CALLAWAY PLANT UNITS 1 and 2

PRECONSTRUCTION MONITORING

ANNUAL SUMMARY

Union Electric Company

8102120017

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1. GENERAL INTRODUCTION

This report summarizes the first year (preconstruction) of a two-year preoperational monitoring program. The preconstruction monitoring program consisted of three sampling periods (winter, spring, and fall) for monitoring selected aquatic parameters and three (spring, midsummer, and fall) for monitoring selected terrestrial parameters. The results of the winter sample were included in the five aquatic sampling periods comprising the baseline inventory and summarized in the Callaway Plant, Units 1 and 2, Environmental Baseline Inventory Annual Summary.

The objectives of the preconstruction monitoring program are generally complementary to those of the previously completed baseline studies. However, the orientation of investigation differs. Whereas the baseline study was a broad-based investigation to characterize factors or components of the plant site environment, the focus of monitoring studies is to document intensively the ecological relationships of selected permanent sampling stations for the purpose of detecting changes in the natural system. The ultimate goal of the monitoring program is to obtain sufficient background data and a degree of surveillance compatability whereby natural variation in key environmental parameters can be distinguished from significant environmental impact, if any, caused by plant construction and operation.

Although the preconstruction monitoring program was designed and to a considerable extent implemented by Dames and Moore, outside consultants were retained to undertake portions of the monitoring program. Dr. David B. Dunn, Professor and Curator of the Herbarium, University of Missouri-Columbia, performed all plant identification and supervised fall sampling of vegetation and birds; Dr. Dean E. Metter, Associate Professor of Zoology, University of Missouri-Columbia, performed the fall sampling and identification of the amphibians and reptiles; and Dr. Thomas R. Yonke, Associate Professor of Entomology, University of Columbia-Missouri, was responsible for identification of the invertebrates and invertebrate sampling in the fall.

This report consists of two major parts: Aquatic Ecology and Terrestrial Ecology. Each is an entity, with its own Introduction, Methods and Materials, Results and Discussion, Ecological Summary, and Conclusions and Recommendations. The subsections are the standard divisions found in most environmental reports, with the possible exception of the Ecological Summary and Conclusion and Recommendations. The Ecological Summary for both the aquatic and terrestrial disciplines attempts to summarize the ecological interrelationships pertinent to the plant site. The biotic and abiotic interrelationships are discussed very briefly and at a very general level because the lack of published information of this type precludes a more elaborate discussion. The Conclusions and Recommendations section attempts to relate survey data to potential environmental impact from plant construction and operation.

Tables and figures are placed in the text following the three-digit subsection in which they are mentioned.

2. AQUATIC ECOLOGY

2.1 INTRODUCTION

This report contains the spring and fall survey results for the proposed Callaway Nuclear Power Plant preconstruction environmental monitoring program. Aquatic sampling was conducted from the 20th to the 23rd of June and from the 2nd to the 7th of September, 1974.

The purpose of the monitoring program is to detect impact resulting from plant construction and operation. The preconstruction monitoring program is designed to further inventory important aquatic flora and fauna near the proposed plant site and to document seasonal variation in local populations. Specifically, the first year's preconstruction monitoring program is designed to estimate the degree of homogeneity among sampling stations and to provide a quantitative base from which plant-induced effects, if any, can be measured. Components of the aquatic ecosystem being considered in this investigation are:

Water Quality	Benthic Macroinvertebrates
Phytoplankton	Vascular Hydrophytes
Zooplankton	Fish

This portion of the report is divided into six major subsections. Section 2.1 (Introduction) outlines the purpose and scope of the study and discusses report format. Subsection 2.2 (Methods and Materials) describes sampling stations and methods and materials used to analyze various aquatic parameters. Subsection 2.3 is Results and Discussion; 2.4, Ecological Summary; 2.5, Conclusions and Recommendations; and 2.6, References.

2.2 METHODS AND MATERIALS

2.2.1 DESCRIPTION OF SAMPLING LOCATIONS

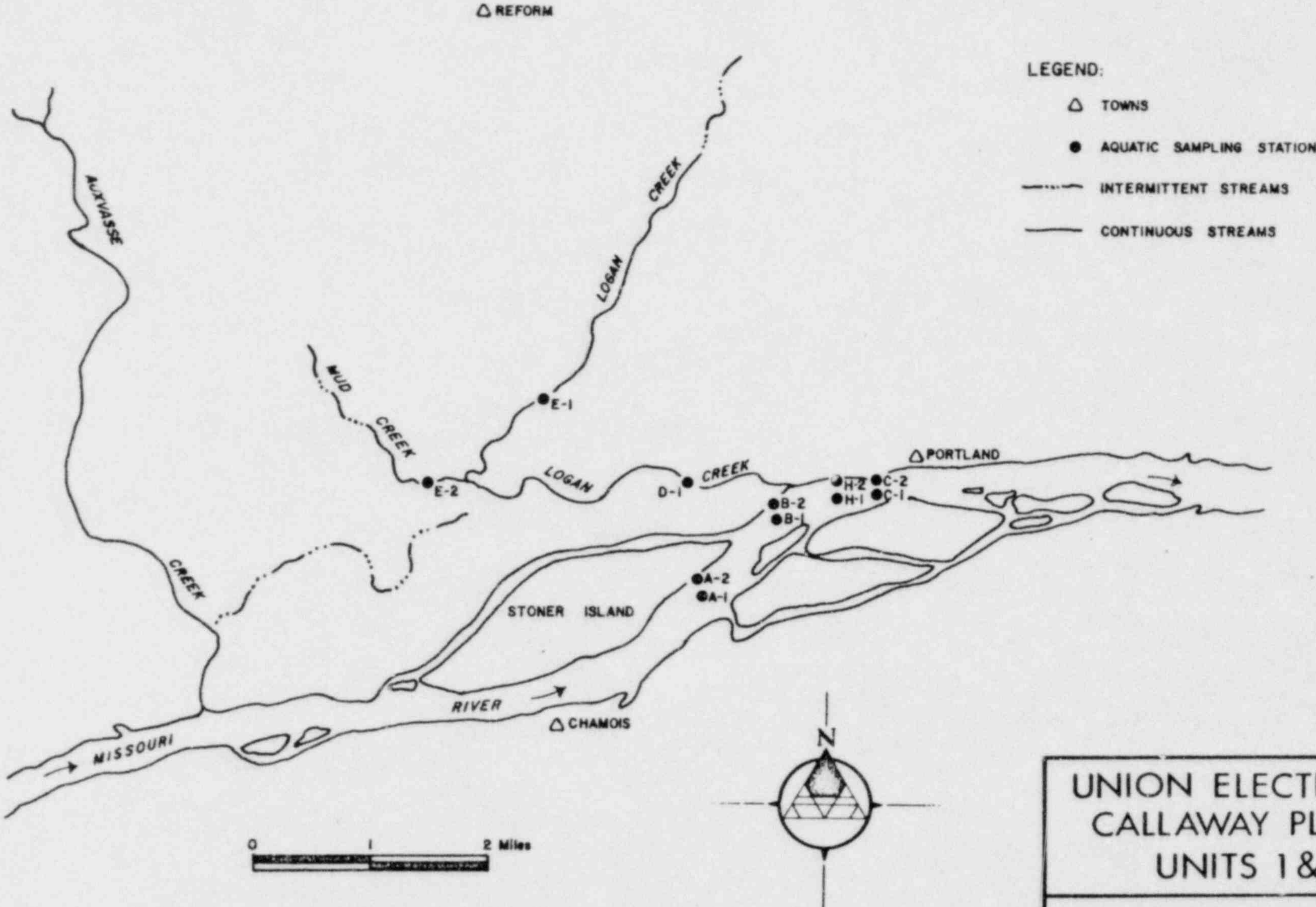
The preconstruction monitoring program was designed to interface with the baseline study (Union Electric Company, 1974). Accordingly, several of the previously established sampling locations were used. These are Transects A, B, and C in the Missouri River and Stations D and E in Logan Creek (Figure 2.2.1-1). Two additional sampling locations were established to provide a better representation of the area that may be affected by plant construction and operation. Transect H was established about midway between Transects B and C on the Missouri River. Station E-2 was added about midway between Stations D and E on Logan Creek, just below the mouth of Mud Creek. Station E-2 was relocated on Mud Creek in September to provide a measure of water quality for this creek.

Sampling stations on the Missouri River transects are designated with the numerals -1 and -2 for mid-channel and north shore locations, respectively. North and south ends of the transects, as discussed in Section 2.3.7, are designated by letters. For example, H-S and H-N refer to the south shore and north shore areas of Transect H, respectively.

The 1974 aquatic monitoring program consisted of three sampling periods, winter, spring, and fall. The winter sample was completed as scheduled and the results are presented in Callaway Plant Units 1 and 2, Environmental Baseline Inventory, Annual Summary, and will not be included in this report.

Spring sampling was scheduled to begin mid-May, but spring rainfall and high water levels delayed sampling until June 20th. During the sampling period, Missouri River flow ranged from 95,000 to 103,000 cfs; river flow had reached 278,000 cfs during May and 232,000 cfs in early June. The delay in the aquatic sampling program is not believed to have significantly affected achievement of the objectives of the preconstruction monitoring program or the quality of the data collected.

Fall sampling occurred as scheduled in early September.



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CALLAWAY PLANT
UNITS 1&2

LOCATION OF AQUATIC SAMPLING STATIONS

Figure 2.2.1-1

2.2.2 WATER QUALITY

In order to expedite sampling and prevent further delays, the June water quality sampling was restricted to Transects H and C. This modification of the program was acceptable because previous statistical analyses of water quality data had shown that all river transects were generally homogeneous with respect to water quality parameters (Union Electric Company, 1974). Therefore, for the spring survey, water quality at Transect H was considered representative of that at Transects A and B. Further, samples were taken both upstream (Transect H) and downstream (Transect C) of Logan Creek to detect any differences in water quality due to the influence of the creek.

Analyses of the June water quality data and further review of the sampling program led to the implementation of a modified water quality sampling program for the fall. Based on knowledge of the relationship among transects and the proposed location of the Callaway Plant intake and discharge structures, Stations A-2, B-2, H-2, C-1, and C-2 were selected for sampling in the September and subsequent surveys. It is believed that Station B-2 will provide a base from which to compare plant discharge, which is proposed to emanate from that point. Station C-2 and H-2 will provide a baseline from which the downstream effect of the discharge may be measured. Also, given that Stations A-2 and A-1 are statistically homogeneous, A-2 will provide an upstream "control" sample for comparison with other downstream samples. Finally, the extent to which the discharge plume will extend into the open river channel will be assessed, in part, through comparisons with water quality data from C-1.

Samples were collected from the first 1 meter below the surface with a Van Dorn PVC sampler and placed in polyethylene bottles containing appropriate preservations, as recommended by the U.S. Environmental Protection Agency (1971). Samples for fecal and total coliform analyses were collected in sterilized glass bottles. Following collection, all samples were packed in ice for transportation to the laboratory. Field determinations were made for dissolved oxygen (YSI Model 54), conductivity (YSI Model 33), temperature (YSI Model 54), pH (Fisher Acumet), and alkalinity (field titration).

Water samples were also collected in June for pesticide analyses. Samples were placed in glass containers and shipped to Analytical Biochemistry Laboratory, Columbus, Missouri for analyses of 15 different pesticides and herbicides.

Wilcoxan's sum rank test was used in the statistical analysis of the water quality data. Wilcoxan's test is a nonparametric test designed to evaluate two independent samples (Hollander and Wolfe, 1973). The analysis was conducted on the following variables: pH, dissolved oxygen, chemical oxygen demand, total suspended solids, total dissolved solids, temperature, and specific conductivity. Data collected for four distinct sampling locations were analyzed for each parameter listed above. Specifically, station comparisons included:

A-2 vs B-2	A-2 vs C-2	A-2 vs C-1
B-1 vs B-2	B-2 vs C-1	C-1 vs C-2
B-1 vs C-1	B-2 vs C-2	B-1 vs C-2

Copper and cadmium were found to be present in the water samples at concentrations that warranted further analysis. This analysis consisted of single and step-wise multiple regression analyses to correlate and rank selected water quality parameters with copper and cadmium concentration. Those water quality parameters that, in single regression analysis, accounted for 50 percent or more of the variability in concentrations of copper and cadmium were then reevaluated by means of multi-regression analysis.

2.2.3 PHYTOPLANKTON

One gallon whole-water subsurface samples for phytoplankton analyses were taken with a Van Dorn sampler. These samples were preserved with merthiolate. (USEPA, 1971).

Phytoplankters were identified and enumerated from Sedgwick-Rafter cell preparations in the following taxonomic categories: coccoid and filamentous blue-green algae; coccoid, filamentous, flagellated, and colonial green algae; euglenoid algae; and centric and pennate diatoms. The following taxonomic references were used in identifications: Palmer (1962), Prescott (1962, 1970), Smith (1950), Whitford and Shumacher (1969), and U.S. Department of the Interior (1966).

Chlorophyll _a_, _b_, and _c_ analyses were attempted but, due to interference from large amounts of suspended solids in the samples, no reliable data were obtained. In lieu of chlorophyll analysis the ^{14}C method was used to determine river productivity.

Phytoplankton primary productivity was estimated _in situ_ by the ^{14}C method (Strictland and Parsons, 1972). A solution of radioactive carbonate (HCO_3) was added to light and dark bottles filled with water samples from Stations H-2, C-2, D, and E plus one additional location downstream of Logan Creek in June; and from Stations A-2, C-2, and H-2 in September. Bottles were placed at their respective stations and suspended at the depth from which subsurface phytoplankton samples were collected. After an approximate 4-hour _in situ_ incubation, the water samples were fixed with 10 ml of formalin. The samples were later filtered in the laboratory and treated with hydrochloric acid to remove inorganic carbon. Liquid scintillation counting was conducted at Virginia Commonwealth University.

2.2.4 ZOOPLANKTON

Subsurface net zooplankton samples were taken by filtering 24.3 liters of water (collected with a Van Dorn sampler) through a Wisconsin plankton net having a No. 20 mesh plankton bucket. The concentrate was washed into sample bottles and preserved with Lugol's solution.

Sedgwick-Rafter cell preparations were examined in the laboratory at 200X magnification. Zooplankters were enumerated and identified to the genus level according to the following taxonomic references: Ahlstrom (1940, 1943), Edmondson (1959), Pennak (1953), and Brooks (1957).

2.2.5 VASCULAR HYDROPHYTES

Vascular hydrophyte investigations were limited to field observations of aquatic vegetation in both the Missouri River and Logan Creek.

2.2.6 BENTHIC MACROINVERTEBRATES

Missouri River benthic macroinvertebrates were collected with a Ponar dredge, larval meter nets, and by random sampling. Ponar dredge samples were taken in duplicate (June) and in triplicate (September) at the four north shore stations with a 520 cm^2 Ponar in approximately 0.5 to 0.8 meters of water. Samples were screened in the field with a U.S. No. 30 standard sieve (0.59 mm). All material retained by the sieve was washed into 0.95-liter wide-mouth jars and preserved with 10 percent buffered formalin containing 0.002 percent rose bengal. Larval meter net samples were taken in triplicate at Stations B-2 and C-2 with a 0.6-m-diameter conical drift net having a 0.76-mm mesh collecting bucket. A flow meter attached to the net opening quantitatively measured water passing through the net. Triplicate samples of approximately 7 minutes each were made at the two stations. Random sampling consisted of identifying organisms attached to gill nets (used for fish sampling) and sticks and rocks contained in the grab samples.

Logan Creek benthic macroinvertebrate collections were similar to those of the Missouri River, except that the Ekman sampler (230 cm^2) was used instead of the Ponar dredge and a drift net (No. 6; 30 x 45 cm) was used in lieu of the larval meter net. Random sampling consisted of identifying organisms attached to rocks and sticks.

All samples from both the Missouri River and Logan Creek were washed in a No. 35 sieve (0.50 mm) in the laboratory and placed in a white enamel tray, where invertebrates were sorted from detritus. Wet-weight biomass was determined for all major groups. Each group was blotted dry and immediately weighed to the nearest 0.1 mg. Worms and midge larvae were then permanently mounted with $CMCP_{10}$ mounting medium on glass slides for identification and enumeration. Remaining macroinvertebrates were preserved in 70 percent ethanol after identification. All samples were retained as legal voucher specimens.

The following taxonomic references were used: Beck (1968); Brinkhurst (1964, 1965); Brown (1972); Hamilton, Saether, and Oliver (1969); Hilsenhoff and Narf (1968); Hiltunen (1973); Holsinger (1972); Kennedy (1969); Mason (1973); Roback (1957); Ross (1944); Usinger and Day (1968); and Williams (1972).

Species diversity was calculated for Ponar and Ekman grabs; the Shannon-Wiener diversity index was used:

$$\bar{d} = \Sigma (N_i/N) \log_2 (N_i/N)$$

where: $\bar{d}$ = species diversity

N = total number of individuals in a composite sample for a particular station

N_i = total number of individuals of a particular species in the composite sample.

2.2.7 FISH

In June, the fish community of the Missouri River near the plant site was sampled by nets and boom electroshocking. Gill and fyke netting was conducted behind L-head dikes, revetments, and in back chutes on both the north and south sides of the river. Transects were sampled in the following general areas: A-S, B-N, C-N, C-S. Electroshocking was conducted along the north and south ends of Transects A, B, H, and C. The fish sampling gear was the same as that used previously and is described in the Annual Report (Union Electric Company, 1974). In September, fish sampling was the same, except that boom electroshocking was omitted. Earlier experience with boom shocking in the Missouri River showed that this technique is ineffective in collecting fish.

In Logan Creek fish were sampled at Stations D, E-2, and E using electroshocking and seines. In addition, standing crop biomass estimates were made at Station E. A measured area of creek at Station E was blocked off with seines; fish were collected either with a back-pack electroshocker or minnow seine. The area was fished until catch per unit effort was reduced significantly. The total population estimate was then made from the relation of fishing success to cumulative fish catch (Leslie and Davis, 1939). This technique was utilized both on the 31st of May and 23rd of June, 1974.

Fish were weighed to the nearest gram and total length was measured to the nearest millimeter. Scales were removed from selected forage and sport species for age and growth analyses. Selected specimens were preserved in 10 percent formalin for later taxonomic identification or retained as voucher specimens. Taxonomic references used for identification were Eddy (1969), Hubbs and Lagler (1967), Cross (1967), Pflieger (1968), and Moore (1968). Larval and juvenile fish were identified with the aid of a key by May and Gasaway (1967).

Length-weight relationships of selected fishes were calculated; log-transformed values were used in the calculations. Regression lines were fitted by the least squares method; the equation describing the line is presented in the general form:

$$\log W = \log a + b \log L$$

where: W = estimated weight in grams (gm)

a = intercept of the regression line

L = total length in millimeters (mm)

b = regression coefficent

The correlation coefficient was also calculated for each regression.

Condition factor (K_{TL}) was calculated for individual fish, and the mean value for each of the selected species in each age group was calculated. The condition factor, which describes the relative plumpness or well-being of a fish, is defined as:

$$K_{TL} = \frac{W \times 10^5}{L^3}$$

where: K_{TL} = condition factor

W = weight (gm)

L = total length (mm)

Larval fish were sampled in both the Missouri River and Logan Creek. The Missouri River was sampled near the north end of Transects B and C with a 0.6-m diameter conical drift net having a 0.76-mm mesh collecting bucket. A flow meter attached to the net opening quantitatively measured the water passing through the net. Triplicate tows of approximately 7 minutes each were made at the two stations. Larval fish in Logan Creek were sampled with smaller drift nets, as described in Section 2.2.6.

Age and growth analyses of fish were made from scales collected during the study. Impressions of at least three scales per fish were made in the laboratory on plastic slides with a roller press. Scale measurements (mm) were then made with the aid of a microscopic projector; two or more scales were examined to verify the number of annuli. Total scale radius was obtained by measuring from the center of the focus to the anterior-most portion of the scale.

Linear regression analysis was used to determine body-scale relationships for each fish species. Lee's formula (Tesch, 1971) was used to perform calculations of growth. The intercept values were derived from linear regressions.

2.3 RESULTS AND DISCUSSION

2.3.1 WATER QUALITY

2.3.1.1 Missouri River

Water quality data from both the spring and fall collections are presented in Tables 2.3.1-1 and 2.3.1-2. Wilcoxan's sum-rank test, applied to data from Stations A-2, B-1, B-2, C-1, and C-2, confirmed previous assumptions regarding homogeneity among water quality stations and further supports the basis for the selected modification in the sampling program.

Water quality of the Missouri River near the site has been characterized as primarily influenced by agricultural runoff, dilution phenomena, and industrial and municipal pollution (Union Electric Company, 1974). Variation in concentration of chemical constituents has largely been a function of river discharge. Total dissolved solids generally decreased in concentration with increased river discharge, while suspended materials and sediment load increased. Data from the present study illustrate this phenomenon (Tables 2.3.1-1 and 2.3.1-2). The mean river flow during June sampling was 95,600 cfs; the discharge during the September sampling was 81,800 cfs. Biochemical oxygen demand (BOD), chloride, total hardness, sulfate, and total dissolved solids (TDS) varied inversely with river flow. Constituents that varied directly with discharge, such as chemical oxygen demand (COD), nitrate, Kjeldahl nitrogen, total phosphorus, are directly related to the quantity of suspended particulate matter (seston) in the waterway. The increase in coliform bacteria with increased discharge is probably related to the amount of runoff from livestock grazing land. The State Water Quality Standard of 2,000 coliform bacteria/100 ml (Missouri Clean Water Commission, 1973) river water was exceeded at Station B-2 in September and was probably exceeded in June, as suggested by the over-growth in the plate cultures (Tables 2.3.1-1 and 2.3.1-2). Ballentine, et al. (1970) also found that coliform bacteria densities exceeded several times the National Technical Advisory Committee criteria of 10,000/100 ml total coliform and 2,000/100 ml fecal coliforms. Fall counts upstream at River Mile 118.0 averaged 36,000/100 ml total and 4,700 fecal from October 28 to November 8, 1968 (Ballentine, et al., 1970).

Pesticide contamination was not evident, as concentrations in the spring were below detectable limits. This agrees with results of previous pesticide tests on water samples taken in July, September, and December, 1973 (Union Electric Company, 1974). Only the April 1973 samples revealed the presence of chlorinated pesticides, which were in low concentrations (19-31 µg/l). Chronic pesticide contamination from leached agricultural soils in this area, therefore, does not appear to exist.

The moderately high COD and dissolved oxygen (DO) with concurrently low BOD levels (Tables 2.3.1-1 and 2.3.1-2) are probably related to the presence of allochthonous organic materials in the seston that are more resistant to biological degradation. It is also possible that certain organic materials leached from the surrounding watershed are adsorbed on clay particles where they become more resistant to biological degradation.

Trace metal analyses from previous studies at the site and historical data from Hermann, Missouri point to copper and cadmium as occurring in concentrations that may occasionally be toxic to aquatic organisms (Union Electric Company, 1974). Copper concentrations during the present study ranged from .007 to .04 mg/l (Tables 2.3.1-3 and 2.3.1-4). Although copper toxicity to aquatic organisms has been observed at concentrations as low as .02 mg/l (Battelle's Columbus Laboratory, 1971), it is probable that the copper in the Missouri River is either largely a mineral constituent of the organic detritus in the seston, or adsorbed to suspended clay particles. Figure 2.3.1-1 illustrates the relationship of total suspended solids (TSS) and discharge to copper and cadmium concentrations. Copper concentrations vary directly with TSS, while cadmium appears to be more a function of discharge.

To test the hypothesis that copper concentration is related more to the concentration of suspended solids than to dissolved solids, step-wise multiple regression analyses were performed on data collected from the site since 1973. Independent parameters in the analyses were COD, TDS, TSS, discharge, cadmium, and iron. Sixty-seven percent of the variation in copper concentration was explained by the concentration of TSS; the linear expression:

$$Y = .0075 + .000025X$$

Where: Y = Cu concentration in mg/l

X = TSS concentration in mg/l

No other regressions were significant ($p<.05$); that is, no other variables used in the analyses contributed significantly to the observed variation in copper concentrations. Therefore, these results suggest that the potential for acute copper toxicity to aquatic organisms is minimal because the copper appears to be either a constituent of the organic seston or is adsorbed to clay particles and is not readily available to most aquatic organisms. However, chronic copper toxicity to detritophageous organisms could occur because these organisms ingest organic seston and clay particles.

Multiple regression analysis was performed on the same data; cadmium was used as the dependent variable. The only parameter that contributed significantly to the observed variability in cadmium concentration was discharge, which accounted for 68 percent. The linear regression is:

$$Y = .0085 + .00008X$$

Where: Y = cadmium concentration in mg/l

X = discharge in cfs

Therefore, cadmium concentrations vary directly with discharge levels.

2.3.1.2 Logan Creek

The water quality of Logan Creek is generally better than that of the Missouri River. Concentrations of most water quality parameters measured in Logan Creek increased downstream, probably as a function of increased runoff. In previous samples, evidence of organic pollution generally was not found, although fecal coliform counts were occasionally high. Data from the present study show similar patterns, although a great deal of variation is evident in some parameters (Tables 2.3.1-1 and 2.3.1-2). For example, TSS, COD, BOD, organic nitrogen, and phosphorus levels were higher during the spring, when discharge was high, than during the fall. Most variations in concentration, however, can be explained as a function of discharge rates.

Station E-2 was added in the fall to provide a measure of the effects of Mud Creek on water quality of Logan Creek. Mud Creek appeared to be higher in dissolved solids than upper Logan Creek and, at times, has some bacterial contamination.

TABLE 2.3.1-1

WATER QUALITY DATA FROM THE MISSOURI RIVER AND LOGAN CREEK, SPRING 1974[a]

Parameter	Missouri River Stations				Logan Creek Stations		
	H-1	H-2	C-1	C-2	D	E	E-2
Alkalinity (as $CaCO_3$) Bicarbonate	150	168	157	164	333	139	212
Ammonia	.08	.08	.07	.06	.02	.02	.02
Biochemical Oxygen Demand	0.8	0.9	0.6	0.9	0.4	1.0	1.7
Chemical Oxygen Demand	25.6	32.6	21.0	42.1	12.8	20.8	16.3
Chloride	15.3	19.9	16.7	20.5	5.80	5.30	4.60
Total Hardness (as $CaCo_3$)	196	217	198	220	323	184	231
Hexane Sol. Materials	<.022	<.001	<.001	<.001	<.001	<.002	<.001
Nitrate	1.59	1.59	0.80	2.80	0.78	0.69	0.60
Nitrite	0.01	0.01	<0.01	<0.01	0.02	0.01	<0.01
Total Nitrogen, Kjeldahl	2.30	2.51	3.20	3.40	0.75	1.22	1.75
Orthophosphate, sol.	0.48	0.86	0.63	0.93	0.12	0.36	0.23
Total Phosphorus	0.62	1.10	0.89	1.10	0.40	0.55	0.55
Sulfate	151	154	115	151	157	50	52
Total Dissolved Solids	340	382	322	368	370	238	261

TABLE 2.3.1-1 (continued)

Parameter	Missouri River Stations				Logan Creek Stations		
	H-1	H-2	C-1	C-2	D	E	E-2
Total Suspended Solids	318	350	256	386	16	92	52
Total Solids	720	786	652	826	420	360	368
Total Coliform (col/100 ml)	>20,000	>20,000	>20,000	>20,000	>20,000	>20,000	>20,000
Fecal Coliform (col/100 ml)	O.G.[b]	O.G.	O.G.	288	60	2148	204
pH (standard units)	7.9	7.9	7.8	7.9	8.0	7.9	7.8
Temperature (^{o}C)	25.2	25.0	25.0	25.0	25.0	25.0	25.0
Specific Conductivity (μmho/cm)	520	600	490	610	620	270	430
Dissolved Oxygen	6.4	7.6	6.8	7.6	5.0	7.3	6.2
Turbidity (FTU)	80	97	84	100	13	65	33

[a]All values are expressed in mg/l except where noted.

[b]O.G. = over-grown (to numerous to count).

TABLE 2.3.1-2

WATER QUALITY DATA FROM THE MISSOURI RIVER AND LOGAN CREEK, SEPTEMBER 1974[a]

Parameter	Missouri River Stations					Logan Creek Stations		
	A-2	B-2	H-2	C-1	C-2	D	E	E-2
Alkalinity (as $CaCO_3$)								
Carbonate	0	0	0	0	0	0	0	0
Bicarbonate	153	155	151	129	152	225	230	266
Ammonia (as N)	.08	.08	.04	.06	.08	.08	.02	.02
Biochemical Oxygen Demand	0.7	0.6	1.0	1.1	1.4	0.9	1.4	1.0
Chemical Oxygen Demand	18.8	25.6	22.0	17.2	20.0	20.8	7.8	17.2
Chloride	25.5	25.9	25.5	11.5	25.5	2.47	4.11	3.70
Hardness, Total (as $CaCO_3$)	244	222	226	161	220	272	258	293
Hexane Sol. Materials	.001	.001	<.001	<.001	.002	.002	<.001	<.001
Nitrate (as N)	.55	.51	.42	.29	.31	.14	.16	.24
Nitrite (as N)	.01	.01	.01	.01	.01	.02	<.01	<.01
Nitrogen, Total Kjeldahl (as N)	.97	.08	.75	.73	.87	.83	.25	1.02
Orthophosphate, Sol. (as P)	.10	.09	.11	.07	.11	.03	.02	.02
Phosphorus, Total (as P)	.13	.13	.12	.08	.13	.03	.04	.02
Sulfate	164	161	162	70.8	157	226	16.9	20.6
Total Dissolved Solids	424	418	410	284	456	282	250	302

TABLE 2.3.1-2 (continued)

Parameter	Missouri River Stations					Logan Creek Stations		
	A-2	B-2	H-2	C-1	C-2	D	E	E-2
Total Suspended Solids	96	103	93	87	94	26	<10	17
Total Solids	581	580	582	344	548	328	274	322
Total Coliform (col/100 ml)	3,000	3,000	2,800	2,200	2,300	375	400	2,100
Fecal Coliform (col/100 ml)	900	2,300	1,300	900	850	700	290	360
Turbidity	33	32	24	25	23	15	3.8	5.8
Temperature (^{o}C)	20.5	21.8	21.5	23.0	21.8	20.0	20.0	21.0
Specific Conductivity (μmho/cm)	490	690	1500	400	690	455	425	465
Dissolved Oxygen	8.7	8.5	8.1	6.8	7.5	5.0	10.4	9.3

[a] All values are expressed in mg/l except where noted.

TABLE 2.3.1-3

TRACE METAL CONCENTRATIONS FROM MISSOURI RIVER AND LOGAN CREEK WATER SAMPLES, SPRING 1974[a]

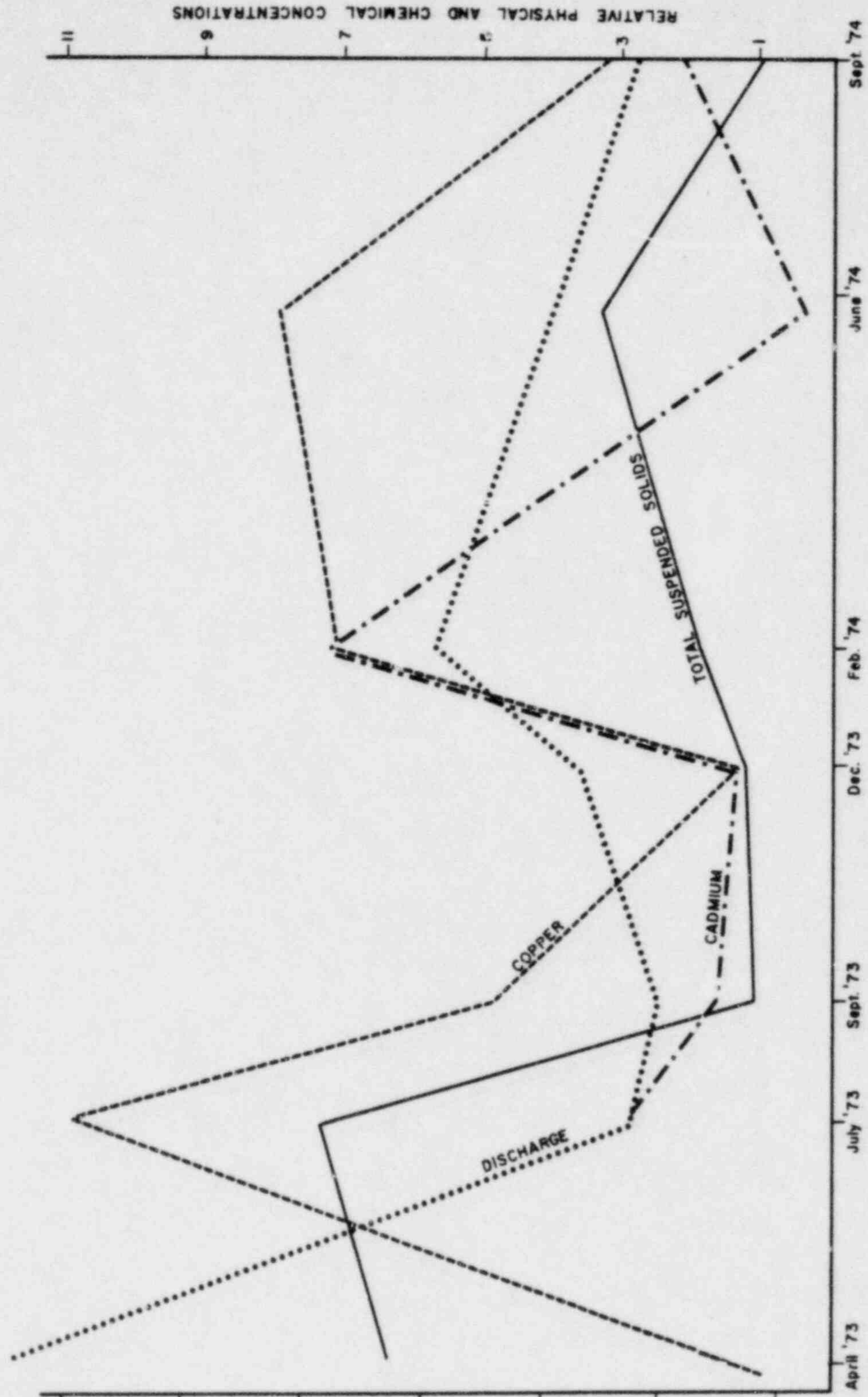
Parameter	Missouri River Station				Logan Creek Station		
	H-1	H-2	C-1	C-2	D-1	E	E-2
√ Arsenic	<.005	<.005	<.005	<.005	<.005	<.005	<.005
√ Cadmium	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Calcium	60	54	54	56	94	50	72
√ Total Chromium	<.005	<.005	<.005	<.005	<.005	<.005	<.005
√ Copper	.04	.019	.012	.011	.004	.008	.006
Iron	8.5	11	8.0	11	1.6	6.5	4.0
√ Total Iron	14	20	16	20	1.6	8.5	4.5
√ Lead	.140	.047	.047	<.020	<.020	.195	.080
Magnesium	15	17	16	17	32	16	23
√ Mercury	.001	.0003	.0005	.0003	.0002	.0002	.0009
√ Selenium	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Sodium	29	39	29	36	7.6	4.0	5.2
√ Zinc	.02	.04	.04	.04	.02	.02	.05

[a] All values are expressed in mg/l

TABLE 2.3.1-4

TRACE METAL CONCENTRATIONS (mg/l) FROM MISSOURI RIVER AND LOGAN CREEK WATER SAMPLES, SEPTEMBER 1974

Parameter	Missouri River Stations					Logan Creek Stations		
	A-2	B-2	H-2	C-1	C-2	D	E	E-2
Arsenic	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Cadmium	.009	.007	.004	.004	.003	.006	.005	.005
Calcium	52	55	52	42	52	57	55	63
Chromium, Total	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Copper	.011	.007	.007	.008	.008	.006	.004	.006
Iron	3.3	2.1	1.6	1.4	1.6	1.2	0.5	0.5
Iron, Total	5.2	3.8	2.8	2.7	2.8	1.9	0.5	0.6
Lead	.020	.020	<.020	<.020	<.020	<.020	<.020	.120
Magnesium	19	19	18	12	18	25	26	31
Mercury	.0003	.003	.0007	.0006	.003	.016	.001	.001
Selenium	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Sodium	58	59	58	23	54	4.4	4.8	4.6
Zinc	.04	.06	.04	.04	.04	.06	.01	.04



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RELATIONSHIP BETWEEN
WATER QUALITY
AND DISCHARGE

Figure 2.3.1-1

2.3.2 PHYTOPLANKTON

2.3.2.1 Missouri River

Phytoplankton of the lower Missouri River characteristically occur in low densities and are dominated numerically by diatoms (Berner, 1951; Damann, 1951; Williams, 1966; Stern and Stern, 1971; Union Electric Company, 1974; University of Missouri-Rolla, 1974). The paucity of phytoplankton is related to excessive turbidity, high current velocity, and the lack of adjoining lentic waters (Berner, 1951). The harsh conditions of the Missouri River are illustrated by their effects on plankton populations entering from tributary rivers. Damann (1951) reports that plankters entering the Missouri River from tributaries were subjected to adverse conditions and did not multiply. A reduction in tributary phytoplankton populations after entering the Missouri River was also noted by Ballentine, et al. (1970). Berner (1951) had earlier suggested that, in the absence of backwater areas, plankton production was autogenic, with little contribution from tributaries. Ballentine, et al. (1970) supported the suggestions of others that the Missouri River phytoplankton community originates in lentic waters.

Diatoms clearly were numerically dominant in the present study, comprising 80 and 76 percent of the total phytoplankton numbers in June and September, respectively (Tables 2.3.2-1 and 2.3.2-2). Diatoms in the June sample were predominately of the pennate form, while the September sample contained primarily centric diatoms. This form of seasonal variation is typical of diatom populations (Patrick, 1948).

Densities of phytoplankton from the present study show a fall maximum not observed in past investigations (Table 2.3.2-2). The mean density increased from 89,842/liter (l) in June to 11,430,780/l in September. Although fall diatom blooms are a common phenomenon in rivers (Williams, 1964), the September value represents a greater than 100X increase in density over the June sample and is greater than any reported for the lower Missouri River. Ballentine, et al. (1970) found total phytoplankton densities of 1,593,000/l upstream at Chamois (RM 118.0) in the fall of 1968. Mean discharge during their study was 55,600 cfs. The greatest observed density reported by Ballentine, et al. (1970) was 2,178,000/l in collections taken between Kansas City and St. Joseph, Missouri.

The high fall densities of phytoplankton observed in the present study illustrate the limiting effect of turbidity on photosynthetic processes in the river. In late summer and early fall, flow rates and water levels decline (Figures 2.3.2-1 and 2.3.2-2), and larger suspended particles settle, reducing river turbidity. General river turbidity is further reduced under low flow conditions due to the increased proportion of groundwater to surface runoff water in the river. As the water level continues to drop, revetments become especially good habitats for phytoplankton because they become closed off, forming lentic pools. The decrease in turbidity coupled with the abundant nutrients (Union Electric Company, 1974) in the Missouri River explain the phytoplankton bloom observed in the fall sampling period.

2.3.2.2 Logan Creek

Past investigations of phytoplankton in Logan Creek have shown species composition to be similar to the Missouri River near the site; phytoplankton densities, however, were one to four orders of magnitude higher (Union Electric Company, 1974). Higher phytoplankton densities in Logan Creek relative to those of the Missouri River appeared to be related to the presence of a stable substrate, lower current velocities, and lower turbidity levels. Seasonal variations in densities and species composition of Logan Creek phytoplankton were found to be typical of temperate streams, where green and euglenoid species attain maximum densities during warmer months but are absent in winter when diatoms predominate. Most of the principal taxa in the creek were benthic diatoms.

The June 1974 phytoplankton sample contained predominately pennate diatoms (see Table 2.3.2-1). Densities were low and did not show the previously observed pattern of increased upstream abundance. Also, in contrast to previous findings, densities in Logan Creek were lower than those in the Missouri River. Presumably, low spring densities were due to the high water levels and discharge that had existed prior to sampling (see Figures 2.3.2-1 and 2.3.2-2).

The September 1974 samples also were dominated numerically by pennate diatoms (see Table 2.3.2-2). Centric diatoms, predominate in the Missouri River samples, comprised only from 4.5 to 23 percent of the total diatom numbers. Total phytoplankton densities were unusually high but were always lower than densities in the river samples. Phytoplankton were slightly more abundant upstream at Station E than at Station D.

The fall maxima in phytoplankton densities in Logan Creek are greater than the previous maximum of 1,115,000 cells/l observed at Station E in July 1973. The maximum phytoplankton density observed in September 1973 was 10,222/l at Station E. Turbidity levels corresponding to these two periods were 90 and 3 Jackson Turbidity Units (JTU's), respectively.

TABLE 2.3.2-1

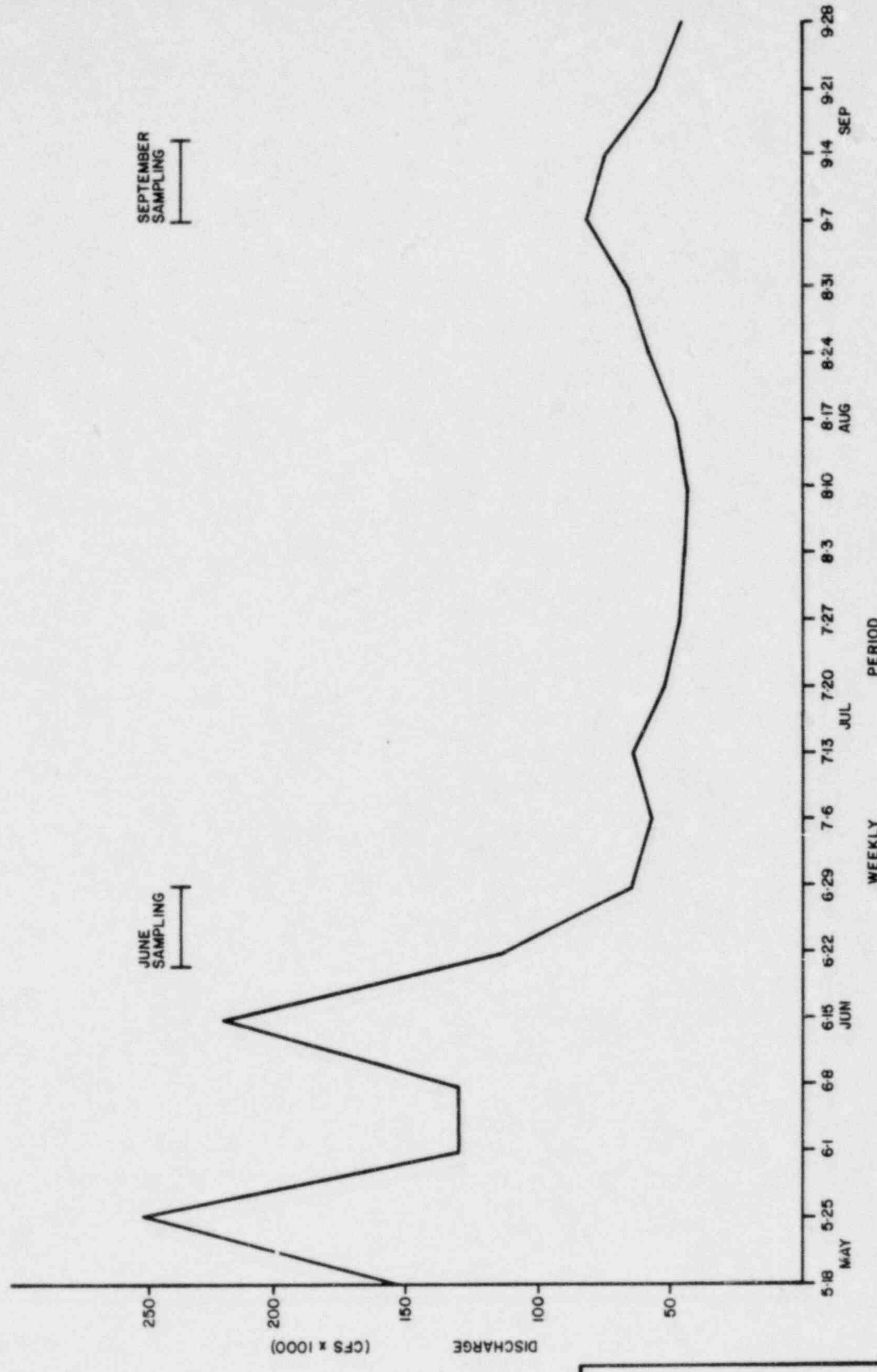
DENSITIES (cells/liter) OF PHYTOPLANKTON COLLECTED IN THE MISSOURI RIVER AND LOGAN CREEK, JUNE 1974

Organism	Missouri River Stations				Logan Creek Stations	
	H-1	H-2	C-1	C-2	D	E
Green						
Coccoid	3,266		6,532	+	1,633	+
Filamentous	+	+	+	1,633	+	+
Flagellated	+	+	+	+	+	+
Other	9,798	14,697	6,532	14,697	3,266	9,798
Euglenoid	+	+	+	1,633	+	+
Diatoms						
Centric	4,899	9,798	8,165	3,266	3,266	6,532
Pennate	71,852	73,540	52,311	65,320	39,192	50,623
Blue-green						
Coccoid	+	+	+	+	+	+
Filamentous	1,633	3,266	3,266	3,266	4,899	
Total	91,448	101,301	76,806	89,815	52,256	66,953

TABLE 2.3.2-2

DENSITIES (CELLS/LITER) OF PHYTOPLANKTON COLLECTED IN THE MISSOURI RIVER AND LOGAN CREEK, SEPTEMBER 1974

Organism	Missouri River Stations					Logan Creek Stations	
	A-2	B-2	H-2	C-1	C-2	D	E
Green							
Coccoid	163,300	163,300	163,300	326,600	163,300	+	+
Filamentous	+	+	+	+	+	+	+
Flagellated	+	+	+	163,300	+	+	+
Other	2,122,900	2,776,100	1,796,300	653,200	1,632,900	979,800	+
Euglenoid	+	163,300	+	+	+	+	+
Diatoms							
Centric	5,388,900	6,042,100	6,205,400	3,919,200	5,551,200	489,900	163,300
Pennate	2,449,500	3,102,700	3,592,600	1,633,000	5,552,200	2,122,900	3,592,600
Blue-green							
Coccoid	+	+	+	+	+	+	+
Filamentous	1,143,100	489,900	+	816,500	653,200	163,300	326,500
Dinoflagellate	+	+	+	+	326,600	+	+
TOTAL	11,267,700	12,737,400	11,757,600	7,511,800	13,879,400	3,755,900	4,082,400



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MEAN WEEKLY DISCHARGE OF THE MISSOURI RIVER, HERMANN, MISSOURI

Figure 2.3.2-1

2.3.3 PRIMARY PRODUCTIVITY

2.3.3.1 Missouri River

Phytoplankton primary productivity, as measured by ^{14}C fixation method, is reported below:

Station	Date	CO_2 fixation mgC/m^3/hr
H-2	20 Jun	2.3
C-2	20 Jun	1.9
C-2	20 Jun	1.4
A-2	7 Sep	122.7
C-2	7 Sep	126.2
H-2	7 Sep	86.9

As expected, high discharge, high turbidities (95 JTU average), and low phytoplankton densities resulted in low productivity values for the June sample. The September study yielded values, consistent with findings of lowered turbidities, decreased flow, and high phytoplankton densities.

2.3.3.2 Logan Creek

The ^{14}C primary productivity study in Logan Creek yielded the following:

Station	Date	CO_2 fixation mgC/m^3/hr
D	20 Jun	5.1
E	20 Jun	40.1
D	7 Sep	8.4
E	7 Sep	4.6

June productivity in the creek was, as expected, higher than that observed for the river (Section 2.3.3.1). Turbidity in the creek was low, and phytoplankton densities were moderately high. However, productivity differences between sampling stations show a direct, rather than inverse, relationship with turbidity. For example, turbidity and productivity were both highest at Station E in June, while a similar relationship existed at Station D in September. Moreover, September productivity did not reflect the high diatom counts observed in the creek (Section 2.3.2.2).

There are several possible explanations for the above observed phenomena. First, many of the diatoms in the phytoplankton samples may be dead frustrules washed from the bottom by earlier rains. These diatoms would not contribute to primary productivity but would increase phytoplankton counts. The predominance of benthic diatoms in Logan Creek samples attests to the fact that benthic diatoms are suspended in the water column. Secondly, a high percentage of the carbon assimilated during photosynthesis may be excreted into surrounding water in soluble form, resulting in an underestimation of primary productivity (Gieskes and Bennekom, 1973). Thirdly, if nutrients become depleted, maximum phytoplankton biomass would be reached, and productivity would decline. Chu (1942) reports that algae are likely to suffer a nutrient deficiency when nitrogen concentration is below 0.2 mg/l and phosphorus below 0.05 mg/l. During the September study, nutrient levels were somewhat below these limits. However, nutrient depletion is related to flow rates. Nutrients that may be limiting in lentic waters are not as important in lotic waters because flow continually renews the aquatic medium (Odum, 1956). Hence, no real nutrient deficit can build up as long as adequate flow is maintained. Once flow is reduced, nutrients can become limiting.

2.3.4 ZOOPLANKTON

2.3.4.1 Missouri River

Rotifers, characteristically the predominant zooplankter in most major river systems (Williams, 1966), were the most abundant component of the net zooplankton samples in the present study (Tables 2.3.4-1 and 2.3.4-2). Earlier collections at the study site were also dominated by rotifers (Union Electric Company, 1974).

The September 1974 collections contained greater net zooplankter densities and taxa diversity than did the June 1974 collections (Tables 2.3.4-1 and 2.3.4-2). Densities averaged 68.4 organisms/l in September and 34.2/l in July. Normally, maximum rotifer densities in large temperate rivers occur in the summer months when the water is warm and clear (Williams, 1966). However, in the present study, maximum water clarity occurred in September.

Hynes (1972) states that rotifers become common when diatom densities increase. Although phytoplankton densities in September were exceptionally high (Section 2.3.2), zooplankton densities remained moderately low. Because zooplankters feed on phytoplankton, particulate organic matter, and bacteria, maximum zooplankton densities often occur after maximum phytoplankton densities. Such a lag in zooplankton abundance was observed in the lower Missouri River by the University of Missouri-Rolla (1974) when a maximum of 2100 zooplankters/l were collected in July 1973. The low densities observed in the present study may be explained in part by this lag effect, in combination with the effects of temperature and flow. Generally, however, the lower Missouri River is considered rotifer poor (Williams, 1966).

Most of the zooplankters collected during the present study are planktonic(free floating). However, sessile rotifers were abundant in September, comprising as much as 69 percent of the total sample (Table 2.3.4-2). In addition, drift net samples taken in June contained large numbers of sessile rotifers attached to organic debris. The appearance of these organisms in both seasonal collections points to the existence of large communities of periphytic invertebrates (Aufwuchs) that become dislodged during high water.

2.3.4.2 Logan Creek

A total of 26 taxa of zooplankton, including 18 rotifers, has been reported for Logan Creek (Union Electric Company, 1974). A maximum density of 2133/l occurred in July 1973 and included 13 taxa. In the present study, 14 taxa were collected, including 7 rotifers (Tables 2.3.4-1 and 2.3.4-2). Maximum density of 34.3/l was observed in September at Station D. Rotifers were numerically predominant at both stations in June, but crustaceans were predominant at Station D in September.

Total densities of zooplankton in Logan Creek were slightly higher in June than were corresponding river collections. In September, Missouri River collections contained two to three times the density of the Logan Creek collection. However, if dislodged sessile rotifers are disregarded, both bodies of water had similar densities.

TABLE 2.3.4-1

DENSITY (organisms/liter) OF ZOOPLANKTON COLLECTED FROM THE MISSOURI RIVER AND LOGAN CREEK, JUNE 1974

Organism	Missouri River Sampling Stations				Logan Creek Sampling Stations	
	H-1	H-2	C-1	C-2	D	E
ROTIFERA						
Branchionus sp.	9.07	9.19	7.98	9.42	9.77	6.81
Filinia sp.	0.95	1.02	+	+	+	2.27
Keratella sp.	1.91	2.55	2.09	3.62	8.15	4.54
Polyarthra sp.	+	2.04	0.42	1.09	1.62	+
Trichotria sp.	+	+	+	+	1.62	+
Total Rotifer Density	11.93	14.80	10.49	14.13	21.16	13.62
CLADOCERA						
Bosmina sp.	1.43	1.53	0.84	0.72	+	+
COPEPODA						
Cyclops sp. (naupli)	1.91	2.55	2.94	1.81	3.25	6.81
Cyclops sp.	+	+	+	+	+	2.27
Cyclopoid	+	2.04	1.26	1.81	+	+
Total Crustacea Density	3.34	6.12	5.04	4.34	3.25	9.08
OTHER INVERTEBRATES						
Ostracoda	0.48	0.51	+	+	+	+
Tardigrada	1.43	+	+	0.36	+	+
TOTAL	17.18	21.43	15.53	18.83	24.41	22.70

TABLE 2.3.4.2

DENSITY (ORGANISMS/LITER) OF ZOOPLANKTON COLLECTED FROM THE MISSOURI RIVER AND LOGAN CREEK, SEPTEMBER 1974

Organism	Missouri River Stations					Logan Creek Stations	
	A-2	B-2	H-2	C-1	C-2	D	E
Rotifera							
Branchionus sp.	10.29	20.58	13.72	13.72	3.43		6.86
Filinia sp.	+	+	+	+	+	+	+
Keratella sp.	+	+	10.29	+	+	3.43	+
Polyarthra sp.	+	6.86	+	+	+	+	3.43
Sessile Rotifera	61.73	30.86	+	34.29	+	+	+
Unidentified Rotifera	+	6.86	+	+	+	+	+
Total Rotifera Density	72.02	65.16	24.01	48.01	3.43	3.43	10.29
Cladocera							
Bosmina sp.	4.12	+	6.86	3.43	+	6.86	+
Unidentified Cladocera	2.06	+	+	+	+	+	+
Copepoda							
Cyclops sp. (naupli)	+	+	6.86	6.86	+	10.29	6.86
Cyclops sp.	2.06	+	3.43	+	+	+	+
Unidentified Copepoda	2.06	+	+	+	+	+	+
Total Crustacea Density	10.29	+	17.15	10.29	+	17.15	6.86
Other Invertebrates							
Chironomidae	+	3.43	3.43	3.43	+	+	+
Ephemeroptera	+	+	+	3.43	+	+	+
Ostracoda	6.17	+	3.43	3.43	+	3.43	+
TOTAL	88.48	68.59	48.02	68.59	3.43	24.01	17.15

2.3.5 VASCULAR HYDROPHYTES

2.3.5.1 Missouri River

During the present study, no vascular hydrophytes were observed in the Missouri River near the site. However, a few hydrophytes, mainly *Potamogeton* sp., were seen in an isolated chute near Station B-2 in September. This chute, closed off by silt deposits and dikes, provided the lentic conditions necessary for establishment of vascular hydrophytes. Ordinarily, physical conditions in the river are too harsh for rooted aquatic plants. Berner (1951) observed no rooted aquatic plants in the river channels, chutes, or backwaters. Likewise, none have been observed previously in the vicinity of the Callaway Plant, Units 1 and 2 (Union Electric Company, 1974).

2.3.5.2 Logan Creek

Dames & Moore reported the occurrence of water primrose (*Jussiaea* sp.), water willow (*Dianthera* sp.), duckweed (*Lemma* sp.), and sedges (*Carex* spp.) at Station E during earlier studies, but no vascular hydrophytes were observed at Station D. During the present study, two submergent vascular hydrophytes were observed at Station E in September. The plants are tentatively identified as a filiform pondweed (*Pontamogeton* sp.) and a water plantain, probably *Alisma* sp.. Lack of fruiting bodies made specific identification impossible. No vascular hydrophytes were observed in Logan Creek in June, and none were seen at any time at Station D.

2.3.6 BENTHIC MACROINVERTEBRATES

2.3.6.1 Missouri River

Benthic communities in the Missouri River are normally composed of oligochaetes, burrowing mayflies, and dipters--mainly chironomidae (Union Electric Company, 1974; University of Missouri, 1972; Berner, 1949). Densities, biomass, and species diversity are generally low, being restricted by spates (excessive currents) and unstable substrate (Union Electric Company, 1974).

June 1974 grab samples contained only 11 species, dominated by oligochaetes (97.1 to 100 percent, Table 2.3.6-1). Densities also were low, with a mean of $1169/m^2$ (Table 2.3.6-2). A combination of two factors could account for the unusual species composition and low densities. First, high water (maximum of 278,000 cfs) in late May and early June eliminated all but those forms suited to burrowing, such as mayflies, chironomids, and oligochaetes (Figure 2.4-1). Secondly, the burrowing mayflies and most chironomids had probably emerged prior to sampling.

September 1974 grab samples showed an increase in species numbers and densities over the June samples (Table 2.3.6-3). This was a result of stable river flows prior to sampling and reappearance of burrowing mayflies and chironomids (Figure 2.4-1). Species numbers increased to 19, and mean densities (from all stations) reached $1347/m^2$. Oligochaete dominance was still high, ranging from 76.4 to 91.7 percent.

An increase in species numbers and densities after the spring high water period (normally April) to a high during the winter period has been noted in the Missouri River (Union Electric Company, 1974). High winter densities are common for both lotic and lentic environments (Hynes, 1972) and are generally considered a result of decreased predation, improved water quality, and life cycle patterns of individual benthic species.

Wet-weight biomass showed a fall increase, as did densities (Table 2.3.6-4). The average biomass for north shore stations in June was 1698 mg/m^2 and 3268 mg/m^2 for September. The mayflies and dragonflies, with their greater weight per individual, accounted for almost a doubling of biomass in September, with only a 20 percent increase in densities. The September 1974 average biomass is exceeded only by the December 1973 Station C-2 biomass of 5797 mg/m^2 (Union Electric Company, 1974). These values are greater than the 241 mg/m^2 maximum reported by Berner (1951). However, even the high winter biomass does not approximate the biomass of 29,000 mg/m^2 reported for an unchannelized portion of the Illinois River between Chillicothe and Grafton (Berner, 1951).

Species diversity indices increased from June to September 1974 as follows:

Station	June	September
A-2	0.67	0.92
B-2	0.89	0.98
H-2	0.22	1.45
C-2	0.64	1.64

Generally, diversity in the Missouri River increases during the winter (Union Electric Company, 1974). According to Wilhm and Dorris (1968), diversities below 2.0 indicate gross pollution and between 2.0 and 3.0, moderate pollution. In the case of the Missouri River at the site, gross pollution would be attributed to physical stress from spates and shifting substrate, which are the result of river channelization. In this sense, channelization could be considered a form of pollution to the bottom fauna.

In addition to grab samples, drift samples were also taken. In contrast to observations by Berner (1949), species composition in drift samples varied greatly from that observed in the grab samples (Tables 2.3.6-5 and 2.3.6-6). Also, the number of drift organisms averaged much lower for both June ($0.0547/m^2$) and September ($0.546/m^2$), than that observed by Berner ($0.7593/m^2$) at Boonville, Missouri on April 18, 1946. Similar low values for the Ohio River were indicated by Philip A. Lewis (personal communication, November 18, 1974, biologist, E.P.A., Cincinnati, Ohio). Drift density seemed to increase from upstream Station B-2 to downstream Station C-2. There is greater dike and revetment surface area upriver from Station C-2 than Station B-2, which could be the source of most drift organisms.

Random samples (rocks and logs removed from a revetment) taken in September at Station B-2 confirm the use of revetments by benthic species not associated with the shifting sand (grab samples). The rocks and logs had a combined surface area of 0.05 square meters and contained the following:

Taxon	Calculated density	Number collected
Turbellaria	$3100/m^2$	(155)
Oligochaeta	$60/m^2$	(3)
Amphipoda	$320/m^2$	(16)
Chironomidae	$4280/m^2$	(214)
Trichoptera	$40,180/m^2$	(2009)
Ephemoptera	$80/m^2$	(4)
Total	$48,020/m^2$	(2401)

Even taking into account the small area sampled to yield numbers per m^2, the values are very high. These values far surpass previously reported values for this and other rivers (Hynes, 1972; Needham and Needham, 1962; University of Missouri, 1972), where a major source of organic enrichment does not exist. This random sample of the revetment indicated a larger benthic food base than previously expected. However, this is an artificial substrate of sorts and would compare better with values for basket samplers. For example, basket samplers in the Wabash River near New Harmony, Indiana (August 25, 1966), yielded densities of $167,600/m^2$ (Mason, et al., 1971).

2.3.6.2 Logan Creek

Historical data concerning Logan Creek benthic fauna are apparently lacking, except for the study by Dames & Moore. Dames & Moore characterized the creek as similar to the Missouri River in species composition, with slightly higher densities, biomass, and diversity.

June 1974 samples at Station D contained 94.1 percent oligochaetes (Table 2.3.6-1), with chironomids and nematodes comprising the remainder for a total density of $3292/m^2$ (Table 2.3.6-2). Ninety-nine percent of the wet-weight biomass of $15,268/m^2$ was contributed by Branchiura sowerbyi. Species diversity was also low at 1.23.

In September, the benthos population at Station D was still dominated by oligochaetes (99.1 percent), as noted previously. Wet-weight biomass was slightly higher at 3806 mg/m^2. However, Branchiura sowerbyi dominance was replaced by Limnodrilus sp. (65.0 percent). A reduction in diversity of fauna after the June sampling resulted in a species diversity of 1.03, the lowest recorded in 2 years of study by Dames & Moore. This reduction in diversity may be the result of a toxic pollutant, such as a pesticide. Saether (1970) noted that oligochaetes are more tolerant of pesticides than chironomids. If pesticides were responsible, the effect was local because the upstream Station E had a normal assemblage of chironomids.

Another factor that may have contributed to the low diversity at Station D is the Missouri River backwater, which deposits a thick layer of ooze in the lower creek. Thick ooze of this nature often becomes anerobic and is a poor substrate for most benthic macroinvertebrates. Only chironomids and oligochaetes, which feed in the ooze and respire through anal gills exposed to the water, can survive (Brinckhurst, 1973). Also, Station D is subject to constant scouring action which limits invertebrate diversity (Hynes, 1972).

The June 1974 samples at Station E contained 79.0 percent oligochaetes and 19.2 percent chironomids (Table 2.3.6-1). Density was $892/m^2$, with a wet-weight biomass of 518 mg/m^2. Diversity increased from 1.23 at Station D to 1.70 at Station E. The greater distance of Station E, as noted above, from the confluence of Logan Creek with the Missouri River probably accounts for the major differences in diversity. Duplicate (2.5-hour sampling periods) drift nets yielded two mayflies and one midge larvae (Table 2.3.6-7). This limited catch reflects the low flows during the June sampling. Random samples in June at Station E revealed the presence of a moderately dense population of mussels, mainly Amblema sp. and Uniomerus sp.. An estimation of their density was $0.5/m^2$. Also, a limited number of Palaemonetes kadrakensis green shrimp and immature crayfish was collected in seine hauls.

September grab samples at Station E indicated an oligochaete dominance of 69.8 percent with chironomids contributing 25.6 percent. Population densities were $868/m^2$ and biomass was $946/m^2$. Species diversity increased from 1.23 in June to 2.39 in September. Station E seems to be receiving mild organic pollution: both nutrients and fecal coliforms have been reported as moderate to high (Table 2.3.1-2). The dominance of benthic fauna by oligochaetes and diversities below 2.5 support possibilities of mild pollution. The pollution source could be agricultural runoff (including cattle waste in the creek), septic tank field lines, or a combination of both. Intermittent flow, as noted by Dames & Moore (1974), could also be a limiting factor.

A summary of the benthic macroinvertebrate species collected in Logan Creek and the Missouri River is presented in Table 2.3.6-8 for the fall 1974 survey, the baseline survey, and the preconstruction survey.

