PUBLIC PERCEPTION AND SUSTAINABLE ROADSIDE VEGETATION MANAGEMENT STRATEGIES

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ABSTRACT

Sustainable roadside vegetation management strategies limit the amount of non-native turf grass and include meadows of native warm season grasses and/or flowering perennials, and masses of native shrubs and trees. Sustainably managed roadsides can contribute to a matrix of economically conservative, environmentally responsible and aesthetically pleasing landscapes. Implementation of sustainable strategies may result in cost savings, better water quality and conductivity, improved safety measures, increased biodiversity, benefits to the socioeconomic health of the state and conformity to state and federal legislation. Sustainable strategies only provide optimal cost savings and enhancement of environmental stewardship when implemented consistently. Aesthetically, sustainable landscapes often represent a departure from the traditional expectation of how a roadside landscape should appear. Lacking an awareness of the inherent values present in sustainably managed roadsides, the public is often hesitant to accept this atypical, and oftentimes less manicured aesthetic, causing many Department's of Transportation (DOT's) to revert to traditional management regimes. Many state DOT's maintain active ties to the public and political communities of their state and bow to the wishes of these communities when appropriate. Because they are often called upon to defend their design, management and operating procedures, DOT's have a new role in raising awareness, assessing perception and informing the public about the benefits associated with sustainable roadside vegetation management strategies.

INTRODUCTION

Roads consume many miles of land and leave in their path vast tracts of rights-of way that must be safely and efficiently managed and maintained in a manner that complies with state and federal regulations. With over 8 million acres of land in the United States devoted to roadways and an additional 12 million more devoted to their rights-of-way (*1*), U.S. departments of transportation (DOT's) are positioned as leaders in stewardship of public land.

In their most utilitarian form, roads facilitate the transport of people, goods and services. However, they also play a pivotal role in community and economic development by connecting people and places. The 20th Century triumph of the automobile eased movement along greater distances while providing a convenience not previously afforded. The birth of suburbanization, an influential byproduct of the automobile's success, resulted in a need for more roads producing factors which contributed to the creation of the complex web of primary, secondary and tertiary roads that comprise the surface transportation system in the U.S. today (*2*).

When managed for sustainability, roadside vegetation can contribute to better water quality and conductivity (*3*) (*4*), increased diversity of insect life (*5*) (*6*) and cost savings (*7*) (*4*), while also benefiting the socioeconomic health of the state (*8*). Sustainably managed roadsides reduce the amount of non-native mown turf and include meadows of native warm season grasses and/or flowering perennials, and masses of native shrubs and trees. However, sustainable strategies only provide optimal cost savings and enhance environmental stewardship when implemented consistently.

Many state DOT's maintain active ties to the public and political communities of their state and bow to the wishes of these communities when appropriate. Lacking an awareness of the intrinsic values present in sustainably managed roadsides, the public is often quick to criticize, which frequently prompts DOT's to revert to more traditional mowing regimes.

HISTORY OF ROADSIDE VEGETATION MANAGEMENT STRATEGIES

Efficient roadside vegetation management strategies have been desired since roads assumed their place as a dominant feature on the modern landscape. In the 1930's, Roadsides, The Front Yard of the Nation, proposed a front yard approach to roadside vegetation management, which advocated the use of large swaths of mown turf along rights-of-way (*9*). Bennett's ideas gained momentum as roads began to carve their paths across America, yielding an expensive, resource and labor-intensive, unsustainable cycle of management that persists eighty years later.

In the 1960's highway beautification and conservation of natural resources joined the list of objectives required of roadside vegetation managers as President Lyndon Johnson announced his beautification initiative by stating, "I want to make sure that

the America we see from these major highways is a beautiful America." Alongside his wife, Ladybird Johnson, the President and First Lady crusaded for roadside enhancement. Mrs. Johnson's voice became a preeminent force stressing the fundamental importance of regionally appropriate materials, including native plants. Mrs. Johnson's cause was more than just a movement to promote aesthetic beauty for highway travelers (*10*). Her ideas sparked a transcendent movement emphasizing the ecological necessity of roadside conservation. She played an integral role in the successful passage of the Highway Beautification Act of 1965, which emphasized natural beauty and ecological stewardship in federally funded projects (*11*). The Highway Beautification Act was the inaugural event that placed significance on the vitality of the natural world as it relates to the vein of transportation, the multifaceted system that carries us in our daily activities.

