Table 1. Comparisons of the agronomic and ecological approaches to roadside management.

Factor	Agronomic Approach	Ecological Approach
Action	Direct	Indirect
Appearance	Neater, more formal, more cared for, more structured, man-formed	More natural, less cared for, less structured, nature formed
Vegetation	Monoculture, single best species	Heteroculture—broad group of species to fit a group of conditions
Inputs	Energy, labor, money, equipment, materials	Time, management, education, seed
Cost	Higher	Lower
Soil	Added inputs applied so it can be treated as a single-like item	Inputs applied to fit a range of edaphic conditions—treated as a mosaic
Fertilizer	Blanket applications, may have to repeat	More single element or unbalanced application to favor certain spaces at cost to others
Nitrogen	Applied, may have to frequently repeat	From legumes and/or soil as much as possible
Weeds	More of a problem	Less of a problem
Public perception of weed problem	Less of a problem	More of a problem
Herbicides	More use, broadcast, for group of plants—more done at one time	Less use spread throughout season, spot application, more for single species
Wildlife habitat	Low to moderate	High
Fire hazard	Low	High
Energy	High inputs	Low inputs
Mowing	More frequent, more area	Less frequent, less area, may not mow at all
Time response	More rapid	Slower, needs more time

late 1800s and early 20th century, agronomists advocated roadside mowing for weed control purposes. For almost the entire first 50 years of this century, mowing, tillage, and crop rotation were the main weapons available to fight weeds. The only one of these that could be readily used on roadsides was mowing, though some states also used fire on a regular basis. Considerable agronomic research efforts were directed at weed control through mowing during the first 30 years of this century.

Starting in the early 1930s, many states added roadside development units to their highway departments. These units often contained trained landscape designers, sometimes agronomists, and generally engineering personnel. The idea that the roadsides were the front yards of the nation and the concept of the complete highway (right-of-way fence to right-of-way fence) were stressed. Roadsides were more frequently mowed and treated in an agronomic manner like a well-cared-for lawn. This approach continued through into the 1960s and chemical weed control was added to the program. Through manuals and training, the approach became institutionalized into many highway department operations.

In the late 1960s, a different approach developed. This was generated by rising costs, increased roadside acreages, environmental and ecological concerns, and the wider knowledge of and appreciation for the ecological approach to vegetation management as put forth by the science of land management. The formal definition of rangelands included public rights-of-way. Table 1 compares the differences in the agronomic and ecological approaches to roadside management. From a review of this table, it will be readily apparent why, in today's era of shrinking funds for transportation agencies, the trend in roadside management has been toward the ecological approach--i.e., the applied science of range management.

MANAGEMENT OF ROADSIDE VEGETATION: SOME PRINCIPLES FROM RANGE SCIENCE

Roger Q. Landers, Jr.

Roadside vegetation is both virtuous and villainous. On the one hand, it may provide welcome shade at rest stops; on the other, an immovable object for an out-of-control vehicle, avenues of wildflower beauty or routes of weed infestations, restful scenery or depressive monotony, and erosion stabilization or pavement destruction. Management makes the difference. Because roadside vegetation is most often a mixture of plant species, its management is more often based on principles from range rather than agronomic sciences. In other words, roadsides are more like rangeland than farmland.

Plants growing in the right-of-way tend to be the same kind as those growing on adjacent land. There are some striking exceptions to this, but generally they are responding to a similar climate and soil. These broad vegetational types of naturally occurring communities of trees, shrubs, forbs, and grasses provide the basis for management. Types change with different rainfall amounts and patterns. The dry summers and mild moist winters of southern California produce chaparral communities; the moist summers and snowy winters of New England produce deciduous forest communities.

Disturbance of the natural vegetation along the roadside during the process of road construction, repair, or maintenance usually initiates a sequence of changes in vegetation during the recovery process. An area begins to revegetate, with a tendency over many years to become similar to the adjacent vegetation. Dandelion, quackgrass, Johnsongrass--the list of species that are capable of moving into relatively new sites and staying there is almost endless. Some of these become permanent members of the community along with the native plants from across the right-of-way line.

We might explore the possibilities of selecting the proper species and manipulating them in the proper way to establish a self-maintaining roadside vegetation. It sounds good, but there are problems. In the first place, it is difficult to find stable combinations of species acceptable for roadside needs. Where annual rainfall averages more than 15 in, the vegetation tends to grow too rank with woody plants and shrubs to be tolerated. In other words, the naturally occurring community is not acceptable as a roadside vegetation despite the low maintenance potential.

The Illinois model indicated that, when you plant lawn grasses in a climate that supports natural communities of tall grass, prairie, and oak forest, the vegetation is not self-maintaining. The Iowa model used taller grasses, primarily smooth bromegrass for an initial installation. After a period of vegetation, although the roadside is not self-maintaining, the Iowa condition is subsidized to a lesser extent than it would be if it were maintained as a lawn. It can be concluded that the more the roadside vegetation is like the natural vegetation of the region, the less energy is required to maintain it.