TABLE 2.3.6-1

BENTHIC MACROINVERTEBRATES COLLECTED FROM THE MISSOURI RIVER AND LOGAN CREEK, JUNE 1974

Organism	Missouri River Sampling Stations A-2	B-2	H-2	C-2	Logan Creek Sampling Stations D	F
Nematoda						
Unknown sp.	P[a]	+	+	P	E[b]	E
Annelida						
Oligochaeta						
Dero sp.	P	+	+	P	E	+
Tubifex sp.	P	+	P	P	E	E
Limnodrilus sp.	P	P	P	P	E	E
Branchiura sowerbyi	+	P	+	+	E	E
Lumbriculus sp.	P	+	+	P	+	+
Crustacea						
Copepoda	+	+	+	+	+	+
Calanoida	P	P	+	R[c]	+	+
Cyclopoid	+	+	+	R	E	E
Cladocera	+	+	+	P	+	+
Amphipoda						
Crangonyx sp.	+	+	+	R	+	+
Decapoda						
Palaemonetes kadiakensis	+	+	+	+	+	R
Astacidae (immature)	+	+	+	+	+	R
Diptera						
Chironomidae						
Ablabesmyia sp.	+	+	+	+	+	R
Chironomus sp.	+	+	+	P,R	E	E
Chironomus sp. B	+	R	+	+	+	+
Cryptochironomus sp.	P	+	+	+	+	+
Tribelos sp.	+	+	+	+	+	E
Polypedilum sp.	+	+	+	R	+	+
Microtendipes sp.	+	+	+	+	+	E
Culicidae						
Chaeborus sp.	+	+	+	R	+	+
Trichoptera						
Hydropsyche sp.	+	R	+	R	+	+
Chematopsyche sp.	+	R	+	+	+	+
Ephemoptera						
Centroptilum sp.	+	R	+	+	R	+
Stenonema sp.	+	R	+	R	+	R
Paraleptophlebia sp.	+	+	+	R	+	+
Isonychia sp.	+	R	+	+	+	+
Caenis sp.	R	+	+	+	+	+

TABLE 2.3.6-1 (continued)

Organism	Missouri River Sampling Stations A-2	B-2	H-2	C-2	Logan Creek Sampling Stations D	E
Odonata						
Zygoptera	+	+	+	+	+	+
Argia sp.	R	+	+	+	+	+
Anisoptera						
Gomphus sp.	+	+	+	P	R	+
Macromia sp.	+	+	+	+	+	R
Mollusca						
Amblema sp.	+	+	+	+	+	R
Uniomeras sp.	+	+	+	+	+	R

[a]Ponar grabs

[b]Ekman grabs

[c]Random samples

TABLE 2.3.6-2

WET-WEIGHT BENTHIC MACROINVERTEBRATE BIOMASS AND DENSITIES FOR MISSOURI RIVER AND LOGAN CREEK, JUNF 1974[a]

Stations	Nematoda	Oligochaeta	Crustacea	Diptera	Odonota	Total Wet-Weight
A-2	(10) 1	(1720) 1919	(10) 5	(19) 14	+	1939
B-2	+	(912) 899	(10) 5	+	+	904
C-2	(19) 1	(1159) 1744	+	(10) 5	(10) 1938	3687
D	(43) 2	(3099) 15136	+	(150) 130	+	15268
E	(21) 1	(705) 280	+	(171) 237	+	518
H-2	+	(808) 262	+	+	+	262

[a] (number of organisms) wet-weight in mg/m^2

TABLE 2.3.6-3

BENTHIC MACROINVERTEBRATES COLLECTED FROM THE MISSOURI RIVER AND LOGAN CREEK, SEPTEMBER 1974

Organism	Missouri River Sampling Stations				Logan Creek Sampling Stations	
	A-2	B-2	H-2	C-2	D	E
Platyhelminthes						
Turbellaria	P[a]	R[b]	+	+	+	+
Annelida						
Oligochaeta						
Branchiura sowerbyi	P	P	P	P	E[c]	E
Limnodrilus sp.	P	P	P	P	E	E
Lumbriculus sp.	+	+	+	+	+	E
Crustacea						
Amphipoda						
Craygonyx sp.	+	R	+	+	+	+
Decapoda						
Astacidae (immature)	+	+	+	+	+	R
Palaemonetes kadiakensis	+	+	+	+	+	R
Diptera						
Chironomidae						
Ablabesmyia sp.	+	P	+	P	+	E
Chironomus sp.	+	P	P	P	+	E
Coelotanypus sp.	+	P	P	P	+	+
Cryptochironomus sp.	+	P	+	P	E	E
Glyptotendipes sp.	+	+	+	+	+	E
Microtendipes sp.	+	+	+	+	+	E
Pentaneurini	+	+	P	+	+	+
Procladias sp.	+	+	P	P	+	E
Polypedilum sp.	+	R	P	+	+	E
Psectrocladius sp.	+	R	+	+	+	+
Pseudochironomus sp.	+	+	+	+	+	E
Tanypodinae	P	R	+	+	+	+

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TABLE 2.3.6-3 (continued)

Organism	Missouri River Sampling Stations				Logan Creek Sampling Stations	
	A-2	B-2	H-2	C-2	D	E
Tanytarsini	+	+	+	+	+	E
Tanytarsus sp.	+	R	+	+	+	+
Culicidae						
Chaoborus sp.	+	R	P	+	+	+
Tipulidae	+	+	+	+	+	R
Tabanidae						
Tabanus sp.	+	+	+	+	+	R
Trichoptera						
Chematopsyche sp.	P	R	P	+	+	+
Hydropsyche sp.	+	P	+	+	+	+
Lype sp.	+	R	+	+	+	+
Ephemoptera						
Caenis sp.	+	R	+	+	+	E
Centroptilum sp.	+	R	+	R	+	+
Hexagenia sp.	+	P	P	P	+	+
Stenonema sp.	+	R	+	R	+	+
Megaloptera						
Sialis sp.	+	+	+	+	+	E
Odonata						
Gomphus sp.	P	P	+	+	+	+
Hemiptera						
Buenoa sp.	+	+	+	R	+	+
Gyretes sp.	+	+	+	R	E	+
Coleoptera						
Stenelmis sp.	+	+	+	R	+	+
Mollusca						
Lasmigona sp.	P	+	+	+	+	+

TABLE 2.3.6-3 (continued)

Organism	Missouri River Sampling Stations A-2	B-2	H-2	C-2	Logan Creek Sampling Stations D	E
Pisidium (*cyclocalyx*) *adamsi*	P	P	+	+	+	+
Shaerium (*musculium*) *partiumeium*	P	+	+	+	+	+

[a]Ponar grab sample

[b]Random sample

[c]Ekman Dredge Sample

TABLE 2.3.6-4

WET-WEIGHT BENTHIC MACROINVERTEBRATE BIOMASS AND DENSITIES FOR MISSOURI RIVER AND LOGAN CREEK, SEPTEMBER 1974[a]

Groups	Stations A-2	B-2	H-2	C-2	D	E
Oligochaeta	(886)1.007	(2219)3.309	(848)0.889	(743)0.893	(3057)3.656	(606)0.594
Diptera	(10)0.005	(48)0.024	(124)0.071	(162)0.081	(14)0.007	(222)0.111
Trichoptera	(10)0.005	(48)0.135	(10)0.042	+	+	+
Ephemoptera	+	(86)0.632	(19)0.322	(67)2.295	+	(10)0.008
Odonata	(10)0.430	(10)0.134	+	+	+	+
Coleoptera	+	+	+	+	(14)0.143	+
Mollusca	(67)1.710	(10)1.086	+	+	+	+
Other	(10)0.005	+	+	+	+	(10)0.233
Total/m^2	(993)3.162	(2421)5.320	(1001)1.324	(972)3.269	(3085)3.806	(868)0.946

[a](number of organisms) wet-weight in mg/m^2

TABLE 2.3.6-5

NUMBER OF BENTHIC MACROINVERTEBRATES COLLECTED
IN A METERED LARVAL NET IN THE
MISSOURI RIVER,
JUNE 23, 1974

Organism	Station B	Station C
Crustacea		
Amphipoda		
Crangonyx sp.	+	1
Diptera		
Chironomidae		
Chironomus sp.	1	1
Chironomus sp. B	1	+
Polypedilum sp.	+	1
Culicidae		
Chaoborus sp.	+	1
Trichoptera		
Hydropsyche sp.	1	1
Chematopsyche sp.	1	+
Ephemoptera		
Centroptilum sp.	3	+
Stenonema sp.	10	13
Paraleptophleba sp.	+	1
Tsonychia sp.	2	+
Caenis sp.	2	+
Odonata		
Gomphus sp.	+	1
TOTAL	20	20
DENSITY	0.0503/m^3	0.0568/m^3

TABLE 2.3.6-6

NUMBER OF BENTHIC MACROINVERTEBRATES COLLECTED IN A METERED LARVAL NET IN THE MISSOURI RIVER JUNE 23 AND SEPTEMBER 8, 1974

Organism	June 23		September 8	
	Station B	Station C	Station B	Station C
Annelida				
Oligocheate				
Limnodrilus sp.	+	+	+	1
Crustacea				
Amphipoda				
Crangonyx sp.	+	1	1	+
Diptera				
Chironomidae				
Chironomus sp.	1	1	+	+
Chironomus sp. B	1	+	+	+
Polypedilum sp.	+	1	1	3
Tanypodinae (unknown)	+	+	1	1
Culicidae				
Chaoborus sp.	+	1	4	3
Trichoptera				
Chematopsyche sp.	1	+	+	+
Hydropsyche sp.	1	1	2	6
Lype sp.	+	+	1	+
Ephemoptera				
Caenis sp.	2	+	+	+
Caenidae (unknown)	+	+	+	2
Centroptilum sp.	3	+	+	+
Hexagenia sp.	+	+	5	4
Isonychia sp.	2	+	+	+
Paraleptophleba sp.	+	1	+	+
Stenonema sp.	10	13	1	2
Odonata				
Gomphus sp.	+	1	+	+

TABLE 2.3.6-6 (continued)

Organism	June 23 Station B	June 23 Station C	September 8 Station B	September 8 Station C
Hemiptera				
Buenoa sp.	+	+	+	1
Coleoptera				
Stenelmis sp.	+	+	+	1
TOTAL	21	20	16	24
DENSITY	$0.0527/m^3$	$0.0568/m^3$	$0.0490/m^3$	$0.0603/m^3$

TABLE 2.3.6-7

NUMBER OF BENTHIC MACROINVERTEBRATES COLLECTED IN DRIFT NETS[a] IN LOGAN CREEK, JUNE 22, 1974

Organism	Station D	Station E
Crustacea		
Copepoda		
Cyclopoid	6	38
Diptera		
Chironomidae		
Ablabesmyia sp.	+	1
Ephemoptera		
Stenonema sp.	+	1
Centroptilum sp.	1	+

[a]0.135-m^2 nets

TABLE 2.3.6-8

BENTHIC MACROINVERTEBRATES COLLECTED FROM THE MISSOURI RIVER AND LOGAN CREEK DURING JULY (J-3), SEPTEMBER (S-3), DECEMBER (D-3), 1973, AND FEBRUARY (F-4), JUNE (J-4), AND SEPTEMBER (S-4), 1974

	Missouri River						Logan Creek					
Organism	J-3	S-3	D-3	F-4	J-4	S-4	J-3	S-3	D-3	F-4	J-4	S-4
Platyhelminthes												
Turbellaria						x						
Nematoda												
unknown sp.					x						x	
Annelida												
Oligochaeta												
Enchytraeidae												
unknown sp.			x	x						x		
Lumbriculidae												
Lumbriculus sp.					x							x
unknown sp.									x			
Tubificidae												
Aulodrilus pigneti									x	x		
Branchiura sowerbyi	x	x	x	x	x	x	x	x	x	x	x	x
Ilyodrilus templetoni				x								
Limnodrilus ceruix			x	x					x	x		
L. claparedeanus			x	x					x	x		
L. hoffmeisteri			x	x					x	x		
L. sp.	x	x	x	x	x	x	x	x	x	x	x	x
L. udekemianus	x		x	x					x	x		
Peloscolex sp.		x										
Tubifex sp.		x			x						x	
unknown sp.	x	x	x	x			x	x	x	x		
Naididae												
Aulophorus sp.								x				
Dero digitata			x	x					x	x		
Dero sp.					x						x	
Nais elinguis			x	x								
N. sp.										x		

TABLE 2.3.6-8 (continued)

Organism	Missouri River						Logan Creek					
	J-3	S-3	D-3	F-4	J-4	S-4	J-3	S-3	D-3	F-4	J-4	S-4
Paranais frici			x	x								
Crustacea												
Amphipoda												
Crangonyx sp.					x	x						
Hyallella azteca		x										
Decapoda												
Astacidae (immature)											x	x
Palaemonetes kadiakensis											x	x
Diptera												
Chironomidae												
Ablabesmyia janta			x									
Ablabesmyia sp.						x					x	x
Chiroromus sp.		x	x	x	x	x	x	x	x	x	x	x
Coelotanypus sp.			x			x						
Conchapelopia sp.			x									
Cricotopus exilis			x	x						x		
Cryptochironomus blarina			x									
Cryptochironomus fuluus			x	x			x		x	x		
Cryptochironomus sp.	x	x			x			x				x
Dicrotendipes sp.		x	x	x			x	x	x			
Glyptotendipes lobiferus			x							x		
Glyptotendipes senilis							x					
Glyptotendipes sp.				x				x				x
Microtendipes sp.											x	x
Orthocladius sp.				x								
Paracladopelma sp.				x					x			
Paralauterborneilla sp.	x	x	x									
Paratendipes sp.		x	x				x					
Pentaneurini (unknown)						x						
Polypedilum halterale				x					x			
Polypedilum scalaenum							x					
Polypedilum sp.		x		x	x	x	x	x				x

	Missouri River						Logan Creek					
Organism	J-3	S-3	D-3	F-4	J-4	S-4	J-3	S-3	D-3	F-4	J-4	S-4
Procladius adumbratus			x	x					x	x		
Procladius riparius	x		x	x			x		x	x		
Procladius sp	x					x						x
Psectrocladius sp.						x						
Pseudochironomus sp.		x						x	x			x
Rheotanytarsus sp.		x	x	x			x	x				
Stictochironomus sp.				x			x			x		
Tanypodinae						x						
Tanytarsini												x
Tanytarsus sp.						x						
Tendipedini		x	x									
Tribelos sp.											x	
Trichocladius sp.		x										
Trissocladius sp.			x	x					x	x		
Zavrelimyia sp.	x						x					
Culicidae												
Chaoborus punctipennis				x						x		
Chaoborus sp.		x	x		x	x		x				
Ceratopogonidae												
Bezzia sp.							x					
Unidentified sp.			x	x						x		
Psychodidae												
Psychoda sp.				x								
Tipulidae												x
Tabanidae												
Tabanus sp.												x
Trichoptera												
Chematopsyche sp.			x	x	x	x						
Hydropsyche orris			x	x								
Hydropsyche sp.					x	x						
Lype sp.						x						
Neureclipsis sp.			x									
Unidentified sp.	x											

TABLE 2.3.6-8 (continued)

Organism	Missouri River J-3	S-3	D-3	F-4	J-4	S-4	Logan Creek J-3	S-3	D-3	F-4	J-4	S-4
Ephemoptera												
Caenis sp.	x			x	x							x
Centroptilum sp.					x	x					x	
Ephemerella frisoni		x						x				
Hexagenia sp.			x			x						
Paraleptophlebia sp.					x							
Isonychia sp.					x							
Pentagenia vittigena		x										
Pentagenia sp.	x		x									
Stenonema femoratum		x						x				
Megaloptera												
Sialis sp.												x
Odonata												
Argia sp.			x									
Gomphus sp.				x	x						x	x
Macromia sp.											x	
Hemiptera												
Buenoa sp.						x						
Gyretes sp.						x						x
Coleoptera												
Dubiraphia sp.	x			x								
Stenelmis sp.						x						
Mollusca												
Gastropoda												
Ferrisia sp.			x									
Pelecypoda												
Amblema sp.											x	
Corbicula sp.		x										
Lasmigona sp.						x						
Pisidium adamsi						x						
Shaeriidae unknown				x								
Shaerium partumeium						x						
Uniomeras sp.											x	

2.3.7 FISH

2.3.7.1 Missouri River

Pflieger (1971) summarized fish collection data from 1853 to 1969 in Missouri. From these data he produced maps that note collection sites for each species of fish reported from Missouri. A tentative species list for the Callaway Plant site has been constructed from these maps (Table 2.3.7-1). The table includes 34 species known to occur in the Missouri River and 32 species in tributaries of the area. Thus, a total ichthyofauna of 67 species has occurred historically near the site.

None of the Dames & Moore collections confirmed the presence of nine species reported by Pflieger (1971). All of these species were minnows, with the exception of the black redhorse (Moxostoma duquesnei). Many minnows species in Missouri are limited to certain parts of the Missouri River. Some, for example, are restricted to the upper and others to the extreme lower parts of the river. Beçause no collections had previously been made between the Osage and Gasconade Rivers (Pflieger, 1971), where the flow differs significantly, it is logical to assume that the Callaway Plant site might have a slightly different assemblage of minnows than those reported by Pflieger.

The present study consisted of two trips, with 35 species being collected from Missouri River (Table 2.3.7-1). Twelve species collected had not been recorded by Pflieger (1971). However, five had been collected previously by Dames & Moore. Their presence reaffirms Pflieger's classification of these species as wide ranging. The remaining seven species had been reported only from tributaries by Pflieger (1971). Low summer flows probably account for their presence in the river.

During the June sampling period, 13 species of fish were captured in gill and fyke nets set in quiet waters behind dikes and revetments (Table 2.3.7-2). Greatest numbers and diversity were obtained from Transect C, which intersects the river near the mouth of Logan Creek. Although there were no clear trends in catch among stations, white crappie, freshwater drum, gar, river carpsucker, and carp were most abundant in the catch. Sport fish such as white crappie, sauger, and northern pike were captured only at Transect C. Commercially important blue catfish and flathead catfish were captured only at Transect A. Smallmouth buffalo, reported to be the second most abundant fish in commercial catches (Robinson, 1973), were not collected.

Electroshocking was conducted in June along the north and south shoreline for a period of about 4 hours but was largely unsuccessful, as only 11 fish were collected (Table 2.3.7-3). High turbidity and high river currents reduced the effectiveness of the electroshocker. Other workers have encountered similar problems with this type of gear in the Missouri River (Minter, 1972).

The September gill and fyke net collections yielded 15 species (Table 2.3.7-4). Most abundant were freshwater drum, smallmouth buffalo, goldeye, and white crappie. Northern pike, black bullheads, and sauger, all collected in June, were not present in the September collections. However, paddlefish, goldeye, smallmouth buffalo, and white bass were present only in September. Most of the seasonal differences in species composition are from species that are classed as wide-ranging (Pflieger, 1971); therefore, their ephemeral appearance in the catch is not unusual.

To put the present (June and September 1974) fish collections in perspective, a discussion by species is in order. For clarity, they will be discussed by family in phylogenetic order.

The lamprey family (Petromyzonidae) has only one representative in the Missouri River, the chestnut lamprey. Dames & Moore collected five specimens in December 1973; during the present study, none were collected. Pflieger (1971) suggests that populations are decreasing because of reduction in spawning areas.

Two of the three species belonging to the sturgeon family (Acipenseridae) in Missouri are considered rare, the lake sturgeon (Acipenser fulvenscens) and pallid sturgeon (Scaphirhynchus albus). Their presence has never been reported at the Callaway Plant site. However, the other species, the shovelnose sturgeon (Scaphirhynchus platyrhynchus), occurs at the site (Table 2.3.7-1).

The collection in September 1974 of the single member of the paddlefish family (Polydontidae) confirms the presence of paddlefish in the lower Missouri River (below confluence of the Osage River), where they have not been reported previously (Pflieger, 1971).

The gar family (Lepisosteidae) is represented by the longnose (Lepisosteus osseus) and shortnose gar (L. platostomus). Similar to findings of Pflieger (1971) and University of Missouri-Rolla (1974), the present study showed that the shortnose gar was more abundant than the longnose gar. This was true in both spring and fall collections.

The eel family (Anguillidae) is represented by the American eel (Anguilla rostrata) in Missouri. Its presence at the Callaway Plant site has not been confirmed by this or previous Dames & Moore studies. Pflieger (1971) reports collections containing eels at several up-river sites. The catadromous nature of this species predicts its presence, at least seasonally, at the Callaway plant site.

The shad family (Clupeidae) contains the gizzard shad (Dorosoma cepedianum), one of the most abundant fish in the Missouri River. Dames & Moore collections in 1973-74 confirmed its abundance at the site. Another species, skipjack herring (Alosa chrysochloris), not normally considered a resident of the lower Missouri River, has been collected both in 1973 and 1974 by Dames & Moore, although it was not collected during the present study. Pflieger (1971) characterizes the species as inhabiting open waters of large rivers and being intolerant of extreme turbidity. Its presence in the lower Missouri River may indicate a reduction in excessive turbidity.

The present collection contained one species of the mooneye family (Hiodontidae), the more common goldeye (Hiodon alosoides). Previous collections (Dames & Moore, 1974; University of Missouri-Rolla, 1974) in the area have contained the mooneye (Hiodon tergisus), which is considered rare in Missouri by Pflieger (1971).

The pike family (Esoxidae) was represented by the northern pike (Esox lucius). There is a question as to whether E. lucius has a natural population in Missouri or is present because of northern intrusion. Pflieger (1971) states that there is a possibility of a self-sustaining population in the Osage River. This is probably the source of the single specimen collected in June 1974.

The minnow family (Cyprinidae) is more diverse than any other family in the Missouri River. During the present study, 10 species were collected, including the common carp (Cyprinus carpio). It was moderate in abundance and accounted for 10 percent of the June net collection and 8 percent of the September net collection (Table 2.3.7-2 and 2.3.7-4). This species, with its granivorous nature and high fecundity (Berner, 1951), is well suited to the Missouri River.

The other minnows collected corresponded closely to those reported by University of Missouri-Rolla (1974). The emerald shiner, Notropis athernoides, was the most abundant for both spring and fall surveys. Second in abundance for the spring survey was the silver chub, Hybopsis storeriana, and for the fall the western silvery minnow, Hybognathus argyritis (Tables 2.3.7-5 and 2.3.7-6). (H. argyrtis is considered a subspecies of H. nuchalis, silvery minnow, by Bailey, et al. [1970].).

The sucker family (Catostomidae) is ecologically well suited to most large river systems. Their use of detritus, an abundant food source, and touch-taste feeding mechanism reduce effects of high turbidities (Hynes, 1972) normally associated with large rivers. At the Callaway Plant site, this family is represented by five species. All three species of the carpsucker genus, Carpiodes, have been collected. The river carpsucker (C. carpio) is by far the most prevalent species of this genus in the Missouri River (Pfleiger, 1971). The other two Carpiodes species were collected during the June 1974 survey.

The remaining sucker species, smallmouth and largemouth buffalo, found at the site are both in the same genus (Ictiobus). Pflieger (1971) and University of Missouri-Rolla (1974) both stated that the largemouth buffalo (I. cyprinellus) is the most common buffalo species in the Missouri River. However, at the site the smallmouth buffalo (I. bubalus) is more common (Union Electric Company, 1974). During the present study, the smallmouth buffalo was the only buffalo species collected.

The catfish family (Ictaluridae) is represented by four species at the site. In order of decreasing abundance, they are as follows: flathead (Pylodictis olivaris), blue catfish (Ictalurus furcatus), channel catfish (I. punctatus), and black bullhead (I. melas). Dominance of blue catfish is higher at the site than previously reported by Pflieger (1971) and University of Missouri-Rolla (1972, 1974) for the Missouri River; conversations with local fisherman support Dames & Moore's findings.

The temperate bass family (Percichthyidae) was represented by a single species, the white bass (Morone chrysops). Several authors have indicated that reduction in turbidity could account for appearance of this species.

The sunfish family (Centrarchidae) was better represented in Logan Creek than in the Missouri River. Only one species of sunfish, the bluegill (Lepomis macrochirus), was collected from the river. However, both largemouth and smallmouth bass (Microptrus salmoides, M. dolomieui) were collected in the river. Dames & Moore's collection of smallmouth bass from the river represents only the third such collection. The remaining sunfish species, white crappie (Pomoxis annualris), was quite abundant behind revetments and at the mouth of Logan Creek. It accounted for 10.2 percent of the fall and 16.2 percent of the spring net catch.

The perch family (Percidae) was represented by the sauger (Stizostedion canadense) and orangethroat darter (Etheostoma spectabile). Several young-of-the-year sauger were collected both in the spring and fall. However, adults were taken only during the spring survey. This indicates low abundance of this species or possible migration of the adults upstream during the spring.

The drum family (Sciaenidae) was represented at almost every station during both surveys by freshwater drum (Aplodinotus grunniens). This species is also common in commercial catches, being taken by net or seasonally by trotline (Robinson, 1973).

Although the fish fauna of the Missouri River is diverse, standing crops and growth rates are reported by several authors as low (Berner, 1951; Carlander, 1969; Gammon, 1970; and Robinson, 1973). Gammon (1970) attributed low productivity resulting from high turbidity as part of the cause. Berner (1951) states that channelization also lowered productivity by reducing backwater where plankton production occurs.

To aid in assessing production potential, food availability, and general suitability of the aquatic environment, condition factor (K) was calculated for the five most abundant species collected during both sampling periods (Table 2.3.7-7). Condition factors for four of the five species were either lower than values reported by Carlander (1969) or as low. [The condition factor for white crappie in the Missouri River is about equal to that attained by this species in rivers of other states, such as in Oklahoma (Houser and Bross, 1963).] This species is able to eat anything from plankton to small fish. It also is not greatly affected by turbidity or mud bottom. Therefore, it is well suited to backwater areas of the Missouri River, as its condition factor illustrates.

The other species with a near average condition factor was the carp. Berner (1951) indicated carp are seed and detritus eaters. The fluctuating water level in the river results in good seed supply at least part of the year. Gizzard shad and river carpsucker, which have a low condition factor, do not selectively eat seeds and rely mainly on detritus.

Drum condition was lower than that of either white crappie or carp. The drum has a more restricted diet than white crappie. It is not able to use plankton and must generally utilize larger food types such as fish and invertebrates.

An age and growth study was conducted on gizzard shad collected in the Missouri River during the present study. Back calculated lengths at age (Table 2.3.7-10) are slightly below the median growths reported by Carlander (1968) for Missouri, Illinois, Kentucky, Tennessee, and North Carolina. Because gizzard shad probably are able to directly derive energy, they utilize organic detritus (Baker and Schmitz 1971).

In an effort to assess the food base of the river, seining was conducted along sand bars and in backwater areas. Seine hauls in June 1974 were dominated by shiners (Notropis spp.) and chubs (Hybognathus spp.). Most abundant in all catches was the emerald shiner, reported to be the most abundant minnow in the Missouri River. The spring sample also contained numerous young-of-the-year gizzard shad, white bass, white crappie, sauger, and others. Sauger, gizzard shad, bluntnose minnow, and brook silverside were collected exclusively at night.

September 1974 seine hauls were also dominated by both adult and juvenile shiners and chubs. The western silvery minnow (Hybognathus argyntis) appeared for the first time. In addition, juveniles of several species were collected, including river carpsucker, channel catfish, largemouth bass, white bass, and sauger. Berner's (1951) seine collections contained fewer minnows and were dominated by Hybognathus spp. and Hybopsis spp.

For both fall and spring periods, approximately 300 fish were collected per 15-m haul of a 7.5-m minnow seine. This abundant population can be explained by the food habits of the collected species. They are able to utilize particulate organic matter (detritus), which is the major energy source for the river's aquatic organisms.

Larval fish data were collected during both spring and fall surveys; a metered net was used for sampling. These data serve a two-fold purpose. First, they indicate spawning use of the Missouri River and, secondly, they document the presence of possible entrainable fauna.

Results of the larval fish sampling, conducted in the spring (June 23), showed that larvae of several species were suspended in the water column and that reproduction had occurred only a short time earlier (Table 2.3.7-8). Some egg-sac larvae were less than 4mm long. Densities of fish larvae and eggs were calculated to be $0.201/m^3$ at Transect B and $0.270/m^3$ at Transect C. The difference in densities probably reflects contributions from Logan Creek and associated backwaters at Transect C. Fish eggs were collected only at Transect C.

In the fall (September 5), no larval fish were collected at Transect B, but two carp about 20 mm long were taken at Transect C. They represent a density of $0.005/m^3$.

2.3.7.2 Logan Creek

Logan Creek does not support the same species diversity as other tributaries in the area. Dames & Moore, in four collecting periods, reported 26 species from two stations, whereas Pflieger (1971) found a more diverse ichthyofauna in tributaries adjacent to the Callaway Plant site. He indicated that 32 species occur only in these tributaries. The creek's small size may account for its moderately low diversity. One of the environmental factors limiting Logan Creek diversity is its periodically low flow. During low flow periods, pools are formed where water temperatures and dissolved oxygen can become limiting to fish survival. Rapid water level change is another stress factor. The short and narrow drainage basin reduces seepage and increases volume and speed of runoff. Station D on Logan Creek suffers from additional stress of heavy silt deposits (50 to 80 cm). This silt is deposited by flood waters of the river. Because of the low gradient and current at Station D, these deposits are removed quite slowly.

Seining at Station D in June 1974 yielded a total of 10 species of fish (Table 2.3.7-5). Five of these (Shortnose gar, gizzard shad, emerald shiner, smallmouth bass, and freshwater drum) were age 0 juveniles and three (channel catfish, bluegill, and white crappie) were probably age 1 juveniles. Juvenile smallmouth are of interest because they have not been previously collected in the creek, though local fisherman catch adults. Adult smallmouth bass have also been collected from the river near Hermann, Missouri (Minter, 1972).

In September 1974 the number of species collected by seining at Station D increased from 10 to 17 (Table 2.3.7-9). Intrusion of river species into the creek accounted for most of the increase. Warmouth (Lepomis gulosus), one of the river species collected, has never been reported in collections from lower Missouri tributaries (Pflieger, 1971).

Sampling was conducted at Station E on May 30 and June 22, 1974. The May sampling yielded seven species, mainly bluegills and green sunfish (Table 2.3.7-5). Green sunfish were absent in June when

13 fish species were collected. In all, 16 species were collected at Station E in the spring of 1974.

Standing crop biomass estimates were made at Station E on both May 30th and June 22nd. During the May sampling, a 30-meter section of the creek was blocked off with minnow seines and sampled with a backpack D. C. electroshocker until the catch per unit effort was reduced sufficiently to allow a population estimate. The same procedure was used in June, with the exception that a 14.1-meter section of the stream was sampled with a minnow seine. A total of 60 fish were collected from the blocked-off area on May 30th. Regression of catch per unit effort on cumulative catch resulted in an X-intercept of 68 fish. Total biomass, extrapolated from the catch, is estimated at 2,469 g, or 24.18 kg/ha. Standing crop biomass, estimated from the regression obtained from 28 fish collected on June 22nd, was 9.265 kg/ha. The difference in the two estimates is due primarily to the large number of green sunfish present in the May sample. The June sample contained fewer sunfish and a greater diversity of smaller fish, such as minnows and gizzard shad.

On September 6th, 1974, an 18-meter section at Station E was blocked and seined. A biomass estimate of 4.342 kg/ha was calculated from the X-intercept of 68 fish. The presence of numerous juvenile fish in the sample accounted for the increase in fish numbers without a corresponding biomass increase.

Biomass at Station D was estimated by use of a beach haul seine. One-half of the seine was strung out directly across to the opposite bank. The other end was played out along the near bank. Then the near bank side of the net was seined across so as to encircle a given area. Two seine hauls sampled an area equal to about $360m^2$. Estimated biomass was 9.678 kg/ha, which almost equals the biomass of the second sampling period at Station E.

The growth rates for bluegill collected from Logan Creek during the present study are very low (Table 2.3.7-10). For example, back calculated length at age are slightly above the lowest reported for Oklahoma during the period 1952 to 1963 (Houser and Bross, 1963).

In general, the number of species and standing crop at Station E is lower that at Station D. Wide-ranging river species frequent Station D and account for most of the difference.

Summary

In summary, the water quality of the Missouri River is influenced primarily by surface drainage from undisturbed and cultivated lands, high discharge rates, and industrial and municipal pollution. Variation in most water quality parameters measured during the present, as well as earlier, studies was a function of discharge rate and the presence of suspended solids. Coliform bacteria counts increased during periods of high runoff and often exceeded state standards. Chronic pesticide contamination does not exist, though chlorinated pesticides have been detected in spring water samples. Copper concentration, earlier suggested as a possible aquatic toxicant (Union Electric Company, 1974), was found to be associated more with the concentration of suspended particulate matter than with total dissolved solids. Therefore, toxicity of copper to most aquatic organisms is not likely. Cadmium, however, is probably a component of the total dissolved solids.

Data from the present study support the contention that water quality is higher in Logan Creek than in the Missouri River. Dissolved solids, suspended solids, turbidity and coliform bacteria levels are generally lower in the creek than in the river. Dissolved oxygen is generally higher in the creek than in the river, though Station D in Logan Creek may, because of its close proximity to the river, have dissolved oxygen levels more characteristic of the river than the creek. Diurnal depletion of dissolved oxygen may occur in the lower reaches of the creek due to respiration of organically enriched bottom muds.

Low phytoplankton and zooplankton densities generally found in the river are related to excessive turbidities and lack of adjoining lentic waters. However, in the present study, seasonal fluctuations, density, and productivity of phytoplankton were unusually great. Phytoplankton densities in September were over 100 times greater than those in June and as much as 8 times greater than the highest densities reported for the lower Missouri River. Primary productivity in September, as measured by uptake of ^{14}C, was also moderately high, indicating that active photosynthesis was occurring. During the summer, river discharge rates dropped below 44,000 cfs, thus reducing turbidity and creating quiet water areas behind revetments. Prior to the September study, discharge increased from 44,000 to 89,000 cfs. Apparently, this water level increase flooded the revetments and washed phytoplankton into the river channel, thus producing the high densities observed in September. Turbidity, which was still moderately low, permitted photosynthesis to continue both in the river channel and behind revetments.

Phytoplankton densities in Logan Creek during the September study were also high, though lower than Missouri River densities. Primary productivity, however, was low at both sampling stations. It appears that the presence of large numbers of dead diatom frustrules accounted for high densities and low productivity measured in the study, though other factors, such as nutrient depletion, may be responsible for this anomaly.

Variation in benthic macroinvertebrate density, diversity, and biomass was found to be a function of river discharge and unstable substrate. High spring water levels plus the normal emergence of mayflies and chironomids resulted in low diversities and densities and the predominance of oligochaete worms in the June river samples. September samples contained a more diverse and dense assemblage of macroinvertebrates as a result of improved water quality, lower predation, and normal life cycle patterns.

Macroinvertebrate drift samples taken in the river yielded a species composition different from that found in the bottom grab samples. The source for many of the drift organisms may be channel modification structures such as dikes and revetments. Samples of rocks and logs taken from a revetment revealed the presence of species not associated with other bottom substrata. Caddis flies, chironomids, flat worms, amphipods, mayflies, and oligochaete worms were present in densities greater than 48,000/m^2.

Logan Creek benthic macroinvertebrates are similar in species composition to those in the Missouri River but usually have higher densities, biomass, and diversity. Seasonal variation in benthic macroinvertebrate diversity, biomass, and density was similar to that observed in the river and was largely influenced by the same physical and biological factors. Variation between stations is primarily related to differences in water quality and substrate. Low diversity observed previously at Station D was also noted in the present study and was the lowest recorded in 2 years of study. The most important factors affecting benthic invertebrates in the lower creek are those related to flooding and silt deposit by the river, though pesticide contamination may also play a role.

During the present study, 35 species of fish were collected in the Missouri River. Seven of these species had not been collected in the area previously but are reported as tributary species. Freshwater drum, white crappie, and river carpsucker were constantly abundant in all collections. Seasonal variation in catch was due largely to the appearance of wide-ranging species. Seine collections on sand bars and backwater areas were dominated by the emerald shiner. Numerous juvenile fish were collected, including gizzard shad, white bass, white crappie, sauger, freshwater drum, largemouth bass, and others.

Results of the larval fish sampling in June indicate that larvae of at least eight species were suspended in the water column. Densities of fish larvae and eggs were estimated at 0.201/m^3. at Transect C, suggesting that Logan Creek and associated backwaters at Transect C contributed to the catch. The September sampling yielded only two larval carp.

Seining and electroshocking in Logan Creek yielded a total of 26 species, including 12 species of juveniles. The eight species of juveniles present in the creek in May and June were mostly river species. A greater number of minnows and sunfish made up the nine species of juvenile fish present in September.

Standing crop biomass estimates from collections made at Station E in May, June, and September are 24.18 kg/ha, 9.265 kg/ha, and 4.342 kg/ha, respectively. Biomass from collections at Station D in September is estimated at 9.678 kg/ha. The appearance of wide-ranging river species at Station D accounts for the observed difference in biomass in September.

Condition factors of the five most abundant fish species collected in the Missouri River were calculated. Condition factors for carp and white crappie were about average when compared to those from other states. Gizzard shad, river carpsucker, and freshwater drum exhibited below-average condition factors.

TABLE 2.3.7-1

SPECIES OF FISH COLLECTED IN THE MISSOURI RIVER AND LOGAN CREEK

Family Species	Common Name	Collection Dates: Missouri River 1853-1969[a]	1972[b]	1973[c]	1974[d]	Logan Creek 1973-74[e]	1974[f]
Petromyzontidae							
Ichthyomyzon castaneus	Chestnut lamprey	R	x	x			
Acipenseridae							
Scaphirhynchus platorynchus	Shovelnose sturgeon	R		x	x		
Polydontidae							
Polyodon spathula	Paddlefish			x[g]	x		x
Lepisostheidae							
Lepisosteus osseus	Longnose gar	R		x	x		
Lepisosteus platostomus	Shortnose gar	R	x	x	x		x
Clupeidae							
Dorosoma cepedianum	Gizzard shad	R	x	x	x	x	x
Alosa chrysochloris	Skipjack herring			x	x		
Hiodontidae							
Hiodon alosoides	Goldeye	R	x	x	x	x	
Hiodon tergisus	Mooneye			x			
Esocidae							
Esox lucius	Northern pike			x	x		
Cyprinidae							
Cyprinus carpio	Carp	R	x	x	x	x	
Semotilus atromaculatus	Creek chub	R					
Hybopsis storeriana	Silver chub	R			x		
Hybopsis x-punctata	Gravel chub	R					
Hybopsis gracilis	Flathead chub	R			x		

Sheet 1

TABLE 2.3.7-1 (continued)

Family Species	Common Name	Collection Dates: Missouri River 1853-1969[a]	1972[b]	1973[c]	1974[d]	Logan Creek 1973-74[e]	1974[f]
Cyprinidae (continued)							
Hybopsis meeki	Sicklefin chub	R					
Phenacobius mirabilis	Suckermouth minnow	R					
Notropis atherinoides	Emerald shiner	R	x	x	x		x
Notropis rubellus	Rosyface shiner	T					
Notropis umbratilis	Redfin shiner	R		x	x	x	x
Notropis shumardi	Silverband shiner	R					
Notropis zonatus	Bleeding shiner	T					
Notropis cornutus	Common shiner	T					
Notropis boops	Bigeye shiner	T					
Notropis lutrensis	Red shiner	R			x	x	x
Notropis stramineus	Sand shiner	R			x	x	x
Notropis topeka	Topeka shiner	T					
Notropis heterolepis	Blacknose shiner	T					
Notropis volucellus	Mimic shiner	R	x				
Notropis buchanani	Ghost shiner	R					
Dionda nubila	Ozark minnow	T					
Phoxinus erythrogaster	Southern redbelly dace	T				x	
Hybognathus argyritis	Western silvery minnow	T			x		
Hybognathus placitus	Plains minnow	R	x				
Pimephales notatus	Bluntnose minnow	T			x	x	x
Pimephales promelas	Flathead minnow	T					
Campostoma anomalum	Stoneroller	T			x	x	x
Catostomidae							
Carpiodes carpio	River carpsucker	R	x	x	x	x	x
Carpiodes cyprinus	Quillback	R		x	x	x	x
Carpiodes velifer	High-finned carpsucker			x	x		
Catostomus commersoni	White sucker	R		x			
Catostomus catostomus	Longnose sucker			x			

TABLE 2.3.7-1 (continued)

Family / Species	Common Name	Collection Dates: Missouri River 1853-1969[a]	Missouri River 1972[b]	Missouri River 1973[c]	Missouri River 1974[d]	Logan Creek 1973-74[e]	Logan Creek 1974[f]
Catostomidae (continued)							
Hypentilium nigricans	Northern hog sucker	T					
Ictiobus cyprinellus	Largemouth buffalo			x			
Ictiobus bubalus	Smallmouth buffalo	R		x	x		x
Moxostoma duquesnei	Black redhorse	R					
Moxostoma erythrurum	Golden redhorse	T	x				
Moxostoma macrolepidotum	Northern redhorse	T					
Ictaluridae							
Ictalurus furcatus	Blue catfish	R		x	x		
Ictalurus melas	Black bullhead	T			x		x
Ictalurus natalis	Yellow bullhead	T			x	x	x
Ictalurus nebulosus	Brown bullhead					x	
Ictalurus punctatus	Channel catfish	R	x	x	x		x
Plyodictis olivaris	Flathead catfish	R	x	x	x		
Noturus exilis	Slender madtom	T					
Cyprinodontidae							
Fundulus catenatus	Northern studfish	T					
Fundulus olivaceus	Blackspotted topminnow	T					
Fundulus notatus	Blackstripe topminnow	T			x	x	x
Poeciliidae							
Gambusia affinis	Mosquitofish	T			x	x	x
Atherinidae							
Labidesthes sicculus	Brook silverside	T			x	x	x
Percichthyidae							
Morone chrysops	White bass		x	x	x		

TABLE 2.3.7-1 (continued)

Family Species	Common Name	Collection Dates: Missouri River 1853-1969[a]	1972[b]	1973[c]	1974[d]	Logan Creek 1973-74[e]	1974[f]
Centrarchidae							
Micropterus dolomieui	Smallmouth bass	T	x		x		x
Micropterus salmoides	Largemouth bass	R		x	x	x	x
Lepomis gulosus	Warmouth						x
Lepomis cyanellus	Green sunfish	T			x	x	x
Lepomis humilus	Orangespotted sunfish	T					
Lepomis megalotis	Longear sunfish	T			x	x	x
Lepomis macrochirus	Bluegill	R	x	x	x	x	x
Pomoxis annularis	White crappie	R	x	x	x	x	x
Percidae							
Stizosteidon canadense	Sauger	R	x	x	x		
Percina phoxocephala	Slenderhead darter	T					
Percina caprodes	Logperch	T				x	
Etheostoma nigrum	Johnny darter	T				x	
Etheostoma spectabile	Orangethroat darter	T			x		x
Etheostoma flabellare	Fantail darter	T					
Etheostoma punctulatum	Stippled darter					x	
Etheostoma exile	Iowa darter					x	
Sciaenidae							
Aplodinotus grunniens	Freshwater drum	R	x	x	x	x	x

[a] River (R) and tributary (T) collections reported by Pflieger (1971).

[b] Collected from one station at Hermann, Missouri (Missouri River Environmental Inventory, 1972). An unidentified *Notropis* species was also collected near Hermann, but has not been included in the table.

[c] Collected from five stations near the site area by Dames & Moore, July, September, and December, 1973.

[d] Collected from six stations by Dames & Moore, June, 1974.

[e] Collected from two stations by Dames & Moore, July, September and December, 1973 and February, 1974.

[f] Collected from two stations by Dames & Moore, June and September, 1974.

[g] Observed during the survey, but not collected.

TABLE 2.3.7-2

TOTAL NUMBER AND LENGTH RANGE OF FISHES COLLECTED WITH GILL AND FYKE NETS FROM THE MISSOURI RIVER, JUNE 1974[a]

Common Name	Station A-North End		Station A-South End		Station B-South End		Station B-North End	
	Number	Length	Number	Length	Number	Length	Number	Length
Shovelnose sturgeon	+	+	2	430(467)490	+	+	+	+
Longnose gar	+	+	1	615	+	+	1	605
Shortnose gar	+	+	+	+	+	+	+	+
Gizzard shad	+	+	+	+	+	+	+	+
Northern pike	+	+	+	+	+	+	+	+
Carp	+	+	2	300(385)470	+	+	2	248(337)425
River carpsucker	+	+	+	+	1	377	+	+
Blue catfish	1	210	1	805	+	+	+	+
Black bullhead	1	200	+	+	+	+	+	+
Flathead catfish	+	+	1	705	+	+	+	+
White crappie	+	+	+	+	+	+	+	+
Sauger	+	+	+	+	+	+	+	+
Freshwater drum	+	+	+	+	+	+	3	225(267)309

Common Name	Station H-South End		Station C-North End		Station C-South End	
	Number	Length	Number	Length	Number	Length
Shovelnose sturgeon	+	+	+	+	1	530
Longnose gar	+	+	+	+	1	965
Shortnose gar	+	+	+	+	4	525(562)570
Gizzard shad	+	+	+	+	2	282(287)292
Northern pike	+	+	1	666	+	+
Carp	+	+	+	+	+	+
River carpsucker	1	377	+	+	2	401(412)422
Blue catfish	+	+	+	+	+	+
Black bullhead	+	+	+	+	+	+
Flathead catfish	+	+	+	+	+	+
White crappie	+	+	1	185	5	178(210)250
Sauger	+	+	1	308	1	423
Freshwater drum	+	+	+	+	3	114(204)340

[a]Total length range (mm) with mean length in parentheses.

TABLE 2.3.7-3

TOTAL NUMBER AND LENGTH RANGE OF FISHES COLLECTED WITH A BOOM ELECTROSHOCKER IN THE MISSOURI RIVER, JUNE 1974[a]

Common Name	Station B-North End Number	Length	Station C-North End Number	Length
Shortnose gar	2	490;517	3	565(582)618
Gizzard shad	+	+	2	210;214
Carp	+	+	1	432
White crappie	+	+	1	185
Freshwater drum	+	+	2	231;234

[a]Total length range (mm) with mean length in parentheses.

TABLE 2.3.7-4

TOTAL NUMBER AND LENGTH RANGE OF FISHES COLLECTED WITH GILL AND FYKE NETS FROM THE MISSOURI RIVER, SEPTEMBER 1974[a]

Common Name	Station A-South End		Station B-South End		Station B-North End		Station H-North End		Station C-North End	
	Number	Length	Number	Length	Number	Length	Number	Length	Number	Length
Shovelnose sturgeon	1	430	+	+	+	+	+	+	+	+
Paddlefish	+	+	+	+	+	+	1	910	+	+
Longnose gar	+	+	1	1366	1	630	2	550(553)555	+	+
Shortnose gar	+	+	+	+	3	484(556)604	5	415(508)649	+	+
Gizzard shad	+	+	1	306	+	+	10	320(342)374	2	457(494)530
Goldeye	+	+	1	263	16	260(277)300	1	259	12	71(170)329
Carp	+	+	1	485	4	450(493)534	5	320(397)450	+	+
River carpsucker	+	+	1	420	+	+	7	391(405)415	+	+
Smallmouth buffalo	+	+	+	+	12	275(373)427	1	340	1	77
Blue catfish	2	460(465)470	+	+	+	+	+	+	+	+
Channel catfish	+	+	+	+	1	163	1	540	+	+
Flathead catfish	+	+	+	+	1	91	+	+	+	+
White bass	+	+	+	+	+	+	+	+	1	130
White crappie	+	+	+	+	1	320	+	+	12	77(206)261
Freshwater drum	+	+	+	+	13	65(134)395	4	66(79)90	2	84(102)119

[a] Total length range (mm) with mean length in parentheses.

TABLE 2.3.7-5

TOTAL NUMBER AND LENGTH RANGE OF FISHES COLLECTED WITH SEINES IN THE MISSOURI RIVER AND LOGAN CREEK, JUNE 1974[a]

Common Name	Station B June 22		Station B-South June 23		Station H June 22		Station D June 22		Station E June 22		Station E May 30	
	Number	Length	Number	Length	Number	Length	Number	Length	Number	Length	Number	Length
Longnose gar	+	+	1	57	+	+	+	+	+	+	+	+
Shortnose gar	+	+	+	+	+	+	1	59	+	+	+	+
Skipjack herring	+	+	7	16(28)35	+	+	+	+	+	+	+	+
Gizzard shad	18	21(27)40	13	22(30)65	1	27	2	33(34)35	9	131(186)322	1	244
Stoneroller	14	35(54)64	2	46-60	+	+	+	+	+	+	+	+
Flathead chub	1	95	+	-	+	+	+	+	+	+	+	+
Silver chub	+	+	46	18(25)34	+	+	+	+	+	+	+	+
Emerald shiner	96	19(30)60	368	17(22)30	47	19(21)27	4	23(25)27	13	36(50)62	1	61
Red shiner	+	+	+	+	+	+	+	+	1	70	+	+
Redfin shiner	+	+	+	+	+	+	+	+	5	54(58)61	+	+
Bluntnose minnow	21	17(22)30	+	+	+	+	+	+	46	15(27)62	+	+
Quillback	+	+	+	+	+	+	+	+	2	139(145)151	+	+
Smallmouth buffalo	+	+	2[b]	21(22)23	2[b]	20(23)26	+	+	1	287	+	+
Channel catfish	+	+	+	+	+	+	5	85(98)137	+	+	+	+
Black bullhead	+	+	+	.	+	+	+	+	+	+	1	95
Blackstripe topminnow	+	+	+	+	+	+	+	+	4	54(59)65	9	51(60)75
Mosquitofish	+	+	+	+	+	+	1	30	1	31	+	+
Brook silverside	3	18(22)25	+	+	+	+	+	+	+	+	+	+
White bass	1	22	13	18(27)35	2	19(23)26	+	+	+	+	+	+
Green sunfish	+	+	+	+	+	+	+	+	+	+	16	61(131)170
Longear sunfish	+	+	+	+	+	+	+	+	25	61(103)129	3	98(107)112
Bluegill	+	+	+	+	+	+	1	56	21	78(109)132	32	91(116)175
Sunfish hybrid	+	+	+	+	+	+	+	+	1	98	+	+
Smallmouth bass	+	+	1	37	+	+	5	27(43)58	1	33	+	+
White crappie	+	+	2	18(22)25	+	+	2	87(100)112	3	164(168)174	+	+
Orangethroat darter	+	+	+	+	+	+	1	22	+	+	+	+
Sauger	7	44(61)91	+	+	1	67	+	+	+	+	+	+
Freshwater drum	+	+	4	27(29)30	+	+	4	22(25)27	+	+	+	+

[a] Total length range (mm) with mean length in parentheses.

[b] May be *Carpiodes* sp.

[+] Not observed.

TABLE 2.3.7-6

TOTAL NUMBER AND LENGTH RANGE OF FISHES COLLECTED WITH SEINES IN MISSOURI RIVER, SEPTEMBER 5, 1974

Common Name	Station B		Station B-South		Station H	
	Number	Length	Number	Length	Number	Length
Skipjack herring	1	75	+	+	+	+
Gizzard shad	3	66(71)80	11	71(145)278	24	33(101)275
Flathead chub	2	42(58)73	+	+	+	+
Silver chub	+	+	15	28(45)62	3	61(65)70
Emerald shiner	77	27(43)72	330	24(36)42	88	23(45)64
Red shiner	+	+	41	28(40)47	+	+
Silvery minnow	22	27(48)80	+	+	+	+
Bluntnose minnow	+	+	8	28(45)62	+	+
River carpsucker	32	45(59)67	8	45(48)51	3	30(32)33
Channel catfish	3	57(59)62	+	+	+	+
Mosquitofish	+	+	2	25(26)26	+	+
White bass	+	+	1	65	2	95(100)104
Bluegill	1	43	6	25(36)48	2	20(24)28
Largemouth bass	+	+	4	25(36)48	+	+
White crappie	+	+	+	+	4	56(71)100
Orangethroat darter	+	+	+	+	2	30(31)31
Sauger	+	+	+	+	1	72
Freshwater drum	2	88(99)109	+	+	+	+

TABLE 2.3.7-7

CONDITION FACTOR AND LENGTH-WEIGHT REGRESSIONS FOR FIVE SPECIES OF MISSOURI RIVER FISH COLLECTED, JUNE AND SEPTEMBER 1974

Species	Condition Factor		Length-Weight Regressions
Gizzard shad (male)	(19)[a]	0.929	log W = -4.87 +2.93 log L
Gizzard shad (female)	(19)	0.971	log W = -5.42 +3.16 log L
Gizzard shad (combined)	(38)	0.950	log W + -5.32 +3.12 log L
Carp	(15)	1.353	log W + -4.83 +2.98 log L
River carpsucker	(21)	1.217	log W + -4.46 +2.82 log L
White crappie (male)	(9)	1.560	log W = -2.15 +1.82 log L
White crappie (female)	(7)	1.654	log W = -4.76 +2.98 log L
White crappie (combined)	(22)	1.546	log W = -2.77 +1.34 log L
Freshwater drum	(12)	1.352	log W = -5.73 +3.36 log L

[a]Number of specimens used for calculation.

TABLE 2.3.7-8

LARVAL FISH COLLECTED WITH A METERED TOW NET FROM THE MISSOURI RIVER, JUNE 23, 1974

Species	Transect B			Transect C		
	Number	Total Length (mm)	No./m^3	Number	Total Length (mm)	No./m^3
Alosa chrysochloris	4	10-15	0.010	2	20-24	0.006
Dorosoma cepedianum	15	6-13	0.377	39	4-12	0.111
Micropterus spp.	2	6-7	0.005	12	6-9	0.034
Notropis spp.	12	4-10	0.030	28	4-7	0.079
Cyprinus carpio	2	22-27	0.005	+	+	+
Morone chrysops	3	6-8	0.007	+	+	+
Centrarchidae species	3	<4	0.007	+	+	+
Unidentified species	39	<4	0.098	14	<4	0.040
Unidentified fish eggs	+	+	+	3	+	(0.008)
TOTAL	80		0.201	98		0.270

TABLE 2.3.7-9

TOTAL NUMBER AND RANGE OF FISHES COLLECTED WITH SEINES IN LOGAN CREEK, SEPTEMBER 6, 1974

Common Name	Station D		Station E	
	Number	Length	Number	Length
Shortnose gar	1	515	1	
Gizzard shad	8	75(162)265	+	331
Stoneroller	+	+	4	45(51)67
Silver chub	9	29(37)52	+	+
Emerald shiner	34	31(39)65	+	+
Red shiner	1	60	+	+
Redfin shiner	7	53(60)67	+	+
Sand shiner	8	30(37)47	6	27(35)49
Bluntnose minnow	+	+	7	33(35)38
Carpiodes spp.	5	44(52)62	+	+
Smallmouth buffalo	1	186	+	+
Carp	2	216(241)266	+	+
Channel catfish	1	75	+	+
Blackstripe topminnow	+	+	4	30(44)72
Mosquitofish	4	29(30)32	+	+
Green sunfish	+	+	6	25(42)69
Longear sunfish	+	+	1	97
Bluegill	15	30(55)108	4	30(49)103
Largemouth bass	1	228	+	+
Warmouth	1	142	+	+
White crappie	10	129(155)187	+	+
Orangethroat darter	+	+	2	38(39)41
Freshwater drum	6	57(79)97	+	+

TABLE 2.3.7-10

MEAN BACK-CALCULATED TOTAL LENGTH (mm) AT END OF EACH YEAR OF LIFE OF BLUEGILL AND GIZZARD SHAD COLLECTED IN 1974

Bluegill

Year Class	Number of Fish	Age 1	2	3	4
1973	4	84			
1972	31	63	91		
1971	9	62	95	111	
1970	5	55	85	122	137
mean length		66	90	116	137
mean increment		66	30	26	21

Gizzard Shad

Year Class	Number of fish	Age 1	2	3	4
1973	6	126			
1972	10	148	218		
1971	25	142	208	260	
1970	1	104	170	268	317
mean length		130	199	264	317
mean increment		130	68	75	53

2.4 ECOLOGICAL SUMMARY

Abundance and diversity of aquatic biota near the Callaway Plant site have been characterized as limited by excessive turbidity, high discharge rates, and lack of quiet backwater area. The following discussion highlights some of the more important features of the aquatic ecosystem as they are related to these limiting factors.

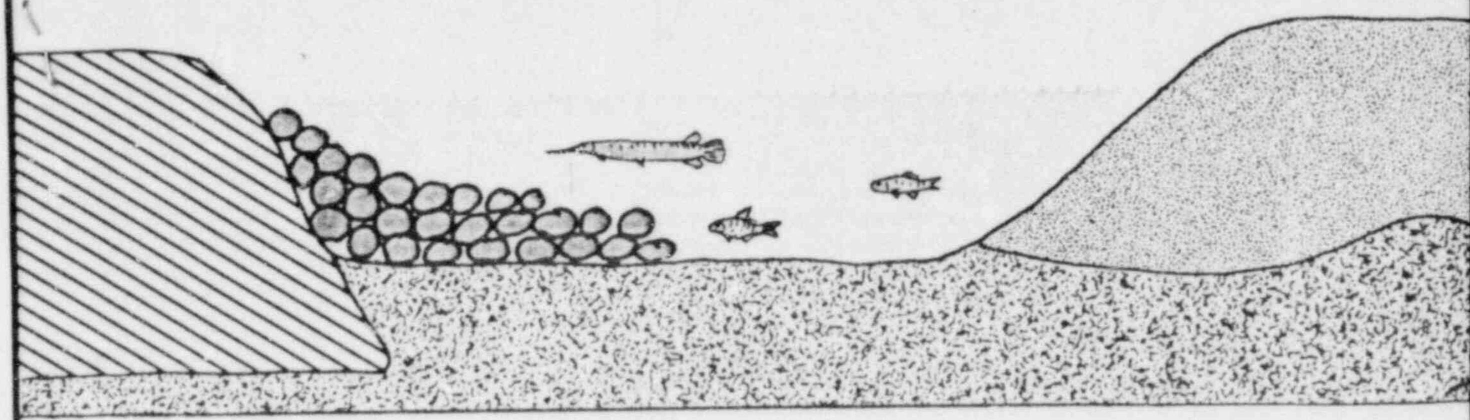
Low primary productivity in the Missouri River has resulted from heavy silt loads, which reduce the amount of light available for photosynthesis by planktonic and periphytic algae. Because primary productivity is low, the major source of energy available to the aquatic community is from terrestrial plant and animal materials in the watershed. This energy source, available directly to both invertebrates (zooplankton, benthic invertebrates) and to vertebrates (fish) can result in short food chains. For example, several of the minnows that provide forage to other fishes can utilize organic detritus directly. Bottom feeders such as the carp probably derive a portion of their energy from detritus.

The single most important feature of the lower Missouri River near the site is its physical nature, resulting from channelization. The channel modification structure blocks side channels and backwater areas and increases the flow. Nearly every aspect of the aquatic ecosystem is subsequently affected. Quiet backwaters, important as plankton-producing areas, spawning sites for fish, and nursery areas for fish larvae are eliminated. As a result, tributary streams such as Logan Creek likely receive increased pressure as a substitute for lost lentic areas. The importance of Logan Creek as a spawning area was shown in this study. That lentic areas are important for plankton production is illustrated by the findings of the present study with regard to phytoplankton production behind revetments. Moreover, high flow rates, siltation, and fluctuating water level resulting from channelization limit the production of bottom-dwelling organisms.

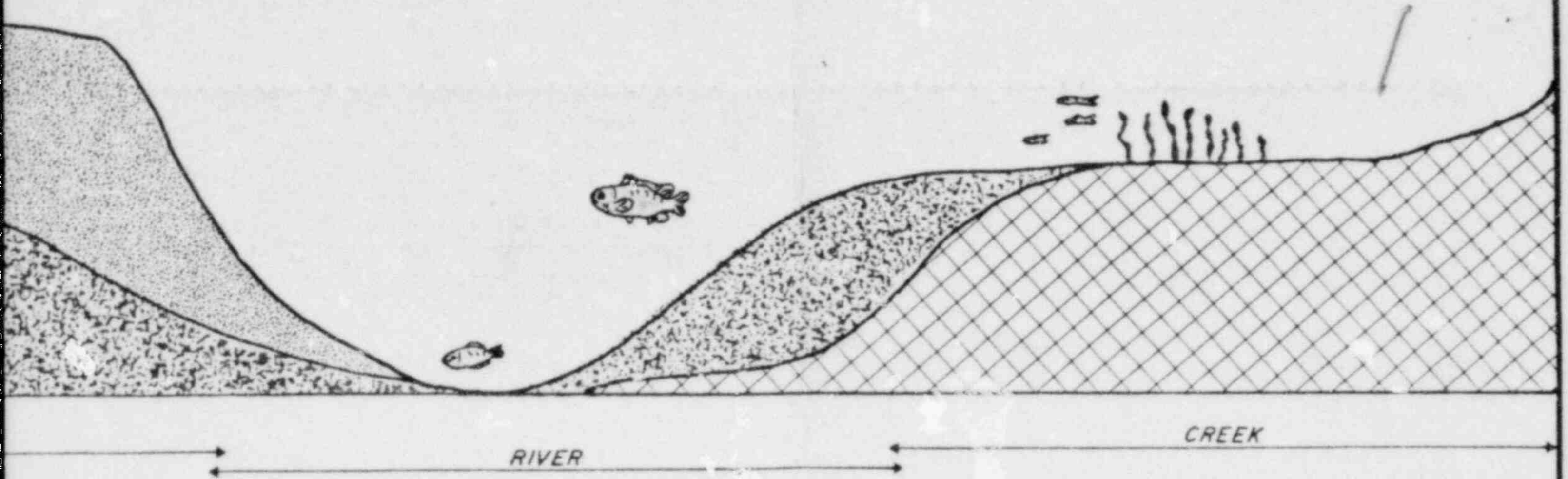
At the Callaway Plant site study area, several L-head dikes and revetments exist on both sides of the river. Different aquatic habitats such as open river channels, sand bars, reveted areas, and creek can be distinguished on the basis of associated biota as well as by physical features. The major components of these associations are presented in Figure 2.4-1. Logan Creek, being less physically stressed, has, for example, a proportionately different assemblage of benthic macroinvertebrates than has the river. The creek also has resident populations of fish, dominated by sunfish and minnows. The energy source to the Logan Creek biota is also largely from terrestrial sources, although phytoplankton productivity is undoubtedly higher as a result of low turbidities.

Numerous minnows were collected on the sand bars and quiet water areas closed off by the bars. Juvenile fish of several species were also collected and a diurnal difference in catch was noted. Several species probably move to the shallows at night to feed.

The revetments were found to contain high densities of macroinvertebrates of a species composition different from that found on the river bottom. These macroinvertebrates are probably the source of a portion of the drift organisms collected in the open channel. Also, the organisms found on the revetment probably are a food source to several species of fish. During the winter months of low flow, the dikes and revetments provide protective areas where fish are known to congregate. Commercial fishermen near the study site take advantage of this phenomenon to increase their catches.



DIKES AND REVETMENTS	SAND BARS
PHYTOPLANKTON (NO COLLECTIONS)	(NO COLLECTIONS)
ZOOPLANKTON SESSILE ROTIFERS	(NO COLLECTIONS)
HYDROPHYTES NONE	NONE
BENTHIC MACRO-INVERTABRATES CADDIS FLY LARVAE MIDGE FLY LARVAE FLAT WORMS AMPHIPODS MAYFLIES OLIGOCHAETE WORMS	(NO COLLECTIONS)
FISH SHORTNOSE GAR LONGNOSE GAR GIZZARD SHAD RIVER CARPSUCKER FRESHWATER DRUM CARP	EMERALD SHINER SILVER CHUB GIZZARD SHAD FRESHWATER DRUM RIVER CARPSUCKER SILVERY MINNOW



RIVER	CREEK
CENTRIC DIATOMS PENNATE DIATOMS	PENNATE DIATOMS CENTRIC DIATOMS
ROTIFERS	ROTIFERS
NONE	PONDWEED WATER PLANTAIN SEDGES
MAYFLY LARVAE (DRIFT) CADDIS FLY LARVAE (DRIFT) MIDGE FLY LARVAE (DRIFT) MIDGE FLY LARVAE (BOTTOM) OLIGOCHAETE WORMS (BOTTOM) MAYFLY LARVAE (BOTTOM)	OLIGOCHAETE WORMS MIDGE FLY LARVAE MAYFLY LARVAE
GIZZARD SHAD LARVAE SHINER LARVAE SKIPJACK HERRING LARVAE WHITE BASS LARVAE CARP LARVAE BASS LARVAE SUNFISH LARVAE	EMERALD SHINER BLUEGILL LONGEAR SUNFISH WHITE CRAPPIE GREEN SUNFISH BLUNTNOSE MINNOW GIZZARD SHAD

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Figure 2.4-1

2.5 CONCLUSIONS AND RECOMMENDATIONS

The results of this report, though they add substantially to the data base collected at the site, do not contradict the conclusions regarding the potential impact of the plant put forth in the Callaway Plant Units 1 and 2, Environmental Baseline Inventory, Annual Report. To reiterate, major factors influencing the aquatic system near the site appear to be channelization, turbidity, and surface run-off. Turbidity and water quality changes from surface run-off are directly related to channelization. Channelization results in a more immediate transport of run-off water downstream and prevents normal modification of water quality. Channelized water, having a greater velocity, reduces the possibility of suspended particles settling out of the water column and increases the erosional potential that results in higher turbidities. Channelization also has resulted in elimination of productive backwaters and marshy habitats. Because of this, tributaries to the Missouri River have become increasingly important as aquatic habitats, especially if they provide spawning and nursery sites for fish.