Currently, national trends of sustainable roadside vegetation management strategies encourage: reduction of expenditures, minimization of maintenance, incorporation of regionally appropriate vegetation and utilization of context sensitive design. Context sensitive design promotes the preservation of scenic, aesthetic, historic and environmental resources while maintaining safety and mobility along transportation corridors (*12*). The desired result of these objectives is the protection and enhancement of the overall corridor, which includes roadside rights-of-way.

In 1996, Delaware launched Enhancing Delaware Highways (EDH) to examine the benefits and liabilities of an alternate roadside vegetation management strategy. Since the EDH project began, Delaware has replaced large swaths of turf along roadside rights of way with a variety of sustainable vegetation strategies including: meadow, meadow with a mown margin, meadow supplemented with native flowering perennials, and native shrub and tree masses. While some Delaware residents have embraced the sustainably managed roadsides, there remains evidence of a lack of acceptance for this new roadside aesthetic based on recent articles in the popular press, letters to the editor, personal communication with DelDOT officials and the results of a Comprehensive Mail Survey (*8*). A New York Times journalist interviewed several people who did not support Delaware's forward thinking roadside vegetation efforts. One reader commented, (the native grasses) "just look awful" (*13*). Several of The News Journal's letters to the editor, blasted DelDOT for their reductions in mowing along the roadside (*14*). The next step in widespread implementation of more sustainable roadside vegetation management, which will save money and enhance the environment, is to determine and secure public acceptance.

A related strategy that has garnered significant attention among roadside managers is Integrated Roadside Vegetation Management (IRVM). IRVM incorporates the use of native plants and contextually appropriate management strategies including controlled burns, competitive plantings and selective use of herbicides to manage invasive weeds (*15*). IRVM has produced successful results in many states including,

Arkansas, California, Florida, Illinois, Iowa, Maryland, Minnesota, New York, Ohio, Pennsylvania, Washington, Wisconsin and Texas (*16*).

LEGAL ACTIONS AND ROADSIDE VEGETATION

More than ever before, environmental managers are required to consider the aesthetic character of their landscape decisions in order to comply with federal, state and local legislation (*17*). The National Environmental Policy Act of 1969 (NEPA) requires Federal Agencies:

Use all practical means to: fulfill the responsibilities of each generation as trustee of the environment for succeeding generations; assure for all Americans safe, healthful, productive and aesthetically and culturally pleasing surroundings; and preserve important historic, cultural, and natural aspects of our national heritage, and maintain, whenever possible an environment which supports diversity, and a variety of individual choice (*18*).

This act clearly outlines the obligation placed upon Federal Agencies to act as responsible stewards of public land. Many of the laws enacted since the NEPA and the Highway Beautification Act have further emphasized use of native plants, control of invasive species, minimization of ecological impact and promotion of regionally appropriate vegetation (*19*).

In 1987, the Surface Transportation & Uniform Relocation Assistance Act (STURAA) decreed, 0.25% of landscape budgets for highway construction shall be used in planting native wildflowers (*20*).

A 1994 Executive Memorandum on Landscaping Guidance called for the use of regionally native plant species whenever possible. This memorandum also placed significance on environmentally and economically beneficial practices on federally landscaped grounds and federally funded projects including: the design, use or promotion of construction practices that minimize adverse affects on natural habitat; and, the prevention of pollution by reducing fertilizer and pesticide use & minimizing runoff (*21*).

In 1999, Executive Order 13112 decreed Federal Agencies must:

Provide for the restoration of native species and habitat conditions in ecosystems that have been invaded; conduct research on invasive species and develop technologies to prevent their introduction and to control them using environmentally sound methods; and, promote public education regarding the issue of invasive species and the means to address it (*22*).

Forman et al stress that road transportation is a critical component in the fight against invasive species because roads can facilitate the spread of plants in the landscape (*4*).

