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Nonoccupational Pesticide Exposure Study (NOPES)

Final Report

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Atmospheric Research and Exposure Assessment Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Notice

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Foreword

The Office of Research and Development (ORD), in 1979, first evaluated a new and innovative research approach for assessing total human exposure to a variety of toxic chemicals. Since that time, the Total Exposure Assessment Methodology (TEAM) approach has been employed in several monitoring studies and has subsequently become an integral component of the monitoring, Total Human Exposure Research Program. The TEAM approach applies probabilistic population sampling techniques, indoor and outdoor microenvironmental personal exposure monitoring, and human activity pattern data for multiple routes of exposure to support total human exposure assessment. The Nonoccupational Pesticide Exposure Study (NOPES) carries this process one step further by estimating potential human health effects associated with nonoccupational exposures to pesticides in the study areas and associated monitoring seasons.

The Atmospheric Research and Exposure Assessment Laboratory located at Research Triangle Park, North Carolina, is committed to performing goal-oriented, high-quality ORD studies to characterize air pollutant sources, sinks, transport, and transformations; assess and predict exposure of humans and ecosystems to environmental pollutants; and develop monitoring systems and other technologies to determine the status and trends in pollutant concentrations and the condition of the nation's ecosystems.

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Abstract

The Nonoccupational Pesticide Exposure Study was the first attempt to develop a methodology for measuring the potential exposure of specified populations to common pesticides. In this study, as in other studies utilizing the Total Exposure Assessment Methodology (TEAM), the exposures were related to actual use patterns. A selected list of 32 household pesticides were evaluated in two different cities during this study.

Air samples were collected over a 24-hour period in indoor, outdoor and personal microenvironments. In addition, limited water and dermal contact samples were collected for selected homes. The study households were selected from stratified random population samples in two urbanized areas. The samples were collected over several seasons in areas contrasting a relatively high and low use of pesticides. The sampling strategy included within-home duplicate, triplicate and replicate samples, as well as single- season and multi-season sampled homes. This comprehensive sampling design permitted estimation of short-term and seasonal temporal differences as well as interpersonal comparisons. Dietary recall, activity pattern, and pesticide use data were collected through survey questionnaires.

The report discusses the results of the study with an emphasis on the various routes of exposure (air, water, dermal, and indirectly, food) and their relative contribution to total human exposure. The effectiveness of the exposure stratification, potential health effects, consumer awareness highlights, and exploratory analyses of activity patterns and pesticide use are also included.

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Acknowledgments

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Section 1
Introduction

In 1984, Congress appropriated FY85 monies to the U.S. Environmental Protection Agency (EPA) to assess the level of pesticide exposure experienced by the general population. Occupational exposure of specific groups of pesticide users, such as farm workers and pest control operators, had been examined and characterized by previous studies (Wolfe, 1976; Bristol et al., 1984). However, little was known about the general distribution of nonoccupational exposures to household pesticides. To begin to overcome this lack of knowledge, the EPA Office of Research and Development, in conjunction with the Office of Pesticide Programs, conducted the Nonoccupational Pesticide Exposure Study (NOPES). NOPES was designed to provide initial estimates of nonoccupational exposure levels and to address the nature of the variability in exposure.

NOPES was based on the Total Exposure Assessment Methodology (TEAM) approach to exposure estimation. The Agency began developing the TEAM approach in 1979 for measuring human exposure to various environmental contaminants (Ott, 1985; Ott et al., 1986). In a TEAM study, probability-based survey sampling procedures are combined with questionnaire data collection and modern personal monitoring techniques to obtain statistically defensible estimates of exposure levels in the general population. Data on exposure levels, rates of use, and activity patterns are then used to develop predictive models for exposure. The initial application of this innovative approach (Wallace, 1987) was in the estimation of exposures to volatile organic compounds (VOCs). The TEAM approach was also applied to estimating population exposures to carbon monoxide (Akland et al., 1985). The success of these projects prompted the decision to conduct NOPES as a TEAM study.

NOPES had both methodological and analytical objectives. NOPES sought to apply the TEAM approach to a class of chemicals not previously addressed by TEAM. Therefore, the primary methodological objective of NOPES was to develop and refine the monitoring instrumentation, laboratory procedures, and survey questionnaires needed for a TEAM study of pesticides. The overall analytical objective of NOPES was to estimate the levels of nonoccupational exposure to selected household pesticides through air, drinking water, food, and dermal contact. Specific objectives were as follows:

- Estimate exposure levels for the populations of two urban areas of the United States.
- Assess the relative importance of each exposure pathway to the overall level of exposure.
- Characterize the components of variability in the observed exposure levels.
- Investigate and, if possible, model the relationships between exposure levels, rates of use, activity patterns, and other factors that could contribute to variation in exposure levels.

Work on the design phase of NOPES began in 1985. Southwest Research Institute (SwRI), of San Antonio, Texas, developed the methodology for collecting air samples and analyzing them for 32 selected pesticides and pesticide degradation products (Hsu et al., 1988). Emphasis was placed on both identifying and quantitating the target compounds. Research Triangle Institute (RTI) of Research Triangle Park, North Carolina, developed the probability-based sampling design and the questionnaires needed to collect information about pesticide use and activity patterns. The questionnaires and monitoring and analysis procedures were tested in a pilot study conducted in Jacksonville, Florida in August and September 1985 (Lewis et al., 1988).

To permit assessment of regional and seasonal variations in exposure levels, the main NOPES data collection was conducted in three phases:

- Phase I : Summer 1986 in Jacksonville, Florida.
- Phase II : Spring 1987 in Jacksonville, Florida, and Springfield and Chicopee, Massachusetts.
- Phase III : Winter 1988 in Jacksonville, Florida, and Springfield and Chicopee, Massachusetts.

The findings of EPA's National Urban Pesticide Applicator Survey and earlier studies were used to select two study areas. Jacksonville was selected as representative of an area of the country with relatively high pesticide use, and the Springfield region was selected to represent an area of low to moderate pesticide use. In both study areas, some sample members were asked to participate in all phases of the study, whereas others were recruited only for a single phase. Monitoring some people in more than one phase permitted assessment of whether the overall differences observed between phases were due to true seasonal variation or due to random sampling variation. Short-term temporal variation was addressed by monitoring selected respondents twice in the same phase.

Sample members were selected from respondents to a screening questionnaire. The questionnaire collected data which were used to stratify screening respondents into three potential-exposure categories. Members of the high-potential-exposure category were sampled at a higher rate than medium or low category members. Members of the high-potential-exposure category were sampled at a higher rate in an attempt to improve the characterization of the upper tails of the estimated air exposure distributions. Because of the unequal sampling rates, estimation procedures that incorporated sampling weights (essentially reciprocals of the probabilities of selection) were used to produce design-unbiased population estimates.

The following activities were performed for each sample member who agreed to participate in the study:

- A study questionnaire was administered.
- A personal air sampler was given to the participant to wear or keep in close proximity for 24 h.
- Two or more fixed-site air samplers were set up and run for 24 h. At least one sampler was run in the respondent's home, and at least one was run outside the home.
- At the end of the 24-h monitoring period, an activity log questionnaire was administered.

In some households, drinking water samples were collected for analyses. Dermal exposure during pesticide application events was estimated for a small number of respondents by analyzing cotton gloves worn during typical application events following the regular monitoring period.

In all phases, RTI recruited the sample households, administered the questionnaires, and statistically analyzed the questionnaire and chemical data. SwRI performed the environmental monitoring and laboratory analyses. In Phases I and II, Environmental Monitoring and Services. Inc. (EMSI), of Camarillo, California, provided overall program management and quality assurance. EPA assumed these functions in Phase III. A series of interim reports provides detailed information on the conduct and results of each phase (Lev-On et al., 1987; Immerman et al., 1988a).

During the Jacksonville portion of Phase III, a dust sampling and analysis study was conducted in conjunction with the NOPES data collection. This study, designed to test a method for measuring the level of pesticides present in residential floor dust, is described in detail in a separate report (Budd et al., 1988).

Table 1 presents an overview of the NOPES project.

Table 1. Overview of the NOPES Project

1. Pilot Study, August 23 - August 29, 1985

   Nine purposively selected people in Jacksonville, Florida, were recruited to test the procedures and instrumentation developed for NOPES. Draft versions of the screening questionnaire, study questionnaire, and activity log were administered to the participants by RTI. Air, water, and glove samples were collected and analyzed by SwRI. The pilot study demonstrated that the TEAM approach proposed for NOPES was feasible and indicated where revisions were needed in the questionnaires, sample collection protocols, and analytical laboratory procedures (Lewis et al., 1988)

2. NOPES Phase I, August 21 - September 18, 1986

   Sixty-five people in Jacksonville, Florida, participated in the summer season of NOPES data collection. Monitoring samples were analyzed for 30 selected pesticides and pesticide degradation products. RTI was responsible for sample design and selection, questionnaire administration, and statistical analysis of the data. SwRI collected and analyzed the monitoring samples. Overall project management and quality assurance was provided by EMSI in this phase and Phase II (Lev- On et al., 1987).

3. NOPES Phase II, March 20 - April 13, 1987 (Jacksonville) and
   May 29 - June 17, 1987 (Springfield/Chicopee)

   Seventy-two people in Jacksonville and forty-nine people in Springfield and Chicopee, Massachusetts, participated in the spring season of data collection. Nineteen of the Jacksonville respondents had also participated in Phase I. Three compounds (4,4'-DDT, 4,4'-DDE, and 4,4'-DDD) were added to the set of thirty studied in Phase I (Immerman et al., 1988).

4. NOPES Phase III, January 30 - February 17, 1988 (Jacksonville) and
   March 11 - March 28, 1988 (Springfield/Chicopee)

   Seventy-one people in Jacksonville and fifty-two people in Springfield/Chicopee participated in the winter data collection. Sixteen of the Jacksonville respondents and fifteen of the Springfield/Chicopee respondents had participated in the earlier phases (Immerman et al., 1988a).

5. Special Study - High-Volume Surface Sampling, February 1 - February 6, 1988

   Nine of the Phase III respondents in Jacksonville also participated in this study, which was conducted to (1) test the ability of a high-volume surface sampler (HVSS) recently developed by Envirometrics to work effectively under field conditons, and (2) permit preliminary assessment of the levels of pesticides present in residential floor dust. The dust samples collected by the HVSS were analyzed by SwRI by the same protocols used for the main study samples (Budd et al., 1988).

Section 2
Conclusions

NOPES achieved both its methodological and analytical objectives, and has provided a wealth of new information about the magnitude of and variation in nonoccupational pesticide exposure. The major findings and conclusions of NOPES are described below in relation to the study objectives specified in the previous section.

Objective: Apply the TEAM approach to pesticides.

Conclusions: The Total Human Exposure Assessment Methodology (TEAM) applies survey sampling techniques, indoor and outdoor microenvironmental monitoring, personal exposure monitoring, and human activity pattern data to assess total human exposures. NOPES applied the TEAM concept to estimation of nonoccupational exposures to pesticides. NOPES investigated the air, water, food, and dermal routes of exposure for probabilistically selected study participants.

NOPES applied all the TEAM monitoring procedures for the air route of exposure. Because routine sampling of public water supplies prior to NOPES did not identify any of the target compounds, a minimal water sampling effort was implemented. Rather than incur the expense of directly collecting and analyzing food samples, dietary intake data were collected to indirectly estimate food exposures. Special gloves were developed and pilot tested in the NOPES for monitoring dermal exposures during pesticide application events.

NOPES demonstrated that the TEAM approach could be successfully applied to estimate nonoccupational pesticide exposures via inhalation. The air sampling instrumentation and analytical procedures proved capable of reliably characterizing personal, indoor, and outdoor air concentrations of the majority of the study analytes. Because the study was based on a probability-based sampling design, the NOPES data can be used to make valid statistical inferences about the distribution of exposures experienced by the populations of the two study areas. In addition, NOPES was the first study to provide information on air concentration relationships for many of the study analytes.

Objective: Estimate population pesticide exposure levels.

Conclusions: NOPES yielded quantitative estimates of air exposure concentrations, and qualitative assessments of water, dietary, and acute dermal exposure levels. All of the compounds studied in NOPES were detected at least once in the NOPES air samples. Some compounds were detected in the majority of households studied. Tables 2 and 3 summarize the estimated prevalence and mean concentration of the NOPES target compounds in personal air in Jacksonville and Springfield/Chicopee, respectively. The reported mean air concentrations may underestimate the true mean concentrations because of (a) lack of adjustment for incomplete recovery from the sampling matrix, and (b) the inclusion in the computations of zeros for samples in which analytes were not detected. Substituting zeros for nondetections primarily affects the analytes with a relatively high limit of detection, such as dichlorvos, because the measured amount of each detected analyte was recorded and used in the computations.

Nearly all the pesticides studied in NOPES have been used in residential settings. Given the sensitivity of the air monitoring techniques (on the order of nanograms per cubic meter of air), the detection of the analytes in many NOPES air samples is, therefore, not surprising.

Objective: Assess the relative importance of the exposure pathways.

Conclusions: The NOPES data only support qualitative evaluation of the relative importance of the exposure pathways studied. For 14 of the 25 analytes for which dietary exposure estimates could be calculated, food appears to be the major contributor to total exposure, whereas air appears to be the dominant contributor for six of the other eleven compounds.

On the basis of the limited number of water samples analyzed in NOPES, exposure to the study compounds from water ingestion appears to be negligible in the two study areas.

NOPES evaluation of the dermal contribution to total pesticide exposure was based on a small number of pesticide application events. The data tentatively suggest that the dermal pathway may be a significant contributor to total exposure for some pesticides.

A preliminary examination of pesticide concentrations in surface dust indicated that dust may be a significant contributor to total exposure for some pesticides, especially for infants and toddlers (Budd et al., 1988).

Objective: Characterize the components of variability in exposure levels.

Conclusions: Estimates of spatial and temporal variation in air exposures were developed from the NOPES data. For the majority of study analytes, indoor air concentrations were substantially higher than outdoor concentrations, often by more than an order of magnitude. Personal air concentrations were usually very similar to indoor concentrations, reflecting the high proportion of time typically spent indoors at home by respondents.

Personal and indoor air concentrations of many compounds were 2 to 30 times higher in Jacksonville than in Springfield/Chicopee. In winter, outdoor air concentrations of most detected analytes were higher in Jacksonville than in Springfield/Chicopee, whereas in spring, no consistent pattern of differences between the two study areas in outdoor concentrations was observed.

Patterns of seasonal variation in indoor, personal, and outdoor air concentrations were observed for many study compounds. The patterns were compound specific and complex, and may reflect interactions among pesticide use, household ventilation, temperature, and other factors.

Air concentrations of some analytes varied substantially over a period of several days, perhaps in response to the same factors that contributed to seasonal variation. This short-term variation was generally greater than the estimated measurement error variation and less than, but more comparable to, the observed seasonal variation.

Objective: Examine relationships between exposure levels and questionnaire data.

Conclusions: A simple, potential-air-exposure categorization was developed from screening questions and used to stratify the sample. The three categories were effective as a general classification device. They consistently differed in measures that summarized air exposure across all analytes. However, the categorization had only limited effectiveness as a predictive tool for air concentrations of specific analytes.

Exploratory analyses indicated that more predictive questionnaire-based models and categorizations may be possible for particular analytes. Termiticide concentrations were related to reported termiticide treatment history, type of housing unit, and age of housing unit. Age of housing unit was also related to concentrations of older pesticides that are now banned or much less frequently used. Weaker relationships were observed between mean concentrations of some commonly detected analytes and presence in household inventories or reported indoor insecticide use.

Table 2. Estimated Percent of Population with Detectable Levels of Target Compounds in Personal Air, Jacksonville, FL - All Three Seasons

Category and Compound	Range of % Detectable	Range of Mean Concentrations (ng/m³)
Commonly Found Compounds		
Chlorpyrifos	83 - 97	118 - 280
Propoxur	88 - 94	141 - 316
Diazinon	79 - 87	89 - 322
ortho-Phenylphenol	71 - 90	40 - 80
Chlordane	50 - 93	191 - 212
Often Found		
Heptachlor	41 - 90	64 - 134
gamma-BHC (lindane)	32 - 70	7 - 22
Dieldrin	22 - 70	5 - 10
Aldrin	20 - 37	7 - 39
Dichlorvos	11 - 35	21 - 148
alpha-BHC	19 - 27	0.7 - 0.9
Bendiocarb	14 - 26	3 - 51
Malathion	11 - 21	9 - 17
Hexachlorobenzene	6 - 45	0.4 - 0.9
Occasionally Found		
Chlorothalonil	<1 - 19	<0.1 - 3
Heptachlor epoxide	2 - 15	0.1 - 0.6
2,4-D (butoxyethyl or methyl ester)	0 - 15	ND[a] - 3
4,4'-DDE	5 - 12	0.5 - 0.8
4,4'-DDT	6 - 9	0.4 - 0.5
Methoxychlor	1 - 12	0.1 - 0.6
Dacthal	0 - 8	ND - 0.6
Rarely or Never Found		
cis-Permethrin	1 - 3	0.1 - 1
trans-Permethrin	1 - 3	0.1 - 0.5
Folpet	1 - 2	0.4 - 0.8
Carbaryl	0 - 2	ND - 28
Resmethrin	0 - 2	ND - 0.4
Atrazine	0 - 2	ND - 0.3
Captan	0 - 2	ND - 0.1
Ronnel	0 - 2	ND - 0.1
Oxychlordane	0	ND
Dicofol	0	ND
4,4'-DDD	0	ND

[a]ND = Not detected.

Table 3. Estimated Percent of Population with Detectable Levels of Target Compounds in Personal Air, Springfield/Chicopee, MA - Both Seasons

Category and Compound	Range of % Detectable	Range of Mean Concentrations (ng/m^3)
Commonly Found Compounds		
ortho-Phenylphenol	82 - 86	27 - 43
Chlordane	50 - 87	36 - 253
Heptachlor	50 - 66	5 - 35
Often Found		
Chlorpyrifos	30 - 40	6 - 7
Propoxur	32 - 38	11 - 16
4,4'-DDE	19 - 23	0.5 - 5
Dacthal	5 - 26	0.3 - 3
4,4'-DDT	12 - 19	0.7 - 0.9
Dieldrin	12 - 18	0.7 - 0.8
Diazinon	10 - 17	1 - 10
gamma-BHC (lindane)	8 - 10	0.7 - 5
Occasionally Found		
Chlorothalonil	2 - 12	0.1 - 0.8
Dicofol	0 - 12	ND[a] - 7
Aldrin	0 - 15	ND - 0.2
Rarely or Never Found		
Malathion	0 - 4	ND - 0.5
Dichlorvos	1 - 2	2 - 4
Bendiocarb	1 - 2	0.2 - 0.3
Folpet	<1 - 2	<0.1 - 0.7
Ronnel	<1 - 2	<0.1 - 0.1
Captan	0 - 2	ND - 0.1
Carbaryl	0 - 2	ND - 0.1
alpha-BHC	0 - 2	ND - <0.1
Hexachlorobenzene	0 - 1	ND - <0.1
Heptachlor epoxide	0	ND
Oxychlordane	0	ND
2,4-D (butoxyethyl ester)	0	ND
Methoxychlor	0	ND
cis-Permethrin	0	ND
trans-Permethrin	0	ND
4,4'-DDD	0	ND
Atrazine	0	ND
Resmethrin	0	ND

[a]ND = Not detected.

Section 3
Future Research Recommendations

Evaluation of NOPES results, in addition to providing important insights about the nature and magnitude of nonoccupational pesticide exposure, suggests a number of possible avenues for further research. Specific recommendations are:

1. Develop guidance for conducting exposure monitoring studies and associated methodologies for assessing human non-dietary exposure to pesticides in residential settings. These follow-up studies will be designed to permit a more comprehensive analysis of the health risks associated with exposure to pesticides from different routes.

