EPRI

technical update

Wildlife and Integrated Vegetation Management on Electric Transmission Line Rights-of-Way

Rights-of-Way Environmental Issues in Siting, Development, and Management

Electric transmission rights-of-way (ROWs) are routes for critical technical infrastructure and contain important ecological features of the landscape. Tens of thousands of miles of such ROWs traverse North America. While opportunities for managing ROWs with considerations to wildlife have been recognized for over 50 years, interest and knowledge has only recently grown to fully explore wildlife-vegetation management potential. Vegetation management has also developed dramatically over the past 50 years. Today, a renewed approach to controlling vegetation on powerline corridors, referred to as Integrated Vegetation Management (IVM), is creating new perspectives on all aspects of ROW values and services. ROW vegetation managers will need to elevate considerations for wildlife as the sophistication level of vegetation management rises, as society more frequently interacts with ROWs, and as appreciation and knowledge grows for landscape-level issues associated with biodiversity and ecosystem integrity and function.

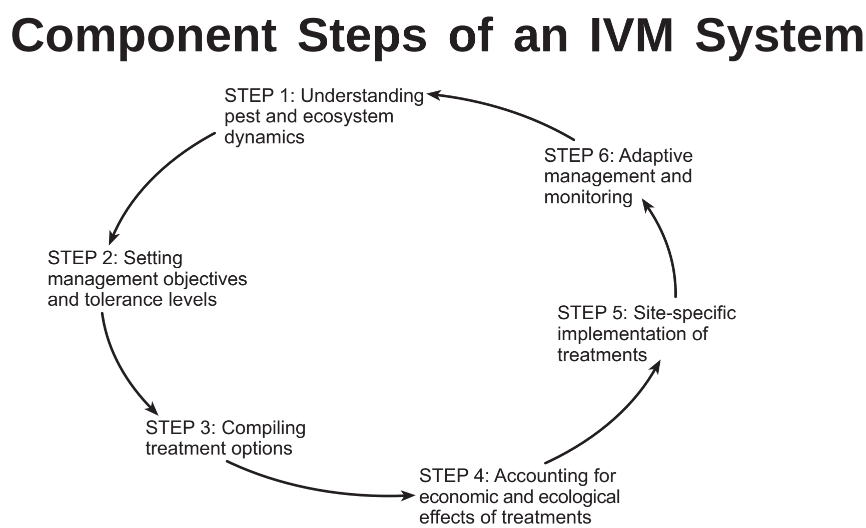

Figure 1. Component steps of Integrated Vegetation Management, a system of managing vegetation on electric transmission line rights-of-way. Wildlife are considered in each step of IVM. (adapted by Nowak and Ballard 2001, from Witter and Stoyenoff 1996)

What is Integrated Vegetation Management?

Vegetation management is a critical endeavor on powerline corridors; without it transmission of electricity fails. From the late-19th century to the mid-20th century, plant communities were maintained in a desirable state on ROWs using only mechanical means. Chemical methods for vegetation maintenance grew in prominence from the 1940s to the present. Beginning in the 1960s, an integrated approach to treating and monitoring vegetation on ROWs began to develop in some parts of the country. IVM is the system that embodies the principles and practices of this approach. IVM is different from other approaches to managing ROWs. It seeks to understand, justify, choose amongst, selectively apply, and monitor different types of treatment-mechanical, chemical, cultural, and biological. Its overall goal is to elicit site-specific, ecosystem-sensitive, economically sensible, and socially responsible treatment effects that lead to refined prevention and control of target pests.

