Management of roadside vegetative cover by selective control of undesirable vegetation. No. 117 1980

Rusch, Alan J.; Thompson, Donald R.; Kabat, Cyril
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MANAGEMENT OF ROADSIDE VEGETATIVE COVER BY SELECTIVE CONTROL OF UNDESIRABLE VEGETATION

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COVER PHOTO:
Roadside vegetation near its prime after 12 years of management. Composition is largely of gray dogwood, sumac, and hazel, and shrubs are well below the utility line. On higher speed roads, however, the 66-ft width of the right-of-way common to town roads such as this, would provide insufficient setback and mowing strip for visibility and snow removal. (Meek Road)

ABSTRACT

Roadside vegetation management through selective removal of undesirable plants was practiced on 15 miles of south central Wisconsin roadsides during 1960-77. Intensive management and measurement were conducted on 3 of these miles comprising 11 segments. The management objective was to restore and/or enhance the quality of the existing roadside cover at a lower cost than that of conventional maintenance for natural resource conservation purposes, with emphasis on wildlife but also including soils, plant and animal diversity, esthetics, and noxious weed control. Plants found to be objectionable or whose anticipated growth would be objectionable on the roadsides, including most trees, were killed or inhibited by cutting, herbicide application, or both. Herbicide use was discontinued in 1969.

Estimates of areal coverage by woody taxa (genera or species) and prominent forbs were obtained annually or biennially to document changes. Strong "increasers" were grape, sumac, plum, and Virginia creeper. Elderberry, rose, black locust, *Populus,* and elm decreased substantially. Some taxa achieved comparative stability after an initial period of change: sumac, plum, dogwood, poison ivy, and oak. *Rubus* was unusual, showing great initial response, presumably due to tree removal, followed by a steady decline.

The practices yielded satisfactory shrub development where adequate stocks were present, and significant values were realized in 5-10 years. Cover indexes exceeding 80% were obtained on some segments during the 18 years with low costs and no resort to planting or seeding.

The results of this study further reinforce the justification for maintaining existing natural shrubby roadsides as a means of preserving and enhancing environmental quality. The environmental value of this method is particularly important at a time when mowing and debrushing are costly users of energy.

MANAGEMENT OF ROADSIDE VEGETATIVE COVER BY SELECTIVE CONTROL OF UNDESIRABLE VEGETATION

By

Alan J. Rusch, Donald R. Thompson, and
Cyril Kabat

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DEPARTMENT OF NATURAL RESOURCES
Box 7921
Madison, WI 53707

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INTRODUCTION

Leopold (1931), citing earlier authors, pointed up the value of fencerow cover (hedges) to upland game and songbirds. This association was amplified by Dambach (1948), and, in Wisconsin, by Kabat and Thompson (1963), who detailed the relationship of roadside and fencerow brush to bobwhite quail numbers in southern Wisconsin. The development of stable shrub communities on highway and utility rights-of-way to reduce vegetation maintenance costs was urged by Egler (1949, 1952, 1953). The esthetic appeal of roadside shrubs at a national level was affirmed by the Natural Beauty Council.

In the light of this knowledge, in addition to concern for noxious weed control and over controversial and expensive debrushing and mowing practices, the Weed and Brush Working Group of the Natural Resources Committee of State Agencies (NRCSA) was formed in 1954 (NRCSA 1958) to preserve and enhance natural rights-of-way. A more specific study emphasizing roadside management was designed in 1958 as a result of the Wisconsin Conservation Department (now the Department of Natural Resources) increasing its commitment to right-of-way enhancement (NRCSA 1964, 1965, 1967; Besadny, Kabat, and Rusch 1968). The objective was to investigate methods of encouraging low and medium cover which simultaneously could increase wildlife habitat and reduce weed control problems while not interfering with utility lines or traffic use of the roadway.

In the spring of 1958 three towns in south central Wisconsin were asked to cooperate in this study by permitting the DNR to conduct selective removals of woody plants on segments of roadside totalling up to 15 miles. Generally this meant permitting desirable shrubs to increase at the expense of undesirable shrubs and trees. Edminster and May (1951) had shown the potential for obtaining shrub dominance following tree removal in areas of northeastern United States where natural woody plant succession had occurred.

Woody vegetation was of interest rather than grasses or forbs for roadside cover because a greater production of wildlife was expected from it than from grasses or forbs and because changes in woody plant composition and growth were more likely to be recognized and accepted by the general public. In 1960 the first roadsides were approved for this maintenance change, and measurements of vegetation and of maintenance were begun.

The primary purpose of this report is to document and evaluate the vegetational changes that occurred during the trial management period and to comment on special problems encountered.

STUDY AREA

The selective management of roadside vegetation was conducted in the towns of West Point, Lodi, and Arlington in southwestern Columbia County, Wisconsin, from 1960 to 1977 (Fig. 1). Total roadside miles (roads x 2) in the area is 363 miles.

The sites selected for study represent many situations encountered in southern Wisconsin, but close representation of all southern Wisconsin roadside types was not attempted. Study segments were located on state, county, and town roads (6, 11, and 83%, respectively) as compared to corresponding mileage percentages of 13, 22, and 65 for all Wisconsin rural roads (Table 1). Roadsides and their vegetation were similar in the three towns, so much of the study could be concentrated in the Town of West Point. This concentration had the advantage of convenience and economy and simplified liaison with town officials.

The Town of West Point lies on the end moraine of the Wisconsin glaciation with its characteristic ponds, lakes, and hills. Prominent sandstone outcrops and limestone ridges are distributed throughout the area, exhibiting only moderate glacial disturbance. The vegetation is characterized as oak savanna. The town lies in the Prairie Province, which is separated by the tension zone from the Boreal Province about 100 miles to the northeast (Curtis 1959). Approximately 18% of the land is wooded, mostly on slopes too steep for cultivation. The woodland is primarily oak-hickory; however, maple, basswood, and white birch occur on north slopes. Prairie remnants occur on south slopes and originally occupied some of the flatlands.

The glacial and outwash soils of the area consist of well-drained sandy loams grading to heavy, poorly drained silt loams. Many of the rights-of-way have been heavily graded and ditched,

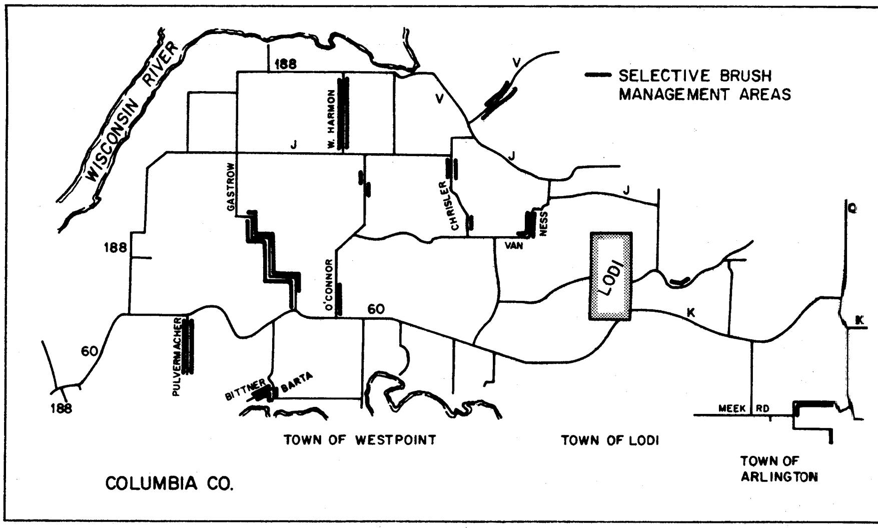


FIGURE 1. *Areas designated for selective brush management trials.*

TABLE 1. *Segments of the intensive roadside vegetation sample, and system percentages for the sample and of Wisconsin rural roads.*

System	Segments	1960-77 Intensive Sample: Length (ft.)	Percent of Sample	1967 Wisconsin Rural Roads Percent*
State Trunk Highway				13
	S.T.H. 60	1,000		
	Subtotal	1,000	6	
County Trunk Highway				22
	C.T.H. V #3	450		
	C.T.H. V #4	1,300		
	Subtotal	1,750	11	
Town Roads				65
	Pulvermacher 1-E	900		
	Pulvermacher 2-E	2,600		
	Pulvermacher 1-W	900		
	Pulvermacher 2-W	2,600		
	Van Ness E	1,550		
	Van Ness W	1,550		
	Gastrow	1,200		
	O'Connor	1,350		
	Subtotal	12,650	83	
Total	11 segments	15,400	100	100

*Adjusted from system mileage, Wisconsin Blue Book, Legislative Reference Library 1968:656.

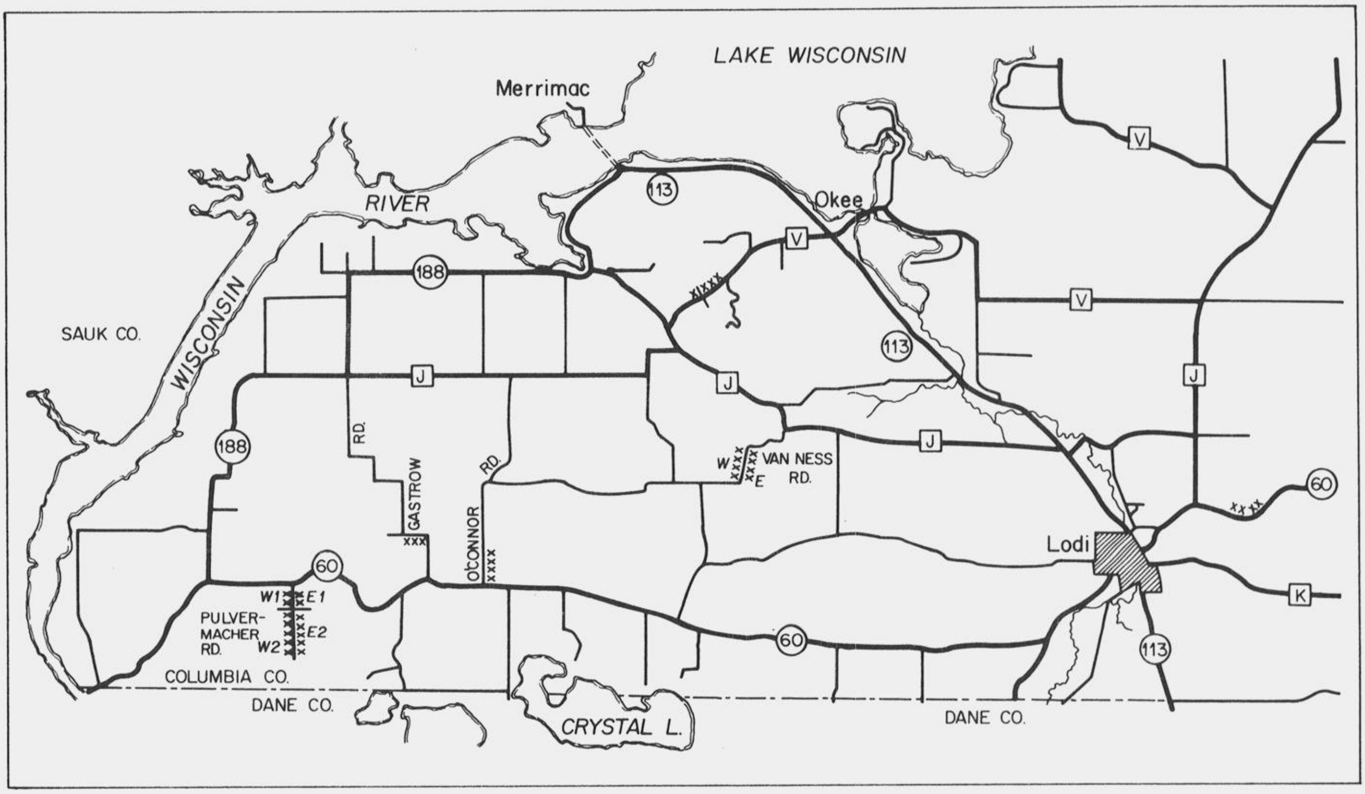


FIGURE 2. *Intensively sampled roadside segments.*

disturbing or removing the original topsoil and frequently exposing subsoils or the unstructured glacial drift or outwash. Agriculture consists of dairying and hog and beef raising, along with canning crop production (sweet corn and peas).

Up to 15 miles of roadside were included in the three townships in the Columbia County trial. Limited records of plant occurrence were collected on 12 of the 15 miles, and management efforts were minimal on about 8 of the 12 miles. More intensive efforts were conducted on the other 3 of the 15 miles, with 11 segments designated on these 3 miles (Fig. 2). This was called the "Intensive Area" and provides the basis of the main substance of this report except where noted. Segment lengths varied from 460 to 2,600 ft (140 m to 800 m) on one side of the road. Ten of these segments were in the Town of West Point and one (S.T.H. 60) was in the Town of Lodi. None of the segments met all of the selection criteria. Some premium was placed on having a wide range of woody cover and composition that would provide a good working base for monitoring woody plant changes and permit appraisal of the various management strategies applied.

Local maintenance considerations required minimum segment lengths, even though these included some poor sections with limited management potential.

By the commencement of the study the disturbed soils had been invaded by weeds and material that originated in remnant rootstocks or propagules, the spreading of adjacent vegetation, or transported seeds. Roadsides have been characterized as "ruderal" sites in reflection of their disturbed state (Curtis 1959).

Use of a 5-ft stick marked at 6-in. intervals to locate sampling units. It is serially repositioned to give the 10-ft sampling line containing the 20 contiguous sampling units. (Van Ness Road)

METHODS

SELECTION OF ROADSIDES FOR TRIAL MANAGEMENT

Roadsides having trial management potential were usually suggested by the DNR and were presented to town chairmen and county highway commissioners for review. Factors evaluated included suitability for application of available techniques, and absence of conflicts or problem situations, or objections by adjacent landowners.

Desirable conditions for practice of selective management include:

1. Volume and velocity of traffic is not excessive.
2. Width of the right-of-way equals or exceeds 4 rods (66 ft).
3. Slope does not exceed 13%.
4. Management does not interfere with fence maintenance.
5. Some vegetation exists and consists largely of preferred shrub species.
6. Potential woody growth that may interfere with driver visibility or safety, can be controlled.
7. Level of the road surface is higher than adjacent lands.
8. Utility lines are absent.
9. Snow drifting is not a problem, or addition of woody plants would reduce drifting.
10. Adjacent land uses are compatible with any change in vegetation.
11. Woody vegetation will aid in delineating the course of the road, especially on outside curves and under conditions of poor visibility, e.g., in fog or blowing snow.

Features such as road corners, culverts, line fences, and large trees were utilized in identification of segment limits. Segments were marked where necessary with 4 x 11-inch white plywood signs on steel posts.

SELECTIVE SHRUB AND TREE CONTROL

Selective control of shrubs and trees was deemed to be the best course to follow to establish additional desirable woody cover. Procedures for accomplishing this control were evaluated—by necessity on the same segments as those selected for vegetation monitoring.

During the first years of the study several methods of control were tried on those woody plants whose presence or anticipated growth would cause roadside maintenance problems or which were of low value to wildlife. Spraying with herbicides and cutting near ground level were used separately and in combination.

In addition to removal of problem plants, some experimental cuts of all woody plants, regardless of species, exceeding 15, 12 and 9 ft in height were made near ground level. These "height" cuttings were abandoned after a few years of trial when this type of management proved to be inferior to species selection. No height cuts were conducted on any of the 3-mile intensive sampling segments.

Generally, selective cutting with spraying of cut stems and root collars, or spraying alone, was most effective in controlling undesirable woody vegetation. A large degree of control was achieved with herbicides in about three years. Herbicide use was reduced and finally abandoned in 1969, and thereafter only selective cutting as necessary was practiced. Cutting proved adequate for several years until some problem species, such as Tartarian honeysuckle, invaded and was not adequately controllable by cutting alone.

Tree removal proceeded intermittently since partial shade was found to be of value in enhancing germination and increasing survival of woody seedlings. Eventually most trees were removed.

After the fifth year the "intensive" 3-mile sample was given first priority in work assignment with considerable neglect of the other segments, especially along those roadsides which were marginally acceptable at the start. All of this 3-mile vegetation sample received identical maintenance after 1969. Only one 1,200-ft segment (Gastrow) did not receive herbicide treatment.