2. Conduct prospective studies to estimate pesticide concentrations in household dust in order to explore the relationship between pesticide use and exposure, and the relative importance of the dust pathway to total human exposure, especially for infants and toddlers.

3. Refine the dermal exposure sampling and analytical methods required for quantifying dermal exposures and the estimation of acute and chronic pesticide exposures. These studies will attempt to estimate transfer coefficients between surface applications and the dermal and inhalation routes of exposure.

4. Improve the PUF sampling technique to reduce variability in matrix spike recoveries, evaluate analytical methodology for new compounds of interest, and prepare quality assurance standards on PUF media.

5. Conduct similar NOPES studies following revision of the population survey instruments. These revisions would incorporate improvements to the original survey design, develop more appropriate stratification variables, and permit the development of a survey data base with a larger regional or national application. The survey instruments would incorporate more detailed activity pattern information and pesticide use applications. The data would be combined with limited monitoring data and used to validate a proposed human exposure model specifically designed to estimate exposures to several of the NOPES pesticides.

Section 4
Study Design

The NOPES project was designed to test whether the TEAM approach could be adapted to develop estimates of exposures to selected household pesticides and pesticide degradation products from air, drinking water, food, and dermal contact in stratified random samples of the populations of two urban areas in the United States. The design also permitted examination of several components of the variation in pesticide air exposures, including regional differences, seasonal changes, short-term temporal variations, and interpersonal differences in patterns of use.

Selection of Study Analytes

Attempting to monitor the levels of all registered pesticides in the air and water of a household would be methodologically difficult and prohibitively expensive. Therefore, a manageable subset of target pesticides had to be defined for this study. EPA's Office of Pesticide Programs recommended a prioritized list of 24 pesticides and pesticide degradation products for the study. These compounds were selected because of current regulatory interests and the potential for occurrence of the compounds in household environments. Eight additional compounds were also suggested on the basis of previous EPA studies. Of the original 24 pesticides, four -- glyphosphate (Roundup^{R}), acephate (Orthene^{R}), paradichlorobenzene, and pentachlorophenol -- were subsequently removed from further consideration because they were difficult to measure by the protocols appropriate for the remaining pesticides. Four other compounds -- hexachlorobenzene, 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD -- were subsequently added at the request of the World Health Organization (WHO). Table 4 presents the final list of 32 target compounds for NOPES and describes their primary residential uses in the two study areas.

Target Population Definition

One of the first decisions to be made in the design phase of NOPES was where to conduct the study. Taking into account the NOPES objectives, the following set of preferred characteristics for the two study areas was developed.

- Each study area was to include both urban and suburban areas and have a variety of housing types and ages. These characteristics would help to ensure that a wide variety of pesticide use patterns was included in the study. Sites with large rural areas were excluded to avoid the potential for agricultural or forestry pesticide "contamination" of the NOPES measurements.

- The population in each study area had to be large enough to allow screening at a relatively low rate and still yield a sufficient number of high-potential-exposure households for monitoring. Using areas with relatively large populations would keep the perceived burden on the community low and would also increase the likelihood that a range of pesticide use patterns would be encountered.

- Each study area was to be similar in some respects to a relatively large number of other urban/suburban locations to permit limited, non-statistical extrapolation of the NOPES findings.

- One study area had to be in a region of relatively high pesticide use, and the other area was to be in a region of lower, but not negligible, use. This would permit regional comparisons of usage levels versus analyte concentration levels. Data from EPA's National Urban Pesticide Applicator Survey were used to characterize relative regional pesticide use.

Application of the set of preferred characteristics resulted in the definition of northern Florida and New England as the primary candidate regions for the high-use and low-use study areas, respectively. Following discussions with regional, state, and local officials, Jacksonville, Florida, and Springfield, Massachusetts, were chosen to be the NOPES study areas. The Springfield area was broadened to include the neighboring town of Chicopee to increase the variety of housing types and ensure a sufficient population size for screening.

Following the decision to conduct the NOPES sampling in the Jacksonville and Springfield/Chicopee areas, the study areas for the survey were defined

Table 4. NOPES Target Compounds

Target Compound	Common Formulations[a]	Primary Residential Uses in the Two Study Areas
DISINFECTANT:		
ortho-Phenylphenol	A, RL	Active ingredient in many Lysol[R] brand disinfectant products.
FUNGICIDES:		
Captan	D, F, WP	Widely used by consumers and pest control operators (PCOs) for control of diseases on trees, shrubs, fruits, and vegetables. Usually applied as wettable powder to plant surfaces.
Chlorothalonil	F, WP	Widely used by PCOs to control lawn, tree, and greenhouse plant diseases. Primarily applied as a flowable spray on lawns.
Folpet	D, F, WP	Used by consumers, rarely by PCOs, for control of leaf diseases of vegetables, flowers, fruits, and roses. Applied as a dust to leaf surfaces, not used in large volumes.
Hexachlorobenzene	WP, D	Currently used primarily as a seed protectant, primarily for wheat. Extremely rare in residential settings. Also found as a contaminant in pesticidal and non-pesticidal products.
HERBICIDES:		
Atrazine	F, G, WP	*Jacksonville*: Commonly applied to suburban settings in granular form combined with granular lawn fertilizer (weed and feed products). Occasionally applied to suburban lawns in liquid formulation. *Springfield/Chicopee*: Pre- and post-emergent selective herbicide, primarily used on corn. Rare in residential settings.
2,4-D (methyl and butoxyethyl esters)	G, EC	Probably the most commonly used lawn herbicide for control of dandelions and broadleaf weeds. Primary consumer applications are in granular lawn fertilizers. PCOs commonly apply as spray, sometimes in combination with other active ingredients. The methyl ester was tested for in Phase I of NOPES; later phases tested for the butoxyethyl ester.
Dacthal	G, WP	*Jacksonville*: Not commonly used in suburban settings *Springfield/Chicopee*: Widely used as a pre-emergent on lawns to prevent germination of crabgrass, annual weeds, and some broadleaf weeds. Primarily applied in granular form.
INSECTICIDES:		
Aldrin	D, G, EC, WP	Formerly used as a termiticide, applied as a soil treatment. Not as commonly used as chlordane; probably comprised less than 10% of termiticide use. Now withdrawn from use in the U.S.
alpha-BHC	---	Banned for use in U.S. Still entering the environment as a conversion product of gamma-BHC.
Bendiocarb	D, WP	Very widely used by PCOs for indoor control of ants, cockroaches, pantry and clothing pests, fleas, and termites (wood surface applications only). Probably most commonly used in multiunit dwellings subject to cockroach infestations. Applied as a dust or wettable powder.
Carbaryl	B, D, F, G, WP flea collars	Probably the most commonly used insecticide for broad-spectrum chewing insect control on fruit, vegetables, flowers, trees, shrubs, and lawns in residential settings. Applied to leaf surfaces primarily in wettable powder and dust forms. Widely used by consumers and PCOs. Also used for household pests and in flea dusts and flea collars.

(continued)

Table 4. (Continued

Target Compound	Common Formulations[a]	Primary Residential Uses in the Two Study Areas
INSECTICIDES (continued):		
Chlordane	EC, oil	The most widely used termiticide prior to being withdrawn in April 1988 (September 1985 in Massachusetts). Comprised approximately 80% of the termiticide market. Applied primarily by PCOs as liquid poured or injected into soil around building foundations.
Chlorpyrifos	A, EC, G	Used both indoors and outdoors. Used outdoors by consumers and PCOs for control of turf insects, ticks, chiggers, and ants. Applied primarily in granular form outdoors. Used in aerosol form by consumers and EC formulations by PCOs for household insect control. Widely used as a termiticide since ban on chlordane. Also used in flea collars, shampoos, and sprays.
4,4'-DDD	---	Environmental conversion product of DDT.
4,4'-DDE	---	Environmental conversion product of DDT.
4,4'-DDT	D, WP	Very widely used from 1940s until early 1970s for control of household, garden, ornamental, and public health insect pests. Also used as a tracking powder for rodents and for control of public health pests living on rodents. Banned from use in U.S.
Diazinon	A, D, EC, G	Widely used outdoor soil insecticide for control of turf and garden soil insects. Applied by consumers and PCOs in granular form. Indoors applied in aerosol form by consumers for control of household insects (ants, cockroaches).
Dichlorvos (DDVP)	impregnated resin strips, EC, A	Primarily used in "no-pest strips" by consumers to kill flying household insects. Available to consumers only in concentrations of 1% or less.
Dicofol	WP, EC, D, A	Most common miticide in residential settings for control of mites on shrubs, fruits, vegetables, flowers, and houseplants. Applied by consumers and PCOs.
Dieldrin	EC	Formerly used by PCOs for subsoil control of termites and on tree bark to prevent borer infestations. Comprised less than 10% of termiticides used. Withdrawn from use in U.S.
gamma-BHC	EC, WP	Primarily used to kill eggs of boring insects on tree bark. Applied as liquid spray by consumers and PCOs. Used for head lice, but only by prescription from a physician.
Heptachlor	EC, WP, G, D	Until 1988, used alone or in combination with chlordane as a subterranean termiticide. Comprised less than 5% of the termiticide market. Now withdrawn from use in U.S.
Heptachlor epoxide	---	Metabolite and/or environmental conversion product of heptachlor.
Malathion	WP, EC, D, B, G, A	Widely used for control of insects on plant surfaces, especially on trees, shrubs, fruit, vegetables, flowers, and houseplants. Primarily used by consumers, less used by PCOs. Used in mosquito control programs (discontinued in Florida in 1986).
Methoxychlor	EC, WP, G, D, A	Used for control of leaf-eating insects on trees, shrubs, fruit trees, flowers, and vegetables. Primarily applied as a liquid spray. Formerly used indoors to control pantry insect pests. Widely used for outdoor control of mosquitos and flies.
Oxychlordane	---	Metabolite and/or environmental conversion product of chlordane.
cis-Permethrin trans-Permethrin	A, EC	Aerosols widely used by PCOs for control of household pests, commonly in multiunit dwellings. Also used by consumers in aerosol form for household insect control. Recently came into use by PCOs as a termiticide, applied by liquid injection into soil.

(continued)

Table 4. Continued

Target Compound	Common Formulations[a]	Primary Residential Uses in the Two Study Areas
INSECTICIDES (continued):		
Propoxur	EC, B, WP, A, fogger, roach tape	Widely used for indoor pest control particularly cockroaches and flies. Used by consumers and PCOs. Less commonly used in granular applications for turf insect control.
Ronnel	A	Use discontinued in U.S. Formerly used for indoor pest control, especially fleas.
Resmethrin	EC, D, WP, A	Commonly used by PCOs for control of indoor household pests, especially cockroaches, ants, and spiders. Less commonly used for outdoor insect control on trees and shrubs. Applied by consumers in liquid formulations to plant surfaces. Used in mosquito control programs.

[a]Formulation codes: A = Aerosol, B = Bait, D = Dust, EC = Emulsifiable concentrate, F = Flowable, G = Granular, RL = Ready-to-use liquid, WP = Wettable powder

more precisely in terms of standard geographic area units used by the U.S. Bureau of the Census for the 1980 Decennial Census. Study area definition was governed by logistic considerations and the desire to examine only urban and suburban areas. In Jacksonville, the study area was restricted to the 10 centrally located Census County Divisions of Duval County. (Governmentally, Jacksonville City and Duval County are the same entities). The 1980 boundaries of Springfield and Chicopee defined the northern study area. The Jacksonville and Springfield/Chicopee study areas are shown as shaded areas in Figures 1 and 2, respectively.

In each study area, the target population (i.e., the population about which statistical inferences were to be made) for NOPES consisted of individuals at least 16 years of age who satisfied the following criteria:

(1) primary place of residence was in the study area when the household screening was conducted,

(2) not institutionalized or living in group quarters or on a military reservation,

(3) not employed in a position in which the primary activity involved the use or handling of pesticides, nor residing in a household with one or more members employed in such a position, and

(4) present in the study area at the time of personal exposure and indoor/outdoor monitoring.

The age restriction was placed on the target population because of the physical requirements and level of responsibility imposed by the personal exposure monitoring equipment. Individuals occupationally exposed or residing with someone who was occupationally exposed were excluded because of potential problems in discriminating between occupational and nonoccupational exposures.

The NOPES sampling weights were used to estimate the size of the target population in each study area. The target population in Jacksonville was estimated to be approximately 290,000 people, residing in 150,000 housing units. The Springfield/Chicopee target population was estimated to be approximately 135,000 people, residing in 73,000 housing units.

Sampling Design

Within the study areas of NOPES, participants were selected at random using standard area household survey sampling techniques. The NOPES sampling design can be generally described as a three-stage design. Probability sampling was used at all stages of selection to ensure that the sample was statistically representative and to allow valid statistical inferences to be made from the data.

In the first stage of the sampling design, a stratified sample of relatively small Census-defined geographic areas (blocks or groups of blocks) was randomly selected in each study area before beginning the first season's data collection. By using 1980 Decennial Census information, the first-stage sampling frame for each study area was stratified by socioeconomic status and by proportion of single-family housing units. Socioeconomic status was selected as a stratification variable because nonoccupational exposure to pesticides was believed to be related to factors such as type and quality of residence, composition of diet, employment of professional pest control services, presence or absence of adequate air conditioning/heating or other ventilation systems, and other characteristics that may be correlated with socioeconomic status. Use of the proportion of single family housing units as a second dimension of the stratification helped ensure that a variety of housing types (e.g., single-family homes, apartment buildings, mobile homes) were included in the sample.

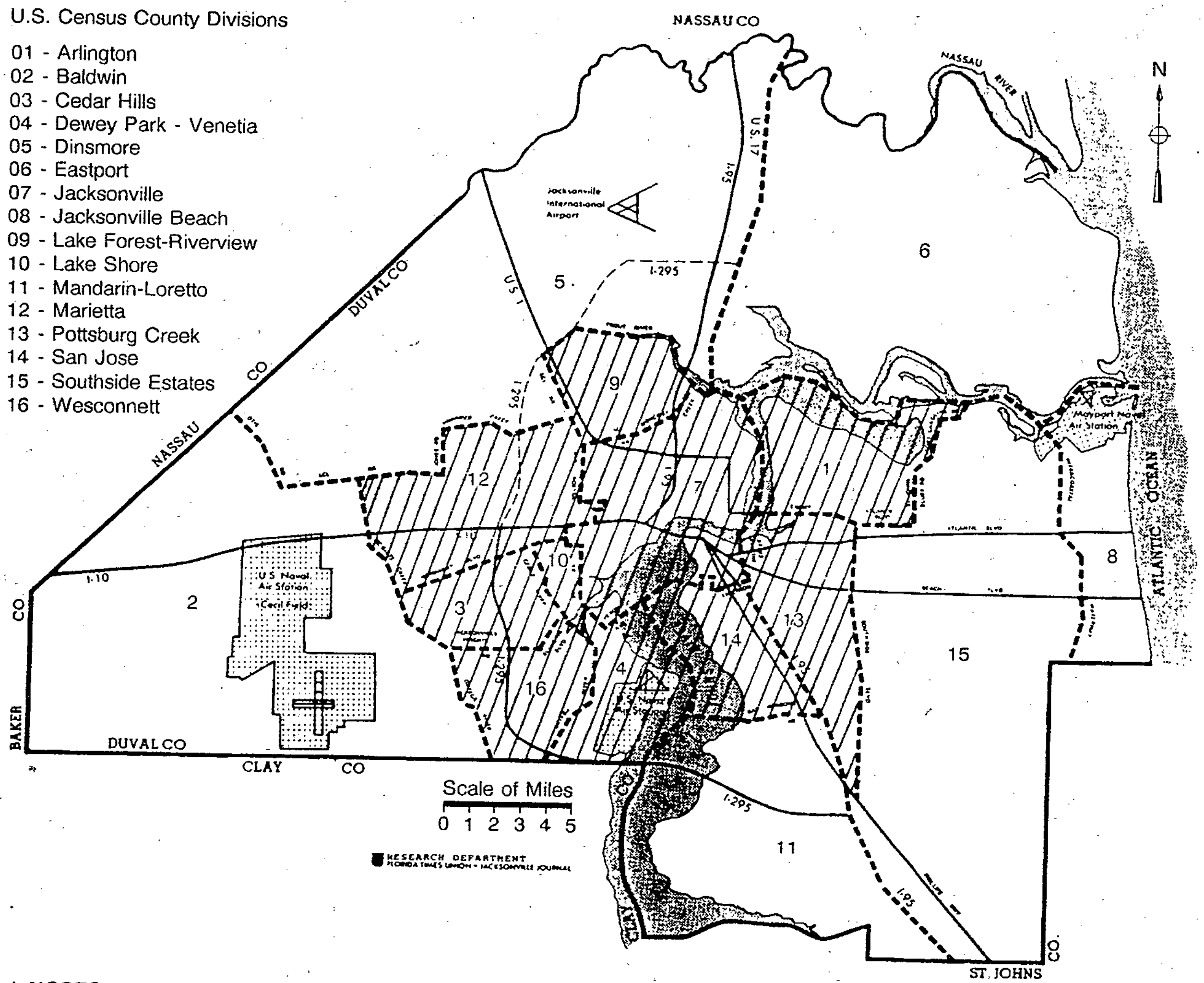

Figure 1. NOPES study area in Jacksonville, Florida.

Within each sampled first-stage unit, all housing units were identified and listed by field enumerators. At the beginning of each season's data collection, a second-stage random sample of housing units was selected, and the sample households were screened to ascertain characteristics of their dwellings and their residents. The screening data were used to stratify the sample households into three categories based on the potential for exposure to pesticides from indoor air. Characteristics used to define the categories included:

- use of pesticides on indoor plants,
- use of insecticides (e.g., flea and tick powders, dips, shampoos, collars) on household pets,
- treatment of the housing unit with termiticides, and
- use of insecticides to control household insect pests.

The stratification permitted respondents from high-potential-exposure households to be included in the third-stage sample in higher proportion than they occurred in the target population. The sample-composition goal for each season's third-stage sample of people was to have 50% "high-exposure" respondents, 30% "medium-exposure" respondents, and 20% "low-exposure" respondents.

Attempts were made to contact all persons selected in the third-stage sample and ask them to participate in the monitoring and interview portion of the study. Third-stage sample members were randomly selected, and no more than one person was selected from any household.

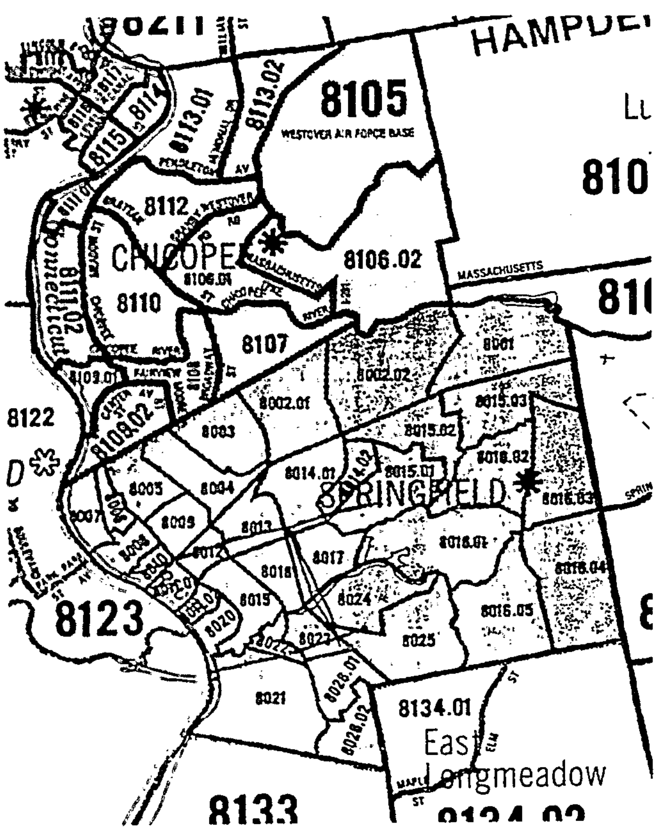

Figure 2. NOPES study area in Springfield/Chicopee, Massachusetts.

