

IMPACTS OF VEGETATION MANAGEMENT TECHNIQUES ON WETLANDS IN UTILITY RIGHTS-OF-WAY IN MASSACHUSETTS¹

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Abstract. This project compared five rights-of-way (R/W) treatments (hand cutting, mowing, cut stump treatment w/ herbicides, basal spraying w/herbicide, and foliar application of herbicides) to determine their impacts on wetlands on utility R/W. The conclusion reached was that there was no significant impact to wetlands from any of the vegetation management techniques used on utility R/Ws in Massachusetts. Mechanical treatments resulted in higher impacts on the cover value for wildlife than those involving herbicides. Residue from petroleum products (bar oil and hydraulic fluid) were recovered on the leaf litter from mechanically treated sites. No herbicide residues were recovered from herbicide-treated sites.

Environmental Consultants, Inc. evaluated impacts of vegetation management techniques on electric utility rights-of-way (R/Ws) crossing wooded wetlands in Massachusetts to meet the requirements of the Code of Massachusetts Regulations which apply to use of herbicides in wooded wetlands [333 CMR 11.00, Rights-of-Way, Section 11.04 (4) (c) 1]. The project included a review of published literature, interviews with subject-matter experts, and field studies on selected R/W wooded wetlands. Simulation models were also used to evaluate potential risk of groundwater pollution from herbicide use in vegetation management in wetlands. The five principal vegetation management techniques evaluated were hand cutting, mowing, foliar herbicide application, basal herbicide application and cut stump herbicide application.

Characteristics of Massachusetts Wetlands

Massachusetts has had a long history of concern over the fates meted to wetlands by our development-oriented civilization. Over half the wetlands known to exist when the colonists arrived have been destroyed by dredging, filling or altering their vegetation cover. Since rainfall over the

same 350 years has been a fairly constant 40 inches per annum, and since the average distance to bedrock in Massachusetts is fifteen feet, much of this rainwater must leave the state as runoff, either over or under the surface. The consequence of this water movement means that nearly all of it must pass over or through a wetland on its way to the sea. Because wetlands serve as storage areas and natural cleaners of these water, removing sewage mineral pollutants, heavy metals, pesticides, bacteria and viruses, the Legislature in 1972 acted to curtail their further destruction by passing the Wetlands Protection Act, Mass. General Laws Chapter 131, Section 40. The present author framed much of the language of the act, which identifies wetlands by their plant species composition and by the fact that water levels are at or near the surface of the ground for a significant part of the growing season. Three of the eight protectable interests in the Act (flood prevention and groundwater recharge, water quality improvement through trapping of sediment and removal of toxic substances, and fish and wildlife habitat values) are of concern here.

In Massachusetts, about 96% of the wetlands are red maple swamps, hence this type is the major one considered in this study. Many of the woody plants found in this swamp type are capable of growing into power lines if left unmanaged.

As defined in the Wetlands Protection Act, swamps are areas where water is at or near the surface of the ground for a significant part of the growing season or where runoff water from surface drainage frequently collects above the soil surface, and where a significant part (50% or more) of the vegetational community is made up of, but not necessarily including, all of the following plants or

1. Presented at the annual conference of the International Society of Arboriculture in Philadelphia in August of 1991.

groups of plants: alders, ashes, swamp azalea, rhodora, black alder, black spruce, buttonbush, American elm, white hellebore, eastern hemlock, highbush blueberry, American larch, poison sumac, red maple, skunk cabbage, Sphagnum mosses, spicebush, black tupelo, sweet pepperbush, Atlantic white cedar, and willows. Scientific names are included in the law for each of the individual species listed above.

Natural plant succession in wooded wetlands in Massachusetts generally does not proceed much beyond the red maple swamp, largely because up until the passage of the Wetlands Protection Act, logging of Atlantic white cedars and hemlocks favored red maple dominance by keeping the wetlands soils basically in a disturbed condition. Construction of an R/W through a wooded wetland changes the distribution, abundance, and character of vegetation found on and bordering the R/W. Repeated vegetation management activities on wetlands along electric utility R/Ws promotes low-growing plant communities, tending to maintain plant succession at the shrub-swamp stage. Balanced against this maintenance of the shrub stage is the continual annual rain of red maple seeds from mature trees off the R/W onto the relatively maple-free R/W itself; their germination insures that there must be continual management of the R/Ws to keep them free of tall-growing vegetation.

