MANAGEMENT OF HIGHWAYS FOR WILDLIFE IN THE CENTRAL APPALACHIANS[1]

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Abstract: A 10-year study of interrelationships between highways and wildlife was conducted to determine potential management options and to identify areas where further research is needed. Management of highways for wildlife is divided into 3 phases: geographic location, design, and maintenance. Specific recommendations are: (1) create wetlands adjacent to highways by using highway base as a dam, (2) design bridges to attract birds such as swallows, but to repel birds such as starlings, (3) mow cover crops at 3-5 year intervals, (4) seed woody species, using native plants, at time of construction, (5) initiate a public education program to explain benefits of managing highways for wildlife, and (6) use management practices to mitigate losses where adverse impacts due to highways cannot be prevented.

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Wildlife are being affected by many different land-use practices, including agriculture, mining, logging, dredging, filling, lake construction, and residential development. One of the most wide-spread effects (although not necessarily the most significant) is that of highway construction. Public roads and highways in the United States now occupy 10,530,000 ha of land (Leedy et al. 1975). High-speed, limited-access highways are being built in all states and when completed the interstate highway program will encompass 607,000 ha (Hancock 1963, Scheidt 1967, Jordan 1968).

These highways have wide rights-of-way (ROW) on both sides which are not only seeded, but portions may also be fertilized and mowed. This ROW is often attractive to many species of wildlife. The presence of some species, such as songbirds, birds-of-prey and small rodents may be desirable because of their aesthetic value to passing motorists and the role they play in the ecosystem. Other species may be undesirable because of the danger they pose to passing motorists.

With the interstate highway system nearly completed, there still exists a paucity of scientific information regarding wildlife in relation to highways. Without such information highway agencies can only use scientific generalities in planning (Sullivan and Montgomery 1972). Wildlife biologists must establish a line of communication and provide highway engineers with the necessary data to enable them to manage highways for the overall best interests of both man and wildlife.

Most research on the management of highways for wildlife has been conducted in the Midwest and has involved nesting studies of waterfowl and ring-necked pheasants *(Phasianus colchicus)* in areas immediately adjacent to the highway. Very little research has been conducted on highways in mountainous or hilly terrain, with the exception of studies to reduce vehicle accidents with hoofed mammals. Management potential may be greatest for those areas with relatively flat terrain, because of the potential to manage wetlands. However, many benefits can be derived by managing highways in hilly terrain.

The objective of this paper is to present recommendations regarding management of highways (specifically limited-access, high-speed ones) for wildlife in the central Appalachians. By familiarizing wildlife biologists with potential management options they can

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better work with highway personnel to improve conditions for wildlife. Because of legislation, public pressure, and increased awareness of ecological problems, highway engineers are more willing than ever before to cooperate with natural resource agencies. Although attempts have been made to familiarize highway engineers with a basic understanding of ecological problems (National Highway Institute 1975), the responsibility rests with wildlife biologists to provide guidance and recommendations.

Most previous participation by natural resource agencies has involved defensive-type actions to prevent or reduce adverse impacts of highways. Benefits to wildlife, however, can occur as a result of highway construction, although it is necessary that biologists and highway engineers cooperate.

A second objective of this paper is to designate areas where further research is needed. Research on the interrelationships between highways and wildlife has increased tremendously in the past 10 years, but many basic unknowns still exist.

Recommendations presented in this paper are based on 10 years of research of interrelations between highways and wildlife in West Virginia, plus a review of available literature. This paper will be primarily concerned with wildlife, although impacts of highways upon fisheries are equally significant. Management of highways for wildlife can be divided into 3 phases: geographic location, design, and maintenance.

GEOGRAPHIC LOCATION

Location involves the geographic placement of the highway. Major concern is that the highway not be located in areas where vulnerable species or vulnerable habitats exist. This commonly involves species which are restricted in distribution and relatively uncommon, such as black bear *(Ursus americanus)*, mountain lion *(Felis concolor)*, and bald eagle *(Haliaeetus leucocephalus)*. Also involved are habitats such as wetlands which are scarce throughout the central Appalachians. Every effort should be made to locate the highway where it will have the minimal impact on such species and habitats. The physical presence of the road, including even heavy construction and vehicular traffic, is often not as significant as the increase in human activity which occurs as a result of improved access into the area. This appears to be especially true with black bear (Brown 1980).

