THIRTY YEARS OF RESEARCH ON DEVELOPMENT OF PLANT COVER ON AN ELECTRIC TRANSMISSION RIGHT-OF-WAY[1]

by W.C. Bramble and W.R. Byrnes[2]

Abstract. A study of vegetation development and production of wildlife food and cover has been made on an electric transmission right-of-way (ROW) in central Pennsylvania over a period of 30 years. Vegetation was maintained with herbicide sprays of 2,4-D, 2,4,5-T, and ammonium sulfamate (AMS) compared with hand-cutting on separate areas assigned in a randomized block design over a 3-mile segment of ROW. A low plant cover resistant to tree invasion was developed which changed from dominant forest plants (bracken, vernal sedge, loosestrife, witch-hazel, and blueberry) to a relatively stable proclimax maintained by spraying and which was dominated by a combination of forest plants plus plants of openings (sweetfern, blackberry, dewberry, goldenrods, and hayscented fern). All of these dominant plants spread vegetatively by rhizomes or shallow roots to produce a mosaic pattern of irregular patches. Wildlife food and cover was increased on all areas and valuable shrubby edges developed. This produced a high wildlife habitat rating for the ROW as compared with the adjoining forest.

A 30-year study of the effects of herbicide applications has been made in central Pennsylvania on an electric transmission right-of-way (ROW) cleared in the winter of 1951-52 (Bramble and Byrnes, 1974). This research, continued to 1982, has produced answers to a number of questions concerning long-term effects of herbicides on plant cover.

At the beginning, the major objectives were aimed at investigating expressed public concerns in regard to potential herbicide effects on game food and cover and use by wildlife. Correlative objectives were to develop a low dense plant cover resistant to tree invasion and to determine the nature and stability of ROW plant communities.

Methods

Six commonly-used maintenance techniques were applied on a 3-mile segment of the ROW. Treatment areas were large enough to permit commercial spray applications and were replicated four times in a randomized block design. Treatments were as follows:

Initial treatments, 1953.

Treatment A. Unsprayed, woody brush cut as needed for control.

Treatment B. Broadcast foliage spray (D+T) of 2,4-dichlorophenoxy acetic acid (2,4-D) plus 2,4,5-trichlorophenoxy acetic acid (2,4,5-T) butoxy ethanol esters, half and half; at a concentration of 4 pounds aehg [acid equivalent per 100 gallons] in water; applied in June 1953 to all vegetation on the right-of-way at an average rate of 460 gallons per acre.

Treatment C. Stem-foliage spray of emulsifiable acids of 2,4-D plus 2,4,5-T, half and half; at a concentration of 6 pounds aehg in an oil-water carrier consisting of 10 gallons of fuel oil in 87 gallons of water. Spray was applied to the stumps plus lower ⅔ of the stems and foliage of tall-growing trees and shrubs to be controlled. Applied June 1953 at an average rate of 345 gallons per acre.

Treatment D. Selective summer basal spray of emulsifiable acids of 2,4-D plus 2,4,5-T, half and half, at a concentration of 12 pounds aehg in fuel oil. The spray was applied under low pressure to the basal 12 inches of stems using enough volume to cause rundown to the root collar. Only tall-growing shrubs and trees were sprayed. Applied June 1953 at an average rate of 140 gallons per acre.

Treatment E. Selective winter basal of 2,4,5-T butoxy ethanol esters at a concentration of 12 pounds aehg in fuel oil. Only tall-growing shrubs and trees were sprayed, using the same technique as in "D" above except that witch-hazel

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2. Professor Emeritus and Professor of Forestry, respectively, Purdue Univesity; in cooperation with the Pennsylvania Game Commission, Union Carbide Agricultural Products Company, Inc., Asplundh Tree Expert Company, and the Pennsylvania Electric Company.

(scientific names of plant and animal species are given in the appendix) and bear oak were not sprayed on 33-foot strips on each side of the right-of-way to encourage development of shrub-by edges. Applied February 1954 at an average rate of 137 gallons per acre.