Shrub control was not practiced at the species level on the intensive area unless incidental to maintenance. "Control" as used in this report does not imply such close hands-on selection.

Some local encouragement of selected shrub species took place on the extensive areas, however, through occasional removal of less desirable competitive species, such as the removal of sumac from hazel seedlings. No documentation of the favorable results achieved by these limited removals are presented in this report.

Time records were kept for on-site vegetation control on all segments.

NOXIOUS WEED CONTROL

During the first 10 years, both selective herbicide application and hand cutting were employed in control of small patches of Canada thistle. Control efforts were usually timed to coincide with early flowering and completed prior to the setting of seed. Little difference in the effectiveness of the two control efforts was evident, although no structured observations were conducted.

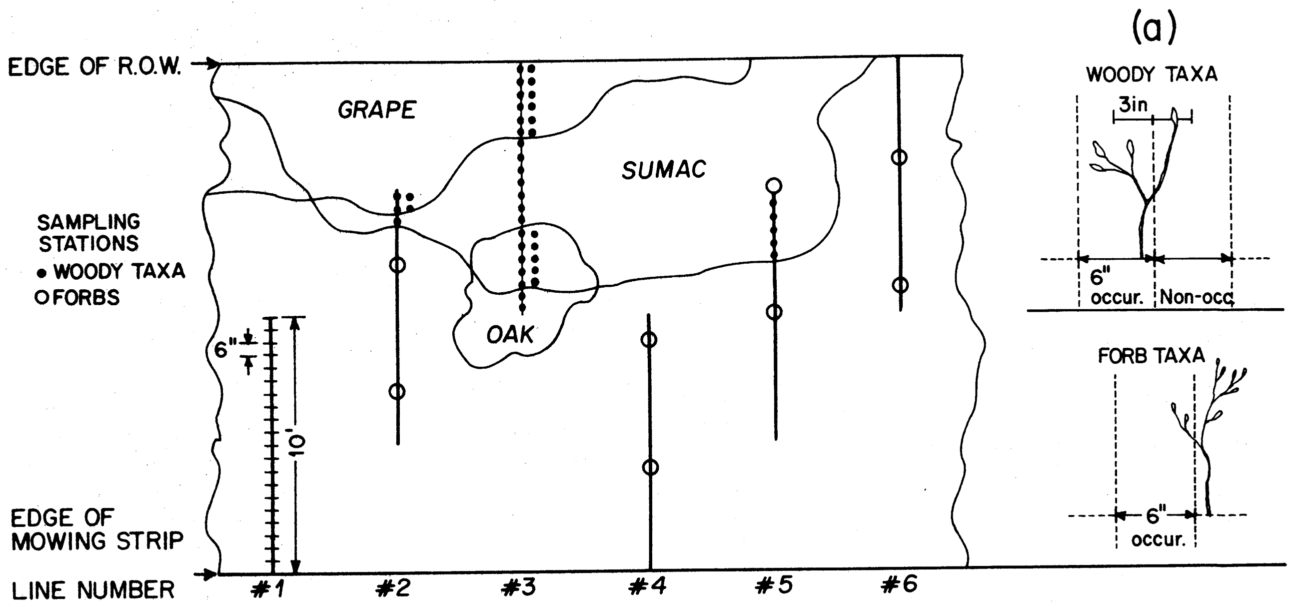
Field bindweed was found on only one or two small areas of the 11 measured segments; consequently special control efforts were not attempted on it. Successional shrub development could be expected to hold this species in check and possible effect a decline.

Leafy spurge, the third species under the Wisconsin noxious weed law, was not found on any of the trial roadsides within the study area.

While not classified as "noxious", poison ivy often requires special consideration. Little control was practiced on it here as it was limited in occurrence.

PLANT MEASUREMENTS

Because of time constraints the measurement of vegetation on the roadside was limited to estimation of the area covered by woody plant taxa, including prostrate vines, and selected forbs (not including grasses, sedges, or forage legumes). Taxa are a single genus or split genera, a single species, or groupings of species, lumped together for ease of field recognition and simplification of roadside maintenance and usually having similar management



	#1	#2	#3	#4	#5	#6	SUMS TAXA	SUMS WOODY	6" Sampling Units	Woody Plant Taxa Index
SUMAC	0	3	18	0	6	0	27		120	22%
GRAPE	0	2	6	0	0	0	8		120	7%
OAK	0	0	7	0	0	0	7		120	6%
SUM	0	5	31	0	6	0	42		120	35%
WOODY	0	3	20	0	6	0		29	120	24%

FIGURE 3. *Plant taxa sampling methods.*

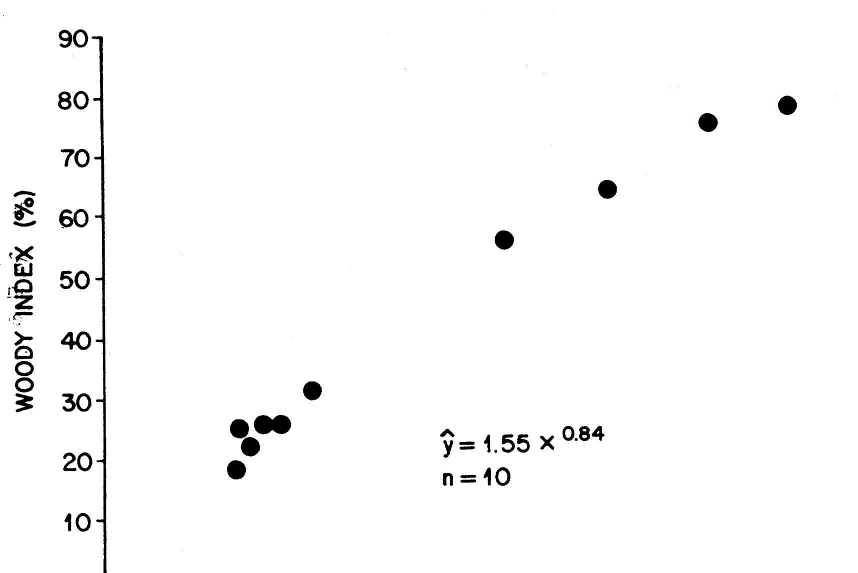


FIGURE 4. *Relationship between the woody index and the taxa summation index, 1960.*

needs. While volume of vegetation is of major interest, it is difficult to determine: although a functional relationship between area and volume can be presumed, it was not investigated. Counts of plants were not made since growth forms of the woody plants studied vary widely by species and maturity, and therefore poorly portray the numbers of plants.

To obtain the woody plant taxa index, 10-ft sampling lines were positioned perpendicular to the road, usually in sets of three along the roadsides (Fig. 3). The 10-ft lines were field delineated by a portable stick serially subdivided into 20 6-inch linear sampling units. (Actually a 5-ft stick positioned twice was more convenient to use.)

The occurrence of a woody plant taxon on a sample unit was recorded if a vertical projection (plane) of the 6-in. sampling unit intercepted at least 3 in. of the canopy of any eligible taxa, with each taxon being separately enumerated (Fig. 3a). Tallies were field recorded as number of occurrences on the 10-ft lines. The percentage of occurrences among all sampling units on all lines in the roadside segment is the index. These measurements were made during 13 of 17 growing seasons.

Forb occurrences were counted on about 800 6-in.-diameter circular plots rather than on linear sampling units. Two plots per 10-ft sampling line were centered successively on the 1- and 6-ft mark, 2- and 7-ft, 3- and 8-ft, etc. Here an occurrence was recorded when *any portion* of an eligible taxon was within or intercepted by the vertical projections of the perimeter of the plot (cylinder), so that the occurrence is different for forbs than for woody plants (Fig. 3b). Therefore, forb indexes are not directly comparable to woody taxa indexes. Forbs were not tallied on 2 of the 11 segments for all years, so the forb data are based on about 2.5 miles rather than 3 miles of roadside.

The sets of three 10-ft lines were positioned repetitively by pacing, with the first line beginning at the inner edge of the mowing strip, often locatable by the appearance of perennials. The second line was positioned with its center approximately on the midline of the roadside. The third line terminated at the edge of the roadside, usually delineated by a fence or agricultural practice.

The pattern was repeated to obtain at least 18 (i. e., six sets of 3) 10-ft sampling lines on the shorter roadside segments (under 1,000 ft) and up to 78 lines for longer roadside segments. The position of the first line and the spacing between lines were varied each year to help randomize samples, although a uniform systematic spacing of lines was used for each roadside segment (Fig. 3).

Since sampling units were contiguous on the sampling lines, the occurrences were not independent, because of plant size and/or clumps. This nonindependence would not affect means, but could affect their variance and testability for differences.

Oversampling of the central portion of the roadside strip arose in using the sets of three 10-ft lines because of central overlapping when roadsides were less than 30 ft wide. This may have biased some of the indexes. Two roadside segments exceeded 30 ft in width and therefore no overlap occurred between sampling lines.

From these sampling arrays, the percentage of occurrences of each taxon was calculated by summing the number of occurrences, dividing by the number of sampling units, and multiplying by 100. This percentage was directly used as the *woody plant taxa index* for each taxon for each of the 11 segments for each year of the survey. Yearly data are not independent, since condition of canopy in any given year is dependent in part on what was present in the preceding years.

TABLE 2. *95% confidence limits for taxa indexes for typical sampling situations.*

Index	Shortest Segment		Longest Segment		All Segments	
	1 year	13 years	1 year	13 years	1 year	13 years
1	0.3- 3	0.7- 1.3	0.6- 2	0.9- 1.1	0.8- 1.2	0.9- 1.1
2	1- 4	1.7- 2.4	1- 3	1.8- 2.2	1.8- 2.3	1.9- 2.1
5	3- 7	4.4- 5.6	4- 6	4.7- 5.3	4.6- 5.5	4.9- 5.1
10	7-13	9.2-10.9	8-12	9.6-10.4	9.4-10.6	9.8-10.2
20	16-24	19-21	18-22	19-21	19-21	20
40	35-45	39-41	38-43	39-41	39-41	40

Changes in coverage were calculated as percentage changes using these index values. Thus a change in index from 27 to 32 is calculated to be a relative increase of 19%, while a change from 32 to 27, a decrease of 16%.

To obtain estimates of the total woody cover on a roadside segment, the individual taxa indexes were summed *(summation indexes)*. These indexes overrepresent total woody plant canopy, since a varying degree of overlap of taxa can occur (Fig. 3). Actual woody coverage would usually be less than indicated by this contrived index. For example, in Figure 3 the sum of the indexes for individual taxa is 35%. The tally labelled "woody" shows only 29, producing an equivalent taxa index of 24%. Such direct field determination of total woody canopy values (as opposed to summed taxa) using the previously described method requires separate measurements and was done only in 1960, the first year of measurement, when 10 segments were studied. The relationship between the woody index and the summation index for all segments is shown in Figure 4. It is not possible to predict individual segment relationships from this figure since these are highly variable. Lower values of the sums could be expected to be more realistic than higher values, because lower values suggest less overlap of taxa than higher values. In succeeding years summation indexes were used to compare roadside segments or classes of vegetation.

On most roadside segments data were collected in late August and early September, prior to most leaf fall and after most of the summer growing season. There was difficulty in identifying biennials, and annuals that flower early in the year.

Since woody plant taxa index is the basic statistic used in this study, it is desirable to have some evaluation of its precision. Sampling errors in the estimates of indexes for individual taxa by segment for each year can be approximated by regarding the proportion of occurrences as one term of a binomial. The assumption must be granted that the sampling units are independent, which has been pointed out as not being true. Nonetheless, useful but underestimated confidence limits can be posited to assist in interpretation of the taxa index values presented.

Table 2 selects a series of index values for the typical shorter roadside segments having about 20 sampling lines and for the longer segments having about 75 sampling lines, each line having 20 sampling units. The 95% confidence intervals for each index value are given for single-year results and for the combined years of measurement, 13 in all. Finally the intervals are given for the combined 11 segments on a 1-year basis for the 13 years.

No realistic evaluation of the summation indexes is possible because they are so variable in content. Their precision would be at least as great as and usually greater than that of the taxa index limits.

RESULTS AND DISCUSSION

WOODY TAXA SUMMATION INDEXES

As indicated earlier, taxa are single species, lumped species, single genera, or split genera, usually with similar management needs. *Rhus* was split into poison ivy and sumac, and *Prunus* was usually split into the three common cherry species.

The progression of summation index values for woody taxa through the year for the 11 segments of the intensive 3-mile vegetation sample (mapped in Fig. 2) are plotted in Figure 5. All segments exhibited long-term increases in index values. The summations are given for convenience in comparing segments, and because of overlap of taxa may not realistically represent canopy, especially the higher index values. The averages of the 11 segments reveal a relatively steady increase from the second year to the end of the study. The index approximately doubled during the period of selective management. The decline after the first year was caused by cutting of undesirable plants (mostly trees).

This progression was interrupted in some of the segments by certain obvious causes. For example, two fires on Van Ness Road E* retarded growth. Both mowing and herbicide applications slowed woody cover expansion on S.T.H. 60 and on segment 2-E of the Pulvermacher Road. Mowing on segment 4 of C.T.H. V likely accounts for some of the growth rate decline in the later years of the study. Five of the segments registered summation indexes near 150% by 1975, representing a high value of total canopy. Two of the above segments, Van Ness W and Gastrow, had meager woody cover at the start of the study but their woody cover at the end of the study was not far below that of other segments with much higher starting points.

TABLE 3. *Average indexes of woody plant taxa of 11 roadside segments for the years 1960-67, 1969, 1971, 1973, 1975, and 1977.*

Class	Taxon	Average Index	Percent of Total
Trees	Chokecherry	2.62	
	Black cherry	1.50	
	Box elder	0.92	
	Black locust	0.84	
	Elm	0.74	
	Oak	0.63	
	Black walnut	0.59	
	Aspen and cottonwood	0.55	
	Hickory	0.43	
	Apple	0.38	
	Hackberry	0.28	
	Pin cherry	0.10	
	Ash	0.03	
	Butternut	0.03	
	Mulberry	0.03	
	Total	9.66	12
Shrubs	Plum	8.04	
	Sumac	6.63	
	Dogwood	6.36	
	Elderberry	5.49	
	Hazel	5.32	
	Honeysuckle	1.22	
	Juniper	0.62	
	Prickly ash	0.34	
	Nannyberry	0.15	
	Willow	0.13	
	New Jersey tea	0.05	
	Juneberry	0.01	
	Leadplant	0.01	
	Hawthorn	TR	
	Total	34.37	43
Brambles	Raspberry and blackberry	10.97	
	Rose	1.94	
	Currant and gooseberry	1.02	
	Total	13.93	18
Vines	Virginia creeper	9.07	
	Grape	8.94	
	Poison ivy	1.83	
	Bittersweet	1.10	
	Greenbrier	0.62	
	Total	21.56	27
	Grand total all woody plants	79.52	100

*The 11 roadside segments intensively managed and measured in this study are listed by road type in Table 1.