The plant intake and discharge structures were located so as to minimize any of the Callaway Plant's adverse ecological effects, especially with regard to Logan Creek. The intake structure was designed to reduce impingement of fish and the discharge effluent to meet water quality standards. Because of these construction and operational considerations, and the already limited biota production in this section of the Missouri River, no major impacts are anticipated.

Since Logan Creek may be an important spawning creek, it is recommended that sampling frequency during spawning be increased over that in the first year of the preoperational monitoring program. The recommended program for determining spawning intensity in Logan Creek is as follows: When the temperature of Logan Creek reaches about 60° F (late April), the first of two samples to be taken during a 2-week period will be made to measure early spawning activities. For measuring late spawning activities, a second sample will be made about 2 weeks following the first sample. Allowing time for sampling, spawning intensity will have been measured over a time period of about 6 weeks. During the second sampling period, routine data on benthos and fish will be collected. This sampling period coincides with 1973 and 1974 samples. Thus the sampling for the aquatic program should consist of a winter, spring and early summer, and fall sampling.

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3. TERRESTRIAL ECOLOGY

3.1 INTRODUCTION

The Callaway Plant site is located on the Coates Plateau in Auxvasse Township (T-46-N, R-8-W), the southeastern portion of Callaway County, Missouri. The small town of Reform, centrally located within the plant site, is about 350 feet higher than and 5.75 miles south of the Missouri River. The plant site, primarily the northeastern and southwestern sectors, is variously dissected by drainageways. Site topography is rolling to steeply rolling in character. In general, the rougher terrain supports forest vegetation, some of which is grazed, and the more level areas have been or are being utilized as pasture and for production of annual agricultural crops.

A broad-based environmental baseline inventory of the Callaway Plant site was conducted in 1973-74. The objectives of this investigation were:

a. to record and describe "important" species of flora and fauna in the site area during all four seasons of the year

b. to provide baseline data that could be used to develop a monitoring program for detecting impacts of plant construction and operation on the environment

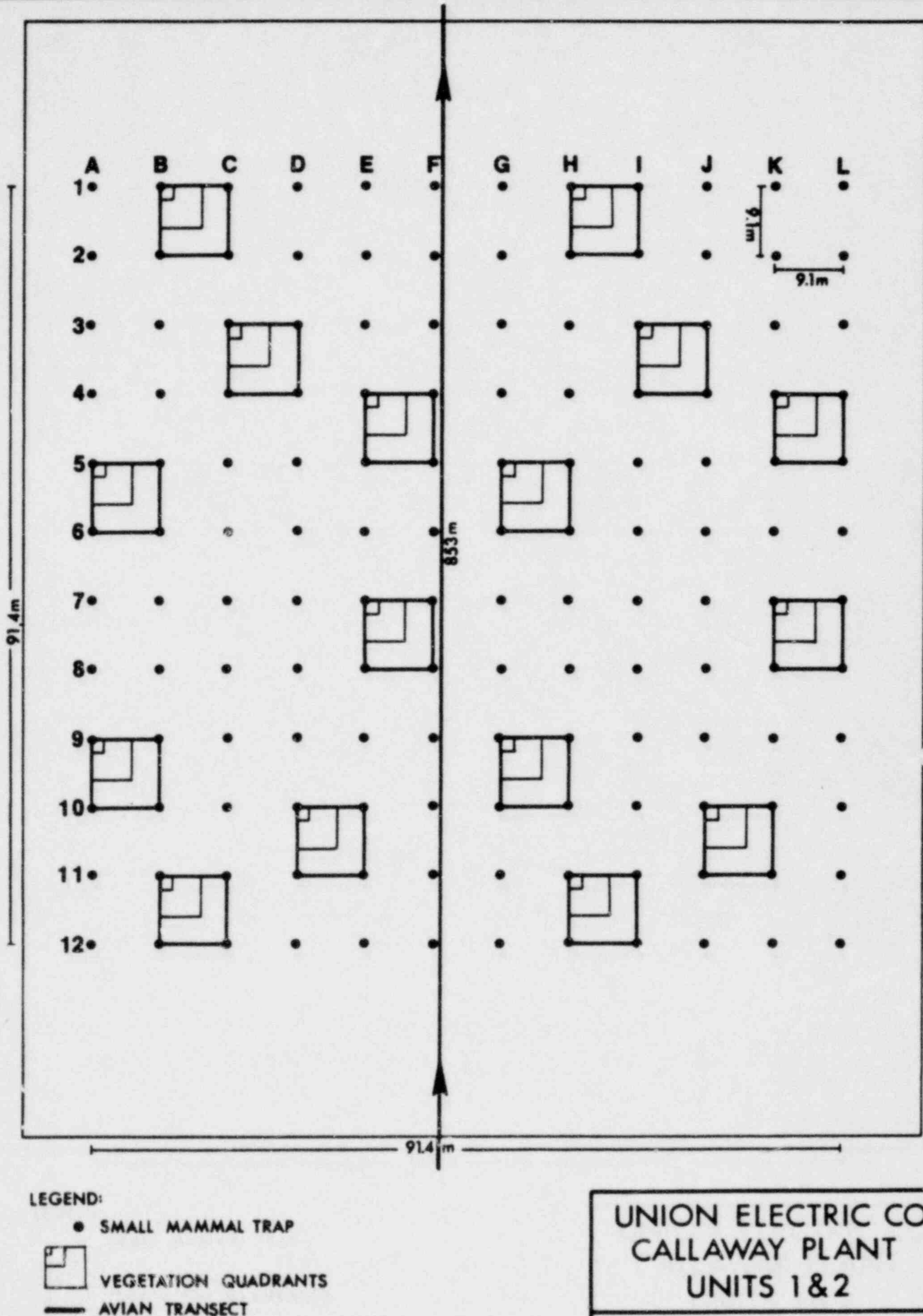
c. to offer recommendations to the Union Electric Company concerning effects of construction on any "unique or unusual" habitat, animals, or a combination of these two life forms found within zones of direct impact

The terrestrial sampling for the preconstruction phase of the environmental monitoring program was initiated at the Callaway Power Plant site in spring, midsummer, and fall of 1974.

The objectives of the monitoring program are generally complementary to those of the previously completed baseline studies. However, the orientation of investigation differs. Whereas the baseline study was a broad-based investigation to characterize the factors or components of the plant site environment, the focus of monitoring studies is to intensively document ecological relationships of selected, permanent sampling stations for the purpose of detecting changes in the natural system. The stations were strategically located at varying distances and bearings from, and outside of, the area to be directly impacted by site development.

The data collected in the three samples are presented and summarized in this report. The purpose of this report is to determine the suitability of the sampling design for achieving the monitoring program objectives and to discuss the ecological relationships among the major environmental components.

This part of the report is organized into six major sections: Introduction, Methods and Materials, Results and Discussions, Terrestrial Ecological Summary, Conclusions and Recommendations, and References. Most major sections are divided into subsections, the number of which depends on the complexity of the subject matter. The Methods and the Results and Discussions are subdivided by broad terrestrial parameters (Vegetation, Mammals, Birds, Amphibians and Reptiles, and Invertebrates). The text ends with a Conclusion and Recommendations section that attempts to relate survey data to potential environmental impact from plant construction and operation.



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DESIGN OF THE 2.5 ACRES TERRESTRIAL STUDY PLOT

Figure 3.2-2

1. Total Density (plants/acre) = $\frac{43{,}560 \text{ sq ft (1 acre)}}{\text{mean area } (ft^2) \text{ of plants}}$

2. Relative Density = $\frac{\text{Number of individuals/species}}{\text{Number of individuals of all species}} \times 100$

3. Frequency of Species = $\frac{\text{Number of times individual species occurs}}{\text{Total number of times all species occur}}$

4. Relative Frequency = $\frac{\text{Frequency of individual species}}{\text{Sum of frequencies of all species}} \times 100$

5. Basal Area per Tree = $\frac{\text{Total basal area}}{\text{Number of trees}}$ (overstory only)

6. Relative Dominance = $\frac{\text{Total basal area of one species}}{\text{Total basal area of all species}} \times 100$ (overstory only)

7. Total Basal Area = Mean area x density (overstory only)

8. Importance Value = (Relative density + relative dominance + relative frequency)
(adapted from Curtis and Cottam, 1956)

In addition to the overstory and understory sampling conducted during the fall 1973 field effort, increment core samples were taken of the major overstory species.

At the laboratory, the core was mounted in a position to vertically expose the vascular structures. Once mounted, the core was macroscopically and microscopically viewed, aged, and characterized by observing any "signatures" of cyclic or unique occurrences indicating the prehistory of the site. This data was then tabulated to further characterize each of the sampled locations.

The general layer vegetation for each of the eight sampling stations was surveyed in the spring, summer (early August) and fall (early September). Ground layer vegetation surveying was limited to herbaceous species and woody plants of less than 20 inches in height.

The sampling procedure (for spring and fall samples) consisted of clipping all ground layer vegetation from quadrats located within vegetation survey subplots as shown in Figure 3.2-1. The area of the clipped quadrats used to sample forest habitat was 0.25 milacres (3.3 x 3.3 feet) and for prairie vegetation, 0.125 milacres in size. Clipped vegetation was sorted and packaged by species. Individual bags were coded in accord with field identification, with subplot and sampling station numbers. Matching voucher specimens of species occurring in subplots were collected in the immediate area. The specimens were placed in press and later forwarded to Dr. D. B. Dunn of the University of Missouri for identification.

Clipped vegetation was transported to the Dames & Moore Laboratory in Cincinnati, Ohio, where the materials were oven dried and weighed. Net oven dry weights were recorded in grams according to species and the subplot and sampling station from which the species were collected.

For the midsummer (August 1974) vegetation sampling, incidental species not previously identified or collected during the spring sampling period were collected. This was done by walking transects through each plot and collecting plants not observed during the spring survey.

Relative frequency and relative dominance based on proportional dry weights were calculated for each species occurring at a given sampling station. Relative frequency and dry weight values were summed to provide a quantitative estimate of the importance (importance values) of individual species in the compositions of ground layer vegetation of respective forest and prairie communities. These values are also shown in the above-mentioned appendices. Species percent frequency, dry weights and importance values were further utilized to characterize and compare ground layer vegetation of the sampling stations as will be made apparent in following discussion.

As part of the monitoring program, certain soil chemical properties were examined. At each sample location, samples were collected at a depth of 3-4 inches with a soil auger. The chemical analysis procedures are similar to those recommended by the Environmental Protection Agency; the analyses were conducted at Dames and Moore's Environmental Laboratory (Cincinnati, Ohio).

The following chemical properties of the soil were determined: ph, total nitrogen, available phosphorus, potassium, calcium, sodium and magnesium; the following heavy metals were also determined: arsenic, cadmium, chromium, copper, lead, mercury, and manganese. An analysis for herbicide and pesticide residues in the soil was also performed. The herbicide and pesticide analyses were performed by abc Analytical Bio Chemistry Laboratories, Inc., Columbia, Missouri.

3.2.2 MAMMALS

Rodents were censused by the trap-and-recapture methods described by Smith, Jorgensen, and Tolley (1972) and Smith and Jorgensen (1974). Trapping grids were established on each of eight permanent sampling stations--four in deciduous forest habitats and four in grassland habitats. Each trapping grid entailed use of 144 Sherman live traps; one trap was placed near each of 144 wooden stakes located at right angles to and 30 feet apart from one another. Stakes were arranged in a geometric square, 12 stakes to a side, encompassing 2.5 acres (Figure 3.2-2). The sampling area of each grid extended one-half trap distance (15 feet) beyond the staked perimeter; thus, the effective trapping area was 2.98 acres per grid. Traps were set for 6 consecutive nights during each of the two sampling periods, spring and fall. Thus, for each sampling period and permanent sampling station, a total of 864 trap nights occurred; and for each major habitat type (prairie and forest), trap nights were 3,456 (864 x 4). During the spring survey, trapping occurred from May 31 to June 5, and for the fall survey from September 18 to September 23.

All traps were baited daily with a mixture of peanut butter and oatmeal. Traps in forest habitats were checked for captures and baited each morning, while traps in grassland habitats were baited each evening and checked for captures each morning. Captured animals were marked by toe clipping, and species, sex, age class, reproductive condition, and capture location on the grid were recorded. When sufficient captures permitted, 10 animals of each species were anesthetized with methoxyfluorane (Richins, Smith, and Jorgensen, 1974), and total tail, ear, and hind foot length measurements were recorded. These measurements were compared to published data to verify field identifications.

A computer program (Smith, Jorgensen, and Tolley, 1972) was used to derive small mammal population estimates from the data obtained from the trap-and-recapture program for each of the eight permanent sampling stations. Population estimates were then converted to density estimates by the following formula:

$$\text{Population density} = \frac{\text{population estimate}}{\text{effective trapping area}}$$

Population density estimates are herein expressed as numbers/acre for each species. Age class - sex relationship of species occurring within each permanent sampling station are also estimated.

Thirty snap-traps, baited with a peanut butter and oatmeal mixture, were set in prairie habitat for four nights (June 5, 1974 to June 9, 1974) to obtain voucher specimens to aid in identification.

Because the cottontail rabbit is a naturally-occurring primary consumer as well as an important prey species for a variety of predators, the status of the rabbit population is particularly relevant to a monitoring program. An automobile survey of about 13 miles on local roads was used to survey the cottontail rabbit. The survey techniques are similar to those described by Lord (1959). The locations of the census route and the schedule of route surveys was adopted to correspond with time and travel requirements of investigators conducting small mammal surveys at the various permanent sampling stations previously discussed. The rabbit survey extended over a four-day period during each sampling period--June 2, 1974 to June 5, 1974 during the spring survey and September 17, 1974 to September 21, 1974 during the fall survey. Results of the survey were used to estimate the relative abundance of cottontail rabbits. The estimated mean relative abundance is expressed as the ratio of number of rabbits/mile traveled.

A 20-mile nighttime census route to inventory larger mammals was established along existing roads in the vicinity of Reform, Missouri. Spotlighting was used to supplement observations made with auto headlights. The surveys began approximately 1 hour after sunset; the numbers and kinds of mammals seen were recorded. The surveys were conducted for three nights during the spring and fall surveys.. Lord's (1959) techniques were used to derive an estimate of relative abundance of the various mammal species observed.

3.2.3 AVIFAUNA

The spring avifauna survey of the Callaway Plant site was conducted during the height of the breeding and nesting period, May 25 to June 11, 1974. A similar survey during the fall coincided with the migration period, September 21 to 30, 1974.

The eight permanent sampling stations selected for intensive investigation of vegetation and small mammal populations were the focal point for the spring avian studies. Walking transects for observing bird activities were established so that a portion of the transect route traversed the permanent sampling stations. Portions of the transect route exterior to the sampling stations were located in habitat conditions very similar to those prevailing within the perimeter of the sampling stations.

The technique described by Emlen (1971) was modified to estimate avian densities within and immediate to the permanent sampling stations. The investigator walked along each transect and recorded all birds observed or heard within a strip of established width and 100 yards ahead. A strip width of 200 feet was adopted for survey of prairie habitats; a 400-foot width was used for forest habitats. The visibility of birds, the disturbing effect of the investigator's movements, and the density of vegetation were important factors determining width selection. This method differs from Emlen (1971) in that coefficients of detection in each study area were estimated rather than mathematically determined. This was necessary because the continuity of habitat required by Emlen (1971) was not present on the Callaway Plant site.

The areas sampled for each transect were as follows:

Pr-1	8.82 acres
Pr-2	6.17 acres
Pr-3	5.29 acres
Pr-4	9.70 acres
F-1	21.16 acres
F-2	21.16 acres
F-3	28.20 acres
F-4	21.16 acres

Species of birds recorded were identified either by sight or song. The plots were not surveyed in order; instead, a random sampling was used to keep the consistency of the data equal for all the plots. Every plot was visited at least twice for each sampling time to provide data consistency throughout the study.

Breeding bird densities were computed by the following formula:

$$\frac{\text{Number of Birds x 2 (breeding pairs)}}{\text{Area of coverage (acres)}} = \text{Birds/acre}$$

The area of coverage acreage was computed for each transect route by multiplying the strip width by transect length (feet) and subsequent conversion to acres. The length of each transect was measured from an aerial photograph (scale 1" = 1920'); no adjustment was made for distance as influenced by topographic variation.

Each transect route was traversed three times during the spring sampling period, and the surveys were conducted at approximately the same time each day. Hence, an average density of birds, as calculated for each transect route, provides a valid basis for comparisons between and within habitat types. A Students "t" test was used to compare means and to test for significant difference between avian densities at the various sampled areas. This test provides a method of substantiating the similarity or dissimilarity of plots on the basis of data obtained in field surveys.

During the fall survey, transect sampling methodology was modified to give a more accurate accounting of birds using the permanent sampling plots during the migration period. Each plot (Figure 3.2-1) was sampled by an investigator who walked a series of transects the length of the plots and 100 feet apart. In addition, he would walk a transect 100 feet from the outer perimeter and completely around it. The area sampled for each plot remained constant at 6.45 acres each.

The formula for computing avian densities for the fall survey therefore is:

$$\frac{\text{Number of Birds}}{\text{6.45 (area of coverage in acres)}} = \text{Birds/acre}$$

The avian densities thus derived are subject to several unavoidable modifying constraints, such as the flocking behavior of migrating birds, the decreased visibility of birds in post-breeding plumage, and the disturbing effects of the investigator's movements. These modifying constraints tend to increase variance in the results. Each plot was sampled four times in a random sequence at varying times of day to yield more accurate estimates of avian density as this relates to activity patterns and time of day.

3.2.4 AMPHIBIANS AND REPTILES

Amphibians and reptiles were recorded whenever encountered at each of the permanent sampling stations established on the Callaway Plant site. A variety of suitable habitats were searched to detect the presence of reptiles and amphibians; for example, pond banks were investigated, and logs and large stones were upturned and then replaced. Care was taken to disrupt the habitat only momentarily to ensure the reliability of subsequent reptile and amphibian surveys. The total survey also included areas adjacent to the primary sampling locations.

Amphibians collected within the permanent sampling areas during the spring survey (June 6-8, 1974) were marked by toe clipping (Woodbury, 1953). Reptiles were usually collected for voucher specimens. The exception was turtles; an identification number and date was carved on the plastron of captured species.

During the fall survey (September 13-15, 1974), herpetofauna were marked by code to indicate the permanent plot nearest their point of capture and released. The code is as follows:

1) <u>Lizards, frogs, toads, and salamanders</u>:

   A toe was cut off in a manner to indicate the nearest plot - left front foot for forest plots, right front foot for prairie plots (1, 2, 3, or 4), starting with the inside toe.

2) <u>Turtles</u>:

   A notch was filed in the marginal scutes (through to the bone) according to the same code.

3) <u>Snakes</u>:

   Subcaudals were clipped by the same code as the snake was held venter up (meaning a reversal of the actual side).

Voucher specimens of each species encountered were collected for later study to assure positive identification, as necessary. Identification and nomenclature follow Blair, Blair, Brodkorb, Cagle, and Moore (1968) and Conant (1958). Whenever possible, identifications were made in the field.

3.2.5 INVERTEBRATES

Invertebrates of the vegetative stratum were sampled at permanent sampling stations established on the Callaway Plant Units 1 and 2 site. The sampled areas were Stations F-1 and F-4 in forest habitats and Stations Pr-1 and Pr-4 in prairie habitats. Station locations are shown in Figure 3.2-1. Sampling dates for the spring survey were June 10 and 11, 1974. Fall samples were taken on September 13, 1974.

An aerial sweepnet with a 38-cm diameter, heavy-duty muslin bag and a 90-cm-long handle was used for collecting the invertebrates. The sampling technique consisted of making 50 sweeps over a distance of 50 paces along three randomly selected transects within each of the four 2.5-acre sampling stations. In both the prairie and the forest communities, some vegetation was collected in the net along with the invertebrates. This necessitated transferring the contents into a 1-gallon ZIPLOC^{R} bag after the first 25 sweeps and again after the second 25 sweeps along a given transect. Both plant and animal contents from each sample were carefully transferred into the bag, which was then sealed and immediately placed on ice in a large ice chest in the field. On arrival at the laboratory, the samples were transferred to a freezer, where they were stored until each sample was processed for identification and counting. Plant parts collected in the sweepnet were examined in the laboratory for invertebrates that might have adhered to them. Organisms were appropriately pinned, pointed, preserved in ethyl alcohol, or mounted on microscope slides for identification (USDA, 1967). This procedure proved highly satisfactory for the majority of organisms collected.

3.3 RESULTS AND DISCUSSION

3.3.1 VEGETATION AND SOILS

3.3.1.1 Vegetation

Prairie Vegetation Type

The Prairie Sampling Stations Pr-1 through Pr-4 were composed of two predominant floristic strata: the ground layer and the understory vegetation. These two strata will be considered separately in the following discussion, which presents species composition and seasonal diversity. The ground layer and understory will, however, be considered as an integral unit in the discussion of successional trends and directions.

Prairie Sampling Station Pr-1 exhibited a moderate diversity, with 17 species present in the fall 1974 sampling. Based on dry weight and presence, several ground layer species held dominant positions within the subplots. Meadow fescue (*Festuca elatior* L.) was by far the most dominant, having a relative frequency of 100 percent and an importance value of 132.94 (Appendix A-1). Cinquefoil (*Potentilla simplex* Michx.) and the graminoid (*Panicum lanuginosum* Ell.) were the second and third most frequent species, both having relative frequencies of 31.25 percent and importance values of 10.83 and 10.75, respectively (Appendix A-1). Subdominants falling within the ground layer strata of Sampling Station Pr-1 having importance values below 10 included Japanese lespedeza (*Lespedeza striata* (Thunb.) H. & A.), a carex (*Carex glaucodea* Tuckerm.), a moss species, and Korean clover (*Lespedeza stipulacea* Maxim.) [Appendix A-1]). The remaining ground layer vegetation (10 species) had importance values less than 4.25, based on relative frequency and relative dry weights.

Dry weight, utilized as an indicator of presence in this study, was an important parameter; it allowed distinctions to be made among the ground layer plots on the basis of species composition. The estimated dry weight based on 3,044.76 grams per 0.125 milacre for Pr-1 was 1,522,380 grams/acre (3,356.84 pounds/acre), shown in Table 3.3.1-1. This sampling station showed an overall increase in production of 261,490 grams (576.84 pounds) of dry weight plant material over the weights obtained during the spring sampling period (Table 3.3.1-2).

Seasonal comparison of the dominant ground layer species from Station Pr-1 indicated that reed fescue (*Festuca arundinaceae* Schreb.) had phased out, while meadow fescue (*Festuca elatior* L.) remained the prominent grass species. Spring subdominants, carex (*Carex glaucodea* Tuckerm.) and orchard grass (*Dactylis glomerata* L.) (Appendix A-2) were replaced in prominence in the fall by the cinquefoil and a species of panicum (Appendix A-1). There was a pronounced change in the species within the supportive community of the ground layer as the season progressed from spring to fall. Twenty-three species were recorded for the spring sample, while only 17 species were recorded in the fall sample. There were eight carryover species found in both samples; however, 15 species recorded in the spring failed to occur in the subsequent fall sample. Within the fall sample, nine new species were tallied that had not occurred in the spring sample. Thus, a total of 34 distinct species were recorded for the ground layer.

The understory vegetation of Prairie Sampling Station Pr-1 displayed a considerable diversity in species composition during the fall 1974 sampling program. The fall sampling period was the first instance data were obtained on understory vegetation present within the Callaway Plant site. Woody species predominated; persimmon (Diospyros virginiana L.) was the most frequent species encountered, with a density of 21 trees and an importance value of 64.2 overall (Appendix A-3). Subdominants of the understory included snowberry (Symphoricarpos sp. Duham.), pasture rose (Rosa carolina L.), and white ash (Fraxinus americana L.) with importance values of 37.1, 29.2, and 11.6, respectively (Appendix A-3).

The subdominant species of the understory found within Prairie Sampling Station Pr-1 all held importance values less than 10 (Appendix A-3). Evidence of regeneration is present in the understory of Station Pr-1 in that the species composition includes black oak (Quercus velutina Lam.), post oak (Quercus stellata Wang.), hickory (Carya sp. Nutt.), slippery elm (Ulmus rubra Muhl.), and white ash mentioned previously. All of these species are elements of the forested sites discussed in detail later within this section and indicate that regeneration of overstory species was not a successional possibility within Station Pr-1. On the average, there were 3.2 understory trees or shrubs in each quadrat, yielding 518.4 trees and/or shrubs per acre within the prairie vegetation type.

The second Prairie Sampling Station, Pr-2, showed an extremely high diversity and composition of various ground layer species. A total of 42 distinct species were recorded during the fall 1974 sampling program. The major dominant ground layer species was redtop (Agrostis alba L.) with a relative frequency of 93.75 percent and an importance value of 39.91 (Appendix A-4). Canada blue grass (Poa compressa L.) was second in prominence with a frequency of 100 percent and an importance value of 24.23 (Appendix A-4). A disparity seemed to exist between redtop, frequency 93.75 percent, and Canada blue grass, frequency 100 percent. This was easily explained when the dry weights of the two species were compared. Redtop accounted for 642.80 grams of dry weight, while Canada blue grass accounted for 314.00 grams of dry weight, roughly half the total for the dominant species, redtop (Appendix A-4). The third, fourth, and fifth species were the graminoid (Panicum lanuginosum Ell.), prairie threeawn grass (Aristida oligantha Michx.), and Japanese lespedeza (Lespedeza striata (Thunb.) H. & A) with frequencies of 87.50 percent, 37.50 percent, and 93.75 percent, and showing importance values of 12.45, 11.78, and 11.66, respectively (Appendix A-4). Ground layer vegetation having importance values less than 10.0 amounted to 37 additional species

(Appendix A-4). Eighteen of the species collected during the fall 1974 sampling period consisted of graminoid types, including sedges, carices, and rushes.

Plot clipping performed during the fall 1974 sampling to obtain herbage dry weight revealed a general increase in vegetative production. This increased biomass was reflected in the total fall sample weight of 1,012,950 grams (2233.55 pounds) per acre (based on 2025.9 grams per 0.125 milacre). Specifically, the fall sample showed an increase of 76,825 grams (169.42 pounds) per acre of dry weight plant material (Table 3.3.1-1).

The dominant ground layer vegetation of Sampling Station Pr-2 showed a remarkable change in structure from the spring to the fall sampling period. In the spring, the dominant species was Kentucky blue grass (Poa pratensis L.); however, in the fall, redtop had replaced the blue grass (Appendix A-5). Kentucky blue grass descended from a spring importance value of 28.57 to a fall importance value of only 9.75, which is explained by the fact that Kentucky blue grass is primarily a "cool season" grass that fades out during the August-September period. In the spring, redtop was number two, with an importance value of 27.05, which rose in the fall to 39.91. Timothy (Phleum pratense L.), was third in importance in the spring, with an importance value of 21.63, but fell to a low of 8.35 in the fall sample. Hairy chess (Bromus racemosa L.) held fourth position in the spring, with an importance value of 11.39, but was not recorded in the fall sample. Finally, a carex (Carex bushii Mack.), holding fifth position in the spring with an importance value of 10.37, was not recorded during the fall period.

This general "replacement" of species is believed to be attributable to the seasonal composition changes brought about by elimination of the heat-intolerant "cool season" grasses. These are replaced by the "warm season" heat-tolerant and xerophytic species that are more adapted to periods of elevated temperature typically associated with the late summer-fall time period. To further illustrate the seasonal species phase change: in the spring sampling period, a total of 49 ground layer species were recorded, while in the fall period, 42 species were recorded. Of these recorded species, only 23 carryover species were found to be concurrent for spring and fall. Overall, 68 individual species were recorded for the ground layer of Station Pr-2.

The understory stratum of Sampling Station Pr-2 was limited to only five species, all of which held importance values greater than 10.0. The most important and most frequent tree species found within the understory stratum of Prairie Station Pr-2 was the woody species persimmon, with a relative frequency of 12 percent, a relative density of 77 percent, and an importance value of 129.2 (Appendix A-6). Subdominant supportive elements of the understory included dewberry (Rubus flagellaris Willd.), white ash, snowberry, and slippery elm, having importance values of 27.5, 23.1, 10.1, and 10.1, in order. Sampling Station Pr-2 did not exhibit the understory species evident of understory-overstory regeneration. White ash and slippery elm were present, but the density data for these species indicated only a sparse representation. This fact suggests that succession within Pr-2 exhibited no well-defined trend other than a general shift to more woody-shrubby composition. Generally, the understory was characterized by 8.7 trees or shrubs per quadrat, extrapolated to 1,409.4 trees and/or shrubs per acre.

Prairie Station Pr-3 had a moderate species diversity within the ground layer stratum during the fall 1974 sampling program. Specifically, 35 species were recorded for Pr-3 during the survey. Canada blue grass was, by a considerable margin, the most dominant species tallied; its importance value was 45.42 (Appendix A-7). Furthermore, Canada blue grass had a relative frequency of 93.80 percent and a density based on dry weight of 657.10 grams (Appendix A-7). Redtop was the species holding secondary importance within Pr-3, with an importance value of 32.04 (Appendix A-7). Kentucky blue grass and a panicum were also grass species and held importance values of 15.52 and 10.51, respectively (Appendix A-7). Japanese lespedeza was the fifth and final species having an importance value over 10 (Appendix A-7). There were 30 additional species recorded having importance values lower than 10. Nineteen of the total 35 species recorded were graminoid species including the allied sedges, carices, and rushes.

Dry weight determined from plot clipping of Station Pr-3 during the fall 1974 sampling revealed a generalized decline in production of herbage from the dry weights obtained during the spring sampling period. This reduction in biomass production was noticeable when weights from both spring and fall were compared. In the spring, the sample station yielded 1,156,205 grams (2.549 pounds) per acre. The fall data yielded figures of 940,500 grams (2,073.80 pounds) per acre, showing a net loss in production of 215.705 grams (475.20 pounds) per acre. A possible explanation of this marked decline in production is that compositional changes occurred from spring to fall, or that the edaphic-climatic regime of the Pr-3 station affected its productivity.

Although the composition of the Pr-3 station changed, fall composition was not radically dissimilar to spring composition. The spring dominant was Kentucky blue grass, with an importance value of 38.76 (Appendix A-8); this dominance was phased out by Canada blue grass (with a value of 45.42) during the fall sampling. Redtop, the second in importance during the spring survey, was also second in the fall survey. The third species in order of importance during the spring was timothy, while Kentucky blue grass was third in the fall period. Hairy chess and a carex were respectively fourth and fifth during the spring, but were displaced by a panicum and Japanese lespedeza in the fall.

Comparison of species diversity of the ground layer between spring and fall reveals that 35 species were recorded from both the spring and fall sampling periods. A total of 16 carryover species were recorded for both sampling periods. The total species diversity of the spring and fall periods from the ground layer of Station Pr-3 was 54 distinct species.

Sampling Station Pr-3 displayed a sparse understory stratum characterized by only three species. The predominant species was snowberry, with a relative frequency of 1.0 percent, a relative density of 4.0 percent, and an importance value of 100 (Appendix A-9). The two remaining species, slippery elm and honey locust (Gleditsia triacanthos L.) were present in equal numbers, both having importance values of 50 (Appendix A-9). If importance values of 100 and 50 seem excessively high, it should be borne in mind that, from all sixteen 6.25-milacre plots, only 6 individual trees or shrubs were tallied. This sparsity of undersotry was reflected in the trees or shrubs per quadrat value 0.4, which indicates a meager stratum. Extrapolation of the quadrat density data yielded 64.8 trees per acre for the understory of Sampling Station Pr-3.

Analysis of the understory from the viewpoint of succession yielded no trend information. The absence of dense, regenerating woody species indicated that succession to the stage of predominant understory had not taken place, but rather that Prairie Station Pr-3 was still in the "grass" stage and was just beginning to experience invading species.

Vegetation comprising the ground cover of Prairie Station Pr-4 exhibited the least diversity of any of the other three prairie stations. The fall 1974 sampling recorded only 13 species in the subplots of this station. Far above all other species in importance was meadow fescue, with a relative frequency of 100 percent, an importance value of 136.20, and a yield of 2,517.35 grams of the total 2,542.55 grams recorded for the station (Appendix A-10). White sweet clover (Melilotus alba Desr.) was second in importance in the fall sampling, with an importance value of 14.25 (Appendix A-10). The third species of prominence was Korean lespedeza, with an importance value of 14.14 (Appendix A-10). The remaining 10 species of the ground cover vegetation had importance values less than 10 (Appendix A-10).

Production of biomass within the ground layer was determined from dry weights of herbage. This dry weight served as an indicator of species presence. For Prairie Station Pr-4, the estimated dry weight per acre was based on 2,542.44 grams per 0.125-milacre (equivalent to 1,271,275 grams (2,803.16 pounds) per acre (Table 3.3.1-1). A comparison of this production data to that obtained during the spring sample indicates an increase in biomass production. The total increase in dry weight per acre was 397,320 grams (877.16 pounds). Therefore, though there are relatively few species comprising the Pr-4 station subplots, the production has increased, the increment almost entirely due to the species meadow fescue. Indeed, from the standpoint of fall production, Pr-4 may be considered as monotypic, owing to the overwhelming influence of meadow fescue.

Spring (Appendix A-11) and fall composition comparisons of predominant ground layer species at Pr-4 are similar to comparisons for Pr-1, in that reed fescue, a dominant in the spring, was overshadowed by meadow fescue, also present in the spring but more widespread in the fall. Horse nettle (Solanum carolinense L.) ranked third in the spring, dropped to an importance value of 13.04, and then increased its presence to an importance value of 14.14 in the fall period. A total of 22 species was recorded from the spring survey, and only 13 species in the fall, with 7 carry-over species from spring to fall. A total of 28 distinct ground layer species was tallied for Pr-4.

The understory of Pr-4 was exclusively one species. Dewberry had a relative frequency of 2.0 percent, a relative density of 3.0 percent, and an importance value of 200 (Appendix A-12). Site statistics indicated 0.2 trees or shrubs per quadrat and 32.4 trees or shrubs per acre. Because of the growth form of dewberry, it was conjectured that the primary reason for lack of an established understory was the intensive competition created by meadow fescue within the subplots. Man-induced stress from cultivation and/or chemical application was also thought to be a possible explanation of the relatively early successional stage found at Prairie Station Pr-4. Generally, the prairie stations reflect the regional vegetation discussed by Kucera (1973), though the site contains none of the unique floras cited by him.

Prairie vegetation Sampling Stations Pr-1 through Pr-4 were composed principally of ground cover, with a representation of understory vegetation present in varying degrees. The composition, both area-wide and seasonal, by species, of these four sampling areas varied considerably, as evidenced in Appendix A-1 through Appendix A-12. The prairie sampling stations may be grouped in several ways according to their individual properties. The spring and fall species composition of Pr-1 and Pr-4 are most similar, with reed fescue and meadow fescue being the predominating species in each area during both seasons. The Prairie Sampling Stations Pr-2 and Pr-3 showed the highest species diversity, Pr-2 having 49 (spring) and 42 (fall), and Pr-3 having 35 (spring and fall) species, respectively. Considering production of biomass as a parameter, Pr-1, Pr-2, and Pr-4 showed moderate gains in herbage yield during the fall sample, while Pr-3 showed a general decline in production during the same time interval.

Structurally, the ground layer vegetation exhibited substantial difference at the various sampling locations, based on the species-area curve (Cain, 1938). On the basis of distribution in the species-area curve (Appendices A-1, A-4, A-7, and A-10), redtop, timothy, Kentucky blue grass, and Canada blue grass are the dominant ground layer species. Japanese lespedeza, Korean lespedeza, hairy chess, a carex, and a panicum were the predominant members of the supportive community.

The distinct seasonal "phasing" of the grass species was also evident. The "cool season" grasses, such as meadow foxtail, redtop, timothy, brome, and orchard grass diminished in importance at the time of the fall survey. "Warm season" grasses, including meadow fescue, panicum, and blue grass increased in prominence during the fall sampling. This natural variation is a normal seasonal occurrence and must not be misconstrued as a successional trend.

Vegetation of the understory, present at all of the prairie sampling stations, showed a considerable individual differentiation at each station. Species diversity for the understory included Pr-1 (10 species), Pr-2 (5 species), Pr-3 (3 species), and Pr-4 (1 species).

Overall, the dominant understory species averaged from all stations included persimmon, snowberry, and dewberry. White ash, slippery elm, honey locust, and pasture rose comprised the supportive elements.

Succession was evident generally throughout the prairie sampling stations, where both the ground layer and the understory vegetation indicated the evolving trend. This successional progression was well documented for Callaway County (Drew, 1942), particularly with respect to revegetation of abandoned land and the ensuing "rebound" or reinvasion by characteristic species. Drew (1942), and Cox et al. (1972) considered several periods of years as indicators of the general trend. These trends include:

1. First year: The dominant species, while reflecting the last grown crop, include primarily panic grasses, crab grass, common ragweed, trailing wild bean, plantain, and horseweed. Generally, the first year is composed of low-value grass species, composites and some legumes.

2. Second year: The composition remains ostensibly the same; however, goldenrods and asters are increasing in importance.

3. Third year: Compositional change alters abruptly from the previous year. The formerly dominant annual grasses and composites evidence a decline. An increase in perennial species is noted, with goldenrods, asters, and broomsedge showing an upsurge in absolute numbers.

4. Fifth year: The perennial species have taken hold by this time, with goldenrod and asters at an almost dominant position. Wire grasses are first noted at this stage. The important species of the first and second year are almost totally absent from the area.

5. Fifth to Twentieth year: The vegetation composition attained at the five-year period remains almost in equilibrium throughout this period, experiencing only minor changes. Subtle additions include development of dewberry, cinquefoil, legumes, and broomsedge. Introduction of woody species commences and is customarily well developed by the twentieth year. Competition between shade-tolerant and shade-intolerant species is pronounced at this time.

6. Twentieth to Thirty-fifth year: Increasing evidence of woody trees and shrubs is found, with a rapidly growing overstory eliminating all but shade-tolerant species. Species within this category include muhlenbergia, goldenrods, snakeroot, and meadow violet.

Subsequent to the thirty-fifth year, the woody species are generally well developed. As the woody species mature, they become important as regeneration seed sources. In transition areas (ecotones) between forests and pastures or oldfields, the presence of oaks, hickories, maples, elms, ashes, red cedars, sassafras, and persimmon was noted. These species served as excellent seed sources for the pastures and oldfields, which they adjoin. It is worthy of note that regeneration of these seed sources was evident during the fall sampling data (Appendix A-1 through Appendix A-12) for Stations Pr-1 through Pr-4.

Several of the understory species are considered to be transgressive, that is, transitional between the oldfield and the immature forest (Buzzaz, 1968). Species falling within this category include red cedar, sassafras, black oak, honey locust, and slippery elm. A listing of invader species, "Transitional Species Preferring Disturbed Sites" prepared by Dr. Dunn, is included (Appendix A-13). Buzzaz (1968) additionally considers the dissemination of propagules (seeds) of different species on old or abandoned fields to be of primary importance. Further, the success and viability of these vegetative species is responsible in large measure for an increase in the animal populations of the area (Johnson and Odum, 1956; Pearson, 1959).

Comparisons of similarity for the ground layer prairie vegetation based on importance values (Table 3.3.1-3) elicited some interesting conclusions. Prairie Stations Pr-2 and Pr-3 evidenced the highest similarity based principally on the mutual occurrence of redtop, a panicum, Canada blue grass, and Japanese lespedeza, with an index of similarity of 84.80 percent (Table 3.3.1-3). Prairie Stations Pr-1 and Pr-4 were also found to be most similar to one another, but here the reason for the similarity was the pervasive presence of meadow fescue based on an index of similarity of 83.76 percent (Table 3.3.1-3). The most dissimilar of the prairie stations were Pr-2 and Pr-4 with an index of similarity of 12.18 percent. Overall, distinct differences in composition were found to occur throughout the prairie ground layer sampling stations based on species composition and presence. Spring comparisons are presented in Table 3.3.1-4.

Similarity comparisons for the understory stratum of the prairie sampling stations (Table 3.3.1-5), indicated that Station Pr-1 and Pr-2 were most similar with an index of similarity of 80.5 percent. Prairie plots Pr-2 and Pr-4 were second in overall importance with an index of similarity of 56.9 percent. The most dissimilar plots were Pr-1 and Pr-4, with a second group Pr-3 and Pr-4 all having indexes of similarity of 0.00 percent (Table 3.3.1-5). These determinations indicated a homogeneity of composition between Pr-1 and Pr-2 which was not found for any other combination of plots.

Succession is influenced by many natural and induced factors. However, within the Callaway site specifically, it is felt that several factors are of paramount importance in regulating the speed of succession. These factors include climatic conditions favorable to seed production and plant growth, vigor of seedlings established in the prairie areas, availability of fertile seed sources, distance of the seed source from the field, size and general morphology of the seeds of various species, and finally, the occurrence of good seed production years. These natural factors, in concert with seasonal composition changes, serve to direct the successional trend of the Callaway Plant site both in composition and in time of development. A complete species table for prairie and forest vegetation was prepared (Appendix A-14).

Generally, the prairie sampling stations, both from the standpoint of ground layer and understory, will progress toward a woody shrub-dominated cover type in the foreseeable future. If undisturbed by man, fire or infestation, these sites potentially would develop into the oak-hickory forest associations characteristic of the vicinity of the Callaway Plant site.

Forest Vegetation Type

In this section, the vegetation of each of three strata--ground layer, understory, and overstory--is described for each of four forest sampling stations.

Generally, the upland central hardwood types were predominantly white oak, black oak, and red oak. On the more moist sites, such as those found in Callaway County, Missouri, codominants or subordinates usually were found to include along with the oaks, white ash, black cherry, sugar maple, slippery elm, Ohio buckeye, shagbark, and bitternut hickory, with flowering dogwood and sassafras the most numerous understory species. Locally common species included shadbush and hop-hornbeam on the drier sites and redbud and hornbeam on the more moist sites. Usually, these overstory and understory species occurred on residual soils developed from sandstone and shale but were also found on shallow limestone soils and areas covered with varying depths of loess.

At the conclusion of the discussion of each of the four sampling stations, an overall discussion of conclusions will be presented.

Forest Sampling Station F-1 showed remarkable diversity in floristic composition of the ground layer, with 41 distinct species present in the fall 1974 sampling. Several ground layer species were found to hold dominant positions in the F-1 sampling area. Fragrant sumac was the dominant, with a relative frequency of 33.3 percent, a relative dry weight of 21.82 percent, and an importance value of 25.15 (Appendix A-15). White oak and a carex (Carex rosea Schk.) were the second and third most frequent species, with relative frequencies of 6.66 and 7.77 percent, respectively (Appendix A-15). White oak had an importance value of 22.46 and the carex value was 16.56 (Appendix A-15). White ash and Virginia creeper (Parthenocissus quinquefolia L. Planch.) were fourth and fifth, with respective importance values of 16.34 and 12.41 (Appendix A-15). The remaining ground layer vegetation (36 species) had importance values lower than 10.

Dry weight, an important indicator of species presence during the spring and fall sampling programs, was utilized for Forest Station F-1. The estimated dry weight per acre, based on 162.63 grams per 0.25 milacre, was 40,657.50 grams (89.64 pounds per acre), as shown in Table 3.3.1-1. The Fall F-1 sampling station showed an overall decline in production of 28,707.5 grams (63.36 pounds) per acre.

Seasonal analysis of the dominant ground layer from Station F-1 indicated that the spring dominant was Virginia creeper (Appendix A-16). Both the spring and fall samples recorded 41 distinct species, with only 19 carryover species found during both surveys. A total of 63 distinct species was recorded from the ground layer of F-1.

The ground layer vegetation, as mentioned previously, exhibited a remarkable diversity in both spring and fall periods. This diversity was in part due to the open nature of the overstory and understory strata, discussed in the following section. The decline in herbage yield of the ground layer of Station F-1 was thought to be due in part to the lack of moisture available to the vegetation during the midsummer and fall of 1974. The ground layer vegetation is the most susceptible strata to moisture deficit. It was believed that succession within the ground layer is in the incipient or early pioneer stage and has not been taken over by the customary goldenrod-broomsedge cover type.

The understory of F-1 exhibited a surprising diversity of vegetative composition, with 24 distinct species represented. The predominant species of the understory in the vicinity of Forest Station F-1, both in importance and frequency, was flowering dogwood (Cornus florida L.). Flowering dogwood comprised 14.1 percent of the understory, on the basis of relative frequency, with an importance value of 35.3 (Appendix A-17). White oak and hickory (Carya sp. Nutt.) were also dominant in the understory, with relative frequencies of 10.1 percent and 12.1 percent, respectively (Appendix A-17). Though the hickory had a higher relative frequency than the white oak, the white oak had a much higher density (45.0) than the hickory (37.0) (Appendix A-17). Subdominant species included white ash, fragrant sumac (Rhus aromatica Ait.), hop-hornbeam (Ostrya virginiana (Mill.) K. Koch.), and black oak, with importance values of 19.6, 19.5, 14.9, and 12.1, respectively (Appendix A-17). The remaining understory species included shadbush (Amelzanchier arborea (Michx. F.) Fern.), slippery elm, red cedar (Juniperus virginiana L.), red oak, winter grape (Vitis vulpina L.), dewberry (Rubus flagellaris Willd.), poison ivy (Rhus radicans L.), red mulberry (Morus rubra L.), summer grape (Vitis aestivalis Michx.), hackberry (Celtis occidentalis L.), Ohio buckeye (Aesculus glabra Willd.), virburnum (Viburnum sp. L.), black cherry (Prunus serotina Ehrh.), hawthorn (Crataegus sp. L.), sassafras (Sassafras albidum (Nutt.) Neew.), sugar maple (Aceor saccharum Marsh.), and grayback grape (Vitis cinerea Engelm.) (Appendix A-17). The vegetation of the understory amounted to an average of 23.0 trees and/or shrubs per quadrat, and by extension, 3,726 trees and/or shrubs per acre.

The great diversity of species within the understory of Forest Station F-1 was explained by the fact that the overstory consisted of an open canopy that permitted the shade-intolerant understory species to flourish and become well established. It was also noted that many of the understory species within range of Station F-1, such as the grapes, ivy, cherry, sassafras, viburnum, mulberry, and dewberry provide outstanding forage sources as well as cover, concealment, and habitat for wildlife species.

Overstory in the Forest Sampling Station F-1 area was dominated by white oak (including species and varieties) with a cumulative basal area of 4,337.4 square inches. White oak held a relative frequency of 25.5 percent, a relative density of 28.8 percent, and an overall importance value of 132.8 (Appendix A-18). Two species of secondary importance included flowering dogwood and black oak, with importance values of 43.8 and 34.2, respectively. The flowering dogwood had a relative frequency of 16.4 percent and a relative density of 25.2 percent, while black oak had a relative frequency of 14.5 percent and a relative density of 17.1 percent. Shagbark hickory and post oak were additional subdominant species having importance values in excess of 15.0, namely 18.7 and 16.1, respectively. The remaining species tallied for Forest Station F-1 included shadbush, black hickory, hop-hornbeam, red oak, slippery elm, red cedar, mockernut hickory and white ash. Statistically, there were 6.9 trees per quadrat, a total of 279.5 trees per acre. The basal area per quadrat was 348.5 square inches, which was equivalent to 14,114.3 square inches per acre.

Structurally, the overstory exhibited substantial stratification, partially due to the open canopy condition. Support for this conclusion, in addition to the sample data, were the increment cores taken and analyzed from the F-1 station. The cores evidenced an age spread from 15 years for a slippery elm and flowering dogwood specimen, to 135 years for a hybrid oak specimen (Appendix A-19). Further support for the uneven-aged nature of the stand was found in the diameter classes of the increment core study. Three distinct groups were evident: a 2.0 to 2.5-inch class, a 4.00- to 7.00-inch class, and a 12.01- to 17.00-inch class. The larger diameter class was composed chiefly of white and hybrid oaks. This size class differentiation indicated that the stand, though diverse, had not attained maturity, evidenced by the "regenerative" nature of the 2.0-inch diameter species. A mature, even-aged stand was not expected to display such diversity; therefore, it was felt that Station F-1, though showing several over-mature specimens, was not a mature, climax oak-hickory forest stand. Succession, if allowed to proceed undisturbed for Station F-1, would be expected to evolve to a closed canopy oak-hickory forest characteristically found within the region.

The ground layer of Forest Sampling Station F-2 had a high species diversity. A total of 38 distinct species was tallied during the fall 1974 sampling program. The dominant species of the ground layer at F-2 during the fall was fragrant sumac, which had a relative frequency of 5.81 percent and an importance value of 21.18 (Appendix A-20). Virginia creeper was second in overall prominence, with a relative frequency of 9.30 percent and an importance value of 16.38 (Appendix A-20). The fragrant sumac was dominant, though its relative frequency was less than Virginia creeper, because its dry weight (19.30 grams) was greater than that of the Virginia creeper (8.90 grams). The third and fourth species in order were white oak and elegant bedstraw (<u>Galium cocinnum</u> Torr. & Gray), with importance values of 15.44 and 13.94, respectively (Appendix A-20). The remaining species with importance values greater than 10 were a carex (<u>Carex rosea</u> Schk.) (13.52), wild bean (<u>Strophostyles helvola</u> L. Britt.) (13.10), and hop-hornbeam (10.52) (Appendix A-20). Ground layer vegetation with importance values less than 10 included 31 species (Appendix A-20).

Clippings from forest subplots during the fall 1974 sampling revealed a general decline in production of herbage from the dry weights obtained during the spring sampling period. This reduction in biomass was reflected in a comparison of the total weights, both spring and fall. In the spring, the sample station yielded 65,725 grams (145 pounds) per acre. The fall sampling yielded a production of 31,387.5 grams (69.20 pounds) per acre for a net loss of 4,337.5 grams (75.8 pounds) per acre of slightly greater than a 50 percent decline in production. It was felt that this decline in production of herbage was due to a particularly dry summer-fall period of 1974 that caused some of the species to be "phased out" due to lack of moisture.

The composition of Forest Station F-2 did not change radically. The spring dominant was Virginia creeper (Appendix A-21), while the fall dominant was fragrant sumac. In the spring, the second species of importance was the fragrant sumac and in the fall Virginia creeper was of second importance. By virtue of the large number of species (54) collected in the spring sample, no individuals other than those already mentioned had importance values above 10 (Appendix A-20). In the fall, species with importance values greater than 10 included white oak, elegant bedstraw, a carex, wild bean, and hop-hornbeam.

Comparison of the species diversity of the ground layer between the spring and fall indicated that 54 separate species were recorded from the spring sampling and 38 species were recorded for the fall sample. A total of 19 carryover species were recorded for both sampling periods. The total species diversity for spring and fall from the ground layer of Station F-2 was 73 distinct species.

Understory at Forest Sampling Station F-2 had the broadest species diversity found to exist at any of the four stations. A total of 30 distinct species were recorded in the fall 1974 sampling program. The most important species, from the standpoint of importance value and relative density, was fragrant sumac, with figures of 25.9 and 18.3 percent, respectively (Appendix A-22). It was interesting to note, however, that flowering dogwood, white oak, and white ash each had greater relative frequency than fragrant sumac, with 9.0 percent, 8.3 percent, and 9.7 percent opposed to the value for sumac, which was 7.6 percent (Appendix A-22). Though these species were more numerous than fragrant sumac, their relative densities were much lower. That is to say, the density of fragrant sumac was higher in those subplots where it was found. This suggests that fragrant sumac had a clustered distribution rather than a random heterogeneous distribution within the sampled quadrats. The importance values of the subdominant species were flowering dogwood (22.8), white oak (18.6), and white ash (15.2) (Appendix A-22). The remaining species found in the subdominant category was sugar maple, with a relative frequency at 4.8 percent and an importance index of 11.5 (Appendix A-22). The remaining species recorded at Station F-2 had importance values less than 10 and included in order, hickory, snowberry, black oak, pasture rose, poison ivy, shadbush, slippery elm, black haw (<u>Viburnum prunifolium</u> L.), wild plum (<u>Prunus americana</u> Marsh.), red cedar, black cherry, prickly ash (<u>Zanthoxylum</u> sp. L.), sassafras, persimmon, bittersweet (<u>Celastrus</u> sp. L.), winter grape, grayback grape, black raspberry (<u>Rubus occidentalis</u> L.), hop-hornbeam, hawthorn, red oak, American bittersweet (<u>Celastrus scandens</u> L.), red mulberry, wahoo (<u>Euonymus atropurpureus</u> Jacq.), and catbrier (<u>Smilax</u> sp. L.). Statistically, Sampling Station F-2 had 39.9 trees and/or shrubs per each 6.25-milacre plot. This density was equivalent to 6,463.8 trees and/or shrubs per acre (Appendix A-22).

Forest Station F-2, with such a rich and interesting diversity of species, was an open canopy overstory. The open canopy permitted a wide variety of shade-intolerant species to prosper, species which in a closed canopy situation would not likely have survived. Successionally, competition among dominants in this sampling area was still in the preliminary stages, judging from the closely bracketed densities of the species comprising the understory at F-2. Forage species were abundant in the Sampling Station F-2 area. Species of importance included fragrant sumac, shadbush, black haw, black cherry, sassafras, persimmon, bittersweet, grapes, black raspberry, red mulberry, and catbrier. The F-2 understory was an excellent area for cover and concealment for wildlife species and met all the requirements for a good habitat with considerable carrying capacity.

Overstory vegetation within Forest Sampling Station F-2 was dominated by 13 species, of which white oak (including the species and varieties) was most dominant. White oak was by far the most ubiquitous species, with an importance value of 134.9 (Appendix A-23). White oak, further, had a relative frequency of 25.0 percent, a relative density of 46.7 percent and a cumulative basal area of 2,859.7 square inches (Appendix A-23). Shagbark hickory was the subdominant species, having second position in the stand with an importance value of 43.5 (Appendix A-23). Black hickory and red oak were the next prominent species in the stand, with importance values of 26.4 and 23.5, respectively. It was interesting to note that although red oak was fourth based on importance value, it ranked second based on basal area (515.9 square inches), which indicated that though red oak had a relative frequency of only 8.3 percent, those specimens tallied were all of a more mature diameter class than the other species of the stand. The remaining species having an importance value greater than 15.0 were black oak (22.2) and flowering dogwood (20.5) (Appendix A-23). The remaining components of the overstory from Station F-2 included, in order, shadbush, mockernut hickory, sassafras, post oak, black cherry, red mulberry, and persimmon. The overstory components amounted to 9.8 trees per quadrat or 396.8 trees per acre with basal areas of 282.7 square inches per quadrat and 11,449.4 square inches per acre.

The overstory of Station F-2 demonstrated stratification, though in this sampling area, the strata were not found to be as distinct as observed for Stations F-1, F-3, or F-4. The oaks and hickories displayed similar dominance of the overstory of F-2, supported by shadbush, dogwood, black cherry, and red mulberry. The lack of observable distinct strata within the sampling area was further related to a lack of refined diameter classes taken for increment core aging (Appendix A-19). The size classes ran from 2.16 through 8.00 inches, with fairly uniform representation throughout. One separate class (11.18 inches) was found for a single white oak specimen. The age classes ran from 17 to 62 years without major breaks. Though this age and diameter class information indicated that forest stand F-2 was an uneven aged stand, the marked absence of clean-cut size and age classes indicated that this stand was becoming a distinct oak-hickory forest. The prominence of the understory vegetation (30 distinct species), coupled with the density, led to the observation that the young overstory stand supported a rich understory flora by virtue of its open canopy. Shade tolerance and species competition were among the prime factors noted serving to shape the Forest Station F-2. If undisturbed, succession will be expected to lead this stand toward the climax oak-hickory forest type characteristic of the area.

Forest Sampling Station F-3 exhibited a moderate species diversity within the ground layer stratum during the fall 1974 sampling. Specifically, 28 separate species were recorded for F-3 in the fall. Fragrant sumac was the most dominant species recorded, with an importance value of 26.73 (Appendix 24), a relative frequency of 6.32 percent and a density based on dry weight of 22.17 grams (Appendix A-24). A carex (Carex rosea Schk.) was the species of secondary importance in Station F-3, with an importance value of 25.31 (Appendix A-24). The third and fourth species, Virginia creeper and tick trefoil (Desmodium nudiflorum L. D.C.), held importance values of 25.26 and 19.93, respectively (Appendix A-24). Wild bean and horse-mint (Monarda russeliana Nutt.) were the fifth and sixth species of importance, with values of 15.09 and 12.26 in order. There were 22 additional species recorded having importance values lower than 10 (Appendix A-24).

Determination of dry weight values from plot clipping at Forest Station F-3 during the fall 1974 sampling revealed a marked decline in production of herbage from the dry weights obtained during the spring sampling period. This decline in biomass was noted in comparison of total weights for both spring and fall. During the spring, Station F-3 yielded 44,300 grams (98.00 pounds) per acre. Data from the fall sample indicated production to be 27,145 grams (59.85 pounds) per acre based on 108.58 grams per 0.25-milacre quadrat. The net loss in production was a total of 17,155 grams (38.15 pounds) per acre. This decline in production was thought to be due largely to the general dry period from midsummer to fall 1974, in the vicinity of the F-3 site.

Species diversity comparisons of the ground layer between the spring and fall demonstrated that 38 species were recorded from the spring sample (Appendix A-25) and 28 species from the fall. A total of 17 carryover species were noted during the 1974 sampling effort. Total species diversity for the ground layer of Forest Station F-3 was 49 separate species. Spring and fall comparisons of species revealed that fragrant sumac remained the dominant species throughout the year. In the spring, Virginia creeper, wild bean, tick trefoil, wild licorice (Galium circaezans Michx.), and grayback grape held the dominant positions. In the fall, a carex (Carex rosea Schk.), Virginia creeper, tick trefoil, wild bean, and horse-mint were the dominant species. This information indicates a stable ground layer vegetation.

The understory vegetation of Forest Sampling Station F-3 exhibited considerable diversity in species composition. Twenty-four species were present and were recorded during the fall 1974 sampling program. The dominant species recorded was fragrant sumac, which had an importance value of 70.7 (Appendix A-26). Flowering dogwood was the next most important species, with an importance value of 22.6 (Appendix A-26). Flowering dogwood had greater relative frequency (13.2 percent) than fragrant sumac (12.3 percent), which indicates that the sumac had a non-random grouped (clonal) distribution (Appendix A-26). Subdominant species with importance values greater than 10 included black cherry (14.7), black oak (13.4), hickory (13.1), and white oak including the varieties (10.8) (Appendix A-26). The supportive species also found within subplots at F-3 included, in order, sugar maple, sassafras, red oak, winter grape, pasture rose, dewberry, grayback grape, wild plum, red mulberry, red cedar, snowberry, hawthorn, white ash, summer grape, shadbush, hackberry, persimmon, and black haw. In total, there were 39.9 trees and/or shrubs per quadrat and 6,463.8 trees and/or shrubs per acre within Forest Station F-3.

The density and importance value of fragrant sumac (Appendix A-26) establish it as the dominant species in Forest Station F-3. Once again, however, as in F-1 and F-2, the open canopy had permitted many species of the understory strata to compete for light and space. This, then, was the reason why the flora of F-3 was so varied. Forage sources were available and considerable in quantity at F-3 and should provide excellent habitat for wildlife.

Overstory vegetation in the F-3 area was composed of 13 distinct species and was dominated by white oak (including species and varieties). White oak had a relative frequency of 26.9 percent, a relative density of 57.0 percent, a relative dominance of 58.3 percent, and an importance value of 142.2 (Appendix A-27). White oak had a cumulative basal area of 3,175.1 square inches, which was more than 2.5 times greater than that of black oak, the next forest dominant, with a basal area of 1,296.3 (Appendix A-27). Black oak had an importance value of 54.5, which would have been a respectable figure were it not for the pervasive size and frequency of the white oak component of the stand. Additional elements of the overstory included flowering dogwood, black hickory (Carya texana Buckl.), and post oak, with respective importance values of 25.2, 23.2, and 16.5 (Appendix A-27). The relative frequencies of these species were: flowering dogwood (17.3 percent), black hickory (11.5 percent), and post oak (7.7 percent) (Appendix A-27). The remaining elements of the overstory with importance values less than 15.0 were red oak (14.5), shagbark hickory (8.7), sugar maple (6.9), mockernut hickory (3.1), red mulberry (2.6), and grayback grape (2.6) (Appendix A-27). There were a total of 10.8 trees per quadrat, or 437.4 trees per acre having a basal area per quadrat of 333.2 square inches and a basal area per acre of 13,494.6 square inches.

The physiognomy of the overstory exhibited considerable stratification, the oaks being the highest within the strata, subtended by the hickories, maple, and red mulberry. This stratification is further supported from the increment core data (Appendix A-19), which show that for Sampling Station F-3, the oaks generally are older species, ranging from 38 to 50+ years, whereas most of the hickories range from 10 to 35 years, with one notable exception being a black hickory 61 years old. The diameters also indicated that this was an uneven-aged stand by virtue of the three size classes observed, namely 2 to 2.5 inches, 3 to 7 inches, and 8 to 13 inches. The oaks were well represented in the largest diameter class and the supportive community in the small and medium-size classes. Probably, then, this oak-hickory stand was not yet mature, judging from diameter classes and strata of the overstory, combined with the wide diversity of the understory species. Reproduction of selected overstory species was noted for the understory, indicating that the overstory was reproductively active and had not gone into the regenerative "stagnation" noted for some mature and overmature forests of the oak-hickory type. This forest in the future will develop into a closed-canopy oak forest type with mixed hickory interspersed. This successional trend is believed to be correct if no detrimental external influences interrupt the direction of the advancing stand development.

Forest Sampling Station F-4 demonstrated considerable diversity of ground layer species, possessing 29 separate species at the time of the fall sampling. Dominance was held by fragrant sumac, which had a relative frequency of 10.6 percent, a relative dry weight of 24.04 percent, and an importance value of 34.64 (Appendix A-28). Wild bean and sunflower (_Helianthus strumosus_ L.) were second and third most frequent species, with relative frequencies of 9.09 percent and 3.03 percent, respectively (Appendix A-28). The importance value of wild bean was 14.85 and for sunflower, 13.33 (Appendix A-28). Pasture rose and black oak were fourth and fifth in order, with importance values of 13.27 and 11.93 (Appendix A-28). A carex (_Carex rosea_ Schk.) and elm-leaf goldenrod (_Solidago ulmifolia_ Muhl.) were the last species having importance values greater than 10.0, namely, 10.33 and 10.3, in order. The remaining vegetation (22 species) of the ground layer had importance values less than 10.0.

Dry weight, utilized in this study, was an important indicator of species presence, both in spring and fall samples. For F-4, the estimated dry weight based on 167.40 grams per 0.25 milacre was 41,850 grams (92.27 pounds) per acre, as shown in Table 3.3.1-1. An overall decline in productivity was noted for Station F-4. This reduction in biomass was 24,270 grams (53.73 pounds) per acre.

Changes in seasonal composition of the dominant flora of F-4 were noted. The spring dominant, Sampson's snake root (_Psoralea psoralioids_ [Walt.] Corry var. _elandulosa_ [Ell.] Freeman) (Appendix A-29) was replaced by fragrant sumac in the fall sampling. The spring subdominants fragrant sumac, black-jack oak, bur oak hybrid (_Quercus macrocarpa_ Michx. V _Q. marilandica_), and the pasture rose shifted importance with the fall sample subdominants, wild bean, sunflower, pasture rose, black oak, a carex (Carex rosea Schk.), and elm-leaf goldenrod. The spring sample recorded 44 distinct species, with 20 carry-over species to the fall sample, which comprised 29 species. Totally, 53 species were present for the spring and fall samples at Station F-4.

The vegetation composing the ground layer at F-4 exhibited a moderate diversity, somewhat greater in the spring than in the fall. The understory and overstory of F-4 support the contention that there was an open canopy condition existing within the F-4 area. The "openness" of the canopy was not as pronounced as that found at F-1 or F-2, which explains why the diversity of species based on shade intolerance was less at Sampling Station F-4. The marked decline in biomass production recorded for F-1 through F-4 supported the belief that the extensive dry midsummer and fall of 1974 caused loss of herbage through wilt and lack of growth generally. The ground layer vegetation was most subject to moisture changes and by virtue of that fact reflected the moisture deficit in terms of reduced or arrested production. Successionally, F-4 will continue to proceed toward the woody perennial stage if left undisturbed.