Treatment F. Broadcast foliage spray of ammonium sulfamate (AMS) at a concentration of ¾ pound per gallon of water. Four ounces of DuPont sticker-spreader were added per 100 gallons of spray. Applied to all vegetation on the right-of-way in June 1953 at an average rate of 415 gallons per acre.

Follow-up basals, 1954.

Treatments B-D, C-D, D-D, E-D, F-D. A followup basal spray (D) was applied in June 1954 (June 1956 for E-D) to one half of each replication of treatments B, C, D, E, and F. The followup was a summer basal spray containing 2 pounds of 2,4,5-T per gallon, at a concentration of 16 pounds aehg in fuel oil and applied at the average rate of 32 gallons per acre.

Retreatments, 1966.

Treatment G. Selective basal and stump sprays of 2,4-D plus 2,4,5-T butoxy ethanol esters, half and half; at a concentration of 16 pounds aehg in fuel oil. Spray was applied to thoroughly wet all exposed roots, stumps, and stems to a height of about 10 inches. Applied in June and July 1966 at an average rate of 25 gallons per acre.

Treatment H. Stem-foliage spray of 2,4-D plus 2,4,5-T amine, half and half; at a concentration of 4 pounds aihg (active ingredient per 100 gallons) in water. Spray was applied to thoroughly wet all foliage and stems at an average rate of 206 gallons per acre in June and July 1966.

Results and Discussion

Control of target species. A necessary and important part of the study of effects of herbicides on wildlife food and cover was the control of species capable of interference with transmission of electric power (target species). Thorough and careful applications of herbicides were necessary to get acceptable control and to cause disturbances typical of the different herbicide applications.

Excellent control of target species was obtained by all of the 1953 spray applications (Treatments B-F) which reduced living plants over 3 feet in height in 1957 to 133 per acre (Table 1). On the winter basal-sprayed areas (Treatment E), sassafras suckered vigorously to produce 1182 plants per acre as compared to 1282 plants per acre on handcut areas (Treatment A).

No retreatments were needed until 1966 when selective basal and stump sprays were applied over the entire ROW, regardless of previous treatments, plus a stem-foliage spray on sassafras patches. Excellent control was obtained, especially on sassafras, so that by 1969 living plants over 3 feet height averaged 46 per acre on spray treatment areas.

The number of target plants gradually increased until by 1973 they averaged 185 plants over 3 feet in height per acre on sprayed areas and 908 on the handcut areas. By 1980, the number of living plants over 3 feet height per acre increased to an average of 612 for sprayed areas; there were 1518 per acre on handcut areas (Table 1). A wide variation in number of trees existed between replications which was indicative of a typical resurge pattern on the ROW at that time.

Relative abundance of species in 1957, expressed as a percent of the total number of plants, was as follows: sassafras 69%, misc. oaks 12%, red maple 5%, bear oak 5%, and misc. hardwoods 9%. This had changed considerably by 1981 when the distribution was: misc. oaks 22%, red maple 21%, witch-hazel 21%, bear oak 17%, sassafras 12%, black cherry 5%, and misc. hardwoods 2%.

Height growth of trees on the handcut areas during the first year after cutting averaged 3 to 4 feet. In subsequent years, height growth averaged approximately 1.5 to 2.0 feet per year between cuts in 1958, 1967, and 1976. Trees reached a maximum height of about 14 to 16 feet prior to each recutting.

Development of non-target vegetation. A typical upland oak forest was present before ROW clearance that contained white oak, chestnut oak, red oak, and black oak plus some hickory (Fig. 1). Oak-hickory forests are the most

Table 1. Control of target species on the ROW. Each value is an average of 4 replications. Sprays were applied in 1953 and 1966 (see Methods).