Pests on ROWs are universal around the world-tall-growing trees and other plants that can directly interact with conductors and interfere with the safe and reliable transmission of electricity. A common IVM approach is to selectively remove trees using targeted applications of various mechanical and chemical treatments to minimize disturbance to the non-target, desirable plant community. The desirable, low-growing plant communities can act as a biological control that prevents establishment, and interferes with the growth, of trees. A wide variety of different herbicide treatment methods are commonly used to achieve these ends, including cut stump, basal, foliar, and stem-foliar methods. An IVM approach to vegetation management does not preclude the integration of other, more coarse or broadcast methods, such as mowing or even broadcast helicopter applications of herbicides. Regular blanket application of these types of treatments; however, without efforts to integrate the development of plant communities as a biological control, is not IVM. Biological control via the persistent presence of desirable grass-forb-shrub communities is the core element of IVM. It is this early successional plant community, in all its various forms, that produce many values associated with ROWs, including wildlife values supported by ROWs as habitat.

What is Wildlife?

Most people think of only game animals as wildlife-deer, bear, squirrel, hares, grouse, etc. Research and management have focused on these game animals for most of the last century. Since the 1980s there has been a growing appreciation of conservation values associated with other wildlife as integral parts of healthy ecosystems. Today, wildlife is often defined as "any living thing that is part of a natural ecosystem" (Hunter 1990), and includes animals such as voles, songbirds, and butterflies.

Wildlife provides unique values and service on ROWs. Many animals, particularly those that are small and often overlooked, are important indicators of environmental change and barometers of healthy and diverse ecosystems. Some species can be food for other wildlife, game animals for hunting, pollinators, and appealing visuals due to their natural beauty and wildness. Wildlife-ROW interactions are germane particularly today as ROWs represent expanses of early-successional habitats that are increasingly rare in the landscape.

Wildlife and Vegetation Management on ROWs

Wildlife management in IVM is often viewed from two different perspectives: (1) the manager manipulating habitats for populations of specific animal species; and (2) the manager considering the environmental effects of management on wildlife in general. Both perspectives view animal populations as varying as a result of management that affects habitat through changes in vegetation condition. In the first case, specific attributes of habitat can be directly altered to favor a single species. In the second case, vegetation management treatments are evaluated for their potential influences on wildlife communities.

The scale at which wildlife use the environment is important to consider. "Landscape-level wildlife," such as deer, turkey, and bear, find only some of their habitat elements on any one tract of land. These animals require a mosaic of large habitat patches across a landscape of which ROWs may provide only one part. Other animals, such as small mammals, songbirds, and insects, are able to meet all of their daily needs within the ROW area. For these "site-level wildlife," small patches of vegetation can be entirely critical to their survival.

Wildlife have four core requirements to meet life needs: food, cover, water, and space. Food is directly related to the vegetation conditions created on a ROW, and indirectly through the animals that live in those conditions that may be food for other animals. Wildlife cover serves primarily as protection while animals conduct one or more of the necessary functions in their lives, such as breeding, nesting, hiding, resting, sleeping, feeding, and traveling. Water can be an important feature that requires protection. In particular, small wetlands can provide valuable breeding habitat for amphibians, waterfowl, and other species. Space is related to the need for animals to move and is often as much a function of off-ROW conditions as on, particularly for landscape-level animals.

Vegetation management on powerline corridors most directly influence food and cover. Managers affect vegetation and habitat by varying the intensity and selectivity of management. Intensity is related to the degree to which the community of vegetation is changed. For example, a mowed ROW can be considered to have undergone a higher degree of community change, at least in the short-term, than one that has only the trees removed by hand cutting or selectively applied herbicides. It is important to note that vegetation management cannot be categorized as good or bad for wildlife. Instead, changes in vegetation with treatment produce changes in habitat, which may then change the species that use that land area. Except in very extreme cases, any ROW will be favorable habitat for some form of wildlife. Setting goals for what type of wildlife is targeted to benefit from management activities is necessary to determine what type of management is best undertaken.

