PRELIMINARY REPORT OF ASSESSMENT OF A FIELD INVESTIGATION OF SIX-YEAR SPONTANEOUS ABORTION RATES IN THREE OREGON AREAS IN RELATION TO FOREST 2,4,5-T SPRAY PRACTICES

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Chapter I

INTRODUCTION

One of the widely used chlorophenoxy herbicides is the chemical 2,4,5-trichlorophenoxy acetic acid, commonly referred to as 2,4,5-T. A selective herbicide, 2,4,5-T is especially useful for brush control on rangeland, along right-of-ways, and in conifer forest habitats. The parent acid is formulated in a variety of emulsifiable esters and specific amine salts registered for use in both Canada and the United States.

Many studies have been conducted to determine the fate of TCDD in the environment. Since TCDD is reportedly not mobile in soil, it is not considered to be a risk in ground water. TCDD does not accumulate in vegetation (1).

In comparison with other pesticide products, the phenoxy herbicides are relatively non-toxic to mammals, and 2,4,5-T is classified as moderately toxic with an acute oral LD_{50} (rat) at 500 mg (acid basis)/kg (2). However, low levels of TCDD have been shown to have oncogenic effects in rodents and related effects in primates. Fetotoxicity and teratogenicity have been demonstrated at low levels, with the appearance of cleft palate and kidney anomalies in rats, mice, and hamsters. Embryotoxic effects in avian species have also been reported (1).

In July, 1978, Staff of the EPA Office of Pesticide Programs (OPP) and Colorado State University epidemiologists met in Oregon with local and State health officials to begin an investigation into a group of women living in the vicinity of Alsea who claimed they had experienced miscarriages because of herbicide spraying in the course of forest management. The investigation was precipatated in late June, 1978, when EPA received a letter signed by eight women living in this area who had experienced 10 miscarriages since 1973. The women claimed to be surrounded by forest land which has been sprayed for years with herbicides known to contain dioxin. They also charted their dates of miscarriage and related dates the forest areas were sprayed. Each of the women was under a physician's care at the time of miscarriage, and neither the women nor their doctors could ascertain the reasons for abortion. The investigators met with four of the women to discuss the circumstances of their reported exposure and any possible relationship to their subsequent miscarriages.

Following the visit by EPA and Colorado State University staff, an extensive health questionnaire (Appendix A) was designed jointly by OPP's Epidemiologic Studies Programs (ESP's) in Miami, Iowa, South Carolina and Colorado, in which detailed questions on self and family pregnancy and medical histories, environmental aspects, diet, occupational and household pesticide usage were included. During the first week of August, 1978, an epidemiologist from Colorado's ESP administered the questionnaire to nine women who had experienced 13 confirmed miscarriages from May, 1973 to March, 1978.

During late August and early September, the health questionnaire and related data (spray application, vital statistics, etc.) were evaluated independently by 10 experts in the fields of obstetrics, gynecology, epidemiology, biostatistics, reproductive endocrinology, and perinatal medicine. The consensus of the reviewers was that:

1. the spontaneous abortions did appear to follow a seasonal pattern (two of the reviewers noted the seasonal relationship but drew no conclusions);

2. Good Samaritan Hospital records for Benton County women for the years 1975-77 showed numerically higher rates of spontaneous abortions per live births during Jan., Feb., Mar., and Oct., Nov., and Dec., of each year than during April through Sept. (these records were based on stillbirths of terms greater than 20 weeks). Conversely, 10 of the 13 miscarriages reported by the Alsea participants occurred during the months of April through September (1973-1978);

3. there was a high numerical incidence of March to June miscarriages (nine of 13) among the Alsea participants. However, there was concern that the reports might comprise a biased sample (albeit unintended) of all miscarriages that occurred within the area and years under investigation;

4. a causal relationship between forest herbicide spraying and reproductive wastage had not been demonstrated from the data presented. Opinions ranged from ". . . no evidence of a causal relationship . . ." to "I cannot support or refute a cause and effect relationship . . ." Reviewers either stated or inferred that there was no real evidence of an epidemic based on the data presented.

An analysis of the data by staff of OPP's Human Effects Monitoring Branch (HEMB) identified:

1) the possibility of a relationship between time of spraying and conception and subsequent abortions among the Alsea women; and

2) the fact that, while State and county records of spontaneous abortions are given for terms of 20 weeks or greater, 12 of the 13 miscarriages experienced by the women in Alsea were for terms of less than 20 weeks.

Based upon the comments of the reviewers and HEMB staff, OPP undertook to develop data on spontaneous abortions of 20 weeks duration or less in the Study area and in a comparable control population.

The current study of 6-year spontaneous abortion rates in three Oregon areas was initiated by the Human Effects Monitoring Branch, Office of Pesticide Programs, in October of 1978. The study was accomplished under contract to the Epidemiologic Studies Program (ESP) projects in Colorado, Florida and Idaho. Scientists from the Colorado Project, under the direction of Dr. Eldon Savage, organized and conducted the field investigations, developed the data including the spontaneous abortion index, and prepared much of the report. Idaho project staff assisted in collection of hospital data in Malheur County. Statistical analysis and the interpretative narrative were developed by Drs. Robert Duncan and Thomas Keefe of the Florida and Colorado projects, respectively.

The following scientist were instrumental in the successful development and conduct of the study:

Dr. Eldon P. Savage, Director, Colorado ESP, Colorado State University

Colorado ESP Staff: Drs. Thomas Keefe, Robert Zimmerman and Richard Hayes; Messrs. William Wheeler, Lawrence Mounce and Jerry Rench; Ms. Lois Cox and Ms. Barbara Stevens.

Idaho ESP Staff (Dr. Charles Brokopp, Director): Ms. Jill Wyatt and Ms. Pamela Smith.

Dr. Robert C. Duncan, Director, Florida ESP, School of Medicine, University of Miami.

HEMB Staff: Drs. Jack Griffith and Charles Miller, Mr. Robert Heath and Ms. Mary Frankenberry.

This report was organized and edited by:

Jack Griffith, Ph.D.
Robert Heath, M.S.
Mary Frankenberry, B.A.

Chapter II

PURPOSE AND SCOPE

The purpose of this study was to assess the rates of spontaneous abortion occurring in a forested region of Oregon's Coastal Range, centered about the Alsea basin, where 2,4,5-T has been commonly used in forest management, and to compare those rates with rates occurring in a comparable control area.

Specific objectives of the study were to test the following hypotheses:

a. whether or not differences in spontaneous abortion rates exist between the study and control populations;

b. whether or not seasonal variations in rates exist within the study and control populations;

c. whether or not such variations, if they exist, can be associated with time and concentration of spray applications in the study area.

The data are limited to in-patient records of women hospitalized for spontaneous abortions of less than 20 weeks term, based upon:

a. the observation that 12 of the 13 miscarriages reported by the original nine participants were for terms of less than 20 weeks duration;

b. the assumption that a possible chemical effect would be most likely during the first trimester of pregnancy and could therefore be masked in abortion data spanning the entire nine months of term.

Chapter III

METHODS

The methods used in this study consisted of defining the study area, developing/confirming a 2,4,5-T use history in that area, researching U.S. Postal ZIP code boundaries, selecting a control area, defining an urban area, abstracting spontaneous abortion data from the hospitals in the three areas, interviewing area physicians, retrieving county birth data from Oregon computer tapes, and collecting various descriptive data ancillary to the study.

Description of the Study Area

The Study Area comprises approximately 1600 square miles of Oregon's forested Coastal Range (Figures 1 and 2). It was selected so as to be centered around the "Alsea basin", an area of approximately 400 square miles. The Study area includes the western half of Benton County, northwestern Lane County and all but the northern and northwestern reaches of Lincoln County. It is bounded on the west by approximately 70 miles of the Pacific Coast entending from Lincoln City southward to Florence, and extends inland for distances ranging from 10 to 35 miles. (Exact boundaries conform to U.S. Postal ZIP boundaries.) The Study area includes all but the northern and southern reaches of the Siuslaw National Forest. Interspaced throughout one numerous commercially owned and Bureau of Land Management forested acreages (Figure 3). Mountain elevations of approximately 1,000 feet are not uncommon; peak elevation is slightly more than 4,000 feet.

Figure 1. · OREGON

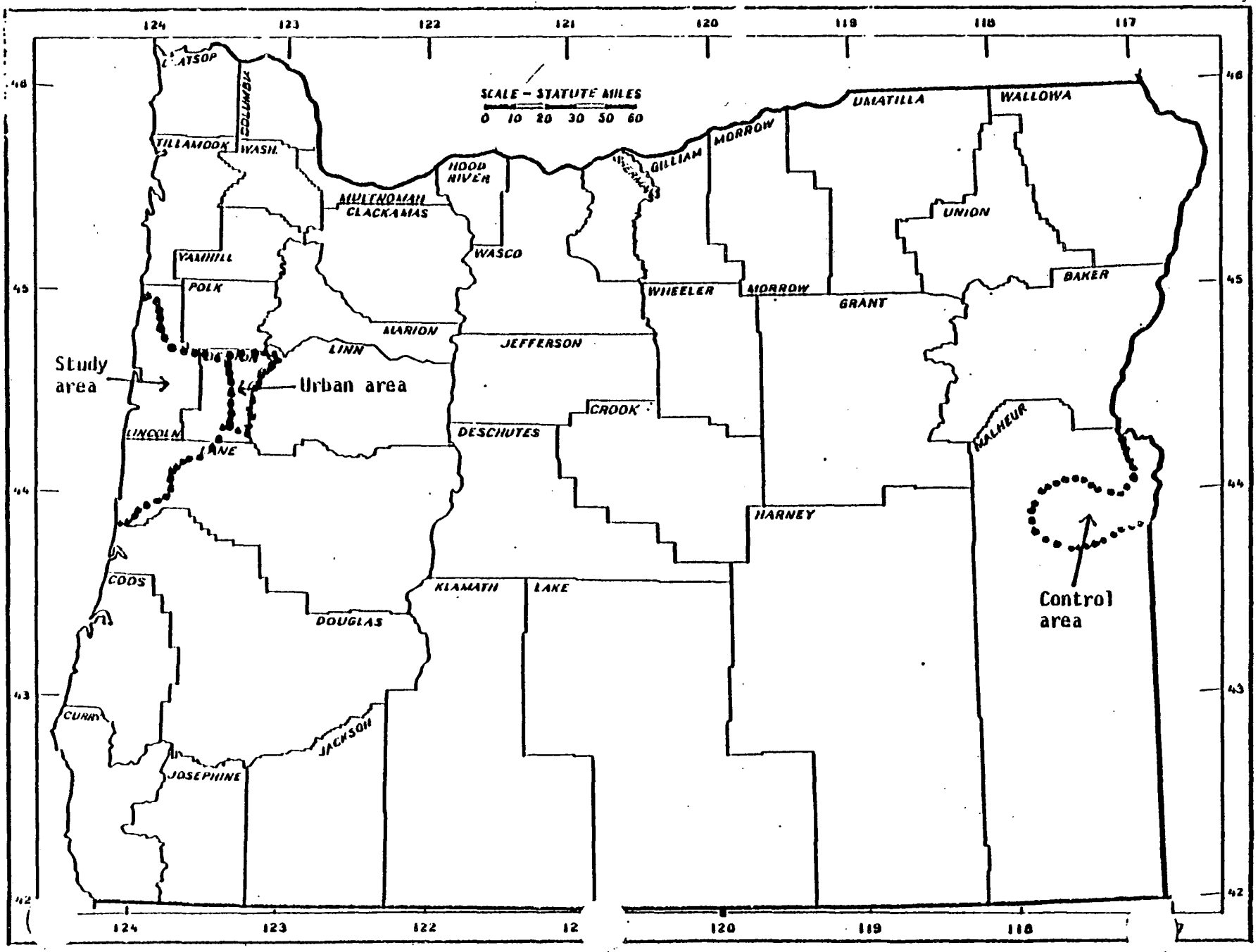


Figure 2. Study Area in Lane, Lincoln and Benton Counties of Oregon

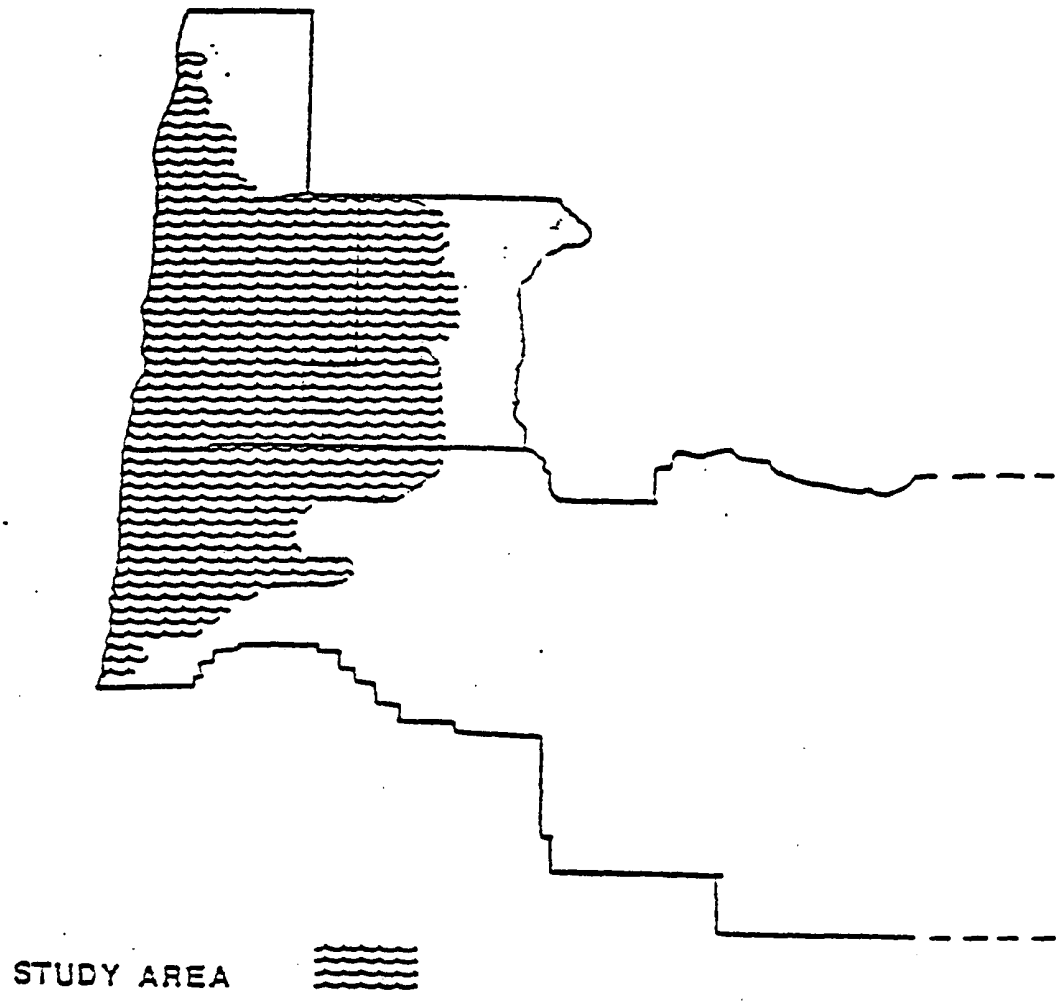
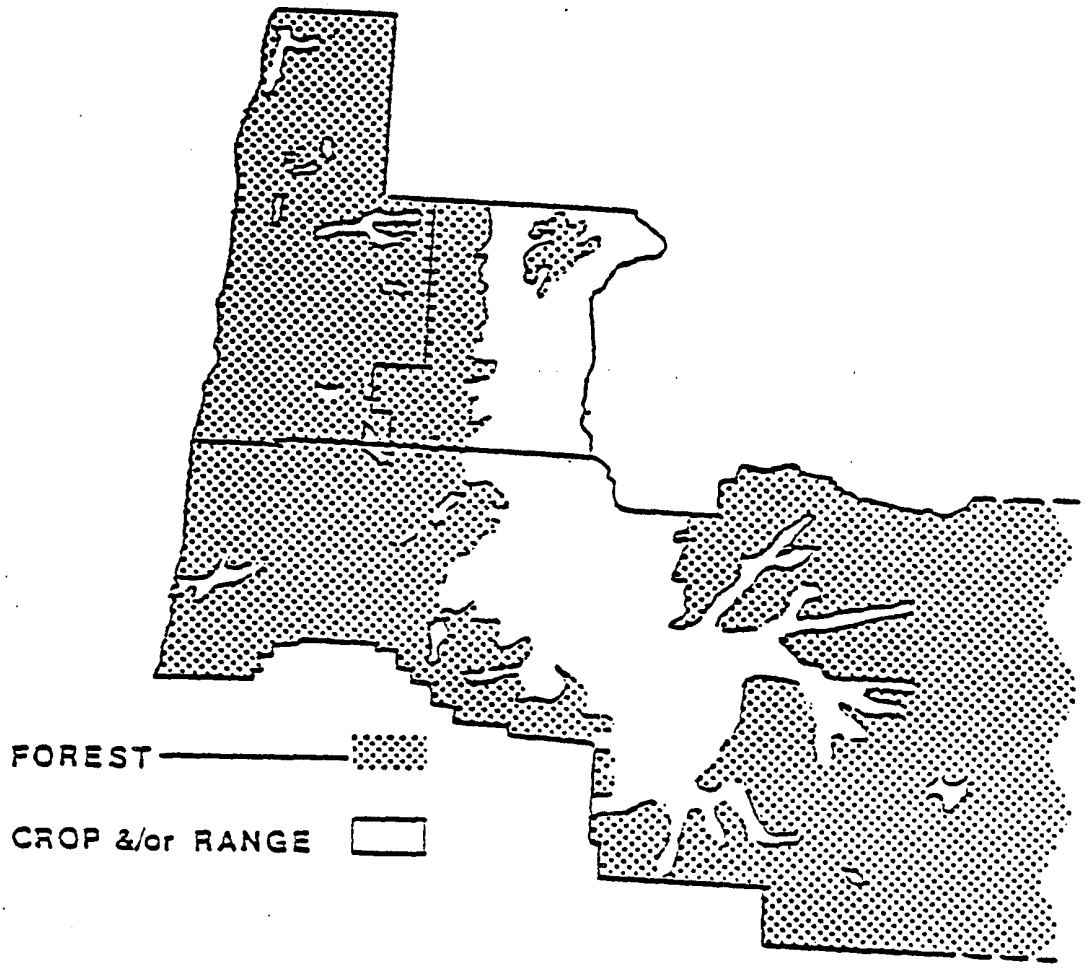


Figure 3. Land Cover in Lincoln, Benton, and Lane (partial) Counties Oregon



Drainage is primarily westward; principal rivers include the Siletz, Alsea, Yaquina and the Siuslaw. Eastern fringes of the area drain eastward into the Willamette Valley. Maximum runoff is reached generally during the winter months as the result of storms off the Pacific occurring usually as rain. There is little snow accumulation.