Vegetation comprising the understory at Forest Sampling Station F-4 demonstrated a wide diversity in composition, with 25 distinct species represented. The most predominant species in the understory of F-4 recorded during the fall 1974 sampling was fragrant sumac, which had an importance value of 44.9 (Appendix A-39). Fragrant sumac had a relative frequency of 13.5 percent and a relative density of 31.4 percent (Appendix A-30). Three other species comprised the supporting subdominants having importance values greater than 10. Black oak was second in prominence, with an importance value of 31.7. White oak and flowering dogwood were third and fourth in rank, with respective importance values of 27.0 and 11.8. The remainder of the species recorded for Station F-4 had importance values less than 10, and in order included red oak, white ash, hophornbeam, hickory, sugar maple, shadbush, black cherry, pasture rose, grayback grape, winter grape, hawthorn, persimmon, red cedar, hybrid oak, post oak, dewberry, red bud, wahoo, wild plum, sassafras, and slippery elm. The understory was developed to the point at which there were 25.7 trees and/or shrubs per quadrat and 4,163.4 trees and/or shrubs per acre.

A diversity of 25 species indicates, as in the other understory Sampling Stations F-1 through F-3, that the forest in which these species comprised the understory is not a closed canopy type. Indeed, with as much diversity as was recorded for the understory, considering density alone, the overstory was quite open, with many "breaks" in the cover. The open canopy has permitted the understory to develop to a high degree. Being highly diverse, Sampling Station F-4 had not established well-developed formal successional patterns. Discounting the dominant species somewhat, consideration was directed toward the specific vegetative components that served to form a foundation for the strata.

Species from the understory of F-4 that provided forage to wildlife populations included hickory, shadbush, black cherry, grapes, hawthorn, persimmon, oaks, dewberry, wild plum, and sassafras. These edible species provided excellent cover and concealment habitat, as well as food, to many wildlife forms.

Overstory vegetation in the area of Forest Sampling Station F-4 exhibited moderate diversity, with 11 species represented. The dominant species was white oak (including species and varieties), with an importance value of 92.7 (Appendix A-31). Black oak was the second species, having an importance value of 88.0 (Appendix A-31). However, if judged solely on basal area, black oak, with 2,115.3 square inches, would have been first, followed by white oak, with 1,241.9 square inches. White oak was more important because of its higher frequency of occurrence (28.6 percent) as opposed to that of black oak (23.8 percent). Post oak was the species holding third position, with a relative frequency of 21.40 percent, a relative density of 23.1 percent, and an importance value of 65.0 (Appendix A-31). The last species holding an overstory importance value greater than 15 was flowering dogwood, with 15.6 (Appendix A-31). The remaining species were tallied for Forest Station F-4 and included, in order, sugar maple, black-jack oak, black hickory, shagbark hickory, slippery elm, shadbush, and white ash. Physically, the overstory comprised 5.7 trees per quadrat, or 230.9 trees per acre. The basal area was 290.5 square inches per quadrat, yielding 11,765.3 square inches per acre.

The overstory of Forest Station F-4 showed a pronounced stratification, dominated by six species of oak, with a supportive strata composed of maple, dogwood, and hickories. The increment cores taken from F-4 added further insight to the stratification. Once again, three predominant diameter classes (2 to 2.5 inch, 3 to 9 inch, and 10 to 16 inch) emerged from the sampling station. The most direct correlation between age and diameter class-species relationship was observed for F-4. Three age classes (30+ years, 60 to 70 years, and over 100 years) supported the supposition that this was yet another example of an uneven-aged stand. The open canopy, the predominance of seedlings of overstory species within the understory, and the age structure data provided emphasis to this determination. The domination by oak species within this station, coupled with the age determinations of the cores, indicated that F-4 was a sub-climax oak-hickory forest type. If this stand were undisturbed, it would in time develop to a more even-aged, mature oak-hickory association with a gradual decline in supportive species such as dogwood, shadbush, and possibly white ash.

The composition by species of Forest Sampling Stations F-1 through F-4 was varied, but most widely diverse in the ground layer. Less diversity was found in the understory, with the overstory remaining fairly stable. Ground layer data were presented in Table 3.3.1-6, understory data in Table 3.3.1-7, and overstory data in Table 3.3.1-8. Species most common in the ground layer included Virginia creeper, fragrant sumac, white oak seedlings, and wild bean. For the understory, white oak, hickory, white ash, fragrant sumac, hop-hornbeam, and black oak were the most commonly occurring species. In the overstory strata, white oak was the overall dominant, with flowering dogwood, shagbark hickory, black oak, black hickory, and red oak also usually present. Comparisons of spring data for Stations F-1 through F-4 are presented in Table 3.3.1-9.

Though a seasonal "phase" change was observable for ground layer vegetation in F-1 through F-4, no such temporal relationship occurred within either the understory or overstory sampling areas. Generally, the openness of the overstory canopy was responsible for the well developed and diversified understory and ground layer vegetation. Succession, particularly in the ground layer, was difficult to describe, with stages varying from incipient oldfield to areas in which the ground layer was substantially interspersed with understory woody specimens. In the understory, however, successional pathways were more distinct, with a profusion of tree seedlings and saplings of overstory species present and usually dominant within the understory stratum. Useful indicator species for disturbance were compiled by Dr. D.B. Dunn (Appendix A-13). These species were considered transgressive or transitional species characterized as "invaders" or decreaser species that indicated a stress to the vegetation. Being highly competitive for space, these species have been found to frequent all types of disturbed sites. Particular reference in Appendix A-13 is made to species found in or among both the prairie and forest sampling locations. In addition to the table of transitional species (Appendix A-13), a complete species table for all sites and strata is included (Appendix A-14). This table identifies the species by common and scientific name, by the location of the sampling station in which it was found, and in what strata it was observed.

The understory of Forest Stations F-1 through F-4 exhibited a marked diversity of species, which was somewhat surprising considering the age of the overstory stratum. This diversity may have been a response to pyric or moisture stresses of the past in which the understory was eliminated and subsequently new species invaded the stressed area. Kucera et al. (1963) indicated that fire (and, by extension, moisture stress) could retard development of woody species growth in prairie locations. Further, subsequent to a fire (or moisture) stress, relatively high productivity was experienced. The accumulation of understory litter was responsible for developing a maximum fuel load, which would increase the effectiveness of fire in controlling woody growth of ground layer or understory species. This information added further support to the hypothesis that in areas F-1 through F-4, some environmental stress of the past brought about the remarkable diversity of species found in the forest sampling areas.

Overstory vegetation of the Callaway County area has been described in the past. Minkler (1971) has described the composition of a Missouri forest of the past as chiefly red gum, black gum, white oak, black oak, hickories, white ash, red maple, elm, hackberry, and cottonwood. His information was drawn from a site evidently more mesic than the Callaway Plant site area based on the red gum, black gum, and cottonwood species. However, the data indicated that this forest of the past had a balanced structure with a great diversity of species and age classes. Minkler (1971) stated that he considered the ability of overstory species to tolerate saturated soils and standing water to have little effect in determining species composition. He felt rather that shade tolerance and growth rate combined with past occurrences created openings in the forest. His observations were found to fit the data very well and supported the contention that some stress had occurred during the past that led to the profusion of species observed in the forest sampling stations.

The overstory was influenced by edaphic factors, as observed in the field. The Menfro soil series, a silt-loam deep loess, extended from the edges of the river bluffs and provided an excellent medium for establishment of forested stands. Based on early land records from 1816 and 1817 (Wuenscher and Valionas, 1967), the major dominant forest species in Missouri that were characteristic of this soil type were, in order of importance, white oak, sugar maple, black oak, hackberry, white ash, and assorted hickories. Specifically, for Callaway County, the dominant species and their importance values were white oak (82), black oak (37), hickory (35), sugar maple (35), and elm (24) (Wuenscher and Valionas, 1967). It was pointed out that during the distant past, the Kansan glaciation extended into Callaway County, leaving soil deposits that have, over the years, provided the edaphic foundation of the current vegetation of the county and, indeed, the Callaway Plant site specifically.

Characteristically, the overstory of the forest sampling stations was composed of white oak found on all upland sites, slopes, and ridgetops except for very xeric or shallow soil ridges (Duncan and Ellis, 1969). Associated species, according to Duncan and Ellis (1969), generally were found to include post oak, sassafras, persimmon, black cherry, and white ash including various xerophytic hickories. For the drier sites, post oak and black oak were observed to occur but because of their intolerance to competition on bottom soils, they usually were relegated to poorer sites. Duncan and Ellis (1969) noted that black oak, due to its extreme shade intolerance, usually was not found to succeed itself unless major disturbance occurs in the forest canopy. It was further illustrated that post oak-black oak stands were generally found as second growth communities following cutting or other major disturbances (Duncan and Ellis, 1967).

Successionally, it was determined that the forest stand types located at Forest Sampling Stations F-1 through F-4 were relatively young, based on diameter classes and the longevity of the dominants determined from the increment core study. Additionally, all stands were found to be uneven-aged, based on diameter class and the observed physiognomic stratification present in the subplots. Characteristic of the more mature overstory was a decrease in the diversity of the species comprising the stand. The overall direction of the forest stands, if undisturbed, is toward a mature, even-aged stand having white oak as the dominant, black oak and various hickories as subdominants, and a mixture of post oak, black jack oak, black hickory, red oak, and flowering dogwood. The canopy openings in the overstory were expected to close gradually, eliminating all but the woody shade-tolerant understory species, which gradually will "fill" the gaps in the overstory.

Comparisons were undertaken for the ground layer to determine the index of similarity for the various forest sampling stations (Table 3.3.1-6). Forest Stations F-2 and F-3 were the most similar with an importance value of 77.79 (Table 3.3.1-6). In decreasing order of similarity, the remaining groups were F-1 and F-3 (72.0 percent), F-1 and F-4 (70.46 percent), F-3 and F-4 (61.98 percent), F-2 and F-4 (61.90 percent), and finally F-1 and F-2 (60.43 percent) (Table 3.3.1-6). The reason there was such a small spread in the indices of similarity (77.79 to 60.43 percent) was believed to be the prominence of four species, a carex (<u>Carex rosea</u> Schk.), fragrant sumac, wild bean, pasture rose, and, at three of the stations, Virginia creeper. The relatively clustered indices of similarity indicated that the ground layer generally was fairly representative throughout the forested sampling areas.

Index of similarity comparisons for the understory of the forest sampling stations (Table 3.3.1-7) was found to have a clustered distribution. Sampling Stations F-3 and F-4 were the most closely similar stations, with an index of similarity of 89.6 percent. Next in order of similarity were Stations F-1 and F-4, with an index of similarity of 88.9 percent (Table 3.3.1-7). The species of importance throughout the understory were fragrant sumac, flowering dogwood, white oak, and white ash. The most dissimilar sampling stations were F-1 and F-3, with an index of similarity of 78.1 percent (Table 3.3.1-7).

The dominance of white oak, as previously discussed, was common to all of the forest overstory sampling stations. Utilizing the species dominance information, an index of similarity based on frequency, density, and dominance values was developed for Stations F-1 through F-4 (Table 3.3.1-8). Based on this data, F-2 and F-3 were most similar with an index of 93.6 percent (Table 3.3.1-8). Next in order, were F-1 and F-3 (92.3 percent), F-1 and F-4 (90.3 percent), F-1 and F-2 (90.1 percent), and F-3 and F-4 (87.5 percent) (Table 3.3.1-8). The forest sampling stations with the lowest index of similarity were F-2 and F-4 (67.4 percent) (Table 3.3.1-8). The overstory vegetation common to all sampling stations included four oak species, three hickory species, sugar maple, shadbush, flowering dogwood, and hop-hornbeam.

Many factors, natural and induced, have served to alter the composition of the vegetation in Callaway County. These factors have greatly influenced the vegetation by altering the succession rates constantly at work. For the county generally, and the site specifically, the vegetation, if removed from influence by man, would develop to the characteristic oak-hickory forest association previously discussed.

3.3.1.2 Soils

The chemical analysis results of the 10 soils at the permanent sampling stations are shown in Table 3.3.1-10. In general, soils in the agricultural areas (Pr-1, Pr-2, Pr-3, and Pr-4) have a higher concentration of plant nutrients than those in the forested areas (F-1, F-2, F-3, and F-4). This is expected since forests in this area do not generally receive fertilizer applications. Concerning the heavy metals, there does not appear to be any clear relationship between vegetative type and concentration, with the possible exception of Prairie Sampling Station Pr-1. This station has a greater abundance of heavy metals, consisting predominantly of lead, chromium, and manganese, than any other permanent sampling station. In general, the chemical composition of the soils of permanent sampling stations does not appear unusual.

The results of the herbicide and pesticide residual analyses of the soils are shown in Table 3.3.1-11. Of these residuals examined, none appear to be abundant.

TABLE 3.3.1-1

SOME CHARACTERISTICS OF GROUND LAYER VEGETATION[a] BASED ON PLOT CLIPPINGS AT THE CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Characteristics	Sampling Stations							
	Prairie				Forest			
	PR-1	PR-2	PR-3	PR-4	F-1	F-2	F-3	F-4
Estimated Dry Weight/acre								
grams	1,522,380.00	1,012,950.00	940,500.00	1,271,275.00	40,657.50	31,387.50	27,145.00	41,850.00
pounds	3,356.84	2,233.55	2,073.80	2,803.16	89.64	69.20	59.85	92.27
Average		1,186,776.25 grams 2,616.83 pounds					35,260.00 grams 77.74 pounds	
Number of species identified in subplots (including hybrids)	17	42	35	13	41	38	28	29
Average number of species occurring in each subplot (16 subplots per station)	2.93	11.43	8.93	2.68	5.62	5.37	4.93	4.12

[a]Includes herbaceous species and woody plants of less than 20 inches in height.

TABLE 3.3.1-2

SOME CHARACTERISTICS OF GROUND LAYER VEGETATION[a] BASED ON PLOT CLIPPINGS AT SAMPLING STATIONS OF THE CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, MAY - JUNE 1974

Characteristics	Sampling Stations							
	Prairie				Forest			
	Pr-1	Pr-2	Pr-3	Pr-4	F-1	F-2	F-3	F-4
Estimated Dry Weight/acre								
grams	1260890	936125	1156205	873955	69365	65725	44300	66120
pounds	2780	2064	2549	1926	153	145	98	146
Average		1056794 grams 2330 pounds				61377 grams 135 pounds		
Number of species identified in subplots (including hybrids)	23	49	35	23	42	55	39	46
Average number of species occurring in each subplot (16 subplots per station)	5.75	15.81	12.00	3.87	6.44	8.94	6.56	5.25

[a]Includes herbaceous species and woody plants of less than 20 inches in height.

TABLE 3.3.1-3

COMPARISONS WITHIN AND BETWEEN SAMPLING STATIONS BASED ON CALCULATED IMPORTANCE VALUES[a] FOR MAJOR COMPONENT SPECIES OF GROUND LAYER VEGETATION[b] OCCURRING IN SUBPLOTS OF PRAIRIE HABITATS, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Species	Sampling Stations			
	Pr-1	Pr-2	Pr-3	Pr-4
Achillea millifolium L.		1.79		
Agrostis alba L.		39.91	32.04	
Ambrosia bidentata Michx.		5.45	4.84	
Andropogon virginicus L.		2.01		
Aristida oligantha Michx.		11.78	1.55	
Aster pilosus Willd.		2.87	4.85	
Bromus sp. L.			1.50	
Carex glaucodea Tuckerm.	6.49	3.60		
Carex sp. L.		2.69		
Convolvulus sepium L.		1.26		
Croton capitatus Michx.		4.95		
Crotonopsis elliptica Willd.			1.40	
Diospyros virginiana L.		1.28		
Festuca elatior L.	132.94		4.03	136.20
Juncus tenuis Willd.		1.86	4.54	
Lespedeza stipulacea Maxim.	4.25	5.02	8.80	14.14
Lespedeza striata (Thunb.) H.&A.	8.56	11.66	10.39	7.08
Lespedeza violacea (L.) Pers.				7.00
Melilotus alba Desr.				14.25
Moss sp.	4.68		6.25	
Muhlenbergii schreberi Gmel.		3.77	6.30	
Panicum lanuginosum Ell.	10.75	12.45	10.51	
Paspalum ciliatifolium Michx.			2.97	
Paspalum laeve Michx.		3.77	5.12	
Phleum pratense L.		8.35	5.91	
Poa compressa L.		24.23	45.41	
Poa pratensis L.		9.75	15.52	
Potentilla simplex Michx.	10.83	3.58		
Prunella vulgaris L.		2.89		
Pycnanthenum tenuifolium Schrad.		5.85		

TABLE 3.3.1-3 (continued)

Species	Pr-1	Pr-2	Pr-3	Pr-4
	Sampling Stations			
Ruellia humilis Nutt.		1.86		
Solanum carolinense L.		3.67	2.24	4.74
Solidago altissima L.		7.37	4.64	
Tridens flavus (L.) Hitchc.		3.31	3.00	
Trifolium repens L.		5.93		
Vernonia baldwini Torr.		1.68		
Vernonia missurica Raf.		1.99		
TOTAL	178.50	196.58	181.81	183.41

Comparisons between Sampling Stations	Summation of Importance Values for Species Common to both Stations	Summation of Importance Values for Species Occurring at only one Station	Index of Similarity (%)[c]
Pr-1 vs. Pr-2	77.19	297.89	20.57
Pr-1 vs. Pr-3	201.16	159.15	55.82
Pr-1 vs. Pr-4	303.17	58.74	83.76
Pr-2 vs. Pr-3	320.88	57.51	84.80
Pr-2 vs. Pr-4	46.31	333.68	12.18
Pr-3 vs. Pr-4	187.62	177.60	51.37

[a] Calculated as $\frac{\text{Number of points of occurrence of the species}}{\text{Number of points of occurrence of all species}} + \frac{\text{Total dry weight of each species}}{\text{Total dry weight of all species}} \times 100$ (each sampling station)

[b] Includes all species for which the percent frequency (16 subplots) and $\frac{\text{Total dry weight of each species}}{\text{Total dry weight of all species}} \times 100$ (relative dominance) exceeded a value of 10.0

[c] Calculated as $\frac{\text{Summation of importance values for species common to any two stations}}{\text{Summation of the total importance values for the same stations}} \times 100$

TABLE 3.3.1-4

COMPARISONS WITHIN AND BETWEEN SAMPLING STATIONS BASED ON CALCULATED IMPORTANCE VALUES[a] FOR MAJOR COMPONENT SPECIES OF GROUND LAYER VEGETATION[b] OCCURRING IN SUBPLOTS OF PRAIRIE HABITATS, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, MAY-JUNE 1974

	Sampling Stations			
Species[b]	Pr-1	Pr-2	Pr-3	Pr-4
Achillea millifolium L.		1.73	3.01	
Agrostis alba L.		27.05	35.69	
Ambrosia artemisiifolia L.				3.24
Ambrosia bidentata Michx.	1.10	2.85	3.18	
Aster sp.	2.25	1.41	1.63	8.09
Bromus racemosa L.		11.39	16.24	
Carex albolutescens Schwein.		0.50	1.09	
Carex bushii Mack.	3.30	10.37	10.72	
Carex glaucodea Tuckerm.	15.24	7.70	3.02	3.24
Cerastium viscosum L.	2.17	4.84	4.49	
Croton monanthogynus Michx.		2.80	0.53	
Dactylis glomerata L.	11.02			
Diospyros virginiana L.		2.10		
Eleocharis compressa Sull.			1.83	
Eleocharis tenuis (Willd.) Schutes		0.83		
Erigeron annuus (L.) Pers.		0.43	3.02	
Erigeron strigosus Muhl.		2.20	5.58	1.63
Festuca arundinacea Schreb. & F. elatior L.	111.51	0.47	0.91	123.80
Fragaria virginiana Duchesne.		3.16		
Juncus tenuis Willd.	9.17	1.39	5.66	
Lactuca canadensis L.		1.25	1.12	1.61
Lespedeza stipulacea Maxim.	1.14	5.53	5.72	13.04
Oxalis europea Jord.	4.36	0.81	0.53	1.62
Panicum lanuginosum Ell.	9.95	11.97	9.22	1.63
Panicum perlongum Nash		0.90		
Phleum pratense L.		21.63	16.61	
Plantago virginica L.	1.09	2.00	0.53	
Poa pratensis L.	6.19	28.57	38.76	
Potentilla simplex Michx.	8.25	0.42		1.62
Prunella vulgaris L.	3.37	4.25	0.53	
Pycnanthemum flexuosum (Walt.) B.S.P.		9.47		
Ruellia humilis Nutt.	2.20	1.34		
Rumex acetocella L.		3.58		
Solanum carolinense L.		4.49	4.25	16.26
Solidago sp.		4.25	6.10	1.70
Strophostyles umbellata (Muhl.) Britt.		0.80	0.53	3.24
Symphoricarpos orbiculatus Moench.		1.59	0.54	
Trifolium campestre Schreb.		2.91	1.29	6.62
Trifolium pratense L.	2.22	1.52	1.70	
Trifolium repens L.	1.09	1.26	6.90	
Vernonia sp.		4.56	6.67	
Totals	195.62	194.32	197.60	187.34

Comparisons between sampling stations	Summation of importance values for species common to both stations	Summation of importance values for species occurring at only one station	Index of similarity (%)[c]
Pr-1 vs. Pr-2	271.30	118.64	69.57
Pr-1 vs. Pr-3	267.65	125.57	68.07
Pr-1 vs. Pr-4	305.74	77.22	79.84
Pr-2 vs. Pr-3	368.29	23.63	93.97
Pr-2 vs. Pr-4	228.31	153.35	59.82
Pr-3 vs. Pr-4	222.38	162.56	57.77

[a]Calculated as $\frac{\text{Number of points of occurrence of the species}}{\text{Number of points of occurrence of all species}} + \frac{\text{Total dry weight of each species}}{\text{Total dry weight of all species}} \times 100$ (each sampling station)

[b]Includes all species for which the percent frequency (16 subplots) and $\frac{\text{Total dry weight of each species}}{\text{Total dry weight of all species}} \times 100$ (relative dominance) exceeded a value of 10.0

[c]Calculated as $\frac{\text{Summation of importance values for species common to any two stations}}{\text{Summation of the total importance values for the same stations}} \times 100$

TABLE 3.3.1-5

COMPARISONS WITHIN AND BETWEEN SAMPLING STATIONS BASED ON CALCULATED IMPORTANCE VALUES[a] FOR MAJOR COMPONENT SPECIES OF UNDERSTORY LAYER VEGETATION[b] OCCURRING IN SUBPLOTS OF PRAIRIE HABITATS, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Species	Sampling Stations			
	Pr-1	Pr-2	Pr-3	Pr-4
Diospyros virginiana L.	64.2	129.2		
Fraxinus americana L.	11.6	23.1		
Gleditsia triacanthos L.			50.0	
Rosa carolina L.	29.2			
Rubus flagellaris Willd.		27.5		200.0
Symphoricarpos sp. Duham.	37.1	10.1	100.0	
Ulmus rubra Muhl.		10.1	50.0	
TOTAL	142.1	200.0	200.0	200.0

Comparisons between Sampling Stations	Summation of Importance Values for Species common to both Stations	Summation of Importance Values for Species occurring at only one Station	Index of Similarity (%)[c]
Pr-1 vs. Pr-2	275.3	66.8	80.5
Pr-1 vs. Pr-3	137.1	205.0	40.1
Pr-1 vs. Pr-4	0.0	342.0	0.0
Pr-2 vs. Pr-3	170.2	229.8	42.6
Pr-2 vs. Pr-4	227.5	172.5	56.9
Pr-3 vs. Pr-4	0.0	400.0	0.0

[a] Calculated as $\frac{\text{Number of points of occurrence of the species}}{\text{Number of points of occurrence of all species}} + \frac{\text{Total density of each species}}{\text{Total density of all species}} \times 100$ (each sampling station)

[b] Includes all species for which the percent frequency (16 subplots) and $\frac{\text{Total density of each species}}{\text{Total density of all species}} \times 100$ (relative density) exceeded a value of 10.0

[c] Calculated as $\frac{\text{Summation of importance values for species common to any two stations}}{\text{Summation of the total importance values for the same stations}} \times 100$

TABLE 3.3.1-6

COMPARISONS WITHIN AND BETWEEN SAMPLING STATIONS BASED ON CALCULATED IMPORTANCE VALUES[a] FOR MAJOR COMPONENT SPECIES OF GROUND LAYER VEGETATION[b] OCCURRING IN SUBPLOTS OF FOREST HABITATS, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Species	Sampling Stations			
	F-1	F-2	F-3	F-4
Antennaria plantaginifolia (L.) Hook.	6.36			4.13
Carex bushii Mack.	3.75	5.86	9.22	3.92
Carex glaucodea Tuckerm.	5.17			
Carex rosea Schk.	16.56	13.52	25.31	10.33
Carya ovata (Mill.) K. Koch	6.03			
Cornus florida L.	4.34		3.53	7.78
Desmodium glutinosum (Muhl.) Wood	5.72			
Desmodium nudiflorum (L.) D.C.	8.16		19.93	
Fraxinus americana L.	16.34			
Galium circaezans Michx.	3.54	3.82	4.05	
Galium concinnum Torr. & Gray	4.00	13.94	4.42	
Helianthus strumosus L.	13.33			
Heuchera sp. L.		2.48		
Lespedeza violaceae (L.) Pers.	3.20			9.19
Lysimachia lanceolata Walt.		2.94		
Monarda russeliana Nutt.	12.26			9.73
Muhlenbergia sobolifera (Muhl.) Trin.		8.80		
Ostrya virginiana (Mill.) K. Koch		10.52		
Panicum boscii Poir.	9.76			
Panicum lanuginosum Ell.	3.61			3.35
Panicum lanuginosum var. lanuginosum (Scribn.) Fern.		3.89		
Parthenocissus quinquefolia (L.) Planch.	12.41	16.38	25.26	
Potentilla simplex Michx.		4.23	3.68	5.57
Prunus virginiana L.	2.71	5.22	3.55	
Quercus alba L. and var.	22.46	15.44	3.04	3.86
Quercus imbricaria Michx.		4.31		
Quercus rubra L.	5.30			
Quercus velutina Lam.	4.79			11.93
Rhus aromatica Ait.	25.15	21.18	26.73	34.64
Rosa carolina L.	7.48	2.87	5.72	13.27
Rubus flagellaris Willd.	3.44			
Solidago ulmifolia Muhl.	3.94	7.49		10.03
Strophostyles helvola (L.) Ell.	8.38	13.10	15.09	14.85
Vitus cinera Engelm.		5.07		7.21
TOTAL	218.19	161.06	149.53	149.79

TABLE 3.3.1-6 (continued)

omparisons between Sampling Stations	Summation of Importance Values for Species common to both Stations	Summation of Importance Values for Species occurring at only one Station	Index of Similarity (%)[c]
F-1 vs. F-2	229.20	150.05	60.43
F-1 vs. F-3	264.79	102.93	72.00
F-1 vs. F-4	259.29	108.69	70.46
F-2 vs. F-3	241.63	68.96	77.79
F-2 vs. F-4	192.44	118.41	61.90
F-3 vs. F-4	185.54	113.78	61.98

[a]Calculated as $\frac{\text{Number of points of occurrence of the species}}{\text{Number of points of occurrence of all species}} + \frac{\text{Total dry weight of each species}}{\text{Total dry weight of all species}} \times 100$ (each sampling station)

[b]Includes all species for which the percent frequency (?6 subplots) and $\frac{\text{Total dry weight of each species}}{\text{Total dry weight of all species}} \times 100$ (relative dominance) exceeded a value of 10.0

[c]Calculated as $\frac{\text{Summation of importance values for species common to any two stations}}{\text{Summation of the total importance values for the same stations}} \times 100$

TABLE 3.3.1-7

COMPARISONS WITHIN AND BETWEEN SAMPLING STATIONS BASED ON CALCULATED IMPORTANCE VALUES[a] FOR MAJOR COMPONENT SPECIES OF UNDERSTORY LAYER VEGETATION[b] OCCURRING IN SUBPLOTS OF FOREST HABITATS, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Species	Sampling Stations			
	F-1	F-2	F-3	F-4
Acer saccharum Marsh		11.5	6.8	6.1
Amelanchier arborea (Michx. f.) Fern.	8.7	6.1		5.8
Carya sp. Nutt.	22.2	8.9	13.4	6.3
Celastrus sp. L.		3.4		
Cornus florida L.	35.3	22.8	22.6	11.8
Crataequis sp. L.		1.8	2.2	4.1
Diospyros virginiana L.		3.7		2.7
Fraxinus americana L.	19.6	15.2	2.2	6.8
Juniperus virginiana L.	7.3	5.2	2.4	2.7
Morus rubra L.			2.6	
Ostrya virginiana (Mill.) K. Koch	14.9	2.2		6.6
Prunus americana Marsh.		5.3	2.9	
Prunus serotina Ehrh.		4.7	14.7	5.3
Quercus alba L. and var.	22.3	18.6	10.8	27.0
Quercus x fernowi Trel. (Quercus alba x Quercus stellata)				2.7
Quercus rubra L. and var.	6.2	1.6	4.6	7.4
Quercus stellata Wang.				2.7
Quercus velutina Lam.	12.1	7.5	13.4	31.7
Rhus aromatica Ait.	19.5	25.9	70.7	44.9
Rhus radicans L.		6.6		
Rosa carolina L.		6.7	4.3	5.3
Rubus flagellaris Willd.	3.4	3.7		2.7
Rubus occidentalis L.		2.4		
Sassafras albidum (Nutt.) Nees		4.5	6.7	
Symphoricarpos sp. Duham		8.8	2.4	
Viburnum prunifolium L.		5.7		
Ulmus rubra Muhl.	7.7	5.8		
Vitis aestivalis Michx.			2.2	
Vitis cinerea Engelm.		2.7	3.4	5.1
Vitis vulpina L.	4.4	3.2	4.6	4.9
Xanthoxylum sp. L.		4.6		
TOTAL	183.6	199.1	192.9	192.6

Comparisons between Sampling Stations	Summation of Importance Values for Species common to both Stations	Summation of Importance Values for Species occurring at only one Station	Index of Similarity (%)[c]
F-1 vs. F-2	310.3	72.4	81.1
F-1 vs. F-3	293.6	82.9	78.1
F-1 vs. F-4	334.5	41.7	88.9
F-2 vs. F-3	343.0	49.0	87.5
F-2 vs. F-4	339.2	52.5	86.6
F-3 vs. F-4	345.5	40.0	89.6

TABLE 3.3.1-7 (continued)

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[a]Calculated as $\frac{\text{Number of points of occurrence of the species}}{\text{Number of points of occurrence of all species}} + \frac{\text{Total density of each species}}{\text{Total density of all species}} \times 100$ (each sampling station)

[b]Includes all species for which the percent frequency (16 subplots) and $\frac{\text{Total density of each species}}{\text{Total density of all species}} \times 100$ (relative density) exceeded a value of 10.0

[c]Calculated as $\frac{\text{Summation of importance values for species common to any two stations}}{\text{Summation of the total importance values for the same stations}} \times 100$

TABLE 3.3.1-8

COMPARISONS WITHIN AND BETWEEN SAMPLING STATIONS BASED ON CALCULATED IMPORTANCE VALUES[a] FOR MAJOR COMPONENT SPECIES OF OVERSTORY LAYER VEGETATION[b] OCCURRING IN SUBPLOTS OF FOREST HABITATS, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Species	Sampling Stations F-1	F-2	F-3	F-4
Acer saccharum Marsh.			6.9	
Amelanchier arborea (Michx. f.) Fern.	12.2	7.3		
Carya ovata (Mill.) K. Koch	18.7	43.5	8.7	
Carya texana Buckl.	11.0	26.4	23.2	
Carya tomentosa Nutt.		5.9		
Cornus florida L.	43.8	20.5	25.2	15.6
Ostrya virginiana (Mill.) K. Koch	10.4			
Quercus alba L. and var.	132.8	134.9	142.2	92.7
Quercus rubra L.		23.5	14.5	
Quercus stellata Wang.	16.1		16.5	65.0
Quercus velutina Lam.	34.2	22.4	54.5	88.0
TOTAL	279.2	284.4	291.7	261.3

Comparisons between Sampling Stations	Summation of Importance Values for Species common to both Stations	Summation of Importance Values for Species occurring at only one Station	Index of Similarity (%)[c]
F-1 vs. F-2	507.7	55.9	90.1
F-1 vs. F-3	526.9	44.0	92.3
F-1 vs. F-4	488.2	52.3	90.3
F-2 vs. F-3	539.5	36.6	93.6
F-2 vs. F-4	374.1	180.6	67.4
F-3 vs. F-4	484.1	68.9	87.5

[a] Calculated as $\frac{\text{Number of points of occurrence of the species}}{\text{Number of points of occurrence of all species}} \times 100 + \frac{\text{Density of a species}}{\text{Density of all species}} \times 100 + \frac{\text{Basal area of a species}}{\text{Basal area of all species}} \times 100$ (each sampling station)

[b] Includes all species for which the percent frequency (16 subplots) + $\frac{\text{Density of a species}}{\text{Density of all species}} \times 100 + \frac{\text{Basal area of a species}}{\text{Basal area of all species}} \times 100$ (relative dominance) exceeded a value of 15.0

[c] Calculated as $\frac{\text{Summation of importance values for species common to any two stations}}{\text{Summation of the total importance values for the same stations}} \times 100$

TABLE 3.3.1-9

COMPARISONS WITHIN AND BETWEEN SAMPLING STATIONS BASED ON CALCULATED IMPORTANCE VALUES[a] FOR MAJOR COMPONENT SPECIES OF GROUND LAYER VEGETATION[b] OCCURRING IN SUBPLOTS OF FOREST HABITATS, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, MAY-JUNE 1974

Species[c]	Sampling Stations			
	F-1	F-2	F-3	F-4
Amelanchier arborea (Michx.) Fern.	1.01	5.14	1.07	4.94
Anemonella thalictroides (L.) Spach.	3.00	3.64	5.07	
Antennaria plantaginifolia (L.) Hook		2.95	1.04	2.20
Aster sp.	3.32	0.93	2.57	7.59
Carex bushii Mack.	6.41	9.31	9.46	4.07
Carex glaucodea		6.72	1.05	
Carex gravida Bailey	4.31		4.17	
Carex rosea Schk.	3.40	6.42	2.03	3.68
Carya ovata (Mill.) K. Koch.	5.59		1.40	
Cornus florida L.	0.99	2.43	5.24	2.44
Desmodium dillenii Darl.			6.64	6.44
Desmodium glutinosum (Muhl.) Wood		4.74		
Desmodium nudiflorum (L.) D.C.	7.01		12.12	1.42
Dioscorea villosa L.		1.48		1.25
Euonymus atropurpea Jacq.			6.56	
Fraxinus americana L.	19.06	7.02		
Galium circaezans Michx.	2.94	2.21	10.56	
Galium cocinnum Torr. & Gray	4.67	6.64	1.02	
Helianthus sp.		0.86		4.61
Lespedeza violacea (L.) Pers.		1.58		2.41
Lactuca sp.		1.44	1.25	1.30
Lysimachia lanceolata Walt.		1.47		
Monarda russelliana Nutt.			4.68	
Ostrya virginiana (Mill.) K. Koch.	5.42			
Panicum lanuginosum Ell.		1.46		
Panicum linearifolium Scribn.				3.10
Panicum subvillosum Ashe.			1.03	2.41
Parthenium integrifolium Ait.				5.33
Parthenocissus quinquefolia (L.) Planch.	33.93	29.58	27.25	2.59
Podophyllum peltatum L.	0.99	4.98	2.82	
Potentilla simplex Michx.		3.85		4.91
Prunus serotina	1.35	0.72	4.48	
Psoralea psoralioides (Walt.) Corey var. eglandulosa (Ell.) Sampson				28.03
Quercus alba L. and/or hybrids	16.33	5.21	3.20	6.10
Quercus macrocarpa Michx. and/or hybrids	15.57	1.94		13.41
Quercus marilandica Muenchh. and/or hybrids	3.73	4.23		18.49
Quercus stellata Wang and/or hybrids	7.07			
Quercus velutina Lam. and/or hybrids				3.84
Rhus aromatica Ait.	13.10	15.01	39.21	20.87
Rosa carolina L.	3.96	4.19	5.43	13.09
Rubus flagellaris Willd.	2.18	0.97	2.09	
Rubus occidentalis L.	2.53	7.95		
Sassafras albidum (Nutt.) Nees.		2.47		1.27
Scutellaria parvula Michx.		1.46		
Smilacina racemosa L.	2.23	2.41	2.97	
Strophostyles helvola (L.) Britt.	5.48	5.24	14.60	3.22
Symphoricarpos orbiculatus Moench.		6.44	2.58	1.19
Tradescantia ohiensis Raf.		4.61		
Viburnum rafinesquianum Schultes.		1.85		
Viola papilionacea Pursh.		4.36		
Vitis cinerea Engelm.	1.16	8.49	10.37	2.45
Totals	177.28	182.40	191.96	172.65

Comparisons between sampling stations	Summation of importance values for species common to both stations	Summation of importance values for species occurring at only one station	Index of similarity[d]
F-1 vs. F-2	282.54	77.14	78.55
F-1 vs. F-3	290.49	78.75	78.67
F-1 vs. F-4	219.76	130.17	62.80
F-2 vs. F-3	286.43	87.93	76.51
F-2 vs. F-4	241.27	113.78	67.95
F-3 vs. F-4	231.09	133.52	63.38

[a]Calculated as $\frac{\text{Number of points of occurrence of the species}}{\text{Number of points of occurrence of all species}} + \frac{\text{Total dry weight of each species}}{\text{Total dry weight of all species}} \times 100$ (each sampling station)

[b]Includes all herbaceous species and woody plants of less than 20 inches in height

[c]Includes all species for which the percent frequency (16 subplots) and $\frac{\text{Total dry weight of each species}}{\text{Total dry weight of all species}} \times 100$ (relative dominance) exceeded a value of 10.0

[d]Calculated as $\frac{\text{Summation of importance values for species common to any two stations}}{\text{Summation of the total importance values for the same stations}} \times 100$

TABLE 3.3.1-10

CHLORINATED HYDROCARBON CONCENTRATIONS OF THE SOIL AT THE UNION ELECTRIC CALLAWAY PLANT, UNITS 1 AND 2 SITE

Parts Per Million (w/w)

	1	2	3	4	5	6	7	8
Mirex	[a]<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Toxaphene	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
PCB's	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lindane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Heptachlor	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aldrin	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Heptachlor Epoxide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
β Chlordane	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
α Chlordane	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
p,p-DDE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dieldrin	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Endrin	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
o,p-DDT	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
p,p-DDD	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
p,p-DDT	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

[a]<Indicates less than, if present at all.

No detectable residues of 2,4 D, 2,4,5-T and Silvex chlorophenoxy acid herbicide esters were detected at a level greater than 0.05 ppm.

TABLE 3.3.1-11

CHEMICAL CHARACTERISTICS OF THE SOIL AT THE UNION ELECTRIC CALLAWAY PLANT, UNITS 1 AND 2 SITE [a]

	F-1	F-2	F-3	F-4	P-1	P-2	P-3	P-4
Available Calcium	255.00	255.00	255.00	300.00	840.00	660.00	1200.00	1095.00
" Magnesium	51.00	60.00	60.00	60.00	72.00	168.00	114.00	123.00
" Potassium	52.80	48.00	50.40	48.00	58.20	71.20	66.00	42.60
" Sodium	7.80	7.20	6.30	6.60	12.00	14.40	14.40	14.40
" K-Nitrogen	3.69	2.85	2.85	3.12	5.10	5.70	4.59	3.59
" Tot. Phosphorus	<.15	<.15	<.15	<.15	.21	<.15	<.15	<.15
pH (units)	5.40	4.90	5.00	5.20	6.40	5.80	6.40	6.40
Lead (Total)	110.00	110.00	60.00	15.00	110.00	13.00	60.00	60.00
Chromium (Total)	56.00	64.00	16.00	32.00	100.00	40.00	40.00	48.00
Copper (Total)	32.00	32.00	17.00	17.00	34.00	24.00	32.00	32.00
Cadmium (Total)	1.20	1.90	1.60	1.00	2.40	1.00	1.80	1.60
Manganese (Total)	2850.00	4100.00	2200.00	900.00	3500.00	1400.00	3000.00	1500.00
Mercury (Total)	0.10	0.20	.02	.02	.02	.02	.10	.10
Arsenic (Total)	19.00	44.00	<.50	<.50	12.00	<.50	.70	12.00

[a]All results are expressed in mg/kg unless otherwise specified.

3.3.2 MAMMALS

3.3.2.1 Small Mammals

Small mammal densities determined during the spring and fall sampling periods for the four permanent sampling stations located in forest habitats are presented in Table 3.3.2-1.

Short-tailed shrews were present at all four sampling stations during the spring survey but were found only at Sampling Stations F-1, F-2, and F-3 during the fall survey. The shrew recaptures at Station F-2 during the spring survey and at Stations F-1, F-2, and F-3 during the fall survey were unusual occurrences, because shrews are not attracted by the bait used in the trapping program. However, shrews are often captured when they blunder into traps, or what is more likely, when they enter the traps to prey on insects attracted by the peanut butter/oatmeal bait. Shrews have poorly developed senses of sight and smell but well developed senses of touch and hearing (Schwartz and Schwartz, 1959).

Short-tailed shrew densities at the forested stations are probably about normal. Schwartz and Schwartz (1959) list "normal" population densities as 1.4 per acre. However, short-tailed shrew densities may exceed 25 animals per acre during periods of peak populations. In addition to preying on insects, short-tailed shrews also eat mice, which they kill with a salivary poison. Thus, they may be at least partially responsible for the low densities of white-footed mice in forest habitats.

One least shrew was captured at Sampling Station F-1 during the fall survey. Although least shrew captures in deciduous forest habitats are not unknown, they are far more common in prairie and oldfield habitats (Briese and Smith, 1974).

Permament Sampling Stations F-2 and F-3 were inhabited by white-footed mice (Table 3.3.2-1). Respective densities of 0.67/acre and 0.40/acre during the spring survey are considered to be low. No white-footed mice were captured at any sampling station during the fall survey. It is possible that the deciduous forest habitats on the Union Electric site are simply unsuitable habitat for white-footed mice; however, it is probable that the white-footed mouse population in this portion of Missouri is in one of its cyclic "lows," which occur every 3 to 5 years (Schwartz and Schwartz, 1959). This "low" has probably been reinforced by the oak mast crop failure due to early frost during the last 3 to 4 years. Acorns are among the staple foods of the white-footed mouse (Schwartz and Schwartz, 1959).

Small mammal densities during the spring and fall sampling periods for the four permanent sampling stations located in prairie habitats are presented in Table 3.3.2-2.

One short-tailed shrew was captured on Station Pr-4 during the spring survey. Although short-tailed shrews do on occasion inhabit prairie situations (Briese and Smith, 1974), their preferred habitat is wooded areas. Therefore, their occurrence on prairie sites should be regarded as an exception (Schwartz and Schwartz, 1959).

Least shrews were captured at Stations Pr-1 and Pr-4 during the spring survey and at Station Pr-4 during the fall survey. These shrews are generally abundant but are seldom caught in live traps because of their marked preference for insects, centipedes, millipedes, spiders, and similar foods. Like the short-tailed shrews, least shrews have poor senses of sight and smell and locate their prey by sound and touch. They have tremendous appetites, consuming one to three times their weight in food daily. This species may contribute to control of insect populations in an area, but the precise relationship between populations of least shrews and insects has not been scientifically established (Schwartz and Schwartz, 1959).

Western harvest mice were captured at Stations Pr-2, Pr-3, and Pr-4 during both surveys. Only at Stations Pr-2 and Pr-4 were sufficient captures made to enable calculation of denisty estimates. Population densities of 0.60/acre and 1.34/acre on Pr-2 and of 0.67/acre and 0.44/acre on Pr-3 (spring and fall surveys respectively) are low for this species and may reflect their "trap shyness" (Briese and Smith, 1974). Bancroft (1966) reported population densities of 10 to 12/acre in relatively similar grassland habitats in Kansas. Populations of western harvest mice may fluctuate rapidly in part because they breed as early as 38 days of age and may bear new litters as often as every 22 days, although this situation is not often seen in field situations (Richins, Smith, and Jorgensen, 1974). Western harvest mice are an exclusively grassland species, feeding primarily on seeds. However, they occasionally supplement their diet with insects (Schwartz and Schwartz, 1959; Bancroft, 1966).

Prairie voles are the most common and most ecologically important species occurring at the prairie stations. It is also the single most important small mammal species present on the Union Electric plant site, both in terms of trophic relationships and numbers. This species is uniquely suited for study as an indicator of environmental change since it reflects change dynamically both as a population and individually. Population densities for all four prairie stations were comparatively low during the spring survey, with the highest density occurring at Station Pr-4 (Table 3.3.2-2). Prairie vole populations generally follow a 4-year cycle of abundance, ranging from less than 15/acre at low levels to more than 250/acre at peak levels. Average population densities generally range between 15 to 50/acre, but population levels are dramatically influenced by such environmental factors as summer drought, severe winter weather, parisitism, epidemic disease, land use changes, and changing habitat suitability

(Schwartz and Schwartz, 1957; Myers and Krebs, 1974).

It would be difficult to overestimate the importance of the prairie vole in the ecology of the prairie regions. The species is preyed on by almost every predator, even bullfrogs and snapping turtles; yet the prairie vole population may increase by threefold to tenfold in a single season. One individual in captivity produced 13 litters totaling 78 offspring before reaching one year of age (Schwartz and Schwartz, 1959).

That this situation can occur in nature is apparent by the data in Table 3.3.2-2. The population density at Station Pr-1 increased approximately six times between the spring and fall samples. At Station Pr-2, the increase was about eightfold; at Pr-3 about fivefold. The vole population at Station Pr-4, however, increased little--from 8/acre to about 9.5/acre. This apparent disparity in population trends can be explained by examining the relationship of prairie vole habitat requirements and existing conditions at the four prairie sampling stations.

The spring mammal data for Prairie Stations Pr-1, Pr-2, and Pr-3 show sharply lower prairie vole densities than for Prairie Station Pr-4. This difference is probably the result of a difference in previous land use at Pr-4. Station Pr-1 is located in a hay field that was apparently harvested annually in previous times. Consequently, only limited litter accumulations were present at the ground surface, providing little habitat for prairie voles, which require litter for runways and nests. The limited habitat probably is the reason for the low spring survey densities of prairie voles.

Much of the same situation exists at Stations Pr-2 and Pr-3 except here the limited litter accumulation is the result of former pasturage rather than hay harvesting. In contrast, the area at Station Pr-4 was apparently unharvested during the previous growing season. Therefore, the litter layer is fairly thick, providing ideal nesting and runway habitat for the prairie vole.

The habitat situation on these same areas during the fall survey is quite different. Stations Pr-1, Pr-2, and Pr-3 all had been released from the restrictive ecological pressures previously imposed by grazing and hay harvesting. Therefore, a rich, thick mat of lodged grasses and litter had accumulated near the ground level. The situtaion at Pr-4, however, had not changed because the process of litter accumulation had occurred at this station approximately one year previously.

Thus population density increase shown in Table 3.3.2-2 is probably due to the response of the vole population to a substantial increase in habitat suitability, in conjunction with a normal increase due to reproductive activity. Station Pr-4 displays no dramatic population density increase because there was no significant increase in habitat suitability. The minor density increase noted at Pr-4 is probably due to normal reproductive activity.

Southern bog lemmings were captured during the spring survey only at Station Pr-4. The presence of lemmings is of questionable ecological significance because the Callaway Plant site is located within the southern distributional limits of the species. Lemmings may be locally abundant in some areas but be totally absent from others that appear to provide suitable habitat conditions. Thus, the presence of the species at Station Pr-4 is not particularly meaningful. One characteristic feature of all habitats in which the species occurs is the presence of a thick mat of vegetation and litter near or at ground level (Schwartz and Schwartz, 1959).

A summary of standard body measurements made for representative small mammals captured during the spring sampling period (May 31, 1974 to June 5, 1974) and the fall sampling period (September 18-23, 1974) is presented in Table 3.3.2-3. These data are matched in the table with the established limits for each species as published by Hall and Kelson (1959); the measured values are within the established limits for the species in every case.

The small mammal snap-trapping program conducted during the spring survey provided only limited useful information, because of the frequent and heavy rainfall that consistently set off traps or washed away bait. A single specimen of short-tailed shrew, white-footed mouse, and prairie vole were prepared, mounted, and used as an aid in validating field identification.

3.3.2.2 Large Mammals

The roadside counts of eastern cottontail were probably influenced by the frequent and heavy rainfall. Unfortunately, the extent of influence cannot be ascertained. A mean relative abundance of 8.25 cottontails/13.2 miles during the spring survey was derived for the census route. It appears that the population was undergoing a natural seasonal increase; this assumption is based on the observation that there were two distinct size classes of young rabbits. At least two litters were assumed to have been born during the current breeding season. The relative abundance of cottontails observed during the fall survey decreased to a mean of 0.25 rabbits/13.2 miles traveled. It is believed that this decrease is more apparent than real. Because the crops in the area had not been harvested, the cottontails had not been forced to utilize roadside vegetation for cover.

Data obtained by nighttime spotlighting during the spring survey indicate a mean abundance of 0.25 raccoons/20 miles of travel. This figure is considerably lower than expected, inasmuch as raccoon tracks were seen in almost every muddy area on the site.

Interviews with local residents indicated that there is a fairly large population of raccoons in the area, which substantiates track observations. However, this is contrary to results obtained by spotlight survey. During the fall survey, 0.50 raccoons/20 miles of travel were observed. This figure, while higher than the spring survey, is still lower than expected.

One fox was observed during the course of the spring spotlight survey. On two other occasions, red foxes were observed in approximately the same area. No white-tailed deer were observed during springtime night spotlighting activities; however, fawns, yearlings, and adult animals were observed during conduct of the preconstruction monitoring program. During the fall survey, an average of two white-tailed deer/per 20-mile survey were observed. One opossum and two striped skunks were also observed.

3.3.2.3 Inventory of Observed Species

Mammals observed at or immediate to the Callaway Plant site are listed in Table 3.3.2-4. Some of these -- the eastern mole and spotted skunk -- were observed only as road-killed animals. Others, such as white-tailed deer, fox squirrel, and gray squirrel were sighted directly. One observed species, the long-tailed weasel, is listed as a "rare" species by the Missouri Department of Conservation (Union Electric Company, 1974).

TABLE 3.3.2-1

ESTIMATED[a] SMALL MAMMAL DENSITIES (PER ACRE) FOR PERMANENT SAMPLING STATIONS LOCATED IN FOREST HABITAT, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, SPRING AND FALL 1974

	FOREST STATIONS							
	F-1		F-2		F-3		F-4	
Species	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Short-tail shrew	P[b]	1.68	0.37	0.34	P	1.51	P	+[c]
Adult	P	1.68	0.37	0.34	P	1.51	P	+
Male	P	0.84	P	0.34	P	0.74	P	+
Female	P	0.84	0.37	+	P	0.75	+	+
Sub-Adult	+	+	+	+	+	+	+	+
Male	+	+	+	+	+	+	+	+
Female	+	+	+	+	+	+	+	+
Juvenile	+	+	+	+	+	+	+	+
Male	+	+	+	+	+	+	+	+
Female	+	+	+	+	+	+	+	+
Least shrew	+	P	+	+	+	+	+	+
Adult	+	P	+	+	+	+	+	+
Male	+	P	+	+	+	+	+	+
Female	+	+	+	+	+	+	+	+
Sub-Adult	+	+	+	+	+	+	+	+
Male	+	+	+	+	+	+	+	+
Female	+	+	+	+	+	+	+	+
Juvenile	+	+	+	+	+	+	+	+
Male	+	+	+	+	+	+	+	+
Female	+	+	+	+	+	+	+	+
White-footed mouse	+	+	0.67	+	0.40	+	+	+
Adult	+	+	0.34	+	P	+	+	+
Male	+	+	0.34	+	P	+	+	+
Female	+	+	+	+	P	+	+	+
Sub-Adult	+	+	0.34	+	0.37	+	+	+
Male	+	+	0.34	+	0.34	+	+	+
Female	+	+	+	+	P	+	+	+
Juvenile	+	+	+	+	+	+	+	+
Male	+	+	+	+	+	+	+	+
Female	+	+	+	+	+	+	+	+

[a] Estimates are based on the EM-2 small mammal estimator (Smith and Jorgensen, 1974) utilizing 144 live traps in a 2.98-acre grid for a total of 864 trap nights.

[b] P=Present, but in insufficient numbers for density estimate.

[c] +=Not observed.

TABLE 3.3.2-2

ESTIMATED[a] SMALL MAMMAL DENSITIES (PER ACRE) FOR PERMANENT SAMPLING STATIONS LOCATED IN PRAIRIE HABITAT, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, SPRING AND FALL 1974

	PRAIRIE STATIONS							
	Pr-1		Pr-2		Pr-3		Pr-4	
Species	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Short-tailed shrew	+[b]	+	+	+	+	+	P[c]	+
Adult	+	+	+	+	+	+	P	+
Male	+	+	+	+	+	+	+	+
Female	+	+	+	+	+	+	P	+
Sub-Adult	+	+	+	+	+	+	+	+
Male	+	+	+	+	+	+	+	+
Female	+	+	+	+	+	+	+	+
Juvenile	+	+	+	+	+	+	+	+
Male	+	+	+	+	+	+	+	+
Female	+	+	+	+	+	+	+	+
Least shrew	P	+	+	+	+	+	P	P
Adult	P	+	+	+	+	+	P	P
Male	P	+	+	+	+	+	P	+
Female	+	+	+	+	+	+	P	P
Sub-Adult	+	+	+	+	+	+	+	+
Male	+	+	+	+	+	+	+	+
Female	+	+	+	+	+	+	+	+
Juvenile	+	+	+	+	+	+	+	+
Male	+	+	+	+	+	+	+	+
Female	+	+	+	+	+	+	+	+
Western harvest mouse	+	+	0.60	1.34	P	P	0.67	0.44
Adult	+	+	0.60	1.01	+	P	0.67	0.44
Male	+	+	P	+	+	+	0.67	+
Female	+	+	0.34	1.01	+	P	+	0.44
Sub-Adult	+	+	+	+	P	+	+	+
Male	+	+	+	+	+	+	+	+
Female	+	+	+	+	P	+	+	+
Juvenile	+	+	+	0.34	+	+	+	+
Male	+	+	+	0.34	+	+	+	+
Female	+	+	+	+	+	+	+	+
Prairie vole	1.81	11.74	1.78	16.11	6.14	31.08	8.09	9.40
Adult	1.81	9.80	1.51	11.21	3.12	21.44	6.78	8.02
Male	1.81	5.64	0.67	5.00	0.44	10.54	5.20	5.65
Female	+	4.09	0.64	5.74	2.35	11.14	1.54	2.39
Sub-Adult	+	1.01	0.34	3.02	0.34	3.19	P	2.01
Male	+	+	+	2.55	0.34	1.68	+	1.01
Female	+	1.01	0.34	0.34	+	1.50	P	1.01
Juvenile	+	P	+	0.67	+	9.47	0.67	+
Male	+	P	+	P	+	4.09	+	+
Female	+	+	+	0.67	+	4.46	P	+

TABLE 3.3.2-2 (continued)

	PRAIRIE STATIONS							
	Pr-1		Pr-2		Pr-3		Pr-4	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Southern bog lemming	+	+	+	+	+	+	1.17	+
Adult	+	+	+	+	+	+	1.17	+
Male	+	+	+	+	+	+	0.67	+
Female	+	+	+	+	+	+	P	+
Sub-Adult	+	+	+	+	+	+	+	+
Male	+	+	+	+	+	+	+	+
Female	+	+	+	+	+	+	+	+
Juvenile	+	+	+	+	+	+	+	+
Male	+	+	+	+	+	+	+	+
Female	+	+	+	+	+	+	+	+

[a]Estimates are based on the EM-2 small mammal estimator (Smith and Jorgensen, 1974) utilizing 144 live traps in a 2.98-acre grid for a total of 864 trap nights.

[b]+=not observed.

[c]P=present, but in insufficient numbers for density estimate.

TABLE 3.3.2-3

STANDARD MEASUREMENTS OF SMALL MAMMALS CAPTURED ON THE CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, SPRING AND FALL 1974

	Sample Size[c]		Field Measurements[a] (mm)		Published[b] Measurements (mm)
	Spring	Fall	Spring	Fall	
Short-tailed shrew	13	7			
Total length			107.5 ± 3.5	105.4 ± 12.0	95-134
Tail length			19.8 ± 0.5	19.0 ± 1.9	17-30
Ear length			3.1 ± 0.1	---	---
Hind foot length			15.1 ± 0.1	13.1 ± 0.7	11.5-17
Least shrew	4	0			
Total length			87.5 ± 1.3	---	75-89
Tail length			15.5 ± 0.6	---	12-22
Ear length			2.0 ± 0.0	---	---
Hind foot length			11.9 ± 0.5	---	9-12
Western harvest mouse	7	8			
Total length			129.1 ± 2.6	122.6 ± 19.2	118-170
Tail length			58.4 ± 3.5	59.6 ± 9.5	55-96
Ear length			12.2 ± 0.3	---	10-16
Hind foot length			16.1 ± 0.8	15.9 ± 0.6	14-20
White-footed mouse	4	0			
Total length			160.8 ± 3.4	---	156-205
Tail length			66.1 ± 1.6	---	63-97
Ear length			15.3 ± 1.7	---	13-16
Hind foot length			23.3 ± 2.5	---	19-24
Prairie vole	20	132			
Total length			143.6 ± 2.9	133.2 ± 3.5	130-172
Tail length			30.7 ± 1.4	33.6 ± 1.1	24-41
Ear length			12.6 ± 0.4	---	11-15
Hind foot length			19.5 ± 0.7	18.2 ± 0.2	17-22
Southern bog lemming	3	0			
Total length			138.0 ±16.9	---	118-154
Tail length			15.7 ± 0.7	---	13-24
Ear length			12.6 ± 1.5	---	8-14
Hind foot length			20.0 ± 1.1	---	16-24

[a] means and confidence limits (p=95%).

[b] Hall and Kelson (1959).

[c] numbers indicate sample size from which means are derived.

TABLE 3.3.2-4

A PHYLOGENETIC[a] LISTING OF MAMMAL SPECIES OBSERVED ON OR IMMEDIATE TO THE CALLAWAY PLANT SITE DURING THE 1973-74 BASELINE SURVEY[b], THE INITIAL MONITORING SURVEY, MAY-JUNE 1974, AND THE FALL SURVEY, SEPTEMBER 1974, CALLAWAY COUNTY, MISSOURI

FAMILY Scientific Name Common Name	Baseline Survey 1973-74	Spring Survey May-June, 1974	Fall Survey September, 1974
DIDELPHIDAE			
Didelphis marsupialis virginiana			
Opossum	X	X	X
SCORICIDAE			
Blarina brevicauda carolinensis			
Short-tailed shrew		X	X
Cryptotis parva parva			
Least shrew		X	X
TALPIDAE			
Scalopus aquaticus machrinoides			
Eastern mole	X	X	
LEPORIDAE			
Sylvilagus floridanus alacer			
Eastern cottontail	X	X	X
SCIURIDAE			
Marmota monax monax			
Woodchuck	X		
Sciurus carolinensis carolinensis			
Gray squirrel	X	X	X
Sciurus niger rufiventer			
Fox squirrel	X	X	X
CRICETIDAE			
Reithrodontomys megalotis dychei			
Western harvest mouse		X	X
Peromyscus maniculatus gairdii			
Deer mouse	X		
Peromyscus leucopus noveboracensis			
White-footed mouse	X	X	
Microtus ochrogaster ochrogaster			
Prairie vole		X	X
Ondatra zibethicus zibethicus			
Muskrat	X		
Synaptomys cooperi gossii			
Southern bog lemming		X	

TABLE 3.3.2-4 (continued)

FAMILY Scientific Name Common Name	Baseline Survey 1973-74	Spring Survey May-June, 1974	Fall Survey September, 1974
CANIDAE			
Canis latrans frustror			
Coyote	X	X	X
Vulpes fulva			
Red fox		X	
PROCYONIDAE			
Procyon lotor hirtus			
Raccoon	X	X	X
MUSTELIDAE			
Mustela frenata primulina			
Long-tailed weasel	X	X	
Mephitis mephitis avia			
Striped skunk	X	X	X
CERVIDAE			
Odecoileus virginiana marcoura			
White-tailed deer	X	X	X

[a]Phylogeny and species nomenclature follow Jones, Carter, and Genoways, 1973. Subspecific nomenclature follows Hall and Kelson, 1959.

[b]Union Electric Company, 1974.

3.3.3 AVIFAUNA

As noted previously, avian survey transects were chosen to traverse relatively homogeneous habitat within or immediate to permanent sampling stations established for intensive investigation of vegetation and small mammal populations. During the course of avian surveys, it was noted that subtle differences in habitat along a given transect frequently resulted in an apparent increase or decrease in the abundance and/or diversity of birds. However, considering the high degree of mobility and wide variance in behavior of bird species, exacting species-habitat preferences cannot be locally established with unequivocal certainty.

3.3.3.1 Prairie Habitats

The average density of birds observed in three daily surveys of each prairie habitat is shown in Table 3.3.3-1. The densities are variable from one habitat to another. The high standard deviation shown for Prairie Transects Pr-1 and Pr-3 indicates there may be a broad range of variability in daily avian densities estimated from the survey (Table 3.3.3-1).

Some portion of the variability was considered to be weather-related. Because surveys of a given transect were conducted on different days, the frequent and irregular occurrence of rainfall before, during, and after a survey undoubtedly influenced bird activities as well as the investigator's ability to detect and recognize birds within the sampling area. However, Students "t" tests (see Table 3.3.3-2) suggest that there are no significant differences in the density of avifauna occurring in or otherwise utilizing the sampled prairie habitats.

The densities of breeding birds associated with the sampled transects are therefore assumed to be relatively similar.

A tally of all birds recorded during the spring survey along each transect through the four prairie habitats (Table 3.3.3-3) indicates that the bird population at Prairie Transect Pr-2 had highest diversity (11 species); that of Prairie Transect Pr-3 had lowest diversity (5 species). Table 3.3.3-3 includes species that are not common nesting inhabitants of prairie or oldfield habitats. Such species were observed flying over the strip or in nearby habitat not representative of the sampled transects. Table 3.3.3-4 includes only those birds common to the site; species uncommon to the site have been omitted. In this table, the similarity or dissimilarity of nesting birds inhabiting the four prairie habitats is more apparent. Pr-1 and Pr-2 are most similar, and Transects Pr-2 and Pr-3 are somewhat similar. Any comparison of Transect Pr-4 nesting birds with those of other transects shows a low degree of similarity.

From the standpoint of comparable habitat, Transects Pr-1 and Pr-4 (fescue grasslands) and Transects Pr-2 and Pr-3 (abandoned pasture) are most similar. Despite some disparities, the density and diversity of birds associated with Transects Pr-2 and Pr-3 were of sufficient similarity to be strongly correlated.

The transects through Prairie Stations Pr-2 and Pr-3 were comparatively short (0.18 miles). However, similar habitat conditions were not available nearby to permit increasing the length of the transects. It is likely that if the sampled areas could have been increased, the estimated nesting bird populations of the two transects would have shown even greater similarity.

In contrast, although avian density of Transects Pr-1 and Pr-4 appeared to be relatively similar, species diversity in the two transects was variable. Transects Pr-2 and Pr-3 were surveyed in sequence, whereas Transects Pr-1 and Pr-4 were the first and last, respectively. This may be an important factor in explaining the difference in nesting species associated with the Pr-1 and Pr-4 transects.

Data from the fall avian survey are not directly comparable with the data from the spring survey because of the differences in density, diversity, and distribution wrought by the factors such as migration, effect of weather on cover, and the tendency of premigratory birds to flock together by species. (Density estimates for each transect are given in Table 3.3.3-1.) With the breeding season over, many of the birds had dispersed over larger areas of territory. Also, some of the prairie nesters had already migrated from the area. Most birds observed on the transects were seen flying overhead; they were either moving to nearby wooded areas or migrating south. Meadowlarks were by far the most abundant of the birds using the prairie areas for feeding and roosting. These birds also seemed to be the most abundant in the areas around Pr-2 and Pr-3, which abounded in short grass preferred by the meadowlarks.

The only other prairie nesters seen feeding or roosting on the prairie areas were field sparrows, bobwhite quail, and mourning dove. These birds were observed feeding either early in the morning or late in the evening; after being flushed, they moved to nearby wooded areas.

Other birds seen feeding or landing in the prairie areas were bluebirds, least flycatchers, and common grackles. These birds were probably after seeds produced by the prairie vegetation. Also seen hunting over the prairie were sparrow hawks and red-tailed hawks.

3.3.3.2 Forest Habitats

The average density of birds observed in three daily surveys of each forest habitat during the spring study is shown in Table 3.3.3-1. The estimated density of breeding birds is relatively similar along the transects through Forest Stations F-2, F-3, and F-4. In contrast, the estimated density of birds associated with Forest Transect F-1 is nearly double that estimated for other forest transects.