It is important to recognize that because ROWs are corridors, they provide unique landscape functions that are keenly related to wildlife. ROWs can act as conduits that facilitate the movement of animals. In forested areas, where the vegetation conditions of a ROW are much different than the surrounding land, ROWs can act as barriers that inhibit animals crossing from one patch of forest to another. ROWs often create edge, particularly in forested areas. The transition zones between the ROW and surrounding lands, where edge is created, are called ecotones. Ecotones generally have high wildlife diversity because different habitat elements are conjoined. Edges; however, can also reduce habitat value for some key species, such as songbirds nesting in adjacent forest that require forest "interior" type conditions. Corridors acting as conduits and the presence of ecotones may promote the actions of predators and parasites on some wildlife. All of these functions-habitat, conduit, barrier, and edge-can be modified by vegetation management.

Case Studies

A wide variety of wildlife has been studied on ROWs, from mice to deer, butterflies to snakes. Five of the most commonly studied species or species groups—deer, songbirds, small mammals, butterflies, and reptiles and amphibians—are highlighted below to provide ideas and concepts that are broadly applicable to other species and are indicative of how IVM relates to wildlife. Table 1 presents specific citations to ROW vegetation management and these five groups of animals.

Deer

Deer are "landscape-level" animals that use ROWs primarily for forage. Having shrubs and small trees on ROWs, mixed with patches of grass and forbs, provide deer with food and the necessary cover when foraging. Most ROW vegetation management treatments can be considered to have some positive effect on deer habitat. Mowing can promote woody browse. Herbicides can be used to create patches of grasses and forbs that facilitate movement or provide bedding. Wintering yards are a critical, large-scale element of habit for deer, particularly in northern ranges. Deer often congregate during the winter at lower elevations, particularly in those areas with conifer cover that limit snow depth, moderate climate, and provide forage. ROWs can fragment these yards and create a barrier to movement within them. Vegetation managers can minimize negative barrier effects by adding foraging opportunities within the ROW, or by managing ROW vegetation to create corridors for crossing from one side of the ROW to the other.

Songbirds, Small Mammals, Butterflies, Reptiles, and Amphibians

ROWs that consist of a mosaic-pattern of grass-forb communities mixed with shrubs provide habitat for diverse communities of songbirds, small mammals, butterflies, reptiles and amphibians. Most of these animals can complete their life cycles within ROWs. Home ranges of many of these animals are so small that patches of vegetation need only be as large as one-tenth acre. Some species benefit from having mixtures of plant communities; one community may provide food, another cover. For songbirds, various sparrows, for example, prefer grass-dominated plant communities as habitat, while some warblers require shrub cover. A diverse ROW can reduce the risk associated with some predators and parasites of birds. For example, parasitism of songbirds by the brown-headed cowbird is higher on ROWs with uniform grass-herb communities or uniform, tall shrub cover. Small mammals are important component of these communities. Some species of voles prefer grass habitats, whereas others prefer shrubs. White-footed mice benefit from a mixture of grass-forb-shrub habitat. Butterflies can be problematic. Some may have specific hosts for some stages of life. If that plant host is missing from the ROW, the animal will not be present. A succession of plants that flower at different times during the growing season will generally benefit butterflies. Many snake species are found on ROWs dominated by grasses, while salamanders may occur on the same ROWs in areas of shrub cover.

Summary

ROWs clearly provide important habitat for many animal species associated with early successional plant communities, i.e., those plant communities dominated by mixtures of grasses, forbs, and shrubs. It is apparent that even within the small confines of a ROW, mosaics of vegetation conditions within a ROW can be valuable. Patches of vegetation at fractions of an acre in size, mixed with other patches, provides diversity of habitat favored by many species. In general, diverse habitat equates with diverse wildlife. A variety of different vegetation management practices can be used to create diverse habitat, so one treatment should not be promoted as being better than others. A need for biological control in IVM; however, often leads to the development and long-term maintenance of shrub habitat. Shrubs are important habitat for a variety of early successional wildlife species. Because shrub habitat is declining across much of the U.S., ROWs managed to include shrubs can be important to national-wide wildlife and biodiversity management efforts.