Conducting NOPES in phases at different times of year permitted seasonal variation in air exposure levels to be estimated. The NOPES study objectives specified that the "within-home" or "within-individual" (i.e., between seasons within the same home or for the same individual) component of the overall seasonal variation was also to be assessed. The third-stage sample for each season and study city therefore consisted of two components: a "single-season" subsample that would be asked to participate in only one phase of NOPES, and a "multiseason" subsample consisting of people recruited to participate in all phases conducted in the study city. Data from the multiseason respondents were used to estimate the between season component of variation for persons and homes.

Prior to the first season's data collection in a study city, third-stage sample members were randomly designated as either single-season or multiseason subjects. Multiseason members who participated were recontacted in each subsequent phase and asked to participate again. New single-season subsamples were selected in each phase from households screened in that phase. Table 5 summarizes the planned number of respondents in each subsample in the third-stage sample design.

Households of third-stage sample members were also randomly designated as standard, duplicate, replicate, or water households. These classifications determined some of the sampling procedures to be used in the households, as follows:

- Standard: air samples collected from one indoor fixed-site, one outdoor fixed-site, and one personal air sampling system.
- Duplicate: same as standard, with one additional indoor fixed-site and one additional outdoor fixed-site system operating concurrently and in close proximity to the other fixed-site systems. Some of these households were subsequently redefined in the field as triplicate households, and additional fixed-site systems were set up indoors and outdoors. Duplicate and triplicate samples were collected to help assess measurement error.
- Replicate: same as standard, with an additional complete set of air samples collected at least three days after the initial set. One set was to be collected on a weekday and the other on a weekend. Data from replicate sampling allowed short-term temporal variation in air exposure levels to be examined.
- Water: same as standard, with a tap water sample collected at the end of the monitoring period.

In each season and study area, five duplicate, three triplicate, 10 replicate, and six water samples were to be collected.

More detailed descriptions of the sampling design and selection procedures used in each phase are presented in the NOPES Interim Reports.

Data Collection Procedures

Field interviewers visited all housing units selected in the second-stage sample. An attempt was made to administer a screening questionnaire in each occupied housing unit. Any responsible adult household member was eligible to respond.

The screening questionnaire collected a variety of information on potential exposure sources, such as whether the home had been treated with termiticides or other insecticides. This information was subsequently used to classify households into the high-, medium-, and low-potential-exposure categories that were used for third-stage stratification. The screening questionnaire also recorded the name, age, sex, and occupation of everyone 16 years of age and older in the household. This information was used to

Table 5. Planned Number of Respondents in the NOPES Third-Stage Sample Design

	Phase I Summer (Aug-Sep 86)	Phase II Spring (Mar-Jun 87)	Phase III Winter (Jan-Mar 88)	Total Number of Different Respondents
		Jacksonville, FL		
Multiseason respondents	30	19	15	30
Single-season respondents	40	51	55	146
	-----	-----	-----	-----
Total	70	70	70	176
		Springfield/Chicopee, MA		
Multiseason respondents	-	22	15	22
Single-season respondents	-	28	35	63
		-----	-----	-----
Total		50	50	85

select and identify specific people for the third-stage sample.

All people selected into the third-stage sample were contacted and asked to participate in the study. A cash incentive for participation was offered, following the standard practice used in earlier TEAM studies. Upon agreeing to participate, the sample member was administered a study questionnaire by a field interviewer. The study questionnaire collected demographic data, verified and updated eligibility and exposure category inputs obtained during screening, profiled occupational pesticide use, and inventoried the pesticides at the respondent's residence. Respondents were prompted to try to recall all pesticides stored indoors or outdoors at the residence. The study questionnaire also included a dietary intake record, which recorded all food items consumed by the respondent the previous day. The dietary information was collected to permit development of estimates of individual dietary pesticide exposures.

While the interview was being conducted, a monitoring technician set up equipment to collect air samples. Each air sample was collected by using a small, portable, constant-flow air pump to draw air through a clean polyurethane foam (PUF) plug. The pump operated at a flow rate of 3.8 standard liters per minute (SLPM) for the 24-h sampling period. A portable calibrator was used to check the flow rate of each pump prior to deployment. Indoor and outdoor air samplers were located about 1.5 m above the floor or ground in an area of high family use and were plugged via a charger/converter into standard 110-V AC outlets. The personal samplers operated for much of the monitoring period on an internal battery supply, but could be plugged in when the respondent was sedentary. The personal air sampler was housed in a case with a shoulder strap, and participants were instructed to keep the sampler in close proximity throughout the monitoring period.

The interviewer and monitoring technician returned to the household approximately 24 h after sample collection began. The technician collected and processed the PUF plugs, completed all necessary documentation, and removed the sampling equipment. If the household was designated as a "water household," the technician also collected a 1-L sample from the primary source of drinking water. Meanwhile, the interviewer completed a 24-h activity log for the participant.

The activity log recorded any pesticide exposures or activities participated in by the respondent that could have affected pesticide levels in the sampled air. Both direct and indirect sources of exposure were examined. The amount of time spent by the respondent in several general locations was profiled, as was the ventilation pattern in the respondent's home during the monitoring period.

After the activity log was completed, each respondent was asked if he or she intended to perform a pesticide application within several days and if the NOPES sampling team could come back to monitor the application event. The study design specified that six events were to be monitored in each city each season. Fewer than six were monitored in some seasons because not enough cooperative respondents planned to perform any application events during the data collection period.

Respondents who agreed to participate in the dermal sampling were asked to wear a pair of precleaned cotton gloves during the preparation, application, and cleanup. These gloves were to be worn under the participant's regular work gloves, if work gloves were normally worn during similar applications. The study gloves were then collected and returned to the laboratory for analysis. The glove data allowed an estimate to be made of the amount of dermal exposure experienced during the application event. The individual's air exposure was monitored with a personal air sampler during the application.

Copies of the Screening Questionnaire, Study Questionnaire, and Activity Log are provided in Appendix A.

Response Rates

Overall second-stage sample sizes were 1,501 housing units in Jacksonville and 2,472 housing units in Springfield/Chicopee. Screening information was obtained from 1,005 Jacksonville households and 1,774 Springfield households. Second-stage response rates, computed as the number of respondents divided by the number of eligible sample members, were relatively low for in-person household screening, ranging from 66% for the Jacksonville spring season to 84% for the Springfield/Chicopee winter season (Table 6). Second-stage nonresponse was due more to inability to contact household members during the time period allotted for screening (56% of nonresponding eligible sample members) than to refusals (32% of nonresponding eligible sample members).

Third-stage response rates varied by study area, season, and whether sample members were single-season or multiseason subjects. Nonresponse in the third stage was primarily due to refusals to participate (73% of nonresponding eligible sample members). The two most commonly cited reasons for refusing to participate were the amount of time required and the perceived burden associated with keeping the personal sampler nearby.

The overall response rates presented in Table 6 were computed by multiplying the second-stage response rate by the third-stage response rate for first-time sample members (i.e., multiseason sample members were not included in the overall response rate calculations after their first season). The NOPES overall response rates were comparable to the 44% response rate experienced in the New Jersey segment of the TEAM-VOC study (Wallace, 1987). Although these response rates are low relative to those experienced in traditional area-household surveys, they are typical of the rates experienced in personal monitoring studies. Low personal-monitoring response rates are believed to be primarily due to the respondent burden imposed by the monitoring systems and procedures.

In any sample survey, low response rates are undesirable because they introduce the *potential* for bias in the estimates computed from the survey data. The extent to which the nonresponse actually produces bias depends on the degree to which respondents and nonrespondents differ in the parameters being estimated. Although the size of the difference can never be precisely quantified (due to the lack of data for nonrespondents), a rough idea of its magnitude can often be postulated by taking into account the subject of the survey questions and the characteristics of the population being surveyed.

Bias can be expected to be low if the following statements are true.

1) The survey does not deal with a sensitive subject, such as income level, sexual preference or habits, or political or religious opinions.
2) The distributions of respondents' characteristics, such as age, sex, race, and socioeconomic status, are similar to those of the population. (The population distributions must be obtained from an independent source.)
3) The parameters of interest are not functions of the same factors that cause nonresponse (e.g., unusual work schedules that make contact with an interviewer unlikely).

Examining the NOPES results in light of the above considerations leads to the conclusion that bias related to the response rate was probably relatively low. Neither the screening questionnaire nor the monitoring phase of data collection dealt with subjects typically considered sensitive.

The sex and race distributions of respondents, discussed in the next section, were slightly different from those observed in the 1980 Census. However, the distributions were not different enough to dramatically impact the pesticide concentration estimates, even if, for example, all the nonrespondents in one group (e.g., males) had higher personal air pesticide concentrations than nonrespondents in the other group (e.g., females). Response rates were relatively similar in the different geographic areas sampled within each study area.

Detailed data on pesticide use habits for different segments of the population are not available. Therefore, any scenario in which respondents and sample members who refused to participate or who could not be contacted differed regarding their use of pesticides would be based only on speculation. The available data suggest that although the low response rate may have caused some bias in the sample estimates, the magnitude of the bias is relatively small.

Table 6. Response Rates

	Jacksonville				Springfield/Chicopee		
	Summer '86	Spring '87	Winter '88	Total	Spring '87	Winter '88	Total
Second Stage							
Sample size	401	550	550	1501	1422	1050	2472
Eligible	363	510	499	1372	1361	978	2339
Respondents	267	336	402	1005	956	818	1774
Response rate	74%	66%	81%	73%	70%	84%	76%
Third Stage							
First-time sample:							
Selected	125	79	95	299	92	73	165
Eligible	120	73	90	283	89	72	161
Respondents	65	53	55	173	49	37	86
Response rate	54%	73%	61%	61%	55%	51%	53%
Overall Response Rate[a]	40%	48%	49%	45%	39%	43%	40%
Followup sample:							
Selected	-	29	19	48	-	20	20
Eligible	-	29	19	48	-	20	20
Respondents	-	19	16	35	-	15	15
Response rate	-	66%	84%	73%	-	75%	75%
Total:							
Selected	125	108	114	347	92	93	1185
Eligible	120	102	109	331	89	92	1181
Respondents	65	72	71	208	49	52	1101

[a]Overall response rate = (second-stage response rate) * (third-stage response rate) for *first time members* of the sample.

Respondent Characteristics

Selected characteristics of third-stage respondents and their homes are presented in Table 7. In both study areas, female respondents outnumbered male respondents. The differential was greater than expected from the general population distribution (48% male and 52% female in the 1980 Census for persons 18 years of age and older in the two study areas) and reflects slightly higher response rates among female sample members in both the second- and third-stage samples. Seventy-two percent of the Jacksonville respondents and 86% of the Springfield/Chicopee respondents were non-Hispanic whites. The sample race/ethnicity distribution was very similar in the 1980 Census population distribution in Jacksonville, whereas in Springfield/Chicopee, whites were slightly overrepresented among respondents relative to the Census distribution. Approximately 70% of the participants were employed.

The two study areas displayed some differences in housing unit characteristics. Attached dwellings were more common in Springfield/Chicopee, and mobile homes occurred more frequently in Jacksonville, although in both areas unattached, single-family units were the predominant housing type in the sample. The Springfield/Chicopee housing units were, on average, 11 years older than the Jacksonville units. The average age for the Springfield/Chicopee housing units was 42 years old, while the Jacksonville housing units averaged 31 years of age. The oldest Springfield/Chicopee sample housing unit was built in 1770, and the oldest home in the Jacksonville sample was built in 1895.

In both areas, approximately half the responding households said that their homes had been treated with termiticides. The accuracy of this information is unclear, because in some cases opposite answers to the termiticide use questions were obtained in the screening and the study questionnaires. A substantial number of respondents indicated that they did not know if their home had been treated for termites.

The average number of pesticide products listed in the study inventory was comparable for the two sites: 4.2 pesticides per household for Jacksonville and 5.3 pesticides per household for Springfield/Chicopee. The maximum number of pesticide products listed in a home was 23 for Jacksonville and 18 for Springfield/Chicopee, which are again comparable figures, given that the Jacksonville sample contains about twice as many homes as the Springfield/Chicopee sample. Some homes in each sample did not have any inventoried pesticide products in the home at the time of the study.

Laboratory Operations

Analysis of the PUF plug, water, and glove samples followed protocols developed by SwRI for the NOPES target compounds (Hsu et al., 1988). An additional

Table 7. Third-Stage Respondent and Household Characteristics

Characteristics	Number of Respondents: Jacksonville	Number of Respondents: Springfield/Chicopee
Sex		
Male	85 (41%)	42 (42%)
Female	123 (59%)	59 (58%)
Race/Ethnicity		
White, non-Hispanic	150 (72%)	87 (86%)
Nonwhite or Hispanic	58 (28%)	14 (14%)
Age		
16-25	39 (19%)	15 (15%)
26-45	91 (44%)	49 (49%)
46-60	41 (20%)	20 (20%)
Over 60	37 (18%)	17 (17%)
Employed		
Yes	143 (69%)	74 (73%)
No	65 (31%)	27 (27%)
Occupational Exposure		
Yes	8 (6%)	5 (7%)
No	135 (94%)	69(93%)
Type of Housing Unit		
Unattached Single Family	153 (74%)	71 (70%)
Attached Single Family	6 (3%)	12 (12%)
Multiunit (apartment)	29 (14%)	16 (16%)
Mobile home	20 (10%)	2 (2%)
Age of Housing Unit		
Less than 6 years old	17 (8%)	2 (2%)
6-15	17 (8%)	12 (12%)
16-25	58 (28%)	16 (16%)
26-35	52 (25%)	23 (23%)
More than 35	64 (31%)	48 (48%)
Any Termiticide Treatment of Housing Unit		
Yes	104 (50%)	46 (46%)
No	65 (31%)	30 (30%)
Don't know	39 (19%)	25 (25%)

analytical protocol was used to determine chlordane and heptachlor concentrations (ASTM, 1989).

After collection, PUF plugs and glove samples were kept on dry ice until extracted by Soxhlet extraction. Water samples were kept at 4°C until extracted and analyzed according to EPA Method 608 (Method 608, 1984). Extractions were almost always completed within seven days after collection.

The extract for each sample was concentrated and divided into two aliquots, one for gas chromatography/electron capture detection (GC/ECD) analysis and the other for gas chromatography/mass spectrometry/multiple ion detection (GC/MS/MID) analysis. For the chlorinated target compounds, GC/ECD was used for quantitation, and GC/MS/MID served as a confirmation analysis (Table 8). For each GC/ECD extract, a primary analysis was performed on a megabore column, and a secondary analysis was performed on a column with a dissimilar liquid phase. The nonchlorinated target compounds were quantified by using GC/MS/MID. More detailed descriptions of the analytical instruments and conditions are presented in the NOPES Interim Reports.

Analytical quality control steps were included throughout the analysis activities. Stringent calibration criteria were nearly always met for 31 of the analytes on the column used for quantitation. Less precise quantitation of dicofol was permitted because of its poor chromatographic behavior. More than 98% of the analyses were performed within 30 days after extraction. Duplicate matrix-spiked samples were prepared and analyzed with every batch of samples from the field (20 to 30 samples per batch). The matrix-spike solution included diazinon, propoxur, alpha-BHC, heptachlor, chlorpyrifos, hexachlorobenzene, and dieldrin. These compounds spanned the chromatographic range and were representative of the different chemical classes of the analytes. Each sample was analyzed for a spiked surrogate compound, octachloronaphthalene (OCN), to monitor the integrity of the entire analytical system.

Table 8. Analytical Methods for NOPES Target Compounds

Analyte	Analytical Method[a]		Air Sample QL Goal[b] (ng/m^3)
	GC/ECD	GC/MS	
Dichlorvos (DDVP)	X	X	360
alpha-BHC	X	X	7
Hexachlorobenzene	X	X	6
gamma-BHC (Lindane[R])	X	X	9
Chlorothalonil (Bravo[R])	X	X	7
Heptachlor	X	X	13
Ronnel	X	X	13
Chlorpyrifos (Dursban[R])	X	X	11
Aldrin	X	X	9
Dacthal	X	X	9
Heptachlor epoxide	X	X	7
Oxychlordane	X	X	11
Captan	X	X	55
Folpet	X	X	36
2,4-D butoxyethyl ester[c]	X	X	180
Dieldrin	X	X	15
Methoxychlor	X	X	18
Dicofol	X	X	180
cis-Permethrin	X	X	73
trans-Permethrin	X	X	73
Chlordane (technical)	X		150
4,4'-DDT[d]	X	X	11
4,4'-DDD[d]	X	X	11
4,4'-DDE[d]	X	X	11
ortho-Phenylphenol		X	36
Propoxur (Baygon[R])		X	18
Bendiocarb (Ficam[R])		X	45
Atrazine		X	45
Diazinon		X	55
Carbaryl (Sevin[R])		X	45
Malathion		X	45
Resmethrin		X	91

[a] GC/ECD = gas chromatography/electron capture detection, GC/MS = gas chromatography/mass spectrometry. Compounds analyzed by both GC/ECD and GC/MS were normally quantified by using the GC/ECD result.

[b] The quantitation limit (QL) goal, established by the Quality Assurance Project Plan (Lev-On et al., 1987a) was defined as approximately five times the expected detection limit.

[c] In Phase I, the methyl ester, rather than the butoxyethyl ester, was measured. The QL goal for the methyl ester was 110 ng/m^3.

[d] Not measured in Phase I and not analyzed by GC/MS in Phase II.

To assess overall accuracy, performance audit samples provided by EPA and EMSI were analyzed. Field and laboratory blank samples were analyzed to check for contamination.

The analytical protocol was refined and altered when necessary over the three phases. On the basis of the Phase I experience, the quantitation limit for ortho-Phenylphenol was raised, and the methyl ester of 2,4-D was replaced as a NOPES target compound by the more commonly used butoxyethyl ester. Peak identification on the GC/ECD chromatographs was initially performed manually but was semiautomated in Phase II. Heptachlor was quantitated from the secondary GC/ECD column in Phase III to avoid a frequently interfering peak on the primary column chromatogram. Chlordane was quantitated without inclusion of the heptachlor peak.

Experience brought refinements to the interpretation of the chromatograms and quantitative data, and efforts were made to review earlier data in light of the revised interpretations. The analytical data for all Phase I and Phase II samples were reexamined to resolve coelution problems in a manner consistent with the Phase III procedures. For heptachlor and chlordane, Phase I and Phase II values were reviewed using the Phase III quantitation protocol, and the earlier concentration estimates were revised as needed to establish concordance between the chlordane and heptachlor results.

A problem developed in Phase I when Boileezer[R] boiling chips were substituted for the standard Teflon[R] boiling granules used during sample extraction and concentration. The problem was recognized and rectified, but only after the loss of accurate quantitative data for specific compounds in 50 Phase I samples (24 primary air, seven replicate air, seven duplicate or triplicate air, four glove air, four sample glove, one water, two air blank, one glove blank, and one water blank sample). The inaccurate data were excluded from all analyses presented in the next chapter.

A total of 1,281 air, water, and glove samples were collected, of which 1,277 were analyzed (Table 9). This represented 97% of the samples originally specified in the study design.