Geographic location is probably the most difficult impact to mitigate, because it usually involves direct conflicts between engineers and biologists. General location of highways is usually determined before resource managers are involved, and, due to the large ranges of animals such as bear and mountain lion, it is very difficult to relocate the highway to bypass these areas. Only when isolated populations of small animals are involved could a highway be relocated and still serve the original objective. Species which are restricted in distribution due to elevation, such as Cheat Mountain salamander *(Plethodon n. nettingi)*, Wellers salamander *(P. welleri)*, and snowshoe hare *(Lepus americanus)* are good examples.

Highways should be located to bypass unique habitats such as bogs or other wetland habitats. Adverse impacts due to siltation and highway runoff may be lessened by locating highways on ridges, away from streams, rather than in valleys. Wetland habitats are scarce throughout the central Appalachians, thus every effort should be made to preserve all those which currently exist.

DESIGN

Design involves engineering specifications, plantings, landscaping, and structures such as bridges. Efforts should be made not only to protect wetlands by having the highway by-pass them, but also to produce them. Construction of highways requires filling many low areas to reduce the highway gradient. The potential exists to create wetlands where none existed previously. This requires early involvement by resource managers to assure

planning prior to construction, thus reducing costs by utilizing construction equipment already involved with highway construction. Terrain in the central Appalachians is not conducive to the creation of large wetlands, but even small ones would be desirable because of the scarcity of existing sites. Design and specifications of these have not yet been developed.

Because of near completion of the interstate system, opportunities to create wetlands using highway fill as dams, are quite limited. Perhaps of greater importance is the development of specifications to create wetlands along already existing highways. Wetlands designed this way will be somewhat more expensive than those created concurrent with highway construction. However, these new wetlands offer a potential area of mitigation in situations where highways destroy existing wetlands.

Wetlands created adjacent to highways may also serve as filter basins to aid in the control of non-point pollution produced by vehicular traffic. Studies are currently being conducted in a few states (including Massachusetts and Minnesota) on the value of wetlands for this purpose, but results are not yet available.

Another area of concern which involves design of highways is that of the median between opposing lanes of traffic. In many mountainous areas it is not feasible to separate opposite lanes of traffic by more than a narrow vegetated area, usually 10 m in width, if at all. In flatter terrain, however, it is feasible to separate opposite lanes by as much as 500 m. These wide median strips usually contain woody vegetation which was present prior to highway construction, unlike the narrow strips which are maintained in low herbaceous cover. The presence of woody vegetation may attract more wildlife crossing of highways than does a narrow, low-cover vegetation. We have no data to support the hypothesis that animals are less likely to cross highways with narrow medians. Resarch is needed in this area, because it may lead to a reduction in highway mortality of wildlife and especially deer-vehicle accidents.

If it could be determined that wildlife more readily cross highways with wide, wooded medians, then the vegetation should be removed during construction. Without serious attractant problems, wildlife in general would benefit by separating the opposite lanes and maintaining a strip of woody vegetation. This strip acts as a mini-refuge for many animals, especially birds which are facing a loss of habitat or direct mortality by humans. The best example in the eastern United States is the red-cockaded woodpecker *(Dendrocopus borealis)*, whose future is dependent on availability of nesting sites (Jackson 1971). Because of land-use practices, pine trees within highway medians or along the ROW may be the only source of such nesting sites in a given area. Unfortunately, terrain in the central Appalachians usually prevents leaving a wide median, such as that which occurs in areas where red-cockaded woodpeckers are found.

Wooded medians are also of value to raptors. Raptors such as red-tailed hawks *(Buteo jamaicensis)* and great horned owls *(Bubo virginianus)* seem to benefit by the presence of a high-speed highway through a wooded area. Ferris (1974) found that red-tailed hawks commonly use ROW areas immediately adjacent to interstate highways, being attracted by a readily available food source of rodents *(Microtus* and *Peromyscus)* and rabbits *(Sylvilagus floridanus)*. Our studies in West Virginia indicate that hawks are rarely hit on highways.

The problem of wildlife mortality on highways must be resolved prior to managing highways for any wildlife. Are animals being attracted only to be killed by the traffic? Groundhogs *(Marmota monax)*, for example, are attracted to highways with wide, herbaceous ROW and groundhog densities are much greater in the ROW than in adjacent wooded tracts. Use of areas immediately adjacent to highways results in more kills by traffic than if the highway did not exist, but the total groundhog population is higher than it would be without the highway. Highway mortality of wildlife is probably density

dependent.

In addition to existing woody vegetation, many trees and woody shrubs are planted as part of the landscaping plan in medians, ROW adjacent to the highway, and around interchanges. These plantings are currently for aesthetic purposes, and little is known about their value to wildlife. Wildlife biologists should provide highway engineers with a list of woody plants beneficial to wildlife. These recommendations could then be considered when original landscaping specifications are prepared.

