learned about effective and cost-efficient vegetation management of highway corridors. Further research can teach us how to work with succession and understand how forest communities can be incorporated into solutions that provide safety and conservation values. We need to know how to:

1. Determine the correlation between deerkill and the proximity of the forest to the road's edge.
2. Explore the relationship of roadside mowing practices and large mammal mortality.
3. Define the optimum mowing cycles to preserve safety, yet reduce maintenance costs.
4. Survey highway user expectations and determine what they will accept for safety and conservation goals of roadsides.

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