Table 9. Number of Samples Collected and Analyzed

	Number of Analyzed Samples	
Sample Type	Jacksonville	Springfield/Chicopee
Personal air	248	128
Indoor air	232	120
Outdoor air	229	118
Water	17	12
Glove	15	9
QA/QC[a]	92	57
Total	833	444

[a]Includes field blanks, duplicates, and triplicates.

Section 5
Results and Discussion

Analyses of the NOPES data presented in this section take into account both the NOPES sampling design and the properties and limitations of the chemical measurement process. The sampling design influenced the way in which parameter estimates and their standard errors were computed, and it provided a framework for making inferences from the data. Both sampling variance and measurement error were incorporated in the parameter estimates. Measurement error reflected the limits in the resolving power and precision of gas chromatography and mass spectroscopy, as well as the variations inherent in sample collection and laboratory activities. Factors that contributed to measurement error included the following:

- Less than 100% recovery of analytes from the sampling devices (e.g., PUF cartridges, gloves).
- Abbreviated sampling times for some air samples due to equipment malfunction.
- Failure by some respondents to keep the personal sampler in close proximity throughout the monitoring period.

The potential influence of such factors needs to be recognized when interpreting the NOPES results.

When a survey includes respondents sampled at different rates from the target population, weighted analyses are needed to produce statistically unbiased estimates from the survey data. The NOPES third-stage samples were based on substantially different selection rates for the three potential-exposure strata. The third-stage samples were designed to be 50% from the high-exposure stratum, 30% from the medium stratum, and 20% from the low stratum. In Jacksonville only 16% of the second-stage screened households were in the high-exposure category, and in Springfield/Chicopee, only 4% were in the high category. Overall, high-exposure stratum members were four times more likely than low-stratum members to be selected in Jacksonville, and 28 times more likely in Springfield/Chicopee. Sampling weights that reflect the sampling design and are adjusted for nonresponse were therefore computed for all NOPES respondents and used for all estimates of population parameters. Unweighted analyses were performed when either very small sample sizes (e.g., the water samples) or nonrandom selection procedures (e.g., the dermal sampling) made statistical inferences to the target population inappropriate.

For each NOPES sample, every analyte was categorized as either detected or not detected. The actual detection limits are discussed in the Data Quality Section. The measured amount of each detected analyte was recorded and used to compute concentration statistics (e.g., means, standard errors, medians, and percentiles). The computations included zeros for samples in which the analyte was not detected. Because the analyte may have been present at less than detectable levels in some samples, the use of zeros in the computations results in statistics that may underestimate the actual concentrations, especially for analytes with relatively high detection limits.

Results of matrix spike quality control analyses indicate that the percent recovery of compounds under NOPES analytical conditions was often less than 100%. When the concentration statistics were computed, data from the field samples were not adjusted to compensate for the percent recovery. In addition, analyte concentrations were not adjusted for the infrequent low level of contamination found in the field blanks.

Air Exposure

The estimated percents of the target population with detectable analyte air levels are profiled by sample type (i.e., indoor, outdoor, and personal) and season in Tables 10 and 11 for Jacksonville and Springfield/Chicopee, respectively. More detailed statistics, including the associated standard errors, are presented in Appendix B (Tables B-1 and B-2). Seasonal differences in the percent detectable may be partly due to seasonal differences in the limits of detection, which were generally lower for most compounds quantitated from GC/ECD analyses (see Table 8) for the Jacksonville summer season, as discussed in the Data Quality Section.

All target compounds except 4,4′-DDD were detected at least once in Jacksonville air samples. 4,4′-DDD was detected in Springfield/Chicopee, but eight other

Table 10. Estimated Percent of Jacksonville Population with Detectable Levels in Air

Analyte	Indoor			Outdoor			Personal		
	Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
Dichlorvos	33	14	10	0	0	3	35	11	16
alpha-BHC	25	23	22	3	0	2	26	19	27
Hexachlorobenzene	50	6	7	10	0	0	45	6	6
gamma-BHC	34	47	68	14	12	24	34	32	70
Chlorothalonil	9	13	20	4	9	9	7	<1	19
Heptachlor	58	71	92	21	22	47	41	68	90
Ronnel	3	0	0	1	0	0	2	0	1
Chlorpyrifos	100	88	96	95	32	30	97	83	97
Aldrin	21	19	31	7	0	5	37	20	36
Dacthal	1	0	9	0	0	0	5	0	8
Heptachlor epoxide	16	3	5	30	1	0	15	3	2
Oxychlordane	2	0	1	0	0	0	0	0	0
Captan	4	5	<1	0	0	0	0	2	1
Folpet	2	1	3	7	2	0	2	2	2
2,4-D ester[a]	8	0	10	2	0	3	6	0	15
Dieldrin	79	37	62	39	1	19	70	22	51
Methoxychlor	7	1	3	0	0	2	12	1	3
Dicofol	0	5	0	0	0	0	0	0	0
cis-Permethrin	3	3	2	0	0	0	1	3	2
trans-Permethrin	1	3	2	0	0	0	3	1	2
Chlordane	61	54	94	23	12	73	53	50	93
4,4'-DDT	-	14	9	-	0	0	-	9	6
4,4'-DDD	-	0	0	-	0	0	-	0	0
4,4'-DDE	-	6	3	-	0	0	-	5	12
ortho-Phenylphenol	85	84	79	10	1	2	90	73	71
Propoxur	98	93	95	27	7	21	92	94	88
Bendiocarb	23	20	20	0	0	0	14	21	26
Atrazine	0	0	0	0	0	0	2	0	0
Diazinon	83	83	83	39	9	11	79	83	87
Carbaryl	17	1	0	2	0	0	2	2	0
Malathion	27	32	17	3	0	4	15	21	11
Resmethrin	1	0	0	0	0	0	2	0	0

[a]Methyl ester in summer; butoxyethyl in spring and winter.

compounds were not. Five analytes - chlordane, chlorpyrifos, heptachlor, ortho-Phenylphenol, and propoxur - were relatively common in indoor and personal air samples in both areas.

Tables 12 and 13 present the estimated arithmetic mean air concentrations for the Jacksonville and Springfield/Chicopee populations by sample type and season. Standard errors of the means, as well as maximum and weighted median concentrations, are given in Appendix B (Tables B-3 and B-4).

Figures 3 through 7 display the cumulative weighted frequency distributions for personal air concentrations of the five most prevalent analytes. The ordinates (Y-axes) in these figures are in log scales to accommodate the skewed distributions of concentrations observed for the analytes. The abscissas (X-axes) are in normal probability scales. Data that exactly fit a log normal probability distribution would lie on a straight diagonal line when plotted on this combination of scales.

Appendix C presents the 25th, 50th, 75th, 90th, 95th and 99th weighted percentiles for all analytes.

Indoor, Outdoor, and Personal Comparisons

In both study cities, more analytes were detected in indoor and personal air than in outdoor air. In Jacksonville, 30 analytes were detected in indoor air, and 29 were detected in personal air, whereas only 20 were detected in outdoor air. Corresponding counts for Springfield/Chicopee are 24 analytes detected in indoor air, 23 in personal air, and 11 in outdoor air. Among analytes detected in all three sample types, the estimated percent of the population with detectable indoor and personal air levels was often substantially higher than the estimated percent with detectable outdoor levels.

Table 11. Estimated Percent of Springfield/Chicopee Population with Detectable Levels in Air

Analyte	Indoor		Outdoor		Personal	
	Spring	Winter	Spring	Winter	Spring	Winter
Dichlorvos	2	1	0	0	1	2
alpha-BHC	2	0	0	0	2	0
Hexachlorobenzene	0	4	0	0	0	1
gamma-BHC	10	21	0	0	10	8
Chlorothalonil	< 1	2	12	1	12	2
Heptachlor	50	70	8	2	50	65
Ronnel	2	< 1	0	0	2	< 1
Chlorpyrifos	29	30	52	< 1	30	40
Aldrin	0	12	0	0	0	12
Dacthal	21	5	17	0	24	5
Heptachlor epoxide	0	0	0	0	0	0
Oxychlordane	0	0	0	0	0	0
Captan	< 1	1	0	0	2	0
Folpet	2	0	2	0	2	< 1
2,4-D butoxyethyl ester	2	0	0	0	0	0
Dieldrin	12	34	0	0	12	18
Methoxychlor	0	0	0	0	0	0
Dicofol	0	0	0	0	12	0
cis-Permethrin	0	0	0	0	0	0
trans-Permethrin	0	0	0	0	0	0
Chlordane	50	83	8	16	50	87
4,4'-DDT	< 1	8	0	1	12	19
4,4'-DDD	0	1	0	0	0	0
4,4'-DDE	13	20	0	0	23	19
ortho-Phenylphenol	90	72	7	0	82	86
Propoxur	49	38	4	1	32	38
Bendiocarb	2	1	0	0	2	1
Atrazine	0	0	0	0	0	0
Diazinon	16	10	12	8	17	10
Carbaryl	2	0	0	0	2	0
Malathion	2	0	5	0	4	0
Resmethrin	0	0	0	0	0	0

The concentration data for indoor, personal, and outdoor air show a similar relationship. Mean outdoor concentrations were almost always lower than mean indoor and personal concentrations of detected compounds. Figures 8 through 12 display the differences for the five most prevalent compounds. In all, there are 157 sets of indoor-outdoor-personal air mean concentrations, counting each season and study area separately. In 122 of these sets there was at least one mean greater than zero. The outdoor concentration was higher than the indoor concentration in only five sets, and higher than the personal concentration in only six sets. In all eleven sets, the mean concentrations were near or below the QL goal. In most cases in which analytes were detected indoors and outdoors, indoor concentrations were 5 to 100 times higher than outdoor concentrations.

These findings are similar to those reported for VOCs in the initial TEAM study (Wallace, 1987). They reaffirm the conclusion of the VOC TEAM study and other studies (Lewis and Lee, 1976; Lewis and MacLeod, 1982) that indoor and outdoor air environments differ considerably in terms of toxic substance levels, with greater levels indoors for many compounds.

Mean personal air and indoor air levels were similar for most analytes. The strength of the association between indoor and personal air levels can be measured by correlation analysis. Because of the highly skewed distribution of concentration values, nonparametric Spearman rank-order correlations were computed. Correlations were computed for each analyte detected in at least one sample in both the indoor and personal air environments.

The correlation analyses, summarized in Table 14, were performed for each study area and season, and indicate a strong association between indoor and personal air levels for the majority of detected

Table 12. Weighted Arithmetic Mean Concentrations in Jacksonville Air[a] (ng/m^3)

Analyte	Indoor			Outdoor			Personal		
	Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
Dichlorvos	134.5	86.2	24.5	0	0	3.2	147.6	40.2	21.4
alpha-BHC	1.2	1.2	1.1	0.0	0	0.0	0.9	0.8	0.7
Hexachlorobenzene	1.3	0.4	0.3	0.2	0	0	0.9	0.4	0.4
gamma-BHC	20.2	13.4	6.0	1.3	0.5	0.6	22.1	7.0	8.5
Chlorothalonil	5.3	2.2	6.7	0.2	0.3	0.6	0.5	0.0	2.5
Heptachlor	163.4	154.9	72.2	30.2	10.7	2.8	129.1	133.7	64.2
Ronnel	0.2	0	0	0.1	0	0	0.1	0	0.0
Chlorpyrifos	366.6	205.4	120.3	16.7	3.5	2.5	280.4	182.8	118.2
Aldrin	31.3	6.8	6.9	0.2	0	0.1	19.9	38.5	6.9
Dacthal	0.2	0	0.3	0	0	0	0.6	0	0.2
Heptachlor epoxide	0.5	0.8	0.8	0.7	0.1	0	0.6	0.5	0.1
Oxychlordane	5.2	0	6.5	0	0	0	0	0	0
Captan	1.9	2.2	0.1	0	0	0	0	0.1	0.1
Folpet	0.5	0.7	0.6	0.3	0.4	0	0.4	0.4	0.8
2,4-D ester[b]	1.8	0	2.5	0.0	0	0.8	0.7	0	3.5
Dieldrin	14.7	8.3	7.2	0.7	0.0	0.8	10.1	5.4	4.8
Methoxychlor	0.2	0.3	0.2	0	0	0.1	0.3	0.1	0.6
Dicofol	0	11.0	0	0	0	0	0	0	0
cis-Permethrin	0.5	1.9	1.3	0	0	0	0.1	1.3	0.8
trans-Permethrin	0.4	1.1	0.8	0	0	0	0.1	0.3	0.5
Chlordane	324.0	245.5	220.3	38.4	9.5	27.3	212.0	190.7	194.8
4,4′-DDT	-	1.0	0.5	-	0	0	-	0.5	0.4
4,4′-DDD	-	0	0	-	0	0	-	0	0
4,4′-DDE′	-	0.6	0.2	-	0	0	-	0.5	0.8
ortho-Phenylphenol	96.0	70.4	59.0	1.2	0.0	0.1	79.7	55.6	39.7
Propoxur	528.5	222.3	162.5	10.2	0.8	2.5	315.6	141.1	142.8
Bendiocarb	85.7	5.5	3.4	0	0	0	51.4	4.4	3.5
Atrazine	0	0	0	0	0	0	0.3	0	0
Diazinon	420.7	109.2	85.7	12.6	1.1	13.8	321.6	112.7	89.0
Carbaryl	68.1	0.4	0	0.2	0	0	28.3	0.8	0
Malathion	20.8	14.9	20.4	0.3	0	0.2	9.2	10.1	16.8
Resmethrin	0.1	0	0	0	0	0	0.4	0	0

[a]A weighted mean of "0" means no detectable levels were observed. A weighted mean of "0.0" means that the weighted mean was less than 0.05.
[b]Methyl ester in summer, butoxyethyl ester in spring and winter.

analytes. As expected, the correlations between personal and outdoor air are much weaker.

The general correspondence between indoor and personal air concentrations is not surprising given the amount of time spent indoors at home by respondents. NOPES respondents spent an average of 17 h per day indoors at home, a figure similar to other survey-based estimates (Letz et al., 1984).

Seasonal Variation

Seasonal variation can be examined in terms of the number of target compounds detected in each season, the detection frequencies of particular analytes across seasons, and the average concentrations of particular analytes across seasons. Analyzing the NOPES data by each of these approaches yields several insights into seasonal variation.

Relatively minor variations occurred across seasons in the number of analytes detected (Table 15). In Jacksonville, the most analytes were found in summer, followed by winter and then spring. In Springfield/Chicopee, more analytes were detected in spring than winter. The level of seasonal variation in number of detected analytes was relatively small compared to variation between sample types.

More information on seasonal variation is provided by looking at patterns for each analyte. Inspection of Tables 10 though 13 reveals that the analytes varied considerably in their seasonal patterns. To summarize these patterns across analytes, within each study area each analyte was classified by the season that it occurred with the greatest frequency or at the highest

Table 13. Weighted Arithmetic Mean Concentrations in Springfield/Chicopee Air[a] (ng/m³)

Analyte	Indoor		Outdoor		Personal	
	Spring	Winter	Spring	Winter	Spring	Winter
Dichlorvos	4.3	1.5	0	0	3.7	2.1
alpha-BHC	0.2	0	0	0	0.0	0
Hexachlorobenzene	0	0.1	0	0	0	0.0
gamma-BHC	0.5	9.5	0	0	0.7	5.4
Chlorothalonil	0.1	0.1	0.4	0.8	0.8	0.1
Heptachlor	31.3	3.6	0.3	0.1	34.7	4.6
Ronnel	0.2	0.0	0	0	0.1	0.0
Chlorpyrifos	9.8	5.1	13.9	0.0	7.5	5.9
Aldrin	0	0.3	0	0	0	0.2
Dacthal	1.6	0.3	0.9	0	2.6	0.3
Heptachlor epoxide	0	0	0	0	0	0
Oxychlordane	0	0	0	0	0	0
Captan	0.1	0.0	0	0	0.1	0
Folpet	0.7	0	0.5	0	0.7	0.0
2,4-D butoxyethyl ester	2.1	0	0	0	0	0
Dieldrin	1.0	4.2	0	0	0.8	0.7
Methoxychlor	0	0	0	0	0	0
Dicofol	0	0	0	0	7.0	0
cis-Permethrin	0	0	0	0	0	0
trans-Permethrin	0	0	0	0	0	0
Chlordane	199.3	34.8	3.1	2.0	252.9	35.9
4,4′-DDT	0.0	0.5	0	0.2	0.9	0.7
4,4′-DDD	0	0.0	0	0	0	0
4,4′-DDE	0.9	0.6	0	0	4.9	0.5
ortho-Phenylphenol	44.5	22.8	1.6	0	43.4	27.3
Propoxur	26.7	17.0	0.8	0.1	16.2	11.3
Bendiocarb	0.2	0.4	0	0	0.3	0.2
Atrazine	0	0	0	0	0	0
Diazinon	48.4	2.5	8.2	9.2	10.1	1.4
Carbaryl	0.3	0	0	0	0.1	0
Malathion	5.0	0	0.8	0	0.5	0
Resmethrin	0	0	0	0	0	0

[a]A weighted mean of "0" means no detectable levels were observed. A weighted mean of "0.0" means that the weighted mean was less than 0.05.

mean concentration. The number of analytes in each category was then compared (Table 16).

In Jacksonville, summer was the season in which the greatest number of analytes had their highest detection frequencies and highest mean concentrations. In terms of the estimated percent of the population with detectable levels, winter had the next largest number of analytes, followed by spring. Highest mean concentration levels occurred in the summer for most analytes. Spring had the next largest number of analytes for indoor air, whereas winter had the next largest number for outdoor and personal air.

In Springfield/Chicopee, more analytes had their highest mean concentrations in spring than winter. In indoor and personal air, spring and winter differed not at all or minimally in the number of analytes with highest detection frequencies. The difference between seasons was much more pronounced when considering mean concentrations.

These results imply that analytes that occurred at low levels were not as consistent as common analytes in their pattern of seasonal differences. The inconsistent pattern of variation was probably due in part to measurement error and in part to statistical sampling variation associated with the small sample sizes. Some of the inconsistent seasonal variation may also reflect analytical protocol and reporting refinements that occurred over the phases of NOPES. Larger sample sizes and/or more refined analytical techniques are needed to accurately assess the seasonal variation for analytes found only at low levels.

Analytes that occurred at higher concentrations exhibited more consistent seasonal patterns. Figures

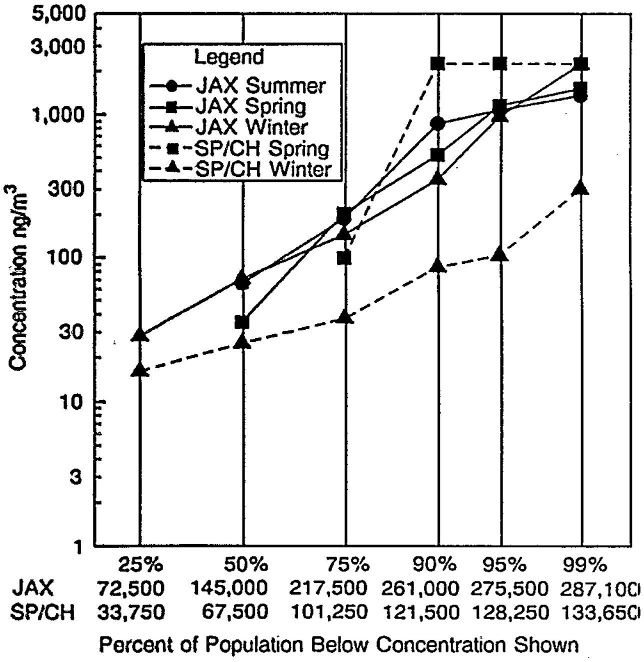

Figure 3. Chlordane weighted cumulative frequency distribution for personal air concentrations.