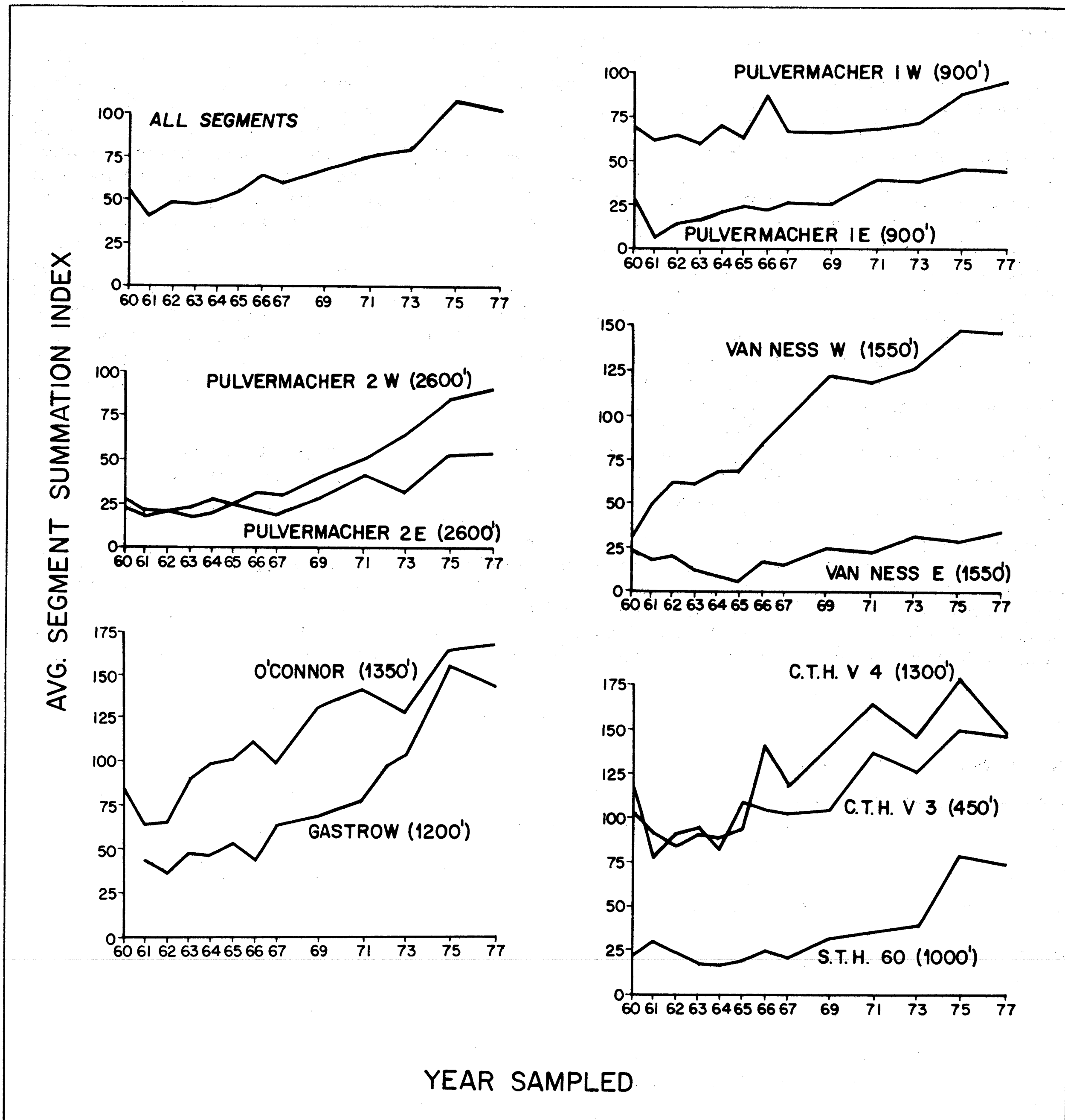


FIGURE 5. *Taxa summation indexes for roadside segments subjected to selective shrub management.*

INDEXES FOR INDIVIDUAL WOODY TAXA

By Combined Years

The averages of 13 years of taxa indexes are given for 37 taxa in Table 3. These are grouped into the conventional growth form classes, *viz.*, trees, shrubs, brambles, and vines. Use of the index average for the period of the study simplifies portrayal of taxa status and provides a basis for comparison of taxa. Similarly, the class values, which are the sums of the averages of the component taxa, can be compared, although such sums, like taxa sums, only crudely represent true canopy. The absence of measurements in 1968, 1970, 1972, 1974, and 1976 weights the averages in favor of the earlier years, but it is not felt that this reduces the usefulness of the averages for comparative purposes. Brambles include all species of the genera *Rubus, Rosa,* and *Ribes.*

The five leading taxa in Table 3, *Rubus* (raspberry and blackberry), Virginia creeper, grape, plum, and sumac, total 43.65 and thus account for over half of the woody plant total of 79.52. Of these five, two are classed as shrubs, two as vines, and one as a bramble. Only one (black cherry) of the twelve leading taxa is undesirable. The leading tree, chokecherry, was considered desirable and was controlled only beneath telephone and power lines. Raspberry and blackberry *(Rubus)*, the leading taxon, exceeded the sum of all tree taxa.

By Individual Year

Average indexes for individual woody taxa on the entire 3 miles of the intensive sample (11 segments) for all years are presented in Figure 6. Additional graphs for the 11 individual segments mapped in Figure 2 are included for the major taxa, demonstrating the considerable variation in both canopy and canopy change. Segment samples with mostly or all zero counts are not graphed. The graphs representing the 3-mile combined sample (11 segments) are weighted for unequal segment lengths.

In Table 4 ranking is made of the taxa indexes for the 3-mile intensive sample for each year of measurement. Since no measurements were taken in some of the later years, early years (1960-67) are overrepresented. To provide a standardized expression of variability, standard deviations of ranks were calculated but should not be used for other purposes.

Since most undesirable large trees were removed in the first and second years they show a drop in their index values. Not included in the graphs are those tree taxa of less than 0.1% occurrence: mulberry, ash, butternut, and pin cherry.

The undesirable trees which show gains in later years were either resistant to herbicides or cutting, or were successful in seeding or resprouting. Elm, box elder, and black cherry increases are believed to have been caused by seedling growth rather than by canopy spread of older trees. Black walnut growth was acceptable when the tree was not in a problem situation. The graph of hackberry does not show any marked index change despite efforts to control it.

Among shrub species, hazel, *Rubus*, dogwood, and plum show above-average stability of rank.

The top 10 ranked species comprised over 75% of the summation index for woody taxa in all years of measurement, and over 80% in 12 of the 13 years of measurement (Table 5).

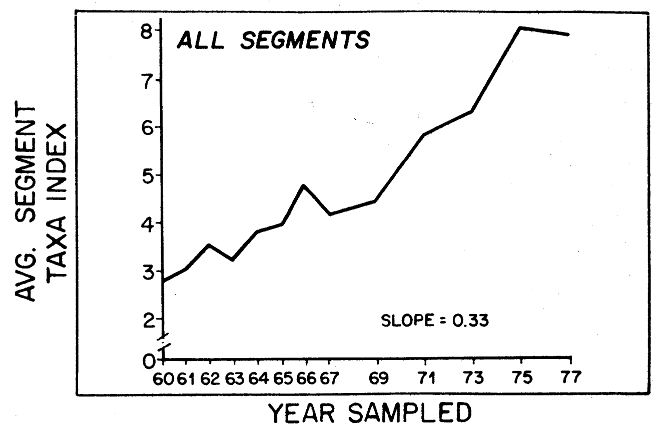
To help evaluate similarity of response of 15 major nontree taxa (those with taxa averages greater than 1%) during the trial period, correlation coefficients were calculated on the paired taxa indexes for each year (Fig. 7). Elderberry index values decreased through the study, thus giving negative correlation values when compared with generally increasing index values of the other species with which it is compared. Rose was inconsistent in index, giving a low correlation. Two of the vines, *Smilax* and bittersweet, also had low (and non-significant) correlations, while grape and poison ivy had many significant positive correlations with the upward trend of most species.

CHANGES IN TAXA AND CLASS PROPORTIONS OF THE WOODY COVER

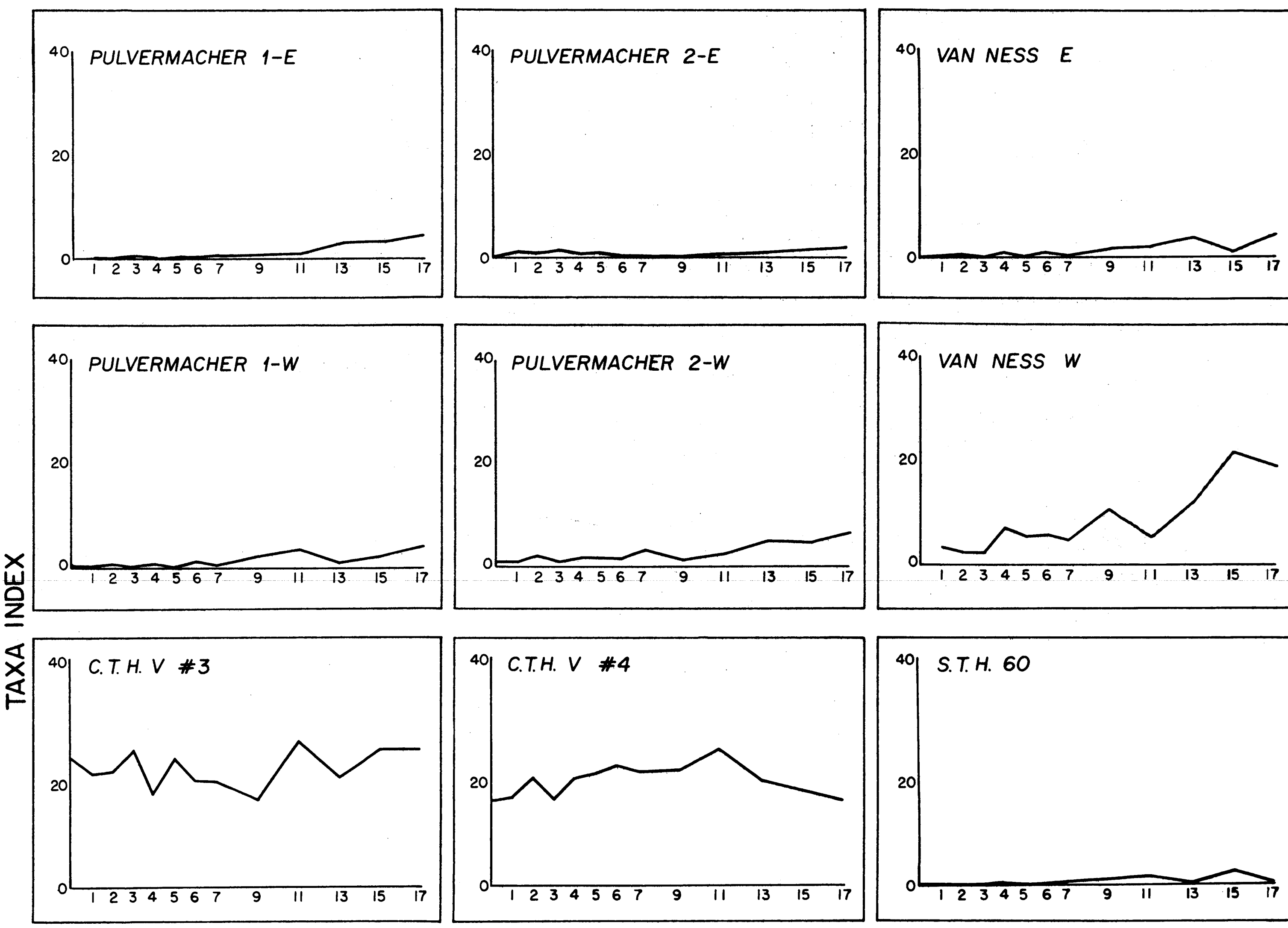
The proportions of each taxon in the woody taxa summation changed because taxa indexes did not increase uniformly. The 18-year record of the proportions of 25 leading taxa in the

TABLE 4. *Rank of 34 taxa indexes.*

	Year														
Taxon	60	61	62	63	64	65	66	67	69	71	73	75	77	Avg. for All Years	S.D.
Rubus	3	1	1	1	1	1	1	1	1	2	2	2	3	1.54	.78
Grape	1	6	3	5	4	4	2	3	2	1	1	1	1	2.62	1.62
Sumac	11	4	6	4	2	2	3	2	3	3	3	4	2	3.77	2.45
Elderberry	2	2	2	2	3	3	5	5	6	8	7	7	7	4.54	2.30
Plum	10	5	5	3	5	6	4	4	4	4	4	5	5	4.92	1.71
Dogwood	6	3	4	6	6	5	6	7	8	6	6	6	6	5.77	1.24
Va. Creeper	9	7	7	8	7	8	7	6	5	5	5	3	4	6.23	1.74
Hazel	8	8	8	7	8	7	8	8	7	7	8	8	9	7.77	.60
Cherry	7	10	10	9	11	10	9	9	9	9	9	9	8	9.15	.99
Rose	4	13	11	10	10	9	11	12	12	10	11	11	10	10.31	2.18
Poison ivy	19	11	9	11	9	11	10	10	11	11	10	10	11	11.00	2.52
Bittersweet	17	14	12	12	12	13	12	11	10	13	12	17	19	13.38	2.66
Ribes	22	22	20	17	13	12	13	19	14	15	13	12	13	15.77	3.77
Elm	12	15	16	16	15	14	16	14	13	22	16	16	20	15.77	2.68
Box elder	15	17	15	15	20	17	15	16	15	14	18	14	17	16.00	1.73
Honeysuckle	24	20	21	18	18	21	20	13	19	12	15	13	12	17.38	3.97
Poplar	5	12	14	14	16	18	17	21	27	19	22	22	21	17.54	5.56
Bl. locust	14	9	13	13	23	16	19	22	20	23	23	19	22	18.15	4.69
Smilax	27	16	17	19	14	15	14	15	16	16	25	23	23	18.46	4.48
Oak	13	19	22	20	17	20	22	17	17	18	17	21	18	18.54	2.50
Hickory	16	18	18	21	24	23	23	20	22	20	21	25	24	21.15	2.70
Hackberry	18	22	26	22	21	22	18	18	23	25	26	24	25	22.31	2.93
Walnut	31.5	31	31.5	24	19	19	21	23	18	24	20	15	15	22.46	5.81
Juniper	25	25	28	27	26	25	24	25	24	21	14	18	14	22.77	4.64
Prickly ash	26	26	24	26	25	27	27	26	21	17	19	20	16	23.08	3.95
Apple	23	24	25	23	22	26	28	30.5	25	27	27	27	27	25.46	1.94
Willow	20	21	19	28	28	28	26	24	26	28	29	33	26	25.85	3.95
N. J. tea	28	31	23	25	27	24	25	30.5	32	26	33	30	33	28.27	3.52
Nannyberry	31.5	31	27	31.5	29	29	30	30.5	28	32	24	26	28	29.04	2.39
Ash	21	31	31.5	31.5	32.5	30	29	30.5	32	29	31	31	29	29.92	2.91
Leadplant	31.5	27	31.5	31.5	32.5	32.5	31	30.5	32	32	28	34	33	31.31	1.92
Juneberry	31.5	31	31.5	31.5	30	32.5	33	30.5	29	32	33	32	30	31.35	1.21
Butternut	31.5	31	31.5	31.5	32.5	32.5	33	30.5	32	32	30	28	33	31.46	1.38
Mulberry	31.5	31	31.5	31.5	32.5	32.5	33	30.5	32	32	33	29	31	31.62	1.10



