

VEGETATION MANAGEMENT ON POWER-LINE RIGHTS-OF-WAY
WITH EMPHASIS ON THE LOWER MAINLAND OF BRITISH COLUMBIA

by

LORNA RUSSELL ALLAN

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APPROVAL

Name: Lorna Russell Allan
Degree: Master of Arts
Title of Extended Essay: Vegetation management on powerline rights-of-way with emphasis on the Lower Mainland of British Columbia

Examining Committee:

Chairman: E. J. Hickin

M. C. Kellman
Senior Supervisor

F. F. Cunningham

R. B. Sagar

R. C. Brooke

Date Approved: 30 Nov 73

Abstract

The concept of vegetation succession was discussed, the conclusion being reached that while there may be general trend towards a succession of vegetation types on similar sites within any region, there are likely to be differences between sites. This was confirmed through a study of the literature on vegetation succession in the Lower Mainland of British Columbia and in other parts of the humid zone of the Pacific Northwest Region, in which both the mature forest and current succession trends were considered.

The use of herbicides was considered, and in particular any possible hazards associated with them. The danger to any animal life seems to be slight, but there may be unknown drawbacks to their use. They can damage the ground cover which protects slopes from erosion. The details of power-line clearing and maintenance methods used by B.C. Hydro and Power Authority were described. It seems to be most important that the correct concentrations of herbicide and techniques of application be used in practice.

Alternatives to blanket spraying were considered. Near towns a variety of land uses may be possible. The stabilization of an inoffensive ground cover, by "replacement control" is considered and some shrub species potentially useful for this purpose are suggested. While new power generating schemes continue to be built, and while land for most purposes continues to become scarcer in most populated areas, the management of power-line rights-of-way will remain an interesting question.

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Introduction

There are about 110,000 acres occupied by powerline rights-of-way in British Columbia, of which about 35,000 acres are in the Lower Mainland region (B.C. Hydro and Power Authority, Anon. Undated). The rights-of-way occupy narrow strips, 400-600 feet wide, which extend through many districts, along 7,000 miles of high voltage transmission line. In addition, there are 15,000 miles of distribution line in the province. Arable land which can be cultivated under the transmission lines occupies a small proportion of the rights-of-way area, but most of the area presents a problem in vegetation management, since the lines have to be kept clear of interference from shrubs or trees.

The use and management of such powerline rights-of-way is of considerable practical interest. Especially near towns, the aesthetic quality of rights-of-way can be important. Moreover clearing and maintenance procedures have a potential for influencing both surface and ground water, which could extend the consequences of such procedures far beyond the cleared area. The potential value of the land for wild life and for recreation can also be affected.

Essentially, the procedures used for clearing and maintaining rights-of-way control secondary vegetation succession, which will be interrupted at least every few years. These disturbed sites on rights-of-way offer opportunities for studies of short term vegetation regeneration. In this essay, types of vegetation in the Lower Mainland of British Columbia will be discussed, with some consideration of succession in general. Current clearing and maintenance procedures will be described, with emphasis on the effects of herbicides, where used. Photographs of several sites in the Lower Mainland will be used as illustrations. Alternative possibilities for vegetation management and land use along the rights-of-way will also be considered.

"Vegetation succession" implies an ordered progression of vegetation changes on a site following either the initial creation of the site - a primary succession, or disturbance - a secondary succession. This also involves an ordered sequence of changes in the habitat conditions. This process can be investigated by an analysis of the vegetation on one site over a period of time, or, be a comparison of several similar sites of various ages within one area. The concept, and most of the terminology of vegetation succession was developed by Clements (1916). Before Clements, some pioneer workers on plant ecology had noted a trend towards some order in the succession of vegetation on primary sites (Cowles, 1899). As developed by Clements, primary vegetation succession is seen as a sequence of phases, or series, which progress from a situation in which there is no vegetation on an exposed site, to one in which the site is occupied by climax vegetation, composed of a particular association of climax species for any given climatic zone. The climax vegetation, in the Clementsian model, is regarded as an integrated unit, while the factors tending to control the succession tend to be autogenic, that is, produced by the plants themselves. A full primary succession under this model would be predicted to be an unvarying progression from mosses and lichens on bare mineral rock or debris, to a forest climax in any region with sufficient moisture to support trees. The climax species would by definition be able to persist in a state of dynamic equilibrium indefinitely, barring a disturbance which would result in secondary succession from some intermediate phase.