Date	Treatment	Oaks	Red maple	Black cherry	Misc. hdwds	Sassafras	Bear oak	Witch-hazel	Total
			No. living plants over 3 ft. ht. per acre						
1957	A	408	158	—	288	1282	126	—	2262
	B	14	—	—	2	4	24	—	44
	C	2	8	—	14	2	2	—	28
	D	4	8	—	8	124	14	—	158
	E	28	2	—	4	1182	8	—	1224
	F	0	10	—	16	0	2	—	28
							Average B-F		133
1969	A	276	74	0	2	2	116	36	506
	B	2	0	0	0	0	36	6	44
	C	2	4	0	0	0	40	0	46
	D	2	0	2	0	2	22	26	54
	E	0	0	0	0	0	14	30	44
	F	2	0	2	0	0	12	26	42
							Average B-F		46
1980	A	630	238	56	14	32	256	292	1518
	B	34	216	16	4	44	98	36	448
	C	66	166	64	22	52	80	64	514
	D	112	78	22	16	66	96	116	622
	E	105	75	3	3	317	186	133	822
	F	50	178	40	2	26	26	326	654
							Average B-F		612

extensive type in the United States and cover in total about 112 million acres. The sparse, tall shrub understory layer was dominated by witch-hazel and sassafras; and a low ground layer of herbs and shrubs was dominated by blueberries, huckleberry, teaberry, bracken, vernal sedge, loosestrife, wild sarsaparilla, and panic grasses.

Initial baseline data taken on the ROW in 1953 before spraying indicated that a uniform plant community existed on all treatment areas (Fig. 1). Blueberries, huckleberry, witch-hazel, and teaberry were the dominant ROW shrubs; bracken, vernal sedge, loosestrife, and wild sarsaparilla were the common herbs. At this time, the shrub cover occupied 14.4 percent of the ROW and herbaceous cover 31.2 percent.

On selectively sprayed areas, the forest shrubs and herbs named above remained dominant until about 1968 (Fig. 2 and 3) when aggressive species typical of open areas became dominants. These were sweetfern, bear oak, blackberry, and dewberry with goldenrods and hayscented fern. A dense plant cover with intermingling layers developed which occupied the entire ROW by about 1956.

On broadcast-sprayed areas, a marked change took place when in 1954 and herb-grass community composed mainly of vernal sedge, panic grasses, tall meadow fescue, loosestrife, and fireweed became dominant (Fig. 1). Beginning at about 70 percent coverage of the ROW in 1954, this vegetation covered the entire ROW by 1956. With continued development of vegetation, broadcast-sprayed areas became similar to selective basal-sprayed areas in about 15 years.