DOGWOOD



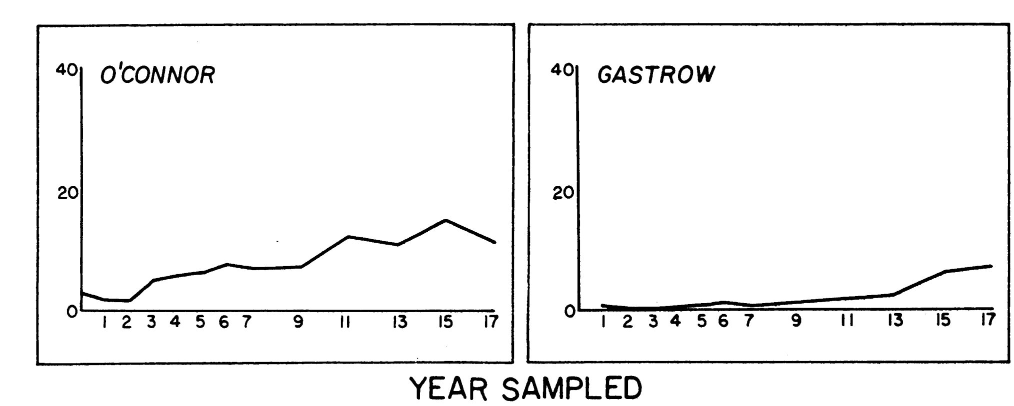
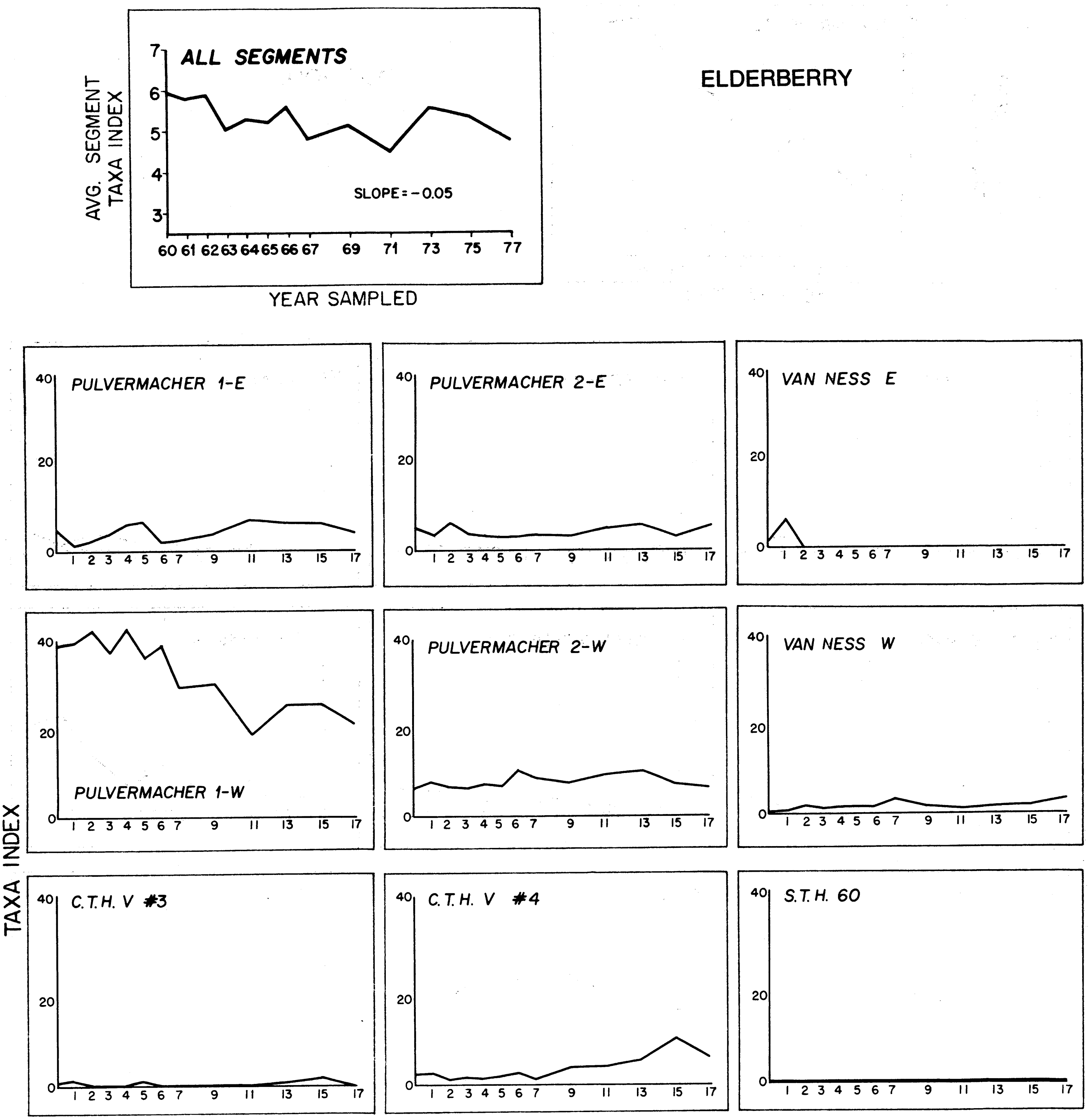
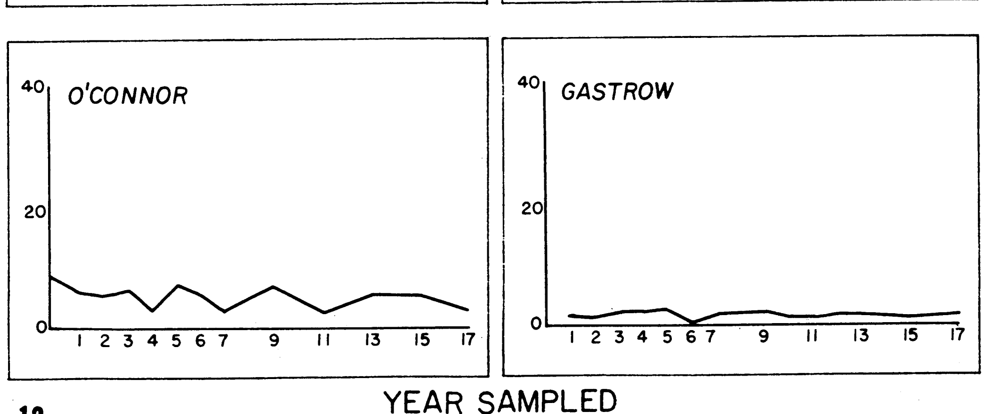


FIGURE 6. *Taxa indexes for roadside segments (1960-77).*





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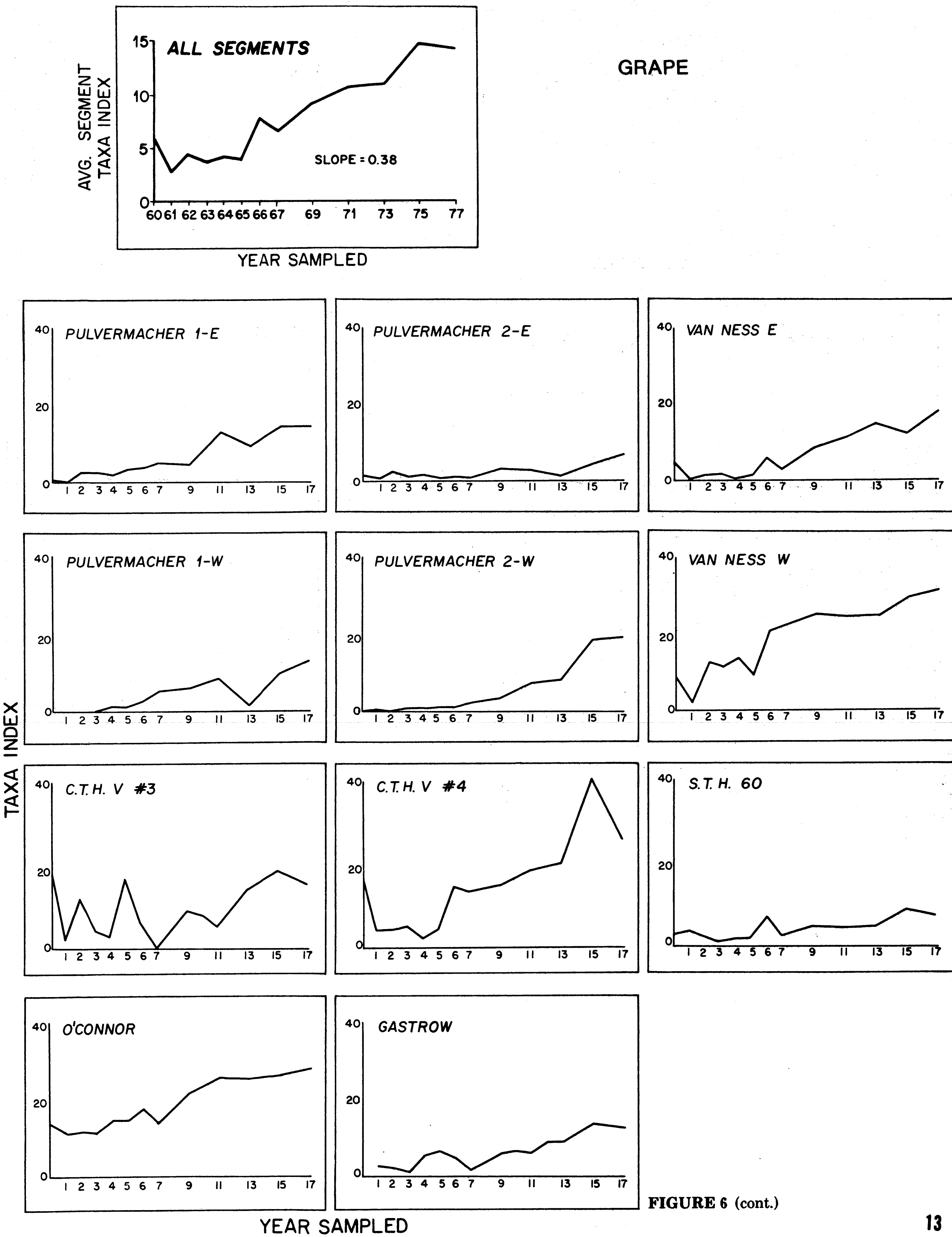

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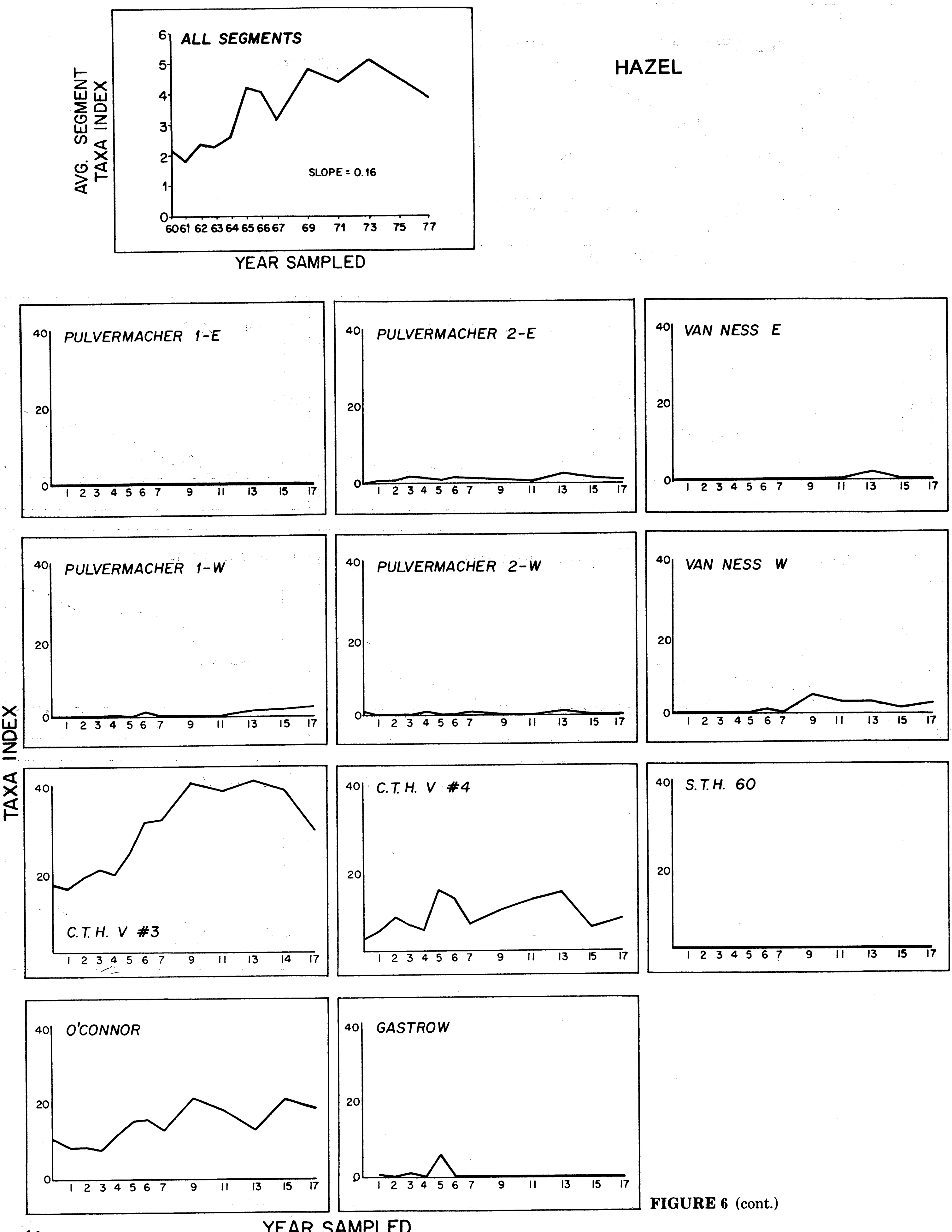

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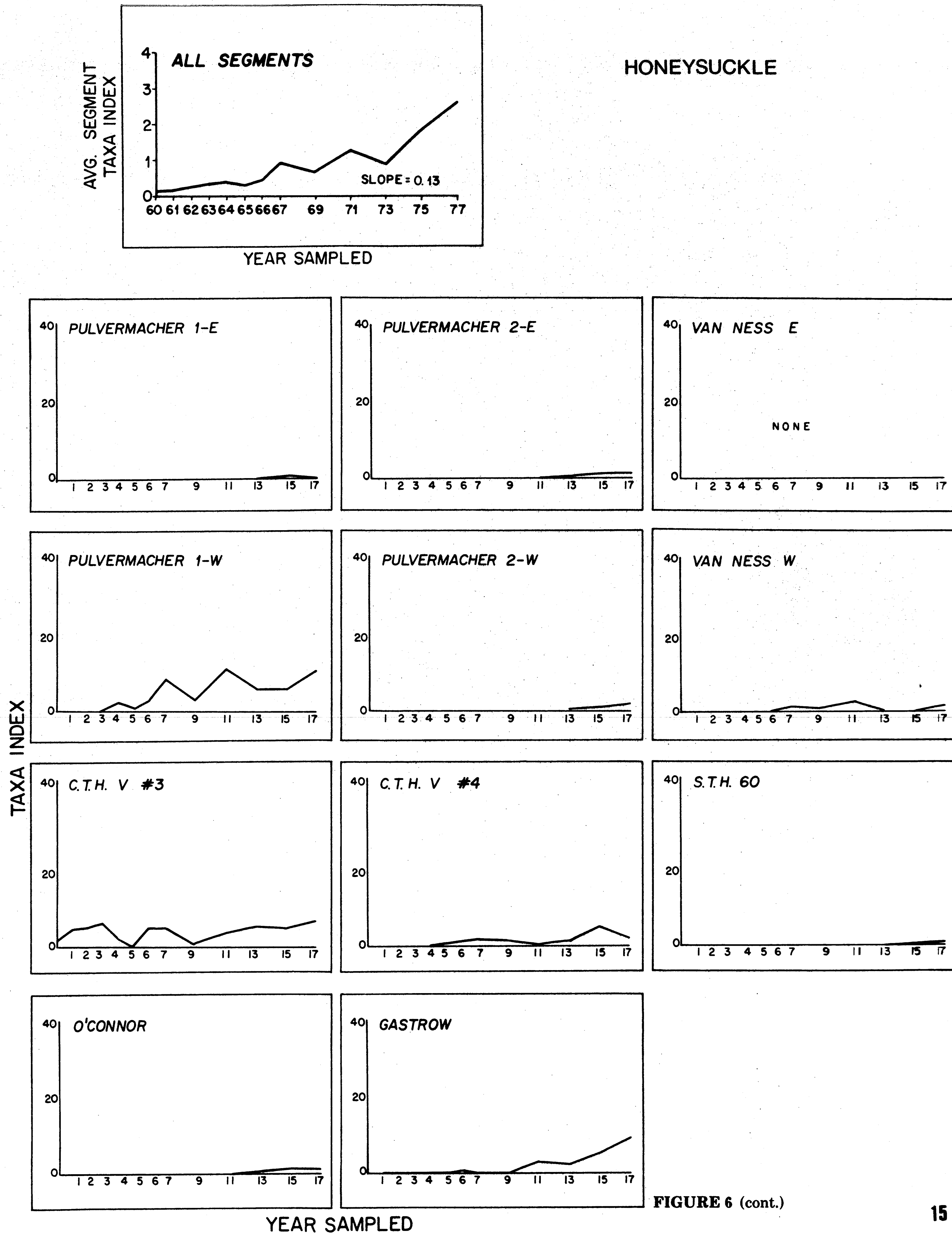