The validity of a stereotyped pattern of succession in any region has been questioned (Tansley, 1935; Egler, 1954b). Tansley points out that in some cases soil conditions may be a sufficiently strong allogenic factor to exclude indefinitely the usual climatic climax vegetation for a region, in which case an edaphic climax may be said to develop. Similarly, physiographic or biotic factors, or fire, might intervene with sufficient regularity to create a long lasting sub-climax. Wet sites may maintain a sub-climax for many years, until natural processes fill in any surface depression. Egler (1954b) emphasises that the vegetation which develops on a disturbed site depends partly on the range of available propagules, and that the initial floristic composition as "selected" by

the environment can influence the subsequent development of vegetation. Keever (1950), drawing evidence from a study of succession on old field sites in North Carolina, notes that the time of year at which the last cultivation of a field takes place greatly influences the trend of succession for at least the first few years, through determining which seeds are most freely available, and which may germinate first after the last cultivation occurs.

Many field studies have been made of vegetation succession on disturbed sites, such as old fields (Bard, 1952), or logged or burned areas (Mueller-Dombois, 1965; McMinn, 1951). These tend to show a general sequence of change from herbaceous plants, including alien weeds, to forest vegetation. However, the rate of change can vary, and the succession may even remain stable at a shrub stage for considerable periods of time. Egler (1958) records areas of low shrubs in the eastern U.S.A. which have remained stable and repelled invasion by trees for decades. Moreover, the floristic composition of vegetation on sites under secondary succession can vary greatly, even on sites sampled a few miles apart. Kellman (1969) found that the assemblage of species on a number of disturbed sites in the Lower Mainland of British Columbia was unique to each site. Probably random chance plays some part in determining which species colonize a disturbed site.

The micro-environmental site changes which tend to accompany succession are related in a complex way to the vegetation changes. Following the catastrophic removal of forest by fire or cutting, conditions are greatly changed towards higher light intensities at the surface, reduced surface humidity, more extreme surface temperatures, and an increase in exposure to wind, which can desiccate plants (Bailey and Poulton, 1968). The soil, too, is likely to undergo both chemical and physical changes, with the organic matter content falling, especially if the site is exposed to fire. The soil surface may be compacted by exposure to heavy rain or may be subject to erosion.

In the early stages of a secondary succession there may be only a low percentage of ground cover, but, as weeds and other light tolerant species become established, they shade the ground, reduce extremes of temperature at ground level, and increase surface humidity. Through these changes the pioneer colonizers tend to produce environmental

conditions in which less light tolerant species can enter the site, and can even displace the pioneer species by competing for moisture and nutrients. Soil conditions will also tend to return towards a state in which more organic matter is present, and the soil micro-organism population has recovered from any disturbance. Most sites will eventually support a vegetation cover at least similar to that which was there before disturbance, if there is no further interruption of the cycle, and if propagules are available from neighbouring sites.

The availability of viable propagules is of critical importance in determining which species will grow on a disturbed site. Some species present on the site before disturbance may survive in a patchy distribution, especially on moist or unburned areas, and be able to propagate as the site becomes more shaded. Viable seeds may be present in the soil, even after light burning, and many wind dispersed seeds are likely to enter (Kellman, 1970; Major and Pyott, 1966). The season of clearing influences which local adventive species will be in seed or ready to germinate.

In summary, it appears that, although there may often be a general trend for sites to develop vegetation similar to that on neighbouring undisturbed sites, and, in the process, to move through occupancy by a series of lower growing plant forms, such as mosses, and then herbaceous species, towards a cover of trees, this process is not uniform in its details. The species present may vary from site to site in an area, as Mueller-Dombois (1965) found on Vancouver Island, where species characteristic of different undisturbed forest associations tended to survive after clearing, and even after burning. There may also be an element of chance in the wind carried adventives which also invade.

Secondary successions in the Lower Mainland of British Columbia

Most of the power-line rights of way in the Lower Mainland of British Columbia are located at relatively low elevations, in a mesothermal, humid, climatic zone. The vegetation currently occupying undisturbed sites in this area is coniferous forest. The dominant species in the climax forest tend to be the conifers, western hemlock (Tsuga heterophylla), western red cedar (Thuja plicata), and Douglas fir (Pseudotsuga menziesii) (Krajina, 1970). There is some evidence that

the presence of Douglas fir at low altitudes in the coastal zone of British Columbia may indicate the relatively high frequency of fire in the past (Munger, 1940). Several deciduous tree species are also commonly present in the native forest in small numbers. Broadleaf maple (*Acer macrophyllum*), vine maple (*Acer circinatum*), and northern black cottonwood tend to occur mainly on moist sites. Some low shrubs such as salal (*Gaultheria shallon*) and Oregon grape (*Mahonia nervosa*), form part of the ground cover, together with a variety of ferns, mosses and low herbaceous plants.