The Students "t" test was used to evaluate differences in the density of birds occurring in the various sampled forest habitats. Of the six possible comparisons, the test indicated two comparisons whereby avian densities were significantly different at a 95 percent confidence limit (Table 3.3.3-2). In both instances, the avian density at Forest Transect F-1 was significantly different from that of other forest habitats.

The reason for the greater density of birds occurring in Transect F-1 is not clear. However, a forest area adjacent to the transect had been recently and selectively harvested. In consequence, saplings, shrubs, vines, and herbaceous vegetation were responding vigorously to the increased insolation penetrating openings in the overhead canopy. It is likely that this change in the environment following logging activities resulted in a greater variety and availability of suitable food items; this in turn may have attracted birds to the harvested and adjacent areas, such as the F-1 transect.

Common yellowthroats, cardinals, and bluejays were among the species most commonly observed to be associated with the harvested forest area. These species were also among the most frequently observed in surveys of Transect F-1. This situation provides some support for the assumption that post-logging habitat is attractive to some bird species, thus effecting an increase in bird density within the local area. Additionally, Transect F-1 is located adjacent to a creek where belted kingfisher and Louisiana water thrush were observed. These species demonstrate a strong preference for aquatic habitats, and other surveyed forest transects, for the most part, lacked suitable aquatic conditions.

Although a tally of all species recorded along transects through the four forest habitats demonstrates a relatively similar total diversity (Table 3.3.3-3), there is noticeable variability in the species of birds observed in the various transects. However, if only the most commonly occurring breeding birds are considered (Table 3.3.3-4), the species consistently associated with forest habitats become apparent. The bluejay was present in all four transects and was usually seen near field-forest boundaries. This species commonly nests along forest borders where the vegetation is relatively dense. The cardinal was also a common inhabitant of the forest habitat; this species will nest wherever shrubby vegetation exists.

The uncommonly occurring birds, listed in Table 3.3.3-3 but omitted from Table 3.3.3-4, include the red-tailed hawk, belted kingfisher, Louisiana water thrush, common yellowthroat, Baltimore oriole, indigo bunting, and rufous-sided towhee. The red-tailed hawk was observed flying above the plant site. The hawk is a forest inhabitant but often feeds on mammals inhabiting open fields. Their daily range of movement is too extensive to be comparable with that of song birds observed during a walking strip census. The belted kingfisher and Louisiana water thrush were observed only along a woodland creek, as previously noted. The common yellowthroat, indigo bunting, and rufous-sided towhee prefer shrubby surroundings and were observed primarily in forest openings. The Baltimore oriole commonly nests in tall trees near open glades or fields and is not a usual inhabitant of the forest interior.

The uniform and relatively high frequency with which the commonly occurring nesting species were observed within the four forest transects (Table 3.3.3-4) is considered to indicate a basic similarity in bird populations in the sampled areas. The general similarity of habitat conditions in the four transects is also indicated.

The fall avian densities of the eight transects are presented in Table 3.3.3-1. The increased variance among plots, compared to the spring survey, was probably due to the flocking behavior of premigratory birds. This causes a wide degree of variance between successive observations; this variance reflected in the generally wider confidence limits is expressed in the standard deviation values presented in Table 3.3.3-1.

The forests were the most productive of the two habitat types, in that birds were actually observed using the plots. Many large flocks of birds would alight in the trees and sometimes drop to the forest floor to feed. Some of the birds observed doing this were common grackles and red-winged blackbirds. Many of the forest nesters had already migrated from the area by the time the fall survey was taken. Some of the birds that had already emigrated were the eastern wood pewee, wood thrush, ovenbird, and summer tanager.

Of the summer resident birds still in the area at the time of the surveys, one of the most abundant seen in the forest plots was the red-headed woodpecker. It was found in every forest plot and can be seen in just about every forest in the area surrounding the proposed plant site. Other summer residents still present were the bluejay, cardinal, tufted titmouse, and common flicker. Many of these birds also winter in this area and are known to be winter residents.

On September 28, 1974, two bald eagles were seen circling over Forest Transect F-4. They were visible for about 4 minutes, then they separated, one (a juvenile) heading west and one (an adult) moving back towards the river. They were at a fairly low altitude when first spotted but moved quickly up and out of sight. Eagles are known to follow the course of the Missouri River and to winter along large tributaries, feeding on dead fish. Because the site is near the river, bald eagles are expected to be seen occasionally over the site.

Generally, all the forests plots had basically the same species during the fall survey and relative numbers seemed to be very close to each other. Many birds were in flocks and did not readily leave the areas. Although large numbers of species were still present, with the coming of winter the numbers should drop off considerably as more birds migrate south.

A compilation of the avian diversity observed during the fall survey within the eight sampling areas is presented in Table 3.3.3-5.

An inventory of the bird species observed during the spring 1974 surveys (spring and fall) is shown in Table 3.3.3-6. A checklist of species observed in an environmental baseline survey (Union Electric Company, 1974) conducted in the preceding year (June 1973) is also included in the table. The list provides some indication of the annual variability in the species occurring in a given area. However, some of the variability is undoubtedly due to differences in time and effort expended to inventory the local avifauna. This is especially true of the fall survey, where several new species were added to the list of birds observed (Table 3.3.3-6). These are species that summer to the north of the plant site and winter to the south and were merely observed in passage. Little significance should be attached to such observations inasmuch as these birds spend only a miniscule amount of time utilizing the resources of the plant site.

Overall, a high proportion of the species observed during one survey were also reported in the other surveys. Only 2 of the 56 species recorded in the 1973 survey were not identified in one of the 1974 surveys. The greatest number of species (68) was identified in the 1974 spring survey; 17 of these species were not recorded in the 1973 inventory.

On the basis of inventory data, most of the bird species occurring at the Callaway Plant site in June were classified as summer residents (Union Electric Company, 1974); in contrast, the species present in the fall survey were a potpourri of winter, summer, and permanent residents, with a scattered contingent of passage species in migration. Summer residents migrate to the south during the fall season, with a few exceptions. In the case of such exceptions, most individuals migrate south, while a few remain in the area during the winter season; these are then considered winter residents. Approximately one-third of the species inhabiting the plant site in June were permanent residents. The ratio for permanent versus other categories is virtually identical for both the 1973 and spring 1974 inventories.

TABLE 3.3.3-1

ESTIMATED MEAN AVIAN DENSITIES (NUMBER/ACRE) FOR PERMANENT SAMPLING STATIONS ON THE CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, SPRING AND FALL 1974

Sampling Station Transect	Spring		Fall	
	Mean Density	Standard Deviation	Mean Density	Standard Deviation
Pr-1	0.58	1.23	1.81	0.46
Pr-2	1.08	0.36	1.09	0.34
Pr-3	1.75	1.45	5.22	6.37
Pr-4	0.46	0.42	5.22	2.42
F-1	0.66	0.16	5.47	6.32
F-2	0.25	0.15	2.95	1.77
F-3	0.38	0.29	1.40	0.75
F-4	0.34	0.20	1.09	0.72

TABLE 3.3.3-2

COMPARISONS OF MEAN BIRD DENSITY (PER ACRE) BASED ON OBSERVATIONS MADE AT OR IMMEDIATE TO PERMANENT SAMPLING STATIONS LOCATED IN SIMILAR HABITAT TYPES OF THE CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, EARLY JUNE 1974

Habitat Types	Station Comparisons	Respective Mean Densities	t-Values[a]
Prairie	Pr-2 versus Pr-3	1.080 - 1.754	1.100
	Pr-1 versus Pr-4	0.580 - 1.742	0.230
	Pr-1 versus Pr-2	0.580 - 1.080	0.953
	Pr-3 versus Pr-4	1.754 - 0.457	2.094
	Pr-2 versus Pr-4	1.080 - 0.457	2.753
	Pr-1 versus Pr-3	0.580 - 1.754	1.506
Forest	F-1 versus F-2	0.660 - 0.250	4.083*
	F-3 versus F-4	0.389 - 0.336	0.352
	F-1 versus F-4	0.660 - 0.336	2.980*
	F-2 versus F-3	0.250 - 0.389	1.024
	F-1 versus F-3	0.660 - 0.389	1.971
	F-2 versus F-4	0.250 - 0.336	0.818

[a]Students "t" test at the 95% confidence limit ($P=.05_{(4)}=2.776$)

*Significant at the 95% confidence limit. Values not marked or not statistically significant at $\alpha=.05$

TABLE 3.3.3-3

AVIAN DIVERSITY BASED ON THE MAXIMUM SPECIES OBSERVED IN ANY ONE-DAY SURVEY OF TRANSECTS THAT TRAVERSE EIGHT PERMANENT SAMPLING STATIONS LOCATED WITHIN THE CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, SPRING 1974

	Number of Individuals Observed/Transect							
	Prairie				Forest			
Species Observed	Pr-1	Pr-2	Pr-3	Pr-4	F-1	F-2	F-3	F-4
Baltimore oriole	+	+	+	+	1[a]	+	+	+
Barn swallow	+	+	+	2[a,b]	+	+	+	+
Belted kingfisher	+	+	+	+	1[a]	+	+	+
Bluejay	2[a]	+	+	1	3	3	3	1
Brown-headed cowbird	+	+	+	+	+	2	+	+
Cardinal	1[a]	+	+	+	4	2	+	1
Common crow	+	1[a,b]	+	+	+	+	+	+
Common flicker	+	+	+	+	1	1	+	1
Common grackle	+	1[a,b]	+	1[a,c]	+	+	2[a]	+
Common yellowthroat	+	+	+	1	3[a]	+	1[a]	+
Dickcissel	1	+	+	2	+	+	+	+
Eastern kingbird	+	1	+	+	+	+	+	+
Eastern meadowlark	9	4	5	1	+	+	+	+
Eastern wood pewee	+	+	+	+	+	+	2	1
Field sparrow	1[b,c]	2	+	1	+	+	+	+
Grasshopper sparrow	+	+	2	1	+	+	+	+
Indigo bunting	+	1[a]	+	+	+	+	1[a]	+

TABLE 3.3.3-3 (continued)

Species Observed	Number of Individuals Observed/Transect							
	Prairie				Forest			
	Pr-1	Pr-2	Pr-3	Pr-4	F-1	F-2	F-3	F-4
Louisiana waterthrush	+	+	+	+	1[a]	1[a]	+	+
Mockingbird	1[a]	+	+	+	+	+	+	+
Mourning dove	+	1[a,b]	1[a,c]	+	+	+	+	+
Ovenbird	+	+	+	+	2	+	+	1
Purple martin	+	+	+	1	+	+	+	+
Red-tailed hawk	+	+	+	+	+	1[b]	+	+
Red-winged blackbird	5	1[a,b]	3	1	+	+	+	+
Ruby-throated hummingbird	+	+	+	1[a]	+	+	+	+
Rufous-sided towhee	+	+	+	+	+	+	+	1[a]
Summer tanager	+	+	+	+	2	+	1	3
Tufted titmouse	+	+	+	+	+	1	2	1
Whip-poor-will	+	+	+	+	+	+	1	1
White-breasted nuthatch	+	+	+	+	1	2	2	+
Wood thrush	+	+	+	+	+	1	1	+
Yellow-billed cuckoo	+	+	1	+	+	+	+	+
TOTAL SPECIES (Diversity)	7	8	11	5	10	9	10	9

[b] Flying over.

[c] Recorded in adjacent habitat.

[a] Uncommon nesting inhabitant.

TABLE 3.3.3-4

AVIAN DIVERSITY OF COMMONLY NESTING BIRDS BASED ON THE MAXIMUM SPECIES OBSERVED IN ANY ONE DAY SURVEY OF TRANSECTS THAT TRAVERSE EIGHT PERMANENT SAMPLING STATIONS LOCATED WITHIN THE CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, EARLY JUNE 1974

Species Observed	Prairie Transects			
	Pr-1	Pr-2	Pr-3	Pr-4
Dickcissel	1[a]	2	+	+
Eastern kingbird	+	+	+	1
Eastern meadowlark	9	1	5	4
Field sparrow	1	1	+	2
Grasshopper sparrow	+	1	2	+
Red-winged blackbird	5	1	3	+
Total Species (Diversity)	4	5	3	3

Species Observed	Forest Transects			
	F-1	F-2	F-3	F-4
Bluejay	3	3	3	1
Cardinal	4	2	+	1
Common flicker	1	1	+	1
Eastern wood pewee	+	+	2	1
Ovenbird	2	+	+	1
Summer tanager	2	+	1	3
Tufted titmouse	+	1	2	1
White-breasted nuthatch	1	2	2	+
Whip-poor-will	+	+	1	1
Wood thrush	+	1	1	+
Total Species (Diversity	6	6	7	8

[a]Indicates the number of individuals sighted for each species observed.

+Not observed.

TABLE 3.3.3-5

AVIAN DIVERSITY FOR THE EIGHT PERMANENT SAMPLING STATIONS, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Species	Forest Transects				Prairie Transects			
	F-1	F-2	F-3	F-4	Pr-1	Pr-2	Pr-3	Pr-4
Bald eagle	+	+	+	2F	+	+	+	+
Barred owl	1	+	+	+	+	+	+	+
Bluebird	+	1	+	+	+	6	+	+
Bluejay	6 2H	7	5 4H	5	+	10F	+	7F
Bobwhite quail	+	+	+	+	+	+	12	+
Common crow	5H	+	1	2H	+	3F	2H	+
Common grackle	9F	+	30F	67F	84F	+	+	+
Common nighthawk	+	+	+	+	3F	+	+	+
Cowbird	+	+	+	+	+	3F	+	+
Eastern meadowlark	+	+	+	+	3	6 17H	6	2
Eastern phoebe	+	+	+	1	+	+	+	+
Field sparrow	+	+	+	+	2	1	+	+
Great horned owl	+	1	+	+	1H	3H	1H	+
Hairy woodpecker	+	1	+	1	+	+	1F	+
Hooded warbler	+	+	1	+	+	+	+	+
Least flycatcher	+	+	+	+	+	+	1	1
Mourning dove	+	2	+	+	1F	2F	+	+
Pileated woodpecker	1	+	1 1H	+	1F	+	+	+
Red-bellied woodpecker	1	+	1	1H	+	+	+	+
Red-headed woodpecker	6	6 2H	5	2	1H	1F	2H	1F
Red-tailed hawk	+	1	+	+	1F	+	+	1F
Red-winged blackbird	+	+	+	+	10F	+	+	+
Robin	2	+	1	1 1H	4F	3F	+	2F
Starling	+	+	50F	17	8F	6F	2F	6F
Sparrow hawk	+	+	+	1	+	1F	+	1F
Yellow-billed cuckoo	+	+	2	+	+	+	+	+
Yellow-shafted flicker	2	+	1	+	+	1F	+	+
TOTAL	35	21	103	101	119	63	27	21

F = birds seen flying over the plot.
H = birds heard on or adjacent to the plot.

TABLE 3.3.3-6

CHECKLIST OF BIRD SPECIES OBSERVED DURING THE ENVIRONMENTAL BASELINE INVENTORY (JUNE 1973), THE SPRING MONITORING SURVEY (JUNE 1974), AND THE FALL MONITORING SURVEY (SEPTEMBER 1974), CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI

Common Name	Scientific Name	Baseline Inventory	Spring Monitoring Survey	Fall Monitoring Survey
Acadian flycatcher	Empidonax virescens	x	-	-
American goldfinch	Spinus tristus	x	x	x
Bald eagle	Haliaetus leucocephalus	-	-	x
Baltimore oriole	Icterus galbula	x	x	-
Barn swallow	Hirundo rustica	x	x	-
Barred owl	Strix varia	-	-	x
Belted kingfisher	Megaceryle alcyon	x	x	-
Bewick's wren	Thryomanes bewickii	-	x	-
Black-billed cuckoo	Coccyzus erythropthalmus	x	-	-
Black-capped chickadee	Parus atricapillus	x	x	-
Blue-gray gnatcatcher	Polioptila caerulea	-	x	-
Blue grosbeak	Guiraca caerula	-	x	-
Bluejay	Cyanocitta cristata	x	x	x
Bobwhite	Colinus virginianus	x	x	x
Brown creeper	Certhia familiaris	-	-	x
Brown-headed cowbird	Molothrus ater	x	x	x
Brown thrasher	Toxostoma rufum	x	x	x
Cardinal	Richmondena cardinalis	x	x	x
Carolina wren	Thryothorus ludovicianus	-	x	-
Catbird	Dumetella carolinesis	x	x	-
Chimney swift	Chaetura pelagica	x	x	-
Chipping sparrow	Spizella passerina	x	x	x
Common crow	Corvus brachyrynchos	x	x	x
Common flicker	Colaptes auratus	x	x	x
Common grackle	Quiscalus quiscula	x	x	x
Common nighthawk	Chordeiles minor	x	x	x
Dickcissel	Spiza americana	x	x	-
Downy woodpecker	Dendrocopos pubescens	-	x	x
Eastern bluebird	Sialia sialis	x	x	x

TABLE 3.3.3-6 (continued)

Common Name	Scientific Name	Baseline Inventory	Spring Monitoring Survey	Fall Monitoring Survey
Eastern kingbird	*Tyrannus tyrannus*	x	x	x
Eastern meadowlark	*Sturnella magna*	x	x	x
Eastern phoebe	*Sayornis phoebe*	-	x	x
Eastern wood pewee	*Contopus virens*	x	x	-
Field sparrow	*Spizella pusilla*	x	x	x
Grasshopper sparrow	*Ammodramus savannarum*	x	x	-
Great blue heron	*Ardea herodias*	-	-	x
Great crested flycatcher	*Myiarchus crinitus*	x	x	-
Great horned owl	*Bubo virginianus*	x	-	x
Green heron	*Butorides virescens*	x	x	-
Hooded warbler	*Wilsonia citrina*	-	-	x
Horned lark	*Eremophila alpestris*	x	x	-
House sparrow	*Passer domesticus*	x	x	-
House wren	*Troglodytes aedon*	x	x	-
Indigo bunting	*Passerina cyanea*	x	x	-
Killdeer	*Charadrius vociferus*	-	x	x
Lark sparrow	*Chandestes grammacus*	-	x	-
Least flycatcher	*Empidonax minimus*	-	-	x
Loggerhead shrike	*Lanius ludovicianus*	x	x	-
Louisiana waterthrush	*Seiurus motacilla*	-	x	-
Mallard	*Anas platyrhynchos*	-	-	x
Marsh hawk	*Circus cyaneus*	-	x	x
Mockingbird	*Mimus polyglottos*	x	x	x
Mourning dove	*Zenaidura macroura*	x	x	x
Orchard oriole	*Icterus spurius*	-	x	-
Pied-billed grebe	*Podilymbus podiceps*	-	-	x
Pileated woodpecker	*Drycocopus pileatus*	x	-	x
Purple martin	*Progne subis*	-	x	-
Red-bellied woodpecker	*Centurus carolinus*	x	x	x
Red-eyed vireo	*Vireo olivaceus*	x	x	-
Red-headed woodpecker	*Melanerpes erythrocephalus*	x	x	x
Red-tailed hawk	*Ruteo jamaicensis*	x	x	x
Red-winged blackbird	*Agelaius phoeniceus*	-	x	x

TABLE 3.3.3-6 (continued)

Common Name	Scientific Name	Baseline Inventory	Spring Monitoring Survey	Fall Monitoring Survey
Robin	*Turdus migratorius*	x	x	x
Rock dove	*Columba livia*	x	x	-
Ruby-crowned kinglet	*Regulus calendula*	-	-	x
Ruby-throated hummingbird	*Archilochus colubris*	x	x	-
Rufous-sided towhee	*Pipilo erythrophthalmus*	x	x	-
Song sparrow	*Melospiza melodia*	x	x	x
Sparrow hawk	*Falco sparverius*	x	x	x
Starling	*Sturnus vulgaris*	x	x	x
Summer tanager	*Piranga rubra*	x	x	-
Tree sparrow	*Spizella arborea*	-	-	x
Tufted titmouse	*Parus bicolor*	x	x	x
Turkey vulture	*Cathartes aura*	x	x	x
Vesper sparrow	*Poecetes gramineus*	-	-	x
Whip-poor-will	*Caprimulgus vociferus*	x	x	-
White-breasted nuthatch	*Sitta carolinensis*	-	x	x
White-eyed vireo	*Vireo griseus*	-	x	-
White-throated sparrow	*Zonotrichia albicollis*	-	-	x
Wood duck	*Aix sponsa*	-	x	-
Wood thrush	*Hylocichla mustelina*	x	x	-
Yellow-billed cuckoo	*Coccyzus americanus*	x	x	x
Yellow-breasted chat	*Icteria virens*	x	x	-
Yellowthroat	*Geothlypis trichas*	x	x	-

3.3.4 AMPHIBIANS AND REPTILES

Six species of amphibians and 13 species of reptiles were observed in the environs of the Callaway Plant site during the spring 1974 survey. The fall survey resulted in the collection of 21 species of herpetofauna (154 specimens) and the marking and release at their point of capture of 142 animals.

3.3.4.1 Amphibians

The several habitat types on the Callaway Plant site are attractive to a wide variety of amphibians, judged by their presence on the site during the spring and fall surveys.

Most amphibians pass through several stages of development from the egg to the adult. Water is a requirement for breeding and egg development for most amphibians, although some frogs and toads seek terrestrial environs in an immature or adult form and return to aquatic habitats only to breed. Numerous farm ponds, creeks, and ditches on the plant site serve as amphibian breeding areas. Frog tadpoles and young toads were observed during the survey, indicating completion of the reproductive process before the survey had commenced. Numerical estimates of immature amphibians were not attempted.

The species composition (Table 3.3.4-1) of amphibians reported in the fall is quite different from that reported for the spring survey. Three species collected during the fall survey were not reported during the spring survey. A good portion of this variability between sampling periods is due to the secretive nature of amphibians. Undoubtedly, numerous other species could be found with greater expenditures of time and energy. Every pond checked during the fall survey contained bullfrogs, northern cricket frogs, larval bullfrogs, and most also contained larval leopard frogs.

Seining of fishless ponds in the fall revealed several good populations of newts (both adults and efts) not discovered during the spring sample. Fifty-three adults were marked in one pond. It is likely that certain species of salamanders also use these ponds for breeding sites during early spring, although this has not been documented by field surveys.

Adult bullfrogs, green frogs, and leopard frogs are common inhabitants of permanent water bodies. The American toad, Fowler's toad, gray treefrog, spring peeper, and northern cricket frog require water for breeding and post-hatching development but seek terrestrial environments while relatively immature. The treefrog remains near water, but species of both frogs and toads may travel far from aquatic habitats. Adult bullfrogs were the most commonly occurring amphibian observed during the spring survey (Table 3.3.4-1), while newts were the most common during the fall survey. Every pond inspected on the plant site had good populations of bullfrogs (both adult and larval forms), indicating the species is doing well and represents a possibility for limited sport hunting in the future.

Northern cricket frogs and leopard frogs are also present in most plant site ponds but are not as restricted to water as bullfrogs; they are also encountered in moist woodland situations away from the ponds. Leopard frogs were frequently seen crossing roads at night when the relative humidity was high.

In addition to being difficult to census, amphibian populations are highly sensitive to short-term fluctuations in environmental conditions. Therefore, amphibians probably should not be used as "indicator species" detecting change by annual monitoring programs. However, their role or function in the total ecology of the site cannot be overlooked.

No rare or endangered amphibians were observed during the conduct of the field survey(s).

3.3.4.2 Reptiles

The numbers of each reptile species and the habitat types in which they were observed on the site are presented in Table 3.3.4-1. The prairies, forests, wetlands, ponds, streams, hedgerows, and variety of ecotones between communities provide reptiles with a variety of habitats within a predominantly agricultural area.

The three-toed box turtle was the most common reptile observed throughout the site during the spring survey (Table 3.3.4-1). It is adapted to an omnivorous diet of plant and some animal material and is not restricted to special habitat locations as are many of the other reptiles recorded during the study. Only 2 three-toed turtles were collected in the fall survey. Their major period of activity is late spring, which explains the large number collected in the spring survey. This species is not a good indicator, as it is likely to be found in woods, prairie, and cropland.

Many, if not most, lizards and snakes are most abundant in an ecotone habitat (Table 3.3.4-1). As a result, field-forest edges, old roads, and abandoned barns and houses (where litter is plentiful) are the best places to look for these species. At least two-thirds of the lizards and snakes captured in the fall survey were found in these habitats. Populations of lizards and snakes can be expected to increase at the plant site as the farm houses are abandoned; however, the increase will probably be temporary. As the area reverts to forest, the populations of many of the species should decline. Exceptions would be eastern ring-necked snake, ground skink, and five-lined skink, which do well in forest habitats.

The similarities or disparities in habitats of the permanent sampling stations cannot be meaningfully compared on the basis of herpetofaunal abundance and diversity because too few individuals were observed (Table 3.3.4-2). The ground skink and the three-toed box turtle were rather uniformly observed at forest sampling stations. However, both of these species may occur in prairie habitats. The ground skink is difficult to capture for marking; thus, in some instances, the same individual may have been observed on more than one occasion but recorded as a new sighting.

Table 3.3.4-3 shows the results of an extensive marking program initiated during the fall 1974 field survey. As recaptures of marked individuals are made during subsequent field surveys, a more quantitative review of the ecological role played by each species can then be made.

No rare or endangered reptiles were observed at the plant site during the spring survey.

Previous remarks made about the utility of amphibians for characterizing the local wildlife populations and their significance to annual monitoring program objectives are also applicable to reptiles.

TABLE 3.3.4-1

VARIETY AND NUMBERS OF HERPETOFAUNA OBSERVED IN THE VICINITY OF THE CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, SPRING AND FALL 1974

Species	Habitat Type: Shrubland		Cropland		Oldfield		Pasture		Creek		Pond		Forest		Total	
	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
Newt (efts)	+[a]	3	+	1	+	+	+	+	+	+	+	+	+	+	0	4
Newt (adults)	+	+	+	+	+	+	+	+	+	+	+	53	+	+	0	53
Plains spadefoot toad	+	+	+	+	+	+	+	1	+	+	+	+	+	+	0	1
Fowler's toad	+	5	+	+	+	+	+	+	+	+	1	+	+	+	1	5
American toad	+	+	+	+	1	+	+	+	+	+	+	+	12	+	13	0
Gray treefrog	+	+	+	+	+	+	+	+	1	+	+	5	+	+	1	5
Spring peeper	+	+	+	+	+	+	+	+	+	+	+	+	+	1	0	1
Northern cricket frog	+	+	+	+	+	+	+	+	+	+	+	16	+	4	0	20
Leopard frog	+	+	+	5	1	+	+	+	2	+	+	1	1	+	4	6
Bullfrog	+	+	+	+	+	+	+	+	3	+	41	11	+	+	44	11
Green frog	+	+	+	+	+	+	+	+	2	1	1	+	+	+	3	1
Snapping turtle	+	+	+	+	+	+	+	+	+	+	2	+	+	+	2	0
Three-toed box turtle	1	+	9	+	7	+	3	1	+	+	+	+	11	1	31	2
Eastern fence lizard	+	3	+	+	+	+	1	+	+	+	+	+	+	+	1	3
Slender glass lizard	+	+	+	+	+	+	1	+	+	+	+	+	+	+	1	0
Ground skink	+	3	+	2	+	+	+	+	+	+	+	+	9	+	9	5
Five-lined skink	+	14	+	+	+	+	+	+	+	+	+	+	1	3	1	17
Common water snake	+	+	+	+	+	+	+	+	2	+	+	+	+	+	2	0
Brown snake	+	+	+	1	+	+	1	+	+	+	+	+	+	+	1	1
Red-bellied snake	+	2	+	+	+	+	+	+	+	+	+	+	+	+	0	2
Western ribbon snake	+	1	+	+	+	+	+	+	+	+	+	+	+	+	0	1
Common garter snake	+	+	1	+	+	+	+	+	+	+	+	+	+	+	1	0
Smooth earth snake	+	1	+	+	+	+	+	+	+	+	+	+	+	+	0	1
Eastern hognose snake	+	+	1	+	+	+	+	+	+	+	+	+	+	+	1	0
Worm snake	+	+	+	+	+	+	+	+	+	+	+	+	+	1	0	1
Eastern ringneck snake	+	+	+	+	+	10	+	+	+	+	+	+	+	2	0	12
Racer	+	+	+	1	+	+	+	+	+	+	+	+	+	+	0	1
Rat snake	1	+	+	+	2	1	+	+	+	+	+	+	+	+	3	1
Common kingsnake	+	+	+	+	+	+	1	+	+	+	+	+	+	+	1	0
Copperhead	+	+	+	+	2	+	+	+	+	+	+	+	+	+	2	0
TOTAL	2	32	11	10	13	11	7	2	10	1	45	86	34	12	122	154

[a]not observed.

TABLE 3.3.4-2

VARIETY AND NUMBERS OF HERPETOFAUNA OBSERVED WITHIN PERMANENT SAMPLING STATIONS LOCATED ON THE CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, SPRING AND FALL 1974

	Prairie Stations								Forest Stations							
	1		2		3		4		1		2		3		4	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Spring peeper	+	+	+	+	+	+	+	+	+	1	+	+	+	+	+	+
American toad	+	+	+	+	1	+	+	+	+	+	2	+	2	+	1	+
Three-toed box turtle	+	+	+	+	+	+	+	+	1	+	1	1	+	+	1	+
Ground skink	+	+	+	+	+	+	+	+	+	+	2	+	2	+	4	+
Copperhead	+	+	+	+	1	+	+	+	+	+	+	+	+	+	+	+

+ = not observed.

TABLE 3.3.4-3

AMPHIBIANS AND REPTILES MARKED AND RELEASED IN THE VICINITY OF PERMANENT PLOTS, FALL 1974

	Prairie Stations				Forest Stations				Total
	1	2	3	4	1	2	3	4	
Newt - efts	+	+	+	+	+	1	3	+	4
Newt - adults	+	53	+	+	+	+	+	+	53
Fowler's toad	+	+	+	+	+	+	1	+	1
Gray treefrog	+	+	+	+	+	+	5	+	5
Spring peeper	+	+	+	+	1	+	+	+	1
Northern cricket frog	+	4	+	+	+	+	12	4	20
Leopard frog	+	+	+	+	+	+	1	+	1
Bullfrog	+	5	+	+	+	+	6	+	11
Green frog	+	+	+	+	+	+	+	1	1
Three-toed box turtle	+	1	+	+	+	1	+	+	2
Eastern fence lizard	+	+	+	+	+	+	+	3	3
Ground skink	+	+	+	+	1	1	+	3	5
Five-lined skink	+	1	1	+	2	+	6	7	17
Brown snake	1	+	+	+	+	+	+	+	1
Red-bellied snake	+	+	+	+	+	+	2	+	2
Western ribbon snake	+	+	+	+	+	+	1	+	1
Worm snake	+	+	+	+	+	+	+	1	1
TOTAL	12	64	1	0	5	3	37	20	142

+not observed.

3.3.5 INVERTEBRATES

The invertebrates obtained in the field surveys are those normally inhabiting the various vegetative strata of the Callaway Plant site in late May and June (spring survey) and late August and September (fall survey).

The taxonomic identifications of invertebrates collected in both 1974 surveys are shown in Tables 3.3.5-1 and 3.3.5-2. The presence and number of specimens collected are indicated according to major habitat types (forest or prairie), permanent sampling station (F-1, F-4, etc.), and transect number within each station at which a given species was collected.

The preliminary nature of the spring survey precluded making other than very general observations. There was no obvious difference in the species diversity nor numbers of individual invertebrates collected in prairie as opposed to forest habitats. However, a relatively high proportion of the species are apparently associated with only one of the major habitat types; i.e., some species occur only in prairie while others occur only in forest habitats (Table 3.3.5-1). The data indicate that only the thrips occur in both forest and prairie habitats at extremely high densities. The identified families, genera, and species are considered rather numerous, whereas the number of individuals per taxonomic group is relatively few. However, such judgment is highly subjective because a basis for comparison is lacking. There is no known source of base information documenting the diversity and relative abundance of invertebrates in the vicinity of the Callaway Plant site.

The kinds of data reported in Table 3.3.5-2 are typical of those expected from this method of survey. The Insecta represents the largest number of species of any group of organisms. Certain problems are encountered in the identification of certain insects to the species level, resulting in the placement of many specimens only at a higher category such as Family.

The fall survey of invertebrates was dominated by arthropods, especially insects, in the sweeping samples, as was the case in the spring survey. The sweeping method is in fact biased toward collecting these organisms as opposed to other terrestrial invertebrates occupying select habitats or niches other than the exposed surfaces of the vegetative stratum. This bias is inescapable, however, when time and monetary constraints are imposed.

Arthropoda are largely habitat-specific, and this is reflected in the data presented in Tables 3.3.5-1 and 3.3.5-2. A number of trophic levels are represented among the invertebrates sampled. Many species of plant-feeding insects are relatively host-specific, and therefore their relative numbers (by sample) may be a reflection of the density of the host. Others are polyphagous, and some are predaceous on small invertebrates; still others feed on dead or decaying organic matter. Insects in particular are subject to dispersal, both vertical and horizontal, having no difficulty in flying from one site to another over the whole of the area of southern Callaway County, or moving from the ground litter up onto the higher stratum of a plant within a given habitat. Adverse weather conditions prior to or during the collection periods can affect the organisms, reducing the number collected by sweeping. These factors further complicate an analysis of the interrelationships within a given habitat, prairie or forest, and need to be kept in mind both now and in the future when one examines and interprets the data presented in Tables 3.3.5-1 and 3.3.5-2.

The majority of species collected tended to reflect their affinities to either the forest or prairie habitats. For example, species of the planthopper genus Myndus (Homoptera: Cixiidae), and leafhoppers in Erythroneura (Homoptera: Cicadellidae) were well represented in both forest habitats (F-1 and F-4) but were not collected from the prairie sites; the spider Oxyopes salticus (Araneidae: Oxyopidae) was exclusive to the prairie communities. Likewise, some species were collected from one of the paired habitats, but not both. Such was the case of Arthrolips decolor (Coleoptera: Orthoperidae), which was collected from Pr-4 but not the Pr-1 prairie site. This might reflect the different stages of succession of the two prairie habitats.

Many species were collected in relatively low numbers. This could result from a number of factors, including low population levels of the species, aggregations of individuals of a species within the habitat (more easily missed in a given sweep), selectivity in the collection methods used for certain species versus others, adverse microhabitat conditions, weather conditions such as wind, and so forth.

Many more species, organisms, and taxa were collected in the fall survey (ca. 9,500 specimens) than in the spring survey (ca.2,500 specimens) (Table 3.3.5-3), This is probably due in part to the seasonal buildup of populations. It may also be partially due to different personnel taking the June samples and the fall samples.

TABLE 3.3.5-1

TAXONOMIC IDENTIFICATION OF INVERTEBRATES COLLECTED IN SELECTED PERMANENT FOREST (F) AND PRAIRIE (PR) SAMPLING STATIONS LOCATED WITHIN THE CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, JUNE 1974

Class Order Family Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Arachnida												
Araneida												
Araneidae												
Araneus maruoratus	+	+	+	+	+	+	+	+	+	+	1	+
Genus sp.	+	+	1	+	+	+	1	+	+	2	+	+
Chomisidae												
Misumenops sp.	1	+	+	+	+	+	+	+	+	+	+	+
Linyphiidae												
Genus sp.	+	1	1	+	+	+	+	+	+	+	+	+
Micryphantidae												
Ceraticelus sp.	+	+	+	1	1	+	+	+	+	+	+	+
Genus sp.	+	1	1	+	1	+	1	+	1	+	+	+
Phalangidae												
Genus sp.	1	1	+	3	1	+	+	+	+	+	+	+
Salticidae												
Hentzia sp.	+	+	1	+	+	+	+	+	+	+	+	+
Icius sp.	+	+	+	+	+	+	+	+	1	+	+	+
Metaphieppus sp.	+	+	+	+	+	1	+	+	+	3	+	+
Paraphidippus sp.	1	+	+	+	1	+	1	+	+	1	+	+
Thomisidae												
Coriarachne sp.	+	+	1	+	+	+	+	+	+	+	+	+
Misamena sp.	+	+	1	+	+	+	+	+	+	+	+	+
Misumenops sp.	+	1	+	+	+	+	+	+	+	+	+	+
Philodronus sp.	+	1	+	+	+	+	+	+	+	+	+	+
Synema parvula	+	+	+	+	+	+	+	+	1	+	+	+
Genus sp.	+	+	+	+	+	+	+	+	+	1	+	+
Acarina												
Ascidae												
Asca sp.	+	+	+	+	+	+	+	1	+	+	+	+
Bdellidae												
Genus sp.	+	+	+	+	+	+	+	+	+	1	+	1
Clubionidae												
Genus sp.	+	+	+	+	+	1	+	+	+	1	+	+
Erythraeidae												
Leptus sp.	+	+	+	1	+	+	+	+	+	+	+	+
Ixodides												
Amblyomnea americanum	+	+	1	+	+	+	+	+	+	+	+	+

TABLE 3.3.5-1 (continued)

Class / Order / Family / Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Arachnida (continued)												
Acarina (continued)												
Lycosidae												
Pardosa sp.	+	+	+	+	+	+	+	+	+	+	+	1
Oecobiidae												
Oecobius sp.	+	+	+	+	+	+	+	+	+	1	+	
Oxyopidae												
Oxyopes salticus	+	+	+	+	+	+	+	+	1	+	1	+
Trombidiidae												
Genus sp.	+	+	+	+	+	+	+	+	+	1	+	+
Tydeidae												
Genus sp.	+	+	+	+	+	+	+	+	+	2	+	+
Insecta												
Collembola												
Entomobryidae												
Genus sp.	1	+	+	+	+	+	+	+	+	+	+	1
Sminthuridae												
Genus sp.	+	+	+	1	+	+	+	+	+	+	+	+
Orthoptera												
Acrididae												
Genus sp. (Nymph)	+	+	+	+	+	+	+	+	1	+	+	1
Gryllidae												
Genus sp. (Nymph)	+	+	+	+	1	+	+	+	+	1	+	+
Oecanthinae												
Genus sp. (Nymph)	+	+	+	1	+	+	+	+	+	+	+	+
Phasmatidae												
Genus sp. (Nymph)	+	+	+	1	+	+	+	+	+	+	+	+
Tettigoniidae												
Genus sp. (Nymph)	1	+	+	2	4	+	4	7	7	10	+	5
Hemiptera												
Anthocoridae												
Orius insidious	+	+	+	+	+	+	+	+	+	3	+	+
Lygaeidae												
Phlegyas abbreviatus	+	+	+	+	+	+	+	+	+	1	+	3
Miridae												
Leptopterna dolobrata	+	+	+	+	+	+	2	3	+	1	+	1
Lygus lineolaris	+	+	+	+	+	+	+	+	7	13	+	7
Phlagiognathus politus	+	+	+	+	+	+	+	+	1	+	+	+
Platytylellus fraternus	+	+	+	+	+	1	+	+	+	+	+	+

TABLE 3.3.5-1 (continued)

Class / Order / Family / Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Hemiptera												
Miridae												
Reuteroscopus sulphureus (adult)	+	+	+	+	1	+	+	+	+	+	+	+
Reuteroscopus sulphureus (nymph)	+	+	+	+	2	+	+	+	+	+	+	+
Stenotus binotatus	+	+	+	+	+	+	2	4	+	6	+	+
Trigonotylus ruficornis	+	+	+	+	+	+	+	+	+	6	+	1
Genus sp.	+	1	+	+	+	+	+	+	+	+	+	+
Neuroptera												
Chrysopidae												
Chrysopa oculata	+	+	+	+	+	+	+	+	+	2	+	+
Chrysopa sp. (larva)	+	+	+	+	+	+	+	+	+	3	+	1
Coniopterygidae												
Coniopteryx vicina	+	+	+	+	2	+	+	+	+	+	+	+
Homoptera												
Aphididae												
Genus sp.	+	+	+	+	1	+	+	+	+	+	+	+
Genus sp. (nymph)	+	+	2	+	+	+	+	+	+	13	3	+
Cercopidae												
Philaenus spumarius	+	+	+	+	+	+	+	+	+	1	+	2
Cicadellidae												
Albera sp.	+	+	+	+	+	+	+	+	1	1	+	1
Cloanthanus frontalis	+	+	+	3	+	+	+	+	+	3	4	4
Doleranus longulus	+	+	+	+	+	+	4	10	4	1	+	1
Draeculacephala sp.	+	+	+	+	+	+	+	+	+	+	+	1
Remadosus magnus	+	+	+	+	+	1	+	+	+	+	+	+
Genus sp.	+	2	+	+	+	+	+	+	+	2	+	+
Genus sp. (nymph)	1	+	+	3	1	4	+	+	2	+	+	1
Cixiidae												
Cixus coloepeum	+	+	1	+	+	+	+	+	+	+	+	+
Delphacidae												
Stobaera sp.	+	+	+	+	+	+	3	+	2	1	+	+
Derbidae												
Cedusa vulgaris	5	1	4	5	3	4	+	+	1	+	+	+
Otiocerus abbotii	1	+	1	+	+	+	+	+	+	+	+	+
Membracidae												
Micrutalis calva	+	+	+	+	+	+	+	+	+	+	1	2
Psyllidae												
Trioza diospyri	+	+	+	+	+	+	+	+	+	2	5	1

TABLE 3.3.5-1 (continued)

Class / Order / Family / Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Thysanoptera												
Aeolothripidae												
Aeolothrips albicinctus	+	+	+	+	+	+	+	+	1	+	+	+
Aeolothrips bicolor	+	+	+	+	+	+	2	2	+	3	+	+
Thripidae												
Anaphothrips obscurus	91	277	68	54	25	4	271	424	54	363	+	64
Aptinothrips rufus	+	+	1	+	+	+	+	+	+	+	+	+
Caliothrips sp.	+	+	+	+	+	+	+	+	+	1	+	+
Frankliniella fusca	+	+	+	1	+	+	+	3	+	+	+	4
Frankliniella tritica	+	+	+	+	+	+	+	+	+	15	1	7
Genus sp.	+	+	+	+	+	+	+	+	+	4	2	+
Lepidoptera												
Geometridae												
Genus sp.	+	+	+	2	+	+	+	+	+	+	+	+
Genus sp. (larva)	+	+	+	+	+	+	+	+	+	+	1	+
Hesperidae												
Genus sp.	+	+	+	+	+	+	+	+	1	+	1	+
Noctuidae												
Acronicta oblinita	+	+	+	+	+	+	+	+	+	1	+	+
Genus sp. (larva)	+	+	+	+	+	+	+	+	+	2	+	+
Pyralididae												
Genus sp. (larva)	+	1	1	+	+	+	+	+	+	+	+	+
Sphingidae												
Hemaris diffinis (larva)	+	+	+	+	+	+	+	+	+	+	+	1
Unknown												
Genus sp. (adult)	2	+	2	+	+	3	+	+	+	+	+	+
Genus sp. (larva)	1	+	+	+	+	+	+	+	+	+	+	+
Diptera												
Asilidae												
Dioctria sp.	+	+	+	1	+	+	+	+	+	+	+	+
Leptogaster sp.	+	+	1	+	+	+	+	+	+	+	+	+
Cecidomyidae												
Genus sp.	+	+	+	1	+	+	+	+	+	1	1	+
Chironomidae												
Genus sp.	1	+	1	+	+	+	+	+	+	+	+	+
Chloropidae												
Genus sp.	8	+	+	+	+	2	1	+	2	+	+	+
Culicidae												
Aedes vexans	1	+	1	1	1	+	+	+	+	+	+	+

TABLE 3.3.5-1 (continued)

Class Order Family Genus and species	F-1 1[a]	F-1 2	F-1 3	F-4 1	F-4 2	F-4 3	Pr-1 1	Pr-1 2	Pr-1 3	Pr-4 1	Pr-4 2	Pr-4 3
Insecta (continued)												
Diptera												
Dolichopodidae												
Chrysotus sp.	+	+	2	+	+	+	12	8	7	+	+	1
Genus sp.	3	1	2	3	4	1	2	1	1	+	+	1
Empididae												
Genus sp.	+	+	1	+	+	+	+	+	+	+	+	+
Lauxaniidae												
Homoneura philadelphica	+	+	+	1	+	+	+	+	+	+	+	+
Genus sp.	1	+	+	+	+	+	+	+	+	+	+	+
Muscidae												
Genus sp.	+	+	1	1	2	1	1	+	3	7	+	+
Mycetophilidae												
Mycomya sp.	1	1	3	1	2	2	+	+	+	+	+	+
Trichonta sp.	+	+	+	1	+	+	+	+	+	+	+	+
Phoridae												
Genus sp.	+	1	2	+	2	+	+	+	1	+	+	+
Pipunculidae												
Chalarus sp.	1	+	+	+	+	+	+	+	+	+	+	+
Sarcophagidae												
Ravinia sp.	+	+	+	+	+	+	+	4	+	3	+	3
Sciaridae												
Bradsia sp.	+	2	1	+	+	+	+	+	+	+	+	+
Genus sp.	+	+	+	+	+	+	+	+	1	+	+	+
Sphaeroceridae												
Sphaerocera sp.	+	+	+	1	+	+	+	+	+	+	+	+
Syrphidae												
Paragus tibialis	1	+	+	1	+	+	+	+	+	+	+	+
Sphaerophoria cylindrica	+	+	+	+	+	+	+	+	+	+	+	1
Toxomerus geminatus	+	+	+	+	+	+	+	1	1	5	1	4
Tipulidae												
Elliptera sp.	+	1	+	+	+	+	+	+	+	+	+	+
Helius sp.	+	+	1	+	+	+	+	+	+	+	+	+
Genus sp.	+	+	+	+	1	+	+	+	+	+	+	+
Unknown												
Genus sp.	+	+	1	+	+	1	1	+	1	1	+	+
Hymenoptera												
Apidae												
Apid mellifera	+	+	+	+	+	+	+	+	+	1	+	+
Argidae												
Sofus pilicornis	+	+	+	+	+	1	+	+	+	+	+	+

TABLE 3.3.5-1 (continued)

Class / Order / Family / Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Hymenoptera												
Brachonidae												
Genus sp. a.	+	+	+	+	+	+	2	1	+	2	1	2
Genus sp. b.	+	2	1	1	+	1	+	+	+	+	+	1
Chalcidoidea												
Genus sp.	+	+	2	4	+	+	+	+	+	+	+	+
Diapriidae												
Genus sp.	1	1	1	3	2	+	+	+	+	+	+	+
Encyrtidae												
Genus sp.	+	+	+	+	1	+	+	+	+	1	+	+
Eulophidae												
Genus sp.	+	1	+	+	1	+	+	+	+	1	+	+
Eupelmidae												
Genus sp.	+	+	+	+	+	+	1	+	+	7	+	+
Formicidae												
Acanthomyops sp.	+	+	+	+	1	+	+	+	+	+	+	+
Camponotus sp.	1	+	1	+	+	1	+	+	+	+	+	+
Crematogaster sp.	+	+	+	+	+	2	+	+	1	+	+	+
Dolichoderus sp.	+	+	2	+	+	+	+	+	+	+	+	+
Formica sp.	+	+	+	+	+	1	+	+	1	+	2	1
Harpagoxenus americanus	+	+	+	+	+	+	+	+	+	2	+	+
Leptothorax sp.	2	5	2	1	+	1	+	+	+	+	+	+
Monomorium geninatus	+	+	+	+	+	+	+	+	+	+	1	+
Myrica sp.	1	+	1	+	+	+	+	+	+	+	+	+
Paratrechina sp.	+	+	1	+	+	+	+	+	+	+	+	+
Pheidole sp.	+	+	+	3	2	1	+	+	+	+	+	+
Tetramorium caespitum	+	+	+	+	+	1	+	+	+	+	+	+
Halictidae												
Lasioglossum rohweri	+	+	+	1	+	+	+	+	+	+	+	+
Ic[illegible]umonidae												
Genus sp.	1	+	+	+	1	+	+	+	+	+	+	+
Mymeridae												
Genus sp.	+	1	1	1	+	+	+	+	+	+	+	+
Pteromalidae												
Genus sp.	+	+	+	+	+	+	+	+	3	1	+	+
Psocoptera												
Pseudocaeciliidae												
Genus sp.	+	2	1	2	+	+	+	+	+	+	+	+
Psocidae												
Genus sp.												

TABLE 3.3.5-1 (continued)

Class Order Family Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Coleoptera												
Alleculidae												
Isomira sp.	+	1	+	+	1	3	+	+	+	+	+	+
Anobiidae												
Brachytarsus stricticus	+	+	+	+	+	+	+	+	+	+	+	1
Caenocara oculata	+	+	+	+	1	1	+	+	+	+	+	+
Petalium bistriatum	1	+	+	1	+	+	+	+	+	+	+	+
Cantheridae												
Cantharis marginalis	1	+	+	1	1	+	+	+	+	+	+	+
Cantharis tantillus	+	1	2	+	+	+	+	1	+	+	+	+
Chauliognathus marginatus	+	+	+	+	+	+	+	+	+	4	1	+
Malthinus occipitalis	+	+	+	1	+	1	+	+	+	+	+	+
Malthinus sp.	+	+	+	1	+	+	+	+	+	+	+	+
Podabus rugulosus	+	+	+	+	+	+	+	+	+	1	+	+
Cerambycidae												
Hetoemis cinerea	+	+	1	+	+	+	+	+	+	+	+	+
Chrysomelidae												
Babia quadriguttata	+	+	+	1	+	+	+	+	+	+	+	+
Chaetocnema sp.	+	+	+	+	+	+	+	+	+	+	+	1
Chlamys sp. (larva)	+	+	+	+	+	+	+	+	+	+	1	+
Epitrix sp.	+	+	+	+	+	+	+	+	+	1	+	+
Exema sp.	+	+	+	+	+	+	+	1	1	+	+	+
Longitarsus sp.	+	+	+	+	+	+	+	+	1	1	+	+
Microrhopala vittata	+	+	+	+	+	+	+	+	+	+	1	+
Oedionychus quercata	1	+	+	+	+	+	+	+	+	+	+	+
Ophraella cribrata	+	+	+	+	+	+	+	+	+	+	+	2
Paria sp.	1	+	1	+	+	+	+	+	+	1	+	+
Phyllecthris dorsalis	2	1	+	1	+	+	+	+	+	+	+	+
Xanthonia sp.	3	2	2	8	1	4	+	+	+	+	+	+
Cleridae												
Korynetinae opetiopalpus	+	+	+	+	+	+	1	+	+	+	+	+
Phyllobaenus humeralis	+	+	+	+	1	+	+	+	+	+	+	+
Coccinellidae												
Ceratomegilla maculata	+	+	+	+	+	+	+	3	1	1	+	+
Hippodamia convergens	+	+	+	+	+	+	+	+	+	5	+	2
Hippodamia tibialis	+	+	+	+	+	+	+	+	1	+	+	+
Psyllobora vigintimaculata	+	+	+	+	+	1	+	+	+	+	+	+
Scymes terminatus	+	+	+	+	+	+	+	2	1	2	+	+
Genus sp. (larva)	+	+	+	+	+	+	1	5	1	+	+	+

TABLE 3.3.5-1 (continued)

Class Order Family Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Coleoptera (continued)												
Curculionidae												
Anametis grandulata	+	+	+	+	+	+	+	+	+	+	1	+
Apion sp.	9	5	12	10	+	2	+	+	+	+	+	+
Baris sp.	+	+	+	+	+	+	+	+	+	1	+	+
Odontocorynus sp.	+	+	+	+	+	+	+	+	+	2	1	+
Pandeleteius hilaris	+	2	2	+	+	1	+	+	+	+	+	+
Elateridae												
Ctenicera signaticollis	+	+	+	1	+	+	+	+	+	+	+	+
Limonius basillaris	+	1	2	+	1	+	+	+	+	+	+	+
Limonius quercinus	1	2	2	3	3	5	1	+	+	+	+	+
Erotylidae												
Tritoma sanguinipennis	1	+	+	+	+	+	+	+	+	+	+	+
Euglenidae												
Zonantes fasciatus	3	2	3	+	+	+	+	+	+	+	+	+
Histeridae												
Saprinus sp.	+	+	+	+	+	+	+	+	+	1	+	+
Melandryidae												
Micronotus sericans	+	1	+	+	1	+	+	+	+	+	+	+
Scraptia sp.	+	+	+	1	+	+	+	+	1	+	+	+
Mordellidae												
Mordellistena sp.	+	+	1	+	+	+	+	+	+	+	+	+
Orthoperidae												
Orthoperus sp.	+	+	+	+	+	+	2	+	+	+	+	+
Phalacridae												
Phalacrus sp.	+	+	+	+	+	+	+	+	+	1	+	+
Staphylinidae												
Apocellus sphaericollis	+	+	+	1	+	+	+	+	+	+	+	+
Stenus sp.	+	+	+	+	+	+	+	+	+	1	+	+
Tachinus fimbriatus	+	+	+	+	+	+	+	+	+	+	+	1

[a]indicates numbers of specimens collected.

TABLE 3.3.5-2

TAXONOMIC IDENTIFICATION OF INVERTEBRATES COLLECTED IN SELECTED PERMANENT FOREST (F) AND PRAIRIE (PR) SAMPLING STATIONS LOCATED WITHIN THE CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, SEPTEMBER 13, 1974

Class / Order / Family / Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Nematoda												
Unknown												
Unknown												
Genus sp.	+	+	1[b]	+	+	+	+	+	+	+	+	+
Gastropoda												
Pulmonata												
Pupillidae												
Vertigo milium	+	+	+	+	+	+	12	3	32	+	19	2
Succineidae												
Genus sp.	+	+	+	+	+	+	7	3	13	+	+	+
Diplopoda												
Unknown												
Unknown												
Genus sp.	+	+	+	+	2	+	+	+	+	+	+	+
Arachnida												
Chelonethida												
Unknown												
Genus sp.	1	+	+	1	+	+	+	+	+	+	+	+
Phalangida												
Unknown												
Genus sp.	2	2	1	+	1	+	+	+	+	+	+	+
Araneida												
Anyphaenidae												
Anyphaena sp.	+	3	+	+	+	+	+	+	+	+	+	+
Aysha sp.	+	+	+	+	+	1	+	+	+	+	+	+
Araneidae												
Acanthepeira stellata	+	+	+	+	+	+	+	2	+	+	+	+
Aranea sp.	+	+	+	1	+	+	+	+	+	+	+	+
Argiope trifasciata	+	+	+	3	+	+	+	+	+	+	+	+
Micrathena sp.	1	+	+	+	3	+	+	+	+	+	+	+
Neoscona sp.	+	+	+	+	1	+	+	+	+	+	+	+
Genus spp.	+	2	1	+	+	+	7	15	13	1	1	6
Dictynidae												
Dictyna sp.	+	+	+	1	1	+	+	+	+	+	+	+

TABLE 3.3.5-2 (continued)

Class Order Family Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Arachnida (continued)												
Araneida (continued)												
Gnaphosidae												
Drassodes sp.	1	+	+	+	+	+	+	+	+	+	+	+
Genus sp.	+	+	+	+	+	+	+	1	+	1	+	+
Linyphiidae												
Genus sp.	+	4	+	+	+	4	+	+	+	+	+	+
Lycosidae												
Lycosa cardinensis	+	+	+	+	+	+	1	+	1	+	+	+
Pirata sp.	4	+	+	+	+	+	+	+	+	+	+	+
Micraphantidae												
Lophocareninae	+	+	+	+	+	+	+	+	+	+	8	+
Genus sp.	+	2	+	+	+	+	+	+	+	3	+	4
Oonopidae												
Genus sp.	+	+	+	+	+	1	+	+	+	+	+	+
Oxyopidae												
Oxyopes salticus	+	+	+	+	+	+	102	31	77	25	37	8
Pisauridae												
Pisaurina sp.	+	1	+	+	3	+	+	+	+	+	+	+
Salticidae												
Ballus sp.	+	+	+	+	+	+	+	+	+	+	1	+
Icius sp.	+	+	1	+	+	+	+	+	+	+	+	+
Maevia sp.	+	12	+	+	+	+	+	+	+	+	+	+
Metacyrba sp.	+	+	+	+	+	6	+	+	+	+	+	+
Phidippus sp.	+	+	+	+	+	+	7	5	1	+	1	+
Thiodina sp.	6	+	+	+	+	+	+	+	+	+	+	+
Tetragnathidae												
Tetragnatha sp.	+	+	+	+	+	+	+	+	+	+	+	1
Genus sp.	+	+	+	+	+	+	+	+	+	1	+	+
Therediidae												
Pholcomma spp.	36	37	14	9	35	+	1	+	+	+	+	+
Thomisidae												
Coriarchne sp.	+	1	+	+	+	+	+	+	+	+	+	+
Misumenops sp.	3	6	3	1	10	2	1	1	+	+	+	13
Synema parvula	25	25	14	+	19	58	+	+	+	+	+	+
Xyticus sp.	+	+	+	+	+	+	+	1	+	+	4	1
Genus sp.	+	+	+	+	+	+	+	+	+	4	+	+

TABLE 3.3.5-2 (continued)

Class Order Family Genus and species	F-1 1[a]	F-1 2	F-1 3	F-4 1	F-4 2	F-4 3	Pr-1 1	Pr-1 2	Pr-1 3	Pr-4 1	Pr-4 2	Pr-4 3
Arachnida (continued)												
Acarina												
Anystidae												
Genera spp.	+	+	+	+	1	+	+	+	2	9	3	4
Bdellidae												
Genus spp.	+	+	+	+	+	+	+	1	2	+	+	1
Cunaxidae												
Genus spp.	+	1	1	+	+	+	1	+	+	+	+	+
Erythraeidae												
Genus spp.	+	+	+	1	1	+	+	+	+	+	+	+
Oribatelloidae												
Genera spp.	+	4	4	19	14	+	250	318	472	319	262	310
Pachygnathidae												
Genus sp.	+	+	+	+	+	1	+	+	+	+	+	+
Phytoseiidae												
Genera spp.	+	+	1	+	+	14	101	65	70	22	5	23
Tarsonemidae												
Genus sp.	+	+	+	+	+	+	+	1	+	+	+	+
Tetranychidae												
Bryobia sp.	+	+	+	+	+	+	+	1	+	+	+	+
Tetranychus urticae	+	+	+	+	+	+	74	13	54	4	+	2
Tydeidae												
Genera spp.	+	+	+	+	+	+	3	5	8	1	+	2
Insecta												
Collembola												
Entomobryidae												
Genus spp.	+	4	2	+	2	+	545	121	627	99	105	93
Sminthuridae												
Genus spp.	+	+	+	+	+	+	+	+	6	163	154	74
Odonata												
Coenagrionidae												
Enallagma sp.	+	+	+	+	+	+	+	+	+	1	+	+
Isoptera												
Rhinotermitidae												
Reticulotermes flavipes (workers)	+	+	2	+	+	+	+	+	+	+	+	+
Orthopera												
Acrididae												
Dichromorpha viridis	+	+	+	+	+	+	2	1	2	+	+	+
Syrbula admirabilis	+	+	+	+	+	+	+	1	1	+	+	+
Genus spp.	+	1	+	+	+	+	1	+	+	+	+	+
Blattoidae												
Genus sp. (nymph)	+	+	+	+	1	+	+	+	+	+	+	+

TABLE 3.3.5-2 (continued)

Class Order Family Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Orthopera (continued)												
Gryllidae												
Hapithus agitator	+	1	1	2	+	1	+	+	+	+	+	+
Nemobius fasciatus	+	+	+	+	+	+	1	+	4	+	1	4
Oecanthus angustipennis	+	+	2	+	+	+	+	+	+	+	+	+
Oecanthus latipennis	+	2	1	+	+	+	+	+	+	+	+	+
Genus sp.	+	+	+	+	+	+	+	1	+	+	+	+
Phasmatidae												
Diapheromera femorata	1	1	5	2	2	1	+	+	+	+	+	+
Tetrigidae												
Tettigidea lateralis (nymph)	+	+	+	+	+	1	+	+	+	+	+	+
Tettigoniidae												
Conocephalus strictus	+	+	+	+	+	+	17	15	25	6	9	3
Orchelimum nigripes	+	+	+	+	+	+	1	+	1	+	+	1
Psocoptera												
Psocidae												
Genus sp.	+	1	+	1	+	+	+	+	+	+	+	+
Genus sp. (nymph)	+	+	+	+	1	+	+	+	+	+	+	+
Hemiptera												
Alydidae												
Alydus eurinus (nymph)	+	+	+	+	+	+	+	+	+	1	+	+
Megalotomus quinquespinosus	+	+	1	+	+	+	+	+	+	+	+	+
Anthocoridae												
Orius insidiosus	+	+	+	+	+	+	1	+	1	+	+	1
Berytidae												
Jalysus spinosus	8	4	7	+	5	3	+	+	+	+	+	+
Coreidae												
Archimerus alternatus	+	+	2	+	+	+	+	+	+	+	+	+
Largidae												
Euryphthalmus succinctus	+	+	+	+	1	+	+	+	+	+	+	+
Lygaeidae												
Geocoris uliginosus	+	+	+	+	+	+	+	+	1	+	+	+
Orthaea sp.	+	+	+	+	+	+	1	+	+	+	+	+
Genus sp. (nymphs)	+	+	+	+	+	+	+	+	2	+	+	+
Miridae												
Hyaliodes harti	+	1	6	3	2	2	+	+	+	+	+	+
Lygus lineolaris	+	+	+	+	+	+	+	+	+	1	+	3
Phytocoris sp. a.	+	1	+	1	+	+	+	+	+	+	+	+
Phytocoris sp. b.	+	2	+	+	1	+	+	+	+	+	+	+
Plagiognathus cuneatus	+	1	+	1	+	+	+	+	+	+	+	+
Genus spp. (nymphs)	4	7	5	2	5	4	+	+	+	+	+	+

TABLE 3.3.5-2 (continued)

Class Order Family Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Hemiptera (continued)												
Pentatomidae												
Mor idea lugens	1	+	+	+	+	+	+	+	+	+	+	+
Reduviidae												
Sinea sp. (nymphs)	1	+	+	+	+	+	+	+	+	+	+	+
Zelus sp. (nymphs)	+	3	1	+	3	+	+	+	+	+	+	+
Tingidae												
Corythucha arcuata	2	1	4	1	8	7	+	+	+	+	+	+
Corythucha associata	+	+	+	17	+	+	+	+	+	+	+	+
Corythucha cydoniae	+	+	+	5	12	2	+	+	+	+	+	+
Leptopharsa clitoriae	+	7	1	+	+	+	+	+	+	+	+	+
Leptopharsa oblonga	3	+	+	+	10	+	+	+	+	+	+	+
Leptoypha mutica	4	2	+	+	+	+	+	+	+	+	+	+
Physatocheila variegata	+	+	1	+	+	+	+	+	+	+	+	+
Genera spp. (nymphs)	2	1	+	10	9	3	+	+	+	+	+	+
Homoptera												
Acanaloniidae												
Acanalonia bivittata	+	+	2	+	+	1	+	+	+	+	+	+
Achiliidae												
Catonia cinctifrons	+	+	+	3	2	1	+	+	+	+	+	+
Alerodidae												
Genus sp.	+	1	6	1	+	1	+	+	+	+	+	+
Aphididae												
Genera spp. (adults and nymphs)	9	38	17	23	25	28	14	12	10	9	+	1
Cercopidae												
Philaenus spumarius	+	+	+	2	+	+	+	+	+	+	+	+
Cicadellidae												
Cloanthanus cupresecens	2	1	3	1	6	5	+	+	+	2	+	+
Cloanthanus frontalis	+	1	+	1	1	+	+	1	+	+	+	1
Cloanthanus sp.	+	+	+	+	+	+	+	+	+	1	+	+
Coelidia olitoria	1	+	1	+	+	1	+	+	+	+	+	+
Draeculacephala spp.	+	+	1	+	+	+	+	+	+	1	2	+
Empoasca fabae complex	10	3	7	5	3	4	+	+	2	4	3	5
Empoasca spp.	2	1	3	1	+	1	42	14	28	2	1	+
Erythroneura elegans?	+	2	1	+	1	1	+	+	+	+	+	+
Erythroneura comes complex	+	1	1	1	1	+	+	+	+	+	+	+
Erythroneura maculata complex	+	2	3	+	4	+	+	+	+	+	+	+
Erythroneura nigra	1	+	+	+	+	+	+	+	+	+	+	+
Erythroneura obliqua complex	+	+	+	+	+	1	+	+	+	+	+	+
Erythroneura vulnerata complex sp.a	3	+	+	+	+	+	+	+	+	+	+	+
Erythroneura vulnerata complex sp.b	2	2	2	1	2	2	+	+	+	+	+	+
Erythroneura spp.	36	29	92	54	67	30	+	+	+	+	+	+

TABLE 3.3.5-2 (continued)

