Abridgment

How Research Benefits California's Roadsides

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Seven research projects that were directed toward the development of nonchemical pest-managment programs are reviewed. Both insect and weed pest control are discussed, and examples of specific successful research projects are given. Some of the pest-management programs are unique to highway roadsides while others have much in common with agricultural pest-management programs. These research projects have convinced the California Department of Transportation that research studies on the development of balanced programs will improve the environment not only of the highway roadside but also of the surrounding lands.

The state highways of California cover a vast area, which includes many differing climatic zones. There are more than 225 000 acres of roadside, and more than 17 200 acres are fully landscaped and require intensive care. The landscaped acres are generally in urban areas and planted with exotic plant species that are selected both for their aesthetic appeal and for their tolerance of highway roadside conditions.

In less-populated areas, aesthetic treatment frequently consists of preserving as much as possible of the existing flora. Some form of management is required along most of these highways. These natural landscapes range from low desert to alpine flora to redwood forest. It is the policy of the California Department of Transportation (Caltrans) to retain as much native vegetation as possible on highway roadsides. In most of California, land adjoining the highways is put to some productive use--growing of crops, feeding of livestock, timber production, or urban uses. These uses have greatly altered or partly destroyed the characteristic native plants, and for these reasons greater management and understanding of plant growth are required.

In 1966, the California State Legislature requested each state department to look at their operations and do whatever possible to reduce chemical pesticide use. At that time, Caltrans initiated contacts with the University of California in looking into practical methods of reducing chemical use.

Caltrans' first informal research project was on possible nonchemical control of California oak moth (Phrganidia californica) because this insect pest was causing in each succeeding year increasingly severe damage to the foliage of California live oaks. The use of the bacterium Bacillus thuringiensis on this insect pest with correct dosages and timing proved that it was possible to control certain insect pest populations without using chemical insecticides.

The following year a contract with the University of California, Berkeley, for nonchemical pest management in California's highway landscape was initiated. Although the research project was with the Department of Entomology, the Division of Biostatistics provided essential statistical advice.

Since this time, Caltrans has developed research projects with a number of universities and with the Agricultural Research Service of the U.S. Department of Agriculture (USDA). Research efforts show that the management of pests on highway roadsides and in landscape plantings involves the solution of various interacting problems, some in common with agricultural pest management but others conditioned by the unique features of highway roadside conditions. The results of the research have led to recommendations that no chemical insecticides be used on any harmful caterpillars on highway plantings. Some of the caterpillars that previously required repeated applications of insecticides are red-humped caterpillars (Schizura concinna), fruit tree leafrollers (Archips argyrospila), and tent caterpillars (Malacosoma constrictum and Malacosoma californicum). Because many beneficial insects are left unharmed by the use of relatively specific disease agents such as Bacillus thuringiensis, less control by man has been necessary and a balance has been struck that keeps any damage within acceptable limits. Another result of this research is that control of aphids is now done by spraying a pure liquid soap and water mixture with high-pressure spray equipment; this has given better results than previously used insecticides.

The use of these materials does not harm most beneficial insects or vertebrates, and the probability of pest resurgence is greatly reduced. It will be further reduced if the beneficial insects can be managed in a way to keep the pests in check. In California, most insect pests can be controlled by the use of insecticides, but each application of these chemicals tends to diminish the periods of control following each application. This tendency of diminishing control following each application would appear to be due to lack of specificity of the chemicals used because practically all beneficial species of insects are also eliminated during the insecticide treatment. An important factor in this chemical treatment and retreatment is the exposure of maintenance workers and the public to potentially hazardous materials. A further complication is that the pests may develop resistance to the insecticide being used for control. This retreatment and resistance has been noted in agriculture and in public health work; it is often called the chemical treadmill.

Another successful research project conducted between Caltrans and the University of California, Berkeley, was on the importation of insect predators of Acacia psyllid, an insect pest that was accidently introduced from Australia a number of years ago and had become a major pest on the thousands of acacia trees and shrubs planted along California's highways. Acacia trees are generally fast-growing, low-maintenance plants, and this has led to their wide use in ornamental plantings in California. Large numbers of flying adult psyllids were often a source of complaint from nearby residents and highway personnel working in and near infested acacias. At the time, it was obvious that insecticide spraying was not reducing the numbers of this insect pest. Predators of the psyllid were collected in Australia and imported and released on roadside acacias. Since that time no chemical spraying has been done on this insect pest and Caltrans has received adequate control of a serious infestation.

Since 1978, Caltrans and the Federal Highway Administration (FHWA) have been funding a research project with the University of California, Berkeley, on an extensive ecological and biological control of two species of iceplant scale (Pulvinaria). This insect pest was first found in California in 1971. Although it was believed to have been eradicated by 1977, it had become apparent that this insect pest was out of control on iceplants throughout most of the San Francisco Bay area. It has now spread throughout much of California.