The Study area is predominantly rural. The four hospitals in the area are located in the four largest towns: Newport (pop. 5,200); Lincoln City (4,200); Toledo (2,800); and Florence (2,250). Each of these hospitals was utilized in the study. With the exception of Philomath (1,700), all other towns/villages have populations of less than 1,000. Alsea has a population of 400 (1970 census).

All of the nine women who participated in the first phase of the investigation resided, at the time of pregnancy, in rural residences located within 12 miles of Alsea. All but one of the women resided in the Alsea River watershed; the ninth resided southwest of Philomath in the Corvallis watershed.

Description of the Control Area

After careful review and consultation with staff of the Oregon State Health Department, the Control area was selected in Malheur County, Oregon. Selection was based on the following criteria:

1. The area had little or no use of 2,4,5-T.

2. The area is primarily rural, as is the Study area.

3. Physician practices and hospital facilities were expected to be similar to those in the Study area.

4. The area bore topographic similarities to the study area, being of similar elevation and, although not mountainous, having rugged terrain (escarpments, rolling hills, arroyos, canyons).

The Control area comprises four contiguous postal ZIP code zones in the northeastern part of Malheur County (See Figure 4). The area covers approximately 1,000 square miles and is bounded on the east and northeast by the Snake River, which there forms the Oregon-Idaho boundary. Several creeks drain the area eastward into the Snake River. Approximately 90 percent of the area is classified as rangeland, sagebrush being the dominant vegetation. Cropland accounts for a small but important percentage of the area along stream and river courses. Twenty-one percent of the land in the county is in private ownership, 75 percent is Federal and the remainder (5%) is State, county, or local governments. (See Figure 5)

The two hospitals in the Control area are located in the two largest towns: Ontario (pop. 8,200) and Nyssa (pop. 2,900). Both hospitals were utilized in the survey. The area also includes the town of Vale (1,850) and the villages of Harper and Cairo (pop. less than 250).

Figure 4. Control Area in Malheur County Oregon

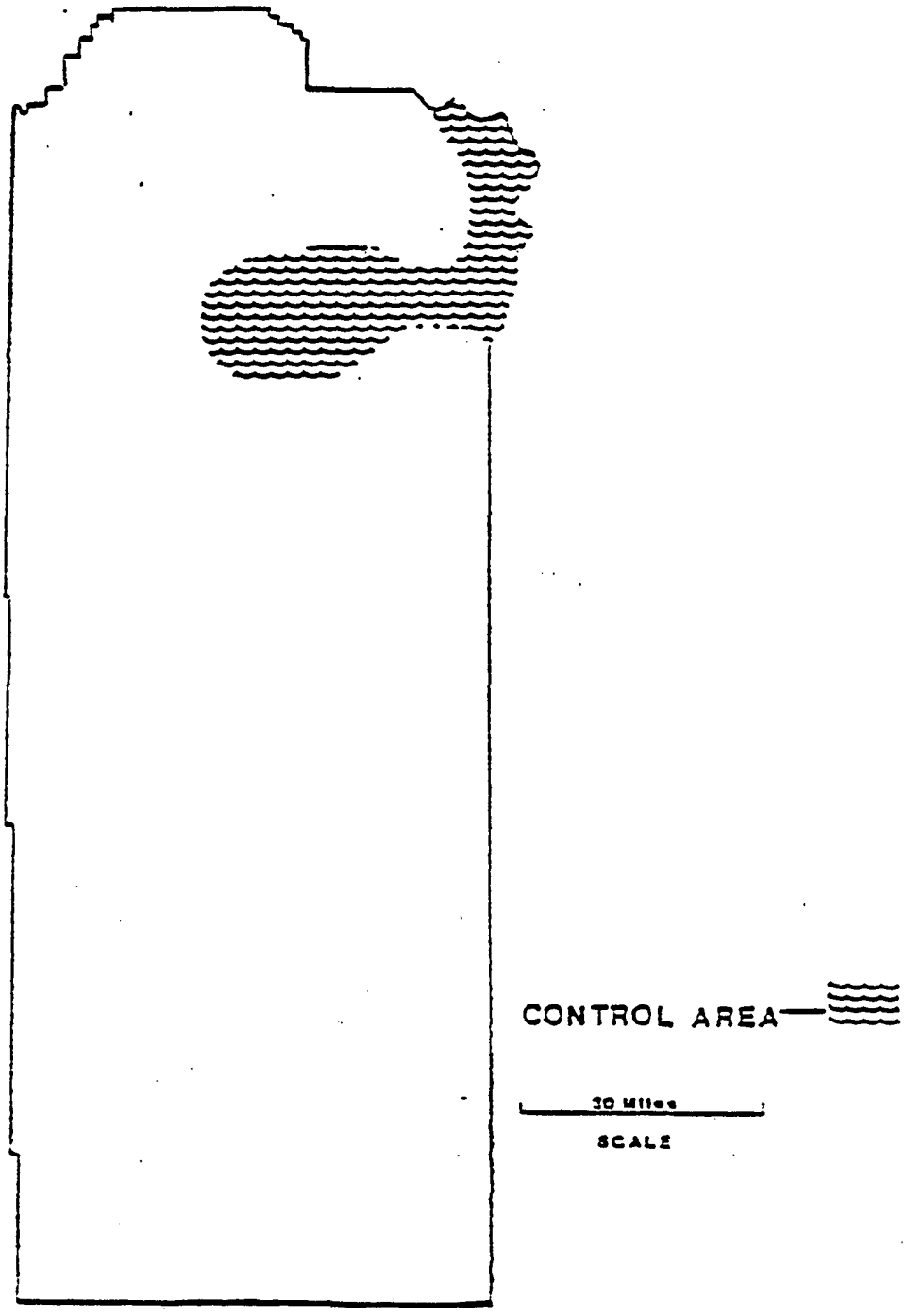
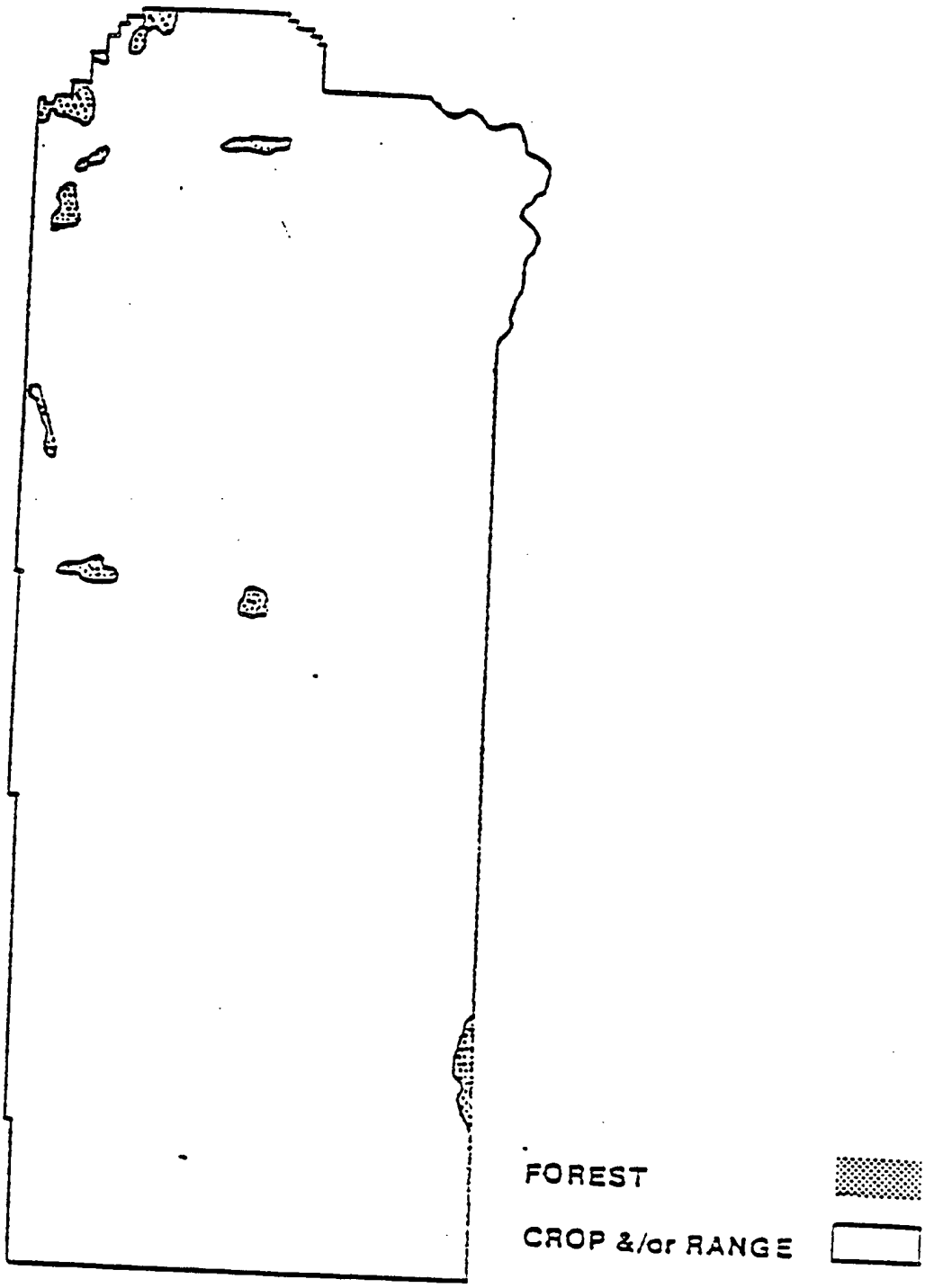


Figure 5. Land Cover in Malheur County Oregon



Personnel from the Malheur County Cooperative Extension Agent's office had no specific figures to report on pesticide use in the county; however, it was stated that there is very, very little use of 2,4,5-T in the county, particularly in the cultivated areas. Personnel from the area office of the BLM, which has the responsibility for management of public land within Malheur County, reported that 2,4,5-T has not been applied on BLM lands in the county since 1972 by either BLM or ranchers with grazing permits. Additionally, BLM personnel stated that no pesticides of any kind had been applied to BLM grazing land since 1968. A sagebrush control program used 2,4-D but not 2,4,5-T in Malheur County.

Description of the Urban Area

The Urban area is comprised of the two connecting Postal ZIP zones that encompass the cities of Corvallis and Albany, Oregon. Both sites are located in the agricultural non-forested Willamette Valley. The Corvallis ZIP zone is contiguous with the east-central boundary of the Study area and the Albany zone connects the Corvallis zone at its north-east corner (see Figure 6). The populations of Corvallis and Albany are over 37,000 and 21,000 (1970 census).

Figure 6. — Urban Area in Benton County, Oregon

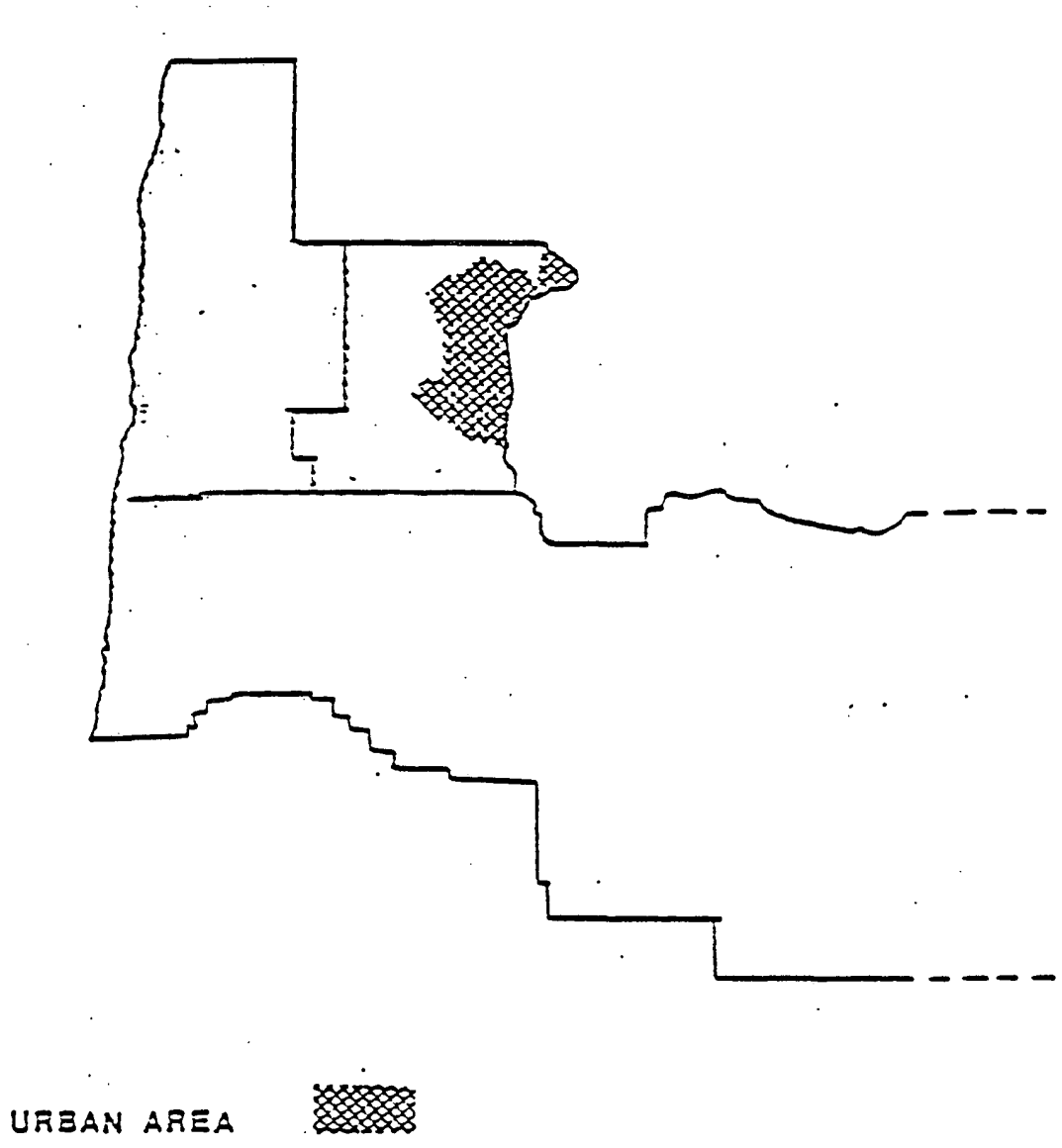


TABLE 1

Selected Agricultural Statistics* for Counties Including the Study, Control and/or Urban Areas

Oregon, 1972 - 1977

	County and Area			
	Malheur Control	Lincoln Study	Lane Study	Benton Study & Urban
All Farms, Number	1,357	258	1,840	575
Land in Farms, Acres	1,360,195	47,390	270,587	129,034
Approximate Land Area, Acres	6,309,760	631,104	2,913,280	427,520
Percent in Farms	21.6	7.5	9.3	30.2
Forest Production, Number of Farms	5	38	158	58
Forest Production, Dollars	1,278	208,726	553,042	457,813
Crops, Number of Farms	935	59	900	301
Crops, Dollars	23,040,163	495,703	11,780,769	5,317,112
Livestock, Number of Farms	991	214	1,152	423
Livestock, Dollars	20,063,573	1,028,121	9,319,416	2,667,955

*U.S. Bureau of the Census, Census of Agriculture, 1969 Vol. 1 area Report Part 41. Oregon Section 2. County Data. U.S. Government Printing Office, Washington, D.C. 1972.

Women in both cities use Good Samaritan Hospital in Corvallis for gynecological and/or obstetrical care, as do various women throughout the Study area. All spontaneous abortion records for terms of less than 20 weeks were obtained from the Hospital, first, to derive additional data for the Study area and, second, to permit comparison of seasonal spontaneous abortion patterns and frequencies in an unsprayed urban area adjacent to the Study area.

The abortion data for the Urban area are considered to be of limited utility in this study because of an apparent tendency for first-trimester abortions to be frequently handled in urban clinical facilities of a type that do not exist in the Rural Study and Control areas. The data are useful, however, in providing a measure of monthly and seasonal trends on patterns in abortion frequencies.

Research of ZIP Code Boundaries

To facilitate an identification of the boundaries of the Study area, ZIP code maps were developed with the cooperation of personnel in local post offices. The boundaries of the Study area, which coincide with the zip code delivery routes, remained unchanged during the study time frame of 1972-1977 (See Table 2).