Beginning in 1968 and continuing through

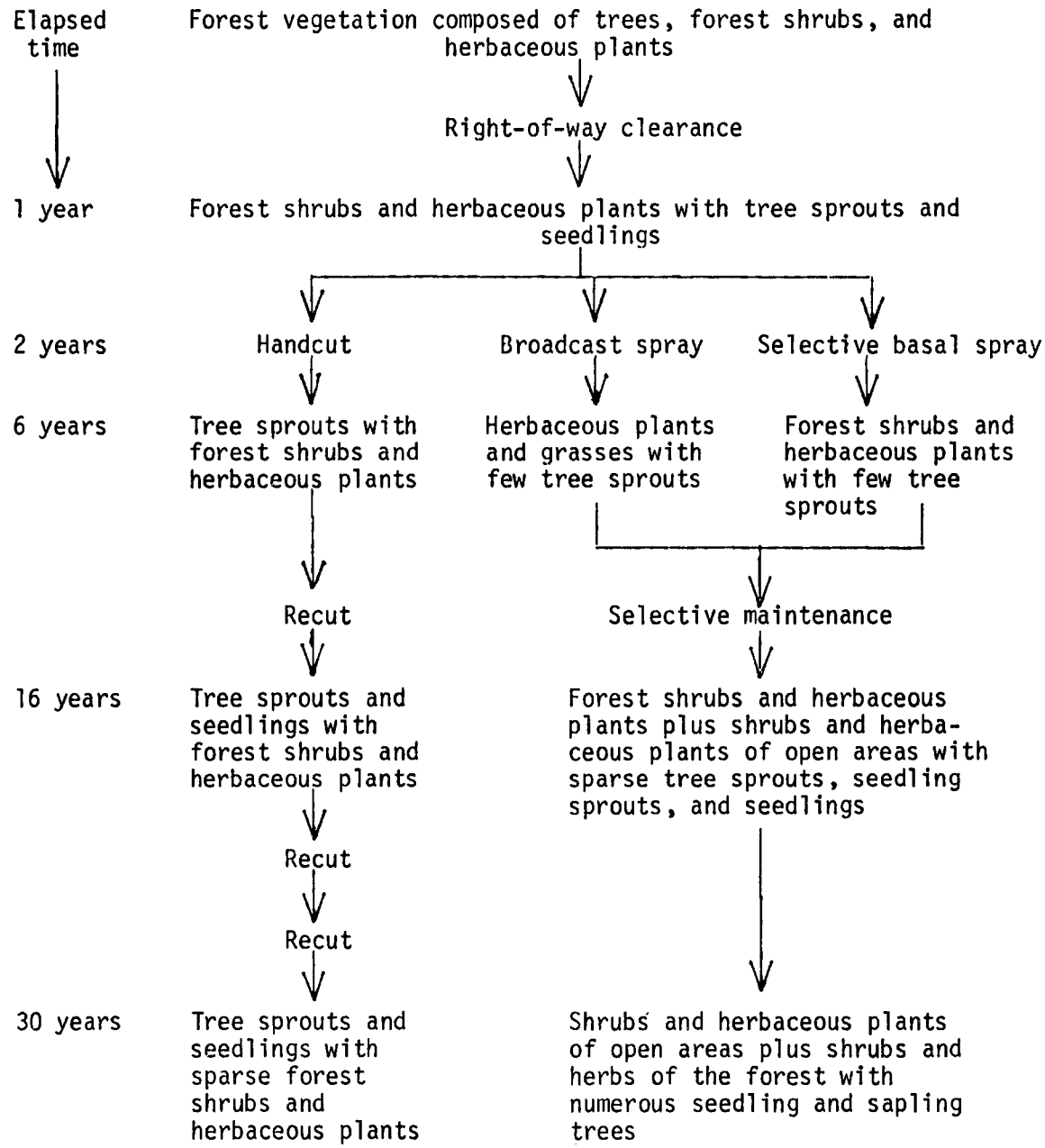

Fig. 1. A simplified model of the development of vegetation on a right-of-way showing dominant life forms.

1981, a typical proclimax plant community that was maintained by selective spraying of emergent trees existed over the sprayed ROW. This was composed of a mixture of forest plants plus species of open areas. The number of plant species on the ROW increased to 35 in 1981 as compared with 29 in 1953.

An important feature of the dominant plants on the ROW was their ability to spread vegetatively by underground stems (rhizomes) or rhizomatous roots (Fig. 4). This strategy permitted such plants as blueberry, sweetfern, blackberry, bracken, goldenrod, and hayscented fern to form large patches under the conditions imposed by severe competition on the ROW (Fig. 5 and 6). These dominant species that formed a dense ROW plant cover varied considerably in their resistance to tree invasion (Bramble and Byrnes, 1976).

Effects on wildlife habitat. Several important habitat changes that are considered favorable to wildlife were caused by construction of the ROW and its subsequent maintenance with herbicide sprays. These changes were evaluated by a wildlife habitat evaluation technique based on food plant abundance and diversity, type of vegetative cover present, edge development (Fig. 7), and type interspersion (Brambles and Byrnes, 1979). White-tailed deer was used as a key species owing to its importance as a game animal and its abundance in the area.

Habitat values obtained for sprayed ROW areas in 1979 averaged 8.2 (a high class habitat) on a scale of 1 to 10. An average value of 5.5 (a low class habitat) was obtained for the adjoining forest. These may be compared with a value of 7.2 (a high class habitat) for a wildlife clearing in adjacent state gamelands.

Major conditions responsible for the higher rating of the sprayed ROW were the presence of a prominent shrub layer that was very sparse in the forest, presence of shrubby edges and patches, and various early stages of plant succession which formed a mosaic pattern of shrub patches interspersed with herb-grass openings.