The commonest cause of destruction of mature forest in the Lower Mainland region is felling by logging companies, in which forest trees are removed, and the site may be further disturbed by the burning of slash. Clearing for rights-of-way by B.C. Hydro creates similar conditions. The secondary vegetation which develops on such sites has been described by Bailey and Poulton (1968), Kellman (1969), McMinn (1951) and Mueller-Dombois (1965). Wherever temperatures during a burn have been extremely high, the soil structure may suffer severe damage, and on steep slopes erosion may occur, even down to bed rock in places (see Fig. 1). Adjoining sites away from the rights-of-way are often forested and covered by at least some soil and organic matter.

FIGURE 1

Exposed rock on a right-of-way - north of Squamish, B.C.



In such cases even the commonest weeds which usually colonize disturbed sites in the Lower Mainland may not be able to become established, and the site may revert to the earliest stages of primary succession, in which only mosses or lichens can obtain a foothold (McMinn, 1951). Such species were almost the only plants re-established on the power-line shown in Figure 2 below. This site is near that shown in Figure 1.

FIGURE 2

Moss and lichen covered boulders on
a right-of-way



However, even where there has been some burning, relics of the forest ground flora often persist, especially in damp habitats. Mueller-Dombois (1965) found, in a study on Vancouver Island, that the species characteristic of the forest floor were still present on sites which had been logged 2-12 years prior to study. Some species, such as Gaultheria shallon and Polystichum munitum had even managed to extend their ranges.

Some light tolerant pioneer species which are common in this region are Epilobium angustifolium, Anaphalis margaritaceae, and Cirsium vulgare,

and such species may entirely dominate burned sites for the first two or three years at least. Another species, which is particularly important on many sites during the first year after a burn is Senecio sylvaticus. According to West and Chilcote (1968) there are relatively high phosphorus and nitrogen levels available the first year after a burn, before these nutrients are lost by leaching, or tied up by plants or soil micro-organisms, and Senecio sylvaticus can take advantage of these nutrients, but becomes less common in subsequent years.

Mueller-Dombois (1965) reports that there seems to be some degree of association between certain adventive species and certain habitat characteristics, in a coastal western hemlock and Douglas fir zone on Vancouver Island. Lactuca biennis, Crepis capillaris and C. vulgare were found on moist sites. Hypochaeris radicata, H. albiflorum, and Gnaphalium microcephalum were characteristic on dry sites. Kellman (1969) found strong associations and habitat preferences on the youngest site within his area of study, but not on the other sites. Possibly most of the species present in this case on the older sites had wide ecological tolerances, and there may not have been very great habitat variations within the area studied. Many of the species which were present on the sites surveyed by Mueller-Dombois did not occur within the area studied by Kellman, possibly indicating that the sites on the latter area were inaccessible to propagules of these species. Competition between species may thus have been less on the sites studied by Kellman (1969) than on the Vancouver Island sites.

Some species which are uncommon within the forest cover of the Lower Mainland may occupy much more area on a cleared site. For example, Rubus parviflorus and R. leucodermis, which probably occurred in the mature forest only in clearings caused by the death of old trees or by windfalls, can be important on disturbed sites. Rubus parviflorus, once established, can discourage the establishment of trees for some time, because of extreme shading. Spirea douglasii seems to be common on extremely wet or extremely dry sites, perhaps because of reduced competition under these habitat conditions.

A most important pioneer species is the deciduous tree, red alder (Alnus rubra), which can completely dominate some cleared areas. Before the widespread disturbance of the forest cover last century, this species was probably largely confined to gravel banks in rivers, or naturally

created openings in the forest. Red alder sets large numbers of light seeds which are easily dispersed by the wind, and which are probably available at any site in the Lower Mainland. Red alder is shade intolerant, and tends to disappear once other species pass it in height. However, it can grow very well in conditions of high light intensity unsuited to many trees of the mature forest. Red alder is particularly adapted to colonizing bare mineral soils, on which competition is slight, because it can contribute nitrogen to the soil through the fixation of that nutrient by bacteria which live symbiotically in the root nodules (Fowells, 1965). Because of this characteristic of red alder, the exposure of bare mineral soil at the time of the original clearing of a right-of-way, or through subsequent herbicide use, is likely to perpetuate a severe management problem, since under these conditions this species can form dense thickets, and can grow very quickly. Figure 3 below, photographed north of Squamish in early spring shows a dense group of one to three year old alder.