In July 2002, Delaware passed Senate Bill #324, Chapter 351, which promotes:

Increases in forested land in the State, together with landscape features such as trees, shrubs and ground covers other than or in addition to grass, not only improve the aesthetic value of Delaware, but also carry with them valuable benefits to the health and welfare of citizens and the environment. In addition, DelDOT is considered a leader in replacing forested acres previously cleared for building projects and in providing travelers through the State with scenic vistas along its roadways while maintaining safe design and construction standards (23).

These statutes highlight a few of the key regulations passed for ecological conservation and environmental stewardship since the Johnsons brought their roadside enhancement message to the forefront of objectives required of roadside managers and into the public spotlight.

PUBLIC PERCEPTION, EDUCATION AND ROADSIDE LANDSCAPES

Public acceptance of the roadside landscape is crucial to the success or failure of a roadside enhancement project. Lacking an awareness of the benefits associated with sustainable, but less manicured roadsides, the public is often quick to issue criticism with letters to the editor (*14*), popular press articles (*13*), or complaint phone calls (Roumillat, unpublished data).

Most state DOT's have close ties to the public and political communities of their state and have bowed to the wishes of the public whenever appropriate (*24*). In the past, DelDOT has tried to reduce maintenance expenditures by mowing roadside vegetation less frequently. However, they often receive complaint phone calls from the public and from legislators when they try this alternative method of management (Roumillat, unpublished data). In response to negative publicity and feedback, DOT's frequently revert to more traditional regimes of management (Rosan, unpublished data). In June 2009, DelDOT spokesman Darrel Cole was quoted in The News Journal as saying, "A couple of weeks ago, we had a call from someone who complained about tall grass, so we went ahead and cut the grass. People are noticing and they're calling" (*25*). This is not surprising based on the results of the Comprehensive Mail Survey (*8*). The least preferred scene was an un-mown roadside edge. While a green, mown turf infield received a moderately desirable rating; respondents rated an un-mown roadside with a mown edge, as equal in desirability. This strategy allows many acres of land to be released form the constant pressure and expense of routine mowing, so long as the public sees some evidence of maintenance and order; an important component that allows many people to appreciate this strategy of highway vegetation management.

Since it is important for DOT's to be able to respond to criticism and provide explanations of the environmental and economic benefits associated with sustainable management strategies, an understanding of which factors influence public perception is valuable.

Many factors contribute to influence the public's reluctance to embrace sustainable landscape strategies. Native plantings may take two or more years to reach an attractive state, looking like a failure at first while plants are allocating energy towards establishment of healthy root systems. The ecological disturbance caused by development renders roadsides rights-of-way harsh and inhospitable environments in which to grow, resulting in failed plantings unless care is taken to select adapted species. And finally, many people are simply not used to the style of less manicured landscapes. Public awareness of the establishment process of sustainable plantings, and the benefits provided by a natural landscape, are crucial for public support (*24*). Without public support, DOT's are challenged in their move towards alternative, yet sustainable management strategies.

Aesthetically, sustainable landscapes often represent a divergence from the traditional expectation of how a landscape should appear. Without knowledge of the intrinsic values associated with this atypical, and oftentimes, less manicured aesthetic, public response is frequently critical. Koh espoused the virtues of an 'ecological aesthetic' in sustainable landscapes where aesthetics incorporate ecological quality as well as visual beauty (*26*). In support of this ecological aesthetic, research suggests intellectual engagement of the public is necessary to assist in their understanding and appreciation of the environment and an awareness of the ecological functions

performed with sustainable landscapes; all of which can ultimately contribute to wider acceptance of sustainable landscape practices (*27*) (*28*).

Interpretation, a method of communicating information to an audience, has garnered attention in recent years. The National Association for Interpretation (NAI) defines it as "a mission-based communication process that forges emotional and intellectual connections between the interests of the audience and the meanings inherent in the resource" (*29*). Brochu and Merriman suggest that interpretive strategies can vary. Strategies can involve personal interpretation in which the interpreter communicates directly to the audience, or non-personal interpretation, which includes media such as signage, brochures, exhibits, websites, social media and audiovisual materials (*30*).

The impact information imparts on perception should not be undervalued. Public engagement and information about traditional and sustainable roadside vegetation management strategies may lead to a shift in the paradigm of perceived aesthetic expectation of landscape management strategies.