The main objective of roadside vegetation management should be to keep the highway a safe and pleasurable place to drive. What is growing along the roadside should not imperil nor distract the driver, yet it should provide a series of restful glances for the experienced driver and a certain flow of countryside scenes for the passengers. For ecological and economical reasons, the composition of roadside vegetation should depend on the locally adapted native species and a selected number of introduced species that are dependable. Due to the variability of most roadside conditions, a mixture of species has to be used since no single species has the adaptive scope to cover it all.

This program should promote beauty, prevent erosion, and reduce the spread of noxious plants. Mowing is an important maintenance procedure that has been designed for average vegetation of the region. Mowing height, interval, and placement, particularly on slopes, are very important to the roadside program, In the Iowa model, they found that by raising the mowing height 3 in, more vigorous birdsfoot treoil could be retained in the Interstate medians on a less frequent mowing schedule. In the same model, the backslopes were not mowed and a vigorous stand of smooth brome, switchgrass, and other taller species was developed. This had a desirable result and proved to be a good natural habitat for certain nesting birds.

The use of herbicides has traditionally been associated with the control of noxious species adjacent to crops and pastures into which they could readily spread. Often, it is the other way around. In Texas, glyphosate and velpar are currently approved for sterilization around signposts, guiderails, culverts, bridges, and warning posts to make the mowing effort less restrictive and more efficient. Sterilants should be applied no closer than three times the distance between the dripline of the tree and the trunk of the tree. Roadside vegetation management is too important to be left to the field operators. It must be closely supervised by ecologically trained personnel who recognize the limitations of mowing and spraying. The design of roadside facilities, placement of signs, construction of slopes, and other land-mowing operations should be done with maintenance in mind.

INFLUENCE OF RESEARCH AND DEVELOPMENT ON ROADSIDE MANAGEMENT

D. James Morre

Research is an important source of new developments in roadside management. However, for research to impact practice, it must be implemented. Sight distances must be maintained, signs not obscured, erosion prevented, and a healthy weed-free turf maintained. Research should include a planning phase that involves an analysis of the problem, outlines objectives and procedures, and assembles the required personnel and resources. This is followed by the actual conduct of the research, which may require several years.

Testing under field conditions is especially slow because weeds germinate and grass seedheads form only at a particular time each year. One must usually wait a year to repeat or confirm an observation although some additional information can come from the laboratory. After analysis, recommendations are formulated and, if appropriate, implementation is performed. Implementation is aided if the major findings are evaluated under actual-use conditions as part of the research project. All should be aware of advantages, benefits, and projected or actual cost savings as well as any disadvantages or undesirable features. An individual should be prepared to modify recommendations to accommodate local needs.

In Indiana, the present program of research was initiated in 1966. Between 1966 and 1970, surveys were made to determine weed and brush species and densities and to further identify the problem. Work also included the evaluation of various herbicides. In the first period, only environmentally safe amine forms of 2,4-D were used as a fall-spring rotation. In the fall, hard-to-kill perennial and biennial weeds, such as thistle, milkweed, wild carrot, and curled dock, are actively moving nutrients from the foilage to the underground roots in preparation for the winter. Herbicides likewise moved to the roots. In the spring, plants are at a most susceptible stage--either just at the beginning of growth or just on germination. Most annual and winter annual weeds have been eliminated from Indiana roadsides by this treatment. Annual grasses including crabgrasses and the foxtails were reduced by about 90 percent. At least 3 years are required for a sufficient weed population to become reestablished and to justify another spray application.

A major advantage of the fall-spring rotation is environmental safety due to the fact that the crops are dormant. Through improved weed control, we were able to reduce from five-cycle mowing to three-cycle mowing with a net cost saving of \$300 000/year.

Banvel plus 2,4-D was used to reduce mowing or even eliminate mowing altogether. Two-cycle mowing was possible through careful timing where it was required for safety or appearance. Mowing was delayed until the grass reached a height of 18 in, when fescue was starting to form seedheads. The only problem encountered was encroachment of brush. Either spraying for brush control once every 3 years or late one-cycle mowing was recommended. This research resulted in a first year saving of nearly \$1 000 000.

We are now in phase 4 of the program--chemical mowing. The objective is to develop and test materials or mixture materials that will eliminate the need for mechanical mowing.

Research has a continuing and important role in roadside vegetation management. A few examples from the Indiana program illustrate how research, once implemented, can lead to new maintenance practices with substantial cost savings. Many research and implementation activities would be facilitated by more information on what are the desirable or necessary ingredients of a well-maintained roadside and of special problems where solutions are currently unavailable. Research, and especially the implementation of research, ultimately involves not only the researcher but the user as well. An important ingredient of research implementation is good planning that begins even before the research is initiated.

APPLICATION OF WEED CONTROL MATERIALS WITH NEW SPRAYING SYSTEMS

Ray Dickens

(Dickens' presentation was not available for publication.)