Stepwise Considerations for Wildlife in IVM

IVM can be viewed as a system composed of steps that formalize the relationship among phases of management. Moreover, it broadens the considerations for ecological, environmental, economical, and societal opportunities and constraints for management. At each step of IVM, critical outcomes and outputs are being produced that must be integrated into the system.

A model developed by Witter and Stoyenoff (1996) for Integrated Pest Management (IPM) of insects in urban systems is adapted below to present key steps of IVM and wildlife considerations as they relate to each of those steps (after Nowak and Ballard, 2001; see Figure 1). The model should be viewed as a systems approach for IVM and the treatment of wildlife. Wildlife considerations are to be made at each step.

STEP No. 1: Understanding Pest and Ecosystem Dynamics

The first step in an IVM program is to develop a working knowledge of the organisms—plants and animals—that may be affected by management. ROW vegetation management necessarily puts a focus on plants, but all organisms affected by management activities should be considered, including wildlife. Knowledge starts with species identification, but focuses on understanding what species are potentially present, their life histories (reproduction, growth, longevity), their habitat requirements, and how they may respond to changes in vegetation conditions. Specific considerations should be made to determine the potential for any threatened, rare or endangered animals to exist near or on a ROW. These animals are critical elements of biodiversity and are often considered important indicators of changing ecosystem health and integrity. If information on plant and animal populations and ecosytems is inadequate, efforts must be made to garner such information through monitoring or formal research.

STEP No. 2: Setting Management Objectives and Tolerance Levels

While the overall goal for ROW vegetation management remains unchanged—providing safe and reliable transmission of electricity—there is much flexibility as to how managers can meet this goal. Different types of low-growing plant communities can be cultured on any one ROW to meet the goal. Various wildlife can be provided for using treatment methods that conserve or develop important elements of habitat. Concern for the environmental effects of management is always included in IVM. In a general sense, objectives should always include a recognition that habitat is being manipulated, and that management efforts will be made to minimize the negative aspects of those effects. Stakeholders in ROWs-anyone influenced by ROWs and their management-should be engaged in the process of developing management objectives. Stakeholders can have varied interests, and management of ROWs with a focus on a single animal species may be an objective, for example, for deer. Conversely, whole guilds of animals such as birds or buttteflies could be of general interest to stakeholders, for example, to birdwatchers. Managers must learn the needs and interests of other parties, and adjust techniques to accommodate where possible. Collaborative interaction between ROW managers and various stakeholders can be fostered by partnerships formed around wildlife (see Sidebar on Project Habitat®).

In IVM, it is critical to have a predetermined tolerance level of the number of individual pests that can live in a ROW ecosystem and not create an impact that requires immediate treatment. With such a defined level, vegetation is not routinely treated, but is instead treated only as needed. Monitoring of ROWs is conducted regularly to judge the conditions of targeted species, particularly pest species that can interfer with transmission lines. There is some flexibility in defining thresholds in IVM. Different thresholds may be developed near transmission towers or along ROW edges compared to the mid-span and centerline. Vegetation under the conductors (the "wire zone") may be managed differently than near the towers or along the edges (the "border zone"). For example, researchers working together on ROWs in Pennsylvania have utilized a "wire zone/border zone" management technique (see Figure 2), and have demonstrated that the associated diversity of vegetation conditions supports high diversity of wildlife (Table 1).

Project Habitat®

Project Habitat® began in 1995 as an educational and community relations program that is meant to help utilities manage wildlife habitat on ROWs and earn positive recognition in their communities for these efforts. The program is sponsored by various industry, government agency, private citizens, and non-government organization groups.

Objectives of Project Habitat® are to:

1. manage ROWs with an eye towards wildlife habitat;
2. increase biodiversity on or near ROWs;
3. involve local citizens in the effort; and
4. gain positive publicity for the participants.