FIGURE 3

Site with dense patches of young alder



Red alder can reach a height of fifteen feet within five years on good sites (Fowells, 1965). Once established, it can increase its height by as much as ten feet a year. It is one of the species most likely to

interfere with overhead transmission lines. Figure 4 shows a group of alder which had reached an age of about five years and a height of about eighteen feet before being eliminated by aerial spraying with 2,4-D herbicide. The strip of cleared ground on the distant slope shows the typical appearance of a right-of-way in a forested landscape. This view was photographed near the south end of Buntzen Lake, by Ioco.

FIGURE 4

Red alder killed by herbicide



If a cleared, well drained site in the Lower Mainland of British Columbia were left to regenerate indefinitely, red alder, black cottonwood, vine maple, and in some cases the paper birch (Betula papyrifera) would for some time be most likely to be the dominant trees. The conifers tend to come in later, and, at about twenty five years, Douglas fir, the most light tolerant species of the local conifers, can overtake red alder (Munger, 1940).

Once established, Douglas-fir is likely to dominate the forest for over a century, with other conifers existing in a suppressed state as an understory. Munger (1940) found from a study of low altitude forest areas in the Pacific Northwest, that on sites which had been undisturbed for two hundred years in a humid climatic zone, Douglas fir was beginning to thin out. At three hundred years, shade tolerant conifers, such as Tsuga heterophylla and Thuja plicata would be likely to dominate, while in forests in which trees reached over four hundred years in age, the Douglas

fir was over-mature and was fast disappearing.

From the available literature based mainly upon sites on which the forest has been felled and sometimes burned, in areas in or close to the Lower Mainland region, the generalization can be made that the early stages of the secondary succession are likely to include both some relics of the forest ground flora and some adventive weeds, and that there will be a tendency for the site to change in the direction of being occupied by a cover of trees. There is thus some confirmation in a very general way of the concept of a vegetation succession. However, this succession varies considerably from site to site to site in the floristic composition of the species present. No completely invariable succession at the species level can be observed. In this region Gleason's concept of the individualistic association seems to be applicable, with each site showing unique characteristics (Gleason, 1926; Goodall, 1962-63).

The use of herbicides for vegetation management

In the 1940's, the first growth regulator herbicides were developed, as a result of research on indoleacetic acid, a natural plant auxin. The most important of these hormone herbicides in use on power-line rights-of-way are the phenoxyacetic compounds such as 2,4-D(2,4-dichlorophenoxyacetic acid), and 2,5-T(2,5-trichlorophenoxyacetic acid), and compounds based on picolinic acid such as picloram or Tordon(4-amino-3,5,6-trichloropiocolinic acid).

These systemic herbicides are undoubtedly effective, and are relatively economical for the purpose of maintaining rights-of-way clear of tall vegetation. Their mode of operation is not fully understood, but depends basically on interference with a plants' growth mechanisms (Crafts and Robbins, 1962; Muzik, 1970). Systemic herbicides have to be absorbed by the plant, in contrast to those herbicides which produce only a contact leaf surface kill. The active constituents, to be effective, must then be translocated through the system of the plant to the growing points, at which they critically affect its life processes. The hormonal herbicides kill plants relatively slowly, by causing distortion in any new growth. At the cellular level there is tissue proliferation and disorganization. Stems and roots are stunted. Many of the plant's physiological processes are affected.

Enzyme growth reactions are inhibited (Crafts and Ashton, 1970).

The effectiveness of a systemic herbicide depends on the rate of foliar absorption, on the effectiveness of translocation, and then on the degree to which the plant's critical life processes are affected by the active constituents in the herbicide. Any of these stages may be different in different plant species, or even in the same species under different environmental conditions. Foliar absorption, in particular, is influenced by air temperature and by humidity levels. It is at a higher rate when conditions are warm and humid (Freed, 1967). Each herbicide is most effective on a different range of species, Tordon 101 being particularly effective against conifers and maples (Watson and Wilise, 1963). Grass species have a high resistance to systemic herbicides, partly because the grass leaf cuticle tends to be resistant to penetration by the herbicides, and partly because grasses have a different growth pattern from most broad leaved species.