Several factors must be considered in making recommendations for wildlife enhancement regarding tree species and location. Trees or shrubs which attract deer should be avoided. Woody plantings along highways are beneficial to several songbirds, which use trees and shrubs for nesting, feeding, and perching. Preliminary findings of our current research in West Virginia indicate that conifers are most preferred for nesting (90 of 98 nests in the ROW were located in conifers). Conifers and deciduous hardwoods are equal in number in our study area, are approximately 3 m tall, and are less than 10 years old. Preference by songbirds may change as trees get larger.

Woody species, such as Scotch pine *(Pinus sylvestris)*, Austrian pine *(P. nigra)*, red cedar *(Juniperus virginianus)*, and flowering crabapple *(Malus* spp.) are all of some value to wildlife, but it would be more beneficial and economical to propagate woody plants which commonly grow in that geographic region. Sumac *(Rhus* spp.), locust *(Robinia pseudoacacia)*, and aspen *(Populus* spp.) are examples of woody plants which naturally invade highway ROW. These plants are as aesthetically pleasing as are the ornamental ones currently planted. Also, by seeding them directly at the time of construction they would be present many years before they normally would invade. Our studies indicate that 8-10 years are required before these woody invaders reach a size adequate to be used as nest sites. Research is currently being conducted by the West Virginia Department of Highways to determine the best methods of direct seeding of woody plants.

Equally important to woody species which are planted in ROW is the cover crop which is used. Common cover crops used in the central Appalachians are crownvetch, *(Coronilla varia)*, sericea lespedeza *(Lespedeza cuneata)*, and Kentucky fescue *(Festuca* spp.). Earlier research (Michael 1980) indicates that: (1) deer prefer crownvetch, (2) rabbits prefer sericea lespedeza, (3) small mammals exhibit no preference for any of the 3 cover crops, and (4) each of the 3 is preferred by certain songbird species.

Fill areas adjacent to highways are created in many locations where excess earthen material must be removed to construct a highway. These fill areas are frequently as large as 100 ha and thus have the potential to provide habitat for several wildlife species. Currently they are planted in a cover crop such as crownvetch or Kentucky fescue. These areas could be planted in a crop which is more beneficial to wildlife or even have seed of native woody plants added to the original seed mixture.

Bridges, culverts, signs, guard rails, and fences all have some potential to be designed for use by wildlife, aimed at attracting and increasing such wildlife as phoebes *(Sayornis phoebe)*, cliff swallows *(Petrochelidon pyrrhonota)*, and bats. They may also be designed to reduce use by such wildlife as pigeons *(Columba livia)* and starlings *(Sturnus vulgaris)*. Little information currently exists on this topic, but it is an area of great potential.

MAINTENANCE

Maintenance, as it presently exists, primarily involves mowing and other practices to maintain vegetation at the desired height and composition; however, several other maintenance practices also affect wildlife. Mowing is conducted to prevent invasion of woody species and/or to maintain a neat lawn-like appearance. Neither of these objectives may be desirable since invasion of woody species increases stability of roadsides, and unmowed vegetation may be aesthetically pleasing to motorists. Many states currently

conduct mowing several times per year in areas where a tractor can be safely driven. This is not only expensive but undesirable from the standpoint of wildlife management. Recent studies indicate that some species of vegetation should be mowed, but most should not (Morash and Michael 1979).

Kentucky fescue is a good example of a species which should not be mowed (Morash 1980). Unmowed fescue has greater vegetative diversity (more weeds), greater variety of insects, and greater bird use than does mowed fescue. In contrast, unmowed sericea lespedeza is not as desirable as mowed sericea. While sericea cover is useful in reducing erosion and increasing soil nitrogen, wildlife would benefit more if sericea cover were converted to a more desirable type. Since sericea lespedeza seeds are commonly eaten by only juncos *(Junco hyemalis)*, increased vegetative diversity resulting from frequent mowing would benefit many songbirds.

Succession in highway ROW should be permitted to continue to a shrub-grassland stage, at which time selective maintenance can be conducted. Narrow strips should be mowed through the ROW at intervals of 3-5 years. Such a mowing schedule would entail low maintenance costs and result in a diverse community which could support a wider variety of birds and mammals. Raptors such as kestrels *(Falco sparverius)* would benefit as a result of improved foraging areas.