Class Order Family Genus and species	F-1 1[a]	F-1 2	F-1 3	F-4 1	F-4 2	F-4 3	Pr-1 1	Pr-1 2	Pr-1 3	Pr-4 1	Pr-4 2	Pr-4 3
Insecta (continued)												
Homoptera (continued)												
Cicadellidae (continued)												
Exitianus exitiosus	+	+	+	+	+	+	3	1	3	3	1	+
Flexamia sp.	+	+	+	+	+	+	10	5	4	+	+	+
Graminella nigrifrons	+	+	+	+	+	+	+	1	+	+	+	+
Gyponana sp.	+	+	+	+	+	+	+	+	+	1	+	+
Hymetta trifasciata	1	3	+	+	1	1	+	+	+	+	+	+
Hymetta spp.	+	1	1	4	4	2	+	+	+	+	+	+
Latulus sayi	+	+	+	+	+	+	34	12	24	1	+	+
Neokolla hieroglyphica	1	4	2	+	+	+	+	+	+	+	+	+
Paraphlepsius irroratus	6	1	4	3	+	3	+	+	+	+	+	+
Paraulacizes irrorata	+	+	2	+	+	1	+	+	+	+	+	+
Polyamia apicata	+	+	+	+	+	+	+	+	7	+	+	+
Scaphoideus spp.	+	2	2	+	+	+	+	+	+	+	+	+
Xestocephalus publicarius	+	+	+	+	+	+	+	2	+	+	+	+
Genera spp. (mostly numphs)	14	25	17	1	23	21	78	13	81	16	2	5
Cixiidae												
Myndus enotatus	20	28	23	4	8	1	+	+	+	+	+	+
Myndus fulvus	17	24	8	21	21	14	+	+	+	+	+	+
Myndus sp.	+	+	1	+	+	+	+	+	+	+	+	+
Coccoidea												
Genera spp.	+	+	+	1	+	1	+	+	2	+	+	+
Delphacidae												
Kelisia axialis	+	2	+	+	+	+	+	+	+	+	+	+
Libernilla ornata	+	+	+	+	+	+	2	4	2	+	+	+
Genus spp.	+	1	2	+	1	+	3	4	4	+	+	+
Derbidae												
Otiocerus degeerii	+	2	+	+	+	+	+	+	+	+	+	+
Dictyopharidae												
Phylloscelis atra	+	+	+	+	+	+	+	+	+	2	3	2
Flatidae												
Ormenis pruinosa	2	+	+	+	+	+	+	+	+	+	+	+
Ormenis septentrionalis	+	+	+	+	+	2	+	+	+	+	+	+
Ormenis venusta	+	1	+	+	+	+	+	+	+	+	+	+
Issidae												
Bruchomorpha vittata	+	+	+	+	+	+	50	36	55	14	10	2
Membracidae												
Campylenchia latipes	1	+	1	+	+	+	+	+	1	+	1	3
Publilia reticulata	+	1	22	+	+	1	+	+	+	+	+	+

TABLE 3.3.5-2 (continued)

Class Order Family Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Homoptera (continued)												
Membracidae (continued)												
Tylopelta americana	+	+	+	1	+	+	+	+	+	+	+	+
Genus spp. (nymphs)	+	+	2	+	+	+	+	+	+	+	+	+
Pseudococcidae												
Genus spp.	+	2	+	+	+	+	+	+	+	+	+	+
Psyllidae												
Livia vernalis	+	+	+	+	+	+	1	+	+	+	+	+
Thysanoptera												
Aeolothripidae												
Aeolothrips bicolor	+	+	+	+	+	+	6	4	5	+	+	+
Phlaeothripidae												
Genera spp.	2	2	+	2	+	+	8	3	18	19	7	10
Thripidae												
Anaphothrips obscurus	+	+	+	+	+	+	9	+	+	+	+	+
Aptinothrips rufus	+	+	+	+	+	+	7	4	8	2	4	2
Chirothrips crassus	+	+	+	+	+	+	+	+	3	+	+	+
Echinothrips americanus	1	1	1	+	1	+	+	+	+	+	+	+
Frankliniella tritici	+	+	+	+	+	+	+	1	3	3	2	3
Scirtothrips niveus	1	2	+	+	+	+	+	+	+	+	+	+
Sericothrips baptisiae	+	+	+	+	+	+	4	+	2	10	1	1
Thrips helianthi	+	+	+	1	+	+	+	+	+	+	+	+
Thrips spp.	+	+	4	+	1	2	+	27	21	15	2	2
Neuroptera												
Chrysopidae												
Chrysopa rufilabris	+	2	1	3	1	1	+	+	+	+	+	+
Chrysopa spp. (larvae)	5	2	4	2	3	1	+	+	1	+	+	+
Coniopterygidae												
Coniopteryx vicina	+	+	+	+	1	+	+	+	+	+	+	+
Coniopteryx vicina ? (larvae)	1	1	+	+	5	3	+	+	+	+	+	+
Hemerobiidae												
Hemerobius humulinus	+	+	1	+	+	+	+	+	+	+	+	+
Lepidoptera												
Aegeriidae												
Synanthidon sp.	+	+	+	+	+	+	+	+	+	1	+	+
Amatidae												
Scepsis fulvicollis	+	+	+	+	+	+	1	+	+	+	+	+
Arctidae												
Genus sp. (larvae)	+	1	1	+	2	+	+	+	+	+	+	+
Eriocranidae												
Genus sp. (larva)	+	+	1	+	+	+	+	+	+	+	+	+

Class Order Family Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Lepidoptera (continued)												
Geometridae												
Genus spp. (larvae)	7	7	13	3	7	6	+	+	+	1	2	4
Hesperidae												
Genus spp. (larvae)	+	+	1	+	1	+	+	+	+	+	+	+
Limacodidae												
Genus sp. (larvae)	+	+	+	1	2	+	+	+	+	+	+	+
Megalopygidae												
Genus sp. (larva)	+	+	+	+	1	+	+	+	+	+	+	+
Noctuidae												
Genus spp. (larvae)	+	+	3	+	1	2	+	+	+	3	+	3
Noctuoidae												
Genera spp.	3	4	1	2	+	3	2	1	2	2	1	+
Notodontidae												
Cerura sp. (larva)	+	+	+	+	+	+	+	+	+	+	+	+
Heterocampa sp. (larvae)	+	+	+	1	+	+	+	+	+	+	+	+
Schizura sp. (larvae)	+	+	1	+	+	2	+	+	+	+	+	+
Genus spp. (larvae)	5	3	2	5	3	2	+	+	+	+	+	+
Nymphalidae												
Genus spp. (larvae)	2	5	7	1	3	2	+	+	+	+	+	+
Pyralidae												
Genus sp. (larva)	+	1	[illegible]	+	+	+	+	+	+	+	+	+
Sphingidae												
Genus sp. (larva)	+	+	+	+	1	+	+	+	+	+	+	+
Tortricidae												
Genus spp. (larvae)	4	+	4	7	3	6	+	2	+	1	+	1
Unknown												
Genus spp. (larvae)	4	1	8	1	3	2	+	+	+	+	1	1
Coleoptera												
Anobiidae												
Caenocara tenuipalpa?	1	+	+	+	+	+	+	+	+	+	+	+
Bruchidae												
Acanthoscelidae longistilus	+	2	1	+	+	+	+	+	+	+	+	+
Meibomeus musculus	+	+	1	+	+	+	+	+	+	+	+	+
Buprestidae												
Pachyscelus purpurens	+	+	+	+	+	1	+	+	+	+	+	+
Cantharidae												
Chauliognathus pennsylvanicus	+	+	+	+	+	+	+	1	+	+	+	+
Carabidae												
Notiophilus novemstriatus	+	+	+	+	+	1	+	+	+	+	+	+
Chrysomelidae												
Altica sp.	+	+	1	+	+	+	+	+	+	+	+	+
Blepharida rhois	+	+	+	1	+	+	+	+	+	+	+	+

TABLE 3.3.5-2 (continued)

Class Order Family Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Coleoptera (continued)												
Chrysomelidae (continued)												
Chaetocnema confinis	+	3	2	+	1	+	+	+	+	+	+	+
Chaetocnema pulicaria	+	1	+	1	1	1	4	2	4	9	6	13
Diabrotica undecimpunctata	+	3	3	+	3	+	1	1	+	1	+	8
Epitrix fuscula	+	+	+	+	+	+	+	+	+	+	+	+
Epitrix sp.	+	+	+	1	+	+	+	+	+	+	+	1
Longitarsis sp.	+	+	+	+	+	+	+	+	+	+	+	+
Microrhopala vittata	+	+	+	+	+	3	+	+	+	+	1	+
Paria cancellagilvipes	2	+	+	+	+	+	+	+	+	+	+	+
Paria spp.	1	1	3	+	+	+	+	+	+	+	+	+
Genus spp. (larvae)	+	2	+	+	+	+	1	+	+	+	+	1
Cleridae												
Hydrocera humeralis	+	+	+	+	+	2	+	+	+	+	+	+
Genus spp. (larvae)	+	+	+	1	+	+	+	+	+	+	+	+
Coccinellidae												
Psyllobora vigintimaculata	+	+	+	2	+	2	+	+	+	+	+	+
Scymnus xanthespis?	1	+	+	+	+	+	+	+	+	+	+	+
Scymnus spp.	+	+	1	+	1	+	+	+	+	+	+	+
Genus sp. (larva)	+	+	+	1	+	+	+	+	+	+	+	+
Curculionidae												
Apions spp.	1	12	+	1	2	+	+	+	+	+	+	+
Centrinites strigicollis	+	+	+	+	1	+	+	+	+	+	+	+
Conotrachelus sp.	+	+	+	+	1	+	+	+	+	+	+	+
Curculio sulcatulus	+	+	+	+	+	1	+	+	+	+	+	+
Cyrtepistomus castaneus	1	3	+	11	+	1	+	+	+	+	+	+
Geraeus picumnus	+	+	+	+	+	+	+	2	+	+	+	+
Hypera punctata	+	+	+	+	+	+	+	1	+	+	+	+
Pandeletius hilaris	1	+	+	+	2	1	+	+	+	+	+	+
Smicronyx sp.	+	+	+	+	+	+	+	+	+	+	+	2
Genus sp. (larvae)	+	1	1	+	+	+	+	+	+	+	+	+
Euglenidae												
Zonantes fasciatus	+	+	+	+	+	1	+	+	+	+	+	+
Zonantes subfasciatus	2	1	4	+	+	+	+	+	+	+	+	+
Lamperidae												
Lucidota corrusca	+	+	+	1	+	+	+	+	+	+	+	+
Lathridiidae												
Cartodere sp.	+	+	+	+	+	+	+	+	2	+	+	+

TABLE 3.3.5-2 (continued)

Class Order Family Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Coleoptera (continued)												
Lathridiidae (continued)												
Corticaria sp.	+	+	+	+	+	+	3	+	+	+	+	+
Melanophthalma sp.	3	10	6	5	7	4	2	+	+	+	+	+
Genus spp.	1	+	+	1	+	+	+	+	+	+	+	+
Genus spp. (larvae)	+	+	+	+	+	+	+	+	+	25	36	39
Mordellidae												
Mordella discoidea	+	+	+	1	+	+	+	+	+	+	+	+
Genus sp. (larvae)	+	+	1	+	+	1	+	+	+	+	+	+
Orthoperidae												
Arthrolips decolor	+	+	+	+	+	+	+	+	+	25	47	45
Arthrolips sp.	+	+	+	+	+	+	+	+	+	3	1	5
Corylophodes marginicollis	+	+	+	+	+	1	+	+	+	+	+	+
Phalacridae												
Genus sp. a.	+	+	1	+	+	+	+	+	+	+	+	+
Genus sp. b.	+	+	+	+	1	+	+	+	+	+	+	+
Scaphidiidae												
Scaphisoma distincta	+	+	+	+	+	+	+	+	1	+	+	+
Scolydidae												
Chramerus hicoriae	+	1	+	+	+	+	+	+	+	+	+	+
Hypothenemus dissimilis	+	+	1	+	+	+	+	+	+	+	+	+
Hypothenemus intertitialis	+	+	2	+	+	+	+	+	+	+	+	+
Pseudopityophthorus minutissimus	+	+	+	+	1	+	+	+	+	+	+	+
Scolytus multistriatus	+	+	+	+	+	+	+	1	+	+	+	+
Staphylinidae												
Stenus humilis	+	+	+	+	+	+	+	+	1	+	+	+
Genus sp.	+	+	1	+	+	+	+	+	+	+	+	+
Tenebrionidae												
Paratenetus punctatus	+	+	1	+	+	+	+	+	+	+	+	+
Unknown												
Genus spp. (larvae)	+	3	+	+	+	+	7	2	4	6	10	+
Diptera												
Anthomyiidae												
Hylemya sp.	+	1	+	+	+	1	+	+	+	1	+	+
Pegomyia sp.	1	+	+	1	+	+	+	+	+	+	+	+
Genus sp.	+	+	+	+	+	+	+	+	+	+	1	+
Bibionidae												
Genus sp.	+	+	+	1	+	+	+	+	+	+	+	1
Bombyliidae												
Systoechus sp.	+	+	+	+	+	+	+	+	+	+	1	+
Calliphoridae												
Lucilia illustris	+	+	+	1	+	+	+	+	+	+	+	+

TABLE 3.3.5-2 (continued)

Class / Order / Family / Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Diptera (continued)												
Cecidomyiidae												
Genus spp.	3	8	5	+	5	3	4	+	+	+	1	+
Chironomidae												
Genus spp.	+	+	1	1	1	+	14	31	16	3	2	1
Chloropidae												
Meromyza americana	+	+	+	+	+	+	+	+	2	+	+	+
Genus spp.	+	+	1	1	1	1	31	19	18	2	+	7
Clusiidae												
Clusa lateralis	+	+	+	+	1	+	+	+	+	+	+	+
Culicidae												
Genus spp.	+	2	1	1	2	1	+	+	+	+	+	+
Cyclorrhaphae												
Genera spp. (larvae)	+	2	+	+	+	+	7	5	4	+	3	2
Dolicopodidae												
Genus spp.	4	3	6	+	3	1	1	+	2	+	1	+
Drosophilidae												
Chymomyza amoena	5	3	1	+	1	2	+	+	+	+	+	+
Genus sp.	+	1	1	1	+	+	+	1	1	+	+	+
Empididae												
Genus sp.	1	1	+	+	+	+	+	+	+	+	+	+
Heleomyzidae												
Genus sp.	1	+	+	+	+	+	+	+	+	+	+	+
Muscidae?												
Genus sp.	+	1	+	+	+	+	+	+	+	+	+	1
Mycetophilidae												
Genus spp.	4	1	1	4	+	3	1	+	+	1	+	1
Nematocerae												
Genus spp.	4	5	9	6	7	2	35	32	29	7	5	5
Otitidae												
Genus sp.	+	+	+	+	+	+	1	+	1	1	+	+
Phoridae												
Genus sp.	+	1	6	4	+	+	+	+	+	+	+	+
Pipunculidae												
Pipunculus sp.	+	+	1	+	+	+	+	+	+	+	+	+
Genus sp.	+	+	+	+	1	+	+	+	+	+	+	+
Platypezidae												
Platypeza sp.	1	+	+	+	+	+	+	+	+	+	+	+
Psilidae												
Loxocera cylindrica	1	+	+	+	+	1	+	+	+	+	+	+

TABLE 3.3.5-? (continued)

Class Order Family Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Diptera (continued)												
Sarcophagidae												
Ravinia querula?	+	+	+	+	+	+	+	1	+	+	+	+
Scatopsidae												
Genus sp.	+	+	+	+	+	+	+	+	+	3	3	3
Sciaridae												
Genus sp.	+	4	+	+	4	1	3	+	4	2	2	2
Sciomyzidae												
Limnia sp.	+	+	+	+	1	+	+	+	+	+	+	+
Schizophora												
Genus sp.	+	2	6	+	2	3	+	2	2	5	4	1
Simuliidae?												
Genus sp.	+	+	+	+	+	+	+	1	+	+	+	+
Sphaeroceridae												
Genus sp.	1	+	+	+	+	1	+	+	+	+	+	+
Stratiomyidae												
Sargus cuprarius	+	2	+	+	+	+	+	+	+	+	+	+
Syrphidae												
Ocyptamus fuscipennis	+	+	+	1	+	+	+	+	+	+	+	+
Toxomerus marginatus	+	1	1	+	+	2	+	+	+	+	+	+
Toxomerus politus	+	1	+	1	+	+	+	+	+	+	+	+
Genus sp.	+	+	+	+	+	+	1	+	+	+	+	+
Tachinidae												
Cholomyia inaequipes	+	+	1	+	+	+	+	+	+	+	+	+
Genus sp.	1	+	+	+	+	+	+	+	+	+	+	+
Tipulidae												
Genus sp.	1	4	3	1	2	+	1	+	+	2	+	+
Unknown												
Genus spp.	2	2	+	+	1	+	+	1	+	+	+	+
Hymenoptera												
Apidae												
Bombus americanorum	+	+	+	+	+	+	+	+	+	1	+	+
Bethylidae												
Pristocera sp.	4	2	1	+	2	+	+	+	+	+	+	+
Brachonidae												
Genus spp.	11	6	5	6	6	2	1	+	1	1	1	1
Chalcididae												
Eurytoma sp.	+	+	+	1	+	+	+	+	+	+	+	+
Perilampus sp.	+	+	1	+	+	+	+	+	+	+	+	+
Genus sp.	+	+	+	+	+	1	+	+	+	+	+	+

TABLE 3.3.5-2 (continued)

Class Order Family Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Hymenoptera (continued)												
Chalcidoidae												
Genera spp.	51	47	21	22	25	16	31	27	22	7	7	10
Cynipidae												
Genus spp.	8	4	2	1	2	+	+	1	+	+	+	+
Encyrtidae												
Genus sp.	+	+	+	1	+	1	+	+	+	+	+	+
Eulophidae												
Euplectrus sp.	+	+	1	+	+	+	+	+	+	+	+	+
Tetrastichus sp.	2	+	+	+	+	2	+	+	+	+	+	+
Genus spp.	+	+	1	+	+	1	+	3	+	+	+	+
Eupelmidae												
Eupelmus sp.	+	+	+	+	+	+	+	1	+	+	+	+
Genus sp.	+	+	+	+	+	+	+	+	2	+	+	1
Formicidae												
Aphaenogaster fulva	+	+	+	+	+	1	+	+	+	+	+	+
Crematogaster cerasi	4	1	2	1	+	+	+	+	+	+	+	+
Crematogaster clara	+	+	+	+	+	+	+	2	+	+	+	+
Crematogaster lineolata	3	+	1	1	+	1	+	+	+	+	+	+
Crematogaster sp.	+	+	2	+	+	+	+	+	+	+	+	+
Formica fusca	+	+	2	1	+	+	+	+	+	+	+	+
Lasius sp.	+	+	+	+	+	+	+	+	+	+	+	1
Leptothorax ambiguus	20	9	8	2	+	+	+	+	+	+	+	+
Monomorium minimum	+	+	+	+	+	+	+	+	1	+	+	+
Prenolepis imparis	5	4	5	15	9	4	+	+	+	+	+	+
Solenopsis molesta	+	+	+	+	+	+	1	2	+	+	+	+
Tetramorium caespitum	1	3	1	2	+	+	+	+	+	+	1	+
Ichneumonidae												
Gelis sp.	1	+	+	+	+	+	+	+	+	+	+	+
Genus spp.	1	1	2	+	+	1	1	+	+	+	+	+
Mymaridae												
Genus spp.	5	4	+	+	+	+	11	8	17	5	7	1
Ormyridae												
Ormyrus sp.	1	+	+	+	+	1	+	+	+	+	+	+
Pompilidae												
Genus sp.	+	1	+	+	+	+	+	+	+	+	+	+
Pteromalidae												
Genus sp.	+	+	+	+	+	+	+	3	+	+	+	+
Tiphiidae												
Genus sp.	+	+	+	+	1	+	+	+	+	+	+	+

TABLE 3.3.5-2 (continued)

Class Order Family Genus and species	F-1			F-4			Pr-1			Pr-4		
	1[a]	2	3	1	2	3	1	2	3	1	2	3
Insecta (continued)												
Hymenoptera (continued)												
Unknown												
Genera spp.	+	2	1	1	2	+	+	5	+	+	+	+

[a]samples of 50 sweeps each.

+not observed.

TABLE 3.3.5-3

COMPARISON OF INVERTEBRATE SPECIMENS COLLECTED BY PERMANENT STUDY PLOT AND TRANSECT DURING THE SPRING AND FALL SAMPLING PERIOD, 1974 ON THE CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI

Transect	Spring			
	F-1	F-4	Pr-1	Pr-4
1	143	130	319	539
2	326	92	485	41
3	149	54	115	126
Total	618	276	919	706
Grand Total		2519		

Transect	Fall			
	F-1	F-4	Pr-1	Pr-4
1	436	355	1677	934
2	535	392	974	796
3	490	336	1899	751
Total	1461	1083	4550	2481
Grand Total		9575		

3.4 ECOLOGICAL SUMMARY

The following paragraphs and illustrations describe, in a general way, functional relationships and structural components of the regional ecosystem within Callaway County, Missouri. Figure 3.4-1 is a diagrammatic representation of the major ecological associations of the Callaway Plant site. Figure 3.4-2 shows diagrammatically the various trophic levels, their relative contribution to the total biomass of the system, and natural and man-made stresses.

Soil inherently produces and concomitantly is subject to diverse influences, biotic as well as abiotic in nature. Natural soils serve as the starting point in the process of developing the carrying capacity of land for plant and animal communities (Figures 3.4-1 and 3.4-2). Natural soils, including the Goss soil of steep timbered hills and Menfro soils on hills bordering the floodplain in the site area, serve as a foundation upon which the "pyramid of biomass" is based. These soils (Goss and Menfro) have not been significantly altered by man. (Soil is ultimately a storehouse for the raw materials required by plants [the primary producers] for development and growth). The distinction is made between natural and agricultural soils subject to the influence of man. This distinction is further based on use, form, and composition, which additionally separate natural and agricultural soils.

Agricultural soils, including the Mexico-Putnam soils of the site area, start out initially as natural soils but subsequently are somewhat altered. The farmer alters the soil, such as at the Callaway Plant site, by first clearing the land, plowing the soil, and then cultivating for production of a standing crop. Additionally, to further assist in optimizing production from the soil, he utilizes fertilizers, pesticides, herbicides and other chemicals to enhance production and limit or eliminate waste. Productive agricultural land in some respects is "short-circuited" successionally, in that the normal organic cycle must be continually supplemented to maintain a high soil fertility, the prerequisite for successful agricultural development. Cultivation physically increases soil aeration and allows for some organic additions at a more rapid rate; however, it also causes greater moisture evaporation by exposing a greater proportion of the soil surface to the air. Surface water runoff from agricultural soils may be made up of considerable quantities of soluble and suspended material including organic material, fertilizers, silt and residues from herbicides and pesticides. These materials can enter adjacent waterways and have a pronounced influence on the aquatic ecosystem.

Litter, another element of the ecosystem, consists fundamentally of organic components, namely leaves and other vegetative plant parts shed throughout a growing season. These organic additions to the litter layer provide food to decomposers and microorganisms in addition to insects that inhabit the litter mat of various vegetative cover types. Litter generally is composed of two main forms: first, organic litter consisting of twigs, leaf debris, mulches, duff, and brush, or the undecomposed component of the biotic community. The second major component of litter is humus--litter that has undergone and is undergoing aerobic and anerobic decomposition into organic and inorganic components.

Litter provides input to the soil by adding humus content to the upper horizons of the soil profile (Figure 3.4-2). This addition aids in building the soil profile while helping to increase the capability of the soil to retain moisture necessary for plant growth. Plant roots, stems, bacteria, fungi, and small animals residing in the soil or litter mat provide both physical and chemical additions to the substrate that enhance the soil characteristics.

At the elemental level, litter is a storage point in the nitrogen, phosphorus, and sulfur cycles. Carbohydrates, as well as ligins, proteins, and amino acids present in the litter layer are food for the microorganisms, which are important in cycling nutrients into the inorganic forms required for plant growth and development.

The green plant (Figure 3.4-2), in all its diverse shapes, sizes, and locations, forms the basic source of energy upon which all elements of the ecosystem are totally dependent. The reason for this total reliance on the plant is due to the unique ability of green plants to convert solar energy and chemicals through the photosynthetic process into an organic form which is usable by other organisms. As a result, the green plant, the primary producer in the ecological community, functions as the foundation of the food web.

Vegetation of the field and forest, serving as the basis of the ecosystem, receives its energy inputs from the sun, water, minerals, and the atmosphere. Sunlight, as previously mentioned, provides the energy necessary for photosynthesis. Water is an important requirement of plants for physical support metabolism and assists in transporting gases and chemicals throughout the plant. Minerals are required by plants to provide the basic units and cellular materials necessary for normal growth, flowering, and reproduction. Atmospheric gases, in particular carbon dioxide and oxygen, are required by the individual plant to permit photosynthesis and respiration to occur. These primary inputs supply vegetation with the materials necessary for survival and development.

Plants, in their unique position, supply energy in several forms to the primary consumers of the biota. Basically, the energy from plants is in the form of forage materials from the site area, such as acorn, hackberry, greenbriar, smooth sumac, juniper berries, maple seed, persimmon, blackberry, strawberry, black walnut, and wild grape, plus a variety of grains and succulent shrubs, which supply vitamins, starches, sugars, and other compounds necessary for the life of birds and animals (herbivores). In oldfields and transition areas in particular, the forage value of the vegetation is very high, owing to the prevalence of grasses and shrub species used by herbivores including several bird species, rabbits, white-tailed deer, fox, and gray squirrels (Figure 3.4-1).

In addition to providing forage, vegetation also provides cover and concealment for wildlife utilizing the various habitats. Cover is an important factor in controlling the rate of predation occurring in wildlife populations. The vegetation of the site area consists of a diverse flora including forest associations such as oak, oak-hickory, oak-maple, and black walnut-red cedar. Field associations of the site include pasture and oldfield (prairie). Hardwood forests within the site area in addition to dense shrub thickets afford excellent cover and concealment to a broad spectrum of wildlife species (Figure 3.4-1).

Invertebrates are the most abundant of the faunal forms found in the Callaway Plant site area. The multifarious insect species are the most important of the invertebrate fauna, and this position is reinforced by their sheer numbers both in species and individuals. Insects represent every conceivable trophic level from primary consumers such as aphids, to facultative parasites such as wood ticks, to tertiary carnivores such as assasin bugs. There are fructivorous insects, granivorous insects, herbivorous insects, parasitic insects, detritivorous insects, carnivorous insects -- every available plant and animal species is either preyed upon or parasitized by insects. The diets of a good many of the higher animals are based, at least in part, upon the availability of insects as food. The invertebrates, especially the insects, are an integral, essential, and omnipresent component of every terrestrial ecosystem on earth.

Most of the smaller herptiles of the Callaway Plant site are predaceous upon insects. Species such as the ground skink, five-lined skink, and the eastern fence lizard live in the forested areas or edges and feed exclusively upon the insects there. Many of the more grassy areas are inhabited by various species of snakes, which prey upon a variety of species. The hog-nosed snake feeds almost exclusively upon toads, while garter snakes and rat snakes eat small mammals, lizards, skinks, baby birds - almost anything available. The three-toed box turtle is more omnivorous in its habits, eating vegetation and occasional insects. The frogs and toads are largely insectivorous, though the larger species such as the bullfrog may prey upon prairie voles and garter snakes.

The herptiles are in turn prey for a number of larger species such as hawks, crows, owls, weasels, and even hogs.

In a natural system, the wild animals are the principal users or consumers of the available botanical component of the habitat (Figure 3.4-2). This utilization may be direct, as in the case of a white-tailed deer browsing on smooth sumac leaves, or perhaps indirect, as in the case of a prairie vole building a runway from lodged fescue stems and accumulated leaf litter. In any case, the key concept is utilization of available resources and this takes on myriad forms throughout zoological components of the ecosystem. Resource utilization is not, however, a one-way operation, for many of the components are recycled within the system and again become available for use by the plants, i.e., the smooth sumac eaten by the deer is converted within the system and again becomes available for use by the plants; the fescue stems and leaf litter decay in time and their elemental components enrich the soil and, in turn, provide essential nutrients for plant growth; the same recycling occurs when an animal dies and the components of its body decay and eventually are recycled and reused.

The birds of the Callaway Plant site are a very diverse lot, changing their food habits and habitats with the season (Figure 3.4-1). During the nesting season in the spring, various vegetative components of the ecosystem are incorporated into the nesting territory and are fiercely defended by the males, while during the fall, a wide range of habitat type may be frequented. Many birds are granivorous and thus their territories include areas where weeds grow and seeds are abundant. Others are largely insectivorous and their territories are chosen by those areas, primarily grasslands, where insects are abundant. Predatory birds are more wide-ranging, since they prey upon a wider variety of animals. Small raptors such as the sparrow hawk feed primarily upon large insects such as grasshoppers. Larger raptors such as the great horned owl are nocturnal and feed upon species such as mice, voles, and rabbits, which are active at night. Other birds, such as bob-white quail, are omnivorous, feeding alternatively upon seeds, leaves, flowers, insects, spiders, and other materials found along the ground.

Birds are also preyed upon by a variety of predators. Some larger hawks prey upon mourning doves and quail, while many nests are raided by arboreal snakes, specifically the gopher snake and the rat snake.

Birds occupy various zones within a habitat--some preferring the ground surface, others, tall weedy vegetation. Still others occupy the various strata within the forest canopy (Figure 3.4-1).

Birds are very important in the dispersal of vegetative seeds, especially weed seeds. This is important in the natural succession of vegetative communities.

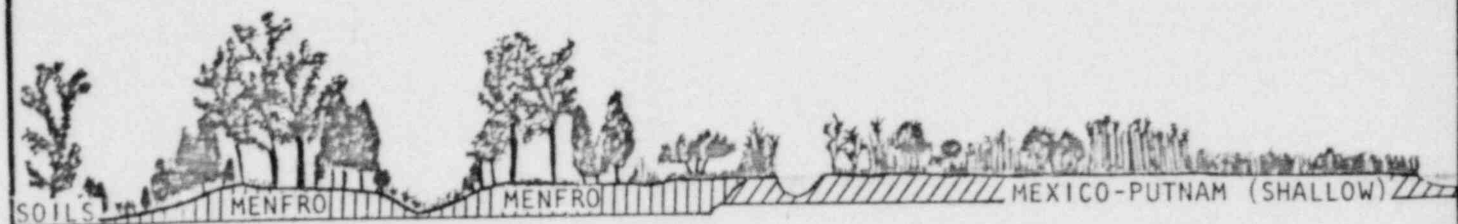
Mammals of the Callaway Plant site are easier to categorize than most other fauna of the area due to their limited numbers and their position in the trophic web (Figures 3.4-1 and 3.4-2).

Shrews are almost exclusively insectivores, although the short-tailed shrew does prey upon the young of mice and of ground-nesting birds. Most rodents are herbivorous, with an occasional insect in their diet. Harvest mice and white-footed mice are granivorous, while the prairie vole and the southern bog lemming cut grass stems to make small "haystacks." Cottontail rabbits also consume a variety of herbaceous plant parts.

The opossum is an omnivore as is the raccoon, but their tastes are such that there is little, if any, competition between them. Carnivorous mammals include the red fox, the coyote, and the long-tailed weasel.

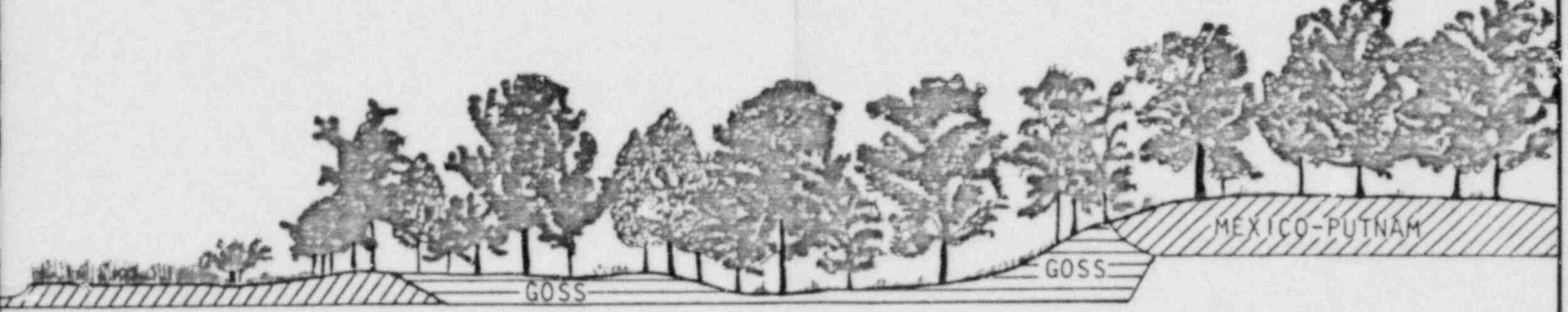
The only really large wild mammal on the site is the white-tailed deer, which is a browser, eating the succulent leaves, stems, and buds of woody plants and forbs.

Small mammals are preyed upon by snakes, bullfrogs, hawks, owls, weasels, foxes, and coyotes; while larger mammals are preyed upon by large hawks, foxes, coyotes, and other top carnivores. Most of the top carnivores are preyed upon only by man.



VEGETATION TYPE

BLACK WALNUT-RED CEDAR	OLDFIELD	PA
VEGETATION BLACK WALNUT RED CEDAR HONEY LOCUST AMERICAN ELM	GLOBOSE CYPERUS REED FESCUE MEADOW FESCUE RED CLOVER SHEEP SORREL YELLOW FOXTAIL	ELM-LEAF GOLDE CANADA GOLDENR WHITE CLOVER RED CLOVER HORSE NETTLE
HERPETOFAUNA WORM SNAKE FIVE-LINED SKINK THREE-TOED BOX TURTLE	COPPERHEAD LEOPARD FROG THREE-TOED BOX TURTLE	COPPERHEAD LEOPARD FROG THREE-TOED BOX GARTER SNAKE
AVIFAUNA CARDINAL DICKCISSEL WARBLERS FLYCATCHERS BLACKBIRDS SPARROW HAWK QUAIL MOURNING DOVE	DICKCISSEL SPARROWS FLYCATCHERS BLACKBIRDS STARLINGS GRACKLES QUAIL MOURNING DOVE	DICKCISSEL SPARROWS FLYCATCHERS BLACKBIRDS STARLINGS GRACKLES QUAIL MOURNING DOVE
MAMMALS OPOSSUM RACCOON WHITE-TAILED DEER PRAIRIE VOLE STRIPED SKUNK LONG-TAILED WEASEL RED FOX COYOTE COTTONTAIL RABBIT	OPOSSUM RACCOON WHITE-TAILED DEER PRAIRIE VOLE STRIPED SKUNK RED FOX COYOTE COTTONTAIL RABBIT SOUTHERN BOG LEMMING	OPOSSUM RACCOON WHITE-TAILED PRAIRIE VOLE STRIPED SKUNK RED FOX COYOTE COTTONTAIL RA SOUTHERN BOG

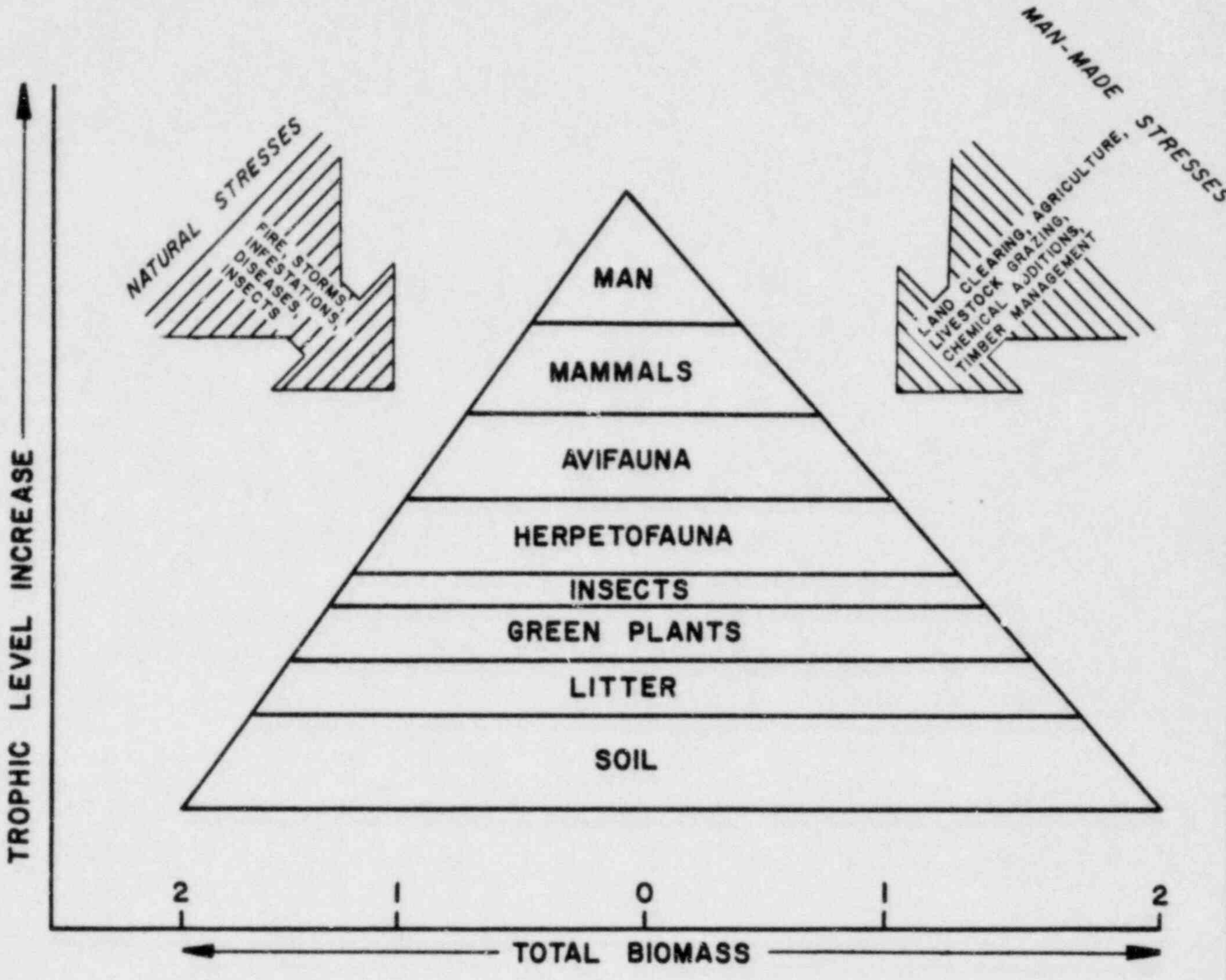


STURE	OAK-MAPLE	OAK-HICKORY	OAK
NROD OD	RED OAK SUGAR MAPLE WHITE OAK PIGNUT HICKORY WHITE ASH	WHITE OAK RED OAK BLACK OAK BUR OAK SHAGBARK HICKORY BITTERNUT HICKORY HOP-HORNBEAM	WHITE OAK POST OAK BLACK OAK RED OAK WHITE ASH SUGAR MAPLE SHAGBARK HICKORY
TURTLE		AMERICAN TOAD FIVE-LINED SKINK BLACK RAT SNAKE THREE-TOED BOX TURTLE HOG-NOSED SNAKE	
		CARDINAL RED-HEADED WOODPECKER HAIRY WOODPECKER DOWNY WOODPECKER CROWS BARRED OWL GREAT HORNED OWL	
DEER BBIT LEMMING		OPOSSUM RACCOON WHITE-TAILED DEER SHORT-TAILED SHREW STRIPED SKUNK GRAY SQUIRREL FOX SQUIRREL RED FOX COYOTE COTTONTAIL RABBIT	

UNION ELECTRIC CO.
CALLAWAY PLANT
UNITS 1&2

MAJOR ECOLOGICAL ASSOCIATIONS

Figure 3.4-1



UNION ELECTRIC CO.
CALLAWAY PLANT
UNITS 1&2

PYRAMID OF BIOMASS

Figure 3.4-2

3.5 CONCLUSIONS AND RECOMMENDATIONS

The results of the preconstruction monitoring program substantiate the conclusions reached after the baseline inventory regarding anticipated environmental impact from plant construction and operation. To reiterate, the ecology of the Callaway Plant site is not unique, and its particular ecological balance reoccurs many times throughout central and eastern Missouri. Intensive farming has produced favorable habitat for wildlife populations, but these conditions can be found in areas adjacent to the site. Since construction of the facility will remove only a small portion of the total acreage from production and since the ecology of the Callaway County Plant site is not unique, no significant impact from plant construction on the resident wildlife population is anticipated.

Rare and endangered or extremely important economic species occurring near or on the site will be affected little by development of the facility. The turkey, white-tailed deer, and ruffed grouse require forested habitats broken by small fields or openings and a relatively large home range. Only a few acres of forest will be disrupted during construction, and the access road, pipelines, and railroad spur should not affect movement of these species. Other species, such as the bald eagle, are extremely mobile and are not expected to be found near or on the site very often.

As a result of the first year's surveys, some recommendations can be made to improve the program, especially with regard to the invertebrates.

A voluminous amount of material was collected by sweeping, far too much to analyze critically. Also, large numbers of species cannot be dealt with taxonomically and must be identified only to a higher level. This is due to the lack of adequate keys and/or correctly determined collections of certain taxa (and accessibility to them), and to the inadequate knowledge of certain groups possessed by any identifier.

Even with the large amount of material collected, the methods provide at best a survey of only a component of the terrestrial invertebrates. This is not necessarily a shortcoming, but rather a reality. Spring and fall season comparisons are not expected to be completely alike either in species composition or abundance. Thus a certain taxa from the total survey should be selected for comparison. These should be invertebrates that provide the best chance of being identified to the genus and/or species level, or in selected cases, order or family. The chosen higher taxa (genus, family) should, within the taxon, reflect a relatively homogeneous trophic level and not have species representing two or more trophic levels. As a group, the spiders should prove to be a useful monitoring barometer. They occur in large enough numbers to be meaningful, are all predators, are generally habitat specific, and as adults are identifiable to some meaningful level, genus, or species. The Hemiptera and Auchenorrhynchous Homoptera are generally plant feeders whose species suck plant juices via piercing-sucking mouthparts. There is a distinct plant-insect interaction with many of the species being host specific. They are also fairly well known and can be identified. The predaceous Hemipterans are well known and afford observation of an insect predatory group. Also the Orthopterans are largely a mandibulate plant-feeding or scavenger group. The Thysanopterans (Thrips), Neuropterans (lacewings), and Coleopterans (beetles) are fairly well known and reflective of different trophic levels and should continue to be monitored.

Certain orders of arthropods appear to offer little chance of being identified to either family or genus and should be eliminated from serious consideration, as they probably will not satisfy the objectives of a monitoring program. These include the Collembola, Lepidoptera, Diptera, Hymenoptera, and Acarina. Others such as the Odonata, Psocoptera and non-arthropod groups do not occur in sufficient numbers in the sweeps to warrant their inclusion.

Since the invertebrates constitute the largest single component (in terms of number of species) on these permanent study sites, it is necessary to include them in a monitoring program. However, it has been found impractical and scientifically unrealistic to consider all of the invertebrates in the monitoring program.

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4. APPENDIXES A AND B

Both appendixes consist only of tables, the titles of which follow:

4. APPENDIXES A AND B (continued)

APPENDIX A-1

DATA SUMMARY FOR PRAIRIE VEGETATION[a] CLIPPED FROM SUBPLOTS OF SAMPLING STATION PR-1, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Scientific Name Common Name	Subplots-presence indicated by dry weight (grams/0.125-milacre plots)																Frequency[b] (%)	Relative[c] Frequency	Dry Weight[d] for Species	Relative[e] Weight(%)	Important[f] Value
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16					
Festuca elatior L. meadow fescue	224.65	191.90	181.00	180.15	204.55	157.90	141.00	83.90	140.00	215.40	205.00	149.00	259.00	112.00	180.70	285.20	100.00	34.04	3,011.35	98.90	132.94
Carex glaucodea Tuckerm. ---	.10			.80				2.50									18.75	6.38	3.40	0.11	6.49
Cyperus ovularis (Michx.) Torr. hedgehog club rush	1.25																6.25	2.12	1.25	0.04	2.16
Lespedeza striata (Thunb.) H.& A. Japanese lespedeza		.05			.10			1.40								.20	25.00	8.51	1.75	0.05	8.56
Trifolium repens L. white clover		.05															6.25	2.12	0.05	0.00	2.12
Panicum lanuginosum Ell. ---				.05	.10			3.20		.20						.15	31.25	10.63	3.70	0.12	10.75
Potentilla simplex Michx. cinquefoil					.30		.90	4.40		.40					.15		31.25	10.63	6.15	0.20	10.83
Moss sp.					.01											13.20	12.50	4.25	13.21	0.43	4.68
Prunella vulgaris L. self heal					.05												6.25	2.12	0.05	0.00	2.12
Andropogon virginicus L. broom sedge					.80												6.25	2.12	0.80	0.02	2.14
Eragrostis spectabilis (Pursh) Steud. bent grass						1.00											6.25	2.12	1.00	0.03	2.15
Lespedeza stipulacea Maxim. Korean clover						.10									.10		12.50	4.25	0.20	0.00	4.25
Lechia tenuifolia Michx. pineweed								1.20									6.25	2.12	1.20	0.03	2.15
Lespedeza violacea L. Pers. bush clover								.30									6.25	2.12	0.03	0.00	2.12
Solidago nemoralis Ait. old-field goldenrod															.05		6.25	2.12	0.05	0.00	2.12
Juncus tenuis Willde. sedge																.25	6.25	2.12	0.25	0.00	2.12
Cyperus strigosus L. umbrella sedge																.35	6.25	2.12	0.05	0.00	2.12
TOTALS	226.00	192.00	181.00	181.00	205.91	159.00	141.90	96.90	140.00	216.00	205.00	149.00	259.00	212.00	181.00	299.05	293.75	99.89	3,044.76	99.93	199.82

[a]Includes woody and herbaceous plants of less than 20 inches in height.

[b] $\frac{\text{Number of subplots the species occurs}}{\text{Number of subplots sampled (16)}} \times 100$

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d]Cumulative weight (16 subplots) by species

[e] $\frac{\text{Cumulative weight (a species)}}{\text{Cumulative weight (all species)}} \times 100$

[f]Relative frequency + relative weight

APPENDIX A-2

DATA SUMMARY FOR PRAIRIE VEGETATION CLIPPED FROM SUBPLOTS OF SAMPLING STATION PR-1,
CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, MAY-JUNE 1974

Scientific Name / Common Name	Subplots - presence indicated by dry weight (grams/0.25-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[a] (%)	Relative[b] Frequency	Dry[c] Weight Per Species	Relative[d] Weight (%)	Importance[e] Value
Festuca arundinacea Schreb. / reed fescue	150.57		152.31		195.22		179.88		119.46		177.05	159.96	102.46		173.78						
Festuca elatior L. / meadow fescue		145.31		146.19		13.76		127.49		175.55				190.63		163.92	} 100.00	17.39	2373.60	94.12	111.51
Dactylis glomerata L. / orchard grass	0.35	3.97	2.29		11.39						1.18		0.91	2.98	3.55	4.70	56.25	9.78	31.32	1.24	11.02
Juncus tenuis Willd. / path rush	0.32	0.45	2.51									0.77	2.41	0.58	3.91	1.01	50.00	8.70	11.94	0.47	9.17
Carex glaucodes Tuckerm. / ----	3.85	3.67	3.10	3.86	0.35	24.48			2.64	0.99		0.24		0.05	7.59	[illegible]	75.00	13.04	55.43	2.20	15.24
Cerastium viscosum L. / clammy chickweed		0.06		0.10													12.50	2.17	0.16	0.006	2.17
Potentilla simplex Michx. / cinquefoil	0.27			0.08		13.57			1.66	0.31	0.21		0.10				43.75	7.61	16.20	0.64	8.25
Poa pratensis L. / Kentucky bluegrass			0.78				2.53			0.97		0.10	14.79				31.25	5.43	19.17	0.76	6.19
Panicum lanuginosum Ell. / ----				0.10		0.35	0.73	0.35	1.08	0.43			0.29		0.62	0.27	56.25	9.78	4.22	0.17	9.95
Trifolium pratense L. / red clover				1.29									0.07				12.50	2.17	1.36	0.05	2.22
Oxalis europaea Jord. / yellow wood sorrel				0.08		0.08							0.08		0.04		25.00	4.35	[illegible]	0.01	4.36
Aster sp. L. / aster				0.17				1.85									12.50	2.17	2.02	0.98	2.25
Prunella vulgaris L. / self heal					0.15	2.50										0.18	18.75	3.26	2.83	0.11	3.37
Carex bushii Mack. / ----								0.25	0.30	0.46							18.75	3.26	1.01	0.04	3.30
Ambrosia bidentata Michx. / ragweed						0.28											6.25	1.09	0.28	0.01	1.10
Veronica arvensis L. / corn speedwell						0.18											0.25	1.09	0.18	0.007	1.09
Danthonia spicata (L.) Beauv. / poverty grass						0.42											6.25	1.09	0.42	0.02	1.11
Lespedeza stipulaceae Maxim. / Korean clover						1.25											6.25	1.09	1.25	0.05	1.14
Plantago virginica L. / hoary plantain						0.25											6.25	1.09	0.25	0.009	1.09
Ruellia humilis Nutt. / wild petunia						0.23			0.58								12.50	2.17	0.81	0.03	2.20
Agrostis hyemalis (Walt) BSP. / hair grass									0.14								6.25	1.09	0.14	0.006	1.09
Carex festucacea Schk. / ----											0.74						6.25	1.09	0.74	0.03	1.12
Trifolium repens L. / white clover														0.02			6.25	1.09	0.02	.0008	1.09
Totals	155.36	153.44	160.99	151.87	207.11	57.35	183.14	129.94	125.86	178.71	179.18	161.07	121.11	194.30	189.49	174.[illegible]9	575.00	100.00	2521.78	100.10	200.03

[a] = Number of subplots the species occurs / Number of subplots sampled (16) X 100

[b] = Frequency of a species occurrences / Cumulative frequency for all species X 100

[c] Cumulative weight (16 subplots) by species

[d] = Cumulative weight (a species) / Cumulative weight (all species) X 100

[e] Relative frequency and relative weight

APPENDIX A-3

DATA SUMMARY FOR UNDERSTORY VEGETATION[a] OF SAMPLING STATION PR-1, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974
(based on sixteen 6.25-milacre plots)

Scientific Name Common Name	Frequency[b]	Relative[c] Frequency(%)	Density[d]	Relative[e] Density(%)	Importance[f] Value
Diospyros virginiana L. persimmon	3.0	23.0	21.0	41.2	64.2
Symphoricarpos sp. Duham. snowberry	1.0	7.7	15.0	29.4	37.1
Rosa carolina L. pasture rose	2.0	15.4	7.0	13.8	29.2
Fraxinus americana L. white ash	1.0	7.7	2.0	3.9	11.6
Crataegus sp. L. hawthorn	1.0	7.7	1.0	2.0	9.7
Quercus velutina Lam. black oak	1.0	7.7	1.0	2.0	9.7
Quercus stellata Wang. post oak	1.0	7.7	1.0	2.0	9.7
Carya sp. Nutt. hickory	1.0	7.7	1.0	2.0	9.7
Ulmus rubra Muhl. slippery elm	1.0	7.7	1.0	2.0	9.7
Rubus flagellaris Willd. dewberry	1.0	7.7	1.0	2.0	9.7
TOTAL	13.0	100.0	51.0	100.3	200.3

Sheet 1

APPENDIX A-3 (continued)

Trees and/or shrubs per quadrat = 3.2
Trees and/or shrubs per acre = 518.4

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[a] Tree or shrub species less than 2.0 inches diameter at breast height.

[b] Number of subplots a species occurs.

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d] Cumulative number of a species within subplots sampled.

[e] $\frac{\text{Density of a species occurrence}}{\text{Cumulative density of all species}} \times 100$

[f] Summation of relative frequency + relative density.

APPENDIX A-4

DATA SUMMARY FOR PRAIRIE VEGETATION[a] CLIPPED FROM SUBPLOTS OF SAMPLING STATION PR-2, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Scientific Name / Common Name	Subplots-presence indicated by dry weight (grams/0.125-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[b] (%)	Relative[c] Frequency (%)	Dry Weight[d] for Species	Relative[e] Weight (%)	Importance[f] Value
Setaria geniculata (Lam.) Beauv. / prairie foxtail	.05																6.25	0.54	.05	0.00	0.54
Poa compressa L. / Canada blue grass	35.60	36.70	3.20	41.20	33.50	3.20	2.30	8.30	0.20	2.50	1.00	42.30	6.20	50.60	44.60	2.60	100.00	8.74	314.00	15.49	24.23
Carex sp. L. / sedge	.50		4.40			3.10		2.50									25.00	2.18	10.50	0.51	2.69
Panicum lanuginosum Ell. / ---	.85	8.90	5.20	1.90	13.40	2.10	3.40		1.40	6.50		9.90	1.30	16.10	14.60	11.70	87.50	7.65	97.25	4.80	12.45
Tridens flavus (L.) Hitchc. / purpletop	3.60			12.30		0.70	6.30										25.00	2.18	22.90	1.13	3.31
Aristida oligantha Michx. / prairie three awn grass	36.80	6.70			10.30	91.70		21.20						5.80			37.50	3.27	172.50	8.51	11.78
Agrostis alba L. / redtop	17.60	25.30	22.20	54.50	57.00		49.30	21.20	67.20	80.30	61.20	38.30	31.50	17.80	48.20	51.20	93.75	8.19	642.80	31.72	39.91
Aster pilosus Willd. / white heath aster	12.70	2.70		9.90													18.75	1.63	25.30	1.24	2.87
Antennaria neglecta Greene / pussy's toes	1.10																6.25	0.54	1.10	0.05	0.59
Diospyros virginiana L. / persimmon	2.20							1.70									12.50	1.09	3.90	0.19	1.28
Vernonia missurica Raf. / ironweed	6.10											12.20					12.50	1.09	18.30	0.90	1.99
Symphoricarpos orbiculatus Moench / coral berry	2.30																6.25	0.54	2.30	0.11	0.65
Ambrosia bidentata Michx. / ragweed	.70			1.60		1.90	3.20			3.40		4.50		5.10		1.50	50.00	4.37	21.90	1.08	5.45
Prunella vulgaris L. / self heal		4.30						0.60			1.30	8.30					25.00	2.18	14.50	0.71	2.89
Croton capitatus Michx. / hogwort		1.00					2.20		0.40	1.10		0.30	0.80	4.20	1.80		50.00	4.37	11.80	0.58	4.95
Andropogon virginicus L. / broom sedge		2.10					2.50	3.20									18.75	1.63	7.80	0.39	2.01
Achillea millifolium L. / common milfoil		13.20			1.00												12.50	1.09	14.20	0.70	1.79

APPENDIX A-4 (continued)

Scientific Name / Common Name	Subplots-presence indicated by dry weight (grams/0.125-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[b] (%)	Relative[c] Frequency(%)	Dry Weight[d] for Species	Relative[e] Weight(%)	Importance[f] Value
Solanum carolinense L. / horse nettle		0.45	1.00		1.30								2.20	1.20		2.10	37.50	3.27	8.25	0.40	3.67
Potentilla simplex Michx. / cinquefoil		0.30				2.30		0.60		0.60	0.50	2.00					37.50	3.27	6.30	0.31	3.58
Ca/ex glaucodea Tuckerm. / ---		0.70					2.20	0.60				1.90		0.60	0.75		37.50	3.27	6.75	0.33	3.60
Phleum pratense L. / timothy		10.30	14.30			10.30		3.90				2.20	42.20	8.60			43.75	3.82	91.80	4.53	8.35
Lespede•a stipulacea Maxim. / Korean clover		1.10			2.30	1.70				0.70		1.30	3.90	1.00	1.20		50.00	4.37	13.20	0.65	5.02
Lespedeza striata (Thunb.) H.AA. / Japanese lespedeza		5.30	1.30	1.40	4.70	2.10	2.50	0.20	8.20	1.20	0.30	8.60	19.50	10.50	2.10	2.60	93.75	8.19	70.50	3.47	11.66
Strophostyles umbellata (Muhl.) Britt. / wild bean			0.70														6.25	0.54	0.70	0.03	0.57
Pycnanthemum [illegible]nuifolium Schrad. / slender mountain mint			19.60			6.40	1.50	47.00									25.00	2.18	74.50	3.67	5.85
Solidago altissima L. / tall goldenrod			50.30		1.30		3.10				2.20				25.50	0.70	37.50	3.27	83.10	4.10	7.37
Paspalum laeve Michx. / ---					0.70				41.20			1.60					18.75	1.63	43.50	2.14	3.77
Eragrostis spectablis (Pursh) Steud. / purple love grass					4.70												6.25	0.54	4.70	0.23	0.77
Ruellia humilis Nutt. / wild petunia						2.10						2.40		0.20			18.75	1.63	4.70	0.23	1.86
Convolvulus sepium L. / hedge bindweed						1.70							1.80				12.50	1.09	3.50	0.17	1.26
Juncus tenuis Willd. / path rush							1.30			1.20			2.20				18.75	1.63	4.[illegible]	0.23	1.86
Muhlenbergii schreberi Gmel. / nimble will							30.20			1.90		11.30					18.75	1.63	43.40	2.14	3.77
Poa pratensis L. / Kentucky bluegrass							5.20		22.40	20.30	44.60					49.80	31.25	2.73	142.30	7.02	9.75
Fragaria virginiana Duchesne / wild strawberry								1.40									6.25	0.54	1.40	0.37	0.91
Rubus flagellaris Willd. / dewberry								6.20									6.25	0.54	6.20	0.30	0.84
--- / Moss sp.								2.20									6.25	0.54	2.20	0.10	0.64

APPENDIX A-4 (continued)

Scientific Name / Common Name	Subplots-presence indicated by dry weight (grams/0.125-milacre plots)[a] 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[b] (%)	Relative[c] Frequency(%)	Dry Weight[d] for Species	Relative[e] Weight(%)	Importance[f] Value
Paspalum ciliatifolium Michx. / ---									2.20								6.25	0.54	2.20	0.10	0.64
Steironema lanceolatum (Walt.) Gray / loosestrife										1.10							6.25	0.54	1.10	0.05	0.59
Cyperus ovularis (Michx.) Torr. / hedgehog club rush											3.20						6.25	0.54	3.20	0.15	0.69
Cyperus strigosus L. / umbrella sedge											0.90						6.25	0.54	0.90	0.04	0.58
Vernonia baldwini Torr. / ironweed											5.60			6.40			12.50	1.09	12.00	0.59	1.68
Lactuca canadensis L. / wild lettuce												13.70					6.25	0.54	13.70	0.67	1.21
TOTAL	120.10	119.05	122.20	122.80	129.20	130.30	115.20	120.80	143.20	120.80	120.80	160.80	111.60	128.10	138.75	122.20	1,143.75	99.75	2,025.90	100.12	199.87

[a] Includes woody and herbaceous plants of less than 20 inches in height.

[b] $\frac{\text{Number of subplots the species occurs}}{\text{Number of subplots sampled (16)}} \times 100$

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d] Cumulative weight (16 subplots) by species

[e] $\frac{\text{Cumulative weight (a species)}}{\text{Cumulative weight (all species)}} \times 100$

[f] Relative frequency + relative weight.

APPENDIX A-5

DATA SUMMARY FOR PRAIRIE VEGETATION CLIPPED FROM SUBPLOTS OF SAMPLING STATION PR-2, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, MAY-JUNE 1974

Scientific Name / Common Name	Subplots - presence indicated by dry weight (grams/0.125-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency [a] %	Relative Frequency [b]	Dry Weight for Species [c]	Relative Weight (%) [d]	Importance Value [e]
Bromus racemosus L. / hairy chess	1.48	9.34	14.05	0.85	15.59	14.09	0.57		3.52		4.18	0.22	17.01	7.29	12.25	9.19	87.50	5.53	109.63	5.86	11.39
Achillea millifolium L. / common milfoil	0.51				1.54		0.64					0.15					25.00	1.58	2.84	0.15	1.73
Strophostyles umbellata (Muhl.) Britt. / wild bean	0.06								0.07								12.50	0.79	0.13	0.01	0.80
Carex bushii Mack. / ---	1.14		2.76	2.16	3.45	11.50	19.29	3.74	20.26	5.40	16.34	1.46	2.34	0.24	1.10		87.50	5.53	90.68	4.84	10.37
Diospyros virginiana L. / persimmon	2.16				1.86		2.40			3.40							25.00	1.58	9.82	0.52	2.10
Lactuca canadensis L. / wild lettuce	0.26			0.32				0.55									18.75	1.19	1.13	0.06	1.25
Symphoricarpos orbiculatus Moench. / coral berry	13.74															1.21	12.50	0.79	14.95	0.80	1.59
Veronia sp. Schreb. / ironweed	7.26				3.25	6.73	1.11					2.43		6.28		6.36	43.75	2.77	33.42	1.79	4.56
Lespedeza stipulacea Maxim. / Korean clover	0.37		1.69		0.12		0.29	0.06	3.50	1.52	3.44	1.12	2.45	0.26		0.06	75.00	4.74	14.88	0.79	5.53
Solanum carolinense L. / horse nettle	0.44	0.24	0.06		0.10	0.20	0.31		0.09	0.13		0.71			0.05	0.35	68.75	4.35	2.68	0.14	4.49
Oxalis europaea Jord. / yellow wood sorrel	0.11												0.32				12.50	0.79	0.43	0.02	0.81
Ambrosia bidentata Michx. / ragweed	0.83	0.15	0.10									0.12		0.10	0.16	0.04	43.75	2.77	1.50	0.08	2.85
Cerastium viscosum L. / clammy chickweed	0.07	0.08		0.13	0.06	0.09	0.11	0.20	0.03		0.43	0.13	0.21		0.34		75.00	4.74	1.88	0.10	4.84
Phleum pratense L. / timothy	3.58	6.30	7.73	1.98	29.54	10.57	12.07	5.63	24.81	19.02	20.81	6.12	11.00	66.70	34.17	35.66	100.00	6.32	286.69	15.31	2[illegible]
Carex glaucodea Tuckerm. / ---	0.32		12.08	6.13		2.86	0.60	12.69		2.68	1.30	13.13	8.76		0.24		68.75	4.35	60.79	3.35	7.70
Panicum lanuginosum Ell. / ---	0.24	14.44	7.43	1.91	23.61	2.52	4.64	6.63	10.04	1.55	1.43	3.76	10.42	10.15	5.98	1.11	100.00	6.32	105.86	5.65	11.97
Poa pratensis L. / Kentucky bluegrass	8.10	22.68	41.05	16.00	50.88	26.11	9.36	53.09	32.63	26.37	15.93	31.50	17.40	37.86	24.16	3.44	100.00	6.32	416.56	22.75	28.57
Agrostis alba L. / redtop	57.16	4.72		23.89	10.48	37.02	49.42		17.88	63.79	44.20	12.16	9.17	6.00	52.75	14.18	87.50	5.53	402.82	21.52	27.05
Plantago virginica L. / hoary plantain		0.10		0.07	0.13	0.06		0.01									31.25	1.98	0.37	0.02	2.00
Juncus tenuis Willd. / path rush		2.93									0.74	0.09					18.75	1.19	3.76	0.20	1.39
Prunella vulgaris L. / self heal		0.45		0.39	0.24		0.11	0.19				14.16		12.10			43.75	2.77	27.64	1.48	4.25
Erigeron strigosus Muhl. / daisy fleabane		2.97		0.20	0.17			0.47					0.24				31.25	1.98	4.05	0.22	2.20
Croton monanthogynus Michx. / croton		0.15		0.12	0.04		0.04		0.06	0.01					0.09		43.75	2.77	0.51	0.03	2.80
Trifolium pratense L. / red clover		8.58					5.08										12.50	0.79	13.66	0.73	1.52
Pycnanthemum flexuosum (Walt.) BSP / slender mountain mint		19.17	36.45	6.07		8.00	31.85	8.71				15.19					43.75	2.77	125.44	6.70	9.47
Trifolium campestre Schreb. / large hop clover		0.45		0.25	0.17	0.50		0.12					1.09			0.01	43.75	2.77	2.59	0.14	2.91
Potentilla simplex Michx. / cinquefoil		0.40															6.25	0.40	0.40	0.02	0.42
Panicum perlongum Nash / ---		0.17		1.85													12.50	0.79	2.02	0.11	0.90
Rumex acetocella L. / sheep sorrel			5.93	0.19									30.65	0.74			25.00	1.58	37.51	2.00	3.58
Trifolium repens L. / white clover			0.27	0.80									0.26				18.75	1.19	1.33	0.07	1.26
Erigeron annuus (L.) Pers. / whitetop fleabane			0.48														6.25	0.40	0.48	0.03	0.43
Solidago sp. L. / goldenrod			4.67			1.73			0.38			0.31	7.91		7.65	5.00	43.75	2.77	27.65	1.48	4.25
Aster sp. L. / aster			1.11	10.55													12.50	0.79	11.66	0.62	1.41
Gramineae (sterile culm) / ---			2.35														6.25	0.40	2.35	0.13	0.53
Festuca elatior L. / meadow fescue				1.37													6.25	0.40	1.37	0.07	0.47

Sheet 1

APPENDIX A-5 (Continued)

Scientific Name Common Name	Subplots - presence indicated by dry weight (grams/0.125-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[a] (%)	Relative[b] Frequency	Dry[c] Weight per Species	Relative[d] Weight (%)	Importance[e] Value
Erigeron sp. L. fleabane					6.21												6.25	0.40	6.21	0.33	0.73
Convolvulus sepium L. hedge bindweed						1.̣59											6.25	0.40	1.59	0.08	0.48
Ruellia humilis Nutt. wild petunia						2.14						0.61		0.13			18.75	1.19	2.88	0.15	1.34
Fragaria virginiana Dr_nesne wild strawberry								13.94	3.54	1.68	1.11	1.90					31.25	1.98	22.17	1.18	3.16
Gleditsia triacanthos L. honey locust								0.08									6.25	0.40	0.08	.004	0.40
Rosa setigera Michx. var. tomentosa Torr. & Gray prairie rose								0.24									6.25	0.40	0.24	0.01	0.̣41
Penstemon pallidus Small. beard tongue								0.74									6.25	0.40	0.74	0.04	.44
Carex sp. L. ---										0.07							6.25	0.40	0.07	.004	0.40
Carya ovalis (Wang.) Sarg. false shagbark												6.14					6.25	0.40	6.14	0.33	0.73
Eupatorium serotinum Michx. late boneset												0.61					6.25	0.40	0.61	0.03	0.43
Carex festucacea Schk. ---													9.3/				6.25	0.40	9.37	0.50	0.90
Eleocharis tenuis (Willd.) Schultes spike rush															0.68	0.02	12.50	0.79	0.70	0.04	0.83
Dianthus armeria L. deptford pink															0.17		6.2̣5	.40	0.17	0.01	0.41
Carex albolutescens (Willd.) Schwein																1.80	6.25	0.40	1.80	0.10	0.50
Total	97.83	93.32	137.71	75.23	138.44	125.71	137.89	107.09	116.81	125.62	109.91	112.02	128.60	147.85	139.79	78.43	1581.25	100.09	1872.25	100.09	100.18

[a] = Number of subplots the species occurs / Number of subplots sampled (16) X 100

[b] = Frequency of a species occurrences / Cumulative frequency for all species X 100

[c] Cumulative weight (16 subplots) by species

[d] = Cumulative weight (a species) / Cumulative weight (all species) X 100

[e] Relative frequency and relative weight

Sheet 2

APPENDIX A-6

DATA SUMMARY FOR UNDERSTORY VEGETATION[a] OF SAMPLING STATION PR-2, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974 (based on sixteen 6.25-milacre plots)

Scientific Name / Common Name	Frequency[b]	Relative Frequency(%)[c]	Density[d]	Relative Density(%)[e]	Importance Value[f]
Diospyros virginiana L. / persimmon	12.0	52.2	107.0	77.0	129.2
Rubus flagellaris Willd. / dewberry	4.0	17.4	14.0	10.1	27.5
Fraxinus americana L. / white ash	3.0	13.0	14.0	10.1	23.1
Symphoricarpos sp. Duham. / snowberry	2.0	8.7	2.0	1.4	10.1
Ulmus rubra Muhl. / slippery elm	2.0	8.7	2.0	1.4	10.1
TOTAL	23.0	100.0	139.0	100.0	200.0

Trees and/or shrubs per quadrat = 8.7
Trees and/or shrubs per acre = 1,409.4

---

[a]Tree or shrub less than 2.0 inches diameter at breast height.

