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Chapter Twenty

MANAGEMENT AND ENVIRONMENTAL IMPACTS OF ELECTRIC POWER TRANSMISSION RIGHTS-OF-WAY

W.C. BRAMBLE,[1] W.R. BYRNES[1] and R.J. HUTNIK[2]

[1]Department of Forestry and Natural Resources
Purdue University
West Lafayette IN 47907
and
[2]School of Forest Resources
Pennsylvania State University
University Park, PA 16802

As a basis for discussion of impacts, a brief description is given of commonly used Right-of-Way (ROW) management techniques. The impact of these techniques on vegetation varies greatly with the type used; aerial and other broadcast methods producing the most severe impacts. ROW have had a favorable effect on deer habitat and ROW songbird populations. Impacts on soil conditions may be expected to be negligible; as will the impacts on streams where a buffer zone is established to protect streambank vegetation. Impact on visual quality can be reduced by special attention to the type of ROW clearance used and to the method of vegetation control and will be greatest after aerial or other broadcast spray methods.

INTRODUCTION

Rights-of-way (ROW) constitute a large and growing category of land use which affects the local environment in many areas. High voltage transmission lines of 115 kV and above stretched for 164,022 km (273,370 miles) in 1978 and it was estimated that 67,788 km (112,980 miles) would be added by the year 2000 when they would occupy 2.1 million ha (5.2 million acres) of land (Young and Fisher 1981). Public concern has been voiced regarding destruction of vegetation, wildlife habitat alterations, and visual impacts among other problems. Use of herbicides to control unwanted vegetation has been a special cause for concern.

ROW have been used for a variety of purposes in addition to the primary one of electric power transmission (Randall 1973). Typical of these adjunctive uses are: snowmobile and motor bike riding, horseback riding, berry picking, hiking, skiing, birding, pasturing, and growing various crops compatible with electric power transmission such as Christmas trees.

Although ROW may traverse diverse land areas including agricultural fields, urban and suburban areas, and forests, only the environmental impacts of ROW that pass through forested areas will be discussed in this paper. Such ROW have the potential for important impacts as they must initially be cleared and constantly maintained to control tall-growing trees and shrubs that may interfere with electric transmission.

MANAGEMENT OF ROW

ROW must be managed intensively to insure safe and reliable transmission of electric power. This begins with initial clearance of the forest and continues with ROW maintenance to control undesirable trees and shrubs. As management is also charged with production of minimum adverse impacts on the environment, a sizeable group of trained personnel that may include foresters, arborists and ecologists must be employed. For the important program of ROW vegetation control, the work of this group must be highly organized and computerized for effective operations (Rossman 1972). Furthermore, to guide field operations, utilities have developed carefully designed specifications for guidance of utility personnel and contractors (Penelec Forestry Committee, 1986).

INITIAL ROW CLEARANCE

A power line through a forested area begins with clearance of a ROW corridor of sufficient width to insure reliable transmission. The width of ROW may vary from 21-30 m (70-100 ft) for 115 kV lines to 90 m (300 ft) for higher voltage lines. However, a width of between 45 to 60 m (150-200 ft) was typical of the major transmission lines on which this paper is based. Most ROW are established by clear-cutting all woody vegetation to a height of 7.5-10 cm (3-4 inches). The resultant slash may be piled in various configurations, or simply lopped to reduce height to less than 1 m (3 ft). However, in recent years ROW have also been cleared by selective cutting of only tall-growing tree species (Ulrich 1976). Trees have also been retained in deep ravines, for aesthetic purposes as road and river screens, and to reduce general visual impacts.

Resprouting of cut trees may be reduced by herbicide pretreatment of trees before cutting, or by treatment of freshly cut stumps. Sometimes trees are allowed to sprout and grow for 1-2 years before maintenance treatments are applied.