Additional current management practices which could be modified to benefit wildlife involve herbicides and fertilizers. Herbicides are currently used to control vegetation along guard rails and signs. They may also have limited value in controlling the growth of undesirable woody vegetation. Fertilizer is added when original seeding of ROW occurs, but additional benefits may accrue as a result of later application. Both erosion control and wildlife habitat would be improved, but due to the rapidly increasing cost of fertilizer the benefits probably cannot be justified.

More intensive management involve the placement of artificial structures such as nest boxes and perch sites. Nest boxes have been erected for such species as bluebirds *(Sialia sialis)*, but boxes could also benefit such species as kestrels. Perch sites are usually not a limiting factor since smaller birds use guard rails, sign posts, and planted trees. However, larger birds such as red-tailed hawks and kestrels may benefit from the addition of perch sites. Posts set in the ground within the ROW will be used by raptors as well as by other birds. By strategically placing posts to obtain maximum visibility, passing motorists can enjoy seeing these large raptors.

A motorist education campaign consisting of self-interpretative nature study would provide for good public relations and help justify the expenditure of tax dollars. This could be a specially designed pamphlet coordinated with strategically placed signs pointing out to passing motorists various ecologial features occurring along the highway. Such pamphlets could be dispersed at roadside rest areas.

MANAGEMENT IMPLICATIONS

Management of ROW for wildlife basically involves discouraging those species which pose a threat to vehicular traffic while encouraging those which are aesthetically pleasing and pose no threats to vehicles and occupants. General considerations regarding management of ROW for wildlife involve: (1) Rare and endangered species, (2) Vehicle-wildlife accidents, (3) Aesthetically-pleasing wildlife, and (4) Ecological diversity.

Rare and endangered species of wildlife must be given more consideration than other species. This consideration may be necessary both prior to highway construction and after completion.

Loss of human life and the damage to vehicles are major considerations in managing ROW to prevent encounters between wildlife and vehicles. In the central Appalachians deer are the main cause of physical damage to an automobile if there is an encounter. ROW should be managed to discourage animals which cause vehicle accidents.

Many people do not see wildlife while driving even though the animals are present and visible. Some people, however, intentionally look for wildlife while driving. Others cannot help but sight animals such as groundhogs along the road, large hawks sitting in trees, or vultures soaring overhead. Hawks are some of the most interesting and aesthetically pleasing of all wildlife, yet are unlikely to be involved in vehicle accidents. Increasing the numbers of small mammals should have a favorable influence on hawks and scavengers such as crows *(Corvus brachyrhynchos)*. Other than deer, the most aesthetically-pleasing mammal likely to be seen along the highway is the groundhog. Groundhogs feed on succulent green vegetation, but plantings which attract groundhogs might also attract deer. Certain songbirds such as red-winged blackbirds *(Agelaius phoeniceus)* are also of interest to passing motorists, as these birds frequently sit on guard rails or reflector posts.

Highway management might also have as an objective increased ecological diversity of the area through which the highway passes and thus increased stability of the ecosystem. By increasing ecological diversity and stability most species of wildlife will ultimately benefit. Although man may not directly benefit by increased diversity, ultimately some benefits will accrue.

Highways are currently managed for safety, erosion control, and aesthetics. There appear to be no major conflicts between management of highways for wildlife and management for these other purposes. As is true with all wildlife management, the cost of the program must be justified by increased public benefits. Cost-benefits have not been determined but several management practices for wildlife will actually result in lower highway maintenance costs. Cost-benefit relations must be determined before final ROW management recommendations can be given.

RECOMMENDATIONS

Following is a list of recommendations resulting in benefits to wildlife and man. Some recommendations are based on completed research, some on preliminary findings, and others on knowledge of requirements of wildlife. The specific recommendations may vary from region to region, but the general principles remain the same.

1—Locate highways out of the range of vulnerable species or vulnerable habitats.

2—Create wetlands adjacent to highways by using highway base as a dam.

3—Avoid planting crownvetch where deer are abundant.

4—Woody vegetation should be encouraged in the median, within intersections, and within ROW.

5—Design bridges and other structures to attract nesting birds such as phoebes and swallows, but to repel birds such as starlings and pigeons.

6—Mowing of most cover crops should be conducted at 3-5 year intervals.

7—Woody species should be seeded at the time of construction, using plants common to the area and having known wildlife value.

8—Sericea lespedeza should be mowed frequently after it has controlled erosion and built up soil nitrogen, to encourage invasion of a greater diversity of plants.

9—ROW and median should be mowed in strips on a yearly rotation basis to increase vegetative diversity and feeding conditions for raptors.

10—Nest boxes and perch sites should be erected along highways.

11—A public education program should be initiated to inform the public of the benefits of managing highway ROW for wildlife.

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