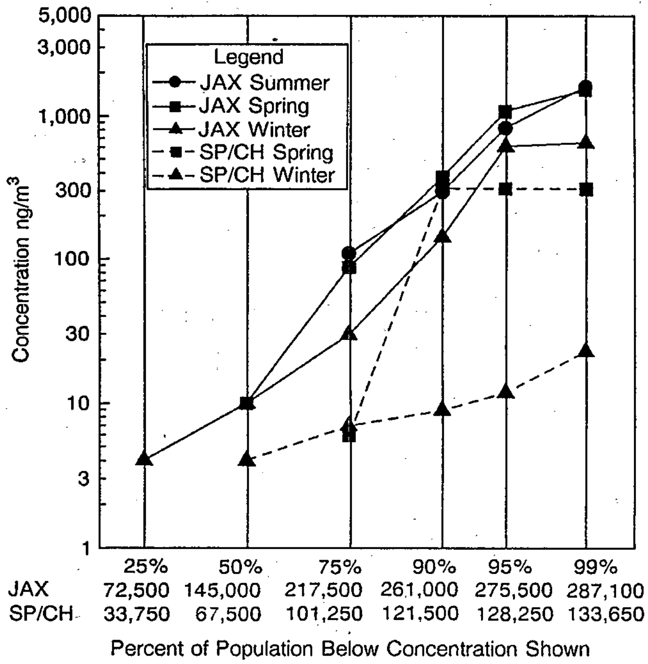

Figure 5. Heptachlor weighted cumulative frequency distribution for personal air concentrations

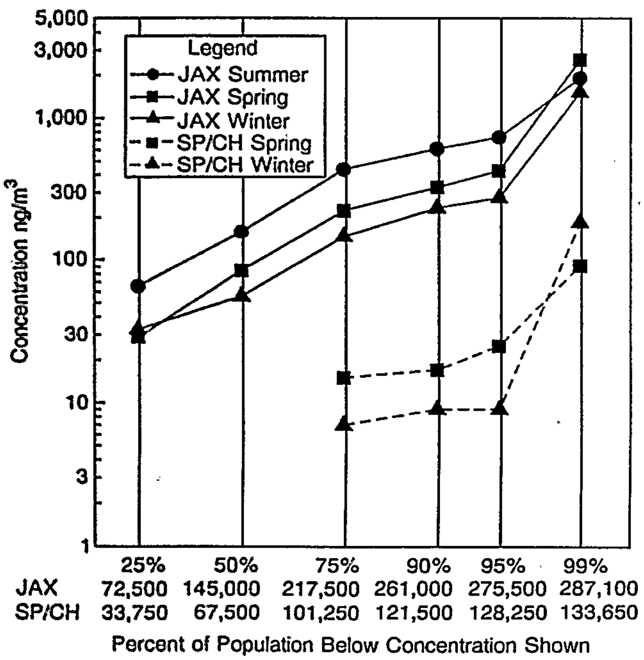

Figure 4. Chlorpyrifos weighted cumulative frequency distribution for personal air concentrations.

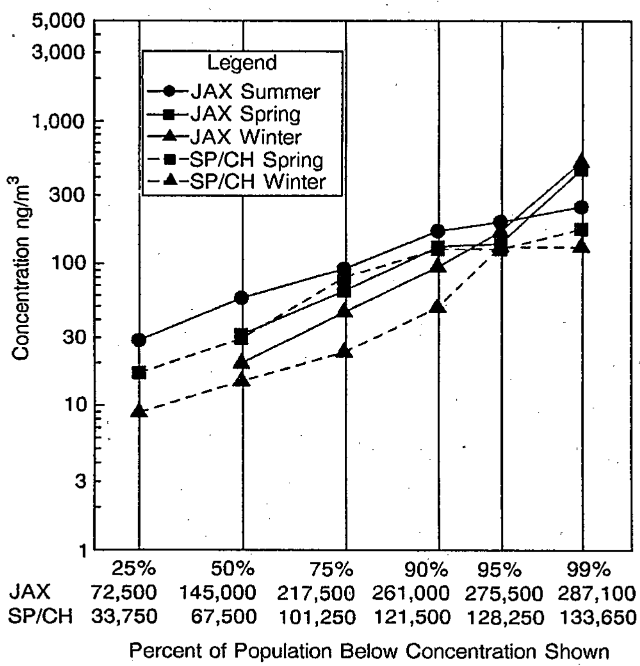

Figure 6. ortho-Phenylphenol weighted cumulative frequency distribution for personal air concentrations.

13 through 18 display the patterns for mean concentrations of the five most prevalent analytes. For most frequent and common analytes in Jacksonville, summer season levels were highest, followed by spring and then winter; however, winter levels were higher than spring levels in outdoor and personal air for some analytes. Spring levels were higher than winter levels in Springfield/Chicopee for the majority of frequent and common analytes.

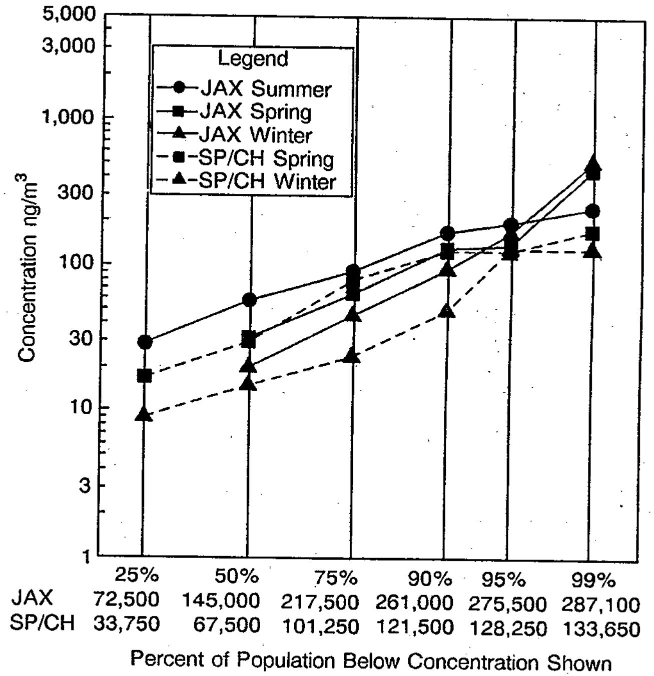

Figure 7. Propoxur weighted cumulative frequency distribution for personal air concentrations

Interpretation of the observed variations must account for weather conditions during the data collection periods. Table 17 summarizes the National Climatic Data Center's Local Climatological Data for Jacksonville and for Hartford, CT (the nearest reporting station to Springfield/Chicopee) during the sampling periods. The temperature data corroborate Jacksonville respondents' comments that the spring and winter sampling periods were colder than usual. Whereas the Jacksonville spring sampling period was locally described as being typical of early spring conditions, the Springfield/Chicopee spring sampling period was felt by some respondents to be representative of late spring or even early summer. Thus, the spring sampling periods were in some sense not comparable in the two study areas. Despite the somewhat below normal temperatures of the Jacksonville winter sampling period, the weather was still relatively mild compared to the Springfield/Chicopee winter sampling period.

Weather may indirectly affect the air concentrations of some analytes by influencing patterns of pesticide use, heating, cooling, ventilation,and peoples'activities. Temperature and humidity may affect concentrations more directly by causing changes in volatility or stability. The potential complexity of the relationship between weather and air concentrations, coupled with the limited number of NOPES sampling periods, prevents development of rigorous models of seasonal variation from the NOPES data. For many analytes, the data are sufficient only to permit rough approximation of the annual levels of air exposure. Further work, building on the NOPES findings, is needed to better understand the seasonal variations in analyte levels in air.

Study Area Comparisons

As expected, the two study areas showed marked differences in the air levels of many target compounds. The differences in personal air were usually similar to those in indoor air but unlike those in outdoor air. As was true in the analysis of seasonal variation, alternative summarizations of the data yield different conclusions and insights on regional variation.

The total number of analytes detected were similar in the two areas in the spring. In winter the number was substantially lower in Springfield/Chicopee than in Jacksonville (Table 15).

For each analyte, detection frequencies were compared for Jacksonville and Springfield/Chicopee, and the analyte was categorized as being higher in Jacksonville, higher in Springfield/Chicopee, or undetected in both. The number of analytes in each category is tabulated by season and sample type in Table 18. Results of a similar categorization based on mean air concentrations are also presented in the table. Figures 19 through 21 display the relative differences in mean concentrations between the study areas for the five most prevalent analytes.

These data clearly show that in indoor and personal air the majority of analytes had higher concentrations and occurred at greater frequencies in Jacksonville than in Springfield/Chicopee. Among analytes detected in both areas, Jacksonville mean concentrations were often 2 to 30 times greater than Springfield/Chicopee concentrations. Four analytes - dacthal, folpet, 4,4'-DDT, and 4,4'-DDE - ran counter to the others and usually had higher concentrations in Springfield/Chicopee.

The relationship between outdoor air concentrations in the study areas depended on the season. In winter more analytes occurred at higher levels in Jacksonville than in Springfield/Chicopee, whereas in spring neither area consistently prevailed. The "early spring" conditions in Jacksonville and "late spring" conditions in Springfield/Chicopee may partially account for the higher Springfield spring concentrations for some analytes (e.g., chlorpyrifos - see Figure 20). Given the mild conditions in Massachusetts, Springfield/Chicopee residents may have been more likely to be outdoors using pesticides than their Jacksonville counterparts, who were kept inside by the relatively cool, wet weather. The harsher winter conditions in Springfield/Chicopee undoubtedly contributed to the more consistently low Springfield/Chicopee winter outdoor air levels.

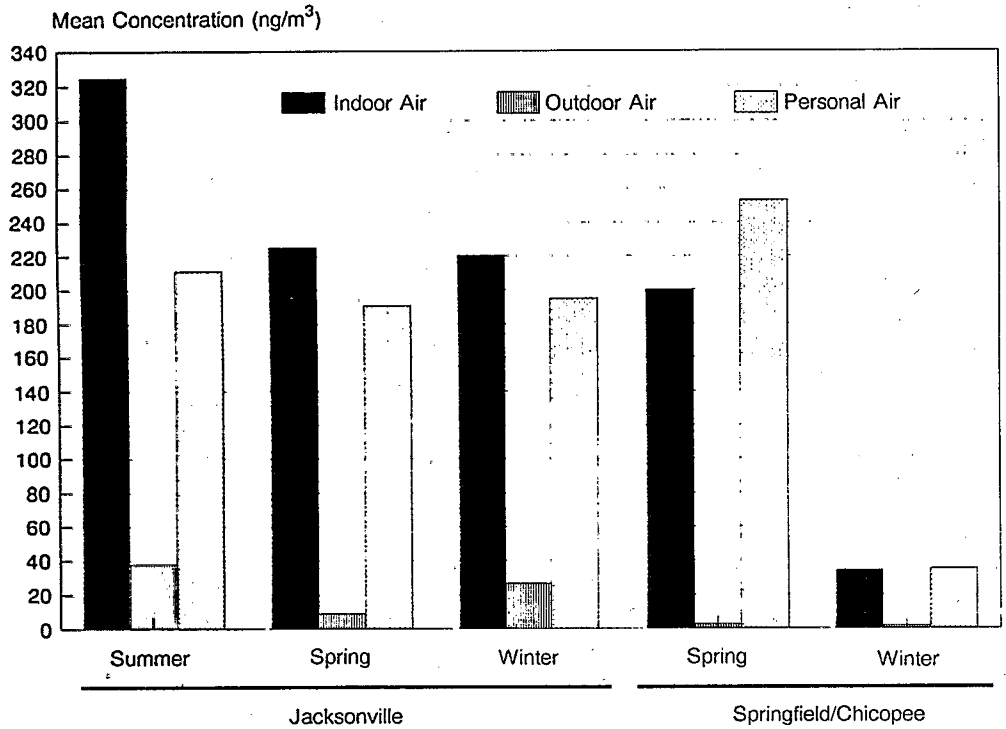

Figure 8. Chlordane mean concentrations for indoor, outdoor, and personal air.

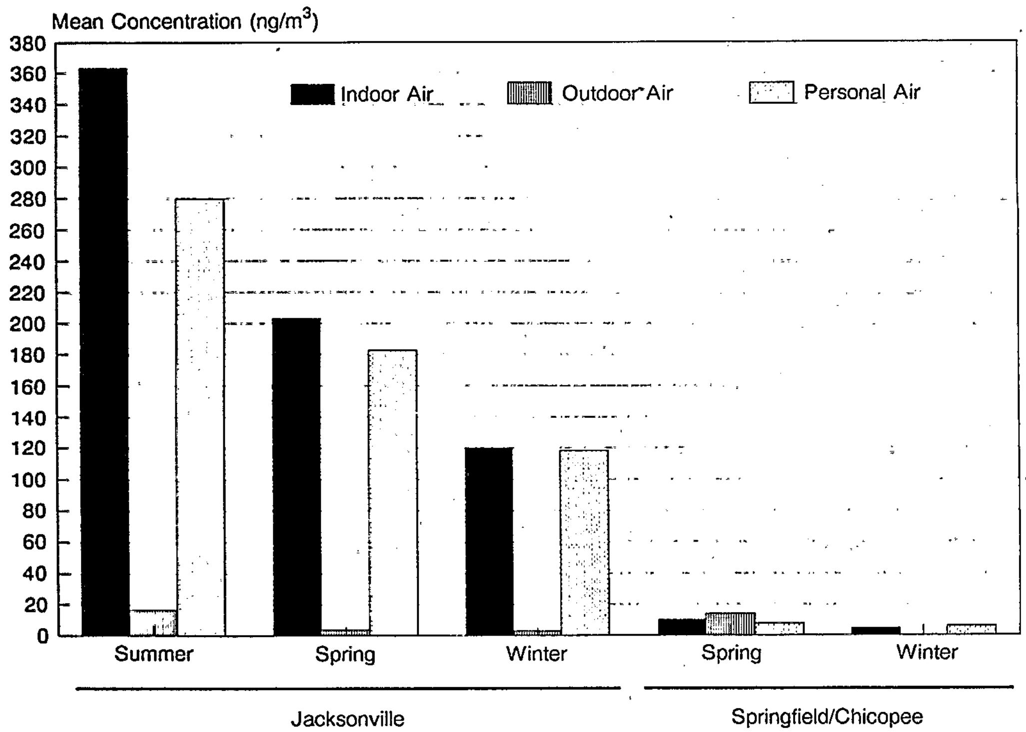

Figure 9. Chlorpyrifos mean concentrations for indoor, outdoor, and personal air.

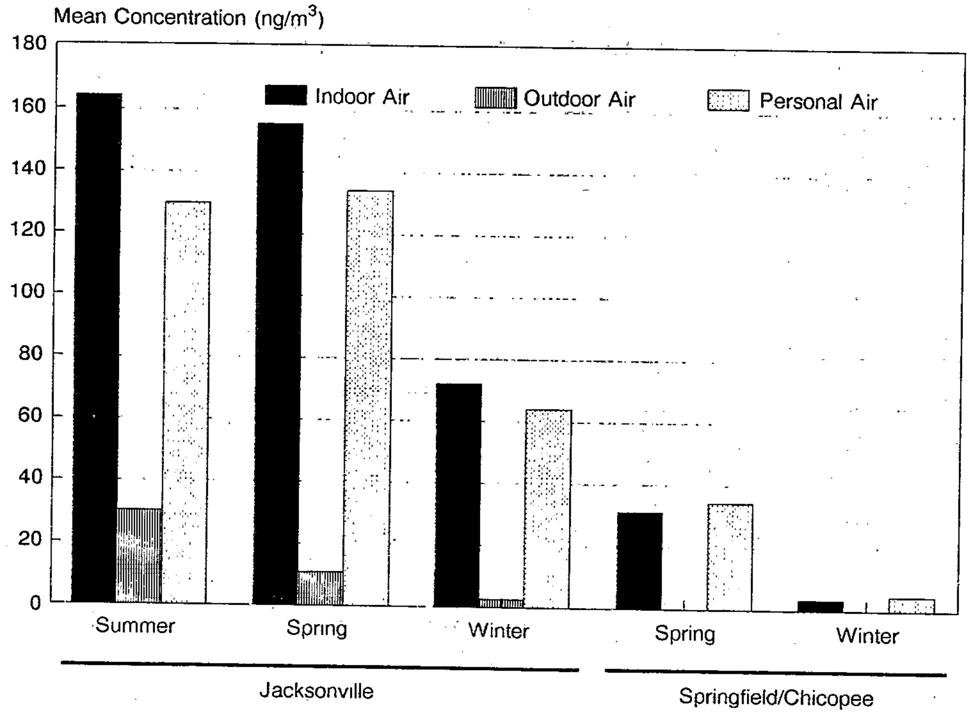

Figure 10. Heptachlor mean concentrations for indoor, outdoor, and personal air.

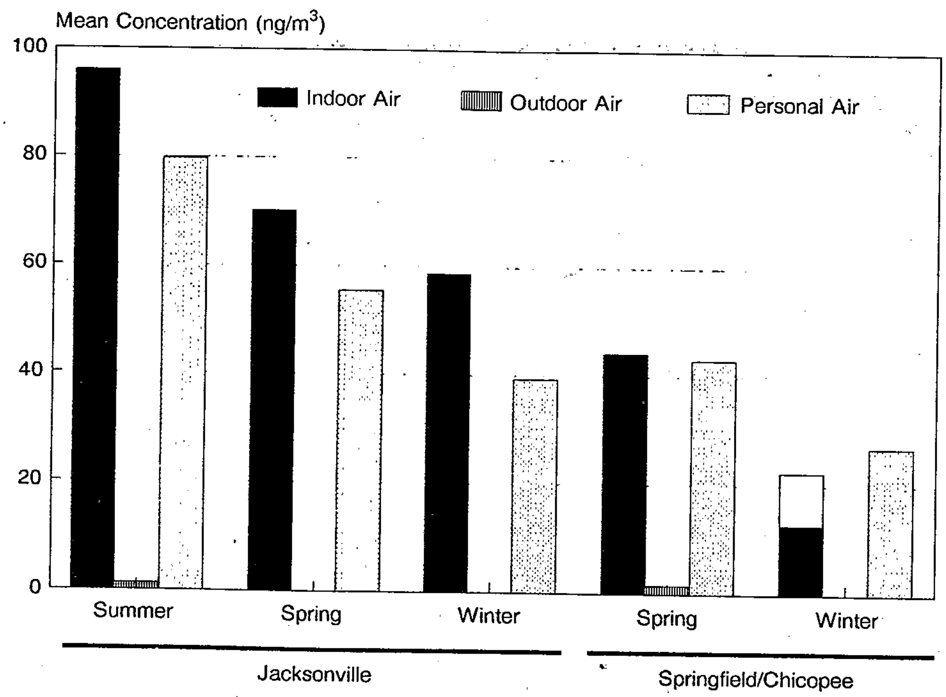

Figure 11. ortho-Phenylphenol mean concentrations for indoor, outdoor, and personal air.