ROW MAINTENANCE

After a ROW has been established, it must be maintained to control tall-growing tree species and undesirable shrubs not compatible with electric power transmission. Failure to do proper maintenance may result in contact of trees with wires with a resultant "line outage" and costly loss of transmission. Maintenance may be carried out through use of a number of standard methods which may be briefly described as follows: (Penelec Forestry Committee, 1986, Environmental Consultants, Inc. 1984)

Handcutting – A ROW may be clearcut as a maintenance operation to remove all trees and tall shrubs to leave 7.5-10 cm (3-4 inches) stumps. Or ROW may be cut selectively to remove only tall-growing trees. Slash is lopped to reduce its height to less than 1 m (3 ft); or it may be piled on the ROW. In some cases the slash is chipped and may be removed from the ROW in areas such as road screens.

Mowing – All woody brush (trees and shrubs) on the ROW is mowed with a Hydro-axe, or other brush cutter. Woody vegetation is reduced to the lowest stump height possible to leave a shattered stubble one foot or less in height. To reduce resprouting, the cut stubs may be sprayed with a herbicide such as picloram immediately after mowing.

Cut and stump treatment – Tall-growing tree species are cut early in the growing season (May-June) to a low stump height, usually 10 cm (4 inches) or less. A herbicide such as picloram + 2,4-D is then applied to the sapwood and inner bark of freshly cut stumps with a squirt bottle; or the entire stump and root collar along with exposed roots may be sprayed with a mixture of picloram + 2,4-D + triclopyr in oil.

Dormant season and summer basal treatments – These selective treatments may be applied as dormant or growing season sprays with spray wands that produce a coarse spray of a herbicide such as triclopyr in oil to the lower 45 cm (18 inches) of stems of undesirable trees. The herbicide must be applied in sufficient volume to cover the root collar and the stem must be completely encircled. As an alternative, a concentrated solution of herbicide may be carefully applied at a low volume to the bases of tree stems.

Stem-foliage spray — Trees are selectively sprayed during the growing season with a herbicide mixture such as triclopyr + picloram + 2,4-D in water which is applied to a tree in two steps. First, the stem is thoroughly wetted using a narrow spray stream, then the foliage is wetted using a broader stream.

Aerial spray — A helicopter is used that is equipped with a microfoil boom that produces large droplets with minimum drift of a herbicide such as triclopyr + picloram + 2,4-D. The entire ROW is thoroughly covered during the growing season with spray during periods of low wind movement.

Pellet or other broadcast applications — Tall-growing trees are treated during the growing season with a pelleted herbicide such as picloram. Applicators walk the ROW and cast the pellets by hand into the crowns of trees to be eliminated. One to two handfuls (approximately 3 oz. per tree) is applied with oak and ash being given special attention. Pellets may also be broadcast over the ROW at a rate of 11 to 97 kg/h (10-85 lb/A).

As picloram pellets may no longer be available in the future, a broadcast spray similar to that described above for stem-foliage application may be used to produce a herb-grass cover.

Although the methods described above are usually applied as single treatments on a specific ROW segment, a different concept has been developed which calls for differentiation of a ROW into a wire zone, ROW area under the transmission wires, and two border zones, ROW areas on each side of the wire zone (Bramble *et al.* 1985). This permits a special treatment that removes all trees and tall shrubs from under the wires and leaves two shrubby borders. Several vegetation types may be developed such as a herb-grass cover in the wire zone with shrubby borders. This approach helps insure reliable transmission of electric power and produces type diversity and interspersion favorable to wildlife.

To accomplish differential treatment of ROW wire and border zones, a number of combinations have been used (Bramble *et al.* 1985). The simplest of these was to clearcut the wire zone with a selective cut on the borders. The same approach has been used with herbicides by broadcast treatment of the wire zone with a selective spray on the borders. A combination of mechanical with herbicide treatments could use mowing in the wire zone and selective basal spray on the borders.