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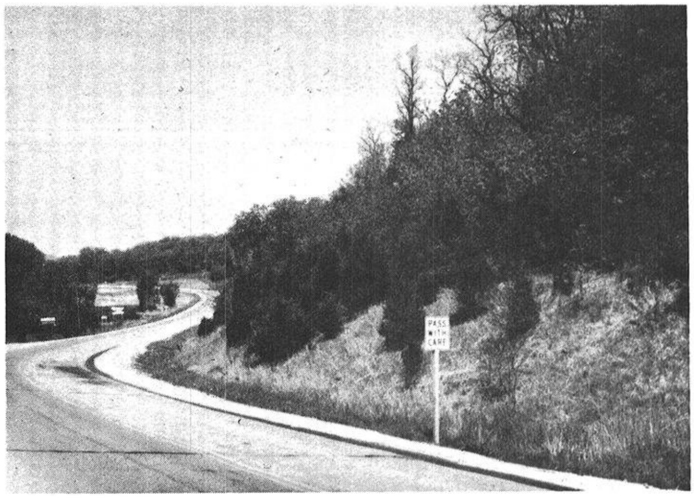
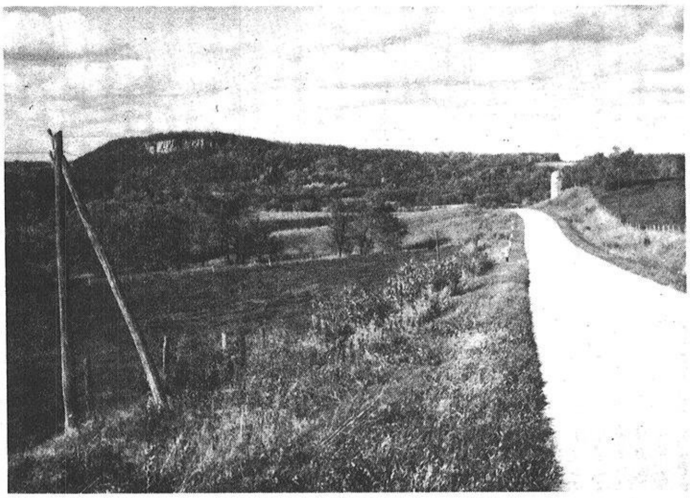
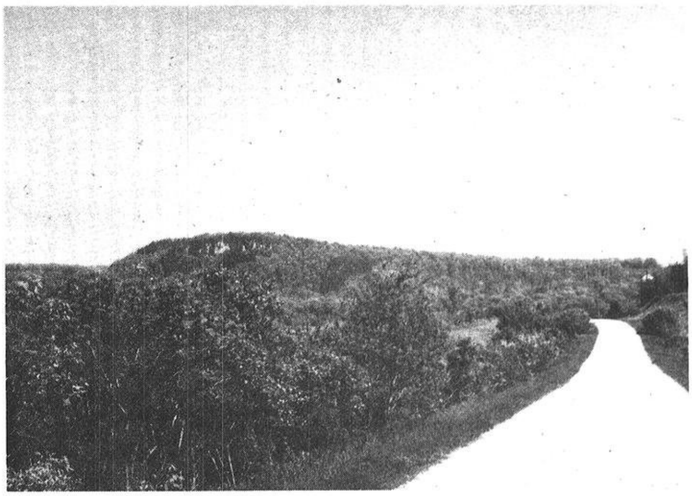
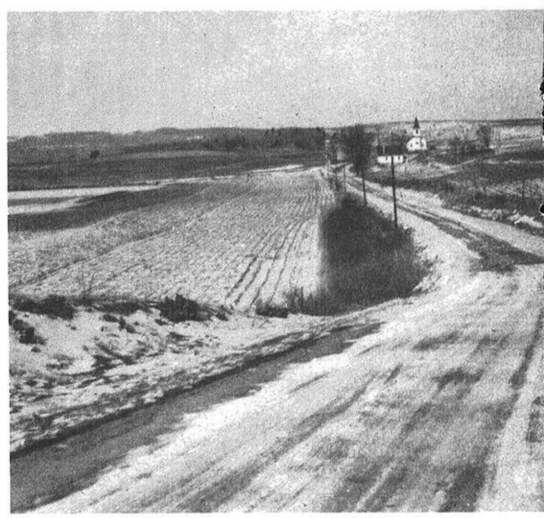


After 19 years a juniper stand has developed on a state highway having a wide right-of-way and no utility lines. Control was practiced to maintain visibility on the curve. It is contiguous with a wooded area above, often a desirable condition. (S.T.H. 60)

Roadside shrub management which began with no apparent cover in 1960. By 1975 (left) sumac had volunteered. By 1980 (right) a nearly ideal mixed shrub complex had developed. Selective cutting and early herbicide tree control was practiced. (Van Ness Road)

Dead box elder stems after selective herbicide treatment amidst gray dogwood and sumac. This is on the west shoulder of the road but the elevation of the roadbed minimizes snow drifting. (Van Ness Road)



Shrub management on the west (left) side of this curve resulted in some drift problems in heavier snowfalls. Locust on left foreground shoulder required removal because of drift and visibility problems. (O'Connor Road)

This pin cherry below a utility line will not interfere for many years, and has sufficient setback to minimize other problems. (O'Connor Road)

Larger trees such as this elm are not tolerable under utility lines and must be removed. They also create severe collision hazards. (Pulvermacher Road)

Selective removal by cutting of occasional saplings is possible with light hand tools. This shagbark hickory would eventually become a traffic hazard this close to the road. (Pulvermacher Road)

Luxuriant growth of gray dogwood with persisting ground cover of spring ephemeral wildflowers adjacent to a woodlot. (Meek Road)

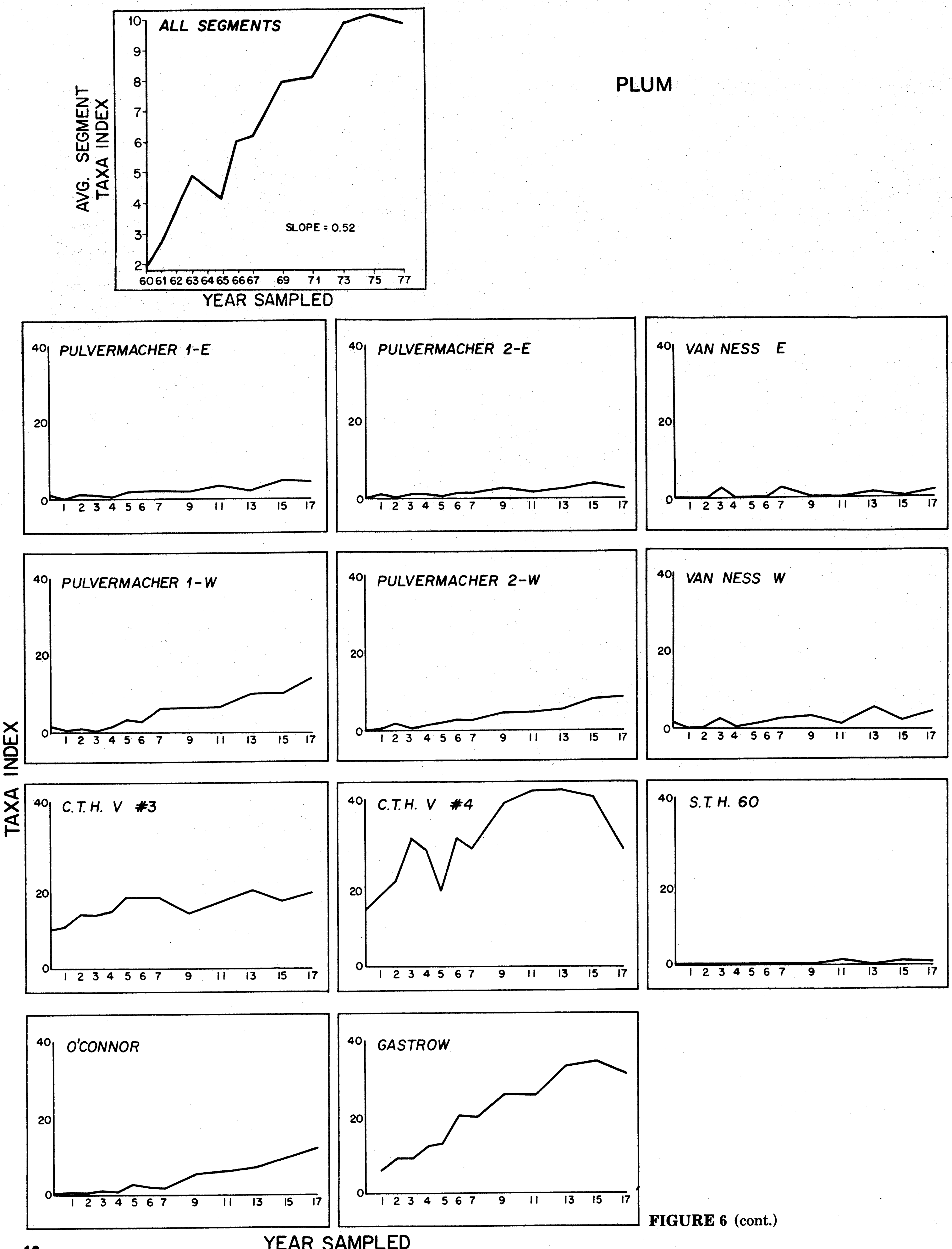
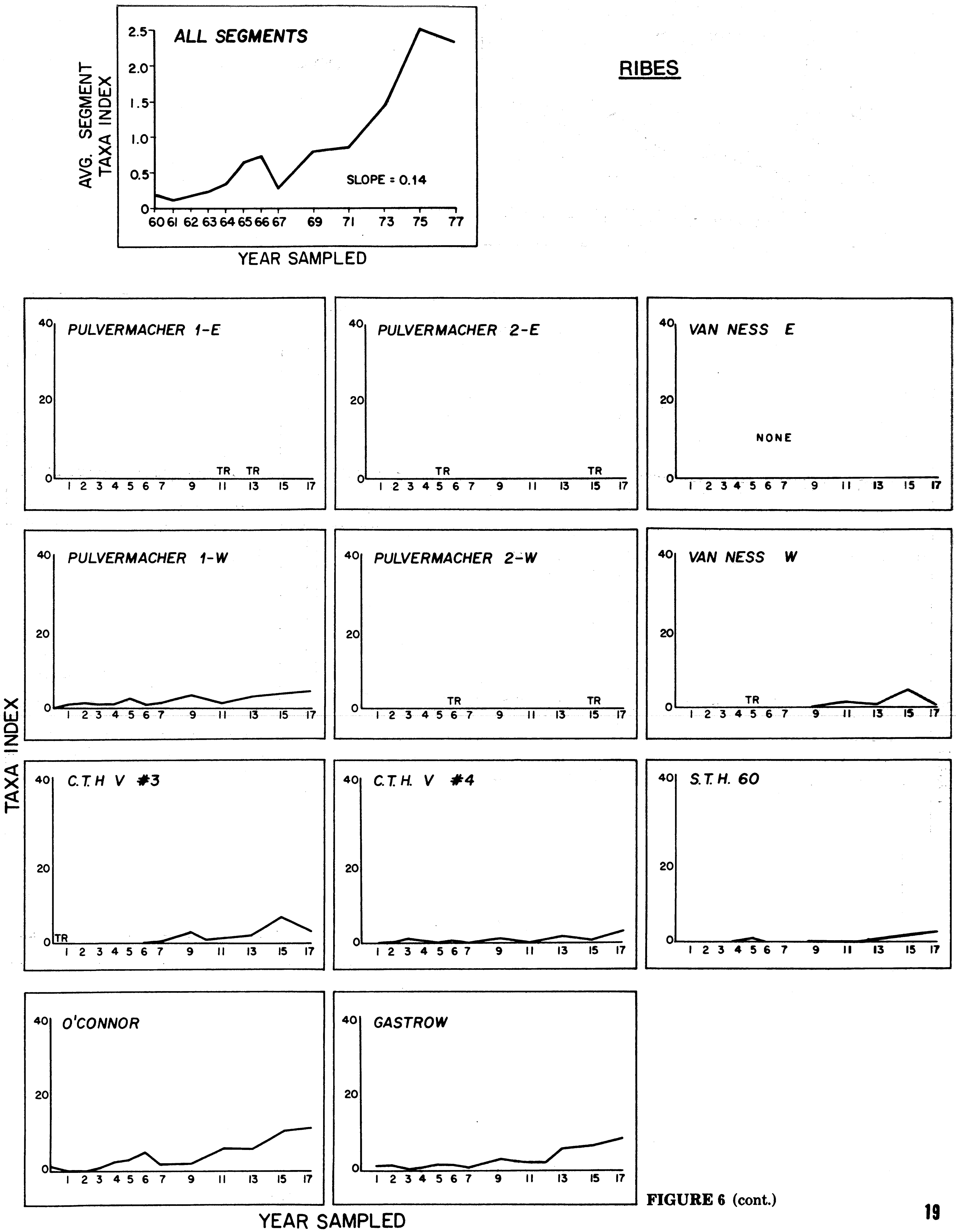


FIGURE 6 (cont.)

RIBES



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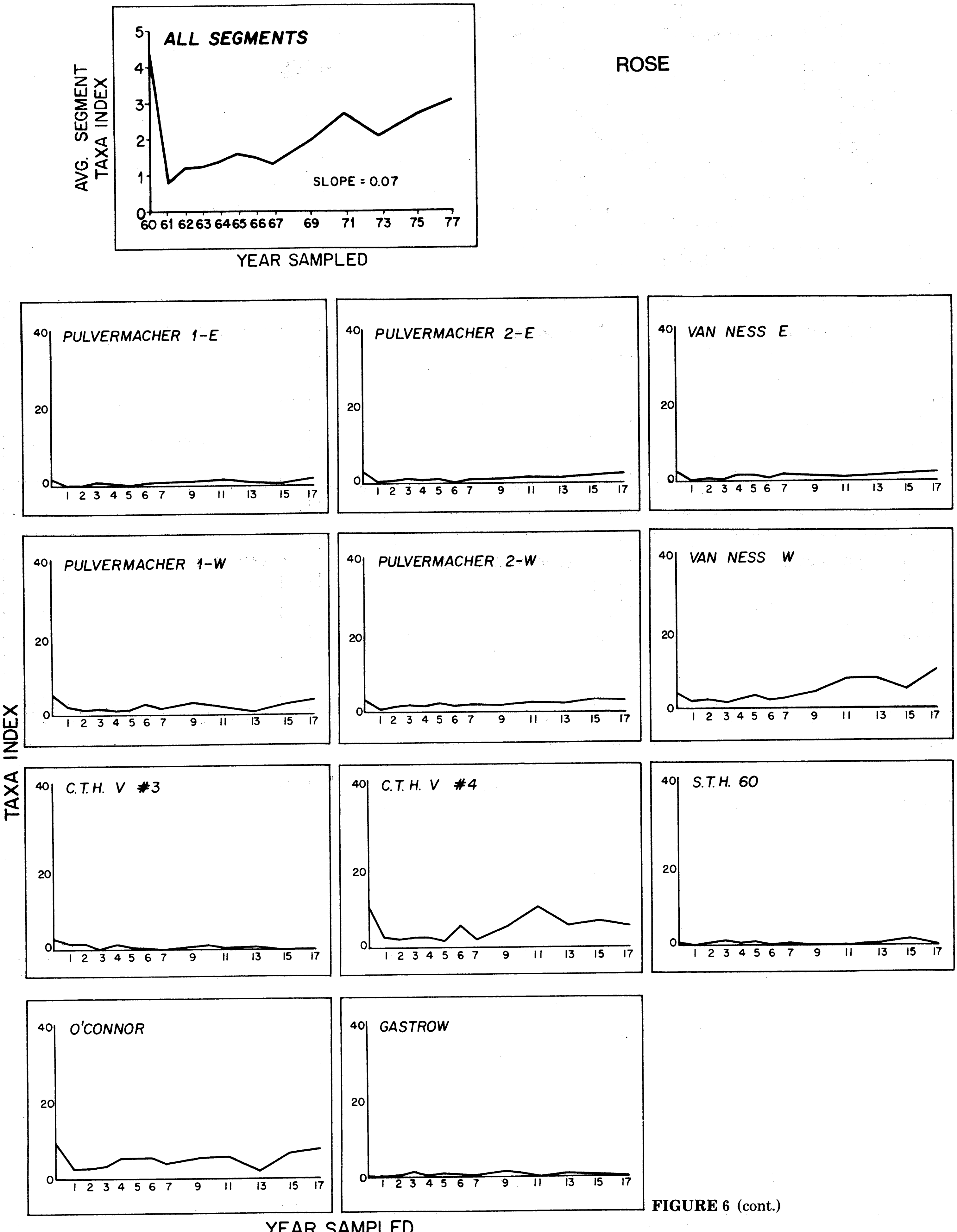