An important feature of ROW vegetative cover was abundant fruiting of shrubs such as blueberries, witch-hazel, bear oak, blackberry and dewberry (Fig. 8). These shrubs plus sweetfern also provided valuable browse in both winter and summer, and were relatively high in feed value (Bramble and Byrnes, 1974). Common herbs such as goldenrods, bracken fern, and panic grasses were also used by wildlife for food and cover.

Use of the ROW by wildlife. Constant use of the ROW by wildlife has been observed over the 30 years. Common game species observed were white-tailed deer, ruffed grouse, wild turkey, and cottontail rabbit. Other game and nongame wildlife species such as woodchuck, gray squirrel, skunk, opossum, fox, white-footed mice, and rattlesnake also have used the ROW.

Fig. 2. Low dense cover of forest species (bracken, sedge, *loosestrife*, blueberry) in 1958, 5 years after a stem-foliage spray (IIC).

Fig. 3. Dominant blackberry and goldenrod on the same stem-foliage spray area (IIC) in 1981, with a dense patch of trees in the background.

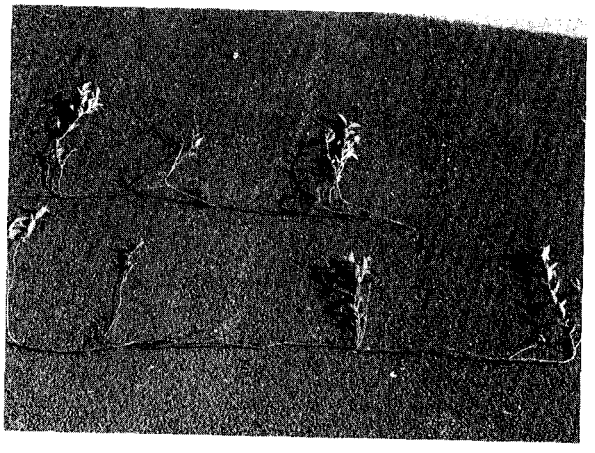

Fig. 4. Rhizomes and shoots of low early blueberry provides for vegetative spread on the ROW.

Fig. 5. A dense patch of low early blueberry on a broadcast area (IVF) in 1973. A few small white oak and red maple seedlings are emerging from the blueberry patch.

Fig. 6. A large patch of tall meadow fescue with sweetfern invading in 1973 (IF). No emerging trees from this grass patch.

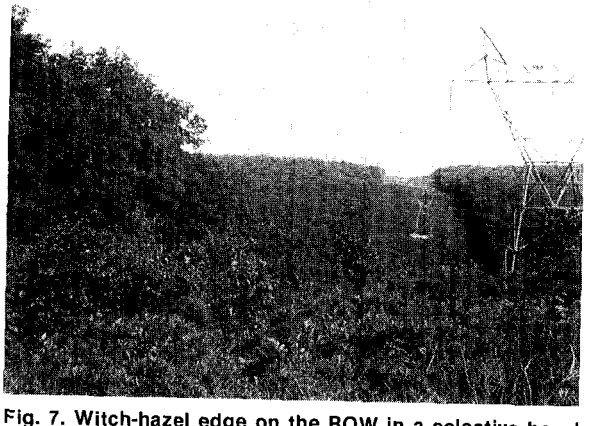

Fig. 7. Witch-hazel edge on the ROW in a selective basal spray area (IIE) furnished food and cover for wildlife.