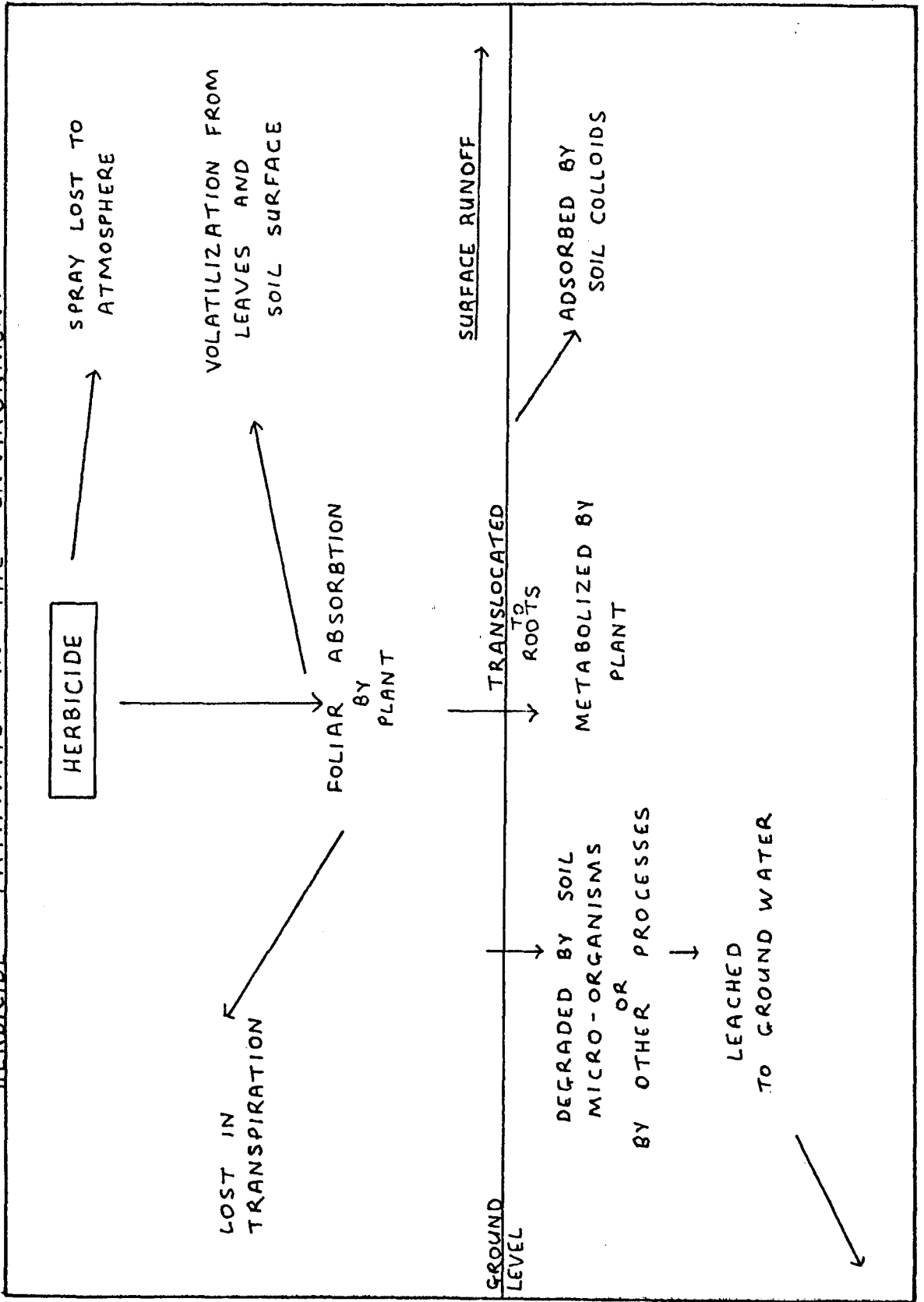
There has been considerable public concern in recent years about the possible harmful effects of any chemical which is being added to the environment in large quantities. Potential hazards which should be considered include the possibilities of damage to vegetation outside the boundaries of the rights-of-way, of water pollution, of destruction by herbicides, and of harm to wildlife or to man. Considerable published research exists in those fields (Fletcher, 1960; Kearney, 1970; Kenaga, 1969; Tarrant, 1967; Warren, 1967).

Herbicides may influence areas outside the rights-of-way through movement by wind or water (see Figure 5, p. 12.) There is commonly a 25% loss of herbicide between the planes which are used for spraying and the ground (Norris, 1967). Possible damage along the edge of the cleared area by this drift is reduced if no spraying is done when winds are blowing at over 10 m.p.h. Spraying is avoided altogether near creeks, which must be clearly flagged so as to be visible from the air. Some herbicides can enter the atmosphere after application by volatilization on warm days. Some 2,4,5-T has even been detected in dust storms in the U.S.A. (Kearney, 1970). However, those levels of herbicide which have been detected in the atmosphere have so far been low in concentration and of short duration.