[b]Number of subplots a species occurs.

[c]$\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d]Cumulative number of a species within subplots sampled.

[e]$\frac{\text{Density of a species occurrence}}{\text{Cumulative density of all species}} \times 100$

[f]Summation of relative frequency + relative density

APPENDIX A-7

DATA SUMMARY FOR PRAIRIE VEGETATION[a] CLIPPED FROM SUBPLOTS OF SAMPLING STATION PR-3, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Scientific Name Common Name	Subplots-presence indicated by dry weight (grams/0.125-milacre plots)																Frequency[a] (%)	Relative[b] Frequency (%)	Dry Weight[c] for Species	Relative[d] Weight (%)	Importance[e] Value
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16					
Lespedeza stipulacea Maxim. Korean clover	1.20				2.65	0.60		2.10	17.50	0.40	3.20			3.90	2.30	0.25	62.50	6.99	34.10	1.81	8.80
Panicum lanuginosum Ell. ---	0.20	3.80			1.30	13.30	11.30	2.00	0.15	3.90	0.35	1.00	1.30			1.40	75.00	8.39	40.00	2.12	10.51
Lespedeza striata (Thunb.) H.& A. Japanese lespedeza	4.70				1.75	2.50	2.30	14.80	1.10	0.80	5.30	0.75		2.20	0.40	1.20	75.00	8.39	37.80	2.00	10.39
Muhlenbergia schreberi Gmel. nimble will	36.70	20.00					2.30	7.10									25.00	2.79	66.10	3.51	6.30
Agrostis alba L. redtop	20.20	20.00	25.00	41.40		12.90	36.60	11.40			47.60	17.30	76.60	29.20	48.30	45.30	81.25	9.09	431.80	22.95	32.04
Phleum pratense L. timothy	2.00				2.20					12.10		4.30	25.10	25.10			31.25	3.49	45.70	2.42	5.91
Solanum carolinense L. horse nettle	0.20		0.55		2.20												18.75	2.09	2.95	0.15	2.24
Ambrosia bidentata Michx. ragweed	0.80					0.90			0.75	6.20					2.60	1.10	37.50	4.19	12.35	0.65	4.84
Poa compressa L. Canada blue grass	70.00	60.70	80.00	55.60	71.20	25.60	81.20	1.20	36.90	67.40	35.60	65.60	1.70		0.20	4.20	93.80	10.49	657.10	34.93	45.42
Juncus tenuis Willd. path rush		1.60		3.45		0.20	0.30								0.80	0.30	37.50	4.19	6.65	0.35	4.54
Vernonia missurica Raf. ironweed		22.20															6.25	0.69	22.50	1.18	1.87
Aster pilosus Willd. white heath aster		4.10			1.65		1.20			4.20	0.20				1.10		37.50	4.19	12.45	0.66	4.85
Trifolium repens L. white clover			0.40		0.20					1.20	0.50	2.90	0.30		0.60	0.40	50.00	5.59	6.50	0.34	5.93
Solidago altissima L. tall goldenrod			2.40		26.50					4.20	1.70						25.00	2.79	34.80	1.85	4.64
Moss sp.				1.20		0.30			62.60		1.10						25.00	2.79	65.20	3.46	6.25
Solidago nemoralis Ait. old-field goldenrod				0.20													6.25	0.69	0.20	0.01	0.70
Festuca elatior L. meadow fescue					7.20								42.50				12.50	1.39	48.70	2.64	4.03

APPENDIX A-7 (continued)

	Subplots-presence indicated by dry weight (grams/0.125-milacre plots)																Frequency[a]	Relative[b]	Dry Weight[c]	Relative[d]	Importance[e]
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	(%)	Frequency (%)	for Species	Weight (%)	Value
Erigeron sp. L. fleabane						9.90											6.25	0.69	9.90	0.52	1.21
Cyperus strigosus L. umbrella sedge						3.45											6.25	0.69	3.45	0.18	0.87
Carex glaucodea Tuckerm. ---						0.20											6.25	0.69	0.20	0.01	0.70
Poa pratensis L. Kentucky bluegrass						36.10		38.30						36.20	60.20	55.50	31.25	3.49	226.30	12.03	15.52
Paspalum laeve Michx. ---						0.80					12.30	43.90					18.75	2.09	57.00	3.03	5.12
Tridens flavus (L.) Hitchc. purpletop						19.10						11.30					12.50	1.39	30.40	1.61	3.00
Eragrostis spectabilis (Pursh) Steud. purple love grass							5.20										6.25	0.69	5.20	0.27	0.96
Bromus sp. L. brome grass							0.60			1.50							12.50	1.39	2.10	0.11	1.50
Crotonopsis elliptica Willd. rushfoil								0.10	0.15								12.50	1.39	0.25	0.01	1.40
Trifolium campestre Schreb. large hop clover									0.10								6.25	0.69	0.10	0.00	0.69
Paspalum ciliatifolium Michx. ---									0.60			1.00	0.20			1.60	25.00	2.79	3.40	0.18	2.97
Aristida oligantha Michx. prairie three awn grass									2.90		0.20						12.50	1.39	3.10	0.16	1.55
Carex sp. L. sedge									0.10								6.25	0.69	0.10	0.00	0.69
Pycnanthemum tenuifolium Schrad. slender mountain mint										3.10							6.25	0.69	3.10	0.16	0.85
Teucrium canadense L. wood sage												7.30					6.25	0.69	7.30	0.38	1.07
Cyperus ovularis (Michx.) Torr. hedgehog club rush														0.10			6.25	0.69	0.10	0.00	0.69
Rubus flagellaris Willd. dewberry														2.20			6.25	0.69	2.20	0.11	0.80
Carex festucacea Schkuhr sedge														1.20			6.25	0.69	1.20	0.06	0.75
TOTALS	136.00	132.40	108.35	10[illegible].85	116.85	125.85	141.00	77.00	122.85	105.00	108.05	151.05	126.90	100.10	116.50	111.25	893.80	99.75	1 881.00	99.85	199.60

[a] Includes woody and herbaceous plants of less than 20 inches in height.

[b] Number of subplots the species occurs / Number of subplots sampled (16) x 100

[c] Frequency of a species occurrence / Cumulative frequency of all species x 100

[d] Cumulative weight (16 subplots) by species

[e] Cumulative weight (a species) / Cumulative weight (all species) x 100

[f] Relative frequency + relative weight

APPENDIX A-8

DATA SUMMARY FOR PRAIRIE VEGETATION CLIPPED FROM SUBPLOTS OF SAMPLING STATION PR-3, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, MAY-JUNE 1974

Scientific Name Common Name	Subplots - presence indicated by dry weights (grams/0.125-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency (%)[a]	Relative Frequency[b]	Dry Weight Per Species[c]	Relative Weights (%)[d]	Importance Value[e]
Phleum pratense L. timothy	29.51	24.44	1.95	1.05	21.31	1.33	2.05		14.75	17.00	9.91	10.92	24.30	1.85	12.25	30.85	93.75	7.81	203.47	8.80	16.61
Bromus racemosus L. hairy chess	6.19	13.30	3.08	7.09	36.84	12.56	6.73	13.98	19.17	14.7[illegible]	8.01	1.39	7.67	10.10	11.62	10.37	100.00	8.33	182.81	7.91	16.24
Agrostis alba L. redtop	48.53	41.29	60.13	54.48	23.30	.25	77.46	2.40	3.99	63.17	8.01	75.12	27.79	30.07	83.50	31.07	100.00	8.33	632.56	27.36	35.69
Poa pratensis Kentucky blue grass	49.01	39.24	48.69	0.14	45.68	[illegible].45	50.98	61.60	80.78	44.96	70.54	46.66	35.68	28.69	32.09	13.46	100.00	8.33	703.66	30.43	38.76
Panicum lanuginosum Ell. ---	0.75	3.54	0.51	4.00		15.15	10.40	3.92	2.97	0.60	1.69	0.30	0.43	0.30	0.18		87.5[illegible]	7.29	44.74	1.93	9.22
Trifolium repens L. white clover	1.52				8.65	0.78			6.13	0.05	3.54	2.37	3.57		2.01	10.47	62.50	5.21	39.09	1.69	6.90
Lespedeza stipulacea Maxim. Korean clover	0.75	0.31		0.33	1.25	2.45	2.65	1.55	1.83		0.31			0.25			62.50	5.21	11.68	0.51	5.72
Carex glaucodea Tuckerm. ---	0.35	3.54		1.78						0.77			3.38				31.25	2.60	9.82	0.42	3.02
Carex bushii Mack. ---	0.78	12.13	4.35	0.65		0.75	0.93	13.98	0.05	4.89	1.39	2.48	4.71	2.45	2.45	15.25	93.75	7.81	67.24	2.91	10.72
Cerastium viscosum L. clammy chickweed	0.36	1.52	0.14		0.25			1.03	0.85		1.82		1.47				50.00	4.17	7.44	0.32	4.49
Prunella vulgaris L. self-heal	0.29																6.25	0.52	0.29	0.01	0.53
Erigeron annuus (L.) Pers. whitetop fleabane		17.16				28.69											12.50	1.04	45.85	1.98	3.02
Vernonia sp. ironweed		6.34	5.25						0.08		1.37	3.01	16.07	25.09	0.76		50.00	4.17	57.87	2.50	6.67
Juncus tenuis Willd. path rush			4.00		0.38							1.45	4.90	18.60	13.08	3.99	43.75	3.6[illegible]	[illegible]	2.01	5.66
Solanum carolinense L. horse nettle			0.28			0.34	0.31	0.41			0.09	0.10	6.15			0.20	50.00	4.17	1.88	0.08	4.25
Solidago sp. goldenrod			16.15								28.24	30.17	18.40				25.00	2.08	92.96	4.02	6.10
Oxalis europaea Jord. yellow wood sorrel				0.15													6.25	0.52	0.15	0.01	0.53
Achillea millifolium L. milfoil				0.22				30.44					2.87				18.75	1.56	33.53	1.45	3.01
Erigeron strigosus Muhl. daisy fleabane				71.41			1.40		3.20		4.81						25.00	2.08	80.82	3.50	5.58
Ambrosia bidentata Michx. ragweed				0.08	0.20	0.36			0.15	0.05				0.27			37.50	3.13	1.11	0.05	3.18
Festuca elatior L. meadow fescue					9.00												6.25	0.52	9.00	0.39	0.91
Croton monanthogynus Michx. croton					0.12												6.25	0.52	0.12	0.01	0.53
Veronica arvensis L. corn speedwell					0.50												6.25	0.52	0.50	0.02	0.54
Barbarea vulgaris (R.) B.R. yellow rocket					0.36												6.25	0.52	0.36	0.02	0.54
Aster sp. aster					0.81					0.64				0.27			18.75	1.56	1.72	0.07	1.63
Eleocharis compressa Sull. spike rush						2.73	1.53					2.02					18.75	1.56	5.28	0.27	1.83
Carex albolutescens Schwein. ---						1.10	0.10										12.50	1.04	1.20	0.05	1.09
Trifolium campestre Schreb. large hop clover							0.15		5.60								12.50	1.04	5.75	0.25	1.29
Strophostyles umbellata (Muhl.) Britt. wild bean							0.23										6.25	0.52	0.23	0.01	0.53
Carex muhlenbergii Schk. var. australis Olney ---								5.32									6.25	0.52	5.32	0.23	0.75
Lactuca canadensis L. wild lettuce									0.15			1.65					12.50	1.04	1.80	0.08	1.12
Plantago virginica L. hoary plantain									0.15								6.25	0.52	0.15	0.01	0.53
Juncus dudleyi Wieg. ---											0.84						6.25	0.52	0.84	0.04	0.56
Trifolium pratense L. red clover													6.60			8.67	12.50	1.04	15.27	0.66	1.70
Symphoricarpos orbiculatus Moench. coral berry														0.50							
Totals	138.04	162.71	144.53	141.38	148.65	123.95	154.[illegible]	134.63	139.85	146.84	140.57	177.64	157.99	118.44	15[illegible]	124.33	1200.00	99.97	2312.41	100.02	199.99

a = Number of subplots the species occurs / Number of subplots sampled (16) X 100

b = Frequency of a species occurrence / Cumulative frequency for all species X 100

c = Cumulative weight (16 subplots) by species

d = Cumulative weight (a species) / Cumulative weight (all species) X 100

e = Relative frequency + relative weight

APPENDIX A-9

DATA SUMMARY FOR UNDERSTORY VEGETATION[a] OF SAMPLING STATION PR-3, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974 (based on sixteen 6.25-milacre plots)

Scientific Name / Common Name	Frequency[b]	Relative[c] Frequency (%)	Density[d]	Relative[e] Density (%)	Importance[f] Value
Symphoricarpos sp. Duham. snowberry	1.0	33.3	4.0	66.7	100.0
Ulmus rubra Muhl. slippery elm	1.0	33.3	1.0	16.7	50.0
Gleditsia triacanthos L. honey locust	1.0	33.3	1.0	16.7	50.0
TOTAL	3.0	99.9	6.0	100.1	200.0

Trees and/or shrubs per quadrat = 0.4
Trees and/or shrubs per acre = 64.8

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[a] Tree or shrub less than 2.0 inches diameter at breast height.

[b] Number of subplots a species occurs.

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d] Cumulative number of a species within subplots sampled.

[e] $\frac{\text{Density of a species occurrence}}{\text{Cumulative density of all species}} \times 100$

[f] Summation of relative frequency + relative density.

APPENDIX A-10

DATA SUMMARY FOR PRAIRIE VEGETATION[a] CLIPPED FROM SUBPLOTS OF SUBPLOTS OF SAMPLING STATION PR-4, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Scientific Name / Common Name	Subplots-presence indicated by dry weight (grams/0.125-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[a] (%)	Relative[b] Frequency (%)	Dry Weight[c] for Species	Relative[d] Weight (%)	Importance Value
Festuca elatior L. / meadow fescue	155.35	171.75	163.80	142.30	156.60	152.60	100.90	154.00	112.90	200.25	164.80	131.35	147.00	192.40	142.25	228.90	100.00	37.20	2,517.35	99.00	136.20
Melilotus alba Desr. / white sweet clover	0.20	0.25	0.20	4.10		1.80	1.20										37.50	13.95	7.75	0.30	14.25
Lespedeza stipulacea Maxim. / Korean clover	0.45				0.40	0.30	3.10			0.55	0.20						37.50	13.95	5.00	0.19	14.14
Convolvulus sp. L. / bindweed				0.10													6.25	2.32	0.10	0.00	2.32
Solanum carolinense L. / horse nettle				0.50		1.80											12.50	4.65	2.30	0.09	4.74
Lactuca canadensis L. / wild lettuce						0.40											6.25	2.32	0.40	0.01	2.33
Solidago nemoralis Ait. / old-field goldenrod							0.80										6.25	2.32	0.80	0.03	2.35
Lespedeza violacea (L.) Pers. / bush clover									0.10						0.65	0.10	18.75	6.97	0.85	0.03	7.00
Lespedeza striata (Thunb.) H.&A. / Japanese lespedeza										0.20		0.35		2.50			18.75	6.97	3.05	0.11	7.08
Bidens aristosa (Michx.) Britt. / tickseed sunflower												0.25					6.25	2.32	0.25	0.00	2.32
Vitis cinerea Engelm. / grayback grape												0.50					6.25	2.32	0.50	0.01	2.33
Carex glaucodea Tuckerm. / ---																	6.25	2.32	0.10	0.00	2.32
Sabatia angularis (L.) Pursh / rose pink															4.10		6.25	2.32	4.10	0.16	2.48
TOTAL	156.00	172.00	164.00	147.00	157.00	[illegible]	106.00	154.00	113.00	[illegible]	165.00	132.45	147.00	195.00	147.00	229.00	268.75	99.93	2,542.55	99.93	199.96

[a]Includes woody and herbaceous plants of less than 20 inches in height.

[b]Number of subplots the species occurs / Number of subplots sampled (16) x 100

[c]Frequency of a species occurrence / Cumulative frequency of all species x 100

[d]Cumulative weight (16 subplots) by species

[e]Cumulative weight (a species) / Cumulative weight (all species) x 100

[f]Relative frequency + relative weight

APPENDIX A-11

DATA SUMMARY FOR PRAIRIE VEGETATION CLIPPED FROM SUBPLOTS OF SAMPLING STATION PR-4
CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, MAY-JUNE 1974

Scientific Name Common Name	Subplots - presence indicated by dry weights (grams/0.125-milacre plots)																Frequency (%)[a]	Relative Frequency[b]	Dry Weight Per Species[c]	Relative Weights (%)[d]	Importance Value[e]
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16					
Festuca arundinacea Schreb.																					
reed fescue	94.32	71.11		147.85			121.64			97.65	108.00			95.95	120.73	115.67)					
Festuca elatior L.																)	100.00	25.81	1712.83	97.99	123.80
meadow fescue			103.38		119.06	160.45		106.68	117.65			66.93	65.96			)					
Melilotus officinalis (L.) Lam.																					
yellow sweet clover	6.91																6.25	1.61	6.91	0.40	2.01
Lespedeza stipulacea Maxim.																					
Korean clover		0.05	0.23	1.75			0.12			0.08	0.08			0.09		0.03	50.00	12.90	2.43	0.14	13.04
Aster sp. L.																					
aster		0.11	0.05	0.15								0.15			0.10		31.25	8.06	0.56	0.03	8.09
Solanum carolinense L.																					
horse nettle		0.02	0.84	0.06	0.08	0.40	0.01	0.37				0.15		0.03	0.27		62.50	16.13	2.23	0.13	16.26
Cirsium altissimum (L.) Spreng.																					
tall thistle			0.15														6.25	1.61	0.15	0.01	1.62
Erigeron strigosus Muhl.																					
daisy fleabane			0.42														6.25	1.61	0.42	0.02	1.63
Trifolium campestre Schreb.																					
large hop clover			0.16		0.01	1.96		0.82									25.00	6.45	2.95	0.17	6.62
Strophostyles umbellata (Muhl.) Britt.																					
wild bean			0.04	0.07													12.50	3.23	0.11	0.01	3.24
Lactuca canadensis L.																					
wild lettuce						0.06											6.25	1.61	0.06	.003	1.61
Oxalis europaea Jord.																					
yellow wood sorrel							0.15										6.25	1.61	0.15	0.01	1.62
Sabatia angularis (L.) Pursh																					
rose pink									1.00								6.25	1.61	1.00	0.06	1.67
Panicum lanuginosum Ell.																					
---											0.32						6.25	1.61	0.32	0.02	1.63
Carex glaucodea Tuckerm.																					
---											0.09	0.10					12.50	3.23	0.19	0.01	3.24
Rubus pensilvanicus Poir.																					
high-bush blackberry												13.67					6.25	1.61	13.67	0.78	2.39
Ambrosia artemisiifolia L.																					
common ragweed												0.10		0.03			12.50	3.23	0.13	0.01	3.24
Eupatorium perfoliatum L.																					
boneset												0.36					6.25	1.61	0.36	0.02	1.63
Ulmus rubra Muhl.																					
slippery elm												0.06					6.25	1.61	0.06	0.003	1.61
Hypericum punctatum L.																					
dotted St. Johns-wort														1.64			6.25	1.61	1.64	0.09	1.70
Solidago sp.																					
goldenrod															1.59		6.25	1.61	1.59	0.09	1.70
Potentilla simplex Michx.																					
cinquefoil																0.15	6.25	1.61	0.15	0.01	1.62
Totals	101.03	71.29	105.27	149.88	119.15	162.87	121.92	107.87	118.65	97.73	108.49	81.52	65.96	97.74	122.69	115.85	387.50	99.97	1747.91	100.00	199.97

[a] - $\frac{\text{Number of subplots the species occurs}}{\text{Number of subplots sampled (16)}} \times 100$

[b] - $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency for all species}} \times 100$

[c] - Cumulative weight (16 subplots) by species

[d] - $\frac{\text{Cumulative weight (a species)}}{\text{Cumulative weight (all species)}} \times 100$

[e] - Relative frequency + relative weight

APPENDIX A-12

DATA SUMMARY FOR UNDERSTORY VEGETATION[a] OF SAMPLING STATION PR-4, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974 (based on sixteen 6.25-milacre plots)

Scientific Name Common Name	Frequency[b]	Relative Frequency(%)[c]	Density[d]	Relative Density(%)[e]	Importance Value[f]
Rubus flagellaris Willd. dewberry	2.0	100.0	3.0	100.0	200.0
TOTAL	2.0	100.0	3.0	100.0	200.0

Trees and/or shrubs per quadrat = 0.2
Trees and/or shrubs per acre = 32.4

---

[a]Tree or shrub less than 2.0 inches diameter at breast height.

[b]Number of subplots a species occurs.

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d]Cumulative number of a species within subplots sampled.

[e] $\frac{\text{Density of a species occurrence}}{\text{Cumulative density of all species}} \times 100$

[f]Summation of relative frequency + relative density.

APPENDIX A-13

TRANSITIONAL SPECIES PREFERRING DISTURBED SITES
(including overstory, understory, and ground layer)

Family / Genus & Species	Forest Sampling Stations F-1	F-2	F-3	F-4	Prairie Sampling Stations Pr-1	Pr-2	Pr-3	Pr-4
Aceraceae								
Acer saccharum Marsh	x	x	x	x				
Acanthaceae								
Ruellia humilis Nutt.					x	x		
Anacardiaceae								
Rhus radicans L.	x	x						
Apocynaceae								
Apocynum cannabinum L.				x	x	x		x
Caprifoliaceae								
Symphoricarpos orbiculatus Moench	x	x	x	x	x	x	x	
Caryophyllaceae								
Cerastium viscosum L.					x	x	x	
Dianthus armeria L.						x		
Celastraceae								
Celastrus scandens L.		x	x					
Cistaceae								
Lechea tenuifolia Michx.	x	x			x			
Compositae								
Achillea millifolium L.						x	x	
Ambrosia artemisifolia L.			x					
Ambrosia bidentata Michx.					x	x	x	x
Aster pilosus Willd.		x			x	x	x	x
Aster anomalus Engelm.	x			x				
Bidens aristosa (Michx.) Britt.		x						
Cirsium altissimum (L.) Spreng.				x			x	x

Sheet 1

Family Genus & Species	Forest Sampling Stations				Prairie Sampling Stations			
	F-1	F-2	F-3	F-4	Pr-1	Pr-2	Pr-3	Pr-4
Erigeron strigosus Muhl.						x	x	x
Erigeron annuus (L.) Pers.						x	x	
Eupatorium serotinum Michx.		x			x	x		x
Helianthus strumosus L.			x	x				x
Lactuca canadensis L.			x	x			x	x
Solidago altissima L.		x	x			x	x	
Solidago nemoralis Ait.		x		x				
Vernonia baldwinii Torr.				x	x		x	
Vernonia missurica Raf.					x	x	x	x
Convolvulaceae								
Convolvulus sepium L.		x				x		x
Cruciferae								
Barbarea vulgaris R. Br.							x	
Cupressaceae								
Juniperus virginiana L.	x	x	x	x		x		
Cyperaceae								
Carex bushii Mack.	x		x	x	x	x	x	
Carex festucacea Schk.						x		
Carex gravida Bailey	x					x	x	
Cyperus ovularis (Michx.) Torr.					x			
Cyperus strigosus L.						x	x	
Ebenaceae								
Diospyros virginiana L.	x	x	x		x	x		x
Euphorbiaceae								
Croton capitatus Michx.				x	x	x		x
Croton monogynanthus Michx.						x	x	
Crotonopsis elliptica Willd.		x	x					

APPENDIX A-13 (continued)

Family Genus & Species	Forest Sampling Stations				Prairie Sampling Stations			
	F-1	F-2	F-3	F-4	Pr-1	Pr-2	Pr-3	Pr-4
Gramineae								
Agrostis alba L.					x	x	x	
Agrostis hyemalis (Walt.) BSP					x			
Aristida oligantha Michx.						x		
Dactylis glomerata L.					x			
Danthonia spicata (L.) Beauv.		x						
Festuca elatior L.					x		x	x
Eragrostis spectabilis (Pursh) Steud.					x		x	
Panicum lanuginosum Ell. & Vars.	x				x	x	x	x
Paspalum laeve Michx. & Vars.						x	x	
Phleum pratense L.				x	x	x	x	
Poa compressa L.						x	x	
Poa pratensis L.					x	x	x	
Guttiferae								
Hypericum punctatum Lam.		x	x	x	x	x		x
Juncaeae								
Juncus tenuis Willd.					x	x	x	
Labiatae								
Prunella vulgaris L.				x	x	x	x	
Pycnanthemum tenuifolium Schrad.		x				x	x	x
Teucrium canadense L.				x	x			
Lauraceae								
Sassafras albidum (Nutt.) Nees			x	x				
Leguminosae								
Amorpha canescens Pursh				x				
Gleditsia triacanthos L.						x	x	
Lespedeza stipulacea Maxim.				x	x	x	x	x
Lespedeza striata (Thunb.)H.&A.		x	x	x			x	
Lespedeza violacea (L.) Pers.	x	x	x	x	x			

Family Genus & Species	Forest Sampling Stations F-1	F-2	F-3	F-4	Prairie Sampling Stations Pr-1	Pr-2	Pr-3	Pr-4
Melilotus alba Desr.								x
Trifolium campestre Schreb.						x	x	x
Trifolium pratense L.						x	x	
Trifolium repens L.						X	X	
Moraceae								
Morus rubra L.	x		x	x		x	x	
Oleaceae								
Fraxinus americana L.	x	x	x	x		x		
Plantaginaceae								
Plantago virginiana L.					x	x		
Podophyllaceae								
Podophyllum peltatum L.				x				
Polygonaceae								
Rumex acetocella L.						x		
Primulaceae								
Lysmachia lanceolata Walt.		x						
Rosaceae								
Potentilla simplex Michx.	x	x			x	x		
Prunus americana L.	x	x		x				
Prunus serotina L.	x	x	x	x				
Prunus virginiana L.	x	x	x					
Rosa arkansana Porter	x							
Rosa carolina L.	x	x	x	x	x			
Rosa setigera Michx.	x					x		
Rubus flagellaris L.		x	x		x	x	x	x
Rubus occidentalis L.	x	x		x				
Rubus pensylvanicus Poir.			x			x		x

APPENDIX A-13 (continued)

Family Genus & Species	F-1	F-2	F-3	F-4	Pr-1	Pr-2	Pr-3	Pr-4
	Forest Sampling Stations				Prairie Sampling Stations			
Saxifragaceae								
Heuchera sp.		x						
Solanaceae								
Solanum carolinense L.						x	x	x
Ulmaceae								
Ulmus rubra Muhl.	x	x	x		x	x	x	
Vitaceae								
Parthanocissus quinquefolia (L.) Planch	x	x	x	x				
Vitis aestivalis Michx.	x		x					
Vitis cinerea Engelm.	x	x	x	x				
Vitis vulpina L.	x	x	x	x				

Adapted from D. B. Dunn, 1974-personal communication.

APPENDIX A-14

DATA SUMMARY FOR IDENTIFIED SPECIES OF SAMPLING STATIONS,
CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI,
SPRING, SUMMER, FALL 1974

(Letter designations: A=ground cover, B=understory, C=overstory-stratifications)

Scientific Name Common Name	Prairie Sampling Stations				Forest Sampling Stations			
	Pr-1	Pr-2	Pr-3	Pr-4	F-1	F-2	F-3	F-4
Acalypha gracilens Gray three-seeded mercury					A		A	
Acer saccharum Marsh sugar maple					B	AB	BC	BC
Achillea millifolium L. common milfoil		A	A					
Aesculus glabra Willd. Ohio buckeye					B			
Agrimonia rostellata Wallr. agrimony							A	
Agrostis alba L. redtop		A	A			A		
Agrostis hyemalis (Walt.) BSP. hair grass	A						A	
Agrostis perennans (Walt.) Tuckerm. upland bent					A	A		A
Agrostis sp. L. bent grass	A							
Ambrosia artemisifolia L. common ragweed			A	A				
Ambrosia bidentata Michx. ragweed	A	A	A					
Amelanchier arborea (Michx.) Fern. shadbush					ABC	ABC	AB	ABC
Amorpha canescens Pursh. lead plant								A
Andropogon virginicus L. broom sedge	A	A		A				
Anemonella thalictroides (L.) Spach. rue anemone					A	A	A	
Antennaria neglecta Greene pussy's toes		A						
Antennaria plantaginifolia (L.) Hook. pussy's toes						A	A	A

APPENDIX A-14 (Continued)

Scientific Name Common Name	Prairie Sampling Stations Pr-1	Pr-2	Pr-3	Pr-4	Forest Sampling Stations F-1	F-2	F-3	F-4
Apocynum cannabinum L. Indian hemp					A			
Aristida oligantha Michx. prairie three-awn grass		A	A					
Asclepias hirtella (Pennell) Woods milkweed		A						
Asclepias purpuresceus L. purple milkweed			A					
Asclepias quadrifolia Jacq. milkweed						A		
Asclepias sp. L. milkweed					A			
Asimina triloba (L.) Dunal. pawpaw							A	
Asplenium platyneuron (L.) Oakes ebony spleenwort					A		A	
Aster anomalus Engelm. aster						A		A
Aster patens Ait. spreading aster					A		A	
Aster pilosus Willd. white heath aster		A	A					
Aster sp. L. aster	A	A	A	A	A	A	A	A
Aster turbinellus Lindl. aster								A
Baptisim leucantha T. & G. white wild indigo		A	A					
Barbarea vulgaris (R.) B.R. yellow rocket			A					
Bidens aristosa (Michx.) Britt. tickseed sunflower				A				
Botrychium virginianum (L.) Sw. rattlesnake fern					A	A		A
Brachyelytrum erectum (Schreb.) Beauv. ---					A			
Bromus purgans L. Canada brome					A	A		

Scientific Name Common Name	Prairie Sampling Stations Pr-1	Pr-2	Pr-3	Pr-4	Forest Sampling Stations F-1	F-2	F-3	F-4
Bromus racemosa L. hairy chess		A	A					
Bromus sp. L. Brome grass			A					
Campsis radicans (L.) Seem. trumpet creeper							B	
Carex alata Torr. and Gray ---								A
Carex albolutescens (Schwein) ---		A	A			A		
Carex artitecta Mack. ---					A	A		
Carex bushii Mack. ---	A	A	A		A	A	A	A
Carex cephalophora Muhl. ---							A	
Carex festucacea Schkuhr. ---	A	A	A					
Carex glaucodea Tuckerm. ---	A	A	A	A	A	A	A	A
Carex gravida Bailey ---					A		A	
Carex muhlenbergii Schk. ---								A
Carex muhlenbergii Schk. var. australis Olney ---			A					
Carex rosea Schk. ---					A	A	A	A
Carex sp. L. sedge	A	A	A					
Carya ovalis (Wang.) Sarg. false shagbark		A						
Carya ovata (Mill.) K. Koch shagbark hickory					AC	C	AC	C
Carya sp. Nutt. hickory	B				B	B	B	B
Carya texana Buckl. black hickory					C	C	C	C
Carya texana Buckl. var. villosa (Sarg.) Little black hickory					A			

APPENDIX A-14 (Continued)

Scientific Name Common Name	Prairie Sampling Stations				Forest Sampling Stations			
	Pr-1	Pr-2	Pr-3	Pr-4	F-1	F-2	F-3	F-4
Carya tomentosa Nutt. mockernut hickory					AC	C	C	
Cassia fasciculata Michx. partridge pea		A						
Ceanothus americana L. New Jersey tea								A
Celastrus scandens L. bittersweet						AB	A	A
Celastrus sp. L. bittersweet						B		
Celtis occidentalis L. hackberry					B		B	
Celtis tenuifolia Nutt. var. smallii (Beadle) Sarg. dwarf hackberry					B			
Cerastium viscosum L. clammy chickweed	A	A	A					
Cercis canadensis L. redbud					A		B	B
Cirsium altissimum (L.) Spreng. tall thistle				A				
Compositae (genus unident.) ---								A
Convolvulus sepium L. hedge bindweed		A						
Convolvulus sp. L. bindweed				A				
Conyza canadensis (L.) Cron. horse weed					A			
Cornus florida L. flowering dogwood					ABC	ABC	ABC	ABC
Crataegus danielsii Palmer hawthorn								A
Crataegus sp. L. hawthorn	B				B	B	B	B
Crataegus uniflora Muench. hawthorn	A							
Croton capitatus Michx. hogwort		A						
Croton monanthogynus Michx. croton		A	A					
Crotonopsis elliptica Willd. rushfoil			A				A	

Scientific Name / Common Name	Prairie Sampling Stations Pr-1	Pr-2	Pr-3	Pr-4	Forest Sampling Stations F-1	F-2	F-3	F-4
Cunila origanoides (L.) Britt. dittany					A	A	A	
Cyanchum laeve (Michx.) Pers. angle-pod						A		A
Cyperus esculentus L. yellow nut grass			A					
Cyperus ovularis (Michx.) Torr. hedgehog club rush	A	A	A					A
Cyperus strigosus L. umbrella sedge	A	A	A					
Dactylis glomerata L. orchard grass	A							
Danthonia spicata (L.) Beauv. poverty grass	A				A	A	A	
Daucus carota L. wild carrot		A						
Desmodium dillenii Darl. tick trefoil					A	A	A	A
Desmodium glutinosum (Muhl.) Wood tick trefoil						A	A	A
Desmodium nudiflorum (L.) D.C. tick trefoil					A	A	A	A
Dianthus armeria L. deptford pink		A						
Digitaria ischaemum (Schreb.) Muhl. crab grass		A						
Diodia teres Walt. rough buttonweed				A				
Dioscorea villosa L. yam						A		A
Diospyros virginiana L. persimmon	B	AB				ABC	B	AB
Echinochloa muricata (Beauv.) Fern. barnyard grass			A					
Eleocharis compressa Sull. spike rush			A					
Eleocharis tenuis (Willd.) Schultes spike rush		A						
Elymus villosus Muhl. wild rye					A	A		A
Eragrostis spectablis (Pursh) Steud. purple love grass	A	A	A					

APPENDIX A-14 (Continued

Scientific Name Common Name	Prairie Sampling Stations Pr-1	Pr-2	Pr-3	Pr-4	Forest Sampling Stations F-1	F-2	F-3	F-4
Erechtites brieracifolia (L.) Raf. fireweed					A			
Erigeron annuus (L.) Pers. whitetop fleabane		A	A					
Erigeron sp. L. fleabane		A	A					
Erigeron strigosus Muhl. daisy fleabane		A	A	A				
Euonymus atropurpeus Jacq. wahoo						B	A	B
Eupatorium fistulosum Barrett joe-pye weed							A	
Eupatorium perfoliatum L. boneset				A				
Eupatorium serotinum Michx. late boneset		A						
Euphorbia corollata L. flowering spurge		A						A
Euphorbia maculata L. nodding spurge				A				
Euphorbia sp. L. spurge								A
Festuca arundinacea Schreb. reed fescue	A			A				
Festuca elatior L. meadow fescue	A	A	A	A				
Festuca obtusa Biehler nodding fescue					A			
Fragaria virginiana Duchesne wild strawberry		A						
Fraxinus americana L. white ash	B	B			ABC	AB	AB	BC
Fraxinus pennsylvanica Marsh red ash								A
Galium circaezans Michx. wild licorice					A	A	A	A
Galium concinnum Torr. & Gray elegant bedstraw					A	A	A	
Galium pilosum Ait. hairy bedstraw					A	A		
Gaura filiformis Small. ---		A						

Scientific Name / Common Name	Prairie Sampling Stations Pr-1	Pr-2	Pr-3	Pr-4	Forest Sampling Stations F-1	F-2	F-3	F-4
Geum canadense Jacq. white avens					A			
Gillenia stipulata (Muhl.) Trel. Indian physic						A		A
Gleditsia triacanthos L. honey locust		A	B					
Gramineae (sterile culm) ---		A						
Helianthus sp. L. sunflower						A		A
Helianthus strumosus L. sunflower								A
Helianthus tuberosa L. Jerusalem artichoke							A	
Helienium flexuosum Raf. sneezeweed		A						
Heuchera hirsuticaulis (Wheelock) Rydb. alum root							A	
Heuchera sp. L. alum root					A	A	A	
Hieraceum gronovii L. hawkweed					A	A	A	A
Hypericum punctatum L. dotted St. Johns-wort				A				A
Ipomoea pandulata (L.) G.F.W. Mey. wild potato vine	A							
Juglans nigra L. walnut						A		
Juncus dudleyi Wieg. ---			A					
Juncus tenuis Willd. path rush	A	A	A					
Juniperus virginiana L. red cedar					ABC	B	B	B
Krigia biflora (Walt.) Blake dwarf dandelion						A		
Lactuca canadensis L. wild lettuce		A	A	A				A
Lactuca canadensis L. var. obovata Wieg. wild lettuce		A		A			A	
Lactuca sp. L. lettuce						A		A

Scientific Name Common Name	Prairie Sampling Stations				Forest Sampling Stations			
	Pr-1	Pr-2	Pr-3	Pr-4	F-1	F-2	F-3	F-4
Lechia tenuifolia Michx. pineweed	A					A		
Lespedeza procumbens Michx. bush clover	A							
Lespedeza stipulacea Maxim. Korean clover	A	A	A	A				
Lespedeza striata (Thunb.) H.&A. Japanese lespedeza	A	A	A	A				
Lespedeza violacea (L.) Pers. bush clover	A			A	A	A	A	A
Lespedeza virginica (L.) Britt. bush clover					A			
Linum sp. L. flax					A			A
Lobelia inflata L. Indian tobacco	A				A		A	
Lobelia spicata Lam. ---						A		
Lysmachia lanceolata Walt. loosestrife		A				A		
Melilotus alba Desr. white sweet clover				A				
Melilotus officinalis (L.) Lam. yellow sweet clover				A				
Monarda russelliana Nutt. horsemint							A	A
Monotropa uniflora L. Indian pipe								A
Morus rubra L. red mulberry					B	BC	BC	B
Moss sp. ---	A	A	A					
Muhlenbergii schreberi Gmel. nimble will		A	A					
Muhlenbergia sobolifera (Muhl.) Trin. muhly					A	A		
Oenothera strigosa (Rydb.) Mac. & Bush evening primrose				A				
Ostrya virginiana (Mill.) K. Koch hop-hornbeam					ABC	AB	B	B
Oxalis europaea Jord. yellow wood sorrel	A	A	A	A	A	A		

Scientific Name Common Name	Prairie Sampling Stations				Forest Sampling Stations			
	Pr-1	Pr-2	Pr-3	Pr-4	F-1	F-2	F-3	F-4
Panicum boscii Poir. ---							A	A
Panicum clandestinum L. ---			A					
Panicum dichotomum L. ---							A	
Panicum dichotomiflorum Michx. ---			A					
Panicum lanuginosum Ell. ---	A	A	A	A	A	A		A
Panicum lanuginosum var. implicatum (Scribn.) Fern. ---			A		A		A	
Panicum lanuginosum var. lanuginosum (Scribn.) Fern. ---						A		
Panicum linearifolium Scribn. ---								A
Panicum perlongum Nash ---		A						
Panicum sp. L. panic grass						A		
Panicum sphaerocarpon Ell. ---								A
Panicum subvillosum Ashe ---							A	A
Parthenium integrifolium Ait. American feverfew								A
Parthenocissus quinquefolia (L.) Pursh Virginia creeper					A	A	A	A
Paspalum ciliatifolium Michx. ---		A	A					
Paspalum floridanum Michx. ---		A						
Paspalum laeve Michx. ---		A	A					
Penstemon pallidus Small. beard tongue		A						
Phleum pratense L. timothy		A	A					
Phryma leptostachya L. lopseed					A			
Physalis virginiana Mill. ground cherry							A	

APPENDIX A-14 (Continued)

Scientific Name Common Name	Prairie Sampling Stations Pr-1	Pr-2	Pr-3	Pr-4	Forest Sampling Stations F-1	F-2	F-3	F-4
Plantago rugelii Decne. plantain	A							
Plantago virginica L. hoary plantain	A		A					
Poa compressa L. Canada bluegrass		A	A					
Poa pratensis L. Kentucky bluegrass	A	A	A					
Poa sylvestris Gray sylvan bluegrass					A			
Podophyllum peltatum L. may apple					A	A	A	
Polygonum scandens L. var. cristatum (Engelm & Gray) Gl. false buckwheat					A			
Polystichum acrostichoides (Michx.) Scott Christmas fern					A		A	
Potentilla simplex Michx. cinquefoil	A	A		A		A	A	A
Prunella vulgaris L. self heal	A	A	A					A
Prunus americana Marsh. wild plum					A	B	B	B
Prunus mexicana Wats. big tree plum								B
Prunus serotina Ehrh. black cherry					AB	ABC	AB	B
Prunus sp. L. cherry						A		A
Prunus virginiana L. choke cherry					A	A	A	
Psoralea psoralioides (Walt.) Cory var. eglandulosa (Ell.) Freeman Sampson's snakeroot								A
Pycnanthemum tenuifolium Schrad. slender mountain mint		A	A					
Quercus alba L. and/or var. white oak					ABC	ABC	ABC	ABC
Quercus x *fernowi* Trel. (Quercus alba x Quercus stellata) oak								B
Quercus imbricaria Michx. shingle oak						A		

APPENDIX A-14 (Continued)

Scientific Name Common Name	Prairie Sampling Stations Pr-1	 Pr-2	 Pr-3	 Pr-4	Forest Sampling Stations F-1	 F-2	 F-3	 F-4
Quercus macrocarpa Michx. bur oak					A	A		
Quercus macrocarpa Michx. x Q. marilandica bur oak hybrid								A
Quercus marilandica Muenchh. x Q. unknown black jack and/or oak hybrid					A	A		AC
Quercus rubra L. and var. red oak					BC	BC	BC	AB
Quercus shumardii Buckl. shumard oak					A			A
Quercus stellata Wang. post oak	B				C	AC	C	BC
Quercus stellata Wang. x Q. alba or Q. mari. post oak hybrid					A			
Quercus velutina Lam. black oak	B				ABC	ABC	ABC	ABC
Quercus velutina Lam. x Q. bushii Sarg. black oak hybrid								A
Rhamnus lanceolata Pursh buckthorn					A			
Rhus aromatica Ait. fragrant sumac					AB	AB	AB	AB
Rhus radicans L. poison ivy					B	AB	A	
Ribes missouriensis Nutt. Missouri gooseberry					A			
Rosa arkansana Porter cockerell					A			B
Rosa carolina L. pasture rose	B				A	AB	AB	AB
Rosa setigera Michx. var. tomentosa Torr. & Gray prairie rose		A			A			
Rubus argutus Link high-bush blackberry			A					
Rubus flagellaris Willd. dewberry	B	B	A	B	AB	A	AB	B
Rubus occidentalis L. black raspberry					A	AB		

APPENDIX A-14 (Continued)

Scientific Name Common Name	Prairie Sampling Stations				Forest Sampling Stations			
	Pr-1	Pr-2	Pr-3	Pr-4	F-1	F-2	F-3	F-4
Rubus ostryfolius Rydb. high-bush blackberry	A			B		B		
Rubus pensilvanicus Poir. high-bush blackberry				A			A	
Rudbeckia hirta L. black-eyed susan		A						
Ruellia humilis Nutt. wild petunia	A	A						
Rumex acetocella L. sheep sorrel		A						
Rumex crispus L. sour dock			A					
Sabatia angularis (L.) Pursh rose pink			A	A				
Sanicula canadensis L. black snakeroot					A	A		A
Sassafras albidum (nutt.) Nees sassafras					AB	ABC	B	AB
Schrankia nuttallii (A.D.C. ex Britt. & Rose) Standl. sensitive brier	A	A	A			A		A
Scutellaria parvula Michx. skullcap						A		
Setaria geniculata (Lam.) Beauv. prairie foxtail		A						
Setaria glanca (L.) Beauv. yellow foxtail	A							
Smilacina racemosa L. Desf. false Solomon's seal					A	A	A	
Smilacina stellata (L.) Desf. starry false Solomon's seal					A			
Smilax sp. L. catbrier						B		
Smilax tamnoides L. bristly greenbrier					A	A		A
Solanum carolinense L. horse nettle		A	A	A				
Solidago altissima L. tall goldenrod		A	A					
Solidago nemoralis Ait. old-field goldenrod	A		A	A				
Solidago petiolaris Ait. goldenrod								A
Solidago sp. L. goldenrod		A	A	A	A			A

APPENDIX A-14 (Continued)

Scientific Name / Common Name	Prairie Sampling Stations Pr-1	Pr-2	Pr-3	Pr-4	Forest Sampling Stations F-1	F-2	F-3	F-4
Solidago ulmifolia Muhl. elm-leaf goldenrod					A	A	A	A
Spiranthes tuberosa Raf. little ladies' tresses					A			
Strophostyles helvola (L.) D.C. wild bean					A	A	A	A
Strophostyles leiosperma (T&G) Piper wild bean	A							
Strophostyles umbellata (Muhl.) Britt. wild bean		A	A	A				
Symphoricarpos orbiculatus Moench coral berry		A	A			A	A	A
Symphoricarpos sp. Duham. snowberry	B	B	B			B	B	
Teucrium canadense L. wood sage			A					A
Tradescantia earnestiana Anders. & Woods spiderwort					A			
Tradescantia ohiensis Raf. spiderwort						A		
Tridens flavus (L.) Hitchc. purple-top		A	A					
Trifolium campestre Schreb. large hop clover		A	A	A				
Trifolium pratense L. red clover	A	A	A					
Trifolium repens L. white clover	A	A	A					
Triphora trianthophora (S.W.) Rydb. nodding pogonia					A			
Ulmus rubra Muhl. slippery elm	B	B	B	A	ABC	AB	B	BC
Verbena hastata L. blue vervain			A					
Vernonia baldwini Torr. ironweed		A	A					
Vernonia missurica Raf. ironweed		A	A					

APPENDIX A-14 (Continued)

Scientific Name Common Name	Prairie Sampling Stations Pr-1	Pr-2	Pr-3	Pr-4	Forest Sampling Stations F-1	F-2	F-3	F-4
Vernonia sp. Schreb. ironweed		A	A					
Veronica arvensis L. corn speedwell	A		A					
Veronicastrum virginicum (L.) Farw. culvers root							A	
Viburnum prunifolium L. black haw						B	B	
Viburnum rafinesquianum Schultes downy arrow-wood						A		
Viburnum rufidulum Raf. southern black haw					A	AB	A	
Viburnum sp. L. viburnum					B			
Viola papilionacea Pursh common violet						A		
Viola triloba Schwein. f. dilatata Ell. three-lobed violet					A		A	A
Vitis aestivalis Michx. summer grape					B		AB	[illegible]
Vitis cinerea Engelm. grayback grape				A	AB	AB	ABC	AB
Vitis vulpina L. winter grape					B	AB	AB	B
Zanthoxylum americanum Mill. prickly ash						B		

APPENDIX A-15

DATA SUMMARY OF FOREST GROUND VEGETATION[a] CLIPPED FROM SUBPLOTS OF SAMPLING STATION F-1,
CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Scientific Name / Common Name	Subplots-presence indicated by dry weights (grams/0.25-milacre plots)																Frequency[b] (%)	Relative[c] Frequency(%)	Dry Weight[d] for Species	Relative[e] Weight(%)	Importance[f] Value
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16					
Carex rosea Schk. / ---	2.50		0.60	0.35		2.20			0.80	7.60						0.25	43.75	7.77	14.30	8.79	16.56
Amelanchier arborea (Michx.) Fern. / shadbush	0.50																6.25	1.11	0.50	0.30	1.41
Solidago ulmifolia Muhl. / elm-leaf goldenrod	1.30							1.50									12.50	2.22	2.80	1.72	3.94
Cornus florida L. / flowering dogwood	3.20								0.25								12.50	2.22	3.45	2.12	4.34
Quercus alba[g] L. and var. / white oak	4.30				2.10	13.30		3.95						1.70	0.35		37.50	6.66	25.70	15.80	22.46
Strophostyles helvola (L.) Ell. / wild bean	0.15	0.60	0.40				0.30							0.30		1.05	37.50	6.66	2.80	1.72	8.36
Desmodium nudiflorum (L.) D.C. / tick trefoil	1.20	2.00							1.25			1.60					25.00	4.44	6.05	3.72	8.16
Galium concinnum Torr. & Gray / elegant bedstraw		0.30	0.50				0.30										18.75	3.33	1.10	0.67	4.00
Fraxinus americana L. / white ash		5.20		8.60		0.30	2.20				1.25						31.25	5.55	17.55	10.79	16.34
Botrychium virginianum (L.) Sw. / rattlesnake fern		0.10															6.25	1.11	0.10	0.06	1.17
Galium circaezans Michx. / wild licorice			0.25						0.05				0.05				18.75	3.33	0.35	0.21	3.54
Geum canadense Jacq. / white avens			2.10														6.25	1.11	2.10	1.29	2.40
Sanicula canadensis L. / black snakeroot			1.40														6.25	1.11	1.40	0.86	1.97
Muhlenbergia sobolifera (Muhl.) Trin. / muhly			1.70														6.25	1.11	1.70	1.04	2.15
Carya texana Buckl. var. villosa (Sarg.) Little / black hickory				3.00													6.25	1.11	3.00	1.84	2.95
Triphora trianthophora (S.W.) Rydb. / nodding pogonia				0.01													6.25	1.11	0.01	0.00	1.11
Vitis cinerea Engelm. / grayback grape				1.15													6.25	1.11	1.15	0.70	1.81

Sheet 1

APPENDIX A-15 (continued)

Scientific Name Common Name	Subplots-presence indicated by dry weights (grams/0.25-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[b] (%)	Relative[c] Frequency(%)	Dry Weight[d] for Species	Relative[e] Weight(%)	Importance[f] Value
Rhus aromatica Ait. fragrant sumac					18.90		4.90							11.70			18.75	3.33	35.50	21.82	25.15
Carya tomentosa Nutt. mockernut hickory					5.60												6.25	1.11	5.60	3.44	4.55
Lespedeza violacea (L.) Pers. bush clover					0.50												6.25	1.11	0.50	0.30	1.41
Rosa carolina L. pasture rose					1.20		1.25		0.10		2.40						25.00	4.44	4.95	3.04	7.48
Rubus flagellaris Willd. dewberry					0.90						1.10						12.50	2.22	2.00	1.22	3.44
Festuca obtusa Biehler nodding fescue						1.30											6.25	1.11	1.30	0.79	1.90
Carex bushii Mack. ---						0.70		1.80									12.50	2.22	2.50	1.53	3.75
Carya ovata (Mill.) K. Koch shagbark hickory						1.10							5.10				12.50	2.22	6.20	3.81	6.03
Sassafras albidum (Nutt.) Nees sassafras						0.60											6.25	1.11	0.60	0.36	1.47
Cercis canadensis L. redbud							0.15										6.25	1.11	0.15	0.09	1.20
Prunus americana Marsh. wild plum							0.60										6.25	1.11	0.60	0.36	1.47
Carex glaucodea Tuckerm. ---							0.10	0.40	0.15				0.55				25.00	4.44	1.20	0.73	5.17
Parthenocissus quinquefolia (L.) Planch. Virginia creeper							0.50	0.60		2.60	1.45			1.05	0.15	1.20	43.75	7.77	7.55	4.64	12.41
Panicum lanuginosum Ell. ---								0.40	0.02				0.05				18.75	3.33	0.47	0.28	3.61
Desmodium dillenii Darl. ---								1.10									6.25	1.11	1.10	0.67	1.78
Smilacina stellata (L.) Desf. starry false Solomon's seal								0.80									6.25	1.11	0.80	0.49	1.60
Apocynum cannabinum L. Indian hemp									1.05								6.25	1.11	1.05	0.64	1.75

APPENDIX A-15 (continued)

Scientific Name / Common Name	Subplots-presence indicated by dry weights (grams/0.25-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[b] (%)	Relative[c] Frequency(%)	Dry Weight[d] for Species	Relative[e] Weight(%)	Importance[f] Value
Juniperus virginiana L. / red cedar									0.20								6.25	1.11	0.20	0.12	1.23
Quercus velutina Lam. / black oak										4.20							6.25	1.11	4.20	2.58	3.69
Prunus virginiana L. / choke cherry												0.15		0.65			12.50	2.22	0.80	0.49	2.71
Rosa setigera Michx. / prairie rose												0.80					6.25	1.11	0.80	0.49	1.60
Heuchera sp. L. / alum root												0.10					6.25	1.11	0.10	0.06	1.17
Viburnum rufidulum Raf. / southern black haw														0.20			6.25	1.11	0.20	0.12	1.23
Ostrya virginiana (Mill.) K. Koch / hop-hornbeam																0.20	6.25	1.11	0.20	0.12	1.23
TOTAL	13.15	8.20	6.95	13.11	29.20	19.50	10.30	10.55	3.87	14.40	6.20	2.65	5.75	15.60	0.50	2.70	562.50	99.90	162.63	99.82	199.72

[a] Includes woody and herbaceous plants of less than 20 inches in height.

[b] $\frac{\text{Number of subplots the species occurs}}{\text{Number of subplots sampled (16)}} \times 100$

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d] Cumulative weight (16 subplots) by species

[e] $\frac{\text{Cumulative weight (a species)}}{\text{Cumulative weight (all species)}} \times 100$

[f] Relative frequency + relative weight.

APPENDIX A-16

DATA SUMMARY OF FOREST GROUND VEGETATION[a] CLIPPED FROM SUBPLOTS OF SAMPLING STATION F-1,
CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, MAY-JUNE 1974

Scientific Name Common Name	Subplots - presence indicated by dry weights (grams/0.25-milacre plots)																Frequency (%)[a]	Relative Frequency[b]	Dry Weight Per Species[c]	Relative Weights (%)[d]	Importance Value[e]
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16					
Fraxinus americana L. white ash	4.10	19.33		17.37				0.03			0.10						31.25	4.85	40.93	14.75	19.60
Amelanchier arborea (Michx.) Fern. shadbush	0.10																6.25	0.97	0.10	0.04	1.01
Rubus flagellaris Willd. dewberry	0.40		0.26														12.50	1.94	0.66	0.24	2.18
Desmodium nudiflorum (L.) D.C. tick trefoil	0.48		0.13				1.46					0.70	0.30			0.20	37.50	5.83	3.27	1.18	7.01
Parthenocissus quinquefolia (L.) Pursh Virginia creeper	7.56	9.82	11.15	1.97	0.05	8.13	2.29	2.35	3.46	0.52	1.87	0.15	0.01	1.30	0.17	0.24	100.00	15.53	51.04	18.40	33.93
Aster sp. aster	1.03										0.09				0.02		18.75	2.91	1.14	0.41	3.32
Quercus alba L. white oak	1.50							4.92		26.82			1.29				25.00	3.88	34.53	12.45	16.33
Carex rosea Schk. ---	0.54	0.02	0.81														18.75	2.91	1.37	0.49	3.40
Prunus serotina Ehrh. black cherry	1.06																6.25	0.97	1.06	0.38	1.35
Quercus macrocarpa Michx. bur oak		1.58	10.96		22.59												18.75	2.91	35.13	12.66	15.57
Anemonella thalictroides (L.) Spach. rue anemone		0.01									0.22					0.03	18.75	2.91	0.26	0.09	3.00
Galium circaezans Michx. wild licorice		0.02	0.02									0.05					18.75	2.91	0.09	0.03	2.94
Poa sylvestris Gray sylvan bluegrass			2.03														6.25	0.97	2.03	0.73	1.70
Ostrya virginiana (Mill.) K. Koch hop hornbeam			0.97										0.40	0.04	0.01	0.15	31.25	4.85	1.57	0.57	5.42
Strophostyles helvola (L.) D.C. wild bean			1.32			0.19			0.17	0.01			0.07				31.25	4.85	1.76	0.63	5.48
Solidago sp. goldenrod			3.17														6.25	0.97	3.17	1.14	2.11
Galium concinnum Torr. & Gray elegant bedstraw			0.78	0.11		1.00	0.30										25.00	3.88	2.19	0.79	4.67
Danthonia spicata (L.) Beauv. poverty grass			2.00														6.25	0.97	2.00	0.72	1.69
Rhamnus lanceolata Pursh buckthorn			0.17														6.25	0.97	0.17	0.06	1.03
Rhus aromatica Ait. fragrant sumac			0.31		15.85	0.07			3.08					3.59			31.25	4.85	22.90	8.25	13.10
Carex bushii Mack. ---				0.68								2.55	3.29		0.50		25.00	3.88	7.02	2.53	6.41
Elymus villosus Muhl. wild rye					0.51												6.25	0.97	0.51	0.18	1.15
Smilax tamnoides L. bristly greenbriar						0.45											6.25	0.97	0.45	0.16	1.13
Sanicula canadensis L. black snakeroot						6.64											6.25	0.97	6.64	2.39	3.36
Festuca obtusa Biehler nodding fescue						7.15											6.25	0.97	7.15	2.58	3.55
Rubus occidentalis L. black raspberry						4.32											6.25	0.97	4.32	1.56	2.53
Carya ovata (Mill.) K. Koch shagbark hickory							3.01	0.22					0.05		1.46		25.00	3.88	4.74	1.71	5.59
Quercus marilandica** Moench. X Q. unknown black jack and/or oak hybrid							0.26							(4.71)			12.50	1.94	4.97	1.79	3.73
Carex gravida Bailey ---								4.48			2.09						12.50	1.94	6.57	2.37	4.31
Rosa carolina L. pasture rose									3.27					2.33			12.50	1.94	5.60	2.02	3.96
Quercus stellata Weng. X Q. alba or Q. mari. post oak hybrid									*16.92								6.25	0.97	16.92	6.10	7.07
Podophyllum peltatum L. may apple										0.06							6.25	0.97	0.06	0.02	0.99
Tradescantia earnestiana Anders. & Woods spiderwort											0.10						6.25	0.97	0.10	0.03	1.00

APPENDIX A-16 (continued)

Scientific Name Common Name	Subplots - presence indicated by dry weights (grams/0.25-milacre plots)																Frequency (%)[a]	Relative Frequency[b]	Dry Weight Per Species[c]	Relative Weights (%)[d]	Importance Value[e]
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16					
Cornus florida L. flowering dogwood											0.06						6.25	0.97	0.06	0.02	0.99
Asclepias sp. L. milkweed											0.08						6.25	0.97	0.08	0.03	1.00
Smilacina racemosa L. Desf. false Solomon's seal												3.49					6.25	0.97	3.49	1.26	2.23
Rosa arkansana Porter cockerell												1.27					6.25	0.97	1.27	0.46	1.43
Ulmus rubra Muhl. slippery elm												0.[illegible]					6.25	0.97	0.27	0.10	1.07
Quercus shumardii Buckl. shumard oak															1.25		6.25	0.97	1.25	0.45	1.42
Vitis cinerea Engelm. grayback grape															0.52		6.25	0.97	0.52	0.19	1.16
Carex artitecta Mack. ---																0.10	6.25	0.97	0.10	0.04	1.01
Totals	16.77	30.78	34.08	20.13	39.00	27.95	7.32	12.00	26.90	27.41	4.61	8.48	5.41	11.97	3.93	0.72	643.75	99.93	277.46	100.00	199.93

*Includes woody and herbaceous plants of less than 20 inches in height.
**Includes the species and/or its hybrids.

a = $\frac{\text{Number of subplots the species occurs}}{\text{Number of subplots samples (16)}} \times 100$

b = $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

c = Cumulative weight (16 subplots) by species

d = $\frac{\text{Cumulative weight (a species)}}{\text{Cumulative weight (all species)}} \times 100$

e = Relative frequency + relative weight

APPENDIX A-17

DATA SUMMARY FOR UNDERSTORY VEGETATION[a] OF SAMPLING STATION F-1, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974 (based on sixteen 6.25-milacre plots)

Scientific Name Common Name	Frequency[b]	Relative[c] Frequency(%)	Density[d]	Relative[e] Density(%)	Importance[f] Value
Cornus florida L. flowering dogwood	14.0	14.1	78.0	21.2	35.3
Quercus alba[g] L. and var. white oak	10.0	10.1	45.0	12.2	22.3
Carya sp. Nutt. hickory	12.0	12.1	37.0	10.1	22.2
Fraxinus americana L. white ash	7.0	7.1	46.0	12.5	19.6
Rhus aromatica Ait. fragrant sumac	5.0	5.1	53.0	14.4	19.5
Ostrya virginiana (Mill.) K. Koch hop-hornbeam	8.0	8.1	25.0	6.8	14.9
Quercus velutina Lam. black oak	6.0	6.1	22.0	6.0	12.1
Amelanchier arborea (Michx. f.) Fern. shadbush	6.0	6.1	10.0	2.6	8.7
Ulmus rubra Muhl. slippery elm	6.0	6.1	6.0	1.6	7.7
Juniperus virginiana L. red cedar	5.0	5.1	8.0	2.2	7.3
Quercus rubra[g] L. and var. red oak	4.0	4.0	8.0	2.2	6.2

Sheet 1

APPENDIX A-17 (continued)

Scientific Name Common Name	Frequency[b]	Relative Frequency (%)[c]	Density[d]	Relative Density (%)[e]	Importance Value[f]
Vitis vulpina L. winter grape	3.0	3.0	5.0	1.4	4.4
Rubus flagellaris Willd. dewberry	2.0	2.0	5.0	1.4	3.4
Rhus radicans L. poison ivy	1.0	1.0	7.0	1.9	2.9
Morus rubra L. red mulberry	1.0	1.0	2.0	0.5	1.5
Vitis aestivalis Michx. summer grape	1.0	1.0	2.0	0.5	1.5
Celtis occidentalis L. hackberry	1.0	1.0	2.0	0.5	1.5
Aesculus glabra Willd. Ohio buckeye	1.0	1.0	1.0	0.3	1.3
Viburnum sp. L. viburnum	1.0	1.0	1.0	0.3	1.3
Prunus serotina Ehrh. black cherry	1.0	1.0	1.0	0.3	1.3
Crataegus sp. L. hawthorn	1.0	1.0	1.0	0.3	1.3
Sassafras albidum (Nutt.) Nees sassafras	1.0	1.0	1.0	0.3	1.3
Acer saccharum Marsh sugar maple	1.0	1.0	1.0	0.3	1.3
Vitis cinerea Engelm. grayback grape	1.0	1.0	1.0	0.3	1.3
TOTAL	99.9	100.0	368.0	100.1	200.1

Trees and/or shrubs per quadrat = 23.0

Trees and/or shrubs per acre = 3,726

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[a]Tree or shrub less than 2.0 inches diameter at breast height.