ENVIRONMENTAL IMPACTS OF ROW

The following sections on environmental impacts of ROW will concentrate on 5 important facets of the natural environment that may be affected in forested areas: vegetation, wildlife habitat, soil, streams, and visual quality. The impacts may be positive or negative, that is they may reflect an improvement or a degradation of the environment. The aim of current ROW management is to minimize the negative impacts through use of maintenance methods designed to protect the environment (Olenik and Rossman 1977).

IMPACTS OF ROW ON VEGETATION

The initial clearance of a ROW has the general effect of producing a continuous narrow corridor through the forest from which all tall-growing tree species have been reduced to stumps by cutting. It has the characteristics of a linear forest opening. The negative impacts of this initial clearance may be ameliorated by selective cutting of undesirable trees whereby desirable small tress such as dogwood (*Cornus florida*) and shrubs such as witch-hazel (*Hammamelis virginiana*) are left intact (Ulrich 1976).

ROW vegetation in the years immediately after clearance will typically be made up of the forest species plus species of open areas such as sweetfern (*Comptonia peregrina*) that were present in forest openings (Bramble and Byrnes 1982). In the following years, a proclimax vegetation more typical of ROW will develop on xeric, mesic, and hydric sites (Johnston and Bramble 1981).

IMPACT ON TARGET TREES

Periodic maintenance treatments to control tall-growing tree species (target trees) are begun shortly after initial ROW clearance using one or more of the methods described in the preceeding section on management.

A major difference between impacts of common ROW treatments on target trees occurs between mechanical and herbicide methods (Bramble and Byrnes 1982). Handcutting and mowing remove trees and leaving stumps that produce sprouts which require recutting at 5 to 8 yr intervals, or less. And when such treatments are repeated over time, a dense tree thicket may develop.

Herbicide treatments, on the other hand, will cause a significant and important decrease in the number of trees on the ROW. This reduction in number of trees per acre should range from 70 to 90 percent after a single herbicide treatment. When herbicide treatments are repeated in 5 to 10 yr cycles, the number of trees per acre over 1 m (3 ft) in height should be reduced to 500 or less.

IMPACT ON NONTARGET VEGETATION

The impacts of ROW maintenance on nontarget vegetation (desirable shrub and herbaceous species that do not need to be controlled) varies considerably with the treatment method used. From results of research in the northeastern United States, (Bramble and Byrnes 1982, Carvell and Johnston 1978), the following predictions may be made for common types of ROW maintenance methods:

Handcutting — On a ROW with medium to high tree density (over 3750 trees/ha (1500/acre), handcutting will lead to development of a dense thicket of resurging trees that will tend to suppress sparse shrub and herb layers. Blackberry (*Rubus allegheniensis*), raspberry (*Rubus idaeus*), and meadowsweet (*Spiraea latifolia*) will occur in openings. Dewberry (*Rubus hispidus*) may form a dense ground cover. Maple-leaf viburnum (*Viburnum acerifolium*) and wild grape (*Vitis spp.*) will also be prominent species. Grasses (*Graminae*), sedges (*Carex spp.*), goldenrods (*Solidago spp.*), hayscented fern (*Dennstaedtia punctilobula*), and bracken (*Pteris acquilina*) will be common herbaceous species, accompanied by wild sarsaparilla (*Aralia nudicaulis*), wild strawberry (*Fragaria spp.*) dogbane (*Acpocynum spp.*) twisted stalk (*Streptopus spp.*), and wild lily-of-the-valley (*Maianthemum canadense*).

On a ROW with low tree density (less than 3750 stems/ha (1500/acre), handcutting will lead to development of a scattered tree cover with many large openings. Shrubs will occupy about one half of the ROW with herbaceous species occurring in small to large patches intermingled with trees and shrubs.

Selective basal and stump sprays — Where tree density is high (over 3500 stems per acre), the impacts will be similar to those produced by broadcast sprays. However, where tree density is light to medium (less than 8750 stems/ha (3500/acre), only non-target vegetation at the bases of sprayed stems will be affected.