The probability of herbicides reaching run-off or ground water was

FIGURE 5

HERBICIDE PATHWAYS IN THE ENVIRONMENT



investigated by the United States Federal Water Pollution Control Administration, in cooperation with other agencies, from 1963-1968, during research on possible environmental contamination from herbicides used on forest lands (Norris, 1967). The main danger of contamination occurred if any direct aerial spray reached the water surface, or if heavy rains followed the spraying immediately, or if spraying was done in areas of high water table. The only detectable contamination was in the period shortly after spraying. The U.S. Geological Survey has found few residues in water (Kearney, 1970).

Possible damage to soil micro-organisms may occur. In most cases these micro-organisms act as effective agents in the degradation of herbicides (Audus, 1960; Fletcher, 1960; Sheets and Kaufman, 1970). As shown in Figure 5, there are several paths through which herbicides may move after application. Metabolic degradation by soil micro-organisms is one of these, and is the main process through which herbicides are detoxified as opposed to being merely diluted or leached away unaltered. There is usually some time lag after the application of any herbicide, and then a period of more rapid breakdown by the soil micro-organisms. The time lag may be interpreted as an interval during which either some mutant organisms are increasing in number, or some existing strains of organism are developing pre-existing potentials for using different degrading enzymes (Audus, 1960; Fletcher, 1960).

Herbicides vary in their rate of degradation by the organisms present in the soil. For example, at the usually recommended rates of application, 2,4-D can be degraded to 75-100% levels within one month while 2,4,5-T can take as long as four to five months to be reduced to the same level of concentration (Kearney, 1970). Picloram, the main active ingredient in Tordon, a herbicide now commonly used as part of B.C. Hydro Authority's rights-of-way maintenance programme, has an even longer period of active persistence in soil, being degraded slowly. Moreover it is not easily absorbed on to soil colloids, and so it is more easily leached from the soil than other common herbicides (Freed, 1967).

Most authorities believe that the use of herbicides at normal levels of concentration, as distinct from the very high levels used in such instances as military operations in Viet-nam, is unlikely to result

in any damage to wildlife, or to man (Kearney, 1970). Animals, and even insects, show a high tolerance for herbicides, even when fed to them directly in their diet because their metabolic systems are so different from those of plants (Warren, 1967). Unlike insecticides, with which they are often confused, herbicides do not tend to accumulate in the fatty tissues of any animals which consume them. In a study by the United States Water Pollution Control Administration, little herbicide residue was found in deer tissue from animals browsing in the sprayed area (Norris, 1967). There seems to be little effect even from long term administration of such chemicals, indicating a low toxicity for most living things except plants (Kenaga, 1969). Wild herbivore populations may even increase, as strips of low vegetation cover on rights-of-way increase the habitat diversity, the amount of grazing available, and also the length of forest edge, important for wildlife (Bramble and Byrnes, 1967; Gysel, 1962).

In regard to fish, Tarrant (1967) quotes the conclusion reached by the Research Division of the Oregon Fish Commission,

"It appears unlikely that herbicide pollution of streams as a result of alder spraying will reach toxic levels."

Even bees were tested in New Zealand, and found to be apparently unaffected at normal rates of application (Kearney, 1970). The conclusion that herbicides may be innocuous to most forms of life applies only to situations in which the herbicides are applied at the recommended or low levels of concentration, and if particular care is taken near streams, and in the disposal of empty containers, since very high concentrations of these chemicals may be poisonous to fish or other wildlife.

Against these reassuring observations on the generally low toxicity of most herbicides in the environment must be set some indications of possible danger, and some general cautions. 2,4,5-T has been found to have teratogenic effects on mice at high feeding rates, and was for this reason withdrawn from use by the general public in the U.S.A. This effect may be assignable to impurities in the herbicide, and not to the active component itself. Many common chemicals such as aspirin, nicotine and

caffeine have such effects when administered in comparably large dosages (Wilson, 1973). It may be that the low levels of herbicide pollution which might occasionally reach drinking water through run-off or leaching would have no such consequences, but whether there is a threshold below which no effect whatsoever would occur is a moot point.

Some of the most cogent warnings about the introduction of herbicides into the environment are based on unknowns, such as the possibility that the breakdown products of the degradation of herbicides may have toxic effects, or that when several herbicides are applied to one site over a period of time, the synergistic effects may be quite different from the effects of one herbicide applied alone. Another possibility is that, although the general population might not be adversely affected by ingesting small quantities of herbicide, some allergically susceptible individuals might be harmed. Moreover, for the general population, the long term effects of even occasional slight traces of herbicide are incalculable.