Although the Wetland Protection Act does not depend upon soils to identify wetlands as do similar laws in other states (e.g., Connecticut), and while soil properties are by nature highly variable from site to site, wooded wetland swamps have soils typically high in organic matter. This organic matter confers on the soils higher water-holding capacity, higher cation exchange and binding properties, lower nutrient availability, lower oxygen levels (soils are often anaerobic and charged with hydrogen sulfide, indications of enhanced denitrifying activity), lower bulk density, and higher acidity. These soil properties are important for the interception, adsorption, and decomposition of herbicide and petroleum-based residues that may reach the soil during vegetation management activities.

There are 310 citations in the published report (1). They provide what little information is known on the current state of knowledge on wooded wetlands,

as well as on the properties of herbicides and petroleum products commonly used in vegetation management techniques for the control of target vegetation, and the impacts of vegetation management on red maple swamps and their variants in the form of bogs, swamps and banks found on electrical utility R/Ws in Massachusetts. The review included both scientific and technical literature, and was intended to establish a broad base of knowledge for the study of the impacts of different vegetation management techniques on Massachusetts wetlands. Literature studies conducted in other regions of the country were included when necessary to supplement information from studies in New England.

Field studies

The field studies were conducted to collect quantitative information on the impact of four vegetation management techniques on 12 representative wetland sites; three sites were studied for each technique. Two important objectives of the field research were: 1) to determine which R/W technique produced the least environmental impact on wooded wetlands, and 2) to determine the most effective technique for controlling target vegetation.

Impacts on vegetation. Control of target vegetation density was at an acceptable level only on R/W sites where either foliar or basal application of herbicide was used. Density of target vegetation on hand cut and mowed R/W sites was significantly higher than on sites managed with foliar or basal application of herbicides.

The R/W sites for all vegetation management techniques retained their characteristic wooded wetland shrub and herbaceous species; species composition of the wooded wetland plant community had not changed. Shrub cover values on all R/W sites were also found not to be significantly different from their adjoining off-R/W sites. However, the herbaceous cover value for hand cut and mowed R/W sites were both significantly less than for foliar and basal application sites, indicating a greater impact by the two mechanical techniques on herbaceous cover at the time this evaluation was conducted.

Impacts on wildlife habitat. The general wildlife habitat conditions present on the R/W study

sites were consistently rated high in value for food, cover, presence of edges, type interspersion and stages in plant succession. This finding agrees with others made in the course of this study, because the same wooded wetland plant community was present on all the R/W sites examined.

While the average wildlife habitat value of all off-R/W sites was rated "medium", the range of ratings for all 12 sites varied widely between different locations. The R/W habitat rating of the four vegetation management techniques for five wildlife species were "high" for white-tailed deer, grey catbird, rufous-sided towhee, and ruffed grouse, but the meadow vole was an exception. Its habitat rating was "low" for hand-cut and mowed sites, and only "medium" on sites treated with selective foliar and basal herbicide applications.

Chemical residues in soil and water. Laboratory analyses were conducted on soil and water samples to determine the presence of chemical residues. Field and laboratory data on herbicide residues showed no evidence of 2,4-D, picloram, glyphosate, or triclopyr in any sample from either the R/Ws maintained by foliar or basal herbicide applications or untreated areas adjacent to the R/Ws. Rapid decomposition of fosamine precluded its analysis in soil and water samples.

Specific analyses were made to detect 2,4-D, picloram, triclopyr and petroleum products (bar oil and hydraulic fluids). Petroleum products (bar oil or hydraulic fluid) were found in four samples of soil or sediment. Of these, three were from the R/W and one was from an adjacent site. Results of the field study indicated no long-term contamination of soil and a low probability of chemical movement to ground water. Based on the quality assurance samples (checks), independent laboratories successfully analyzed the soil and water samples that ECI collected. Laboratory recovery of herbicide from fortified samples was in the acceptable range used in the laboratory certification program approved by the US EPA.