To accomplish these objectives, members are required to use integrated vegetation management (IVM) programs that feature low-volume, selective application of herbicides to control trees, which fosters the development of diverse, early succession plant communities. Project Habitat® provides the utilities national recognition and organizational support for generating publicity through various mediums, including brochures, signage, and personal contacts.

Case Study: the Karner Blue Butterfly

One of the original Project Habitat® projects was associated with the Karner Blue Butterfly (KBB) in New York. Of the 12 original projects, it was the only one to feature a non-consumptive (game) species.

The KBB was listed as endangered in New York in 1977 and is now a federally endangered species. ROWs in east-central New York provide some of the last refugia for KBB. Until the 1980s, habitat for KBB was maintained on ROWs by happenstance. Routine broadcast herbicide applications in the 1960s and 1970s favored lupine, a plant whose foliage is required by KBB as food during its larval stage. A habitat preserve was formed by the utility in 1988 to protect the KBB. Cooperation of interested parties in protecting KBB was facilitated by Project Habitat®. Public recognition and publicity have been overwhelmingly favorable in response to education and research aimed at evaluating ROW vegetation management techniques to expand habitat for blue lupine, while retaining traditional ROW operations and maintenance techniques that are consistent with IVM. Selective application of herbicide to remove individual trees and shrubs that can out-compete lupines for site resources and growing space is consistent with the objectives of Project Habitat®. The main goal of the KBB project research is to demonstrate which of the available IVM strategies and techniques can be optimized to fulfill the goals of cost effective, reliable ROW vegetation management while providing optimal conditions for blue lupine and other nectar plants.

This Sidebar was written using select text and ideas from Hurst (1997), Shupe et al. (1997), and Smallidge et al. (1995, 1996), and was supplemented and confirmed with information from the Project Habitat® website located at www.projecthabitat.com.

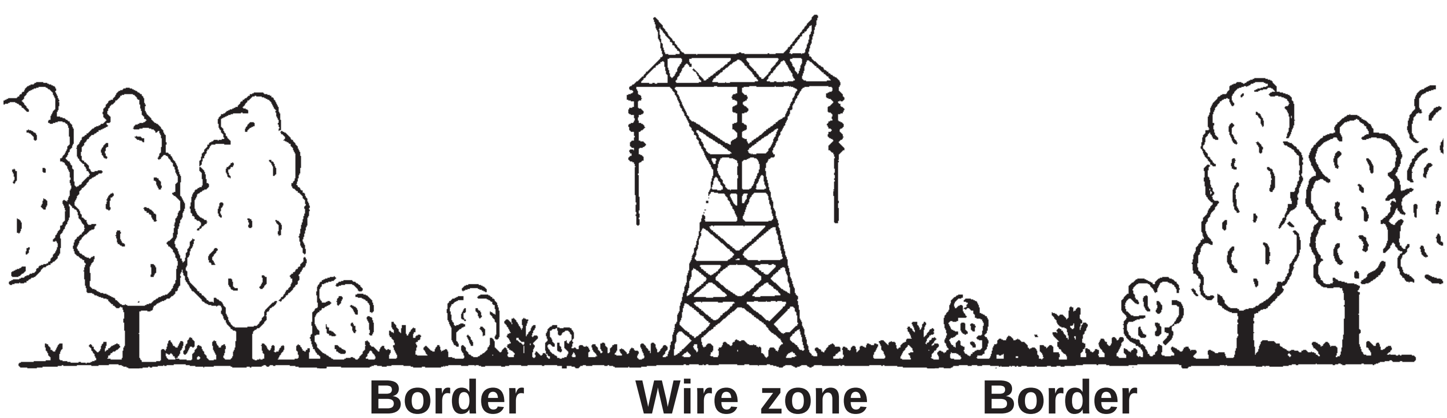

Figure 2. Bramble and Byrnes' wire zone-border zone approach to vegetation management on powerline corridor rights-of-way. Note that shrubs and short trees are fostered in the borders, and grasses and forbs are managed in the wire zone. (Diagram adapted from Yahner et al. 2001)

Table 1. Select information on interactions between wildlife and electric transmission line rights-of-way vegetation management activities.