B.C. Hydro and Power Authority does not sponsor any research on the effects on the environment of the herbicides it employs, or on possible health hazards which might arise from such use. All the chemicals it uses, however, and the concentrations at which they are applied are approved by both the federal and provincial Departments of Public Health, and by the Departments of Agriculture and Forestry. In British Columbia there is a Provincial Interdepartmental Herbicide Committee which monitors herbicide use in the province.

Clearing and maintenance by B.C. Hydro and Power Authority

The clearing and maintenance procedures for powerline rights-of-way determine the conditions under which secondary succession will develop, while in turn the direction the succession takes will direct future vegetation management decisions for sites on the rights-of-way. In effect, such sites are maintained in the early stages of a secondary succession. Clearing is contracted out by B.C. Hydro, to be done to their specifications, which require that no plants reach a height of over fifteen feet; that access remains free of obstruction; and that the cover vegetation presents a minimal fire hazard. A strip 300 feet wide is required for a 230K.V. transmission line, and one 400-600 feet wide for a 500K.V. line,

the precise width depending on the number of cables.¹

Trees are felled along the right-of-way, and "hazard trees" in any forest alongside the cleared strip, which might present a threat to the line are also removed. The felled trees are bulldozed together, along with any shrub cover, and burned. The current management trend in right-of-way maintenance in the Lower Mainland is to "groom" any stretches near built up areas, provided that they are not too steep or rough to allow the use of mowing equipment. Grooming entails clearing and levelling the right-of-way completely, ploughing it, and seeding it to grass, which can be maintained by mowing. Figure 6, below, and Figure 9 on page 20, are both examples of groomed sites. The photograph shown in Figure 6 was taken just north of Burnaby Lake.

FIGURE 6

A groomed section of right-of-way



Until 1960 most maintenance was done by slashing crews. As well as being a hazardous task on steep slopes, this maintenance is increasingly expensive, as labour costs have risen, and aerial spraying with herbicides

¹ The information in this section was obtained in verbal communications from employees of B.C. Hydro and Power Authority, who preferred to remain anonymous.

is now the preferred means of tree control in the Lower Mainland, wherever grooming is not used. 98% of herbicide spraying is aerial. Maintenance by hand clearing costs \$450 an acre, by grooming \$65 an acre, and aerial spraying with herbicide about \$85 an acre per year in the area under consideration. Rates in the Lower Mainland are considerably higher than in regions which are drier, or in which the growing season is shorter. For example, mowing costs \$15 an acre in the Prince George area. In much of the interior of British Columbia, in natural grassland regions, the right-of-way can be kept clear by grazing livestock.

Annual inspections of the right-of-way are made, and pelleted herbicides are used to kill any individual trees which have grown too tall between applications of herbicide. Hand clearing is still used for fifty feet along the sides of streams or reservoirs, and the methods used, including any herbicides applied in water catchment areas, have to be approved by the Greater Vancouver Water Board. Some low shrubs and trees have to be left along the sides of streams as required by the provincial Department of Fisheries. Trees near stream banks also help to control erosion. Figure 7 below shows a right-of-way crossing Lynn Creek in North Vancouver. No signs of herbicide use, such as dead trees, can be seen.

FIGURE 7

A right-of-way at Lynn Creek



On sites where broadleaved shrubs or trees are the main secondary regrowth, a mixture of 2,4-D and 2,4,5-T is commonly used being more effective than either chemical used individually. Where conifers are present, Tordon 101 is the herbicide used, because most coniferous species are resistant to the phenoxyacetic compounds. The precise concentration which is applied to an area depends on the type of vegetation present, and on the season and weather conditions. These systemic herbicides are applied after the tree leaves have matured, because young leaves may react by falling off, with no translocation to the rest of the plant.

Following blanket spraying there may be no immediate "brown-off", and the first sign of damage to young trees is often a twisting and distortion of the leaves and of growing points. Such distortion of red alder leaves is shown in Figure 8. This photograph also illustrates an example of damage to vegetation off the right-of-way, since it was at least one hundred feet away from it. It was located at a site near Buntzen Lake, Ioco.

FIGURE 8

Herbicide damaged red alder leaves



Upward growth tends to be halted, and the trees then become extremely susceptible to fatal damage by frost or drought. Many will be dead by the end of the season, and few will survive the following winter. Some lower trees may be shielded from the spray by taller ones, and any of these which might threaten the transmission lines are removed by the use of pelleted herbicides. Most sites on the Lower Mainland are likely to require a repetition of blanket spraying within four to five years. However, some sites do stabilize under a cover of grass, with very little intervention, as happened to the section of right-of-way shown on Figure 6, page 16, which has been in grass for eight years, without any original planting of grass seed. This can be cited as a rather elementary example of the "replacement control" discussed in the next section of this essay.