On basal-sprayed areas an existing plant community will remain undisturbed over most of the ROW. Shrubs will occupy about one-third of the ROW area and herbaceous plants about two-thirds. Blackberry, raspberry, meadowsweet, and witch-hazel will be the most common shrubs. Grasses and sedges will be prominent species along with hayscented fern and goldenrod. Cinquefoil (*Potentilla* spp.) wild strawberry, and aster (*Aster* spp.) will also be common.

Stem-foliage spray — Where tree density ranges from medium to high (over 3750 stems/ha (1500/acre), stem-foliage sprays will have impacts similar to broadcast sprays. Grasses, sedges, hayscented fern, goldenrod, and cinquefoil will develop a complete ROW cover. Total shrub cover will be reduced slightly and will slowly increase over the years between treatments. Species such as blackberry, raspberry, and meadowsweet will increase in importance as they spread vegetatively underground.

Where tree density is low (less than 3750 stems/ha (1500 /acre), a stem-foliage spray will produce impacts similar to a selective spray, that is, vegetation will be killed only in the vicinity of sprayed trees.

Aerial or other broadcast sprays – These sprays will be followed by a marked increase in grass-herb cover and a decrease in shrub cover. Shrub species such as blackberry, raspberry, and meadowsweet that spread vegetatively

underground will spread slowly. Some herbaceous species such as hayscented fern will spread dramatically after spraying, while goldenrod will be reduced in abundance to scattered clumps and small patches. Blueberry (*Vaccinium* spp.) will be severely damaged but will recover slowly if selective sprays are used in subsequent maintenance.

Repeated aerial sprays will result in development of a grass-sedge-herb community with scattered clumps, or patches, of shrubs. The most common herbaceous species will be grasses along with hayscented fern, wild buckwheat, (*Polygonum scandens*), skullcap (*Scutellaria* spp.), goldenrod, and bracken.

IMPACT ON RARE, ENDANGERED AND PROTECTED PLANTS

Possible impacts of ROW on rare, endangered, and protected plant species were considered in a study of 18 ROW in New York State (Environmental Consultants, Inc. 1984). Although rare and endangered species were not recorded on the mesic ROW areas studied, it was considered possible that some microhabitats where such plants grow could possibly occur at ROW locations such as limestone areas, swamps or bogs, and shaded rock outcrops. "Protected" plant species are those attractive plants that cannot be collected without the owner's consent. Thirty-seven such species listed in New York's state regulations were recorded on the 18 ROW where their presence before and after treatments by herbicidal and mechanical methods was found to be highly variable and not related to treatment. For example, of the 24 protected species found on handcut areas, 13 were present before and after cutting, 5 were not found after cutting, and 6 new species appeared. Of the 25 protected species on summer basal sprayed areas, 14 were present both before and after spraying, 7 were not found after spraying, and 4 new species appeared. Of the 20 protected species on aerial sprayed areas, 10 were present before and after spraying, 8 were not recorded after spraying and 2 new species appeared. Of special interest is that purple trillium (*Trillium erectum*) was observed on ROW after herbicide treatments in New York where shrubs had been left, and pink lady's slipper (*Cypripedium acaule*) on a selectively sprayed ROW in central Pennsylvania.

IMPACT OF ROW ON WILDLIFE

ROW may be expected to have three important desirable impacts on wildlife in forested areas (Bramble *et al.* 1985). First, there will be an increase in cover type diversity brought about by creation of a linear opening in the forest when the ROW is cleared. This opening will be covered with a diverse shrub-herb-grass ROW plant community. Second, the two different plant communities, forest and ROW, will be in close juxtaposition so that wildlife can move readily

from one community to another. And finally, shrubby ROW-forest edges may develop to add a highly desirable wildlife habitat component. On the negative side, initial clearance for a ROW will remove a strip of trees that could furnish food and cover for tree-inhabiting wildlife species. This impact would be serious only in very small woodlands.