Vegetation Management Techniques

ECI evaluated the principal techniques for vegetation management on wooded wetlands along Massachusetts R/Ws. The evaluation was conducted on two mechanical techniques (hand cut-

ting and mowing), two herbicide techniques (foliar and basal), and one combination technique (cut stump).

Mechanical Techniques. Mechanical vegetation management techniques such as hand cutting and mowing require the physical removal of all or part of the above-ground portion of the target vegetation, but do not affect the root systems. These mechanical techniques stimulate sprouting from most woody and some herbaceous plants. The major advantage of both mechanical techniques is that the results are immediate. Major disadvantages include the fact that desirable shrubs and herbs may be suppressed first by piles of slash and later by dense thickets of resprouted target vegetation. Mechanical techniques greatly increase both density and height of target vegetation, ultimately resulting in higher costs and increased safety hazards to workers during future control efforts.

The major advantage to hand cutting is that small or otherwise inaccessible areas may be treated. Disadvantages are that chainsaws result in relatively high rates of dispersal of the bar and chain lubricating oil, and occasional gas and oil spills may occur. These petroleum-based materials break down slowly and thus may remain on site for many months.

Advantages of mowing are seen in requirement of smaller crews, less labor intensive activity, and lessened hazards to workers than those occurring with hand cutting. Disadvantages of mowing are size and weight of equipment required, topographic limitations (rocks and boulders), potential to cause ruts and erosion, and adverse safety and aesthetic impacts. Because selective mowing is now practical on R/Ws with medium to high densities of target vegetation, the usual result is a leveling of all vegetation to a rather low height.

Herbicide Techniques. Vegetation management with herbicides employs one of three application techniques: foliar, basal, and cut stump. These methods control both the above- and below-ground portions of the target vegetation, thus effectively preventing target vegetation from resprouting. Density of target vegetation would be reduced over time, thus lowering the requirement of herbicide needed as well as frequency of appli-

cation in future control operations. Herbicides can be applied selectively to specific target vegetation with minimal effect on surrounding desirable vegetation, thus reducing its competition and encouraging its growth. The major disadvantage of herbicide techniques is the public perception of herbicides as residual poisons.

The advantage of the foliar technique is that target species are easily identified with their leaves out; treatment can be applied very efficiently. The major disadvantage of selective foliar application is the relatively short period of time (3 to 4 months) in which this technique may be employed on Massachusetts R/Ws. A second disadvantage is the out-of-season unnatural color change (brownout) on vegetation after most foliage herbicidal applications.

An advantage of the basal technique is that it includes an application season which extends into the dormant period, thus allowing retention of experienced workers and more time in which to spread the annual workload. Also, basal application during the dormant season may be performed at a time when very little public use of the R/Ws is occurring. Further, backpack basal application techniques lack the noise of large motorized equipment that may annoy people near the application area. The major disadvantage of the basal application method is the petroleum odor from the herbicide carrier, typically either kerosene, diesel, or No.2 fuel oil. Again, some soil contamination from these carrier oils may occur on sites with high densities of target vegetation.

The cut stump technique has an advantage in that it can be used at any time of the year except when a deep snow cover occurs; such conditions could prevent workers from cutting stumps low or could cover stumps, precluding their receiving the herbicide application. Worker safety is one disadvantage of cut stump treatments due to the use of chainsaws. Further, the cutting operation itself makes the cut stump method more expensive than foliar or basal applications. As stem densities increase, the effectiveness of this method may be reduced by failure of the applicator to find those stumps that may have become inadvertently covered by slash and debris.

Alternative Techniques. Five other vegetation management options are briefly considered in this

report. These techniques were controlled burning, grazing, planting competitive vegetation, roller chopping, and shear dozing. None of these techniques was considered practical for use on Massachusetts R/Ws for various reasons. Massachusetts state regulations prevent the use of controlled burning. Shear dozing and roller chopping require heavy equipment which would greatly disturb sensitive wetland sites. Planting competing vegetation requires site preparation which disturbs the wetland, and desirable native plants are difficult to establish from seed or from small plants. Grazing livestock are difficult to control without expensive fencing, and the animals can become mired in deep wet soil.