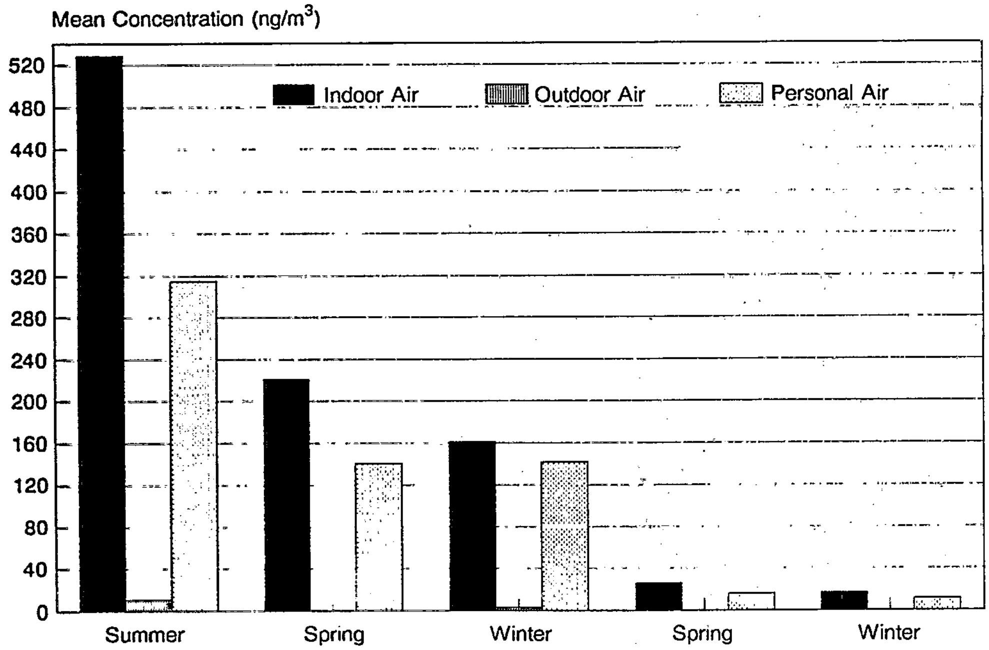

Figure 12. Propoxur mean concentrations for indoor, outdoor, and personal air.

Table 14. Indoor, Outdoor, and Personal Air Concentration Correlations[a]

	Number of Analytes with Spearman rank-order correlations of				
	<0.2	0.2-0.35	0.35-0.5	0.5-0.75	0.75-1
Indoor vs Outdoor Air					
Jacksonville					
Summer	6	1	5	6	0
Spring	4	4	2	1	0
Winter	5	2	5	3	0
Springfield/Chicopee					
Spring	2	2	2	4	0
Winter	2	3	2	0	0
Indoor vs Personal Air					
Jacksonville					
Summer	2	1	5	8	10
Spring	1	1	0	8	14
Winter	0	0	1	15	9
Springfield/Chicopee					
Spring	2	0	2	10	6
Winter	1	1	2	8	5
Personal vs Outdoor Air					
Jacksonville					
Summer	8	2	4	3	1
Spring	4	4	2	1	0
Winter	4	4	5	2	0
Springfield/Chicopee					
Spring	5	0	1	4	0
Winter	3	4	0	0	0

[a]Correlations computed only for analytes detected in at least one sample from each air environment (e.g., indoor and outdoor) in the given study area and season.

Table 15. Seasonal Variation in Number of Detected Analytes in Air

	Number of Detected Analytes		
	Indoor Air	Outdoor Air	Personal Air
Jacksonville[a]			
Summer	27	18	26
Spring	23	11	22
Winter	24	15	24
Springfield/Chicopee			
Spring	21	10	21
Winter	19	7	18

[a] 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE were excluded from the calculations for Jacksonville because they were not included in the summer season analyses.

Table 16. Seasonal Comparisons

	Number of Analytes[a]		
Seasonal Rankings of Estimates	Indoor Air	Outdoor Air	Personal Air
Estimated percent with detectable levels			
Jacksonville[b]			
Summer > Spring, Winter	15	12	12
Spring > Summer, Winter	5	0	4
Winter > Summer, Spring	8	7	11
Springfield/Chicopee			
Spring > Winter	12	9	13
Winter > Spring	12	2	10
Mean concentration			
Jacksonville[b]			
Summer > Spring, Winter	19	12	17
Spring > Summer, Winter	7	1	3
Winter > Summer, Spring	3	7	7
Springfield/Chicopee			
Spring > Winter	16	8	20
Winter > Spring	7	3	3

[a]Number of analytes for which the seasonal ranking given in the row heading was true. For example, in the first row of the table, in terms of the estimated percent of the Jacksonville population with detectable indoor air levels, 15 analytes had a higher percent in summer than in spring or winter. In both outdoor air and personal air, 12 analytes had their highest "percent detectable" in the summer.

[b]4,4'-DDT, 4,4'-DDD, 4,4'-DDE were excluded from the calculations for Jacksonville because they were not included in the summer season analyses.

Short-Term Temporal Variation

Short-term temporal variations in analyte levels were examined in each season by selecting up to 10 respondents for replicate air samples collected at least three days apart. The relatively small sample size coupled with the low frequency of detection of many analytes prevents precise quantitation of the levels of short-term variation. However, the data do permit assessment of the general magnitude of the variation and allow rough quantitative estimates for the prevalent analytes.

For each replicate pair, the percent relative difference between the replicates was computed for each analyte detected in both samples. Table 19 summarizes the replicate pair differences and also presents the number of pairs in which an analyte was detected in only one sample or in neither sample.

The data indicate that a substantial amount of variation existed between some replicates. The variation was more pronounced in Jacksonville than Springfield/Chicopee. In a small number of cases the pairs differed by more than a factor of 10.

To assess the magnitude of short-term variability relative to measurement error and seasonal variations, absolute differences between pairs of indoor air measurements were computed for the five prevalent analytes. Zeros were included in the calculations for samples in which the analytes were not detected. The mean absolute differences in replicate indoor air concentrations were computed for each study area and season and compared to the mean absolute differences between duplicate indoor air readings (Table 20). Small sample sizes occasionally led to considerable differences in the mean air concentrations of the set of duplicate pair data and the set of replicate pair data. Therefore, the mean concentrations are presented in Table 20 to allow the reader to assess the relative magnitude of the mean absolute difference given the associated mean concentration. The mean absolute differences between seasons in multiseason respondent indoor air concentrations were also computed and are presented in Table 20.

The magnitude of the differences between estimated measurement error variability (duplicates), estimated short-term variability (replicates), and seasonal variability (multiseason respondents) varied considerably both within and between analytes. Because of the small sample size devoted to this aspect of the study and the magnitude of the variability observed, only qualitative conclusions are supported regarding the relative magnitudes of these components of variation in the two study areas.

Measurement error variability is generally less than short-term variability, which itself is usually less than seasonal variability. Moreover, short-term and seasonal variability are generally more comparable than short-term and measurement error variability. The fact that the short-term and seasonal variations were generally comparable in magnitude suggests that the factors contributing to short-term variations may also be major components of seasonal variations.

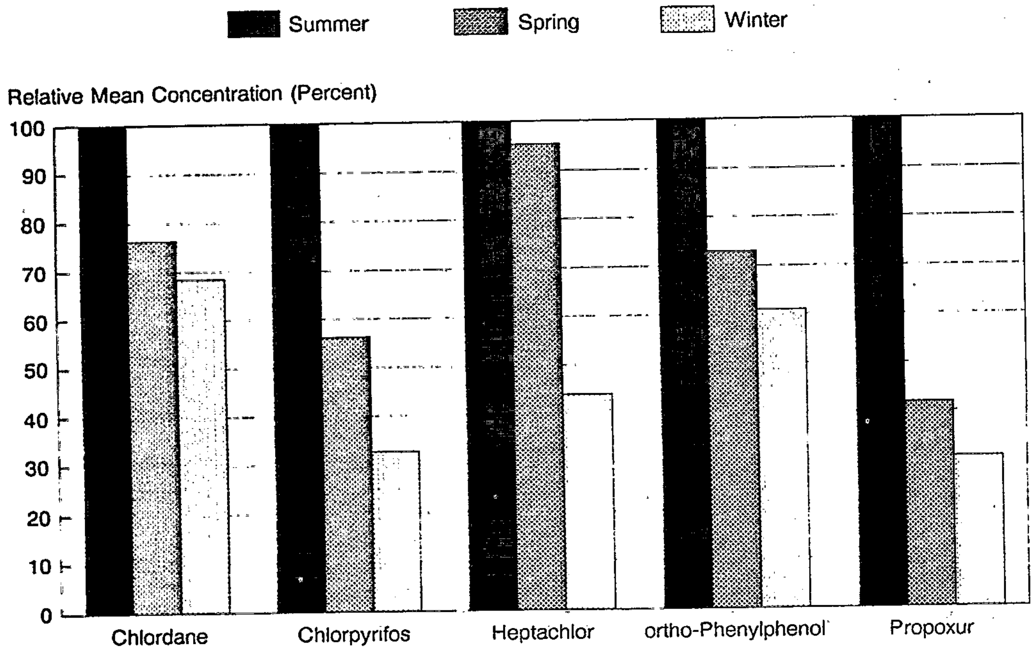

Figure 13. **Seasonal variation in relative mean indoor air concentrations in Jacksonville as percents of summer mean concentrations.**

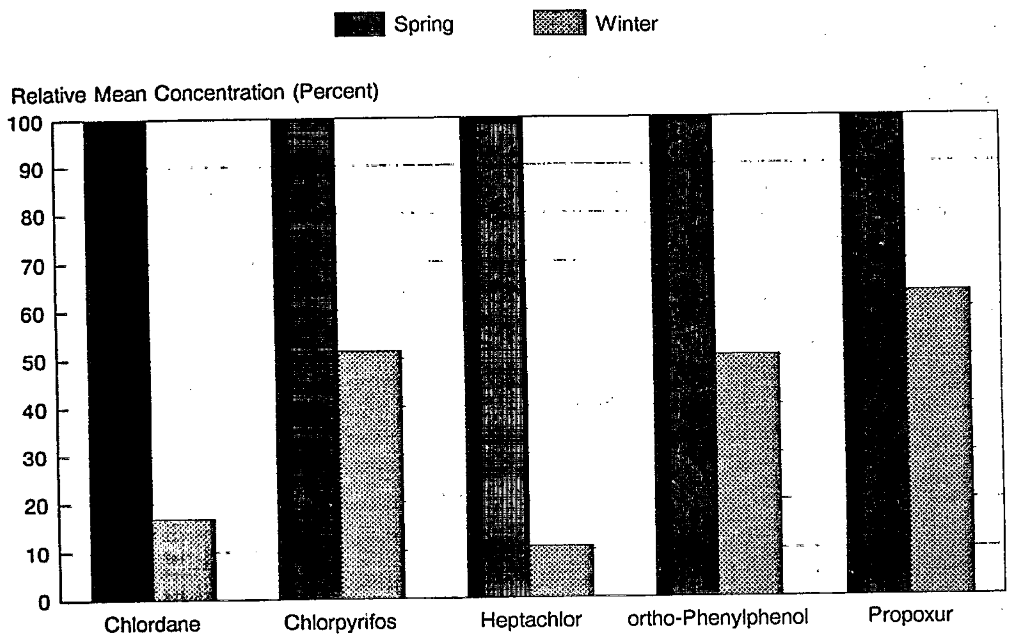

Figure 14. **Seasonal variation in relative mean indoor air concentrations in Springfield/Chicopee as percents of spring mean concentrations.**

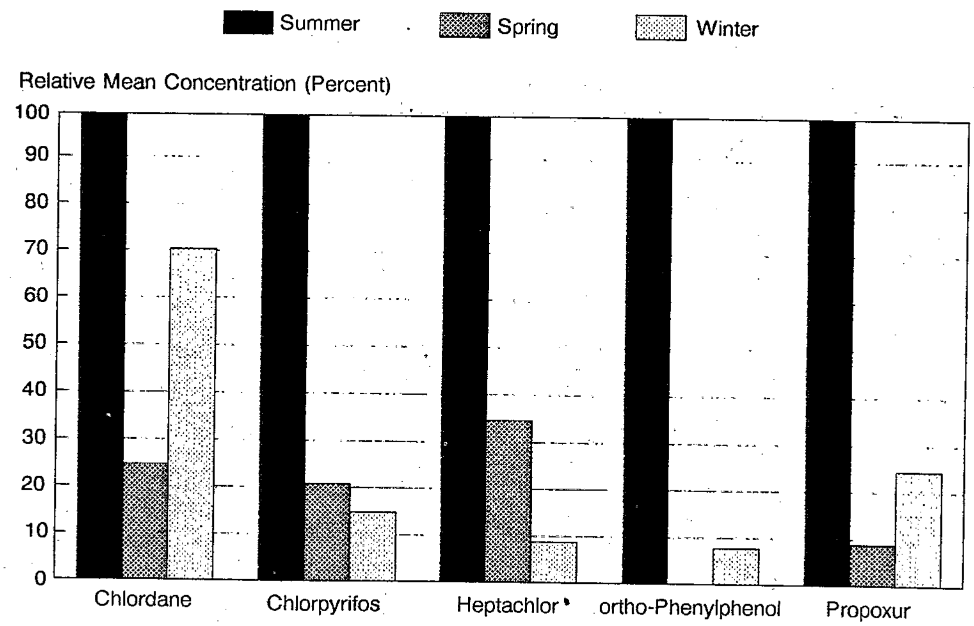

Figure 15. **Seasonal variation in relative mean outdoor air concentrations in Jacksonville as percents of summer mean concentrations.**

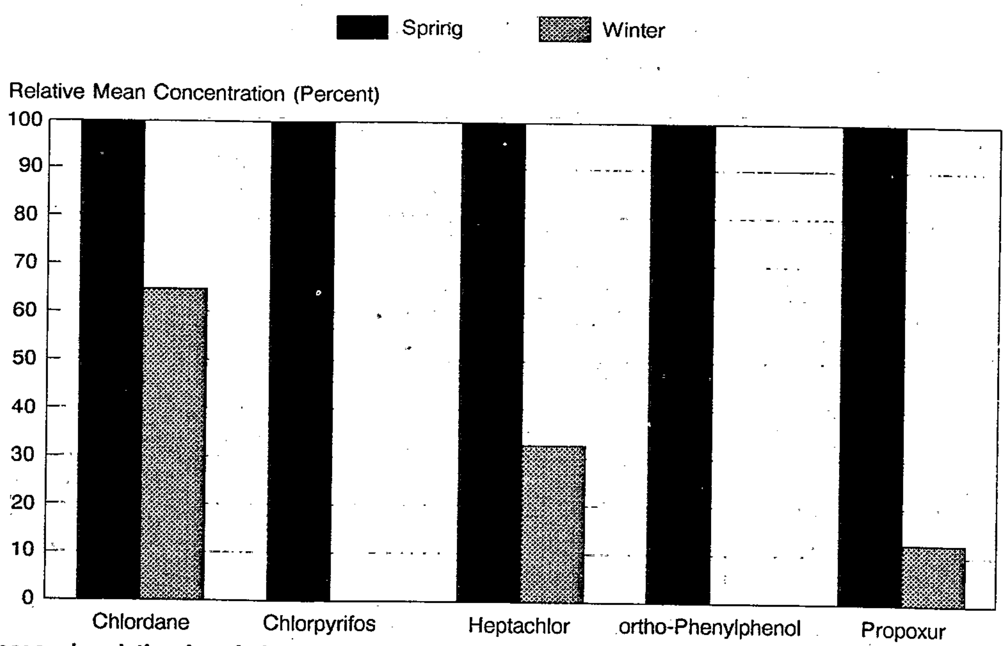

Figure 16. **Seasonal variation in relative mean outdoor air concentrations in Springfield/Chicopee as percents of spring mean concentrations.**

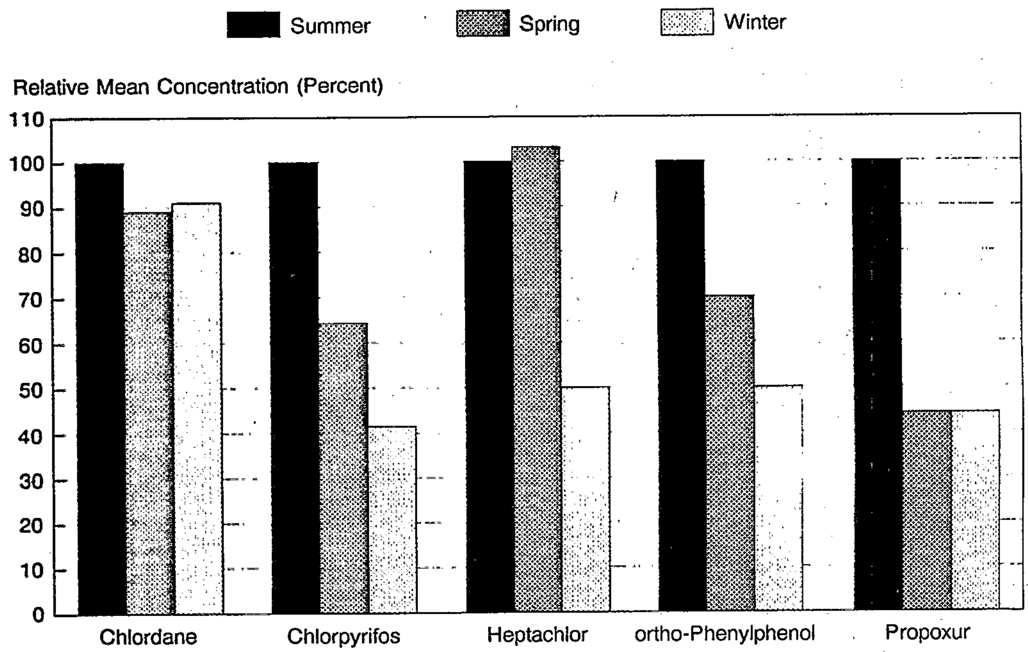

Figure 17. **Seasonal variation in relative mean personal air concentrations in Jacksonville as percents of summer mean concentrations.**

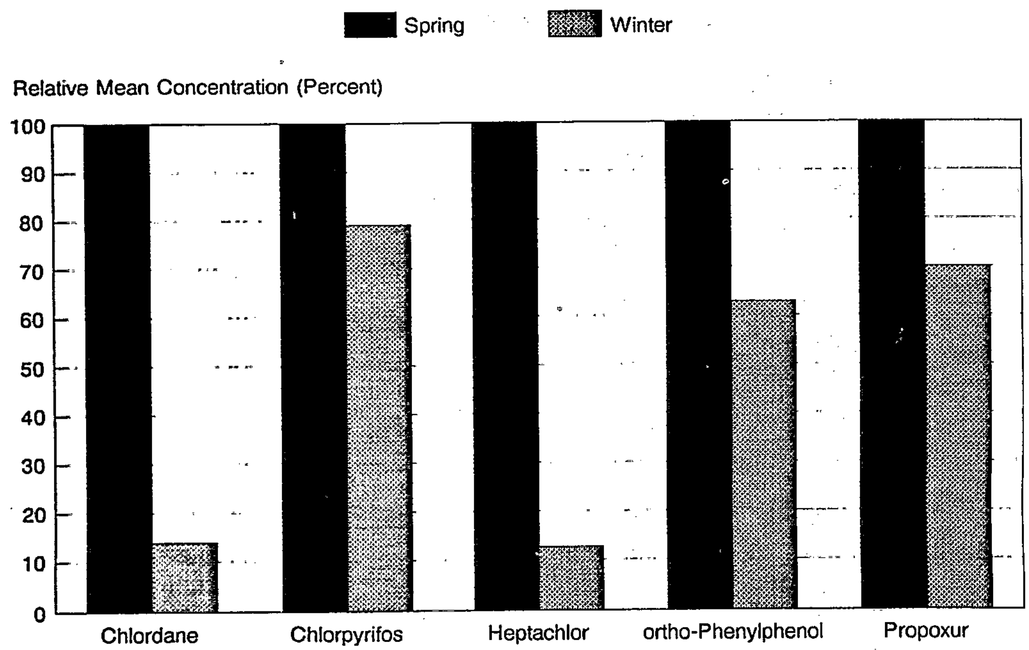

Figure 18. **Seasonal variation in relative mean personal air concentrations in Springfield/Chicopee as percents of spring mean concentrations.**

Table 17. Local Weather During NOPES Data Collection Periods[a]

	Jacksonville			Springfield/Chicopee	
	Summer (8/21-9/18/86)	Spring (3/20-4/13/87)	Winter (2/1-2/17/88)	Spring (6/1-6/17/87)	Winter (3/11-3/28/88)
Temperature (°F)					
Minimum	67	34	25	43	12
Maximum	96	86	82	92	74
Avg Daily Minimum	71	50	40	57	29
Avg Daily Maximum	88	74	65	79	48
Avg Daily Average	80	62	52	69	39
Avg Departure from Normal	0.1	-2.6	-1.8	1.1	1.0
Precipitation					
Days with Precip.	15	9	6	7	9
Total (in.)	5.1	3.1	1.2	2.5	1.4
Avg Percent of Total Possible Sunshine	80	71	75	57	55

[a]Based on Local Climatological Data provided by the National Climatic Data Center. Springfield/Chicopee values are based on data for Hartford, CT.