Animal	Information	Reference
Deer	- Total habitat values considered desirable for deer remained high after various chemical and mechanical treatments on a ROW in an oak-hickory forest in Pennsylvania.	Bramble et al. 1985
	- Browse production at transmission line tower sites in Quebec, Canada, was increased from 16,000 to 192,000 twigs/acre after mechanical treatment of vegetation, leading to increased deer activity. Sustained availability of browse in a ROW for deer may require selective cutting rather than complete cutting of a ROW.	Garant et al. 1987
	- Food for white-tailed deer can be enriched on ROWs by planting and fertilization. A plant-and-fertilize treatment (cereal rye and legumes with additions of NPK fertilizer) increased plant biomass and improved nutritive quality of browse compared to the other treatments.	Harlow et al. 1995
	- Planted deer forage was found to be nutritionally superior to native and naturalized forages that occurred on unplanted ROWs. A mow-and-fertilize treatment was shown to be most cost effective, where effectiveness was measured by the production of crude proteins as an indicator of forage quality.	Harlow et al. 1993
	- Forage on ROWs provided by IVM can enhance survival of deer in wintering yards.	Doucet et al. 1987
	- Mechanical treatment of ROW vegetation can be used to provide short-term winter food to deer and to accelerate the regeneration of browse as part of ROW vegetation management. Felling of woody plants into slash piles just before winter can provide an immediate food source as browse above 6 feet height, outside the reach of deer, is made available by the cut.	Garant and Doucet 1995
	- Forested travel corridors left in a 500-foot wide powerline ROW were found to facilitate deer movement across the ROW in yards during winter in southern Quebec, Canada. Deer used the travel lanes during the first winter. Periodic surveys indicated that the deer regularly used these forested travel lanes for 17 years after construction.	Doucet and Garant 1997
Songbirds	- Shrubs are frequently used as plant cover for nesting songbirds, but grasses and forbs are also important for several common bird species typically found on ROWs, such as the field sparrow. Nesting success was not different between mechanical and chemical treatment of ROWs in Pennsylvania, averaging over 70%.	Bramble et al. 1994
	- Increases in shrub cover, from 20 to 40%, on two ROWs in Upstate New York, led to a doubling of bird territories and nests, though bird richness was generally the same at 12-14 species. On the ROW with lesser shrub cover, the song sparrow was found in greater abundance. Average nesting success for all birds was about 50% for these varied shrub cover communities.	Marshall et al. 2002
	- Broadcast application of herbicides with helicopters or high volume stem-foliar techniques can cause a shift in bird communities from shrub-dependent to those birds dependent on grass communities	deWaal Malefyt 1987
	- Mowing treatments can lead to a decrease in songbird populations if the treatments are conducted during the nesting season. Conservation of birds was promoted with vegetation management that maintained shrub cover, even if this maintenance occurred only along the edges of the ROW. Basal, stem-foliar, and foliar herbicide methods can all be used to maintain adequate shrub cover to support rich populations of songbirds.	Bramble et al. 1992a
	- Most shrubland species showed a habitat preference for areas with 50% shrub cover, although some rare species occurred in greatest density in areas with 5-20% cover. Diversity of songbirds is increased if management created some areas dominated by grasses and herbs, and other areas dominated by shrubs.	Confer 2002
	- Forest bird species that prefer edge, such as the chestnut-sided warbler and mourning warbler, were abundant along ROW edges.	Hanowski et al. 1995
	- Parasitism of songbirds by the brown-headed cowbird can be promoted on ROWs with treatments that increase uniform grass-herb communities or uniform, tall shrub cover.	Confer 2002
	- Golden-winged warbler and the blue-winged warbler have declined so severely in parts of their range that they are under status assessment for listing under the Endangered Species Act; both species have been commonly found on ROWs in New York.	Confer 2002

Table 1 Continued. Select information on interactions between wildlife and electric transmission line rights-of-way vegetation management activities.