TABLE 2

ZIP Codes Corresponding to the Study, Urban, and Control Areas

Oregon, 1972 - 1977

Area	Zip Codes
Urban	97321, 97330
Control	97906, 97913, 97914, 97918
Study	97324, 97326, 97341, 97343 97357, 97365, 97366, 97367 97369, 97370, 97376, 97380 97388, 97390, 97391, 97394 97439, 97453, 97480, 97498

Spray Data

In the study of the Alsea area women, spray data on the use of 2,4,5-T were collected and plotted for the immediate area referred to as the "Alsea Basin". This information was supplied by the following major organizations that used the chemical: USFS-Siuslaw National Forest; USDI-Bureau of Land Management, Alsea Resources Area; Willamette Industries, Inc., Philomath, Oregon; and Starker Forest, Philomath, Oregon. The supplied data consisted of the date(s) of application, rate of application, formulation, number of acres treated, and the location of the treated land.

The locations of the sprayed areas were plotted to quarter-section on township maps. In this manner the perimeter of the "Alsea Basin" could then be defined as one covering approximately 400 square miles or 256,000 acres. During the 6-year period from 1972-1977, a total of 7131 acres was treated with 9916 pounds of 2,4,5-T. The poundage and acreage varied from year to year (Table 3). The areas treated during this period represent approximately 3% of the total acreage within the "Alsea Basin".

As mentioned previously, the predominant feature of the study area is the forested Coastal Range. Since the Coastal Range extends from northern California into Washington, it was considered necessary to establish that: 1) topography and vegetation are similar throughout Oregon; and 2) forest management practices in the Alsea basin are representative of the

Table 3

Total Acres Treated and Pounds 2,4,5-T Used in Alsea Basin

Oregon, 1972-1977

Year	Acres Treated	Treatment	Total 2,4,5-T (lbs.)
1972	88	0.5 lb/A	44
	98	1.0 lb/A	98
	219	2.0 lbs/A	438
	63	3.0 lbs/A	189
	468		769
1973	444	1 lb/A	444
	25	2 lbs/A	50
	469		494
1974	207	1 lb/A	207
	80	3 lbs/A	240
	287		447
1975	223	1 lb/A	223
	239	2 lbs/A	478
	90	3 lbs/A	270
	552		971
1976	1619	1 lb/A	1619
	1259	2 lbs/A	2512
	2875		4131
1977	1946	1 lb/A	1946
	444	2 lbs/A	888
	90	3 lbs/A	270
	2480		3104
Total	7,131		9,916

entire forested area. Personal communications with representatives of the U.S. Forest Service and commercial tree farm operators substantiated that the ecological characteristics of the Coastal Range were consistent in the Oregon Coastal Range and that the chemical, 2,4,5-T, is used as a common forest management tool in this region.

The herbicide 2,4,5-T is applied almost exclusively by helicopter at an average rate of two pounds per acre for control of undesirable vegetation such as red alder, vine maple, salmonberry, and Thimbleberry. Certain weather factors such as wind and precipitation dictate time of application, but in general the compound is used in the spring (March, April, or May) with a second application made, if needed, in middle to late summer (July and/or August). These seasonal usage patterns are shown in Table 4 and Figures 7 and 8.

To avoid contamination of water sources prior to 1978, the general application policy was to avoid spraying near homes and provide for a single swath of 30 to 60 feet on each side of any major stream. In September, 1978, the Oregon Forest Practices Act provided extended guidelines. These guidelines required that no spraying was to be made within 500 feet of an inhabited residence nor within 200 feet on either side of a Class A stream. Class A streams are defined as major streams with fish and/or ones that are used for domestic water supplies.

Thus, the data from the Alsea basin illustrate a pattern which may be considered as representative of the Study area. In general, greater amounts of the chemical were applied during the spring than

Table 4

Applications of 2,4,5-T by Day and Month in the Alsea Basin

Oregon, 1972-1977

Year	Dates	Total Days	Acres treatment	Amount Applied (lbs)
1972	March 17, 20, 31	3	148	296
	April 4	1	121	110
	July 31	1	48	144
	August 1, 19, 23, ?	4	151	219
		9	468	769
1973	May 5,6,10,13,14	5	444	444
	August 15	1	25	50
		6	469	494
1974	April 26, 27, 29	3	180	180
	May 4	1	27	27
	July 29	1	48	144
	August 2	1	32	96
		6	287	447
1975	April 9, 16	2	239	478
	May 25, 27, 29	3	202	282
	July 31	1	16	16
	August 20	1	95	195
		7	552	971
1976	April 3-10	8	2840	4096
	May 6	1	35	35
		9	2875	4131
1977	March 12-15, 19	4	534	1158
	March 24 - April 14	22	1946	1946
		26	2480	3104

Figure 7.

Acres Sprayed with 2,4,5-T in Alsea
Basin Accumulated by Respective Month, 1972 through 1977

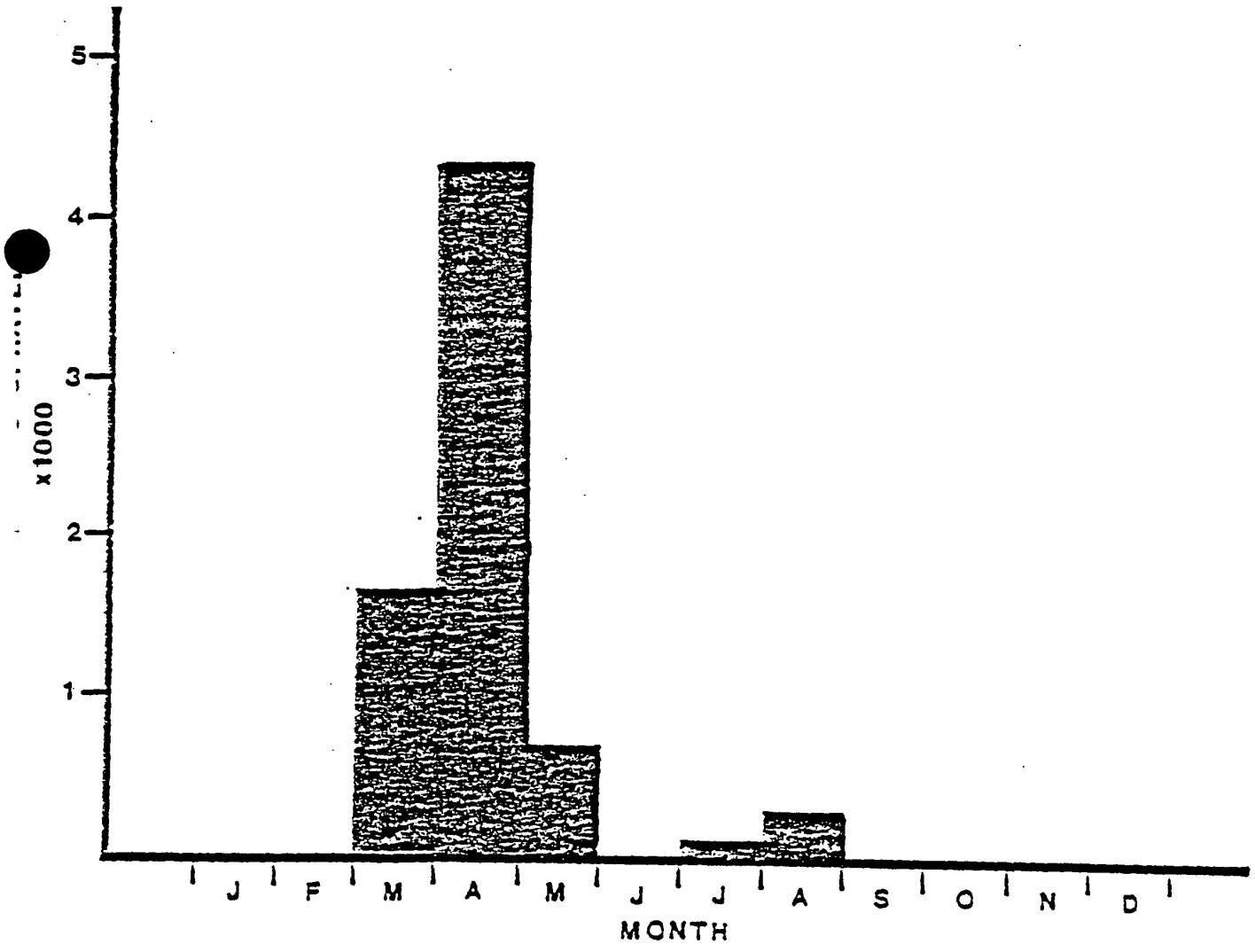
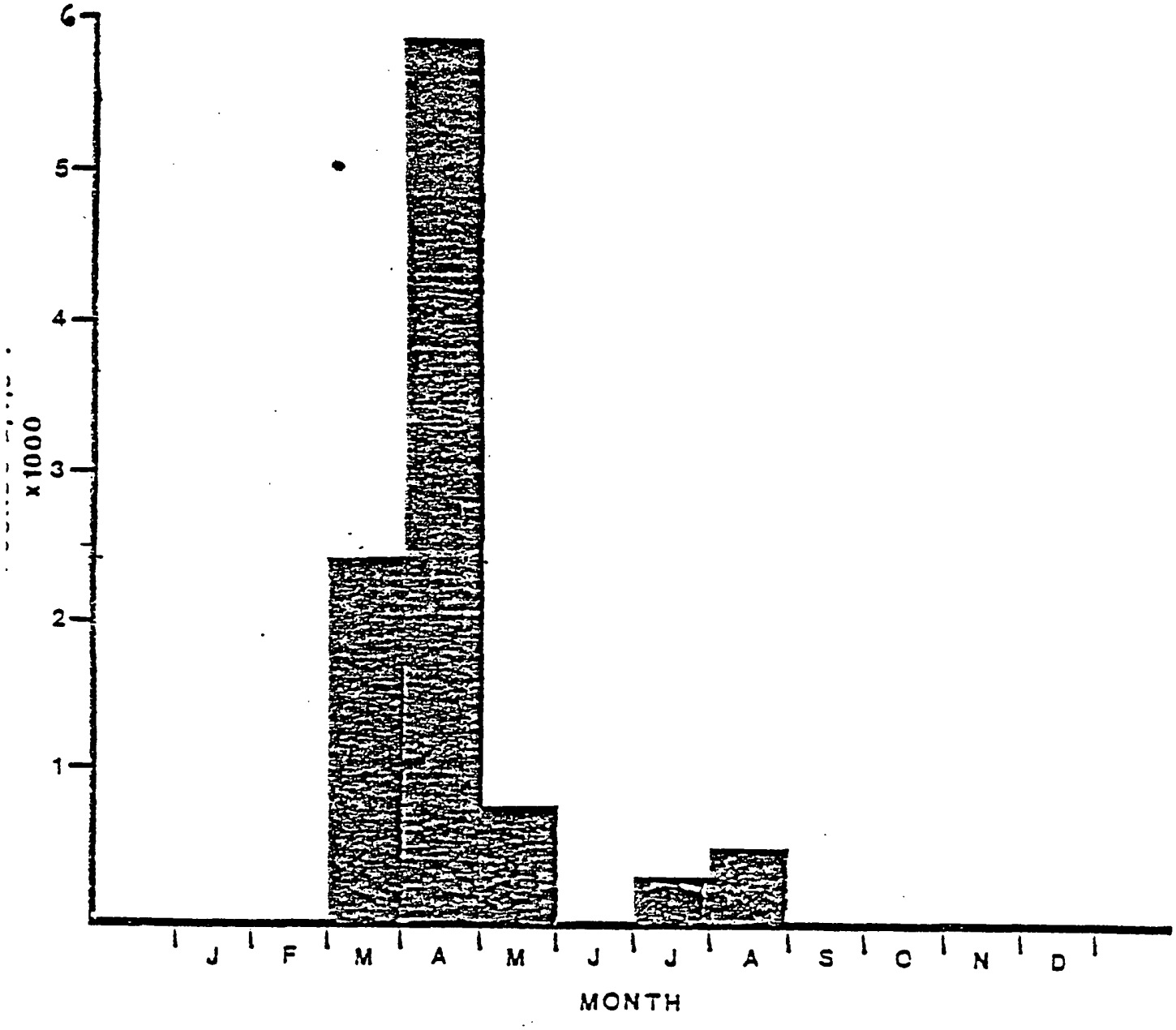


Figure 8.

Pounds* of 2,4,5-T Sprayed in Alsea
Basin Accumulated by Respective Month, 1972 through 1977.



*Active ingredient

during the summer treatments. Additionally, the spray program is not a month-long operation. Usually it spans only a few days' time. The duration of the spraying depends on the number of acres to be treated and on the weather conditions.

Selection of Hospitals and Abstraction of Spontaneous Abortion Data

Spontaneous abortion data were abstracted from all five hospitals located in the Study and Urban areas (See Figure 9) and from the two hospitals located in the Control area (See Figure 10). These hospitals were viewed as the primary source of health care delivery for the respective areas. The seven Oregon hospitals contacted are located in Corvallis, Lincoln City, Newport, Toledo, Florence, Nyssa, and Ontario. Those hospitals and the number of admissions and live births that each recorded in 1975 are found in Table 5. All field work was completed during November and December, 1978.

Most of the hospitals were reluctant to participate in a record search with non-hospital personnel because of patient confidentiality. Three hospitals permitted a complete record search by field epidemiologists, while at the other four hospitals the data were abstracted by hospital personnel. Patients' names and addresses, excepting ZIP codes, were not recorded.

For each of the spontaneous abortions the following information was provided or abstracted: H-ICDA diagnosis code, age of patient, date of

Figure 9. Hospitals in Study and Urban Areas

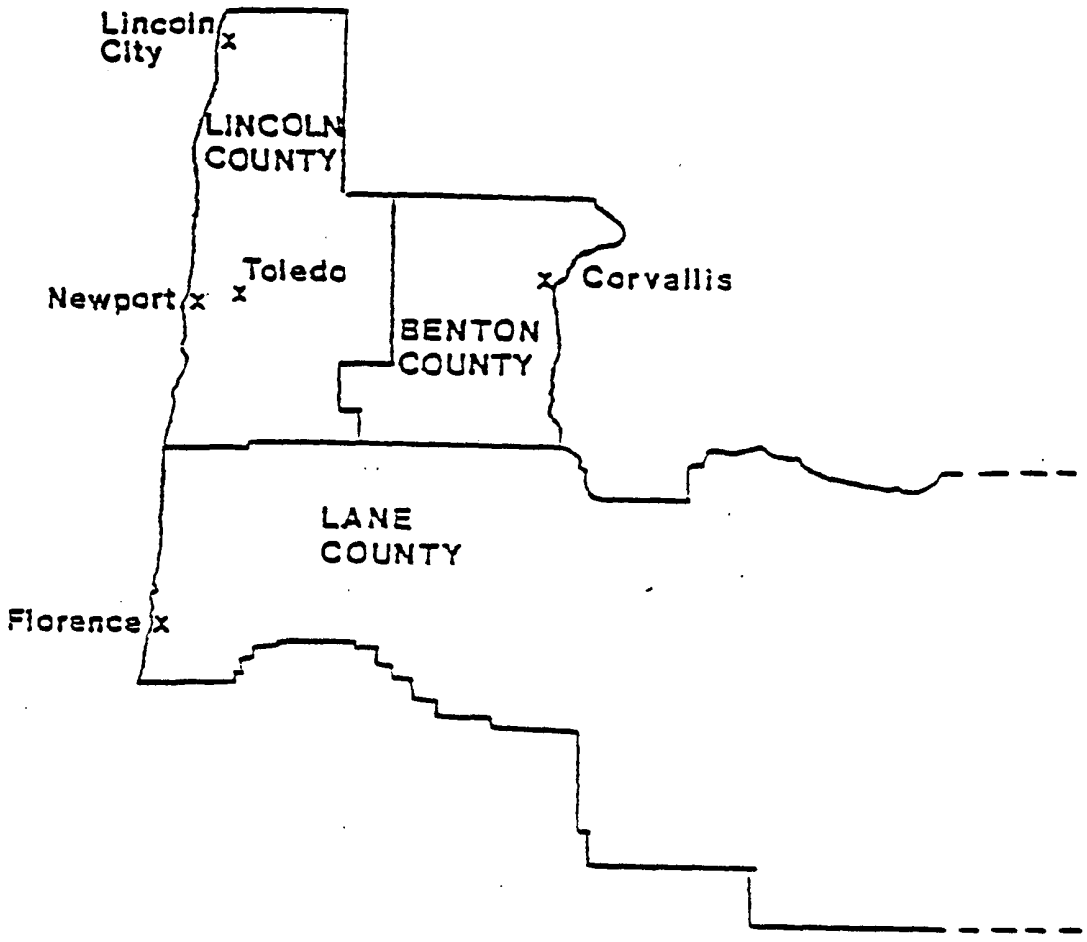


Figure 10. Hospitals in Control Area

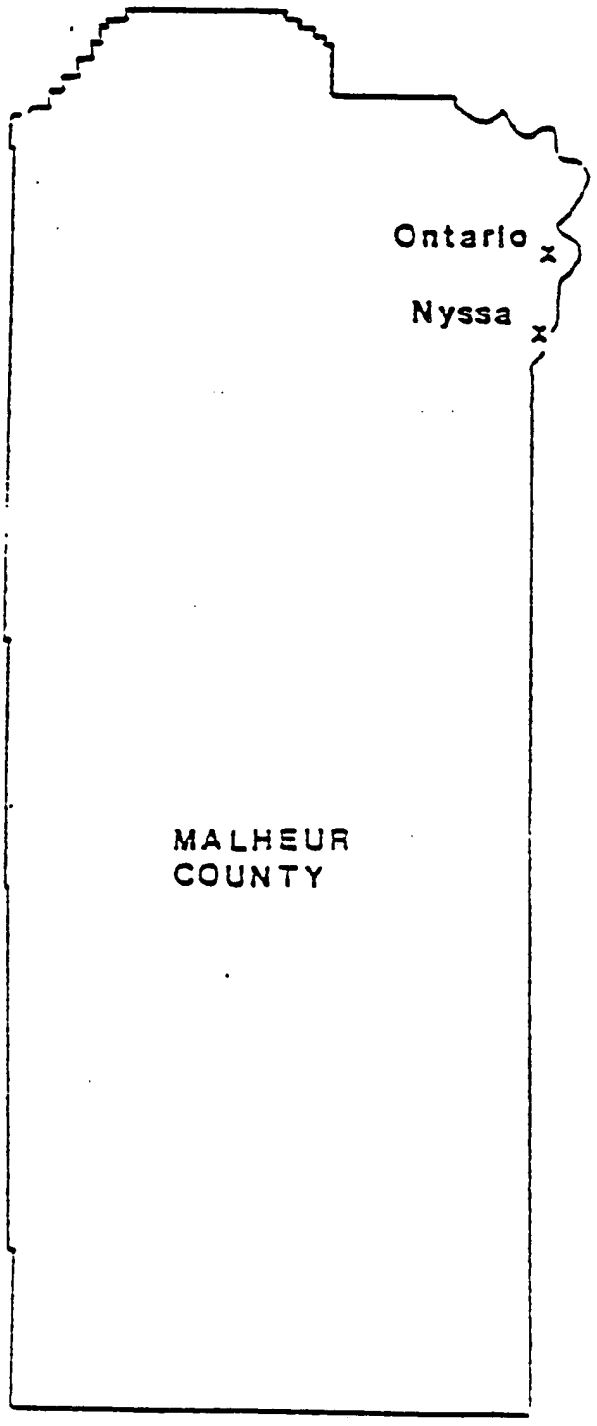


TABLE 5

Annual Admissions and Births in Hospitals in
Study, Urban, and Control Areas

Oregon 1972 - 1977

Hospital Location	Hospital Name	City	Admissions 1975	Births 1975
Urban Area	Good Samaritan	Corvallis	7589	986
Study Area	Western Lane	Florence	802	87
	North Lincoln	Lincoln City	1367	77
	Pacific Communities	Newport	1159	48
	New Lincoln	Toledo	875	103
Control Area	Malheur Memorial	Nyssa	710	110
	Holy Rosary	Ontario	4097	474

spontaneous abortion, gestation period, and ZIP code of patient's residence. Only records of spontaneous abortions that occurred from 1972 through 1977 were sought. This time period coincided with the temporal miscarriage pattern of the nine original Alsea women.