Table 18. Study Area Comparisons

	Number of Analytes[a]		
Order of Study Area Estimates	Indoor Air	Outdoor Air	Personal Air
Estimated percent with detectable levels			
Spring			
Jacksonville > Springfield	21	6	18
Springfield > Jacksonville	7	7	9
Winter			
Jacksonville > Springfield	24	15	20
Springfield > Jacksonville	4	1	3
Mean concentration			
Spring			
Jacksonville > Springfield	24	6	19
Springfield > Jacksonville	4	7	8
Winter			
Jacksonville > Springfield	22	14	24
Springfield > Jacksonville	6	2	2

[a] Number of analytes for which the study area ranking given in the row heading was true. For example, in the first row of the table, in spring the estimated percent of the population with detectable indoor air levels was higher in Jacksonville than in Springfield/Chicopee for 21 analytes. In outdoor air, 7 analytes had a higher "percent detectable" in Jacksonville than in Springfield/Chicopee, and in personal air 18 analytes were higher in Jacksonville.

Water Exposure

Water sampling was by design only a small component of NOPES. Routine sampling of public water supplies by Jacksonville and Springfield prior to NOPES had not identified any contamination by the target compounds, and water samples collected and analyzed during the NOPES pilot study also did not contain detectable levels of any analytes. Therefore, a minimal sampling effort was believed to be sufficient for estimating water exposure to the target compounds.

In all, 29 tap water samples were analyzed in NOPES - 17 from Jacksonville and 12 from Springfield/Chicopee. Six Jacksonville samples were from private wells or water supplies; all Springfield/Chicopee samples were from the public water supply. Most of the samples contained no detectable levels of any of the analytes. The only analytes detected were as follows:

Jacksonville

- gamma-BHC – 6 ng/L in a summer sample from a home served by a private water company
- Diazinon – 58 ng/L in a spring sample from a home served by a private water company
- Dichlorvos – 327 ng/L in a winter sample from a home served by the public water supply

Springfield/Chicopee

- ortho-Phenylphenol – 110 ng/L and 36 ng/L in two spring samples
- Propoxur – 30 ng/L in a spring sample.

Among households in the water subsample, no correlation was observed between indoor air concentrations and water concentrations.

The small sample sizes prevent estimation of weighted population exposure estimates from these data. However, the lack of detectable levels for most analytes and the relatively low levels occasionally detected for others suggest that

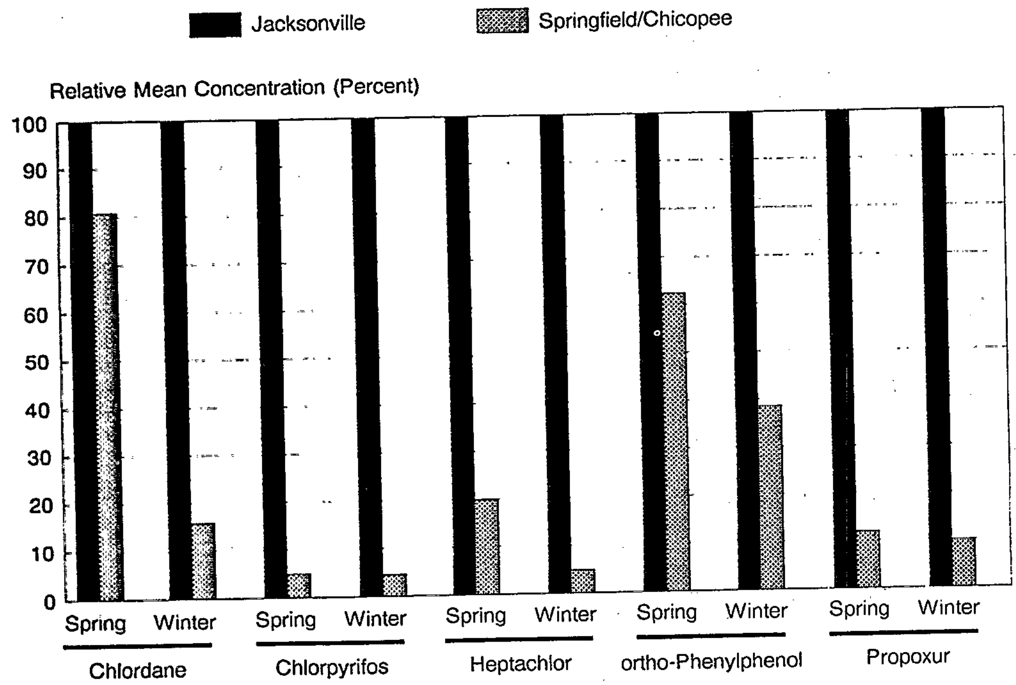

Figure 19. **Mean indoor air concentrations in Springfield/Chicopee as percents of Jacksonville mean concentrations.**

exposure to the NOPES target compounds from water is minimal in the two study areas.

Dermal Exposure

The dermal exposure component of NOPES was primarily a pilot study of a method for quantifying dermal exposure levels during acute exposure events. Chronic dermal exposure was not addressed. The number of events monitored was small, and events were not randomly selected, so estimated population exposure levels cannot be developed. However, analysis of the glove data does permit assessment of the method, and provides an initial impression of the relative importance of acute dermal exposure.

The monitored application events included spraying and shampooing pets to eliminate fleas, spraying insecticides inside and outside residences, spraying herbicides, spraying disinfectants, and spreading granular insecticides. Many applications involved ready-to-use aerosols; in others, pesticides were applied by hand, handsprayer, or mechanical spreader. Precautionary measures, such as wearing protective clothing or work gloves (over the sample gloves), were rarely taken during the applications. Twenty-two events were monitored, eight of which involved products containing one NOPES target compound, and four of which involved products containing two target compounds. The compounds applied were chlorpyrifos, diazinon, malathion, carbaryl, dicofol, dichlorvos, resmethrin, and methoxychlor.

In all events involving the application of one or more target compounds, the compounds were measured on the sample gloves, usually at high concentrations. In the majority of these events, detectable levels of the applied target compound were also measured in the personal air samples collected during the events. The lack of detected air levels in five cases may have been due to the high limits of detection inherent in short-duration sampling. This is especially likely for the cases involving dicofol and dichlorvos, which had relatively high detection limits compared to other analytes.

When assessing the suitability of the cotton gloves worn during application events as sampling devices, the fact that the applied target compounds were always found in the gloves is a desirable characteristic. However, the data reveal that the gloves collected more than just the applied compounds. In 18 of the 22 monitored events, analytes other than those being applied were also detected in the gloves. These other analytes were usually, but not always, at low concentrations. A reasonable explanation for some of these findings is that the "unexpected" analytes were present as residues on the application equipment (especially handsprayers and spreaders), in the application area, or on the respondent from a previous event. The unexpected analytes were in some cases present in the household pesticide inventory of the participant.

Before accurate estimates of acute dermal exposure levels can be obtained, the measurement method must be refined. Questions that need to be addressed include the following:

- What were the sources of the unexpected analytes?
- For a particular type of application event, such as bathing a dog with a flea shampoo, how much do concentration measurements vary between applications?
- Do the gloves overestimate certain types of dermal exposure, such as that due to liquid contact, because of their absorptive and/or adsorptive nature?
- Are gloves adequate for assessing total acute dermal exposure during application events, especially during warm weather when people may be working in shirt sleeves and shorts?
- What is the distribution of application events over time and across the population?

Although the NOPES data cannot support estimation of population dermal exposure levels, they can be used to gain insight on the general magnitude of the exposure experienced during application events. Lewis (1988) used some of the NOPES data to model the dose associated with a particular summer season application and then compared it to the mean estimated daily personal air exposure levels. The event modelled (a 5 minute outdoor application of granular chlorpyrifos by hand) had the highest glove concentration observed during Phase I and so in some sense represented a worst-case scenario. His findings for the particular case examined indicated that the dermal dose (assuming a 1% dermal absorption factor) from the event was 40 times greater than the daily air exposure. A lack of information on the number of times similar events were performed over the course of a year prevents computation of annual exposure levels. Nonetheless, the single day comparison indicates that dermal exposure is potentially a significant contributor to overall exposure levels.

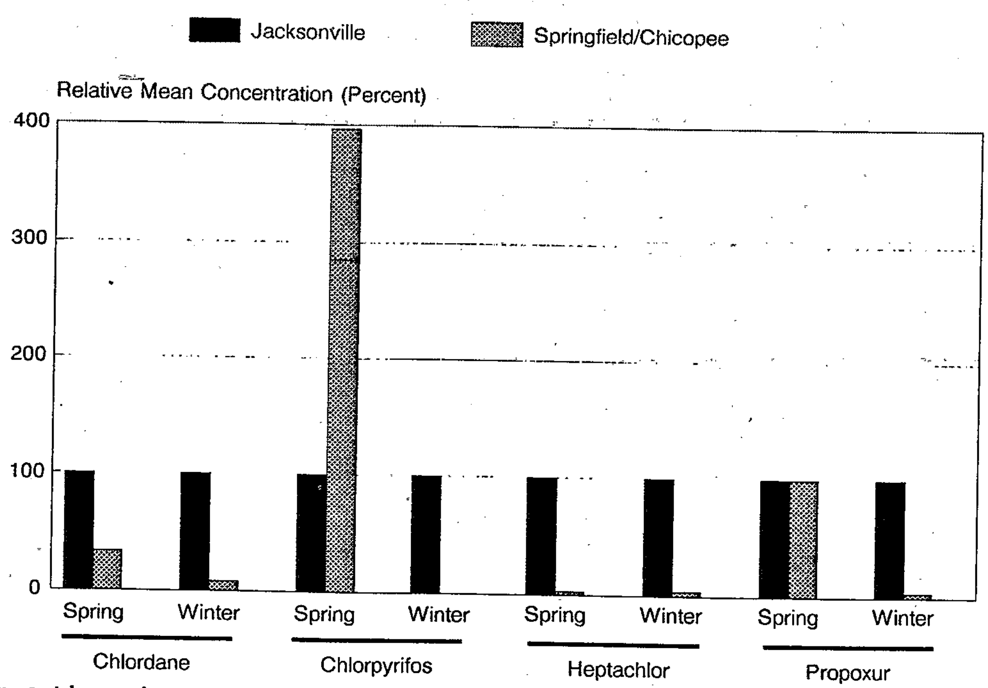

Figure 20. **Mean outdoor air concentrations in Springfield/Chicopee as percents of Jacksonville mean concentrations.**

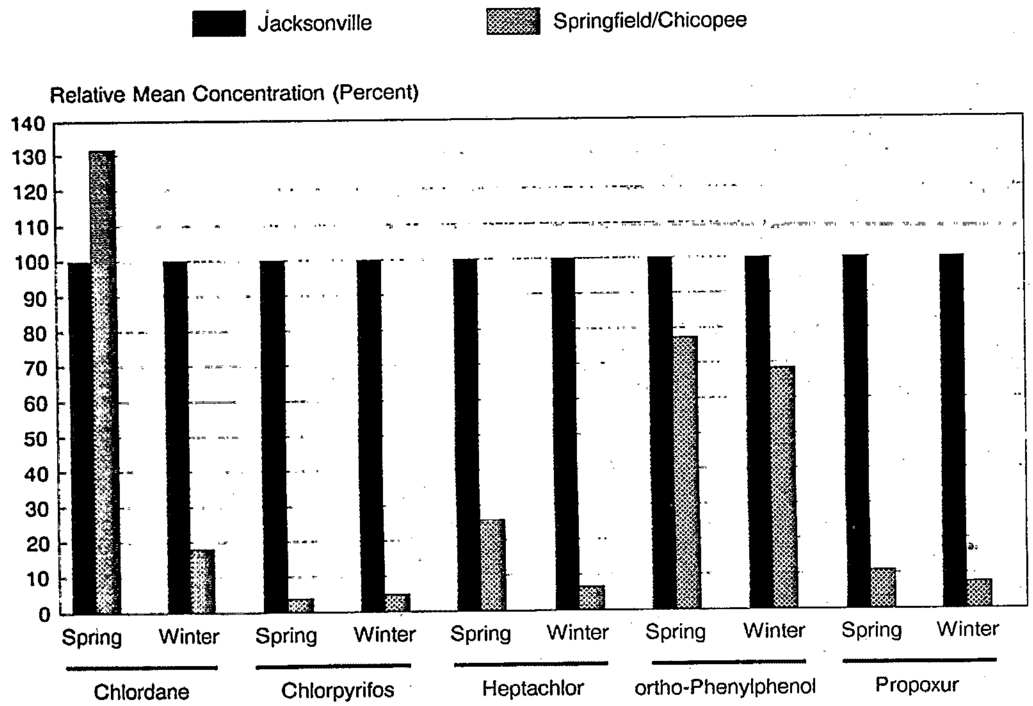

Figure 21. Mean personal air concentrations in Springfield/Chicopee as percents of Jacksonville mean concentrations.

Table 19. Replicate Relative Percent Differences[a]

	Number and Percent of Replicate Pairs					
	Relative Percent Difference[b]			Only Detected in One Sample	Not Detected in Either Sample	Total[c]
	<67%	67-164%	>164%			
Jacksonville						
Indoor air						
Summer	43 (21%)	12 (6%)	2 (1%)	28 (13%)	116 (58%)	201 (100%)
Spring	29 (8%)	24 (7%)	3 (1%)	25 (8%)	249 (76%)	330 (100%)
Winter	46 (16%)	19 (6%)	1 (0%)	24 (8%)	207 (70%)	297 (100%)
Outdoor air						
Summer	11 (6%)	3 (2%)	0 (0%)	20 (12%)	137 (80%)	171 (100%)
Spring	1 (0%)	3 (1%)	1 (0%)	21 (7%)	304 (92%)	330 (100%)
Winter	4 (1%)	5 (2%)	0 (0%)	19 (6%)	269 (91%)	297 (100%)
Personal						
Summer	28 (15%)	18 (10%)	1 (0%)	20 (11%)	121 (64%)	188 (100%)
Spring	36 (11%)	19 (6%)	3 (1%)	21 (6%)	251 (76%)	330 (100%)
Winter	49 (17%)	9 (3%)	6 (2%)	24 (8%)	209 (70%)	297 (100%)
Springfield/Chicopee						
Indoor air						
Spring	23 (7%)	4 (1%)	0 (0%)	20 (6%)	283 (86%)	330 (100%)
Winter	27 (8%)	6 (2%)	0 (0%)	9 (3%)	287 (87%)	329 (100%)
Outdoor air						
Spring	6 (2%)	3 (1%)	0 (0%)	16 (5%)	305 (92%)	330 (100%)
Winter	0 (0%)	0 (0%)	0 (0%)	2 (1%)	294 (99%)	296 (100%)
Personal						
Spring	14 (4%)	6 (2%)	1 (0%)	13 (4%)	296 (90%)	330 (100%)
Winter	28 (9%)	6 (2%)	1 (0%)	17 (5%)	277 (84%)	329 (100%)

[a] Relative percent difference, computed for pairs with detected values for both samples, calculated as: 100 * |primary value - replicate value| / (mean of the two values).

[b] Relative differences of less than 67% indicate that the paired values differed by a factor of 2 or less; relative differences greater than 164% indicate the pair differed by an order of magnitude or more.

[c] Total for up to 10 households and 33 analytes (including pentachlorophenol, for which all values were non-detect).

Table 20. Duplicate, Replicate, and Seasonal Indoor Air Concentration Differences, (ng/m³)

	Duplicates			Replicates			Multiseason Respondents		
	Mean Conc.[a]	Mean Abs. Diff.[b]	No. of Pairs	Mean Conc.[a]	Mean Abs. Diff.[b]	No. of Pairs	Mean Conc. Over Seasons[c]	Mean Abs. Diff. Between Seasons[d]	No. of Pairs
Chlordane									
Jacksonville									
Summer	55	2	6	271	98	8			
Spring	505	40	10	249	55	10	369	343	19
Winter	145	60	9	129	22	9	242	114	16
Springfield									
Spring	51	38	8	64	43	10			
Winter	54	12	7	140	32	10	32	29	15
Chlorpyrifos									
Jacksonville									
Summer	247	38	6	362	169	8			
Spring	268	8	10	162	101	10	259	276	19
Winter	187	17	9	152	198	9	122	114	16
Springfield									
Spring	63	16	8	34	14	10			
Winter	18	1	7	5	2	10	13	11	15
Heptachlor									
Jacksonville									
Summer	13	3	6	157	41	8			
Spring	142	14	10	114	75	10	218	223	19
Winter	43	3	9	64	22	9	124	108	16
Springfield									
Spring	5	4	8	20	11	10			
Winter	7	<1	7	26	3	10	10	15	15
ortho-Phenylphenol									
Jacksonville									
Summer	81	29	4	91	46	5			
Spring	101	33	10	96	145	10	75	72	17
Winter	51	6	9	82	87	9	80	117	16
Springfield									
Spring	107	39	8	26	22	10			
Winter	54	12	7	46	23	10	34	38	15
Propoxur									
Jacksonville									
Summer	142	28	4	289	138	5			
Spring	378	13	10	168	137	10	529	629	17
Winter	92	10	9	51	30	9	197	184	16
Springfield									
Spring	48	36	8	64	18	10			
Winter	10	4	7	17	12	10	52	77	15

[a]Unweighted mean of all matched pair data.
[b]Unweighted mean of the absolute differences between matched pairs.
[c]Unweighted mean of data for two seasons from multiseason respondents. Values on the rows labelled 'Spring' are means for combined summer and spring data; rows labelled 'Winter' are for combined spring and winter data.
[d]Values on rows labelled 'Spring' are the unweighted mean absolute differences between summer and spring concentrations; values on rows labelled 'Winter' are for mean absolute differences between spring and winter concentrations.

The approach used in Lewis (1988) was applied to all 16 target compound applications monitored in NOPES. The following assumptions were used to compute dermal and daily air exposure doses for the applied compounds:

- 20 m^3 of air per day respired by a 70 kg adult
- dermal absorption factors of 0.01 for granular and dust applications and 0.1 for liquid and spray applications.

The estimated dermal doses, computed by multiplying the glove concentration by the appropriate absorption factor, ranged from 0.02 µg to 16,000 µg. Daily air exposure doses were calculated as the mean personal air concentration estimates (ng/m^3) from Tables 12 and 13 multiplied by 20 m^3 per day of respired air. In only three of the 16 cases was the dermal dose less than the estimated daily air dose. The dermal dose was more than an order of magnitude greater than the daily air dose in more than half the cases.

These results confirm the earlier conclusion that the acute dermal component may for some analytes contribute substantially to total exposure. More accurate exposure measurements and data on the frequency of applications are needed to better quantify the actual contribution. A complete understanding of dermal exposure also requires identification of all chronic dermal exposure pathways, such as contact with dust or residues on surfaces, and measurement of exposures via those pathways.