Recent research has confirmed that people notice the roadside landscape. In 1999, Delaware Speaks Out, a statewide Cooperative Extension survey, revealed that Delawareans notice the impact of roadside plantings. Fifty-eight percent of the respondents surveyed agreed plantings along the roadside have a moderate, significant or major impact on short trips and seventy-eight percent believed this to be true for long trips (*8*).

A 2003 assessment of the scenic beauty of roadside vegetation, found that eighty-three percent of respondents surveyed described the scenic quality of roadside vegetation as an important feature of the roadside environment indicating awareness among the public about the roadside landscape (*31*).

A 1999 study on consumer viewpoints of native grasses and wildflower plantings found that consumers had a high level of interest in reducing landscape inputs and a keen interest in native warm season grasses and forbs along with a desire for more information (*32*).

A considerable body of research on visual perception of landscapes exists to support people's preferences for natural versus man-made scenes (*33*) (*34*) (*35*). While it is not practical to expect development of roads and man-made structures to halt, the question becomes how to remediate existing development and plan for new development in a way that minimizes the negative aesthetic quality of the landscape (*31*). It is therefore essential that DOT's establish guidelines that balance the aesthetic desires of the public with the ecological and economic goals of their state.

SUSTAINABLE ROADSIDE VEGETATION MANAGEMENT AND ASSOCIATED BENEFITS

Adherence to economic, environmental and contextual goals set forth in state and federal policy insures that roadsides, managed for sustainability, contribute to a matrix of shared benefits for present and future generations including: cost savings, better water quality and conductivity, increased bio-diversity and an improved socioeconomic health of the state.

Economic benefits

In 2009, Delaware was one, among many states, required to trim their mowing budget as a result of reduced income generated from fuel taxes amid an economic recession and, a shift towards more fuel-efficient vehicles. Since DelDOT relies heavily upon the revenue generated from fuel taxes for their operating budget (*36*), this strain contributed to a 25% reduction of mowing along roadside rights-of-way (Roumillat, unpublished data). By diversifying their strategy, including the release of turf from routine mowing, establishment of meadows- either of warm season grasses or native flowering perennials, or stands of native shrubs and trees, DelDOT can decrease or redirect their mowing expenditure while increasing the aesthetic value of areas released. One acre of turf grass mown eight times per year costs approximately $3480 to maintain; while one acre of meadow, mown annually costs $435 to maintain and $870 if mown biannually as some meadows require (*7*). DelDOT could save $2610 to $3045 per acre in maintenance costs for every acre currently vegetated with turfgrass. If DelDOT took between 500 and 1000 acres of roadside out of routine mowing, the state could save between $1,305,000 and $3,045,000 per year and that would allow DelDOT to substantially reduce or redirect their operating budget.

The financial advantages gained with sustainably managed roadsides warrant judicious consideration given the contemporary economic climate. In 2008, DelDOT spent over $3.4 million dollars mowing roadside rights-of-way (*37*). There exists sufficient evidence to support the economic practicality of varying mowing practices, however, a paradigm shift among roadside engineers and managers must first occur (*38*). Maintenance staff, trained to mow turf, must be retrained to develop the skills necessary to manage un-mown rights-of-way, such as species identification and selective herbicide application (*8*).

Improved hydrology and erosion control

Recent ecological goals of roadside vegetation management strategies have called for reducing erosion and sediment flow and improving hydrology (*4*). Vegetation serves as a cost effective yet, aesthetically pleasing way to achieve these two objectives.

Appropriately chosen vegetation, such as native warm season grasses, help stabilize the soil surface to reduce stormwater erosion and sedimentation activity from occurring. These two phenomenon continue to present a serious problem throughout the state, resulting in water quality problems, which damage not only fish and wildlife, but also threaten public health, welfare and safety (*39*). Because of the deep and/or fibrous root systems present in many native grasses and forbs, they act as an efficient soil stabilizer and increase infiltration more efficiently than shallow-rooted turf grass (*40*).