From 1972 to 1977, two ICDA texts were used by the hospitals. In 1973 8-ICDA was published and spontaneous abortions were listed by the codes 643.0, 643.1, 643.2, and 643.9. The 643.9 code includes any spontaneous abortions not listed as induced or spontaneous. Prior to 1973, hospitals used the 8th revision of ICDA. Spontaneous abortions were coded as 643.0, 643.1, 643.2, and 643.9. The code number 644- was also used for 1972, since this code approximated 8-ICDA code number 643.9.

Physician Interviews

A list of private physicians who practice at each of the five hospitals in the Study and the Urban areas was compiled from information provided by the hospitals and by local health officials. From the list, 30% of the physicians were randomly selected for interview. However, since physicans tended to practice in groups, doctors not randomly selected were also interviewed whenever available. In the Study area 19 of 27 (70%) of the physicians—all general practitioners—were contacted. In Corvallis all eight of the obstetricians/gynecologists were interviewed as well as 20% (five) of the general practitioners and 10% (two) of the internists.

When possible, interviews were carried out in the doctor's office. Each physician was asked to estimate the number of spontaneous abortion cases of terms less than 20 weeks that he or she had treated per year during the 1972 to 1977 time period. Each was also asked to estimate the percentage of those cases which had been hospitalized.

Because of similarities in medical facilities and rural population distribution in the Control and the Study areas, physician practices were assumed to be similar in the two areas. Therefore, it was decided not to conduct physician interviews in the Control area.

Data Preparation

The data on spontaneous abortions of less than 20 weeks from the seven study hospitals were edited, coded, keypunched, and computer edited. The number of monthly hospitalized spontaneous abortions during 1972-1977 were tabulated for each of the three areas. These data were also tabulated and cross-tabulated according to the several variables of interest. For example, the data on hospitalized spontaneous abortions were cross-tabulated according to area (Study, Urban, and Control) and gestation period (less than 4 weeks, 5-8 weeks, 9-13 weeks, 14-17 weeks, and 17-20 weeks).

Birth certificate data for 1972 through 1977 were obtained in the form

of computer tapes from the Vital Statistics Section of the Oregon State Health Department. These computer tapes were used to obtain the number of births per month in the Study, Urban, and Control areas for 1972-1977.

The Spontaneous Abortion Index: In order to make comparisons among areas and among the months of the year, especially within areas, the data on spontaneous abortions need to take into account the number of births in the three areas during each of the twelve months. The index described below is basically the ratio of the number of hospitalized spontaneous abortions to the number of births corresponding to the spontaneous abortions, based on the residence ZIP Code of the women contributing to each event. Thus, the ratio is not a true rate but rather an index of the hospitalized spontaneous abortion experience of the women residing in the three areas.

In order to describe the spontaneous abortion index, the following notation is required:

Y_{ij} = the number of hospitalized spontaneous abortions in the i^{th} area ($i = 1,2,3...$) in the j^{th} month ($j = 1,2,...,12$) during 1972-1977;

X_{ij} = the number of births in the i^{th} area and in the j^{th} month during 1972-1977.

An index that has been used in similar studies is simply the ratio Y_{ij}/X_{ij}. The inherent problem with such an index is that the numerator involves women of one conception period whereas the denominator involves women of a different non-overlapping conception period.

The spontaneous abortion index developed here is $Z_{ij} = Y_{ij}/C_{ij}$ where C_{ij} is a five-month moving-average of the X_{ij}'s which have been appropriately shifted. In particular, $C_{ij} = \sum_{k=1}^{5} W_k X_{i,j+3+k}$ where the weights (W_1, ..., W_5) represent the proportions of abortions of varying gestation. In the above definition of C_{ij}, the second subscript on the number of births is taken modulo 12; for example, $j+3+k = 13$ refers to January births. The rationale for the use of C_{ij} rather than X_{ij} is that a woman who has a spontaneous abortion in month j could have delivered between month j+4 and month j+8, depending on her length of gestation. In averaging the number of births in the five months between month j+4 and month j+8, one could use a simple average (i.e., $W_1 = W_2 = \ldots = W_5 = .20$). Instead, a weighted average of the number of births was applied with estimated weights given by the proportions of abortions for the five gestation periods.

Index values were calculated, by month and area, for the aggregated six-year data and for the two three-year periods 1972-1974 and 1975-1977.

Statisticial Procedures

Statistical evaluation of the data is based on the following analyses:

1. Analysis of variance of the abortion index by area and month, deriving a residual error term by dividing the data into two 3-year periods.

2. Frequency table analyses, by chi-square, to test monthly variation in the cumulated number of spontaneous abortions analyzed as simple frequencies and as expected monthly frequencies of spontaneous abortions calculated from the frequencies of corresponding live births.

3. Tests of cyclic trends including:

   (a) A power-spectrum analysis of the abortion index over months to test for cyclic trends in the monthly data.

   (b) Adjustment of the abortion index data to account for phase differences between the Study area and the Control and Urban areas.

   (c) Fit of a sine-wave model to the abortion index data.

   (d) Cyclic analysis of the raw abortion data (unadjusted for births).

(e) Examination of birth data from Miami, Florida (Jackson Memorial Hospital, 1976-77) for cyclic behavior.

(f) A test for cyclic trends after recalculating the abortion index by raw numbers of births as the denominator rather than the five-month moving average.

4. Cross-correlation analyses between Study area abortion indices and spray patterns.

(a) Cross-correlation analyses, parametric and non-parmetric, between the Study area abortion index and the monthly spray pattern of 2,4,5-T in pounds sprayed per month.

(b) Cross-correlation analysis with the monthly spray pattern after adjusting the abortion index data for differences in cyclic trends.

(c) Cross-correlation analyses of Study area abortion index and spray patterns for the periods 1972-74 and 1975-77.

5. Evaluation of physician interview data.

Chapter IV

RESULTS

The annual numbers of hospitalized spontaneous abortion cases in the three areas appear in Table 6. There was a total of 477 cases: 188 in the Study area, 109 in the Control area and 180 in the Urban. Table 7 depicts these cases accumulated by month of the year for the 1972 to 1977 time period. The same cases are also represented according to the age of the patient in Table 8. Table 9 presents, for each area, the cases by weeks-of-term categories for those cases (456) for which term was known.

As mentioned previously, the number of births in these three areas needs to be taken into account in any comparisons made among the areas with respect to the number of spontaneous abortions. Table 10 presents the number of births per calendar month for the Study, Urban and Control areas; the five-month moving average of the number of births corresponding to the month of spontaneous abortion is given in Table 11 for each area, where the weights were obtained from the tabulation of spontaneous abortions according to length of gestation (Table 9).

Table 12 presents the monthly spontaneous abortion index for each of the three areas in the study; the monthly spontaneous abortion index for these areas is also displayed graphically in Figure 11. An obvious feature of this graph is the elevated index of the Study area for the month of June.

TABLE 6

Number of Hospitalized Spontaneous Abortion Cases for Study, Urban, and Control Areas

Oregon, 1972 - 1977

Year	Study Area	Urban Area	Control Area
1972	37	44	9
1973	34	40	19
1974	23	38	27
1975	31	19	27
1976	33	20	8
1977	30	19	19
Total	188	180	109

TABLE 7

Number of Hospitalized Spontaneous Abortion Cases for Study, Urban, and Control Areas, Accumulated by Month

Oregon, 1972 - 1977

Month	Study Area	Urban Area	Control Area
January	10	25	12
February	17	17	4
March	18	15	7
April	11	16	14
May	16	17	9
June	24	15	6
July	20	5	7
August	17	11	10
September	9	17	11
October	15	19	7
November	16	7	8
December	15	16	14
Total	188	180	109

TABLE 8

Hospitalized Spontaneous Abortion Cases by Study, Urban, Control Area, and Age Group of Patient

Oregon, 1972 - 1977

Age Group	Study Area	Percent	Urban Area	Percent	Control Area	Percent
10-14	3	1.6	0	0	0	0
15-19	38	20.2	12	6.7	14	12.8
20-24	69	36.7	68	37.8	38	34.9
25-29	44	23.4	62	34.4	24	22.0
30-34	18	9.6	26	14.4	21	19.3
35-39	9	4.8	7	3.9	9	8.3
40-44	6	3.2	5	2.8	3	2.8
45-49	1	0.5	0	0	0	0
Total	188	100.0	180	10.0	109	100.1

TABLE 9

Number and Percent of Spontaneous Abortions According to Length of Gestation in the Study, Urban, and Control Areas

Oregon, 1972 - 1977

Gestation Period	Study Area	Urban Area	Control Area	Overall
1. 18 - 20 weeks	8	12	7	27
	(4.6%)	(6.7%)	(6.8%)	(5.9%)
2. 14 -17 weeks	24	15	14	53
	(13.8%)	(8.3%)	(13.7%)	(11.6%)
3. 10 - 13 weeks	68	83	48	199
	(39.1%)	(46.1%)	(47.1%)	(43.6%)
4. 5 - 9 weeks	62	60	28	150
	(35.6%)	(33.3%)	(27.5%)	(32.9%)
5. 4 weeks or less	12	10	5	27
	(6.9%)	(5.6%)	(4.9%)	(5.9%)
Total	174	180	102	456

TABLE 10

Total Number of Births by Months for the Study, Urban, and Control Areas

Oregon 1972 - 1977

	Study Area	Urban Area	Control Area
January	194	338	124
February	188	353	124
March	202	344	126
April	189	335	131
May	201	357	155
June	228	378	145
July	203	315	156
August	212	351	131
September	204	342	154
October	170	343	136
November	172	337	155
December	181	327	129
Six-Year Total	2344	4120	1666

TABLE 11

Number of Births Corresponding to the Month of Spontaneous Abortions* in the Study, Urban, and Control Areas

Oregon, 1972 - 1977

Month	Study Area	Urban Area	Control Area
January	208.8	338.3	146.3
February	206.8	345.0	142.6
March	191.8	341.5	145.6
April	177.8	340.4	143.6
May	177.9	334.8	142.3
June	184.0	334.3	130.5
July	189.7	342.0	126.5
August	193.0	345.7	125.4
September	195.6	342.5	129.0
October	196.7	346.9	138.7
November	208.7	358.1	147.3
December	213.4	350.7	148.1
Total	2344	4120	1666

*Based on five-month moving average.

TABLE 12

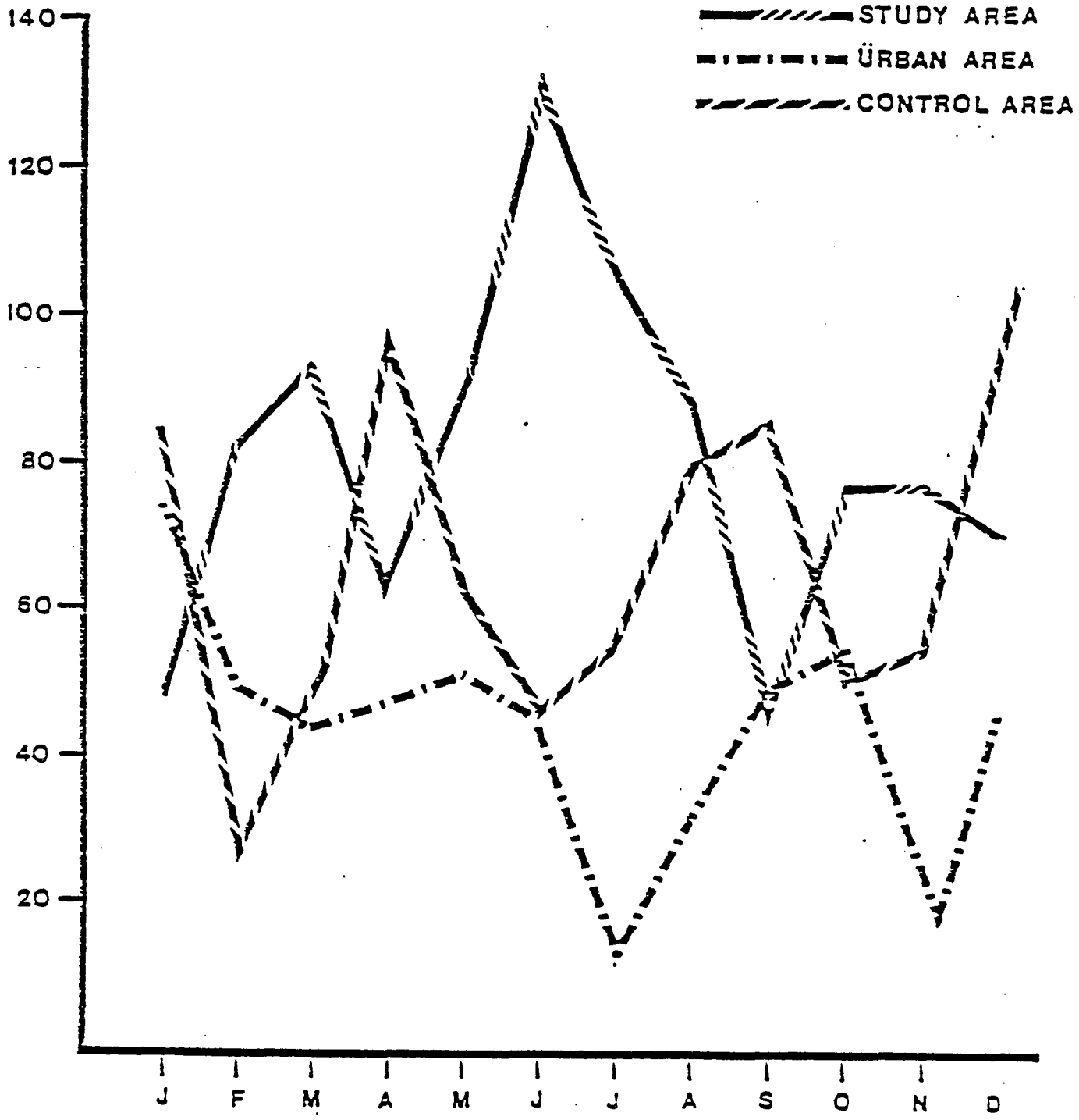
Monthly Spontaneous Abortion Index* for the Study, Urban, and Control Areas

Oregon, 1972 - 1977

Month	Study Area	Urban Area	Control Area	Average
January	48.1	73.9	82.0	68.0
February	82.2	49.3	28.1	53.2
March	93.8	43.9	48.1	61.9
April	61.9	47.0	97.5	68.8
May	89.9	50.8	63.2	68.0
June	130.4	44.9	46.0	73.8
July	105.4	14.6	55.3	58.4
August	88.1	31.8	79.8	66.6
September	46.0	49.6	85.3	60.3
October	76.2	54.8	50.5	60.5
November	76.7	19.6	54.3	50.2
December	70.3	45.6	94.5	70.1
Average	80.8	43.8	65.4	63.3

*The spontaneous abortion index is defined as the ratio of the number of hospitalized spontaneous abortions to the corresponding number of live births based on a five-month moving average, and is expressed as abortions/1,000 births.

Figure 11. Plot of Monthly Spontaneous Abortion Index for the Study, Urban, and Control areas Oregon, 1972-1977



Statistical Analyses

In order to arrange the data in such a way that proper error terms for hypothesis tests could be calculated and to see whether seasonal spontaneous abortion patterns were consistent over time, the data were gathered into two 3-year periods as shown in Table 13. The plots of these data are shown in Figures 12, 13, and 14.