Animal	Information	Reference
Small mammals	- Management of early successional habitat on ROWs in New York and Pennsylvania can promote the inhibition of tree invasions through herbivory by small mammals, particularly meadow voles. Voles were shown to kill at least 60% of trees seedlings in various ROW communities.	Bramble et al. 1992b; Ostfeld and Canham 1995
	- Vegetation management can affect species composition of small mammals. Grass-herb dominated communities were associated with meadow voles and shrub communities with red backed voles on ROWs in Pennsylvania; white-footed mice were found across both community types.	Bramble et al. 1992b
	- ROWs can act as barriers to travel by small mammals such as snowshoe hare, red squirrels, and gray squirrels, but the barrier effects diminish as shrub cover is increased.	Doucet and Brown 1997
Butterflies	- Different mechanical and herbicide treatments schemes were found to all produce habitats to support 19-21 different butterfly species. Eight different shrubs and 15 different herbs were used as nectar sources among these treatments. Diverse butterfly populations were related to diverse cover of shrubs and herbs that flowered in succession over the growing season.	Bramble et al. 1997
	- In addition to old-field vegetation habitat found on ROWs, it was important to have some bare ground that provide puddling areas. Puddles are a source of water, essential salts, and nutrients for butterflies.	Lanham and Nichols 2002
	- 101 species of butterflies and related skippers, 82 flowering nectar sources, and 102 larval target-host plant species were found on six ROWs in South Carolina.	Lanham and Nichols 2002
	- Endanger butterflies, such as the Karner Blue Butterfly in New York and Lange's metalmark butterfly in California, have been successfully managed on ROWs (see Sidebar on Project Habitat®).	Smallidge et al. 1995, 1996; DeBecker and McKinney 1987
Reptiles and amphibians	- ROW management treatments effects are less critical to reptiles and amphibians than the act of siting and clearing a line. These animals can be categorized into a priority list of species based on vulnerablity to transmission corridors and conservation status.	Kamstra et al. 1995
	- Mosaics of different early successional plant communities promote the diversity of snakes and salamanders on ROWs. Snakes are more abundant in areas of grass-forb cover; salamanders are more abundant in areas of shrub cover.	Yahner et al. 2001.

Why should right-of-way vegetation managers consider wildlife?

Right-of-way vegetation managers should consider wildlife because they can:

1) reduce vegetation management treatments efforts by favoring animals that consume seeds and seedlings of undesirable plants, which is a common phenomenon with mice, voles, rabbits, and deer;

2) promote positive interactions with the public by collaborating on management programs to promote locally desirable wildlife for hunting or other wildlife-related recreational activities, e.g., bird watching while hiking;

3) meet stewardship responsibilities by developing healthy animal populations, particularly birds, reptiles, amphibians, and butterflies that are indicative of healthy ecosystems; and

4) contribute to biodiversity conservation at various scales by managing habitat for threatened and endangered species, or by dedicating important early-successional plant habitat that may be generally lacking across a region.

STEP No. 3: Compiling Treatment Options

ROW vegetation managers can conduct IVM and prevent or suppress pest populations only if there are various treatment options. Different treatments may be needed to match variable conditions on the ROW environment or to address stakeholder concerns and interests. Vegetation treatments can be grouped into four categories: physical or mechanical, chemical, cultural, and biological. Integration of information and knowledge from the previous steps is needed to select the right combination of these different treatments. Singular use of any one treatment through time, across all sites and conditions, is not an IVM approach. Along any one ROW, site-specific prescriptions of treatments are needed that are sensitive to surrounding land uses, local water resources, variation in vegetation conditions, and opportunities for enhancing wildlife habitat. Dozens of different treatments may be used throughout a single ROW to control trees and other undesirable vegetation. The use of biological controls and the resultant development of complex, low-growing, stable grass-forb-shrub communities is a particularly valuable outcome of IVM. Such plant communities, created by the selective removal of trees, can function on ROWs as an important preventive measure in that they can reduce pest abundance. They are, in and of themselves, important wildlife habitat.