In spite of reassurance by government agencies that the herbicides being used were innocuous, there has been at least one conflict over herbicide use, between B.C. Hydro and Power Authority and a local community in British Columbia. In 1968, the council of the Municipality of Squamish passed a by-law, through which they attempted to halt the application of herbicide to power-line rights-of-way within their area. However, it was subsequently found, when the issue was taken to court, that the local council did not have the authority to determine B.C. Hydro's maintenance policies in this way.

Alternatives to repeated blanket spraying

Near towns, where recreational land is scarce, the rights-of-way can be useful for the grazing and exercising of ponies. Such use has helped to maintain the site shown in Figure 7 clear of trees. Trails for the currently popular trail bikes can be laid down and maintained under sawdust. The section of right-of-way shown below in Figure 9 is in North Vancouver. It was groomed about three years ago and is now a popular section for walking and for the use of trail bikes.

Planting the right-of-way to a low crop such as Christmas trees is another possibility. In North Vancouver forty acres along a 230K.V. stretch of the transmission line have been planted by Junior Forest Wardens from the Vancouver area. Allotment gardens might be another possibility, where the soil is good enough.

FIGURE 9A right-of-way used for recreation

On rights-of-way far from built-up areas, some more generally applicable method of vegetation management is necessary. Agricultural sections are no problem, since ploughing or grazing can continue under the transmission lines. Forest areas are a major problem. However, as Piemiesel (1954) found from study of prairie grassland in the U.S.A. the return towards a mature vegetation cover can be influenced by many factors, the deliberate manipulation of which he termed "replacement control". Egler (1954a, & 1958) mentions examples of this from forested areas in the eastern U.S.A. and is a strong advocate of such procedures.

If the secondary succession on sites in the Lower Mainland were to be managed by a process of replacement control, it would be necessary to encourage the establishment of a ground cover which could exclude trees, and which would not impede access for maintenance. According to Egler (1958), a dense cover of low shrubs can exclude tree seedlings more effectively than can grass, mainly by very heavy shading of the ground. The problem, then, would be to determine which shrub species might provide a heavy ground cover, in different types of habitat, and whether such a cover could be established and maintained economically.

Where salal (Gaultheria shallon) survives the initial clearing, it is one potential ground cover plant which might, if encouraged, be able to shade out sufficient tree seedlings to make maintenance by spot clearing with pellets an adequate procedure for controlling the vegetation. Oregon grape (Mahonia nervosa) is another native shrub which could form part of a continuous ground cover. Salmonberry (Rubus spectabilis) and more especially thimbleberry (Rubus parviflorus) seem to be capable of providing a heavy cover, and between them they can cover a range of soils of various moisture contents. On marshy sites, and on some really dry ones, hardhack (Spirea douglasii) becomes important. All these species seem of potential value in the Lower Mainland as ground cover plants. That such shrubs might be capable of suppressing the regrowth of trees in this region is largely speculation, based on evidence from other regions. The only section of right-of-way in this area which is known to have been under a stable low cover for some time may owe this partly to having been grazed. Further observation and research would be necessary to establish whether "replacement control" would be feasible and economic in the Lower Mainland region. Some exotic shrub species might also be investigated as potential ground cover plants.

Whichever system of keeping the transmission lines free from interference is used, multiple use of the rights-of-way can add to their contribution to the public interest. In many places, paths along rights-of-way offer the only easy access to the dense forest characteristic of the coastal districts of British Columbia. Such paths can be used for fire access, or for various forms of recreation.

Conclusions

Vegetation management on rights-of-way is related to the broader topic of the conservation of man's environment. In British Columbia, as in the rest of North America, the situation remains one in which the public uses more and more electric power, generally encouraged in this by advertisements, and may not be willing to pay the extra costs which would arise from hand management of power-line rights-of-way (Efford and Smith, 1972). On the other hand, such methods may not be a true saving to the province,

at a time when unemployment rates are high.

An understanding of secondary vegetation successions in the Lower Mainland is necessary for any analysis of the effect of management procedures on the ground cover on rights-of-way. Herbicides seem to be harmless to animal life in general, but continual observation and research is needed on this point. Alternative means of vegetation management seem to be at least worth considering, and, since each area of secondary vegetation can be unique, there would have to be some experimentation with sample areas within each region, including the Lower Mainland of British Columbia.

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