From the graphical representations it is seen that the time (seasonal) patterns within each area are remarkably similar for the two periods.

The analysis of variance appropriate for the data in Table 13 is given in Table 14. Although the three-year time periods could have been viewed as a blocking factor, it was decided to test the various interaction terms for possible significance. Clearly, the only significant variation is among the three areas.

The mean values for the three areas are: Study area = 80.8; Urban area = 43.8; and Control area = 65.4 (see Table 12). By the New Duncan's Multiple Range Test, all three means are significantly different from each other ($p<.05$, two tailed).

From Table 13 and Figure 14 it is seen that there is a decrease in the overall Abortion Index for the Urban area during Period II. Analysis showed that this decrease is significant ($p<.0002$). The mean

TABLE 13

Abortion Index* by Period, Area, and Month
Oregon, 1972-1977

	PERIOD I (1972 - 3 - 4)			PERIOD II (1975 - 6 - 7)		
	Study Area	Urban Area	Control Area	Study Area	Urban Area	Control Area
January	48	95	68	48	53	96
February	77	58	28	87	41	28
March	94	59	14	94	29	82
April	45	76	84	79	18	111
May	112	54	84	67	48	42
June	98	72	46	163	18	46
July	95	29	63	116	0	47
August	76	52	96	104	12	64
September	61	76	140	31	23	31
October	71	63	29	81	46	72
November	105	22	68	48	17	41
December	84	57	95	56	34	95
Average	80.5	59.4	67.9	81.2	28.3	62.9

*Hospitalized spontaneous abortions/1,000 live births adjusted for gestational age distribution of observed abortions. The computed monthly births for the six-year interval were divided equally between the two periods.

Figure 12 Abortion Index for the Study Area By Month and Period

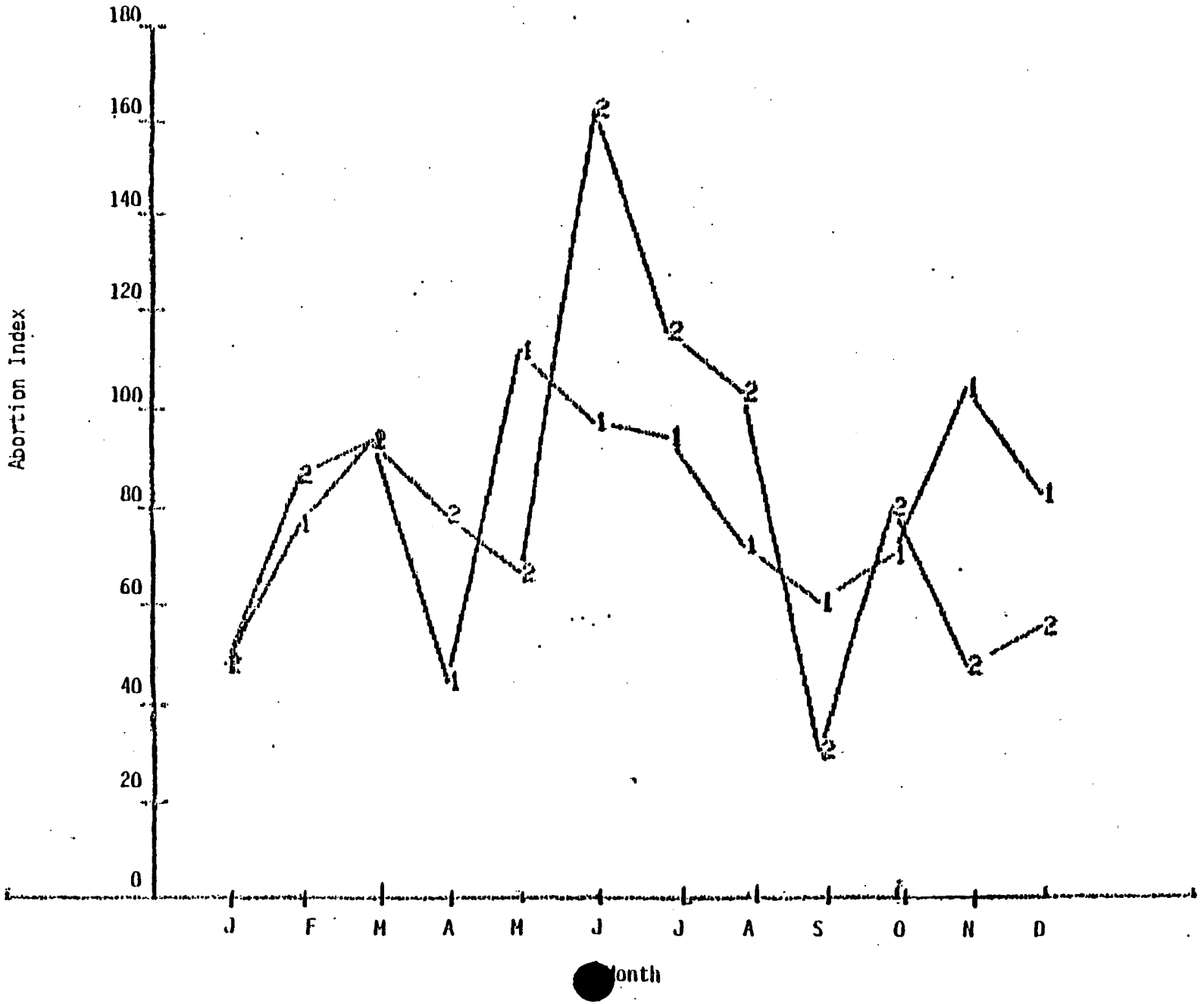


Figure 13 Abortion Index for the Control Area By Month and Period

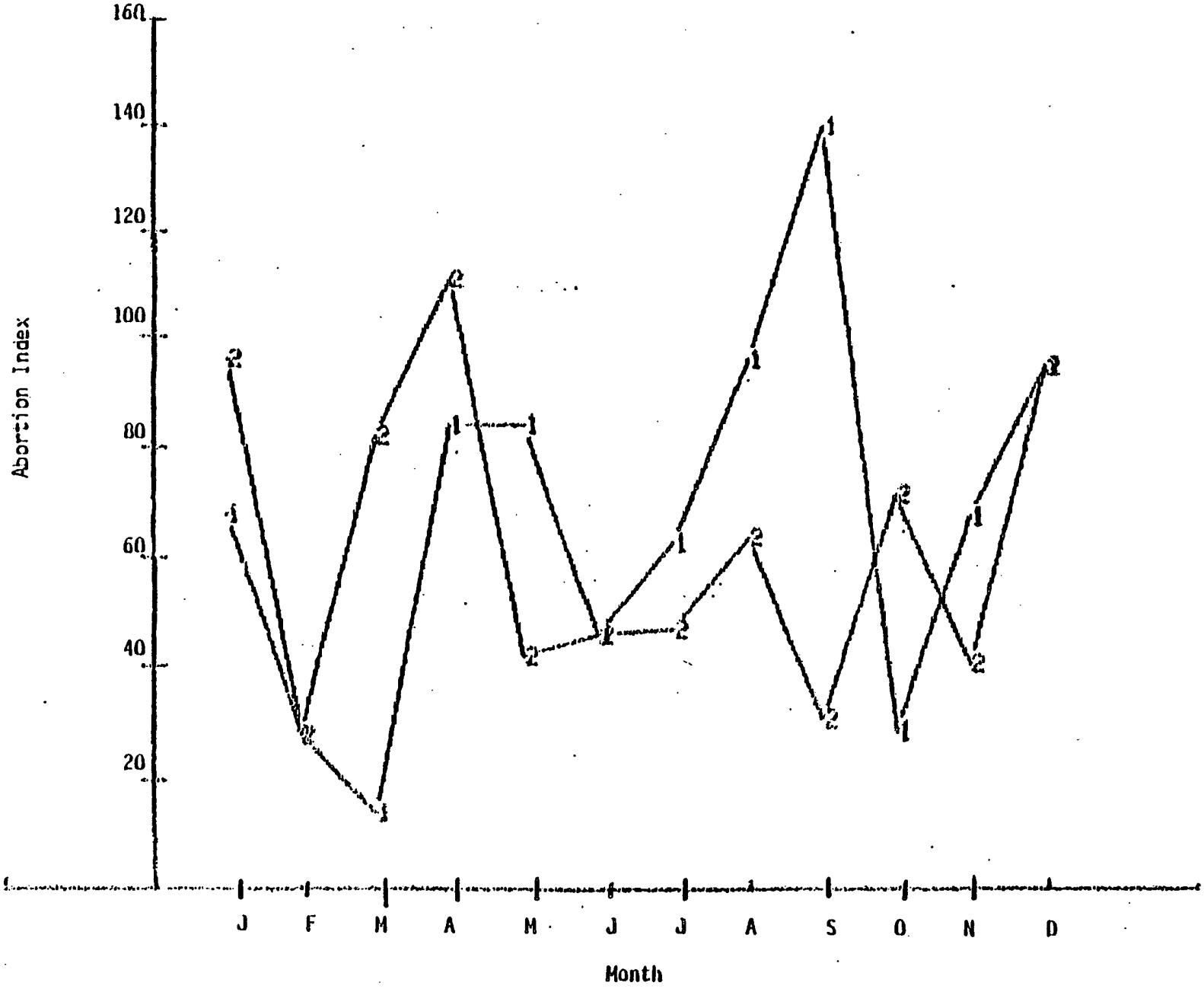


Figure 14 Abortion Index for the Urban Area By Month and Period

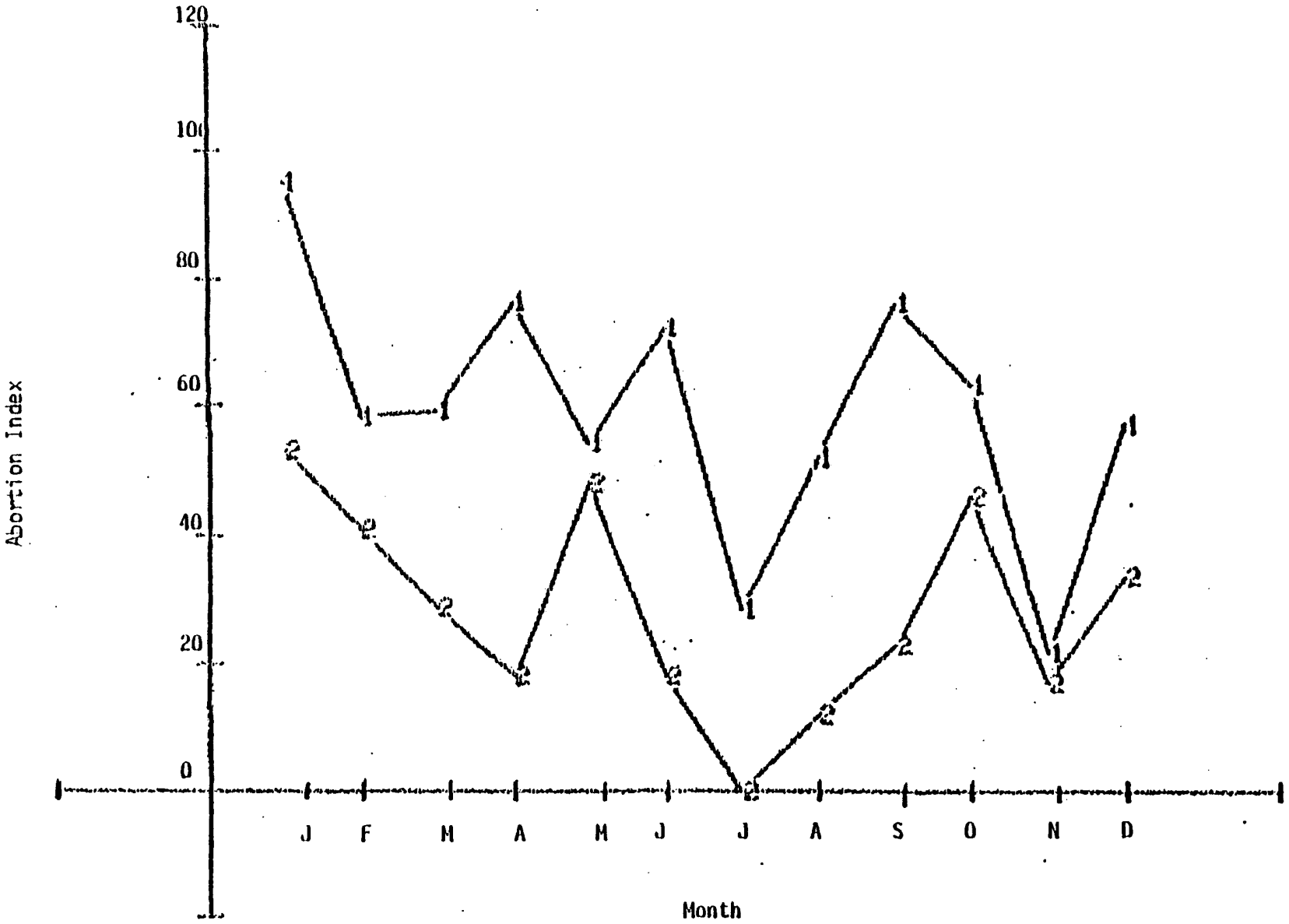


TABLE 14

Analysis of Variance of Abortion Index by Period, Area, and Month
(See Table 13)

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio
Periods	1	2,485.13	2,485.13	4.10
Areas	2	16,475.53	8,237.76	13.58*
Months	11	3,377.82	307.07	<1
Periods x Areas	2	3,498.08	1,749.04	2.88
Periods x Months	11	7,749.38	704.49	1.16
Areas x Months	22	25,156.81	1,143.49	1.89
Non-additivity	1	0.34	0.34	<1
Residual	21	12,738.58	606.60	

*$p<.0002$

abortion index of the Urban area for Period I is 59.4. When this is compared to the six-year mean for the Study area (30.8) and that for the Control area (65.4) using the New Duncan's Multiple Range Test it is found that both the Urban area and the Control area differ from the Study area ($p<.05$, two tailed), but not from each other. This seems a more conservative analysis since the reason for the precipitous decrease of the abortion index during Period II is presently unknown.

Figure 12 is noteworthy for two reasons. First, there is striking similarity in the patterns, especially the "shoulders" on the curves following the peaks for each period. Second, the peak for the second period corresponding to a greatly increased pesticide usage is higher than that for the first period.

Frequency Table Analyses

Uniform Hypothesis: Since the adjusted numbers of births used for the denominators in calculating indices appear sensibly flat (see Table 11) monthly variations in the cumulated number of spontaneous abortions were analyzed as simple frequencies (see Table 7).

Under the hypothesis that monthly accumulated spontaneous abortions were uniformly distributed throughout the year, chi-square analyses were performed for each area. The urban area showed a significant variation among months due to a high number of spontaneous abortions in December and low numbers in July and November. The other two areas did

not show significant variation among months, but in the Study area the month of June had a significant contribution to the overall chi-square value. Further, in each area, various months showed large contributions to the overall chi-square.

Expected Frequencies Based on Live Births: When the expected monthly frequencies of spontaneous abortions were calculated from the frequencies of corresponding live births from Table 11, the chi-square analyses were virtually the same as when based on the actual number of spontaneous abortions.

Cyclic Trends

Spectral Analysis: The Analyses of Variance and the chi-square analyses, together with a close study of Figure 11, strongly suggested the possibility of cyclic trends in the data.

Power-spectrum analysis of the abortion index over months showed that for each area there was only one cycle of significance and it had a period of about four months in each area.

Adjustment For Cyclic Trends: The importance of indentifying cyclic trends is two-fold. First, their presence might have some biological meaning relevant to this study. Second, a month-to-month comparison between the Study area and the Control areas should take into account phase differences which might be related to fertility patterns or some other as-yet-unknown phenomenona.

The need for this type of adjustment is shown in Figure 15. Since the Study area and the combined Urban and Control areas seem to be almost exactly 180° out of phase, any month-by-month differences could be falsely amplified. Clearly, if the Control data are shifted back in time as shown in Figure 16, monthly differences could possibly reflect excess abortions in the Study area if they exist.

The Sine Wave Model: Since the power-spectrum analysis identified only one frequency for each set of data, it was decided to fit the simplest cyclic model:

Index = $A + B \sin(\frac{2\pi}{T} t - D)$ where t is in months. Table 15 shows quite clearly that this model adequately represents the data in the Urban and Control areas. Because of the peak in the Study area data around June and July, the model does not fit the Study area as well.

The phase difference between the Study and the Urban and Control areas is on the order of two months.

Tables 16, 17, and 18 show the Study area data adjusted for the Control and the Urban area and for both areas combined. Figures 17 and 18 show the sine wave models fitted to the abortion index data for the Study area and the Control and Urban Areas.

FIGURE 15 SPONTANEOUS ABORTION INDEX, 1972 - 77 FOR THE STUDY AREA AND THE COMBINED CONTROL AND URBAN AREAS.