Although the Chinese have been using soil bioengineering since 28 B.C., modern solutions have relied on concrete and steel to control erosion (*41*). Soil bioengineering relies on the use of plant materials to provide erosion

control, slope and stream bank stabilization, landscape restoration and wildlife habitat (*42*). Each of these contributes to the safety and efficiency of a balanced transportation corridor. Unlike plants, concrete and steel erode and break down over time with exposure to weather. Plants however grow stronger as vegetation becomes established. Even after their life cycle is complete, their roots and surface organic matter play an important function as new plants begin to re-establish (*41*).

In 2008, the United States National Research Council identified urban stormwater as a leading source of water quality problems in the US (*43*). When stormwater and snowmelt cannot percolate into the earth, it runs off onto roads where it absorbs petroleum and other harmful toxins before making their way into the water supply. Native grasses have been shown to capture precipitation better than mowed turf and their deep roots absorb the runoff more efficiently (*10*). By increasing infiltration and decreasing surface runoff, fewer toxins are deposited into local water supplies.

Vegetation is the most critical factor influencing erosion and provides the following six major benefits: (*4*).

- Reduces raindrop impact
- Reduces runoff velocity
- Provides, via the fibrous root system, structural integrity to the soil
- Filters chemical pollutants and sediments from runoff
- Increases water infiltration into the soil
- Increases evapo-transpiration, the vertical movement of water to the air

Increased biodiversity

Marginal habitats, such as roadsides are particularly important for the conservation of biodiversity. These landscapes serve as an important ecological reserve for wildlife habitat. Animals can be attracted to transportation corridors for any number of reasons, but most are related to habitat, ease of movement and food availability (*4*) (*10*) (*28*).

A 2008 study found roadsides, when restored to native prairie vegetation, provided valuable habitat for bees, our most important group of pollinators. Significantly greater bee abundances and increased species diversity were found in prairie roadsides when compared to weedy roadsides due to floral abundance and floral richness. Hopwood suggests that native plant restoration will positively affect bee communities and roadside restoration may add valuable bee habitat (*5*).

A similar study conducted in 2001, found the Conservation Value of Roadside Prairie Restoration to Butterfly Communities. This study showed a two-fold increase in species richness of habitat sensitive butterflies in prairie compared with grassy or weedy roadsides ($p < 0.0001$) and a five-time increase in abundance in prairie, compared with grassy roadsides ($p < 0.02$). This study further concludes that roadside restoration benefits butterfly populations despite instances of road-killed butterflies. Relative numbers indicated that mortality risk was more than double along grassy corridors (mown-turf)

($p<0.0001$) than along weedy or prairie roadsides. Tracking studies showed that butterflies were less likely to exit prairie roadsides than they were weedy or grassy roadsides (*6*).

By efficiently utilizing land already precluded from development, DOT's could significantly help restore ecological balance to disturbed areas, a fundamental element of a diverse and functional ecosystem (*5*).

Socio-economic health

Aesthetically pleasing, native roadside environments can help identify Delaware's individual sense of place. While many different definitions about sense of place abound, most agree it is primarily reflective of the landscape experience and the human influenced impact upon the land.

The roadside environment is one of the most frequently experienced landscapes in this country (*44*). Roadside rights of-way are often the first and last views a traveler sees of a state. So, in order to promote the visual appeal of Delaware, and to attract and encourage visitors to the state, attractively managed roadsides are imperative. Fisher found that if the roadside environment does not provide an aesthetically pleasant travel experience, tourists would not stay and spend their money in the communities along the way (*45*).

A significant portion of Delaware's economy is dependent upon tourism and hospitality. In 2008, Delaware experienced more than 8.1 million visitors who contributed about $1.5 billion dollars to the state's economy (*46*). Attracting and maintaining this vital source of revenue ensures the livelihoods of many Delawareans and contributes to the overall socioeconomic health of the state.