STEP No. 4: Accounting for Economic and Environmental Effects of Treatments

Once the manager has developed the range of treatment options that are possible for use in a specific setting, these options must be evaluated in terms of their socioeconomic and environmental impacts. A useful metric for this evaluation is cost effectiveness. Cost effectiveness is a measure of the success of a treatment in terms of economics, plant community dynamics, and related environmental considerations. Evaluation of treatments using this metric is done based on individual examinations with the two component parts, cost and effectiveness. Cost of treatments include economic costs for the materials and/or labor, but also costs associated with externalities, such as negative effects on desirable wildlife. Effectiveness pertains to production of desired vegetation conditions and associated benefits and values, including promotion of diverse plant and animal communities, protected riparian areas and water quality, visual attributes fashioned to minimize impacts to aesthetics, and enhanced opportunities for recreational activities.

STEP No. 5: Site-Specific Implementation of Treatments

After the range of options has been examined and evaluated, the manager prescribes and implements treatments. Site-specific treatments can be applied to various sections of any one ROW, and also across a ROW. Water resources, e.g., streams and wetlands, may need protection from herbicide drift or siltation resulting from mechanical treatments. Different wildlife habitat elements can be featured on one site and other elements on another site. Across a ROW, a two-zone concept often referred to as a wire zone-border zone approach-where the edges of the ROW are treated differently than the center of the ROW-is a novel distinction that can afford ROW vegetation managers new opportunities to produce complex vegetation conditions associated with diverse wildlife communities and habitats (Figure 2).

STEP No. 6: Adaptive Management and Monitoring

Adaptive management is a formalization of the process of learning from experience. After the basic steps of management have been completed, and treatments have been applied, the effects of the treatment are monitored over the course of a treatment cycle. Wildlife can be monitored directly by individual animals counts, or indirectly through measures of habitat. At the end of the treatment cycle, vegetation conditions are compared to the desired condition set during the "Setting Management Objectives and Tolerance Levels" step (Step 2), and described in prescriptions during the "Site-Specific Implementation of Treatments" step (Step 5). Any similarities or disparities between "desired" and "achieved" results are investigated, and future treatment options adjusted accordingly. Monitoring in an adaptive management program is valuable in assuring stakeholders that treatment effects are being gauged, and shortfalls adjusted for by adapting management schemes to improve IVM. It is this sense of improvement that draws the circle of steps to close in the form of a self-improving cycle (Figure 1). With the new knowledge gained by completing the work cycle, the process is begun anew with heightened understanding and awareness of the opportunities and potential shortfalls of management.

Final Considerations

Wildlife use ROWs for habitat, whether you plan for it or not. This simple reality is an opportunity. ROW managers have tremendous opportunities to increase populations of certain wildlife through manipulation of specific habitat elements. Of course, managers must balance the primary goal of transmitting electricity with consideration of the full effect of management on the wildlife community. IVM provides such a framework. It outlines a systematic approach for integrating numerous activities/components, including gathering basic information, site-specific inventory, addressing stakeholder concerns, developing assessment results, prescribing and conducting treatments, and monitoring of vegetation management effects. Wildlife is an important consideration in all steps of IVM. Perhaps, most importantly, because IVM promotes the biological control of trees through the effects of low-growing plant communities, special habitat values are produced on ROWs that are important throughout North America.

Abbreviations

KBB	Karner Blue Butterfly
IPM	Integrated Pest Management
IVM	Integrated Vegetation Management
ROW	Right-of-way
ROWs	Rights-of-way

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