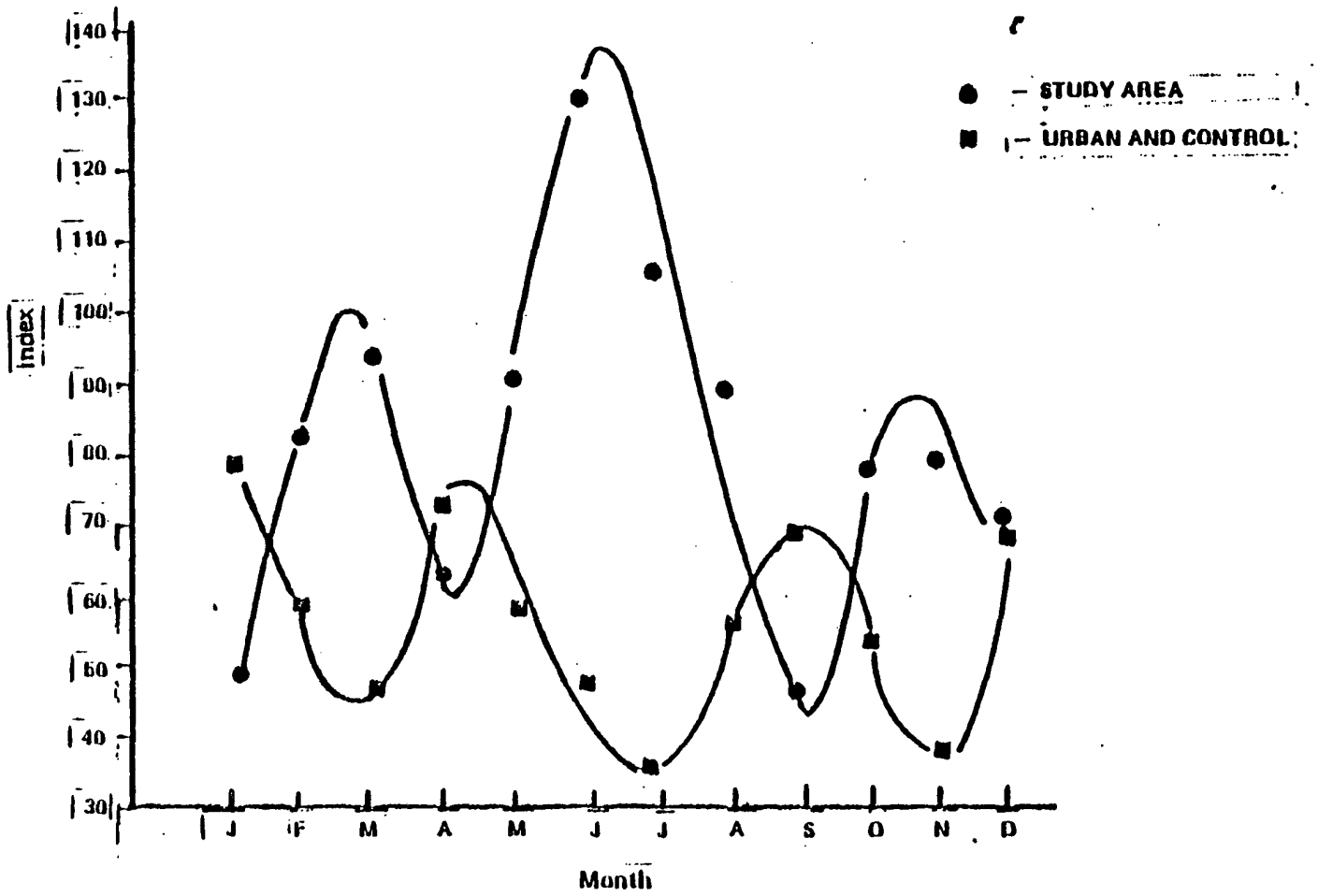


FIGURE 16: STUDY AND CONTROL AREAS: (a) COMBINED URBAN AND CONTROL INDEX, (b) STUDY AREA INDEX, (c) URBAN AND CONTROL INDEX SHIFTED BACK TWO MONTHS

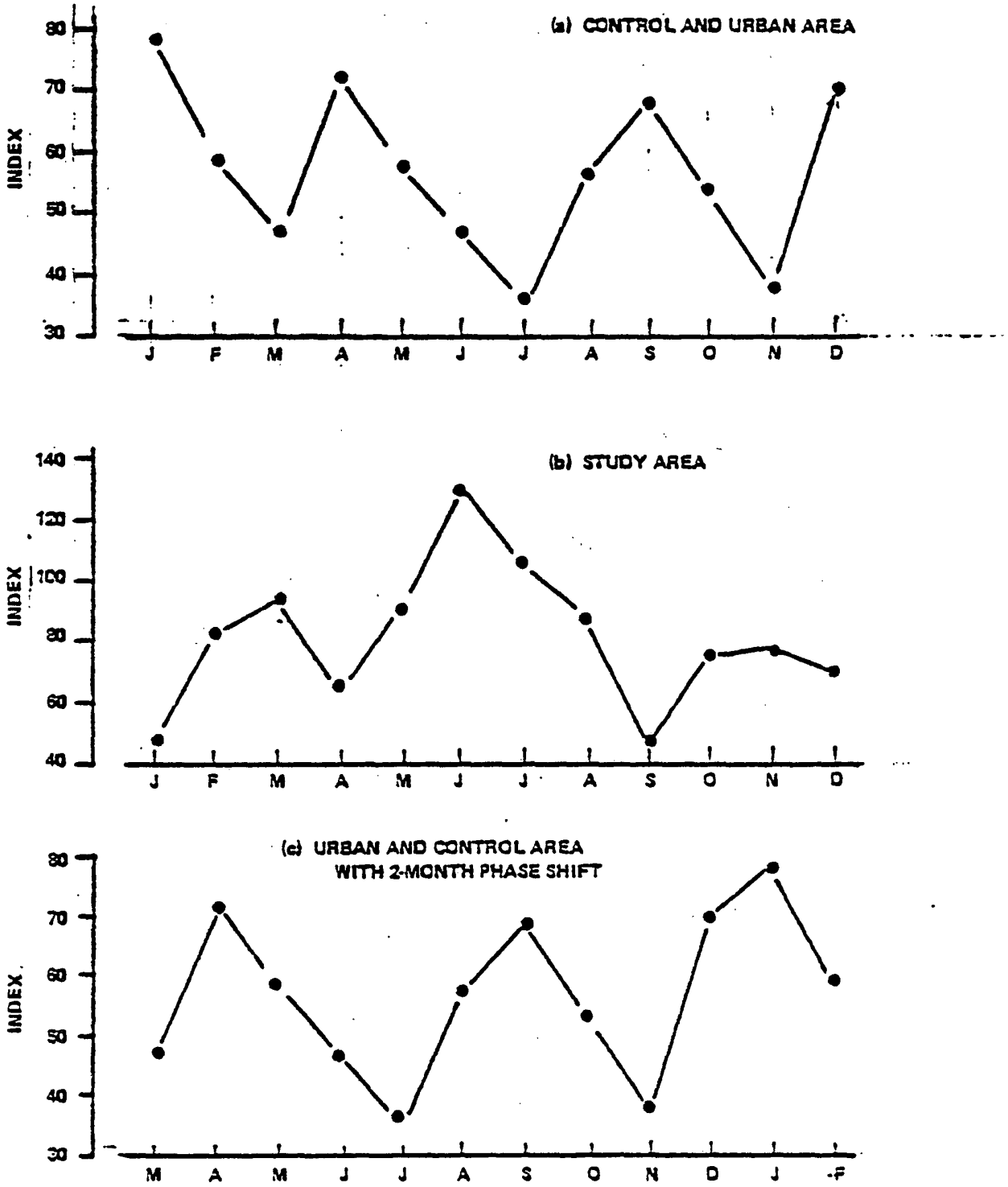


TABLE 15

Parameters of the Model "Index = A + B Sin $(\frac{2\pi}{T} t - D)$"
For the Various Areas

	Study	Urban	Control	Urban + Control
A (Mean)	83.1	43.4	65.5	56.0
B (Amplitude)	15.6	15.2	24.7	15.6
T (Period in Months)	3.6	4.1	4.1	4.0
D (Phase Shift in Months)	1.1	3.1	2.2	2.8
Adequacy of the Model (Correlation)	0.49	0.78*	.92**	.84**

* $0.05<p<.06$
** $p<.001$

TABLE 16

Study Area Index Corrected for Phase Shifts

Study minus Control — 1 month lag

Study	Control	Difference
48.1 (J)	28.1 (F)	20.0
82.2 (F)	48.1 (M)	34.1
93.8 (M)	97.5 (A)	-3.7
61.9 (A)	63.2 (M)	-1.3
89.9 (M)	46.0 (J)	43.9
130.4 (J)	55.3 (J)	75.1
105.4 (J)	79.8 (A)	25.6
88.1 (A)	85.3 (S)	2.8
46.0 (S)	50.5 (O)	-4.5
76.2 (O)	54.3 (N)	21.9
76.7 (N)	94.5 (D)	-17.8
70.3 (D)	82.0 (J)	-11.7

TABLE 17

Study Area Index Corrected for Phase Shift

Study minus Urban — 2 month lag

Study	Urban	Difference
48.1 (J)	43.9 (M)	4.2
82.2 (F)	47.0 (A)	35.2
93.8 (M)	50.8 (M)	43.0
61.9 (A)	44.9 (J)	17.0
89.9 (M)	14.6 (J)	75.3
130.4 (J)	31.8 (A)	98.6
105.4 (J)	49.6 (S)	55.8
88.1 (A)	54.8 (O)	33.3
46.0 (S)	19.6 (N)	26.4
76.2 (O)	45.6 (D)	30.6
76.7 (N)	73.9 (J)	2.8
70.3 (D)	49.3 (F)	21.0

TABLE 18

Study Area Index Corrected for Phase Shift

Study minus (Urban plus Control) — 2 month lag

Study	Urban + Control	Difference
48.1 (J)	46.0 (M)	2.1
82.2 (F)	72.3 (A)	9.9
93.8 (M)	57.0 (M)	36.8
61.9 (A)	45.5 (J)	16.4
89.9 (M)	35.0 (J)	54.9
130.4 (J)	55.8 (A)	74.6
105.4 (J)	67.5 (S)	37.9
88.1 (A)	52.7 (O)	35.4
46.0 (S)	37.0 (N)	9.0
76.2 (O)	70.1 (D)	6.1
76.7 (N)	78.0 (J)	-1.3
70.3 (D)	58.3 (F)	12.0

FIGURE 17 PREDICTED AND OBSERVED POINTS FOR THE STUDY AREA

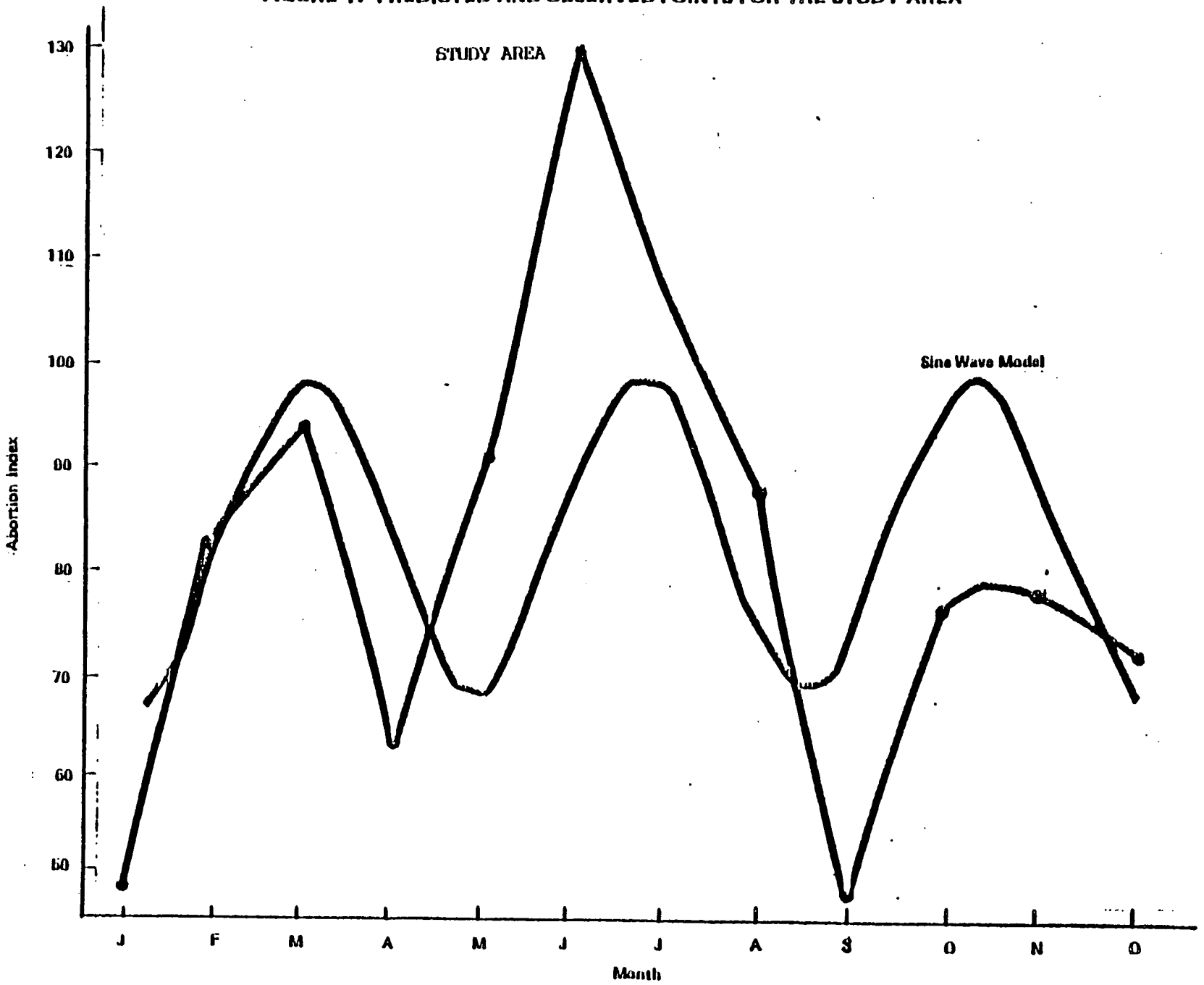
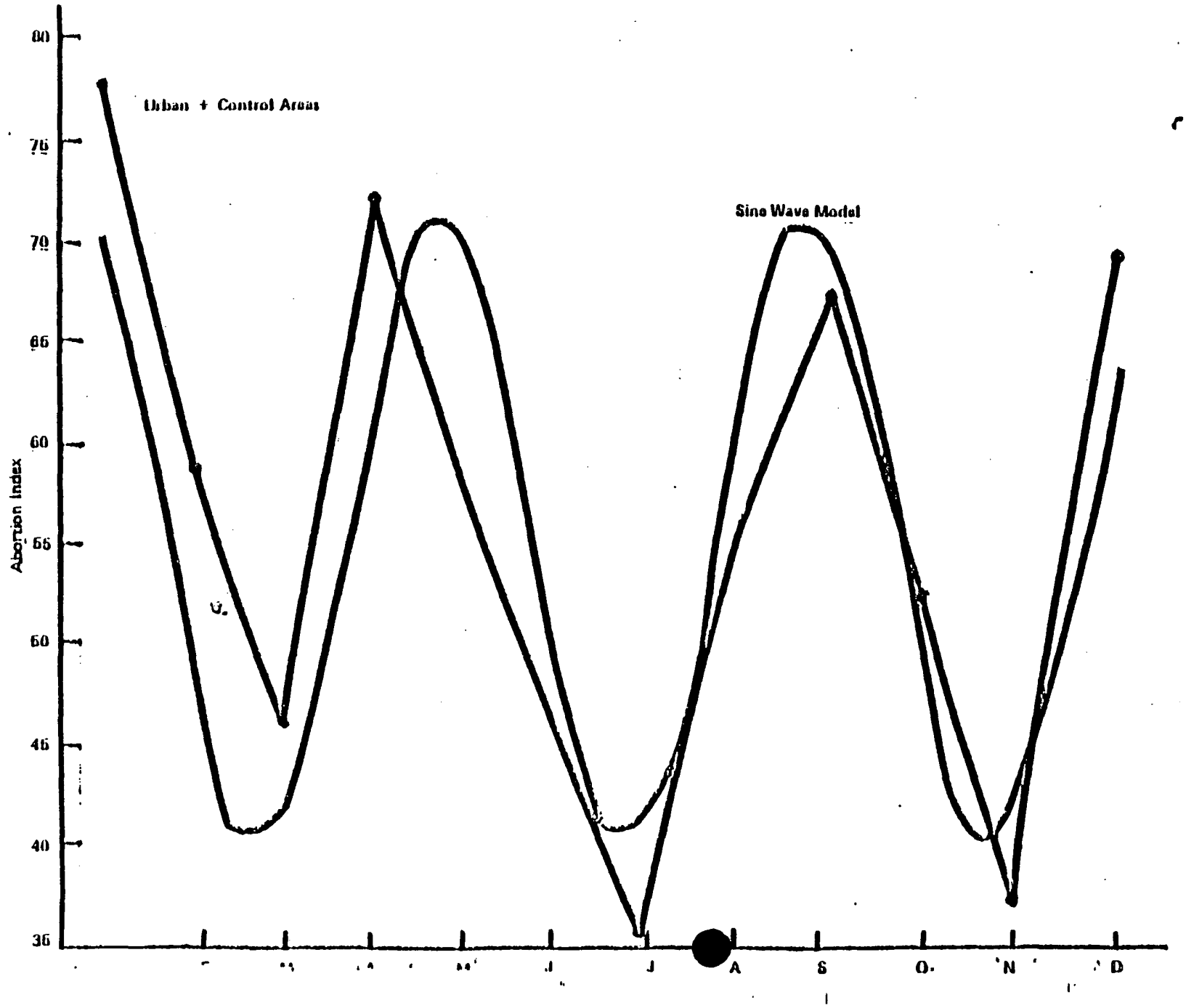


FIGURE 18 PREDICTED AND OBSERVED POINTS FOR THE URBAN + CONTROL AREAS



Cyclic Analysis of the Numbers of Abortions: The raw numbers of abortions showed the same time behavior as did the indices. In order to find some rationale for cyclic variation in spontaneous abortions, a physician board-certified in obstetrics and gynecology was consulted. He was aware that births might show some high frequency cyclic behavior superimposed on a yearly cycle. The data for 1976-77 for Jackson Memorial Hospital in Miami, Florida are shown in Appendix B. A plot of these data suggests cycles of two-months duration. Plots of the Oregon birth data in this report suggest cycles of two-to-three-months duration. Clearly, these patterns need investigation since they might be viewed as "noise" in the data and thus obscure important relationships.