IMPACT ON WHITE-TAILED DEER

Excellent deer habitat has been produced on ROW through careful vegetation maintenance. In central Pennsylvania, for example, deer use of a ROW treated with herbicides and handcutting increased for the first 5 years after initial maintenance treatments, and then remained at a high level through the following years (Bramble and Byrnes 1972). Common herbaceous species such as bracken, goldenrod, and loosestrife were browsed by deer during the growing season; woody plants such as sweetfern, witch hazel, blackberry, and bear oak furnished browse throughout the year.

Deer presence on a central Pennsylvania ROW remained at a high level following use of a special type of ROW maintenance which permitted the development of shrubby borders (Bramble *et al.* 1985). Deer habitat values remained high after both handcutting and herbicide treatments.

IMPACT ON SONGBIRDS

During the 1970's the effects of ROW on songbirds reported that initial clearance had the general effect of causing a decrease in breeding forest birds on the immediate ROW area accompanied by an increase in shrubland species (Bramble *et al.* 1984). The net result was an increase in total bird species.

Although it appears that, in some cases, maintenance by selective spraying of herbicides may be more favorable for songbirds than aerial spraying or mowing, (Malefyte 1982); repeated mowing on a 4-year cycle has produced in one case, at least, an increase in bird species, numbers, diversity and density as compared to a forest area (Kroodsma 1982).

In general, it appears that the total number of birds on ROW is highly consistent regardless of the type of maintenance (Carvell and Johnston 1982, Bramble *et al.* 1986). This consistency in total numbers of birds on ROW before and after various maintenance treatments was further documented by recent research in central Pennsylvania (Bramble *et al.* 1986).

A shift occurred, however, in the number of individuals among dominant bird species after both handcutting and herbicide treatments. Thus, while common species still remained numerous on the ROW, species typical of shrub-grass habitats became the most abundant after treatments owing presumably

(Howlett 1979). Tower colors have been found to be important in helping to conceal transmission lines within the natural landscape. A tan to brown color typical of wooden poles and dark green that blends with vegetation ranked high as desirable colors.

In New York state, two factors proved to be most important in production of visual impacts: lighting and condition of the vegetation (Environmental Consultants, Inc. 1984). Vegetation conditions that most affected visual impacts were height and density of vegetation. ROW vegetation conditions produced by maintenance treatments that caused visual impacts were brownout, dead stems, and slash accumulation. Hand-cutting produced a negative impact owing to slash accumulation; mowing owing to dead stubble; cut and stump herbicide application to slash accumulation; and other herbicide applications owing to brownout and dead stems.

Aerial spraying, which by its very nature, calls for a blanket coverage of the ROW with herbicide spray, is a method that invariably causes a complete brownout and dead stems. Stem-foliage spraying of dense tree cover causes similar impacts. Although the browning of the vegetation is temporary and usually of only one year's duration, it causes a severe visual impact that must be repeated with each spray application. However, aerial sprays are excellent to begin the reduction of a tall, dense tree cover to lower densities. As the tree density is reduced other herbicide techniques should be employed that are more selective. Where a grassy ROW is desirable, aerial spraying has proven to be the best way to get vegetation converted to a grass-herb community.

As may be expected, the height to which trees are permitted to grow before treatment and their density on the ROW greatly affects the extent and severity of visual impacts. Therefore, management should aim to reduce the tree density on the ROW to less than 1000 per acre, and ROW should be treated when the dominant canopy of trees is not over 3-5 m (10-15 ft) in height.

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to an increase in grassy openings.

The Pennsylvania research indicated that the total number of bird species on the ROW treatment areas remained high before and after treatment. And that the diversity index was not significantly different between treatments or between ROW and adjoining forest (Bramble *et al.* 1986). This similarity was due in large part to use of the ROW by forest-inhabiting species for various activities, and use of the forest by brushland-inhabiting species for perching and escape cover.