Herbicide Risk Assessment.

ECl performed an analysis of human health risks and risks to wildlife from chemicals used in vegetation management techniques on wooded wetland R/Ws in Massachusetts. A risk analysis is a procedure in which the exposure of various organisms to a specific chemical is compared with that chemical's toxicity characteristics and the risk of adverse health effects if quantified. A risk analysis provides a basis by which decisions can be made concerning the appropriateness of specific patterns of chemical use based on the risks which might result.

An herbicide risk assessment requires information on the exposure organisms are likely to receive (exposure analysis), the toxicity of the herbicide to which these organisms might be exposed (hazard analysis), and the toxicological consequences (or risk assessment) for the specific exposure in question. Risk analysis determines the margin of safety which is the ratio of the "no-effect" level to the exposure level. A margin of safety that is more than 100 for humans (i.e., the levels of exposure are 100 times less than the level which would cause no effect) is generally considered an acceptable risk. In analyzing herbicide risks, when the margins of safety are adjusted for the proportion of R/W actually treated, all margins of safety exceeded at least 200.

An analysis of the cancer risk was also conducted for those materials about which there is scientific uncertainty concerning their cancer-causing po-

tential (such as 2,4-D, glyphosate and picloram). The ECI analysis is based on the intensive risk analysis procedure used by the USDA Forest Service. The multi-stage model is a conservative one which likely overestimates cancer risk. Triclopyr (Garlon) and fosamine (Krenite) are clearly not carcinogenic. 2,4-D, picloram, and glyphosate (Roundup) are probably not carcinogenic, but because of incomplete test data, ECI conducted a cancer risk assessment for these herbicides to determine maximum potential risks to humans. The results of this cancer risk analysis shows no cancer risk from any of these herbicides which is more than one in 510 million lifetimes. The cancer risks calculated were: diesel oil -- 1 in 8.4 million million lifetimes; 2,4-D -- 1 in 510 million lifetimes; picloram -- 1 in 2,000 million lifetimes; glyphosate -- 1 in 62,000 million lifetimes. A cancer risk which is 1 in 1 million is usually regarded as an acceptable risk.

The results of these risk analyses show that the herbicide applications as used on wooded wetland R/Ws in Massachusetts do not pose a risk of adverse impacts on humans, either from effects for which there are established thresholds or for non-threshold effects such as cancer.

An analysis of risk to wildlife showed margins of safety greater than 1 in all cases except for triclopyr ester and trout, and diesel oil and shrimp. By avoiding their direct application to water, these margins of safety will increase to more than 1, eliminating significant risk to wildlife. The key to maintaining these margins of safety and low cancer risks is to continue to use herbicide practices which minimize human exposure.

Predictions of herbicide fate. ECI employed mathematical models to determine whether herbicides applied to wooded wetland R/Ws have the potential of contamination of groundwater and wells. Computations from the models indicated that the quantities of the various herbicides that reach the perched groundwater in wetlands are exceedingly low.

One factor affecting this result is the slow percolation of water in wooded wetland soils, indicating that the vertical movement of water to underlying aquifers is slow. Other factors are the very small fraction of the land surface of R/Ws

versus the total land area which contributes water to the aquifers, low rates of herbicide application, the infrequency of application, and the short persistence and limited mobilities of the chemicals in the soil.

Models of groundwater dispersion in aquifers are impossible to apply in Massachusetts without expensive investigative work. In most cases, important parameters such as direction of subsurface water flow, permeability of underlying geological strata, aquifer recharge rates, the volume and depth of the water-bearing strata in the aquifers below the perched water tables of the wetland sites are largely unknown. The exceedingly low levels of herbicide which could conceivably reach groundwater depth make such efforts unnecessary.