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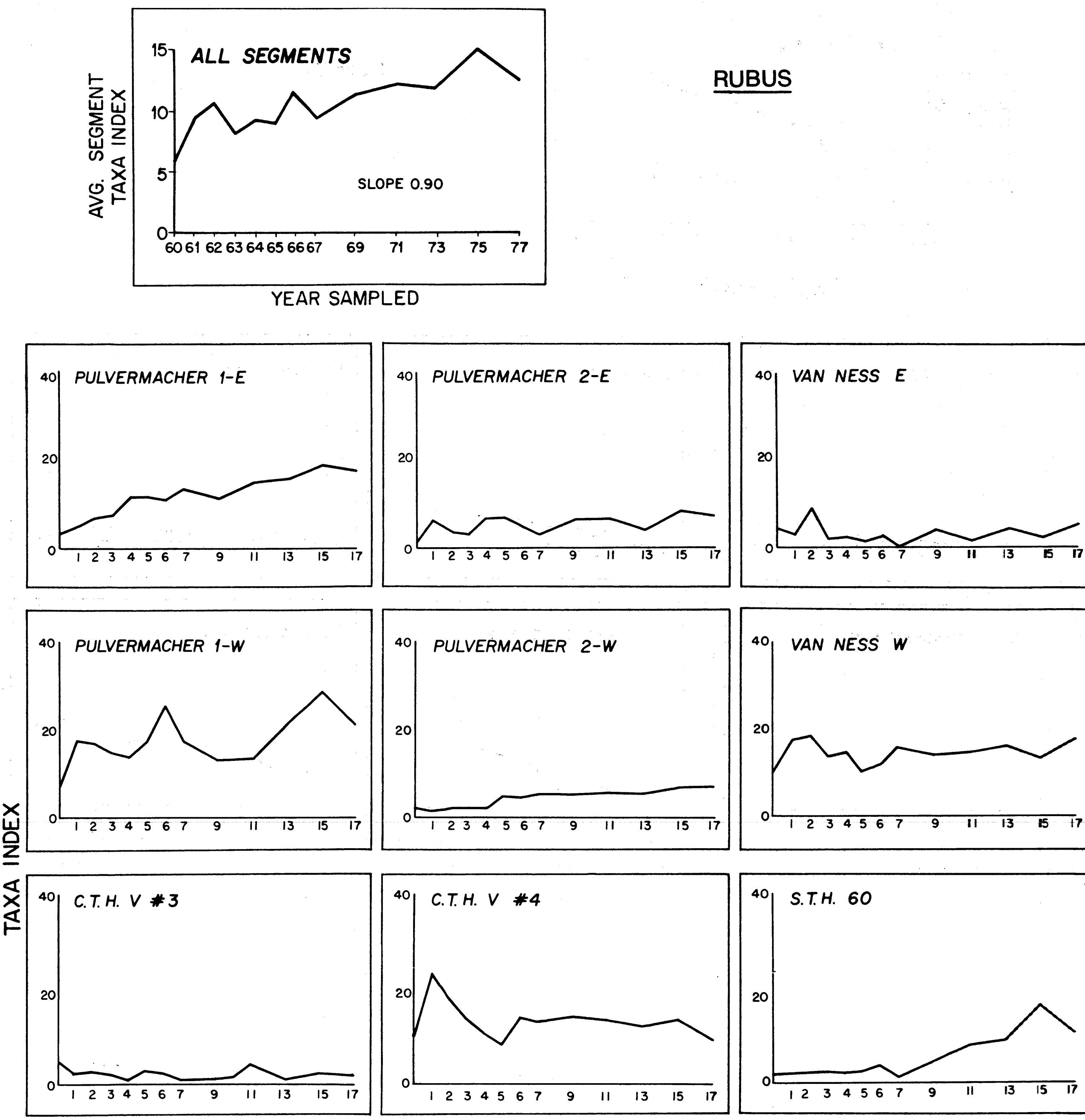

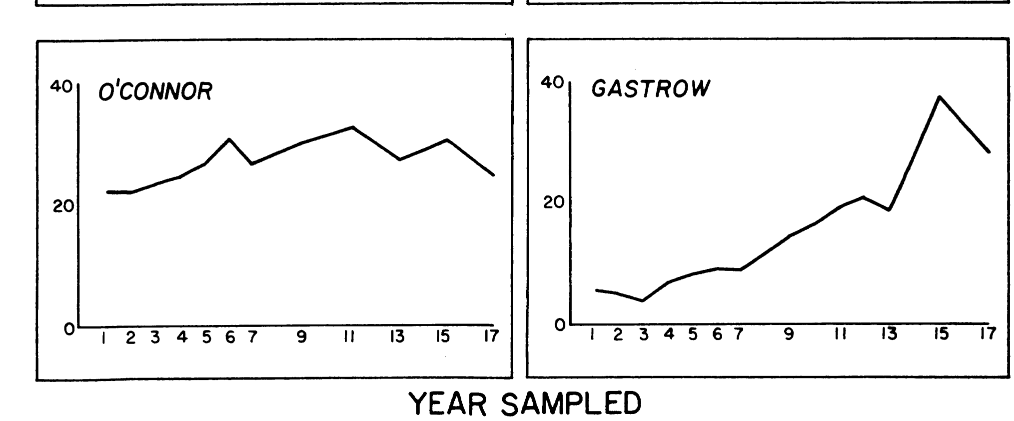

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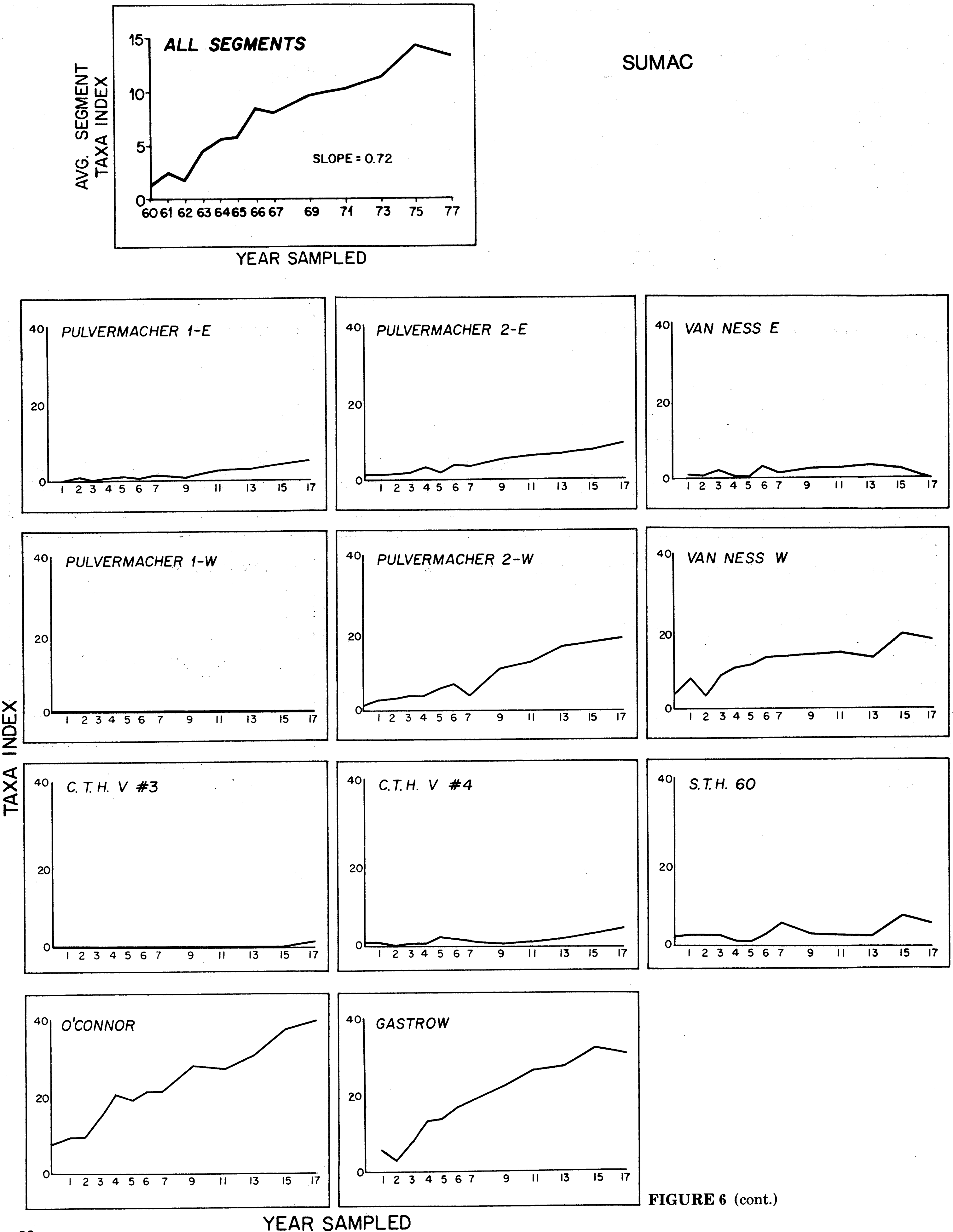

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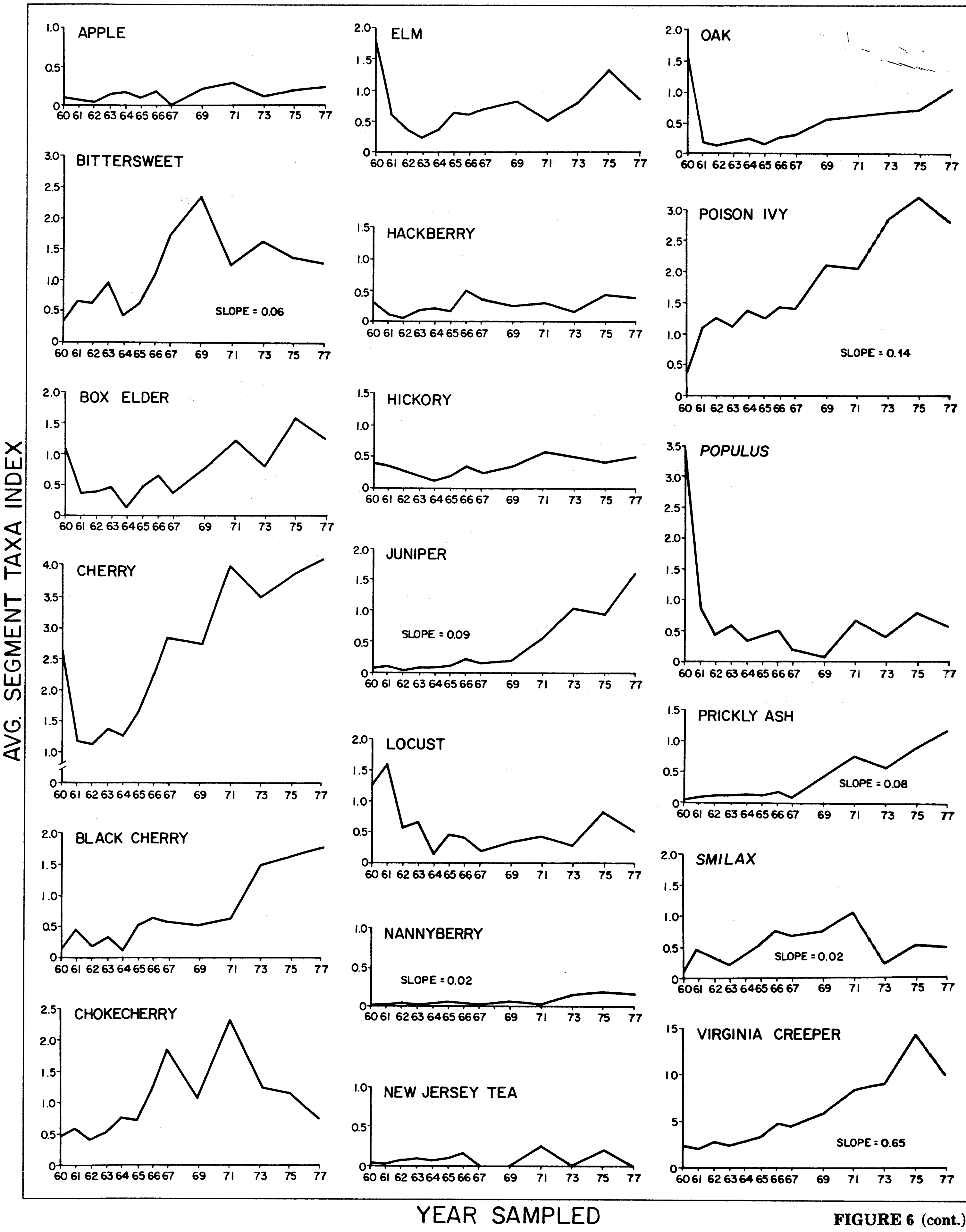

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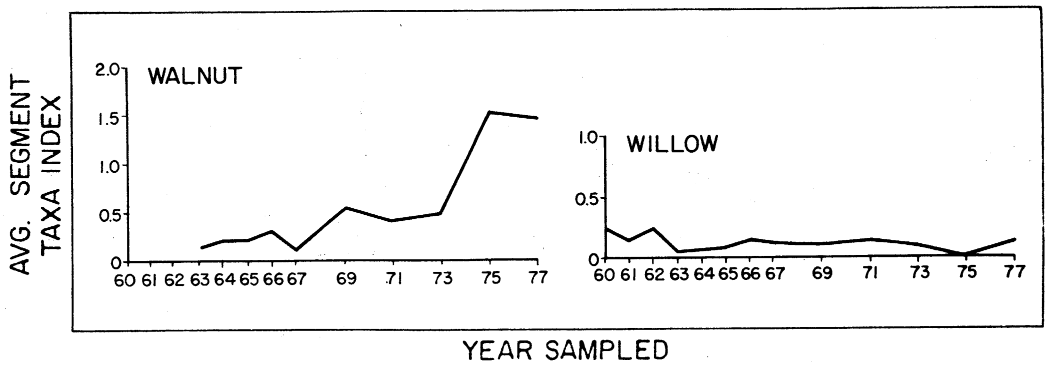

FIGURE 6 (cont.)

TABLE 5. *Percentage of woody summation index of 10 major taxa.*

	Year												
	60	61	62	63	64	65	66	67	69	71	73	75	77
Rubus	12.3	24.6	23.9	19.1	20.1	18.2	16.7	16.2	14.9	14.0	13.5	13.1	11.6
Grape	13.0	6.4	10.4	8.9	9.6	9.5	11.9	11.5	13.3	14.3	13.8	15.2	16.5
Sumac	3.7	7.5	5.8	9.9	12.0	11.0	11.3	11.7	12.3	11.6	12.3	11.8	12.1
Elderberry	12.8	14.7	13.7	11.8	11.4	10.3	8.6	8.0	6.8	5.1	6.0	4.5	4.2
Plum	4.2	6.7	8.5	11.2	9.6	8.4	9.6	10.9	10.9	9.6	10.9	8.9	9.3
Dogwood	6.1	7.7	8.6	8.1	9.0	8.4	7.6	7.5	6.5	7.1	7.3	7.0	7.7
Va. creeper	4.3	5.1	5.7	5.6	5.8	6.0	7.3	7.8	7.3	9.1	9.5	12.4	9.3
Hazel	4.8	4.7	5.7	5.7	5.7	8.4	6.5	5.4	6.5	5.2	5.7	3.8	3.5
Cherry	5.5	3.1	2.8	3.3	2.8	3.4	3.6	4.8	3.7	4.6	3.8	3.3	3.9
Rose	9.5	2.1	2.6	3.1	3.1	3.5	2.5	2.5	2.8	3.4	2.2	2.5	3.1
Total	76.2	82.6	87.7	86.7	89.1	87.1	85.6	86.3	85.0	84.0	85.0	82.5	81.2

total woody canopy is plotted for each of the 13 years of measurement in Figure 8.