Simple Number of Births as the Denominator for the Abortion Index: In order to see if any unanticipated algebraic relationships involved in computing the denominator for the index could be causing a problem, the raw numbers of births were used to compute abortion indices. The results of the analyses did not change from the above. Table 19 shows the distribution of births by month and the computed indices.

Cross-Correlation Between Study Area Abortion Indices and Spray Pattern

Cross-Correlation Analysis: A cross-correlation was computed between the abortion index for the Study area and the monthly pattern of spraying 2,4,5-T in pounds sprayed by month ~~(see Figure 19)~~. This

TABLE 19

Number of Births per Month and Unweighted Abortion Index for the Study, Urban, and Control Areas

Oregon 1972 - 1977

Month	Study Area		Urban Area		Control Area	
January	194	51.5	338	74.0	124	96.8
February	188	90.5	353	48.1	124	32.3
March	202	89.1	344	43.6	126	55.6
April	189	58.2	335	47.8	131	100.9
May	201	79.6	357	47.6	155	58.1
June	228	105.3	378	39.7	145	41.4
July	203	98.5	315	15.9	156	44.9
August	212	80.2	351	31.3	131	76.3
September	204	44.1	342	49.7	154	71.4
October	170	88.2	343	55.4	136	51.5
November	172	93.0	337	20.8	155	51.6
December	181	82.9	327	48.9	129	108.5
Total/Average	2344	80.1	4120	43.6	1666	65.8

FIGURE 10 (a) STUDY AREA ABORTION INDEX CORRECTED FOR PHASE-SHIFTED URBAN INDEX; (b) POUNDS OF 2,45-T SPRAYED BY MONTH

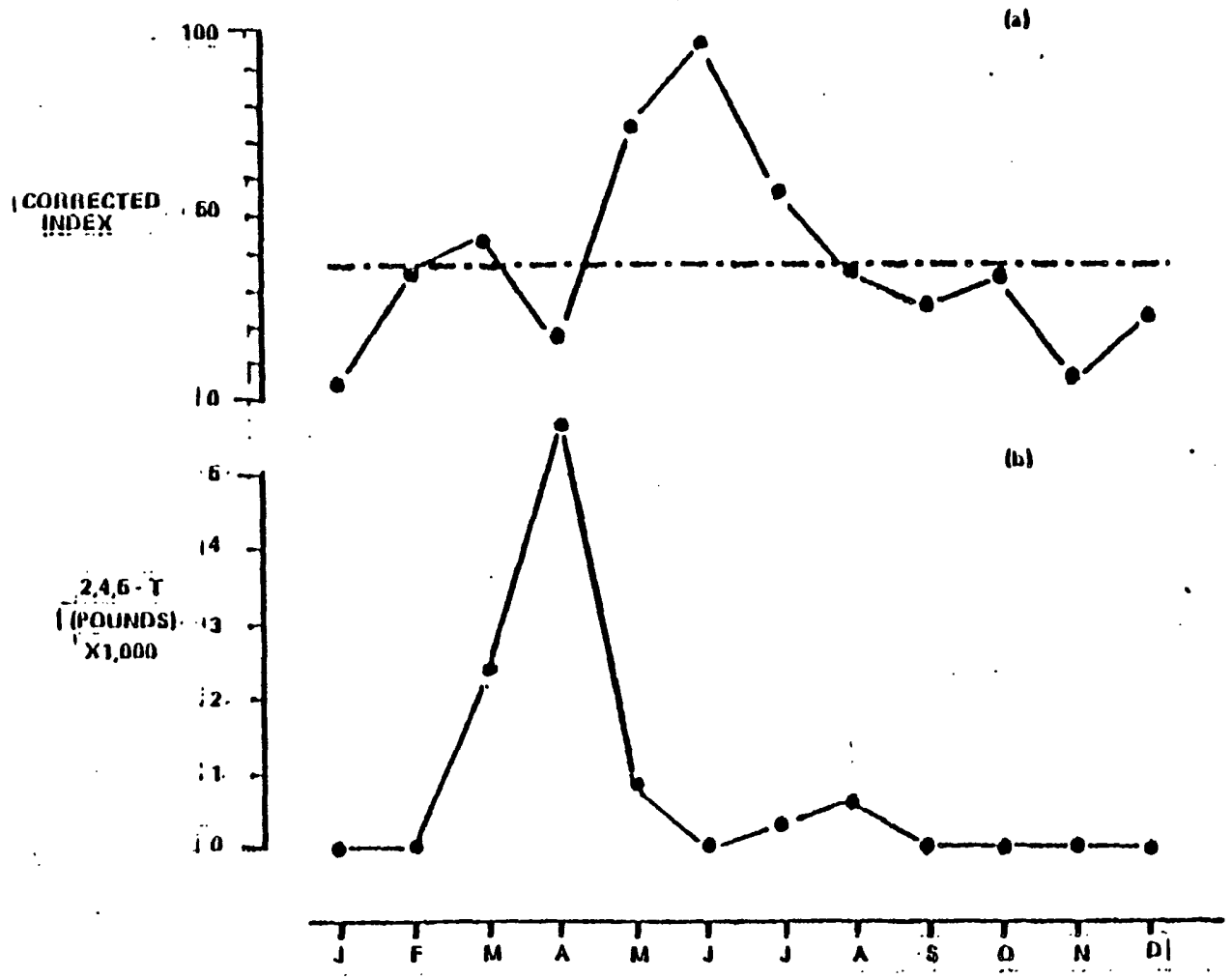
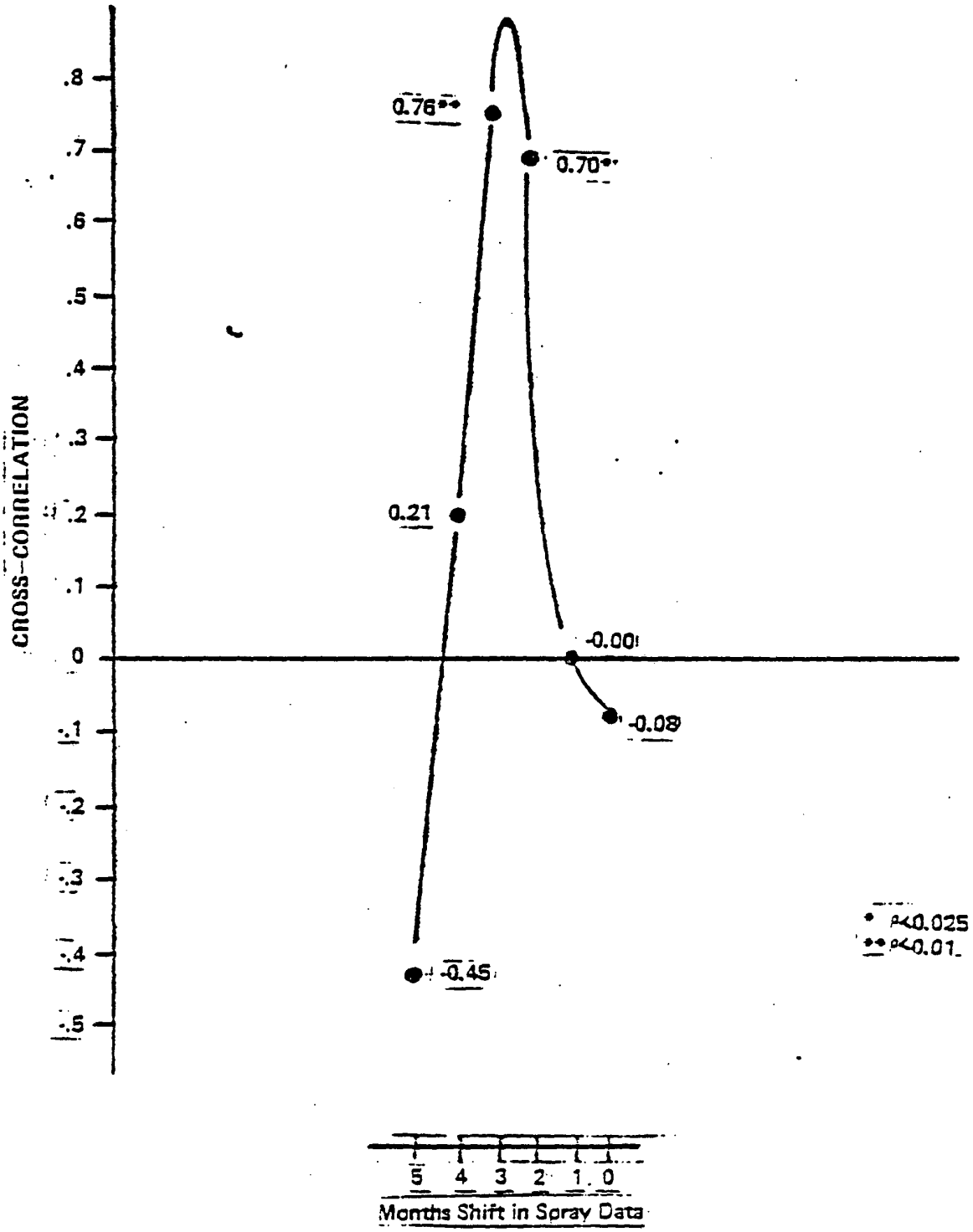


FIGURE 20 CROSS-CORRELATION OF STUDY AREA ABORTION INDEX WITH SPRAY PATTERN IN TOTAL POUNDS OF 2,4,5-T APPLIED BY MONTH, 1972-77.



analysis showed that the abortion index for the Study area was significantly correlated ($p<.01$) with the spray pattern after a lag of two ($r=.70$) to three ($r=.76$) months (see Figure 20).

To avoid problems with a non-normal distribution of the spray data, a Spearman rank correlation corrected for ties was computed. The two-month lag was not quite significant ($r=.46$), but the three-month lag was ($r=0.58$, $p<.05$).

Cross-Correlation Between the Adjusted Study Area Index and the Spray Pattern

Removal of the Cyclic Trend: The differences shown in Tables 16, 17, and 18 now appear to be free of cyclic trends. This is shown in Figure 19. Thus, the adjusted indices over time can be related to the spray pattern over time in a straight-forward way. This is a more conservative approach than to use the unadjusted differences between the Study area and the Control or Urban areas when correlating with the spray pattern.

Cross-correlation of Spray Pattern with Adjusted Abortion Index: From Figure 19 it appears that the peak in the corrected abortion index for the Study area follows the peak in the spray pattern by two to three months. This is borne out in Table 20 which shows significant correlations ($p<.01$) after two months.

TABLE 20

Cross - Correlation of Corrected Study Area Index with Spray Data

	Lag (months)				
	0	1	2	3	4
Study vs. Urban	-.08	0.33	0.89*	0.56	0.04
Study vs. Control	-0.27	0.24	0.84*	0.48	-0.15
Study vs. Urban + Control	0.09	0.38	0.83*	0.54	0.17

* $p < .01$

TABLE 21

Pounds of 2,4,5-T Applied in the Alsea Basin and Abortion Index For the Study Area by Month and Period
Oregon, 1972-1977

	PERIOD I (1972 - 3 - 4)		PERIOD II (1975 - 6 - 7)	
	Abortion Index	Pounds 2,4,5-T	Abortion Index	Pounds 2,4,5-T
January	48	0	48	0
February	77	0	87	0
March	94	296	94	2131
April	45	290	79	5574
May	112	471	67	317
June	98	0	163	0
July	95	288	116	16
August	76	365	104	195
September	61	0	31	0
October	71	0	81	0
November	105	0	48	0
December	84	0	56	0

TABLE 22

Cross-Correlation* of Study Area Abortion Index with Spray Data

	Lag (months)				
	0	1	2	3	4
Period I	0.19	-0.06	0.27	0.31	0.00
Period II	0.32	-0.24	0.31	0.66**	0.00

* Spearman Rank Correlation corrected for ties

** $0.01 < p < 0.05$

Abortion Index/Spray Pattern Cross-Correlation Analyses for Periods I and II

Table 21 shows the pounds of 2,4,5-T used by month and the abortion index by month for Periods I and II (1972-74 and 1975-77). Cross-correlation analyses were completed between the abortion indices for each period and the respective monthly patterns of spraying 2,4,5-T in pounds sprayed by month in the "Alsea Basin." Since the spray data are clearly not approximately normally distributed, a Spearman Rank Correlation corrected for ties was done to find the cross-correlation between spray patterns and the abortion index in the Study Area.

The results are shown in Table 22. These correlations show the same pattern as those for the six-year aggregate of data (see Table 20), although the correlation does not reach significance for the Period I data.

Physician Interviews

Table 23 lists the physicians' estimates of the number of spontaneous abortion cases of terms less than 20 weeks treated per year (1972-77) and the percentage that were hospitalized.

Of the 19 doctors contacted at the four hospitals in the Study area, four refused to provide estimates and four indicated they did not handle such cases. The remaining 11 physicians provided positive

responses on number of cases handled and/or percentage hospitalized. Assuming that the four who refused to respond do handle such cases, 79% (15 of 19) of the physicians contacted have treated spontaneous abortions during the study period.

From the physician interviews, it is estimated that approximately 70% of the spontaneous abortion cases are hospitalized among those treated by physicians practicing at one of the Study area's four hospitals. The percentage is calculated by weighting the individual hospitalized percentage estimates by the respective number of cases treated by each responding physician.

It is concluded, therefore, that the abortion data presented for the Study area are, indeed, representative of that area. It is further assumed that because of the aforementioned medical/population similarities between the Study and the Control areas, a similar representative percentage of spontaneous abortions are hospitalized in the Control area.

The percentage of spontaneous abortion cases hospitalized in the Urban area is estimated to be approximately 30%. (The estimate is adjusted for general practitioners not selected for interview). The percentage is clearly less than that for the Study area, apparently due to those cases treated at the clinic and medical center facilities not available in the Study area. The data are considered to be reflective

of seasonal spontaneous abortion patterns; however, Urban area index values are undoubtedly biased downward relative to those for the Study and Control areas.

TABLE 23

Study and Urban Area Physician Interviews: Estimated Numbers of Spontaneous Abortions Treated Annually and Percentages Hospitalized, 1972 - 1977

Hospital	Contacted Physician	Type of Patients	Annual Mean Number of Spontaneous Abortion Cases, 1972 - 1977	Percent Hospitalized
Pacific Communities Newporte, OR (9 Physicians)	A	GP	*	75-80
	B	GP	0	—
	C[1]	GP	0	—
	D[2]	GP	10.0	95
	E[3]	GP	0	—
Western Lane Hospital Florence, OR (6 Physicians)	F	GP	1.5	20-30
	G	GP	<1.5	Unknown
	H	GP	6	25
	I	GP, Surgery	1.5	95
	J[4]	GP	15	75
New Lincoln Hospital Toledo, OR (4 Physicians)	K	GP	7.1	50
	L	GP	*	—
	M	GP	0	—
	N	GP	0.3	100

TABLE 23 (Continued)

Hospital	Contacted Physician	Type of Patients	Annual Mean Number of Spontaneous Abortion Cases, 1972 - 1977	Percent Hospitalized
North Lincoln Hospital Lincoln City, OR (8 Physicians)	O	GP	5.0	80
	P	GP	5.0	80
	Q	GP	*	—
	R	GP	*	—
	S	GP	*	—
Good Samaritan Hospital Corvallis, OR	T	GP	5.0	80
	U[5]	GP	1	50
	V[6]	GP	3.9	30
	W	GP	*	—
	X	Internist	0	—
	Y	OB/GYN	50.0	10
	Z	OB/GYN	50.0	10
	AA	OB/GYN	50.0	10
	BB	OB/GYN	50.0	10
	CC	Internist	0	—
	DD	GP	11	0

TABLE 23 (Continued)

Hospital	Contacted Physician	Type of Patients	Annual Mean Number of Spontaneous Abortion Cases, 1972 - 1977	Percent Hospitalized
Good Samaritan Hospital Corvallis, OR (continued)	EE	OB/GYN	50.0	10
	FF	OB/GYN	0	—
	GG	OB/GYN	50.0	10
	HH	OB/GYN	50.0	10

*Refused to release data.

[1]Physician C has practiced in the community since January 1978.

[2]Physician D has practiced in the community since 1975.

[3]Physician E has practiced in the community since 1977.

[4]Physician J has practiced in the community since 1976.

[5]Physician U has not taken any obstetric cases in past three years.

[6]Physician V has practiced for 14 months.

Chapter V

SUMMARY AND CONCLUSIONS

The objectives of the study were to test the following hypotheses:

(a) whether or not differences in spontaneous abortion rates exist between the study and control population;

(b) whether or not seasonal variations in rates exist within the study and control populations;

(c) whether or not such variations, if they exist, can be associated with time and concentration of spray applications in the Study area.

The statistical analyses of the spontaneous abortion and spray data presented herein to test these hypotheses have demonstrated that:

1. The 1972-77 abortion rate index for the Study area is significantly higher than those for either the Control or the Urban area.

2. There is a statistically significant seasonal cycle in the abortion index in each of the areas with a period of about 4 months. In particular, there is an outstanding peak in June in the Study area.

3. There is a statistically significant cross-correlation between the Study area spontaneous abortion index and spray patterns in terms of pounds applied by months in the Alsea basin, 1972-77, after a lag time of 2 or 3 months.