Conclusion

This study indicated that there is no significant impact to wetlands from the current vegetation management techniques used on R/Ws in Massachusetts. Mechanical treatments result in relatively higher impacts than did selective herbicide use. Mechanical techniques had a slightly higher impact on the cover value of herbaceous vegetation than did herbicide techniques. Wildlife habitat values were rated low for mechanical techniques and medium for herbicide techniques. Residues from petroleum products (bar oil or hydraulic fluid) were found in the leaf litter on mechanically treated sites. No herbicide residues were found on herbicide-treated sites.

Literature Cited

1. Environmental Consultants, Inc. 1989. Study of the impacts of vegetation management techniques on wetlands for utility rights-of-way in the Commonwealth of Massachusetts. Report to six utilities. Southampton, PA 18966. 198 pp. + 7 appendices.

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Résumé. La projet comparait cinq traitements (coupe manuelle, fauchage, traitement à l'herbicide sur les souches de coupe, traitement herbicide à la base, application foliaire d'herbicide) pour déterminer leur impact sur les marécages des corridors utilitaires. La conclusion obtenue était qu'il y avait aucun impact significatif sur les marécages par quelque technique que ce soit de gestion de la végétation sur les corridors utilitaires au Massachusetts. Les traitements mécaniques résultaient en des impacts plus élevés sur la valeur du couvert pour la vie sauvage animale que ceux impliquant les herbicides. Les résidus de produits pétroliers (bande d'huile et de fluide hydraulique) étaient retrouvés sur la litière de feuilles des sites traités mécaniquement. Aucun résidu d'herbicide était retrouvé sur les sites traités par cette méthode.

Book Review

Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses by Michael A. Dirr. Stipes Publishing Company, 10-12 Chester Street, Champaign, Illinois 61820, USA. Fourth edition, 1990. 1,107 pages, including an 18 pp bibliography, a 15 pp index by Latin names and a 17 pp index by common names. Hardcover, US\$ 43.80; paperback US\$ 32.80.

It's rare that a tree's appearance and landscape usefulness on the one hand, and its propagation on the other hand, are discussed on the same page of the same book. Dr. Dirr deserves thanks from us all for having taken this approach. We may thank him also for his numerous entrancing and well-documented comments based on botanical literature, e.g., his reference to Prince's article on possible reasons for *Franklinia's* disappearance in the wild and Orton's article on attempts to hybridize *Gordonia* with *Franklinia*.

The book is organized as a single alphabet by Latin names of genera and species, something far and away more familiar and convenient for most of us than we're likely to find in the USDA's *Host Index* (which is organized by Latin Family names)! True, Dirr may give us no colorful photos (except his cover) but there's a wealth of carefully executed line drawings -- an average of one per page. And under a given species one finds up to 20 headings: family, leaves, buds, stem, hardiness, habit, rate of growth, texture, leaf color, flowers, fruit, culture, diseases and insects, landscape value, cultivars, propagation, native habitat, related species, and additional notes.

The fact that Dirr treats 300 genera with some 1,300 species or hybrid species, goes nowhere near telling the whole story. He also comments about a vast number of cultivars, which you'll find listed alphabetically under the appropriate species. For example, in *Acer* he discusses 38 species (and 2 subspecies). Yes, but under some of those maple species he also treats 153 maple cultivars (including 3 varieties and 1 forma).

Of the 300-500 possible crabapples that Dirr says might be distinguished by some one or other around the country, he describes -- in one long alphabetical series -- 208 named cultivars and varieties under *Malus*, pages 527-552. No wonder this valuable volume needs more than a thousand pages. (Francis Holmes)

Free Tree Care Literature

Arborists must have ready access to technical information if they are to succeed. The wealth of practical circulars and scientific reports about tree care is largely scattered and uncataloged. A compendium of information about diseases, insects, weeds and cultural problems of trees is available. It was compiled from information sources submitted from 42 states and 2 Canadian provinces. Names and location of sources of 1,982 publications are given in this book. Most of the publications are free. Send \$4.00 along with your name and address requesting the Compendium of Information on Tree Health Care to the Illinois Natural History Survey, 607 East Peabody Drive, Champaign, Illinois 61820.