Strong "increasers" were grape, sumac, plum, and Virginia creeper. Elderberry, rose, black locust, aspen and cottonwood, and elm decreased substantially. Some taxa achieved comparative stability after an initial period of change: sumac, plum, dogwood, poison ivy, and oak. *Rubus* was unusual, showing great initial response, presumably due to tree removal, followed by a steady decline.

Taxa indexes are summed by year for the major classes of woody vegetation (trees, shrubs, brambles, and vines) and presented in Figure 9. Again, these sums are for comparative use and do not adequately represent true canopy. Class proportions of woody cover with each year represented as 100% are also shown. Except for the first 3 years, class proportions did not change greatly. Brambles have declined and vines have increased, but tree and shrub percentages have remained relatively constant.

To evaluate only rate of change (discounting actual starting level), Table 6 was prepared giving the median change for 15 major taxa excluding the tree class. Since there was a 2-year interval between many of the management periods, the 2-year percentage changes were expressed on an annual basis and the median of these changes given. These changes are ranked within form class and for all 15 taxa; e.g., the median annual change in canopy for juniper was 30.1. Strong rate of change was found for prickly ash, juniper, honeysuckle, and *Ribes*. Walnut, not included in Table 6, also had a very high rate of change.

To evaluate rates of change, linear slopes calculated by least squares are

ELDERBERRY	RUBUS SPP	ROSE SPP	GRAY DOGWOOD	HAZEL	POISON IVY	BITTERSWEET	PLUM	SUMAC SPP	GRAPE	RIBES SPP	SMILAX SPP	HONEYSUCKLE	PRICKLY ASH	JUNIPER
-0.36														
-0.12	0.08													
-0.49	0.89	0.40												
-0.39	0.68	0.24	0.70											
-0.48	0.96	0.11	0.93	0.77										
-0.45	0.52	-0.01	0.45	0.70	0.62									
-0.56	0.87	0.33	0.94	0.81	0.95	0.71								
-0.57	0.88	0.34	0.97	0.80	0.95	0.62	0.98							
-0.48	0.75	0.59	0.90	0.58	0.80	0.45	0.85	0.87						
-0.36	0.85	0.45	0.97	0.65	0.89	0.36	0.88	0.92	0.89					
-0.61	0.49	-0.10	0.34	0.51	0.43	0.51	0.40	0.43	0.17	0.20				
-0.61	0.74	0.47	0.92	0.45	0.78	0.37	0.82	0.86	0.90	0.87	0.32			
-0.53	0.77	0.52	0.94	0.57	0.70	0.38	0.86	0.89	0.93	0.91	0.28	0.95		
-0.40	0.71	0.47	0.92	0.53	0.78	0.32	0.83	0.85	0.88	0.91	0.10	0.91	0.96	

FIGURE 7. *Correlation coefficients of 15 major woody taxa in 13 years of measurement* ($p_{.05}$ = *0.55, d.f. = 11*).

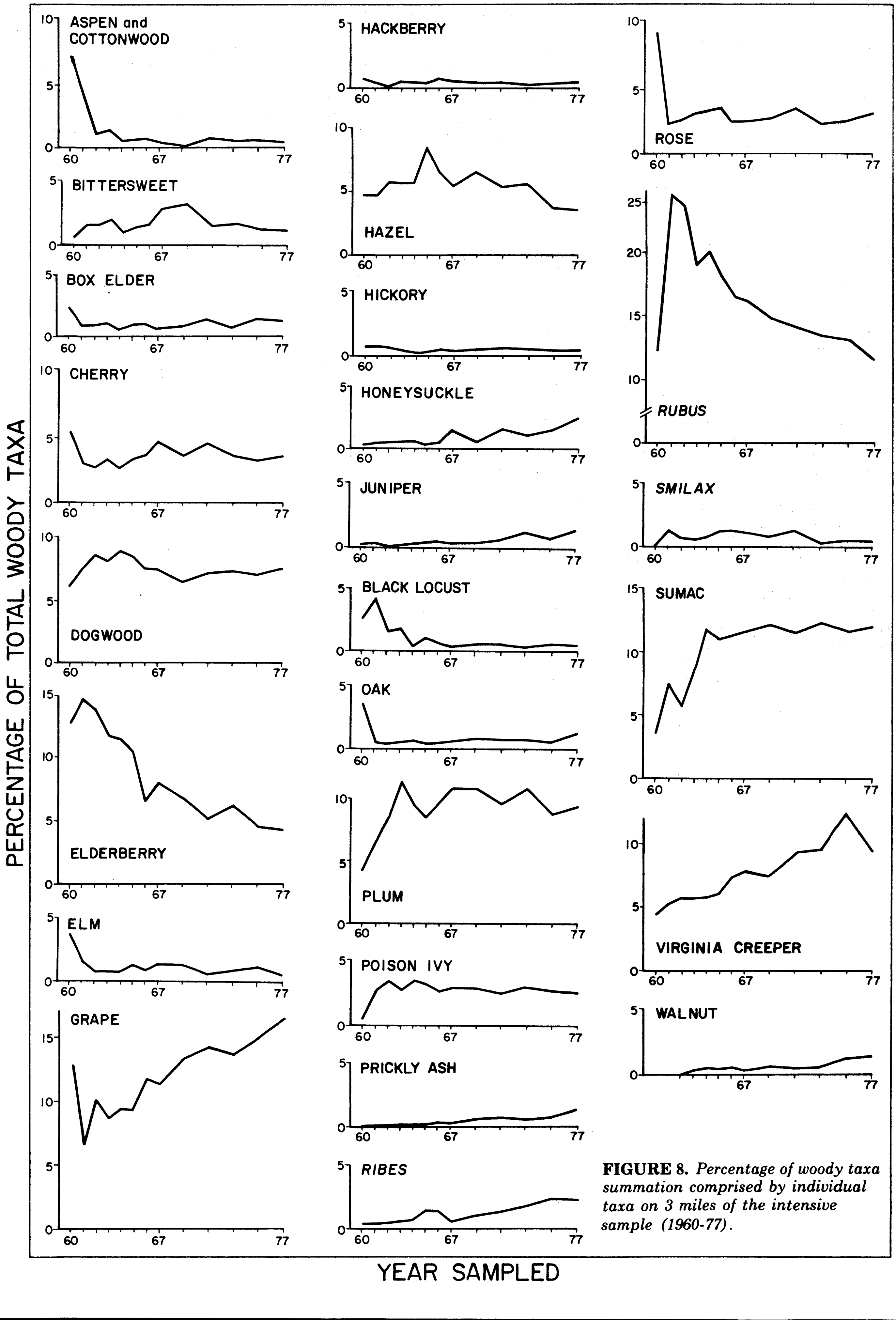

FIGURE 8. *Percentage of woody taxa summation comprised by individual taxa on 3 miles of the intensive sample (1960-77).*

included for major non-tree taxa in Figure 6.

FORB INDEXES

Non-woody plants (forbs) were consistently sampled on 2.5 miles of roadside in nine segments. Domestic legumes, grasses, and sedges were excluded. The S.T.H. 60 and Gastrow Road segments were sampled irregularly and so were not included in the forb summary. As earlier noted, forb occurrence and woody occurrence are determined differently; indexes are not directly comparable and would tend to be higher for forbs.

Because the size of segments sampled varied, it was necessary to weight segment indexes to obtain a summed canopy index for the combined nine segments. Summed indexes for 27 major forb taxa are plotted in Figure 10.

Goldenrod was the predominant forb taxon, followed closely by sunflowers. Wild parsnip, asters, and wild bergamot were also prominent components of the roadside vegetation. These five taxa, along with stinging nettle, motherwort, common milkweed, whorled milkweed, and giant ragweed, constituted the majority of the roadside herbaceous canopy. Each of the above 10 species exhibited considerable change during the management period. Proportionately more of the forb taxa than of the woody taxa declined, while irregularity of trend characterized goldenrod, common milkweed, whorled milkweed, common ragweed, and bergamot. No specific management other than weed control was directed at forbs.

Of more than 40 additional taxa recorded, none exceeded 5% occurrence.

Although forb taxa indexes were summed to obtain summation indexes, no "total forb" canopy counts were made as had been done for "total woody" canopy in 1960.

WILDLIFE OBSERVATIONS

Study of the effect of the roadside vegetation changes upon animal populations was largely beyond the scope of this study. Only one wildlife species, the cottontail, was monitored on the 3-township study area in an attempt to detect changes in population. Live or dead rabbits seen in the right-of-way while either driving or walking were recorded along with miles travelled.

Management segments included only 3% of the area's roadsides and no separation of observations in and near these segments was attempted because of the small numbers of observations obtainable. Hence the counts apply to the whole study area. Yearly trends for the study area population are shown in Figure 11 as rabbits seen per 100 miles of travel. It is evident that the cottontail population has fluctuated widely in the area during the course of the study.

Although there are some quail in the region, they have been noted only very sporadically since 1970. Until the early 1950's quail were common to abundant on the area. Severe winters devastated these populations, and to date they have not recovered.

Numerous small mammals were found entrapped in discarded bottles.

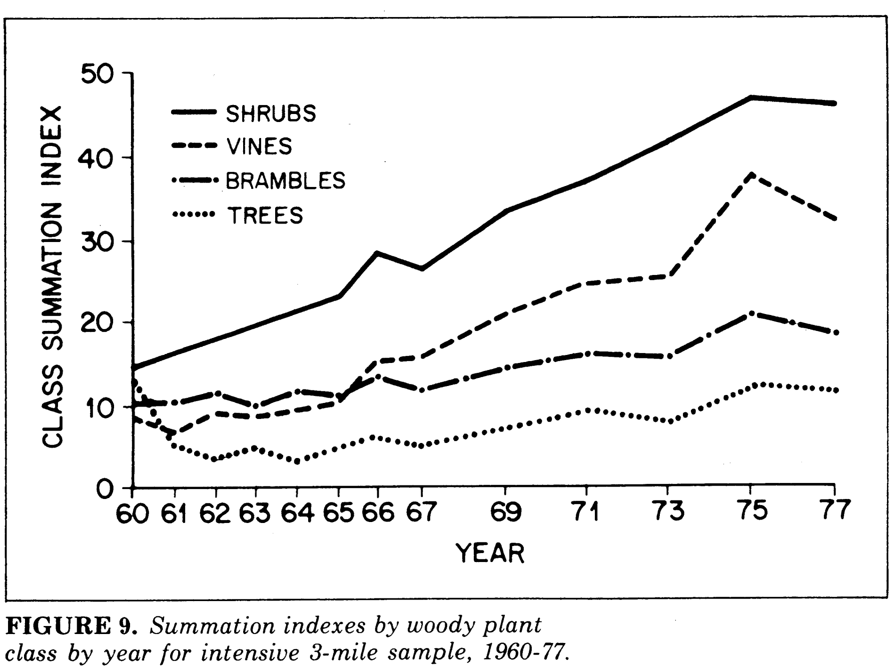

FIGURE 9. *Summation indexes by woody plant class by year for intensive 3-mile sample, 1960-77.*

From 1960 to 1963 bird species found nesting on the Columbia County study area were noted (Table 7). From 1964 through 1977 numbers of nests by species found incidentally to maintenance activities on the demonstration roadsides (largely on the managed segments) were tallied. No formal nest searches were attempted. Most of these records were reported to the Cornell Laboratory of Ornithology in cooperation with the North American Nest Record Card Program. The nest numbers reported in Table 7 should be used to compare relative nesting abundance of different species rather than true density of nests.

TIME SPENT ON SELECTIVE MANAGEMENT

During this trial period of selective management all significant time expenditures in selectively controlling on-site vegetation were recorded by segments which varied in number from 20 to 25 during the period 1960 through 1977. Original roadside segment selections had been made, insofar as possible, to represent all existing densities of plant materials. Segment lengths ranged from 250 to 6,500 ft. A frequency distribution of estimates of the annual hours/acre spent for the 401 segments is presented in Figure 12. Because the frequency distribution of hours is skewed, the geometric mean (2.2 hours/acre) is provided, as well as the median (1.7 hours/acre). Many segments required very few hours of attention or none at all, but effort on large segments reached as much as 76 hours/acre because of the time required for tree removal. Of special interest is the steady decline in the running average, which shows that over the years a decreasing amount of time was required each year for roadside maintenance (Fig. 13). The slope of this decline does not show any marked change at year 10, when herbicides were discontinued, and thus suggests that this restriction did not increase control effort significantly.

Since there was no planting on any of the Columbia County roadsides, there was no time expenditure for this activity.

MANAGEMENT IMPLICATIONS

Special Considerations

In practicing selective shrub management, some specific considerations must be dealt with.

TABLE 6. *Median and rank of relative rates of change in 15 major woody taxa on 3 miles of roadside under selective shrub management, 1960-77.*

	Median	Overall Rank	Rank in Class
Shrubs			
Prickly ash	23.3	3	2
Juniper	30.1	1	1
Honeysuckle	20.6	4	3
Sumac	14.4	5	4
Plum	8.3	9	5
Dogwood	6.0	12	6
Hazel	4.1	14	7
Elderberry	4.4	15	8
Brambles			
Ribes	28.6	2	1
Rose	14.0	6	2
Rubus	5.6	13	3
Vines			
Poison ivy	6.8	10	3
Grape	13.1	7	1
Bittersweet	13.0	8	2
Smilax	6.4	11	4

TABLE 7. *Birds found nesting on Columbia County study area roadsides.*

Species	Species Nesting 1960-63	Nests Found (Minimum Number) 1964-77
Mallard		2
Blue-winged teal	x	—
Ring-necked pheasant		3
Woodcock		1
Mourning dove	x	19
Alder flycatcher		6
Tree swallow	x	—
House wren	x	activity
Gray catbird		8
Brown thrasher		8
Robin	x	34
Eastern bluebird	x	activity
Cedar waxwing		1
Yellow warbler	x	—
Common yellowthroat	x	—
House sparrow	x	—
Meadowlark	x	—
Red-winged blackbird	x	47
Common grackle		2
Brown-headed cowbird		2
Cardinal		2
Rose-breasted grosbeak		1
American goldfinch		5
Savannah sparrow		1
Vesper sparrow		1
Song sparrow		19

Vines provide ground cover when prostrate but soon climb available shrubs, trees, and fences. Some of these may require close control or even eradication in some situations. Poison ivy will rarely be acceptable unless of low frequency; burning volatilizes its toxic substance and is very hazardous. Shading cannot be relied upon to control low vegetation, because sunlight can usually penetrate to the ground from the side if not from overhead. When trees are removed that support desirable vines, simple precautions will usually minimize vine damage and permit a speedy recovery.

Black locust (which has bothersome spines on stems or branches less than 4 years old) responds well to control (Figs. 6 and 8). After resprouting, retreatment of black locust should either be performed as soon as possible to avoid unsightliness, or delayed until the tree is large enough for easier handling.

Some tree species (**hackberry** and **mulberry**) resprout persistently after cutting. Mulberry also may have multiple stems which are difficult to reach with cutting tools.

Many tree species, such as **box elder, elm,** and **black cherry,** are persistent invaders requiring diligent surveillance for suppression.

Chokecherry, which often may be desirable, suffered from a disease that limited its abundance.

Sumac growth is frequently retarded by insect damage and so may be unsightly. It may increase despite this problem.

Honeysuckle may increase very rapidly and spread to woodlots. Despite the reputation of multiflora rose as a spreader, multiflora rose did not appear on the study segments, even though some stock exists in the area.

Elderberry is easily suppressed by competition and may well decrease as it did in this study. If elderberry is desired, encroaching vegetation may have to be controlled.

Hazel and **gray dogwood** clones were relatively free of tree seedlings. **Sumac** and **plum** clones on the other hand often harbored tree seedlings of **ash, elm, hickory, black cherry, walnut, mulberry,** and **hackberry,** as well as **Tatarian honeysuckle.** These observations agree with the findings of Bramble and Byrnes (1976) "that while some shrubs are effective cover plants [ed. note: i.e., repel trees] others are not."

Program Needs

Selective shrub management is less expensive than traditional roadside maintenance and it fosters a diversified and esthetically appealing natural product. Roadsides on which selective shrub management is conducted supply important niches for songbirds, game birds, other wildlife, and wild fruit and nut crops. The increasing insect diversity resulting from such management has possibilities for biological pest control and promoting pollination. Research studies on these functions are badly needed, as information is fragmentary.

Selective woody plant management on roadsides is especially appropriate for the forested and eastern prairie edge of midwestern United States.