IMPACT ON SOIL

The impact of ROW on soils will be considered under two important categories: soil erosion and soil compaction (Byrnes *et al.* 1982). The impact of ROW management activities on erosion was found to be negligible on the general ROW in forested regions due to protective plant cover and organic mulch. Serious soil erosion problems on ROW were associated only with areas disturbed by tower construction and access roads. Such construction impacts are usually mitigated by topsoil replacement and seeding of protective plant cover, and by proper road construction.

It is important to note in this connection that the humus types found on ROW were observed to be essentially similar to those in the adjoining forest, although the source of organic matter was from different types of plants (Holewinski 1979). Also, little difference was found in the depth of organic layers on ROW and in the forest.

Soil compaction on the general ROW area not influenced by construction was found to be of small magnitude, and only 3 percent of the average ROW was actually transversed by the spray truck during maintenance (Environmental Consultants, Inc. 1984). A hydro-axe used for mowing affected 22 percent of the ROW area. Some erosion occurred in deeply rutted wheel tracks caused by vehicle use on the ROW when the soil was very wet. Although erosion did occur in such wheel tracks, it decreased the following year and was not a serious condition as it was usually localized and restricted to the ROW. However, when access roads occur on steep slopes and are not properly constructed to lessen runoff, serious erosion may occur and the resultant sediment will cause siltation of small streams that cross the ROW. After a ROW has been established, nearly all of the necessary vehicle travel occurs on an access road. However, excess use of such roads by unauthorized off-road vehicles and horse riders may cause serious soil erosion problems in hilly terrain.

IMPACT ON STREAMS

The impact of ROW on streams is dependent upon many variables such as streambank vegetation, channel and bank characteristics, rate of flow, stream depth, and adjacent topography (Carvell and Johnston 1978). In most cases, only a small stream segment is affected, unless excess herbicide was allowed to directly enter the stream. To prevent the latter, a stream buffer zone, 15 to 30 m (50-100 ft) wide, is handcut to remove tall-growing tree species that may grow into transmission wires (Penelec Forestry Committee 1986).

As most streams cross ROW, rather than flow along them, only a small segment is affected by temperature changes, and any thermal modification is transient (Carvell and Johnston 1978). Maintenance of a streamside vegetation that will shade small streams keep the normal temperature gradient unaltered; large, deep streams usually will remain "summer cool." On nine small to large streams that crossed ROW studied by Carvell and Johnston (1978) mean temperature changes because of exposure ranged from −0.3 C to almost 3 C on clear, warm summer days. Broadcast application of herbicides appeared to cause more deterioration of stream habitat than selective spraying, or selective cutting, of trees. Repeated broadcast spraying resulted in a herbaceous riparian vegetation that was inadequate for stream protection.

A study of nine diverse streams in New York state indicated that the general effect of ROW on water temperature of free-flowing streams was negligible, (Holewinski 1979) although some streams were only partially shaded by shrubs and herbs rather than trees. Water temperatures downstream of the ROW ranged from 1.8 C less to 2.5 C greater than those upstream. The maximum stream temperature recorded below the ROW was 18.5 C.

Most stream banks on ROW in New York were well protected and hence did not contribute materially to stream sedimentation or cause deterioration of stream quality. Where sedimentation did occur as a consequence of a ROW, it was caused by flow from poorly maintained access roads, or by erosion from construction areas.

IMPACT ON VISUAL QUALITY

A great deal of attention has been paid to possible impacts of ROW on visual quality (scenic impacts) at the time in the management process when the route is being selected for a new transmission line. For example, 24 papers on ROW routing considerations which included visual impacts were presented at the Second Symposium on Environmental Concerns in Rights-of-Way Management held in Ann Arbor, Michigan, in 1979. Papers given at that meeting included reports on new tools that have been developed to assess visual impact (Boundy 1979) and on selection of new designs and colors for transmission towers