Safety and roadside vegetation

DelDOT's mission is to provide a safe, efficient, and environmentally sensitive transportation system (*36*). Roadside landscapes are designed with safety as the top priority, while roadside aesthetics and environmental stewardship play an important role within safety parameters. Within the right-of-way of transportation corridors, vegetation can provide a wealth of safety functions, in addition to creating an attractive and functional groundcover (*7*). The following list outlines safety functions that can be provided by appropriately placed roadside vegetation:

- Properly sited, shrubs or tall grasses can shield headlight glare from oncoming vehicles while larger plants such as trees, can help block sun glare during certain times of the day.
- Recent studies have actually shown shrubs can absorb some of the kinetic energy of errant cars and reduce the chance of human injury or fatality (*47*).
- Diverse types of woody vegetation reduces the monotony of mown turf roadsides (*47*)
- Plantings that reduce monotony can provide a visually varied experience and help drivers remain alert and aware (*7*) (*47*) (*48*)
- Vegetation that does not require routine mowing eliminates the need to operate heavy machinery on steep or difficult to mow sites.
- Vegetation can provide a physical and visual buffer between pedestrian and vehicular traffic.

- Properly sited plants can indicate a change in direction along roads before a turn is visibly evident giving drivers time to anticipate the turn and slow to a safe speed.

A body of research exists to support the restorative effects roadside vegetation can have on stress and fatigue. Fatigue related crashes are responsible for the deaths of about 1,500 people per year and are the cause more than 56,000 accidents annually (*49*). A 1979 study found vegetation has been shown to improve mood, reduce stress, and facilitate recovery from attention fatigue (*50*).

Anger and frustration can trigger road-rage and lead to aggressive and inattentive driving. AAA reports between January 1990 and September 1996 cite 10,037 known incidents of aggressive driving related accidents that claimed the lives of 218 people and injured an additional 12,610 (*51*). A 2003 study tested the frustration levels of subjects after experiencing video stimuli of a built-up highway, a garden highway and a scenic parkway. Results indicated that participants had greater frustration tolerance after viewing roadways with more vegetation relative to built structures along the edges. The effect was most pronounced for the scenic parkway condition and emerged despite higher traffic density. The scenic parkway respondents showed a four times greater frustration tolerance than for the garden highway respondents and a six times greater tolerance than for those experiencing the built-up highway condition (*52*). This research points to an important role roadside vegetation plays for the safety and well being of drivers, their passengers and others occupying the road.

SUMMARY

Roadsides are unarguably challenging environments; however, they provide an opportunity to allow DOT's to serve as leaders of environmental and economic sustainability, and to serve as respectful stewards of public land utilized by all roadway travelers.

Recent budget cuts, climbing oil prices and an increased demand for sustainability have caused many DOT's to re-evaluate their management and operation procedures. Efficient management and responsible stewardship of the United States 12 million acres of roadside right-of-way challenges Department's of Transportation to continue their shift from conventional practices to a more sustainable strategy. Altering these practices may require a paradigm shift for those involved with planning and maintaining the roadsides as well as the stakeholders who utilize the roadways. Inherent values present in sustainable landscapes are often not visible to the naked eye, and communication of such values may be necessary to secure public acceptance of sustainable landscapes (*53*).

Public acceptance of alternate strategies can be challenging, but is a critical component to the continued success of environmentally responsible, economically conservative and aesthetically pleasing rights-of-way management decisions. In the wake of public criticism, DOT's frequently revert to traditional regimes in order to placate public concerns. One reason sustainable landscapes have been slow to gain public support may be a deficiency of public knowledge about the issue. Lacking an awareness of the expense and perils that result from an unsustainable management strategy, many stakeholders unwittingly allow and expect DOT's to continue on an expensive and unsustainable path of management. Fishbein shows attitudes are more susceptible to being changed if the original attitude is not central to the core belief system of the individual (*54*). Since the roadside environment may not be central to

the core beliefs of an individual, perceptions may be readily changed upon receipt of a brief educational intervention. Since roadsides offer harsh and difficult conditions in which to grow, and regionally appropriate plants often take longer to establish than turf, education is essential to inform the public of the intrinsic values present in sustainable landscapes and to keep the public abreast of the process as plants evolve into their attractive and mature state (*25*).

As roadside vegetation management objectives have evolved from simple highway beautification initiatives to sustainable management strategies, dictated by legislation and economic necessity, DOT's have a new role in raising awareness, assessing perception and educating the public about the benefits of sustainable roadside vegetation management strategies; the benefits of which have been well documented. The next step forward in this process to convince the traveling public of these benefits and engage them with educational opportunities that heightens awareness of why roadsides, managed for sustainability are an essential link to the environmental and economic health of each state.

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