The results based on the six-year aggregate of abortion and spray data are confirmed and enhanced by the analysis of the two 3-year aggregates. The cyclic time patterns are consistent over time periods; the Study area shows an elevated abortion index over the Control and the Urban areas; and there is a peak in the abortion index which correlates positively with the spray pattern in the Alsea basin after a lag time of 2 to 3 months.

For all its complexity, however, this analysis is a correlational analysis, and correlation does not necessarily mean causation.

REFERENCES

1. Rebuttable Presumption Against Registration and Continued Registration of Pesticide Products Containing 2,4,5-T. Environmental Protection Agency, Office of Pesticide Programs, Washington, D.C., Federal Register [6560-01] Vol. 43, No. 78 - - Friday, April 21, 1978.

2. Farm Chemicals Handbook - 1978. R. L. Meister, Jr. (ed.), Meister Publ. Co., Willoughby, Chio, pp. 250-251, 1978.

APPENDIX A

QUESTIONNAIRE: Oregon Miscarriage Investigation

NAME _____ DATE _____

ADDRESS _____

_____

Prior addresses:

_____ From 19___ to 19___.
CITY COUNTY STATE

_____ From 19___ to 19___.
CITY COUNTY STATE

_____ From 19___ to 19___.
CITY COUNTY STATE

Family Physician:

NAME _____

ADDRESS _____ PHONE _____

Date of Last Complete Physicial Examination _____.

PREGNANCY DATA

Please list all pregnancies -- if more than 5, add pages. If the answer to any question is "yes" please specify time in weeks of gestation and describe fully.

	PREGNANCIES				
	1st	2nd	3rd	4th	5th
Month and year of conception					
Residence during pregnancy: (City, County, State)					
Indicate live births (give date) (1) Full Term (2) Premature					
Still births/Spontaneous abortions (give date)					
Induced abortions (give date)					
Weeks of gestation					
Birth weight (lb., oz.)					
Any birth defects, mental deficiency, or other congenital impairment? (Answer No, Yes (describe) or unknown)					

PREGNANCY DATA
CONTINUED

PREGNANCIES

	1st	2nd	3rd	4th	5th
For livebirths, did you experience spotting during pregnancy?					
For miscarriages and stillbirths, was there a long period of illness and spotting, or was miscarriage sudden?					
Weight change during pregnancy (lb).					
Did your doctor tell you that your weight gain was excessive?					
Did your doctor indicate that you had high blood pressure during pregnancy?					
Did your doctor indicate that you had kidney infection during pregnancy? (Weeks of gestation)					

PREGNANCY DATA
CONTINUED

PREGNANCIES

	1st	2nd	3rd	4th	5th
Did he prescribe any medications for weight control, high blood pressure, or kidney infections? If yes please specify medications.					
Did you have any respiratory infections during pregnancy? (weeks of gestation)					
Did you use any of the following medication prior to or during pregnancy? If yes, indicate how often.					
1. Oral contraceptives					
2. Hormones					
3. Antinauseants					
4. Antihistamines					
5. Aspirin					
6. Antibiotics (Specify)					
7. Sleeping pills					
8. Vitamins					
9. Tranquilizers (specify)					
10. Other medications (specify)					

PREGNANCY DATA
CONTINUED

	PREGNANCIES				
	1st	2nd	3rd	4th	5th
Did you use any of the following prior to or during pregnancy? (Specify kind, amounts, frequency and when) 1. Tobacco					
2. Alcohol					
3. Marijuana					
4. "Drugs" (cocaine, LSD, etc.)					
Did you suffer any physical injuries during pregnancy? (If yes, show kind, weeks of pregnancy, was physician care required.)					
Were you X-rayed during pregnancy? (If yes, specify type and how often)					

PREGNANCY DATA
CONTINUED

PREGNANCIES

	1st	2nd	3rd	4th	5th
What household chemicals (paints, garment cleaners, solvents, pesticides) were you exposed to prior to or during pregnancy? (Specify types and how often)					
Was your pregnancy confirmed by a physician if an early miscarriage?					
Was your miscarriage documented by a physician?					

PREGNANCY OUTCOME OF SISTERS

For each of your sisters, please list pregnancy outcomes.

	City of Residence	Present Age	Total number of pregnancies: Full term	Premature	Spontan. Abortions	Induced Abortions
1.						
2.						
3.						
4.						
5.						
6.						

MEDICAL HISTORY

A. SUBJECT'S:

Have you had any of the following diseases or disorders in you lifetime?

	NO	YES	If yes, when/how long?
1. Measles:			
Regular	___	___	_____
German	___	___	_____
2. Infectious hepatitis	___	___	_____
3. Pneumonia, other respiratory infections	___	___	_____
4. Allergies (asthma, hay fever, drug reactions)	___	___	_____
5. Blood disorders, anemia	___	___	_____
6. Heart disease	___	___	_____
7. High blood pressure	___	___	_____
8. Kidney disease; cystic nephritis, etc.	___	___	_____
9. Diabetes	___	___	_____
10. Thyroid disorders	___	___	_____
11. Stomach disorders, ulcer	___	___	_____
12. Small bowel disorders, ileitis	___	___	_____
13. Large bowel disorders, colitis	___	___	_____
14. Nervous system disease, central, peripheral	___	___	_____
15. Epilepsy	___	___	_____
16. Muscle system disorders, paralysis	___	___	_____
17. Skeletal (bone) disorders	___	___	_____
18. Skin disease	___	___	_____
19. V.D.	___	___	_____
20. Congenital defects	___	___	_____
21. Mental illness	___	___	_____
22. Other (Please List)	_____		

_____

_____

_____

MEDICAL HISTORY (CONTINUED)

B. Subject's hospitalizations, excluding pregnancies:

APPROXIMATE DATE	PLACE	REASON	LENGTH OF STAY

C. MENSTRUAL INFORMATION:

1. Are your menstrual periods regular? ____ No, ____ Yes.

2. Would you characterize your menstrual period as (check one):

   a. Probably light ____
   b. Probably average ____
   c. Probably heavy ____

D. SUBJECT'S FAMILY

1. Did subject's father, or father's brother(s) or sister(s) suffer from any congenital defect? ____ No, ____ Yes, ____ Not sure.

   If yes, please list:

   Father _____

   His brother(s) _____

   His sister(s) _____

2. Did subject's mother, or mother's brother(s) or sister(s) suffer from any congenital defect? ____ No, ____ Yes, ____ Not sure.

   If yes, please list:

   Mother _____

   Her brother(s) _____

   Her sister(s) _____

MEDICAL HISTORY (CONTINUED)

3. Mother's pregnancies: Total number _____.

   How many were full term _____?

   How many miscarriages _____?

   If known, during which week(s) of pregnancy _____?

4. Did any of subject's brothers suffer from any congenital defect?
   ____ No, ____ Yes, ____ Not sure.

   If yes, list type of defect: _____

   _____

5. Major illnesses or diseases of brothers: _____

   _____

6. Did any of subject's sisters suffer from any congenital defect?
   ____ No, ____ Yes, ____ No sure.

   If yes, list type of defect: _____

   _____

7. Major illnesses or diseases of sisters: _____

   _____

ENVIRONMENTAL ASPECTS

PREGNANCIES

	1st	2nd	3rd	4th	5th
How many miles is (was) your residence or place of work from the nearest area sprayed with herbicides during each pregnancy?					
Could you ever smell the chemical at the time it was applied to the forest? (If yes, specify during which pregnancies.)					
What is (was) the source of your water supply? (Municipal, well, type)					
Were you ever aware of a change in the taste of your water during or soon after herbicide application?					
Were your garden & flowers, trees, shrubs ever damaged when herbicide was applied to the forest?					

ENVIRONMENTAL ASPECTS
CONTINUED

PREGNANCIES

	1st	2nd	3rd	4th	5th
Did you have any pets during your pregnancies? ____ No, ____ Yes. If yes, please list (dog, cat, bird, etc.)					

Has your water supply ever been tested for pesticide residues? ____ No, ____ Yes, ____ Not sure.

If yes, do you know when _____? By whom _____?

Do you know the results? (list) _____?

If not, do you know where they may be obtained _____?

FOOD SUPPLY AND DIET

A. What percentage of your meat and poultry products are raised locally? _____%.

B. What percentage of your fruits and vegetables are raised locally? _____%.

C. Does your milk come from local cows? ____ No, ____ Yes, ____ Some(%).

D. Do you have a home garden? ____ No, ____ Yes.

E. Do you eat game taken from local forest areas that have been treated with herbicides? ____ No, ____ Yes. Kind? _____. Approximate number of meals per year _____.

HOUSEHOLD PESTICIDE USAGE

1. Has a commercial applicator treated your residence for pests within the past five (5) years? ____ Yes, ____ No, ____ Unknown.

2. Has your residence ever been treated for termites? ____ No, ____ Yes, ____ Unknown.

3. Within the past five (5) years has your household used no-pest strips? ____ Yes, ____ No, ____ Unknown.

4. Within the past five (5) years has your household used any of the following pesticides on pets?

   Insecticide Collar ____ Yes, ____ No, ____ NA
   Insecticide Shampoo ____ Yes, ____ No, ____ NA
   Insecticide Powder ____ Yes, ____ No, ____ NA
   Other _____

5. Within the past five (5) years have you used moth balls, crystals, flakes, or aerosols? _____ Yes, _____ No, _____ Unknown.

6. Within the past five (5) years have pesticides been used in the:

   House ____ Yes, ____ No.
   Garden ____ Yes, ____ No, ____ NA.
   Yard ____ Yes, ____ No, ____ NA.

7. Are any pesticides stored on the premises? ____ Yes, ____ No, ____ Unknown.

8. Within the past five (5) years have you used any disinfectants? ____ Yes, ____ No, ____ Unknown.

PESTICIDE NAME	What are names of all pesticides used by the household in the past five years and the names of all non-used pesticides currently stored on the premises. Also, show EPA registration number if known.
PESTICIDE CODE (Office Use Only)	
COMMERCIAL HOUSEHOLD HEAD - MALE HOUSEHOLD HEAD - FEMALE OTHER ADULT->18 yrs old CHILD -<18 yrs old	Who used this specific pesticide?
LIQUID SOLID	Is this pesticide in liquid or solid form? (Aerosols are liquids
	How many ounces of this pesticide have you or any member of your household used in the past 12 months?
	How many ounces of this pesticide are currently stored on the premises?
HOUSE GARAGE LAWN YARD (other than lawn) VEGETABLE GARDEN FLOWER BED OTHER	Where on the premises has this pesticide been used in the past 5 years.
	How many times has this pesticide been used in the past 12 months?
BOOTS GLOVES MASK WASH HANDS AREA OFF-LIMITS TO CHILDREN & PETS OTHER NONE	What type of precautions are taken when using this pesticide?
YES NO NOT STORED	Is this pesticide stored under lock and key?
YES NO NOT STORED	Is this pesticide stored in its original container?
KITCHEN-UNDER SINK KITCHEN-OTHER UTILITY ROOM GARAGE SHED BACK PORCH BASEMENT OTHER NOT STORED	Where on the premises is this pesticide stored?

OCCUPATIONAL HISTORY OF SUBJECT

Please list any employment:

Employer (location)	Describe Type of Business	Job Title	Beginning and ending Dates

Do you launder your husband's work clothes with family wash?
____ Yes ____ No

OCCUPATIONAL HISTORY OF HUSBAND

Employer (location)	Describe Type of Business	Job Title	Beginning and ending Dates
1.			
2.			
3.			
4.			
5.			
6.			

THESE QUESTIONS REFER TO HUSBAND'S OCCUPATION:

Was This Job Considered Dangerous	Was Protective Equipment or Clothing Available	Did He Inhale Chemical Solvents Dust or Other Fumes?	Did Chemical Solvents, Oils, Dusts, etc. Get on His Skin/Clothes?
(1) Yes ____ No ____ If yes, why?	Yes ____ No ____ If yes, what was it?	Yes ____ No ____ If yes, list if known:	Yes ____ No ____ If yes, list if known:
(2) Yes ____ No ____ If yes, why?	Yes ____ No ____ If yes, what was it?	Yes ____ No ____ If yes, list if known:	Yes ____ No ____ If yes, list if known:
(3) Yes ____ No ____ If yes, why?	Yes ____ No ____ If yes, what was it?	Yes ____ No ____ If yes, list if known:	Yes ____ No ____ If yes, list if known:
(4) Yes ____ No ____ If yes, why?	Yes ____ No ____ If yes, what was it?	Yes ____ No ____ If yes, list if known:	Yes ____ No ____ If yes, list if known:
(5) Yes ____ No ____ If yes, why?	Yes ____ No ____ If yes, what was it?	Yes ____ No ____ If yes, list if known:	Yes ____ No ____ If yes, list if known:

THESE QUESTIONS REFER TO HUSBAND'S OCCUPATION CONTINUED:

Was This Job Considered Dangerous	Was Protective Equipment or Clothing Available	Did He Inhale Chemical Solvents Dust or Other Fumes?	Did Chemical Solvents Oils, Dusts, etc. Get on His Skin/Clothes?
(6) Yes ____ No ____ If yes, why?	Yes ____ No ____ If yes, what was it?	Yes ____ No ____ If yes, list if known:	Yes ____ No ____ If yes, list if known:

1. Did your husband serve in Vietnam? ____ No, ____ Yes, ____ Months of service.

2. If yes, was he directly involved with spraying of Agent Orange ____ No, ____ Yes.

3. Was he otherwise exposed to Agent Orange during his military activities? ____ None; ____ Some; ____ Often.

4. Has your husband ever had a sperm examination? ____ No, ____ Yes.

   If yes, were abnormalities suspected? ____ No, ____ Yes.

5. Has your husband ever had V.D.? ____ No, ____ Yes (specify), ____ No knowledge.

6. Has your husband ever used marijuana? ____ No, ____ Yes, ____ No knowledge.

7. Has your husband ever used "drugs" such as cocaine, LDS, etc? ____ No, ____ Yes, ____ No knowledge.

EDUCATIONAL BACKGROUND

Did you graduate from high school? ____ No, ____ Yes, Class of 19___.

If not, what was the highest grade completed? _____.

Did you graduate from college? ____ No, ____ Yes,
degree's _____ and year's _____.

If not, did you attend college? ____ No, ____ Yes, ____ Years.

Did your husband graduate from high school? ____ No, ____ Yes,
Class of 19___.

If not, what was the highest grade he completed? _____.

Did your husband graduate from college? ____ No, ____ Yes,
List degree's _____ and year's _____.

If not, did your husband attend college? ____ No, ____ Yes, ____ Years.

LABOR ROOM STATISTICS

Jackson Memorial Hospital — APPENDIX B

1977-1978

	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	TOTAL FOR YEAR
Admissions													
76-77	584	562	614	570	461	568	491	532	503	574	655	616	6730
77-78	673	592	566	569									
Total Deliveries													
76-77	570	536	604	566	449	578	511	600	474	525	597	605	6749
Private	37	13	30	34	33	34	14	27	22	23	16	33	307
Staff	533	523	566	532	416	404	497	573	452	502	574	572	6042
77-78	654	575	545	543									
Private	15	6	14	8									
Staff	639	569	531	534									
Emergencies													
76-77	66	79	65	66	67	67	66	66	66	77	77	74	779
77-78	56	66	69	66									
Total Live Births													
76-77	560	529	583	540	447	577	506	604	467	571	578	589	6749
Private	39	13	30	34	33	33	14	27	22	23	16	33	307
Staff	521	515	553	526	409	489	395	567	445	498	562	556	6042
77-78	649	570	543	537									
Private	15	6	14	9									
Staff	634	564	529	528									
Vaginal Live Births													
76-77	470	433	507	464	370	423	317	492	390	416	475	483	5140
Private	32	7	21	24	21	24	13	18	12	18	14	14	220
Staff	438	426	486	440	349	399	304	474	378	397	461	469	4920
77-78	549	472	483	442									
Private	10	3	4	5									
Staff	539	469	444	437									
Cesarean Section Live Births													
76-77	90	95	81	96	72	99	93	102	77	105	103	109	1111
Private	7	6	9	10	12	9	1	8	10	4	2	9	87
Staff	83	89	72	86	60	90	91	94	67	101	102	100	1025
77-78	100	98	90	95									
Private	5	3	5	3									
Staff	95	95	85	92									
Multiple Pregnancies													
76-77	7	4	9	5	6	4	9	5	2	4	7	5	67
77-78	7	12	11	6									
Low Birth Weight Infants													
76-77	66	42	71	61	43	54	73	57	51	62	71	68	721
77-78	74	59	72	62									

	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	TOTAL FOR YEAR
Stillborns													
76-77	10	8	6	6	7	7	2	5	7	4	14	2	80
VAGINAL													
Private	0	0	0	0	0	0	0	0	0	0	1	0	1
Staff	10	7	6	4	6	6	2	5	7	4	13	2	72
C/S													
Private	0	0	0	0	0	1	0	0	0	0	0	0	1
Staff	0	1	0	2	1	0	0	1	0	0	0	1	6
77-78	5	6	2	5									
VAGINAL													
Private	0	0	0	0									
Staff	4	7	2	5									
C/S													
Private	0	0	0	0									
Staff	1	7	0	0									
Abortions													
76-77	21	28	29	22	32	44	38	29	50	34	48	35	411
77-78	24	45	31	31									
Labor Room													
Cesarean Section													
76-77	61	71	62	82	50	80	68	80	67	92	92	98	903
77-78	85	68	85	86									
Cesarean Sections													
76-77	93	97	82	97	75	99	93	103	77	107	104	108	1035
Primary	55	76	54	60	56	73	63	73	51	74	76	80	735
Repeat	38	21	28	37	19	26	25	30	26	33	28	29	340
77-78	102	98	80	95									
Primary	65	73	60	60									
Repeat	37	25	20	35									