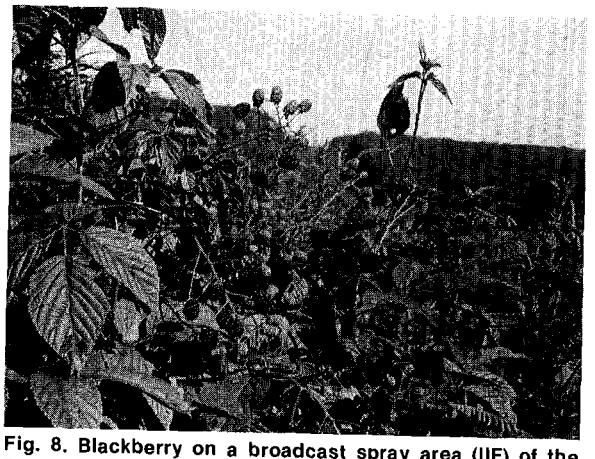

Fig. 8. Blackberry on a broadcast spray area (IIF) of the ROW with abundant berries.

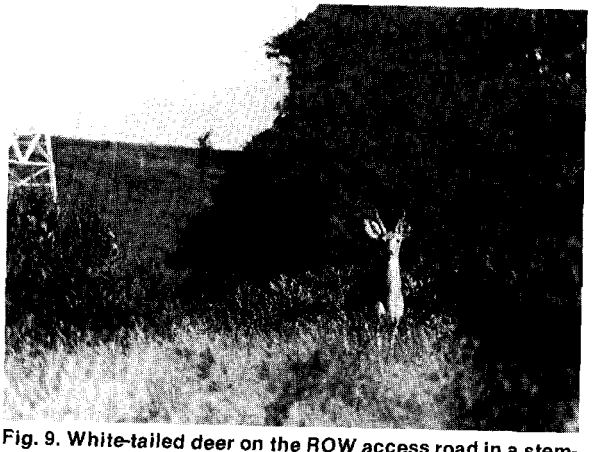

Fig. 9. White-tailed deer on the ROW access road in a stem-foliage spray area in 1976. (IC).

A special study was made of white-tailed deer (Fig. 9) by means of a pellet group count technique. Data collected on the ROW from 1955 through 1973 on annually cleared plots indicated that use was relatively high and in 1970 equalled a population density of one deer to nine acres. Deer use in the adjacent forest averaged 29 deer days per acre as compared with 55 deer days on the ROW in 1972 and 1973.

Another special study made of songbirds indicated that a number of common species typical of shrublands and edges used the ROW in the summer. These included American goldfinch, brown thrasher, catbird, common flicker, field sparrow, indigo bunting, yellow-rumped warbler, robin, rufous-sided towhee, song sparrow, and yellow-throat. Songbirds nested in shrubs, low trees, and patches of blackberry. They fed on seeds, fruit, and insects, and used the ROW vegetation for escape cover.

Some Implications for ROW Management

There are a number of facts documented by this long-term study that have application to ROW management. Such knowledge of what may be expected to happen to a ROW in respect to vegetation development should permit a manager to prescribe maintenance treatments with a reasonably accurate degree of prediction.

An important basic fact to be understood is that a complex secondary succession will take place after capital clearance of a forest that will trend towards a return to a forest climax. There will be a small initial reduction in total plant cover caused by the clearance which will be rapidly made up by spread of plants common in the forest. Species of openings in the forest and clearings will then increase on the ROW. Spread of these species may be gradual or eruptive. The resultant mixture of plants of the forest and of open areas will persist on the ROW as a "proclimax." This is a plant community maintained by a repeated disturbance which in this case is the removal of trees in ROW maintenance. Tree removal thus halts the normal development towards a forest so that a ROW may be considered to be in a suspended state of plant succession. However, there will be a constant flow of tree seeds to the ROW from adjacent areas that will continue pressure of plant succession towards a forest condition. A low dense plant cover on a ROW will slow this process but will not remove the need for constant woody brush (tree) control.

To produce a low dense cover needed to resist tree invasion, species that spread vegetatively by rhizomes or rhizomatous shallow roots should be encouraged by suitable spray techniques. For example, blueberry which is highly resistant to invasion can be favored by selective basal sprays; while sweetfern that is more readily invaded by trees is encouraged by foliar sprays. Herbs such as goldenrods and sod-forming grasses that are resistant to tree invasion can be maintained by either ground foliar sprays or aerial sprays. Selection of species to be favored in ROW maintenance should be based upon local species actually present in any certain case. Thus, encouragement of a desirable natural development evident on a ROW should be used as a guide for treatment prescriptions.