Caltrans has more than 6000 acres of iceplant growing along California state highways. Iceplant was chosen as a ground cover because of its ability to grow well under poor soil conditions, its relatively low maintenance costs, and its adaptability to both cool coast and hot interior California growing conditions.

The Pulvinaria scale is so serious that the infestation threatens the survival of iceplants and possibly other succulent plants as well. Researchers have introduced a number of parasites and predators of these Pulvinaria scales from a search that was made in Africa and in southern Europe. These parasites and predators have been processed through quarantine facilities and have been released on infestations of Pulvinaria scale on roadsides in many areas of California.

Caltrans' involvement in research to reduce pesticide use and also to reduce the cost of roadside care has not been limited to insect pests. Caltrans has funded, with participation from FHWA, a number of research projects on the control of pest weeds. Most troublesome weeds on California's roadsides are introduced species, such as Russian thistle or tumbleweed (Salsola kali), puncture vine (Tribulus terrestris), field bindweed (Convolvulus arvensis), and yellow star thistle (Centaurea solstitialis).

About 20 years ago Caltrans watched with great interest the research work that was done with the importation of a beetle to control Klamath weed (Hypericum perforatum), a weed pest that had made thousands of acres of California agricultural land unfit for any productive use. Chemical control was tried and was found to be economically impossible. Several years after the release of these beetles only scattered stands of Klamath weed could be found. This example of biological control is an outstanding success, and these thousands of acres of previously infested land have been returned to the production of economic crops.

In 1960, host-specific insects were released on puncture vine in California. Caltrans has funded a research project with the USDA Biological Control of Weeds Laboratory, Albany, California, to collect and transfer the insects, to import different insects, and to explore the availability of pathogens against this weed pest. [A copy of the final report on the use of weed-feeding insects for the nonchemical management of puncture vine along California highways is available through the National Technical Information Service, Springfield, Virginia (number 282541) or by request to Caltrans.]

Caltrans has also funded a research project with USDA in Albany, California, to control Russian thistle by the use of imported moths. It is interesting to note that, until several years ago, Caltrans had been spending more than $1 million a year attempting to control and clean up this weed pest. Populations of this weed pest have been noticeably reduced, and the cost of control has been reduced greatly. Caltrans believes this to be at least partly due to the beneficial insects.

Caltrans is convinced of the desirability of spending money on research studies for the development of balanced systems that do not have the disruptive effects on the environment that has marked the widespread use of pesticides.

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Abridgment

Nylon Erosion-Control Mat

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The Pennsylvania Department of Transportation (PennDOT) has placed, and continues to place, emphasis on value engineering—the use of alternative cost-effective materials or procedures to perform a common function. As a result of this emphasis, a nylon erosion-control mat was recently field tested as a ditch lining on a project that was originally designed for rip-rap or paved-concrete lining. This nylon mat, installed with either a bituminous or wood cellulose surface treatment, provided a functional and economic erosion-control measure. In the trapezoidal ditches calculated, nonvegetated velocities were as high as 20 ft/s and vegetated velocities were as high as 8 ft/s. The mat installation resulted in a 60-70 percent cost saving over the rip-rap or paved-concrete lining alternatives. PennDOT has included this nylon mat in its general specifications as a result of the positive findings on this project. A significant benefit of this stabilizing fabric was the structural integrity it provided to the vegetation root system. The use of the nylon mat instead of the rip-rap or paved-concrete alternatives also resulted in slower final velocities and lower flow concentrations.

The Pennsylvania Department of Transportation's (PennDOT's) Design Manual provided for the use of erosion-control lining made of sod, jute matting, rock, gabions, or paved concrete, depending on anticipated velocities. The use of the last items, where higher velocities were expected, added substantial cost to the project.

Prompted by PennDOT's value engineering emphasis and by reports (1-3) of successful uses of the nylon mat by a few other state highway departments, a substitution of the nylon erosion-control mat for the designed rip-rap or paved-concrete lining was proposed. The substitution was allowed on two ditches with the stipulation that a formal research project, funded in combination by the Federal Highway Administration (FHWA) and the state, be initiated to evaluate the performance of the nylon mat. A final report (4), which this paper summarizes, was prepared by PennDOT as required by the research program.

INSTALLATION

The nylon mat was substituted for the rip-rap or concrete lining on two sections of trapezoidal ditches on the Monongahela Valley Expressway (Legislative Route 1125) in Washington County in the southwestern part of the state. The nylon mat was a flexible soil-reinforcement matting made from nylon monofilaments that are fused at the intersections (see Figure 1). It was a bulky mat, and its three-dimensional structure (about 0.75 in thick) allowed 90 percent of its volume to be filled with soil, gravel, or other appropriate material.

The first section was by the bituminous surface method and was placed on July 18 and 19, 1979. The trapezoidal ditch had a bottom width of 2 ft, side slopes of 1.5 on 1.0, and a depth of 3 ft. This