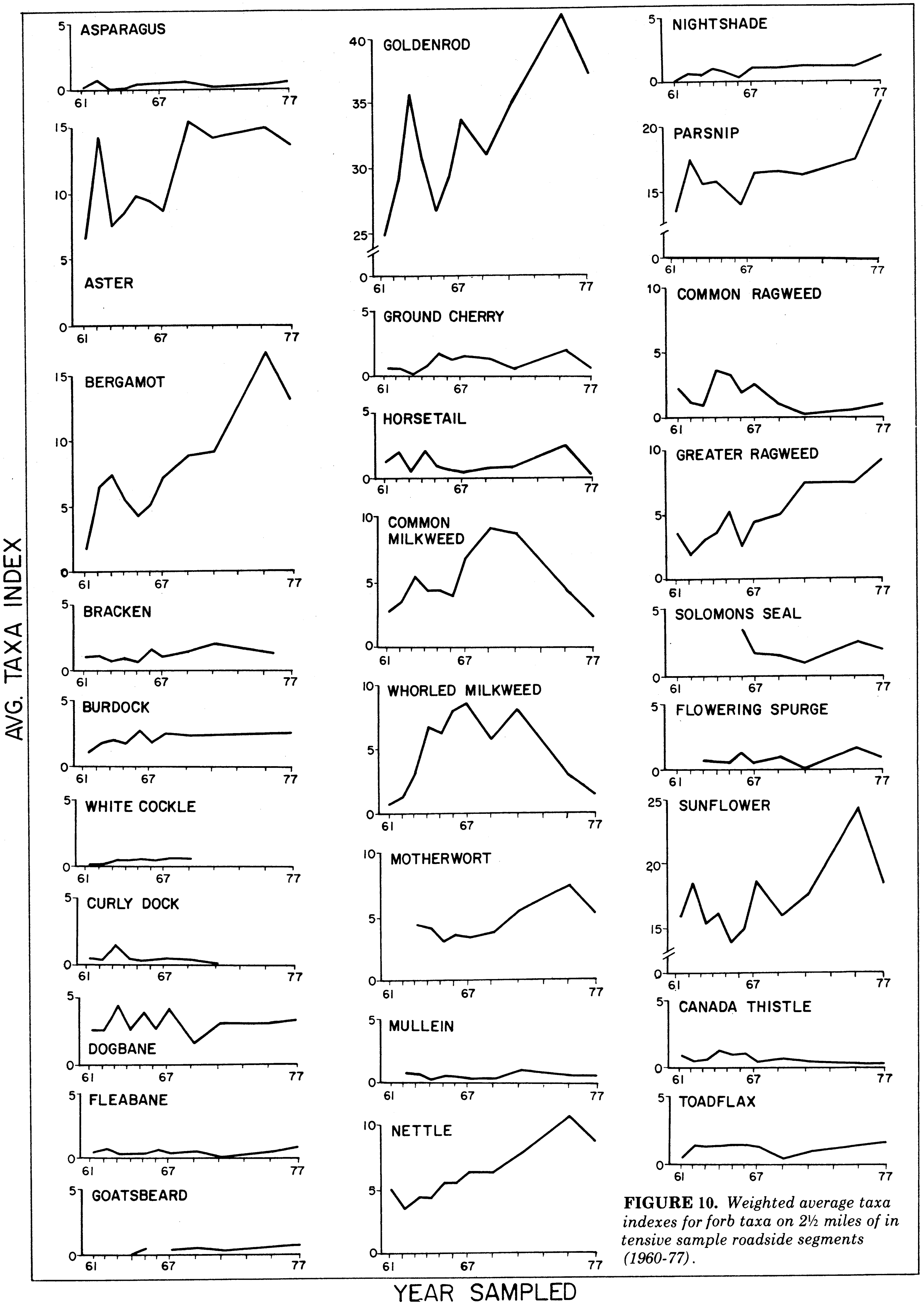

FIGURE 10. *Weighted average taxa indexes for forb taxa on 2½ miles of in tensive sample roadside segments (1960-77).*

Species composition will vary from region to region and the dominant shrub species resulting may differ from those found in this study. Unusually wet or dry sites or rocky sites may not respond to this kind of management.

Where "natural" woody vegetation is acceptable or desired, selective management is less expensive than traditional management because planting or repeated mowing or spraying is not required. Canopy development, however, requires many years, and therefore such management is not worthwhile unless it is continued for long periods.

Biological expertise is required for management success and must also be available over an extended period, not just sporadically. The cooperative efforts of local and county officials and several agencies may be required to select areas and to follow through on management. Adjacent landowner acceptance is also important to success.

A review of features desired in roadside management candidates requires primarily an appraisal of the condition and composition of the roadside segment, with consideration given to the need for snow removal, non-obstruction of vision, utility line and fence maintenance, and proper drainage. The composition of the canopy must then be more closely examined to determine whether it is acceptable and if not, the next steps to be taken. Estimates of the time and effort required to promote or accomplish these changes must be made to permit planning and scheduling.

Opportunities for incorporation of roadside programs sometimes arise regionally when major planning projects are undertaken. Such an opportunity arose in Wisconsin with the Southeastern Wisconsin Regional Planning Commission in 1971 resulting in a program entitled "Roadside Conservation and Beautification" (NRCSA and SEWRPC 1972). State Extension programs also are able to promote roadside conservation, e.g. by means of radio and television presentations and distribution of slide sets with descriptive material (University of Wisconsin Extension).

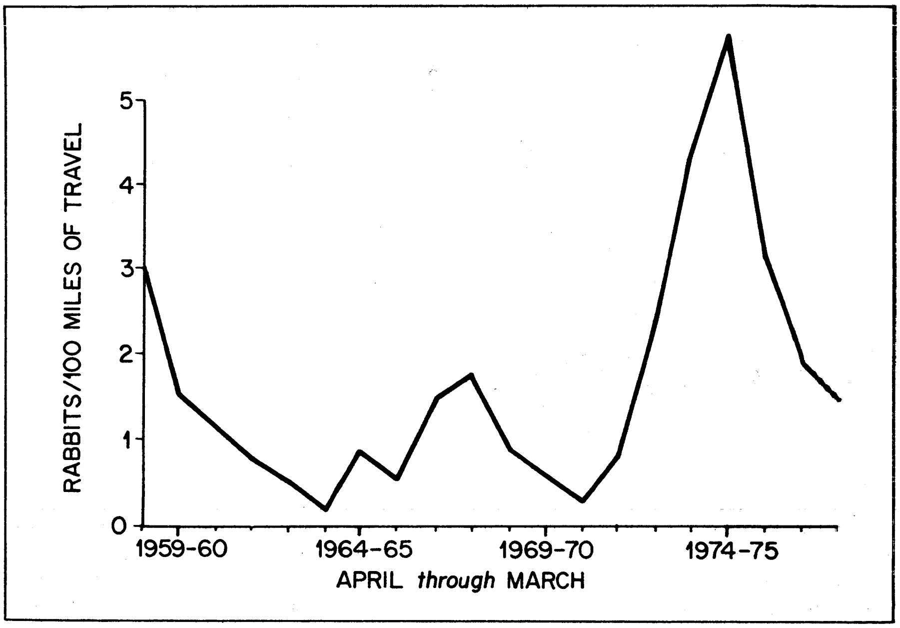

FIGURE 11. *Cottontail index, Columbia County study area.*

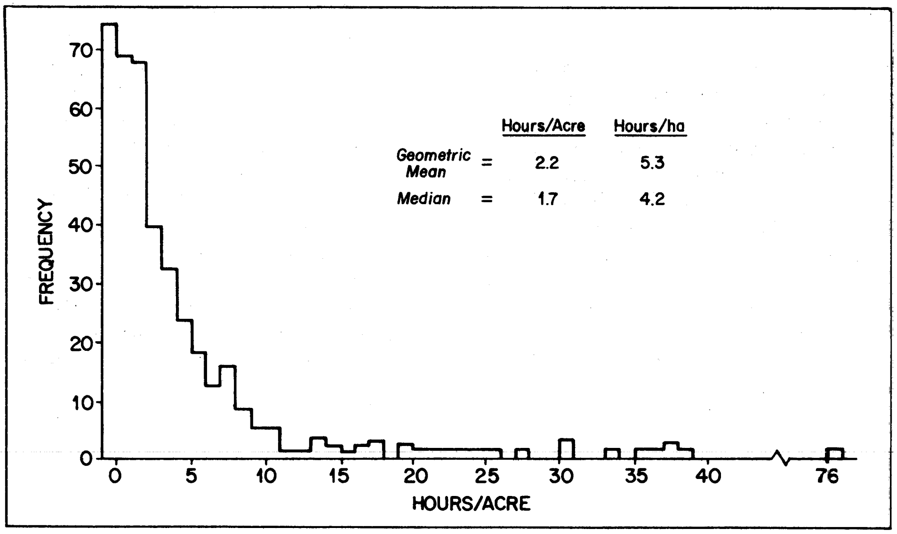

FIGURE 12. *Frequency distribution of annual hours/acre estimates, based on 20 to 25 roadside segments (1960-77).*

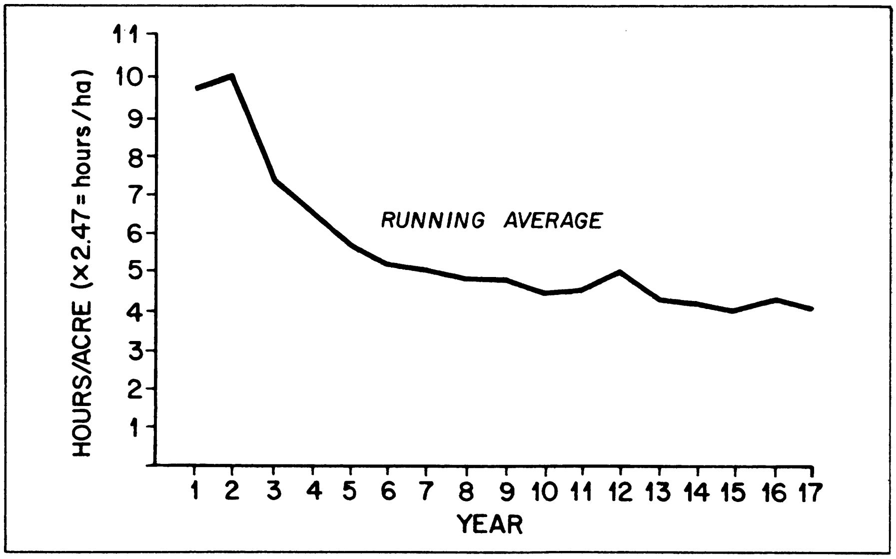

FIGURE 13. *Expenditures of time on selective shrub management on Columbia County roadsides.*

CONCLUSIONS

The management measures applied in this study have been demonstrated to be both feasible and effective. Their costs are low compared to those of planting, mowing, and spraying. Selective cutting used alone is effective, although herbicide use may occasionally be very useful for lasting control of some species.

Shrub disclimaxes of suitable composition increased over the course of the effort. Undesirable vegetation, such as most trees and shrubs in problem areas, could be curtailed through cutting. This replaced the earlier use of herbicides even though additional control was frequently necessary. Of note is that the change was accomplished without planting of stock or seed, since on-site residual material was sufficient to establsih a dense stand.

The process of attaining a full canopy is relatively slow. For example, in the 18 years of this study only 4 of 11 segments developed stands with nearly full canopies. No precise estimate of the time required to achieve such a mature state can be made, since the possible combinations of taxa at varying densities and growth rates are infinite. Judging from the study as a whole, a crude estimate for attainment of about 80% canopy might be 20 years, assuming rootstocks are present or nearby. Species such as sumac might proliferate much more quickly than this. A 100% canopy on any segment would be rare because of local disturbance, diebacks, and unthriftiness, or competition from non-woody plants. With good starting composition and density, significant values may be realized in 5-10 years. Esthetic appeal becomes great by this time as varied patterns of form and color develop. These patterns change seasonally, increasing esthetic appeal.

While attainment of an 80% canopy of shrub growth may require up to 20 years, significant cover value can be achieved in 5-10 years with a minimum of cost and no plantings where an adequate stock of woody species is present in the roadside right-of-way. When the advantages of selective shrub management are compared with the cost of planting hedgerows with nursery-grown seedlings consisting of a few species that have minimal diversity value, the management effort described in this report emerges as far more practical than a special effort to develop pseudo-natural rights-of-way.

The results of this study further reinforce the justification for maintaining existing natural shrubby roadsides as a means of preserving and enhancing environmental quality. Such justification is particularly important at a time when mowing and debrushing are costly users of energy.

APPENDIX:
Common and Scientific Names of Plants Cited in the Study

Apple *(Pyrus* spp.)
Ash *(Fraxinus americana)*
Asparagus *(Asparagus officinalis)*
Aspen and Cottonwood *(Populus tremuloides, P. deltoides)*
Aster *(Aster* spp.)
Basswood *(Tilia americana)*
Bergamot *(Monarda fistulosa)*
Bindweed, Field *(Convolvulus arvensis)*
Birch, White *(Betula papyrifera)*
Bittersweet *(Celastrus scandens)*
Blackberry *(Rubus allegheniensis)*
Box elder *(Acer negundo)*
Bracken *(Pteridium aquilinum)*
Burdock *(Arctium minus)*
Butternut *(Juglans cinerea)*
Cherry, Black *(Prunus serotina)*
Cherry, Choke *(Prunus virginiana)*
Cherry, Pin *(Prunus pensylvanica)*
Cockle, White *(Lychnis alba)*
Current and Gooseberry *(Ribes* spp.)
Daisy fleabane *(Erigeron* spp.)
Dewberry *(Rubus flagellaris)*
Dock, Curly *(Rumex crispus)*
Dogbane *(Apocynum androsaemifolium, A. cannabinum)*
Dogwood, Gray *(Cornus racemosa)*
Elderberry *(Sambucus canadensis)*
Elm *(Ulmus americana)*
Goatsbeard, Yellow *(Tragopogon pratensis)*
Goldenrod *(Solidago* spp.)
Grape *(Vitis spp.)*
Greenbrier *(Smilax rotundifolia, S. hispida)*
Ground cherry *(Physalis heterophylla)*
Hackberry *(Celtis occidentalis)*
Hawthorn *(Crataegus* spp.)
Hazel *(Corylus americana)*
Hickory *(Carya ovata)*
Honeysuckle, Tatarian *(Lonicera tatarica)*
Horsetail *(Equisetum* spp.)
Juneberry *(Amelanchier* spp.)
Juniper *(Juniperus virginiana)*
Leadplant *(Amorpha canescens)*
Locust, Black *(Robinia pseudoAcacia)*
Maple, Sugar *(Acer saccharum)*
Milkweed, Common *(Asclepias syriaca)*
Milkweed, Whorled *(Asclepias verticillata)*
Motherwort *(Leonurus cardiaca)*
Mulberry *(Morus* spp.)
Mullein *(Verbascum thapsus)*
Nannyberry *(Viburnum lentago)*
Nettle, Stinging *(Urtica dioica)*
New Jersey tea *(Ceanothus americanus)*
Nightshade *(Solanum dulcamara, S. nigrum)*
Oak *(Quercus alba, Q. macrocarpa, Q. rubra, Q. velutina)*
Parsnip *(Pastinaca sativa)*
Plum *(Prunus nigra, Prunus americana)*
Poison ivy *(Rhus radicans)*
Prickly ash *(Zanthoxylum americanum)*
Ragweed, Common *(Ambrosia artemisiifolia)*
Ragweed, Giant *(Ambrosia trifida)*
Raspberry, Blackcap *(Rubus occidentalis)*
Raspberry, Red *(Rubus idaeus)*
Rose *(Rosa* spp.)
Solomon's seal *(Polygonatum commutatum)*
Spurge, Flowering *(Euphorbia corollata)*
Spurge, Leafy *(Euphorbia esula)*
Sumac *(Rhus glabra, Rhus typhina)*
Sunflower *(Helianthus* spp.)
Thistle, Canada *(Cirsium arvense)*
Toadflax, Yellow *(Linaria vulgaris)*
Virginia creeper *(Parthenocissus quinquefolia)*
Walnut, Black *(Juglans nigra)*
Willow *(Salix* spp.)

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About the Authors

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