[b]Number of subplots a species occurs.

[c]$\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d]Cumulative number of a species within subplots sampled.

[e]$\frac{\text{Density of a species occurrence}}{\text{Cumulative density of all species}} \times 100$

[f]Summation of relative frequency + relative density.

[g]Includes the species and varieties.

APPENDIX A-18

DATA SUMMARY FOR OVERSTORY VEGETATION[a] OF SAMPLING STATION F-1, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974 (based on sixteen 25-milacre plots)

Scientific Name Common Name	Frequency[b]	Relative[c] Frequency (%)	Density[d]	Relative[e] Density (%)	Dominance[f]	Relative[g] Dominance (%)	Importance[h] Value
Quercus alba[i] L. and var. white oak	14.0	25.5	32.0	28.8	4,377.4	76.5	132.8
Cornus florida L. flowering dogwood	9.0	16.4	28.0	25.2	124.0	2.2	43.8
Quercus velutina Lam. black oak	8.0	14.5	19.0	17.1	143.4	2.6	34.2
Carya ovata (Mill.) K. Koch shagbark hickory	6.0	10.9	8.0	7.2	34.9	0.6	18.7
Quercus stellata Wang. post oak	2.0	3.6	4.0	3.6	495.2	8.9	16.1
Amelanchier arborea (Michx.f.) Fern. shadbush	4.0	7.3	5.0	4.5	22.7	0.4	12.2
Carya texana Buckl. black hickory	2.0	3.6	2.0	1.8	313.6	5.6	11.0
Ostrya virginiana (Mill.) K. Koch hop-hornbeam	3.0	5.5	5.0	4.5	20.9	0.4	10.4
Quercus rubra L. red oak	2.0	3.6	2.0	1.8	9.8	0.2	5.6
Ulmus rubra Muhl. slippery elm	1.0	1.8	2.0	1.8	8.0	0.1	3.7

APPENDIX A-18 (continued)

Scientific Name Common Name	Frequency[b]	Relative Frequency (%)[c]	Density[d]	Relative Density (%)[e]	Dominance[f]	Relative Dominance (%)[g]	Importance Value[h]
Juniperus virginiana L. red cedar	1.0	1.8	1.0	0.9	12.6	0.2	2.9
Carya tomentosa Nutt. mockernut hickory	1.0	1.8	1.0	0.9	4.9	0.1	2.8
Fraxinus americana L. white ash	1.0	1.8	1.0	0.9	3.1	0.1	2.8
TOTAL	55.0	98.1	110.0	99.0	5,570.5	99.9	297.0

Trees per quadrat = 6.9
Trees per acre = 279.5
Basal area per quadrat = 348.5 sq. in.
Basal area per acre = 14,114.3 sq. in.

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[a] Tree species 20 inches or greater diameter at breast height.

[b] Number of subplots a species occurs.

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d] Cumulative number of a species within subplots sampled.

[e] $\frac{\text{Density of a species occurrence}}{\text{Cumulative density of all species}} \times 100$

[f] Cumulative basal area (sq. in.) of a species within subplots sampled.

[g] $\frac{\text{Cumulative basal area of a species}}{\text{Cumulative basal area of all species}} \times 100$

[h] Summation of relative frequency + relative density + relative dominance.

[i] Includes species and varieties.

APPENDIX A-19

INCREMENT CORE SUMMARY FOR OVERSTORY VEGETATION[a] OF SAMPLING STATIONS F-1 TO F-4, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974
(Distribution and Mean Age[b], by Diameter Size Classes)

Sampling Station	Species	Specimen Number	Age	Diameter Class	Age	Diameter Class	Age	Diameter Class	Age	Diameter Class
F-1	Slippery elm	21500	15	2.04	20	2.20				
	White ash	21501	20	2.00						
	White oak	21502	90	17.00	127	15.18	129	13.20	129	13.23
	Post oak	21504	77	7.60						
	Hybrid oak	21505	135	12.10	132	12.01				
	Black oak	21506	29	2.06	31	3.16	38	4.24		
	Red oak	21507	31	2.28	22	2.40				
	Red mulberry	21508	30	2.36						
	Flowering dogwood	21509	29	2.50	15	2.00	22	2.36		
	Shadbush	21510	21	2.16	27	2.39	25	2.30		
	Red cedar	21511	54	4.10						
	Hop-hornbeam	21512	25	2.20						
	Black hickory	21513	111	16.52						
	Shagbark hickory	21514	24	2.12	23	2.06				
	Mockernut hickory	21515	20	2.24						
F-2	Red oak	21516	27	3.44	36	8.30	24	5.00	34	8.00
	Black oak	21517	29	3.00	39	8.16	34	9.00	40	6.32
	Post oak	21518	32	6.60						
	Hybrid oak	21519a	41	7.18	43	6.48				
	White oak	21519	39	5.00	62	11.18	27	6.08		
	Shagbark hickory	21520	28	3.50	18	2.22	54	7.18		
	Black hickory	21521	24	5.40	26	4.04	25	3.43		
	Mockernut hickory	21522	23	3.00	19	2.16	27	5.00		
	Shadbush	21523	22	2.50	30	3.08				
	Sassafras	21524	17	3.40	28	3.18				
	Red mulberry	21525	23	3.00						
	Flowering dogwood	21526	24	2.16	21	2.36				
	Black cherry	21527	25	3.00						

APPENDIX A-19 (continued)

Sampling Station	Species	Specimen Number	Age	Diameter Class	Age	Diameter Class	Age	Diameter Class	Age	Diameter Class
F-3	Red oak	21529	32	7.28		11.19	50	10.18		
	Post oak	21530	29	4.40	50	8.16				
	Hybrid oak	21531	38	6.60						
	White oak hybrid	21532	31	6.36	49	90.38	49	11.14		
	White oak	21533	19	3.06	37	6.34				
	Black oak	21534	16	2.50	47	13.40				
	Black oak hybrid	21535	53	13.08	54	11.18	48	13.04		
	Black hickory	21537	31	4.12	16	3.32	35	5.46	61	7.48
	Shagbark hickroy	21538	43	6.32						
	Mockernut hickory	21539	10	2.06	15	2.00				
	Red mulberry	21540	20	2.12						
	Sugar maple	21541	43	11.18	23	2.17				
	Flowering dogwood	21542	19	2.29	11	2.00				
F-4	Black-jack oak	21543	102	7.14						
	Post oak	21544	97	6.37	103	9.75	84	5.62		
	Hybrid oak	21545	32	3.15	57	6.5				
	White oak	21546	110	16.0	30	4.16				
	White oak hybrid	21547	35	3.56	66	15.40	34	4.22	32	3.22
	Black oak	21548	72	13.26	67	11.55	69	11.30		
	Sugar maple	21549	21	2.56						
	Flowering dogwood	21550	22	2.32	22	2.25	26	2.08		
	Black hickory	21551	32	3.12	27	2.30				
	Shagbark hickory	21552	102	10.62						
	Shadbush	21553	31	2.36	27	2.11				
	Slippery elm	21554	31	3.20						
	White ash	21555	26	2.22						

[a] Tree species 2.0 inches or greater diameter at breast height.

[b] Ages in years were determined from cores taken at 4.5 feet from ground.

APPENDIX A-20

DATA SUMMARY OF FOREST GROUND VEGETATION[a] CLIPPED FROM SUBPLOTS OF SAMPLING STATION F-2,
CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Scientific Name Common Name	Subplots-presence indicated by dry weights (grams/0.25-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[b] (%)	Relative[c] Frequency(%)	Dry Weight[d] for Species	Relative[e] Weight(%)	Importance[f] Value
Galium concinnum Torr. & Gray elegant bedstraw	2.90			2.05	1.60	2.10	0.01					0.10					37.50	6.97	8.76	6.97	13.94
Rubus occidentalis L. black raspberry	1.70																6.25	1.16	1.70	1.35	2.51
Oxalis europaea Jord. yellow wood sorrel	0.03																6.25	1.16	0.03	0.02	1.18
Potentilla simplex Michx. cinquefoil	1.90				0.50												12.50	2.32	2.40	1.91	4.23
Rhus aromatica Ait. fragrant sumac	0.50			0.60	7.20			9.50	1.50								31.25	5.81	19.30	15.37	21.18
Strophostyles helvola (L.) Britt. wild bean	0.04		2.55		0.20				0.55	0.05		2.60		0.25			43.75	8.13	6.24	4.97	13.10
Quercus alba[g] L. and var. white oak	0.20						2.30					2.80	1.50	5.30			31.25	5.81	12.10	9.63	15.44
Carex glaucodea Tuckerm. ---	0.10																6.25	1.16	0.10	0.07	1.23
Parthenocissus quinquefolia (L.) Planch. Virginia creeper	0.60				0.70	0.15	1.30			3.30			0.75	1.30		0.80	50.00	9.30	8.90	7.08	16.38
Carex bushii Mack. ---		1.00												1.50	0.50		18.75	3.48	3.00	2.38	5.86
Vitis cineria Engelm. grayback grape		0.20	1.50												0.30		18.75	3.48	2.00	1.59	5.07
Galium circaezans Michx. wild licorice		0.30				0.10								0.03			18.75	3.48	0.43	0.34	3.82
Quercus stellata Wang. post oak		1.60															6.25	1.16	1.60	1.27	2.43
Ostrya virginiana (Mill.) K. Koch hop hornbeam		2.75		3.60									2.50				18.75	3.48	8.85	7.04	10.52
Panicum lanuginosum[g] var. lanuginosum (Scribn.) Fern. ---			0.02											0.45	0.05		18.75	3.48	0.52	0.41	3.89
Carex rosea Schkuhr ---			2.60			2.20	0.03			4.10					0.75		31.25	5.81	9.68	7.71	13.52
Agrostis perennans (Walt.) Tuckerm. upland bent			0.55														6.25	1.16	0.55	0.43	1.59
Aster anomalus Engelm. aster			0.05														6.25	1.16	0.05	0.03	1.19

APPENDIX A-20 (continued)

Scientific Name Common Name	Subplots-presence indicated by dry weights (grams/0.25-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[b] (%)	Relative[c] Frequency(%)	Dry Weight[d] for Species	Relative[e] Weight(%)	Importance[f] Value
Solidago ulmifolia Muhl. elm-leaf goldenrod			4.30				2.20										12.50	2.32	6.50	5.17	7.49
Heuchera sp. L. alum root			0.01							0.20							12.50	2.32	0.21	0.16	2.48
Desmodium dillenii Darl. ---			3.15														6.25	1.16	3.15	2.50	3.66
Fraxinus americana L. white ash					0.70												6.25	1.16	0.70	0.55	1.71
Quercus imbricaria Michx. shingle oak					0.15					0.60	0.30						18.75	3.48	1.05	0.83	4.31
Rosa carolina L. pasture rose						0.40									0.30		12.50	2.32	0.70	0.55	2.87
Prunus virginiana L. choke cherry							1.40						2.25				12.50	2.32	3.65	2.90	5.22
Vitis vulpina L. frost grape									1.40								6.25	1.16	1.40	1.11	2.27
Muhlenbergia sobolifera (Muhl.) Trin. muhly										9.60							6.25	1.16	9.60	7.64	8.80
Lysimachia lanceolata Walt. loosestrife										0.03		0.75					12.50	2.32	0.78	0.62	2.52
Acer saccharum Marsh sugar maple											3.40						6.25	1.16	3.40	2.70	3.86
Desmodium nudiflorum (L.) D.C. tick trefoil											0.20						6.25	1.16	0.20	0.15	1.31
Danthonia spicata (L.) Beauv. poverty grass												0.60					6.25	1.16	0.60	0.47	1.63
Quercus velutina Lam. black oak													1.00				6.25	1.16	1.00	0.79	1.95
Lespedeza violacea (L.) Pers. bush clover														1.40			6.25	1.16	1.40	1.11	2.27
Ulmus rubra Muhl. slippery elm														0.50			6.25	1.16	0.50	0.39	1.55
Sanicula canadensis L. black snakeroot														0.90			6.25	1.16	0.90	0.71	1.87
Antennaria plantaginifolia (L.) Hook. pussy's toes															3.20		6.25	1.16	3.20	2.54	3.70

APPENDIX A-20 (continued)

Scientific Name Common Name	Subplots-presence indicated by dry weights (grams/0.25-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[b] (%)	Relative[c] Frequency(%)	Dry Weight[d] for Species	Relative[e] Weight(%)	Importance[f] Value
Desmodium glutinosum (Muhl.) Wood tick trefoil																0.20	6.25	1.16	0.20	0.15	1.31
Diospyros virginiana L. persimmon																0.20	6.25	1.16	0.20	0.15	1.31
TOTAL	7.97	5.85	14.73	6.25	11.05	4.95	7.24	9.50	3.45	17.88	3.90	6.85	8.00	11.63	5.10	1.20	537.50	99.83	135.55	99.76	199.59

[a]Includes woody and herbaceous plants of less than 20 inches in height.

[b] $\frac{\text{Number of subplots the species occurs}}{\text{Number of subplots sampled (16)}} \times 100$

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d]Cumulative weight (16 subplots) by species

[e] $\frac{\text{Cumulative weight (a species)}}{\text{Cumulative weight (all species)}} \times 100$

[f]Relative frequency + relative weight.

APPENDIX A-21

DATA SUMMARY OF FOREST GROUND VEGETATION* CLIPPED FROM SUBPLOTS OF SAMPLING STATION F-2, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, MAY-JUNE 1974

Scientific Name / Common Name	Subplots - presence indicated by dry weight (grams/0.25-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency (%)[a]	Relative Frequency[b]	Dry Weight Per Species[c]	Relative Weight (%)[d]	Importance Value[e]
Rubus occidentalis L. / black raspberry	19.05																6.25	0.70	19.05	7.25	7.95
Tradescantia ohiensis Raf. / spiderwort	10.27																6.25	0.70	10.27	3.91	4.61
Potentilla simplex Michx. / cinquefoil	3.63				0.43					0.55							18.75	2.10	4.61	1.75	3.85
Galium concinnum Torr. & Gray / elegant bedstraw	3.41			2.53	0.[illegible]	1.46										0.38	31.25	3.50	8.25	3.14	6.64
Oxalis europaea Jord. / yellow wood sorrel	0.08																6.25	0.70	0.08	0.03	0.73
Carex bushii Mack. / ---	1.24	3.41			1.44	0.20				0.62				4.51		0.21	43.75	4.89	11.63	4.42	9.31
Lespedeza violacea (L.) Pers. / bush clover	0.10				0.38												12.50	1.40	0.48	0.18	1.58
Lactuca sp. L. / lettuce	0.07		0.03														12.50	1.40	0.10	0.04	1.44
Parthenocissus quinquefolia (L.) Planch. / Virginia creeper	1.76	0.13		13.82	1.24	1.81	0.91	0.28	13.62	6.94	0.98	7.15	3.12	0.24		0.02	87.50	9.79	52.02	19.79	29.58
Sassafras albidum (Nutt.) Nees. / sassafras	1.50							1.30									12.50	1.40	2.80	1.07	2.47
Carex glaucodea Tuckerm. / ---	1.55	0.19	0.30		0.21					4.27		0.11					37.50	4.20	6.63	2.52	6.72
Viola papilionacea Pursh. / common violet	0.02		0.01				0.03		0.31		0.05	0.01					37.50	4.20	0.43	0.16	4.36
Vitis cinerea Engelm. / grayback grape		3.60	4.31								0.46			0.01		4.74	31.25	3.50	13.12	4.99	8.49
Panicum lanuginosum Ell. / ---		0.09			0.06												12.50	1.40	0.15	0.06	1.46
Cornus florida L. / flowering dogwood		0.10		2.61													12.50	1.40	2.71	1.03	2.43
Helianthus sp. L. / sunflower		0.43															6.25	0.70	0.43	0.16	0.86
Hieraceum sp. L. / hawkweed		0.24															6.25	0.70	0.24	0.09	0.79
Podophyllum peltatum L. / may apple			2.03				3.19									2.34	18.75	2.10	7.56	2.88	4.98
Strophostyles helvola (L.) Britt. / wild bean			1.03		1.01					0.49	0.10	0.04				0.06	37.50	4.20	2.73	1.06	5.26
Quercus macrocarpa Michx. / bur oak			3.25														6.25	0.70	3.25	1.24	1.94
Desmodium glutinosum (Muhl.) Wood / tick trefoil			6.97		0.34							1.26		1.25		0.34	31.25	3.50	3.26	1.24	4.74
Amelanchier arborea (Michx.) Tern. / shadbush			0.07		0.89	1.11						0.02	0.28		0.09		37.50	4.20	2.46	0.94	5.14
Lysimachia lanceolata Walt. / loosestrife			0.05											0.13			12.50	1.40	0.18	0.07	1.47
Anemonella thalictroides (L.) Spach. / rue anemone			0.01		0.23					0.10			0.01		0.01		31.25	3.50	0.36	0.14	3.64
Scutellaria parvula Michx. / skullcap			0.11		0.04												12.50	1.40	0.15	0.06	1.46
Bromus purgans L. / Canada brome			1.71														6.25	0.70	1.71	0.65	1.35
Carex albolutescens Schw. / ---			4.84														6.25	0.70	4.84	1.84	2.54
Symphoricarpos orbiculatus Moench. / coral berry				12.19												1.07	12.50	1.40	13.26	5.04	6.44
Rhus aromatica Ait. / fragrant sumac				6.45			0.60	13.86	9.16	0.18							31.25	3.50	30.25	11.51	15.01
Dioscorea villosa L. / yam				0.02		0.20											12.50	1.40	0.22	0.08	1.48
Fraxinus americana L. / white ash					3.62			11.15									12.50	1.40	14.77	5.62	7.02
Quercus alba L. / white oak					0.51					0.07	0.31		5.45				25.00	2.80	6.34	2.41	5.21
Antennaria plantaginifolia (L.) Hook. / pussy's toes					1.83								2.24				12.50	1.40	4.07	1.55	2.95
Viburnum rafinesquianum Schultes. / downy arrow-wood					1.03						0.14						12.50	1.40	1.17	0.45	1.85
Galium circaezans Michx. / wild licorice					0.05								0.21	0.03			18.75	2.10	0.29	0.11	2.21
Carex rosea Schk. / ---					0.84		0.38		0.58		1.26		1.22			1.55	37.50	4.20	5.83	2.22	6.42
Agrostis alba L. / redtop					0.49												6.25	0.70	0.49	0.19	0.89
Rosa carolina L. / pasture rose									7.04			0.29					12.50	1.40	7.33	2.79	4.19
Smilacina racemosa L. / false Solomon's seal									0.13						0.48	0.20	18.75	2.10	0.81	0.31	2.41
Asclepias quadrifolia Jacq. / milkweed									0.10 *								6.25	0.70	0.10	0.04	0.74

APPENDIX A-21 (continued)

Scientific Name Common Name	Subplots - presence indicated by dry weight (grams/0.25-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency (%)[a]	Relative Frequency[b]	Dry Weight Per Species[c]	Relative Weights (%)[d]	Importance Value[e]
Rhus radicans L.																					
poison ivy										5.71							6.25	0.70	5.71	2.17	2.87
Erigia biflora (Walt.) Blake																					
dwarf dandelion										0.38							6.25	9.70	0.38	0.14	0.84
Prunus sp. L.																					
cherry										0.11							6.25	0.70	0.11	0.04	0.74
Celastrus scandens L.																					
bittersweet										1.32							6.25	0.70	1.32	0.50	1.20
Aster sp. L.																					
aster												0.61					6.25	0.70	0.61	0.23	0.93
Quercus marilandica** Moench. XQ. spp.																					
black jack and/or oak hybrid														7.40	(0.04)		12.50	1.40	7.44	2.83	4.23
Rubus flagellaris Willd.																					
dewberry														0.72			6.25	0.70	0.72	0.27	0.97
Cynanchum laeve (Michx.) Pers.																					
angle pod														0.45			6.25	0.70	0.45	0.17	0.87
Botrychium virginianum (L.) Sw.																					
rattlesnake fern														0.06			6.25	0.70	0.06	0.02	0.72
Viburnum rufidulum Raf.																					
southern black haw														0.45			6.25	0.70	0.45	0.17	0.87
Elymus villosus Muhl.																					
wild rye														1.03			6.25	0.76	1.03	0.39	1.09
Panicum sp. L.																					
---															0.01		6.25	0.70	0.01	0.004	0.07
Carex artitecta Mack.																					
---															0.13		6.25	0.70	0.13	0.05	0.75
Prunus serotina Ehrh.																					
black cherry																0.05	6.25	0.70	0.05	0.02	0.72
Totals	42.68	8.19	17.82	37.62	15.11	4.78	5.11	26.59	30.94	20.74	3.30	9.49	12.53	16.28	0.76	10.96	893.75	100.08	262.90	109.01	200.09

*Includes woody and herbaceous plants of less than 20 inches in height.
**Includes the species and/or its hybrids.

a. $\frac{\text{Number of subplots the species occurs}}{\text{Number of subplots sampled (16)}} \times 100$

b. $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

c. Cumulative weight (16 subplots) by species

d. $\frac{\text{Cumulative weight (a species)}}{\text{Cumulative weight (all species)}} \times 100$

e. Relative frequency + relative weight

Sheet 2

APPENDIX A-22

DATA SUMMARY FOR UNDERSTORY VEGETATION[a] OF SAMPLING STATION F-2, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974 (based on sixteen 6.25-milacre plots)

Scientific Name / Common Name	Frequency[b]	Relative Frequency (%)[c]	Density[d]	Relative Density (%)[e]	Importance Value[f]
Rhus aromatica Ait. / fragrant sumac	11.0	7.6	117.0	18.3	25.9
Cornus florida L. / flowering dogwood	13.0	9.0	88.0	13.8	22.8
Quercus alba[g] L. and var. / white oak	12.0	8.3	66.0	10.3	18.6
Fraxinus americana L. / white ash	14.0	9.7	35.0	5.5	15.2
Acer saccharum Marsh / sugar maple	7.0	4.8	43.0	6.7	11.5
Carya sp. L. / hickory	9.0	6.2	17.0	2.7	8.9
Symphoricarpos sp. Duham. / snowberry	4.0	2.8	38.0	6.0	8.8
Quercus velutina Lam. / black oak	7.0	4.8	17.0	2.7	7.5
Rosa carolina L. / pasture rose	7.0	4.8	12.0	1.9	6.7
Rhus radicans L. / poison ivy	2.0	1.3	34.0	5.3	6.6
Amelanchier arborea (Michx.f.) Fern. / shadbush	6.0	4.1	13.0	2.0	6.1

Sheet 1

APPENDIX A-22 (continued)

Scientific Name Common Name	Frequency[b]	Relative Frequency (%)[c]	Density[d]	Relative Density (%)[e]	Importance Value[f]
<u>Ulmus rubra</u> Muhl. slippery elm	5.0	3.4	15.0	2.4	5.8
<u>Viburnum prunifolium</u> L. black haw	1.0	0.7	32.0	5.0	5.7
<u>Prunus americana</u> Marsh. wild plum	5.0	3.4	12.0	1.9	5.3
<u>Juniperus virginiana</u> L. red cedar	6.0	4.1	7.0	1.1	5.2
<u>Prunus serotina</u> Ehrh. black cherry	5.0	3.4	8.0	1.3	4.7
<u>Zanthoxylum</u> sp. L. prickly ash	2.0	1.3	21.0	3.3	4.6
<u>Sassafras albidum</u> (Nutt.) Nees sassafras	4.0	2.8	11.0	1.7	4.5
<u>Diospyros virginiana</u> L. persimmon	3.0	2.1	10.0	1.6	3.7
<u>Celastrus</u> sp. L. bittersweet	4.C	2.8	4.0	0.6	3.4
<u>Vitis vulpina</u> L. winter grape	3.0	2.1	7.0	1.1	3.2
<u>Vitis cinerea</u> Engelm. grayback grape	3.0	2.1	4.0	0.6	2.7
<u>Rubus occidentalis</u> L. black raspberry	2.0	1.3	7.0	1.1	2.4
<u>Ostrya virginiana</u> (Mill.) K. Koch hop-hornbeam	2.0	1.3	6.0	0.9	2.2

Scientific Name Common Name	Frequency[b]	Relative Frequency (%)[c]	Density[d]	Relative Density (%)[e]	Importance Value[f]
Crataegus sp. L. hawthorn	2.0	1.3	3.0	0.5	1.8
Quercus rubra L. red oak	2.0	1.3	2.0	0.3	1.6
Celastrus scandens L. american bittersweet	1.0	0.7	3.0	0.5	1.2
Morus rubra L. red mulberry	1.0	0.7	4.0	0.6	1.3
Euonymus atropurpureus Jacq. wahoo	1.0	0.7	1.0	0.2	0.9
Smilax sp. L. catbrier	1.0	0.7	1.0	0.2	0.9
TOTAL	145.0	99.6	638.0	100.1	199.7

Trees and/or shrubs per quadrat = 39.9
Trees and/or shrubs per acre = 6,463.8

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[a] Tree or shrub less than 2.0 inches diameter at breast height.

[b] Number of subplots a species occurs.

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d] Cumulative number of a species within subplots sampled.

[e] $\frac{\text{Density of a species occurrence}}{\text{Cumulative density of all species}} \times 100$

[f] Summation of relative frequency + relative density

[g] Includes the species and varieties.

APPENDIX A-23

DATA SUMMARY FOR OVERSTORY VEGETATION[a] OF SAMPLING STATION F-2, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974 (based on sixteen 25-milacre plots)

Scientific Name / Common Name	Frequency[b]	Relative Frequency (%)[c]	Density[d]	Relative Density (%)[e]	Dominance[f]	Relative Dominance (%)[g]	Importance Value[h]
Quercus alba[i] L. and var. / white oak	15.0	25.0	73.0	46.7	2,859.7	63.2	134.9
Carya ovata (Mill.) K. Koch / shagbark hickory	11.0	18.3	24.0	15.4	442.5	9.8	43.5
Carya texana Buckl. / black hickory	6.0	10.0	17.0	10.9	248.4	5.5	26.4
Quercus rubra L. / red oak	5.0	8.3	6.0	3.8	515.9	11.4	23.5
Quercus velutina Lam. / black oak	6.0	10.0	10.0	6.4	264.4	5.8	22.2
Cornus florida L. / flowering dogwood	6.0	10.0	14.0	9.0	67.2	1.5	20.5
Amelanchier arborea (Michx.f.) Fern. / shadbush	3.0	5.0	3.0	1.9	19.1	0.4	7.3
Carya tomentosa Nutt. / mockernut hickory	2.0	3.3	3.0	1.9	29.8	0.7	5.9
Sassafras albidum (Nutt.) Nees / sassafras	2.0	3.3	2.0	1.3	19.2	0.4	5.0
Quercus stellata Wang. / post oak	1.0	1.7	1.0	0.6	38.5	0.9	3.2
Prunus serotina Ehrh. / black cherry	1.0	1.7	1.0	0.6	7.1	0.2	2.5

APPENDIX A-23 (continued)

Scientific Name Common Name	Frequency[b]	Relative Frequency (%)[c]	Density[d]	Relative Density (%)[e]	Dominance[f]	Relative Dominance (%)[g]	Importance Value[h]
Morus rubra L. red mulberry	1.0	1.7	1.0	0.6	7.1	0.2	2.5
Diospyros virginiana L. persimmon	1.0	1.7	1.0	0.6	4.9	0.1	2.4
TOTAL	60.0	100.0	156.0	99.7	4,523.8	100.1	299.8

Trees per quadrat = 9.8
Trees per acre = 396.8
Basal area per quadrat = 282.7 sq. in.
Basal area per acre = 11,449.4 sq. in.

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[a] Tree species 2.0 inches or greater diameter at breast height.

[b] Number of subplots a species occurs.

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d] Cumulative number of a species within subplots sampled.

[e] $\frac{\text{Density of a species occurrence}}{\text{Cumulative density of all species}} \times 100$

[f] Cumulative basal area (sq. in.) of a species within subplots sampled.

[g] $\frac{\text{Cumulative basal area of a species}}{\text{Cumulative basal area of all species}} \times 100$

[h] Summation of relative frequency + relative density + relative dominance.

[i] Includes species and varieties

APPENDIX A-24

DATA SUMMARY OF FOREST GROUND VEGETATION[a] CLIPPED FROM SUBPLOTS OF SAMPLING STATION F-3, CALLAWAY PLANT-SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Scientific Name / Common Name	Subplots-presence indicated by dry weights (grams/0.25-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[b] (%)	Relative[c] Frequency (%)	Dry Weight[d] for Species	Relative[e] Weight (%)	Importance[f] Value
Carex rosea Schkuhr / ---	2.00	1.65		0.70	0.10	2.00	0.10	1.05		4.60				1.30		0.25	62.50	12.65	13.75	12.66	25.31
Desmodium nudiflorum (L.) D.C. / tick trefoil	1.00					0.20	6.60	0.60	4.60					0.40			37.50	7.59	13.40	12.34	19.93
Strophostyles helvola (L.) Britt. / wild bean	2.50		0.30		2.05							0.50	0.30	2.50			37.50	7.59	8.15	7.50	15.09
Prunus virginiana (L.) / choke cherry		0.75	0.25														12.50	2.63	1.00	0.92	3.55
Monarda russeliana Nutt. / horsemint		0.30			1.60						7.30						18.75	3.79	9.20	8.47	12.26
Panicum boscii Poir. / ---		0.10															6.25	1.26	0.10	0.90	2.16
Parthenocissus quinquefolia (L.) Planch / Virginia creeper		0.30	0.40					0.40	.05	2.60	1.30	0.85	3.95	0.05	3.80		62.50	12.65	13.70	12.61	25.26
Quercus velutina Lam. / black oak			2.30									0.05					12.50	2.63	2.35	2.16	4.79
Carex bushii Mack. / ---	0.80	0.20	0.75			0.80						0.60					31.25	6.32	3.15	2.90	9.22
Quercus alba[g] L. and var. / white oak			0.15								0.30						12.50	2.63	0.45	0.41	3.04
Rhus aromatica Ait. / fragrant sumac			3.50	4.10							3.60	5.40				5.57	31.25	6.32	22.17	20.41	26.73
Galium circaezans Michx. / wild licorice			0.02		0.02					0.25							18.75	3.79	0.29	0.26	4.05
Solidago ulmifolia Muhl. / elm-leaf goldenrod					0.90												6.25	1.26	0.90	0.82	2.08
Lespedeza violacea (L.) Pers. / bush clover						0.02				0.60							12.50	2.63	0.62	0.57	3.20
Fraxinus americana L. / white ash						0.05											6.25	1.26	0.05	0.04	1.30
Potentilla simplex Michx. / cinquefoil						0.35					0.80						12.50	2.63	1.15	1.05	3.68
Heuchera sp. L. / alum root						0.15											6.25	1.26	0.15	0.13	1.39

Sheet 1

APPENDIX A-24 (continued)

Scientific Name Common Name	Subplots-presence indicated by dry weights (grams/0.25-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[b] (%)	Relative[c] Frequency(%)	Dry Weight[d] for Species	Relative[e] Weight(%)	Importance[f] Value
Panicum lanuginosum var. *implicatum* (Scribn.) Fern. ---						0.10											6.25	1.26	0.10	0.90	2.16
Antennaria plantiginifolia (L.) Hook. pussy's toes						2.10	0.20							0.50			18.75	3.79	2.80	2.57	6.36
Vitis cinerea Engelm. grayback grape							3.50										6.25	1.26	3.50	3.22	4.48
Rosa carolina L. pasture rose								0.40							0.90	0.80	18.75	3.79	2.10	1.93	5.72
Lactuca canadensis L. wild lettuce										0.30							6.25	1.26	0.30	0.27	1.53
Cornus florida L. flowering dogwood											0.05	0.05					12.50	2.63	0.10	0.90	3.53
Galium concinnum Torr. & Gray elegant bedstraw												1.15		0.80			12.50	2.63	1.95	1.79	4.42
Desmodium glutinosum (Muhl.) Wood tick trefoil												4.85					6.25	1.26	4.85	4.46	5.72
Viburnum rufidulum Raf. southern black haw													0.50				6.25	1.26	0.50	0.46	1.72
Rubus flagellaris Willd. dewberry														0.80			6.25	1.26	0.80	0.73	1.99
Vitis vulpina L. winter grape															1.00		6.25	1.26	1.00	0.92	2.18
TOTAL	6.30	3.30	7.67	4.80	4.67	5.77	10.40	2.45	4.65	8.35	13.35	13.45	4.75	6.35	5.70	6.62	493.75	100.55	108.58	102.30	202.85

[a] Includes woody and herbaceous plants of less than 20 inches in height.

[b] $\frac{\text{Numbers of subplots the species occurs}}{\text{Number of subplots sampled (16)}} \times 100$

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d] Cumulative weight (16 subplots) by species

[e] $\frac{\text{Cumulative weight (a species)}}{\text{Cumulative weight (all species)}} \times 100$

[f] Relative frequency + relative weight.

APPENDIX A-25

DATA SUMMARY OF FOREST GROUND VEGETATION* CLIPPED FROM SUBPLOTS OF SAMPLING STATION F-3, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, MAY-JUNE 1974

Scientific Name / Common Name	Subplots - presence indicated by dry weights (grams/0.25-milacre plots)																Frequency (%)[a]	Relative Frequency[b]	Dry Weight Per Species[c]	Relative Weights (%)[d]	Importance Value[e]
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16					
Aster sp. L.																					
aster	1.12									0.08							12.50	1.89	1.20	0.68	2.57
Parthenocissus quinquefolia (L.) Pursh																					
Virginia creeper	1.50		7.64	0.84	0.35	1.57		1.96	3.28	0.36	0.54	6.73	0.02	0.94		0.83	81.25	12.26	26.56	14.99	27.25
Carex bushii Mack.																					
---	0.22			1.68		0.35		0.03				1.29	0.01		1.49		43.75	6.60	5.07	2.86	9.46
Galium circaezans Michx.																					
wild licorice	0.11	0.01			0.18			0.13		0.15	0.07	2.39	0.56	0.07			56.25	8.49	3.67	2.07	10.56
Anemonella thalictroides (L.) Spach.																					
rue anemone	0.10	0.40		0.02		0.07								0.03			31.25	4.72	0.62	0.35	5.07
Desmodium nudiflorum (L.) D.C.																					
tick trefoil		0.42					11.95	0.20	2.22								25.00	3.77	14.79	8.35	12.12
Rhus aromatica Ait.																					
fragrant sumac			11.65	1.21	6.00			5.06	0.04		8.78		1.06	0.43		20.20	56.25	8.49	54.43	30.72	39.21
Strophostyles helvola (L.) Britt.																					
wild bean			1.60			0.57		0.01	0.05	0.02	2.41	1.44	1.06	1.67		0.34	62.50	9.43	9.17	5.17	14.60
Rosa carolina L.																					
pasture rose			2.43		0.32							1.85					18.75	2.83	4.60	2.60	5.43
Vitis cinerea Engelm.																					
grayback grape			9.74			0.10	0.03	0.09			0.05						31.25	4.72	10.01	5.65	10.37
Monarda russelliana Nutt.																					
horsemint			4.83		0.11												12.50	1.89	4.94	2.79	4.68
Quercus alba** L.																					
white oak				0.31		0.14	(0.20)										18.75	2.83	0.65	0.37	3.20
Carya ovata (Mill.) K. Koch																					
shagbark hickory				0.81													6.25	0.94	0.81	0.46	1.40
Carex glaucodea Tuckerm.																					
---				0.20													6.25	.94	0.20	0.11	1.05
Rhus radicans L.																					
poison ivy					2.90												6.25	0.94	2.90	1.64	2.58
Celastrus scandens L.																					
bittersweet					0.35												6.25	0.94	0.35	0.20	1.14
Amelanchier arborea (Michx. f.) Fern.																					
shadbush					0.23												6.25	0.94	0.23	0.13	1.07
Smilacina racemosa L.																					
false Solomon's seal					0.08				1.83								12.50	1.89	1.91	1.08	2.97
Cornus florida L.																					
flowering dogwood						1.72		0.20			0.60		0.09				25.00	3.77	2.61	1.47	5.24
Panicum boscii Poir.																					
---						0.01											6.25	0.94	0.01	.001	0.94
Panicum subvillosum Ashe																					
---						0.16											6.25	0.94	0.16	0.09	1.03
Antennaria plantaginifolia (L.) Hook.																					
pussy's toes						0.18											6.25	0.94	0.18	0.10	1.06
Carex rosea Schk.																					
---							1.94										6.25	0.94	1.94	1.09	2.03

APPENDIX A-25 (continued)

Scientific Name Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency (%)[a]	Relative Frequency[b]	Dry Weight Per Species[c]	Relative Weights (%)[d]	Importance Values[e]
	Subplots - presence indicated by dry weights (grams/0.25-milacre plots)																				
Viola triloba Schwein. f. dilatata Ell. three-lobed violet								0.15									6.25	0.94	0.15	0.08	1.02
Lactuca canadensis L. var. obovata Wieg. wild lettuce								0.55									6.25	0.94	0.55	0.31	1.25
Prunus serotina Ehrh. black cherry								0.19		1.56	1.18						18.75	2.83	2.93	1.65	4.48
Podophyllum peltatum L. may apple									3.33								6.25	0.94	3.33	1.88	2.82
Vitis aestivalis Michx. summer grape									0.01								6.25	0.94	0.01	.001	0.94
Symphoricarpos orbiculatus Moench. coral berry										2.91							6.25	0.94	2.91	1.64	2.58
Carex gravida Bailey ---										0.04	0.67			1.66			18.75	2.83	2.37	1.34	4.17
Danthonia spicata (L.) Beauv. poverty grass										0.12							6.25	0.94	0.12	0.08	1.02
Rubus flagellaris Willd. dewberry														2.03			6.25	0.94	2.03	1.15	2.09
Galium concinnum Torr. & Gray elegant bedstraw														0.15			6.25	0.94	0.15	0.08	1.02
Rubus pensilvanicus Poir. highbush blackberry														4.10			6.25	0.94	4.10	2.31	3.25
Veronicastrum virginicum (L.) Farw. culvers root														0.38			6.25	0.94	0.38	0.21	1.15
Euonymus atropurpea Jacq. wahoo																9.96	6.25	0.94	9.96	5.62	6.56
Agrimonia rostellata Wallr. agrimony																0.34	6.25	0.94	0.34	0.19	1.13
Asimina triloba (L.) Dunal. pawpaw																0.86	6.25	0.94	0.86	0.49	1.43
Totals	3.05	0.83	37.85	5.07	10.52	4.87	14.12	8.57	10.76	5.24	14.30	13.70	2.80	11.46	1.49	32.53	662.50	99.92	177.70	100.00	199.92

*Includes woody and herbaceous plants of less than 20 inches in height.
**Includes the species and/or its hybrids.

[a] = $\frac{\text{Number of subplots the species occurs}}{\text{Number of subplots sampled (16)}} \times 100$

[b] = $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[c] = Cumulative weight (16 subplots) by species

[d] = $\frac{\text{Cumulative weight (a species)}}{\text{Cumulative weight (all species)}} \times 100$

[e] = Relative frequency + relative weight

APPENDIX A-26

DATA SUMMARY FOR UNDERSTORY VEGETATION[a] OF SAMPLING STATION F-3, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974
(based on sixteen 6.25-milacre plots)

Scientific Name Common Name	Frequency[b]	Relative[c] Frequency (%)	Density[d]	Relative[e] Density (%)	Importance[f] Value
Rhus aromatica Ait. fragrant sumac	14.0	12.3	306.0	58.4	70.7
Cornus florida L. flowering dogwood	15.0	13.2	49.0	9.4	22.6
Prunus serotina Ehrh. black cherry	12.0	10.5	22.0	4.2	14.7
Quercus velutina Lam. black oak	10.0	8.8	24.0	4.6	13.4
Carya sp. Nutt. hickory	9.0	7.9	27.0	5.2	13.1
Quercus alba[g] L. and var. white oak	9.0	7.9	15.0	2.9	10.8
Acer saccharum Marsh sugar maple	3.0	2.6	22.0	4.2	6.8
Sassafras albidum (Nutt.) Nees sassafras	5.0	4.4	12.0	2.3	6.7
Quercus rubra L. red oak	4.0	3.5	6.0	1.1	4.6
Vitus vulpina L. winter grape	5.0	4.4	1.0	0.2	4.6
Rosa carolina L. pasture rose	4.0	3.5	4.0	0.8	4.3

APPENDIX A-26 (continued)

Scientific Name / Common Name	Frequency[b]	Relative Frequency (%)[c]	Density[d]	Relative Density (%)[e]	Importance Value[f]
Rubus flagellaris Willd. / dewberry	3.0	2.6	6.0	1.1	3.7
Vitis cinerea Engelm. / grayback grape	3.0	2.6	4.0	0.8	3.4
Prunus americana Marsh. / wild plum	2.0	1.8	6.0	1.1	2.9
Morus rubra L. / red mulberry	2.0	1.8	4.0	0.8	2.6
Juniperus virginiana L. / red cedar	2.0	1.8	3.0	0.6	2.4
Symphoricarpos sp. Duham. / snowberry	2.0	1.8	3.0	0.6	2.4
Crataegus sp. L. / hawthorn	2.0	1.8	2.0	0.4	2.2
Fraxinus americana L. / white ash	2.0	1.8	2.0	0.4	2.2
Vitis aestivalis Michx. / summer grape	2.0	1.8	2.0	0.4	2.2
Amelanchier arborea (Michx.f.) Fern. / shadbush	1.0	0.9	1.0	0.2	1.1
Celtis occidentalis L. / hackberry	1.0	0.9	1.0	0.2	1.1
Diospyros virginiana L. / persimmon	1.0	0.9	1.0	0.2	1.1

Scientific Name Common Name	Frequency[b]	Relative[c] Frequency(%)	Density[d]	Relative[e] Density(%)	Importance[f] Value
Viburnum prunifolium L. black haw	1.0	0.9	1.0	0.2	1.1
TOTAL	114.0	100.4	524.0	100.3	200.7

Trees and/or shrubs per quadrat = 39.9
Trees and/or shrubs per acre = 6,463.8

---

[a] Tree or shrub less than 2.0 inches diameter at breast height.

[b] Number of subplots a species occurs.

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d] Cumulative number of a species within subplots sampled.

[e] $\frac{\text{Density of a species occurrence}}{\text{Cumulative density of all species}} \times 100$

[f] Summation of relative frequency + relative density.

[g] Includes the species and varieties.

APPENDIX A-27

DATA SUMMARY FOR OVERSTORY VEGETATION[a] OF SAMPLING STATION F-3, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974
(based on sixteen 25 milacre plots)

Scientific Name / Common Name	Frequency[b]	Relative[c] Frequency (%)	Density[d]	Relative[e] Density (%)	Dominance[f]	Relative[g] Dominance (%)	Importance[h] Value
Quercus alba[i] L. and var. white oak	14.0	26.9	102.0	57.0	3,175.1	58.3	142.2
Quercus velutina Lam. black oak	9.0	17.3	24.0	13.4	1,296.3	23.8	54.5
Cornus florida L. flowering dogwood	9.0	17.3	12.0	6.7	63.6	1.2	25.2
Carya texana Buckl. black hickory	6.0	11.5	14.0	7.8	210.6	3.9	23.2
Quercus stellata Wang. post oak	4.0	7.7	9.0	5.0	204.3	3.8	16.5
Quercus rubra L. red oak	3.0	5.8	6.0	3.4	287.0	5.3	14.5
Carya ovata (Mill) K. Koch shagbark hickory	2.0	3.8	6.0	3.4	84.2	1.5	8.7
Acer saccharum Marsh sugar maple	2.0	3.8	2.0	1.1	108.8	2.0	6.9
Carya tomentosa Nutt. mockernut hickory	1.0	1.9	2.0	1.1	6.2	0.1	3.1
Morus rubra L. red mulberry	1.0	1.9	1.0	0.6	3.1	0.1	2.6
Vitis cinerea Engelm. grayback grape	1.0	1.9	1.0	0.6	3.1	0.1	2.6
TOTAL	52.0	99.8	179.0	100.1	5,442.3	100.1	300.0

Trees per quadrat	=	11.2
Trees per acre	=	453.6
Basal area per quadrat	=	340.1 sq. in.
Basal area per acre	=	13,774.1 sq. in.

---

[a] Tree species 2.0 inches or greater diameter at breast height.

[b] Number of subplots a species occurs.

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d] Cumulative number of a species within subplots sampled.

[e] $\frac{\text{Density of a species occurrence}}{\text{Cumulative density of all species}} \times 100$

[f] Cumulative basal area (sq. in.) of a species within the subplots sampled.

[g] $\frac{\text{Cumulative basal area of a species}}{\text{Cumulative basal area of all species}} \times 100$

[h] Summation of relative frequency + relative density + relative dominance.

[i] Includes species and varieties.

APPENDIX A-28

DATA SUMMARY OF FOREST GROUND VEGETATION[a] CLIPPED FROM SUBPLOTS OF SAMPLING STATION F-4, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974

Scientific Name / Common Name	Subplots - presence indicated by dry weights (grams/0.25-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency[b] (%)	Relative[c] Frequency (%)	Dry[d] Weight for Species	Relative[e] Weight (%)	Importance[f] Value
Rhus aromatica Ait. fragrant sumac	6.00		4.75	5.95		4.25		3.55	4.55						11.20		43.75	10.6	40.25	24.04	34.64[1]
Panicum boscii Poir. ---		0.60			0.65									0.25	3.90		25.00	6.54	5.40	3.22	9.76
Potentilla simplex Michx. cinquefoil		6.80															6.25	1.51	6.80	4.06	5.57
Helianthus strumosus L. sunflower		4.45		12.80													12.50	3.03	17.25	10.30	13.33[3]
Rosa carolina L. pasture rose			2.10				2.80			0.55	2.60					1.50	31.25	7.57	9.55	5.70	13.27[4]
Vitis cinerea Engelm grayback grape			4.10						2.90								12.50	3.03	7.00	4.18	7.21
Quercus velutina Lam. black oak			3.20	2.10				0.05			0.50	1.45					31.25	7.57	7.30	4.36	11.93[5]
Lespedeza violacea (L.) Pers bush clover			2.30		0.90										4.60		18.75	4.54	7.80	4.65	9.19
Carex rosea Schlc. ---					6.25									0.05		3.40	18.75	4.54	9.70	5.79	10.33[6]
Carex glaucodea Tuckerm. ---					0.30												6.25	1.51	0.30	0.17	1.68
Carex muhlenbergii Schk. ---					0.20												6.25	1.51	0.20	0.11	1.62
Carex bushii Mack. ---					0.40											1.10	12.50	3.03	1.50	0.89	3.92
Panicum lanuginosum Ell. ---					0.15											0.40	12.50	3.03	0.55	0.32	3.35
Amelanchier arborea (Michx.) Farr. shadbush					0.55												6.25	1.51	0.55	0.32	1.83
Solidago ulmifolia Muhl. elm leaf goldenrod					8.00			0.30								0.90	18.75	4.54	9.20	5.49	10.03[7]
Monarda russeliana Nutt. horsemint					0.70			5.20						2.80			18.75	4.53	8.70	5.19	9.73
Strophostyles helvola (L.) Britt. wild bean						0.10						0.30	0.75	6.55	1.10	0.55	37.50	9.09	9.65	5.76	14.85[2]
Q-- rcus alba[g] L. and var. -hite oak						1.10						0.30					12.50	3.03	1.40	0.83	3.86

Sheet 1

APPENDIX A-28 (continued)

Scientific Name Common Name	Subplots - presence indicated by dry weights (grams/0.25-milacre plots)																Frequency[b] (%)	Relative[c] Frequency (%)	Dry[d] Weight for Species	Relative[e] Weight (%)	Importance[f] Value
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16					
Cornus florida L. flowering dogwood								10.50									6.25	1.51	10.50	6.27	7.78
Celastrus scandens L. American bittersweet								0.40									6.25	1.51	0.40	0.23	1.74
Quercus rubra L. red oak										2.55					1.25		12.50	3.03	3.80	2.27	5.30
Parthenocissus quinquefolia (L) Planck. Virginia creeper										0.35							6.25	1.51	0.35	0.20	1.71
Amorpha canescens Pursh lead plant										0.65							6.25	1.51	0.65	0.38	1.89
Antennaria plantaginifolia (L.) Hook. pussy's toes												0.55		1.30			12.50	3.03	1.85	1.10	4.13
Linum sp. L. flax													2.10				6.25	1.51	2.10	1.25	2.76
Euphorbia corollata L. flowering spurge															0.45		6.25	1.51	0.45	0.26	1.77
Aster anomalus Engelm. aster																2.65	6.25	1.51	2.65	1.58	3.09
Sassafras albidum (Nutt.) Nees sassafras																0.40	6.25	1.51	0.40	0.23	1.74
Panicum sphaerocarpon Ell. ---																1.15	6.25	1.51	1.15	0.68	2.19
TOTALS	6.00	11.85	16.45	8.05	30.90	5.75	2.80	20.00	7.45	4.10	3.10	2.60	2.85	10.95	22.50	12.05	412.50	100.37	167.40	99.83	200.20

[a]Includes woody and herbaceous plants of less than 20 inches in height.

[g]Includes species and varieties

[b] = $\frac{\text{Numbers of subplots the species occurs}}{\text{Number of subplots samples (16)}}$ x 100

[c] = $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}}$ x 100

[d] = Cumulative weights (16 subplots) by species

[e] = $\frac{\text{Cumulative weight (a species)}}{\text{Cumulative weight (all species)}}$ x 100

[f] = Relative frequency + relative weight

APPENDIX A-29

DATA SUMMARY OF FOREST GROUND VEGETATION[*] CLIPPED FROM SUBPLOTS OF SAMPLING STATION F-4, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, MAY-JUNE 1974

Scientific Name / Common Name	Subplots - presence indicated by dry weights (grams/0.25-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency (%)[a]	Relative Frequency[b]	Dry Weight Per Species[c]	Relative Weight (%)[d]	Importance Value[e]
Symphoricarpos orbiculatus Moench. coral berry	0.01																6.25	1.19	0.01	.003	1.19
Cynanchum laeve Michx. angle pod	0.02																6.25	1.19	0.02	0.01	1.20
Quercus marilandica** Muenchh. black jack oak		1.43	22.05						13.91 (15.98)								18.75	3.57	39.46	14.52	18.49
Potentilla simplex Michx. cinquefoil		9.84															6.25	1.19	9.84	3.72	4.91
Smilax tamnoides L. bristly greenbrier		0.08															6.25	1.19	0.08	0.03	1.22
Rosa carolina L. pasture rose		0.11	1.91	0.58			0.17		1.73		11.24						37.50	7.14	15.74	5.95	13.09
Desmodium dillenii Darl. tick trefoil		0.08						0.07	0.02					0.33		1.36	31.25	5.95	1.82	0.69	6.64
Prunus sp. L. cherry			0.07														6.25	1.19	0.07	0.03	1.22
Psoralea psoralioides (Walt.) Cory var. eglandulosa (Ell.) Freeman Sampson's snakeroot			0.39			3.24	7.31			1.58	5.19	2.46	14.27	10.26		1.11	56.25	10.71	45.81	17.32	28.03
Vitis cinerea Engelm. grayback grape			0.17							0.01							12.50	2.38	0.18	0.07	2.45
Rhus aromatica Ait. fragrant sumac				3.46	0.12	0.01		2.28	3.92			11.54	3.15		5.53		50.00	9.52	30.01	11.35	20.87
Dioscorea villosa L. yam				0.17													6.25	1.19	0.17	0.06	1.25
Botrychium virginianum (L.) Sw. rattlesnake fern				0.02													6.25	1.19	0.02	0.01	1.20
Helianthus sp. L. sunflower					5.05											0.85	12.50	2.38	5.90	2.23	4.61
Crataegus danielsii Palmer hawthorn					5.79												6.25	1.19	5.79	2.19	3.38
Sanicula canadensis L. black snakeroot					0.01												6.25	1.19	0.01	.003	1.19
Lespedeza violacea (L.) Pers. bush clover					0.06										0.02		12.50	2.38	0.08	0.03	2.41
Strophostyles helvola (L.) Britt. wild bean					0.05										2.17		12.50	2.38	2.22	0.84	3.22
Cornus florida L. flowering dogwood					0.05											0.10	12.50	2.38	0.15	0.06	2.44
Carex bushii Mack. ---					1.82											2.66	12.50	2.38	4.48	1.69	4.07
Quercus macrocarpa Michx. X Q. marilandica bur oak hybrid					32.32												6.25	1.19	32.32	12.22	13.41
Carex rosea Schk. ---						1.51								1.92			12.50	2.38	3.43	1.30	3.68
Viola triloba Schwein. f. dilatata Ell. three-lobed violet							0.01										6.25	1.19	0.01	.003	1.19
Parthenocissus quinquefolia (L.) Planch. Virginia creeper								0.27					0.28				12.50	2.38	0.55	0.21	2.59
Quercus alba L. white oak								12.99									6.25	1.19	12.99	4.91	6.10
Quercus velutina** Lam. X Q. bushii Sarg. black oak hybrid										0.21	(3.65)						12.50	2.38	3.86	1.46	3.84
Solidago sp. L. solidago											0.88						6.25	1.19	0.88	0.33	1.52
Aster sp. L. aster											0.60		1.17		0.69	5.02	25.00	4.76	7.48	2.83	7.59
Diospyros virginiana L. persimmon											0.49						6.25	1.19	0.49	0.19	1.38
Parthenium integrifolium Ait. American feverfew												10.95					6.25	1.19	10.95	4.14	5.33
Amelanchier arborea (Michx. f.) Fern. shadbush													9.93				6t25	1.19	9.93	3.75	4.94
Panicum linearifolium Scribn. ---													0.24		1.66		12.50	2.38	1.90	0.72	3.10
Sassafras albidum (Nutt.) Nees sassafras													0.22				6.25	1.19	0.22	0.08	1.27
Hieraceum sp. hawkweed														0.02			6.25	1.19	0.02	0.01	1.20
Carex alata Torr. & Gray ---															0.45		6.25	1.19	0.45	0.17	1.36
Panicum subvillosum Ashe ---															0.01	0.07	12.50	2.38	0.08	0.03	2.41
Antennaria plantaginifolia (L.) Hook. pussy's toes																2.67	6.25	1.19	2.67	1.01	2.20
Elymus villosus Muhl. wild rye																3.61	6.25	1.19	3.61	1.36	2.55
Euphorbia sp. L. spurge																0.10	6.25	1.19	0.10	0.04	1.23
Lactuca sp. L. wild lettuce																0.28	6.25	1.19	0.28	0.11	1.30

APPENDIX A-29 (continued)

Scientific Name Common Name	Subplots - presence indicated by dry weights (grams/0.25-milacre plots) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Frequency (%)[a]	Relative Frequency[b]	Dry Weight Per Species[c]	Relative Weight (%)[d]	Importance Value[e]
Desmodium nudiflorum (L.) D.C. tick trefoil																0.61	6.25	1.19	0.61	0.23	1.42
Compositae (genus unident.) ---																0.37	6.25	1.19	0.37	0.14	1.33
Quercus shumardii Buckl. Shumard oak																9.27	6.25	1.19	9.27	3.50	4.69
Panicum boscii Poir. ---																0.15	6.25	1.19	0.15	0.06	1.25
Totals	0.03	11.54	24.59	4.23	45.27	4.76	7.49	15.[illegible]7	21.[illegible]5	1.80	22.05	24.95	29.26	12.53	10.53	28.23	525.00	99.96	264.48	100.00	199.96

*Includes woody and herbaceous plants of less than 20 inches in height.
**Includes the species and/or its hybrids.

[a] = $\frac{\text{Number of subplots the species occurs}}{\text{Number of subplots sampled (16)}} \times 100$

[b] = $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[c] = Cumulative weight (16 subplots) by species

[d] = $\frac{\text{Cumulative weight (a species)}}{\text{Cumulative weight (all species)}} \times 100$

[e] = Relative frequency + relative weight

APPENDIX A-30

DATA SUMMARY FOR UNDERSTORY VEGETATION[a] OF SAMPLING STATION F-4, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974 (based on sixteen 6.25-milacre plots)

Scientific Name Common Name	Frequency[b]	Relative[c] Frequency(%)	Density[d]	Relative[e] Density(%)	Importance[f] Value
Rhus aromatica Ait. fragrant sumac	12.0	13.5	129.0	31.4	44.9
Quercus velutina Lam. black oak	12.0	13.5	75.0	18.2	31.7
Quercus alba[g] L. and var. white oak	10.0	11.2	65.0	15.8	27.0
Cornus florida L. flowering dogwood	4.0	4.5	30.0	7.3	11.8
Quercus rubra L. red oak	4.0	4.5	12.0	2.9	7.4
Fraxinus americana L. white ash	5.0	5.6	5.0	1.2	6.8
Ostrya virginiana (Mill.) K. Koch hop-hornbeam	3.0	3.4	13.0	3.2	6.6
Carya sp. Nutt. hickory	3.0	3.4	12.0	2.9	6.3
Acer saccharum Marsh sugar maple	3.0	3.4	11.0	2.7	6.1
Amelanchier arborea (Michx.f.) Fern. shadbush	3.0	3.4	10.0	2.4	5.8
Prunus serotina Ehrh. black cherry	3.0	3.4	8.0	1.9	5.3

APPENDIX A-30 (continued)

Scientific Name Common Name	Frequency[b]	Relative Frequency (%)[c]	Density[d]	Relative Density (%)[e]	Importance Value[f]
Rosa carolina L. pasture rose	3.0	3.4	8.0	1.9	5.3
Vitis cinerea Engelm. grayback grape	3.0	3.4	7.0	1.7	5.1
Vitis vulpina L. winter grape	3.0	3.4	6.0	1.5	4.9
Crataegus sp. L. hawthorn	3.0	3.4	3.0	0.7	4.1
Diospyros virginiana L. persimmon	2.0	2.2	2.0	0.5	2.7
Juniperus virginiana L. red cedar	2.0	2.2	2.0	0.5	2.7
Quercus x fernowi Trel. (*Quercus alba x Quercus stellata*) oak	2.0	2.2	2.0	0.5	2.7
Quercus stellata Wang. post oak	2.0	2.2	2.0	0.5	2.7
Rubus flagellaris Willd. dewberry	2.0	2.2	2.0	0.5	2.7
Cercis canadensis L. redbud	1.0	1.1	3.0	0.7	1.8
Euonymus atropurpureus Jacq. wahoo	1.0	1.1	1.0	0.2	1.3
Prunus americana Marsh. wild plum	1.0	1.1	1.0	0.2	1.3

APPENDIX A-30 (continued)

Scientific Name / Common Name	Frequency[b]	Relative Frequency (%)[c]	Density[d]	Relative Density (%)[e]	Importance Value[f]
Sassafras albidum (Nutt.) Nees sassafras	1.0	1.1	1.0	0.2	1.3
Ulmus rubra Muhl. slippery elm	1.0	1.1	1.0	0.2	1.3
TOTAL	89.0	99.9	411.0	99.7	199.6

Trees and/or shrubs per quadrat = 25.7
Trees and/or shrubs per acre = 4,163.4

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[a]Tree or shrub less than 2.0 inches diameter at breast height.

[b]Number of subplots a species occurs.

[c]$\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d]Cumulative number of a species within subplots sampled.

[e]$\frac{\text{Density of a species occurrence}}{\text{Cumulative density of all species}} \times 100$

[f]Summation of relative frequency + relative density.

[g]Includes the species and varieties.

APPENDIX A-31

DATA SUMMARY FOR OVERSTORY VEGETATION[a] OF SAMPLING STATION F-4, CALLAWAY PLANT SITE, CALLAWAY COUNTY, MISSOURI, FALL 1974
(based on sixteen 25-milacre plots)

Scientific Name / Common Name	Frequency[b]	Relative Frequency(%)[c]	Density[d]	Relative Density(%)[e]	Dominance[f]	Relative Dominance(%)[g]	Value
Quercus alba[i] L. and var. white oak	12.0	28.6	34.0	37.4	1,241.9	26.7	92.7
Quercus velutina Lam. black oak	10.0	23.8	17.0	18.7	2,115.3	45.5	88.0
Quercus stellata Wang. post oak	9.0	21.4	21.0	23.1	954.4	20.5	65.0
Cornus florida L flowering dogwood	3.0	7.1	7.0	7.7	35.1	0.8	15.6
Quercus marilandica Muenchh black-jack oak	1.0	2.4	2.0	2.2	151.6	3.3	7.9
Carya texana Buckl. black hickory	2.0	4.8	2.0	2.2	12.0	0.3	7.3
Acer saccharum Marsh. sugar maple	1.0	2.4	3.0	3.3	19.8	0.4	6.1
Carya ovata (Mill.) K. Koch shagbark hickory	1.0	2.4	1.0	1.1	95.0	2.0	5.5
Amelanchier arborea (Michx.f.) Fern. shadbush	1.0	2.4	2.0	2.2	8.0	0.2	4.8
Ulmus rubra Muhl. slippery elm	1.0	2.4	1.0	1.1	9.6	0.2	3.7
Fraximus americana L. white ash	1.0	2.4	1.0	1.1	4.9	0.1	3.6
TOTAL	42.0	100.1	91.0	100.1	4,647.6	100.0	300.2

Sheet 1

Trees per quadrat	=	5.7
Trees per acre	=	230.9
Basal area per quadrat	=	290.5 sq. in.
Basal area per acre	=	11,765.3 sq. in.

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[a] Tree species 2.0 inches or greater diameter at breast height.

[b] Number of subplots a species occurs.

[c] $\frac{\text{Frequency of a species occurrence}}{\text{Cumulative frequency of all species}} \times 100$

[d] Cumulative number of a species within subplots sampled.

[e] $\frac{\text{Density of a species occurrence}}{\text{Cumulative density of all species}} \times 100$

[f] Cumulative basal area (sq. in.) of a species within subplots sampled.

[g] $\frac{\text{Cumulative basal area of a species}}{\text{Cumulative basal area of all species}} \times 100$

[h] Summation of relative frequency + relative density + relative dominance.

[i] Includes the species and varieties.

APPENDIX B-1

SCIENTIFIC AND COMMON NAMES OF HERPETOFAUNA FOUND ON CALLAWAY PLANT SITE, REFORM, MISSOURI, DURING SPRING AND FALL SAMPLING PERIODS, 1974[a]

Scientific Name	Common Name
Notophthalmus viridescens	Newt
Scaphiopus bombifrons	Plains spadefoot toad
Bufo fowleri	Fowler's toad
Bufo americanus	American toad
Hyla versicolor	Gray treefrog
Hyla crucifer	Spring peeper
Acris crepitans	Northern cricket frog
Rana pipiens	Leopard frog
Rana catesbeiana	Bullfrog
Rana clamitans	Green frog
Cheyldra serpentina	Snapping turtle
Terrapène carolina	Three-toed box turtle
Sceloporus undulatus	Eastern fence lizard
Ophisaurus attenuatus	Slender glass lizard
Lygosoma laterale	Ground skink
Eumeces fasciatus	Five-lined skink
Natrix sipedon	Common water snake
Storeria dekayi	Brown snake
Storeria occipitomaculata	Red-bellied snake
Thamnophis proximus	Western ribbon snake
Thamnophis sirtalis	Common garter snake
Virginia valeriae	Smooth earth snake
Heterodon platyrhinos	Eastern hognose snake
Carphophis amoenus	Worm snake
Diadophis punctatus	Eastern ringneck snake
Coluber constrictor	Racer
Elaphe obsoleta	Rat snake
Lamperopeltis getulus	Common kingsnake
Agkistrodon contortrix	Copperhead

[a]Phylogeny and taxonomy follow Blair, Blair, Brodkorb, Cagle and Moore, 1968.