Development of desirable wildlife habitat on a ROW requires that careful attention be given to protecting shrubby borders during maintenance. Species which produce valuable wildlife food and cover such as witch-hazel and bear oak should be allowed to develop along ROW borders. Herbs and grasses which produce seeds and furnish browse can be maintained in patches on the general ROW through use of ground foliar sprays. A ROW with low shrub-herb-grass plant cover under the wires and shrubby borders, for example, would be desirable for wildlife habitat improvement in a forest area.

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Appendix

Common and scientific names of plants and animals referred to in the report.

Plants

Blackberry	*Rubus allegheniensis*
Blueberry	*Vaccinium angustifolium*
	Vaccinum vacillans
Bracken	*Pteridium aquilinum*
Cherry, black	*Prunus serotina*
pin	*Prunus pennsylvanica*
Dewberry	*Rubus hispidus*
Fern, hayscented	*Dennstaedtia punctilobula*
Fescue, meadow	*Festuca elatior*
Fireweed	*Erechtites hieracifolia*
Goldenrod	*Solidago graminifolia*
	Solidago rugosa
Hickory	*Carya* spp.
Huckleberry	*Gaylussacia baccata*
Loosestrife	*Lysimachia quadrifolia*
Maple, red	*Acer rubrum*
Oak, bear	*Quercus ilicifolia*
black	*Quercus velutina*
chestnut	*Quercus montana*
red	*Quercus rubra*
white	*Quercus alba*
Panic grass	*Panicum commutatum*
	Panicum latifolium
Sassafras	*Sassafras albidum*
Sedge, vernal	*Carex pensylvanica*
Sweetfern	*Comptonia peregrina*
Teaberry	*Gaultheria procumbens*
Wild Sarsaparilla	*Aralia nudicaulis*
Witch-hazel	*Hamamelis virginiana*

Animals

American goldfinch	*Spinus tristis*
Brown thrasher	*Toxostoma rufum*
Catbird	*Dumetella carolinensis*
Common flicker	*Colaptes auratus*
Cottontail rabbit	*Sylvilagus floridanus*
Field sparrow	*Spizella pusilla*
E. diamondback rattlesnake	*Crotalus adamanteus*
Gray squirrel	*Sciurus carolinensis*
Indigo bunting	*Passerina cyanea*
Mice	*Peromyscus* spp.
Opossum	*Didelphis marsupialis*
Red fox	Vulpes fulva
Robin	*Turdus migratorius*
Ruffed grouse	*Bonasa umbellus*
Rufous-sided towhee	*Pipilo erythrophtalmus*
Song sparrow	*Melospiza melodia*
Skunk	*Mephitis mephitis*
White-tailed deer	*Odocoileus virginianus*
Wild turkey	*Meleagris gallopayo*
Woodchuck	*Marmota monax*
Yellow-rumped warbler	*Dendroica coronata*
Yellow-throat	*Geothlypis trichas*

Department of Forestry
Purdue University
West Lafayette, Indiana

ABSTRACT

Sievert, R.C., Jr. 1982. **Urban forestry: business for arborists.** Arbor Age 2(2): 16-17, 27.

Several years ago the Urban Forestry Assistance section of the Cooperative Forestry Assistance Act made federal funds available to state forestry agencies on a 50-50 matching basis. As much as $3.5 million was distributed by the Forest Service. Some states undertook a secondary matching process whereby municipalities received a portion ofthe funds by matching a grant from the state. Because the appropriations were restricted to technical assistance, actual tree work such as planting and maintenance could not be done. Instead, temporary consultants were hired to provide the municipality with the necessary advice for directing a tree program. Unfortunately, these temporary services often lasted only as long as the consultant could be retained. In the beginning, some arborists expressed a fear that a tax-supported urban forestry assistance program would be detrimental to the private enterprise system upon which they depend. To date, exactly the opposite is true. The pennies invested from the average commercial arborist have produced thousands of dollars of work.