Dietary Exposure

NOPES was not designed to directly measure dietary exposure to the target compounds. Instead, dietary exposures were estimated using residue concentration information developed by the U.S. Food and Drug Administration as part of their ongoing Total Diet Study (TDS) program together with dietary intake data from the survey participants. The uncertainties associated with the estimated food exposures are much greater than those for air exposures. Air exposures were measured directly, but food exposures were estimated indirectly. The TDS is not designed to be statistically representative of all commodities in commerce. The estimation procedure does not account for the effects of food preparation in the home (e.g., washing and cooking). Therefore, the only conclusions that are supported by the study regarding food exposures are qualitative comparisons of the relative magnitudes of the food and air routes of exposure, as reported in the next section.

Relative Contributions of Exposure Pathways

One of the primary objectives of NOPES was to assess the relative contributions of the four pathways -- air, water, food, and dermal contact -- to overall exposure to the target compounds. The NOPES findings, although not sufficient to permit precise quantification of the relative contributions, do provide some insight on the magnitude of exposure attributable to each pathway.

For all target compounds, exposure from drinking water appeared to be minimal in both study areas. This conclusion is consistent with the NOPES pilot study results and with the sampling performed in ongoing municipal water quality testing programs.

The dermal exposure pathway could not be accurately characterized, making conclusions about its relative contribution to exposure tentative at best. The primary conclusion is that acute dermal exposures that occur during application events may contribute substantially to total exposure for some analytes (Lewis, 1988).

Collection of house dust using a high-volume surface sampler was pilot tested in NOPES in the Jacksonville winter season. House dust may be a source of exposure to pesticides via dermal contact, ingestion, and inhalation of suspended particulates, especially for infants and toddlers. The results of the pilot study (Budd et al., 1988) suggest that further study is warranted but are insufficient to support conclusions about the relative importance of house dust at this time.

Qualitative comparisons of the relative exposure contributions of air and food were possible for some of the target compounds. The relative air and food contributions were computed for daily exposures. Mean daily exposure from inhalation was estimated by multiplying the mean personal air concentration estimates (ng/m^3) for each season (Tables 12 and 13) by 20 m^3 air respired per day. These daily air exposure estimates were then compared to the daily dietary estimates. Only qualitative comparisons were supported by the data. The 25 analytes for which dietary estimates were available were partitioned into five categories on the basis of their estimated relative exposure levels in air and food as shown in Table 21.

For some of the analytes, the relationship between air and dietary exposures seems to reflect the general uses of the analytes. Prior to being withdrawn in 1988, chlordane and heptachlor were used primarily as

Table 21. Relative Air and Dietary Exposure Estimates

Relative Exposure Category	Analytes
1. Mean air exposure always much higher than estimated dietary exposure	Chlordane Heptachlor
2. Variable, but mean air exposure often higher than estimated dietary exposure	Aldrin Chlorpyrifos Diazinon gamma-BHC
3. Generally present in air, but mean air exposure lower than estimated dietary exposure	4,4'-DDT Dacthal Dieldrin
4. Mean air exposure usually much lower than estimated dietary exposure	alpha-BHC Captan Carbaryl 4,4'-DDE Dicofol Heptachlor epoxide Hexachlorobenzene Malathion Methoxychlor cis-Permethrin trans-Permethrin
5. Both exposures estmated to be very low	Ronnel Oxychlordane 4,4'-DDD Chlorothalonil Folpet

termiticides and so would be expected to be present in air at much higher levels than in food. Alternatively, some of the pesticides in the second, third, and fourth categories of Table 21 are used in agriculture or food processing and distribution settings and so are logically found in food as well as air. For analytes in these categories, volatility, the amount of nonagricultural use, and other factors determine the relative exposure levels from air and food.

For the remaining seven analytes, a relative assessment of food and air exposures was not possible because of the lack of dietary exposure estimates. However, three of these analytes -- dichlorvos, ortho-phenylphenol, and propoxur -- occur at relatively high levels in personal air in Jacksonville and have a variety of household uses, leading to the expectation that the air exposures were higher than the dietary exposures. For the other four analytes, the data are insufficient to assess the relative air and dietary contributions. Estimated mean air concentrations of bendiocarb were high in the summer but low in all other seasons, whereas the mean air concentrations of atrazine, 2,4-D, and resmethrin were always low.

Air Exposure and Questionnaire Data Relationships

A primary objective of exposure assessment research is the development of validated, predictive models of exposure. One approach to modelling is to identify and quantify relationships between data collected in questionnaires and exposure levels for the corresponding survey respondents. The ability to estimate exposure levels from questionnaire data is desirable in terms of both cost and respondent burden. Collection and laboratory analysis of samples is costly compared to questionnaire data collection. Moreover, monitoring imposes a relatively high burden of time and responsibility on study respondents. Questionnaire-based modelling has been explored for a number of compounds (see, for example, Akland et al., 1985; Wallace, 1987; Ryan et al., 1988).

NOPES was designed to provide a data base from which to develop and test air exposure models for the target compounds. Exploratory analysis of this data base and the models it may support has begun and is summarized in this section. Ultimately, the NOPES data may be used to construct quantitative multivariate air exposure models for some of the NOPES analytes.

Effectiveness of Exposure Stratification

A preliminary, simplistic questionnaire-based model was an integral part of the NOPES sampling design. Potential indoor air exposure strata were defined using screening questionnaire data and were used to control the distribution of the third-stage sample. The algorithm used to define strata was based on responses to four questions:

- Was there any use of pesticides on indoor plants?
- Was there any use of pesticides on household pets?
- Was the housing unit treated with termiticides?
- Were household insecticides applied within the housing unit during the past year?

A housing unit was assigned to the high-exposure stratum if the answer to at least three of the four questions was "Yes", to the medium-exposure stratum if any two answers were "Yes", and to the low-exposure stratum otherwise.

The effectiveness of the stratification model can be assessed in several ways. One way is to compute the number of analytes detected in indoor air or personal air for each respondent and to then compare the mean number detected in each of the three strata. Alternatively, for each analyte in each study area and season, the mean concentration or the percent of the population with detectable levels can be estimated for each stratum. The strata can then be ranked or otherwise compared, and the results can be summarized across analytes. Both of these approaches were used and are summarized in Table 22. (All analyses are based on the final exposure categorizations of respondents. Because of concerns about the accuracy of the termiticide treatment information obtained during screening, the termite questions were asked again in the study questionnaire. In some cases, the study questionnaire answers prompted a revision of a respondent's exposure category.)

The results presented in Table 22 indicate that the stratification model was effective in a general way for indoor air. The high-exposure category summary measure was usually higher than the medium-exposure measure, which in turn was usually higher than the low-exposure measure. The model's effectiveness was more limited for personal air, which was expected given the definition of the model. The indoor air findings imply that this type of model can be useful when only broad relative categorizations are needed.

However, examination of the stratum-specific statistics for particular analytes reveals that the stratification model was not generally effective as a predictive tool for relative exposure levels for individual compounds. Mean indoor air analyte concentrations rarely differed significantly between strata, and the relative ranking of high-, medium-, and low-exposure stratum means was often inconsistent across seasons (Table 23). The stratum-specific "percent detectable" estimates displayed a similar lack of differentiation and consistency.

This result was not surprising because the strata were only intended to be predictive in a general sense, and not for individual analytes. The NOPES air samples were analyzed for compounds with a wide variety of chemical properties and use characteristics. Any single questionnaire- based index that tries to address all of the compounds does so at the expense of adequate prediction for the individual compounds. Development of predictive models using the NOPES data should therefore focus on individual analytes or classes of analytes with similar properties (e.g., termiticides).

Stratification based on categories related to potential exposure levels was somewhat effective in NOPES, and would be a desirable feature in the design of any subsequent surveys. Analysis of the NOPES data (see below) indicates that the exposure categorization criteria could be altered to make the stratification more effective. Recommended changes include the following:

- Delete the "indoor plant pesticide use" component of the definition because of the infrequent incidence of pesticide use on indoor plants.
- If the target pesticides are similar to those in NOPES, the "use of pet pesticides" component of the definition could be dropped because the majority of current pet pesticide products do not contain any of the NOPES analytes.
- Any survey studying termiticides or pesticides that are no longer in use should incorporate age and type of housing unit in the definition of the exposure strata.

The NOPES experience also indicates that differences in sampling rates across strata should be much smaller than those used in this study. The limited effectiveness of the stratification was not great enough to justify the vastly unequal sampling rates, which resulted in considerable unequal weighting and variance inflation for overall population estimates.

Exploratory Analyses

The exploratory work done to date has examined the relationships between specific analytes and a variety of questionnaire items. Given the relatively small sample sizes, many analytes were detected too infrequently to permit statistical assessment of their relationships to questionnaire data. Therefore, the work has focused primarily on the common and prevalent compounds. Even for these analytes, standard errors for many estimates are large because of small sample sizes, unequal weighting effects, and the inherent variability of the measurement data. Most observed differences were consequently not statistically significant. However, the goal of the exploratory work is to identify those differences that are suggestively large and consistent with known causal processes. Such differences can then be explored further with more sophisticated analytical techniques.

Two types of analyses have been performed: (1) analyses based on general characteristics of respondents' housing units, and (2) analyses focused on potential uses of specific analytes. In analyses of the first type, the reporting error for the questionnaire data is believed to have been relatively slight, because the concepts involved (age of housing unit, type of housing unit, and location of the indoor fixed-site sampler) are familiar and straightforward. Reporting error may have been more of a problem in the second type of analysis because of misunderstanding or lack of knowledge on the part of some respondents.

Characteristics of Housing Units

Age of Housing Unit. A correspondence might be observed between age of housing unit and indoor air concentration of an analyte for several reasons:

Table 22. Overall Effectiveness of the Exposure Stratification Model

	Potential Indoor Air Exposure Category		
	High	Medium	Low
Mean Number of Analytes Detected for a Respondent (standard errors in parentheses)			
Indoor Air			
Jacksonville			
Summer	9.0 (1.5)	8.0 (0.5)	8.7 (0.5)
Spring	8.0 (0.4)	7.3 (0.5)	6.7 (0.8)
Winter	9.3 (0.5)	8.4 (0.8)	7.8 (0.6)
Springfield			
Spring	4.0 (0.4)	3.9 (0.7)	3.4 (0.6)
Winter	4.1 (0.1)	3.7 (0.3)	4.3 (4.1)
Personal Air			
Jacksonville			
Summer	7.7 (1.2)	8.4 (0.5)	7.8 (1.1)
Spring	7.1 (0.6)	6.3 (0.5)	5.7 (1.3)
Winter	8.0 (0.3)	8.9 (0.9)	7.9 (0.4)
Springfield			
Spring	3.7 (0.4)	3.0 (1.2)	4.1 (0.7)
Winter	4.5 (0.1)	3.0 (0.5)	4.5 (0.6)
Mean Rank Over All Analytes (1 = highest value, 3 = lowest value)			
Indoor Air			
Percent Detect			
Jacksonville	1.6	2.0	2.4
Springfield	1.9	2.0	2.1
Mean Concentration			
Jacksonville	1.6	2.2	2.2
Springfield	1.8	2.0	2.2
Personal Air			
Percent Detect			
Jacksonville	1.9	2.0	2.1
Springfield	1.8	2.2	2.0
Mean Concentration			
Jacksonville	2.0	2.0	2.1
Springfield	1.8	2.1	2.0

- Some housing units were built after use of certain analytes was discontinued.
- As units age, the need to use certain analytes may increase or decrease.
- Units might "accumulate" an analyte over time because of repeated applications.
- Residents of older units might typically differ from residents of newer units in their use of pesticides (for reasons not directly related to the age of the unit).

Preliminary analyses suggest that the action of some of these factors can be observed in the NOPES data.

For each analyte, mean indoor air concentrations were computed for three housing unit age categories - 20 years and less, 21 to 40 years, and 41 years and older. Some analytes were detected too infrequently to provide useful comparisons. Others, including some of the more common analytes, such as chlorpyrifos, ortho-phenylphenol, and propoxur, showed no evidence of substantial, consistent differences among the categories. However, such differences were observed for 10 analytes, and these are summarized in Table 24.

Three of the analytes in the table have not been registered for use in the United States since the 1970s (DDT and DDE since 1971, and alpha-BHC since 1978), and the use of two others - aldrin and dieldrin - has been drastically reduced. Concentrations of DDT, DDE, alpha-BHC, and dieldrin were consistently lower in housing units 20 years old or less, presumably reflecting the lack of recent use. The picture for aldrin is not as clear. The fact that older pesticides such as DDT were detected in NOPES samples is not surprising given the known persistence

Table 23. Ranks of Exposure Category Mean Indoor Air Concentrations of Commonly Detected Analytes (H = High exposure category, M = Medium exposure category, L = Low exposure category)

	Jacksonville			Springfield/Chicopee	
Analyte	Summer Rank[a] 1 2 3	Spring Rank[a] 1 2 3	Winter Rank[a] 1 2 3	Spring Rank[a] 1 2 3	Winter Rank[a] 1 2 3
gamma-BHC	H M L	H M L	H L M	L H=M	L H M
Heptachlor	M H L	M L H	L H M	L H M	H M L
Chlorpyrifos	L H M	H M L	H L M	H M L	H M L
Dieldrin	M H L	L H M	H L M	L H=M	L M H
Chlordane	H M L	H L M	L H M	L H M	H M L
ortho-Phenylphenol	H M L	H L M	H L M	M L H	H L M
Propoxur	L H M	L M H	M L H	H M L	H L M
Diazinon	H M L	H M L	L M H	M H L	L H M

[a]1 = highest exposure category mean concentration, 3 = lowest exposure category mean concentration, equal signs represent ties.

of these compounds. The dust sampling pilot study results suggest that dust may be a significant reservoir for older pesticides (Budd et al., 1988).

The two most frequently found termiticides in NOPES -- chlordane and heptachlor -- displayed a similar pattern of generally lower levels in newer homes. Both of these pesticides have been commonly used until recently, and have long residual lifetimes. The observed pattern may therefore be due to higher rates of application in earlier decades, or accumulation of the analytes. However, the pattern could also be an artifact of a correlation of housing unit age with some other factor, such as housing unit type (discussed below).

The other three analytes in the table -- bendiocarb, gamma-BHC, and hexachlorobenzene -- were all detected relatively frequently in Jacksonville, and show some evidence of consistent patterns over the three Jacksonville sampling seasons. Gamma-BHC and hexachlorobenzene concentrations were lowest in the newer homes, and bendiocarb concentrations were highest in homes of intermediate age. These patterns were not observed in Springfield/Chicopee, perhaps simply because the analytes occurred there with such low frequency.

Type of Housing Unit. A goal of the NOPES sampling design was to ensure that various housing types were represented in the sample. Monitored housing units included unattached single-family dwellings, attached single-family dwellings (e.g., duplexes, townhouses), multiunit buildings (e.g., apartments), and mobile homes (the latter primarily in Jacksonville). To examine the possibility that indoor air concentrations were related to type of housing unit, analyte mean concentrations were computed for each type and compared. The comparisons for some analytes are summarized in Table 25.

For most analytes there was little evidence of a relationship between indoor air concentrations and housing type. However, consistent patterns were observed for the analytes that have been primarily used as termiticides - aldrin, chlordane, dieldrin, and heptachlor. All of these compounds had higher levels in unattached and attached single units than in apartments, and were at much lower levels in mobile homes (except for the one Springfield/Chicopee mobile home). The most plausible explanation for the lower multiunit and mobile home levels is that termiticide treatments either were not performed or were needed less often because of the type of construction materials used in these units. Alternatively, because multiunit buildings and mobile homes were younger on average than single-family units, the observed differences between housing types may reflect an age effect. Further analysis is needed to separate the confounding effects of age and type of housing unit.

Alpha-BHC, DDT, and DDE have all been out of use since the 1970s (although alpha-BHC still enters the system as an environmental conversion product of gamma-BHC). All were absent from mobile homes, which is to be expected given the limited lifespan of mobile homes. These three analytes did not display a uniform pattern of concentrations in single-unit versus multiunit dwellings. Although alpha-BHC displayed a tendency toward lower multiunit levels, no such tendency was apparent for DDT or DDE.

Table 24. Indoor Air Concentration vs. Age of Housing Unit

Analyte	Age of Housing Unit (years)		Mean concentration (ng/m³)				
			Jacksonville			Springfield/Chicopee	
			Summer	Spring	Winter	Spring	Winter
Aldrin	≤20	Mean	4.4	19.6	3.4	0	0
		s.e.	(4.9)	(18.7)	(2.8)	-	-
	21-40	Mean	37.1	4.6	11.4	0	0.8
		s.e.	(25.5)	(1.3)	(2.7)	-	(0.5)
	≥41	Mean	70.2	1.6	2.9	0	0.0
		s.e.	(76.4)	(0.8)	(0.4)	-	(0.0)
alpha-BHC	≤20	Mean	0.6	0.2	0.0	0	0
		s.e.	(0.6)	(0.3)	(0.0)	-	-
	21-40	Mean	1.1	1.1	1.1	0	0
		s.e.	(0.6)	(0.1)	(0.7)	-	-
	≥41	Mean	3.1	1.8	2.2	0.4	0
		s.e.	(2.4)	(1.0)	(1.8)	(0.5)	
Bendiocarb	≤20	Mean	16.7	5.8	1.9	0.9	0
		s.e.	(6.6)	(3.3)	(1.2)	(0.9)	-
	21-40	Mean	139.8	8.3	6.1	0	1.1
		s.e.	(111.3)	(5.3)	(2.1)	-	(1.1)
	≥41	Mean	10.4	0.7	0.3	0	0.0
		s.e.	(13.0)	(0.7)	(0.3)	-	(0.0)
Chlordane	≤20	Mean	162.2	71.9	53.2	18.3	30.6
		s.e.	(75.2)	(47.5)	(19.7)	(3.8)	(12.3)
	21-40	Mean	402.8	215.3	128.3	428.6	43.9
		s.e.	(131.8)	(90.1)	(13.3)	(311.8)	(6.9)
	≥41	Mean	383.9	432.7	533.6	41.3	29.8
		s.e.	(88.2)	(86.7)	(93.9)	(15.0)	(11.8)
4,4'-DDE	≤20	Mean	-	0	0	0	0
		s.e.		-	-	-	-
	21-40	Mean	-	0.5	0.1	2.0	1.2
		s.e.		(0.6)	(0.1)	(1.2)	(0.8)
	≥41	Mean	-	1.0	0.5	0	0.4
		s.e.		(0.3)	(0.2)	-	(0.2)
4,4'-DDT	≤20	Mean	-	0.1	0	0	0
		s.e.		(0.1)	-	-	-
	21-40	Mean	-	1.0	0.3	0.0	0
		s.e.		(0.7)	(0.1)	(0.0)	-
	≥41	Mean	-	1.7	1.4	0	1.3
		s.e.		(0.6)	(0.7)	-	(0.3)
Dieldrin	≤20	Mean	5.6	1.7	3.1	0	0.5
		s.e.	(2.8)	(1.7)	(1.8)	-	(0.2)
	21-40	Mean	16.0	6.7	6.8	0	0.2
		s.e.	(1.9)	(2.1)	(2.1)	-	(0.2)
	≥41	Mean	29.7	15.2	11.7	2.7	9.1
		s.e.	(10.9)	(5.1)	(4.0)	(2.6)	(5.8)
gamma-BHC	≤20	Mean	6.6	4.7	1.7	0	40.9
		s.e.	(2.8)	(1.7)	(1.8)	-	(40.2)
	21-40	Mean	16.0	6.7	6.8	0	0.8
		s.e.	(1.9)	(2.1)	(2.1)	-	(0.5)
	≥41	Mean	29.7	15.2	11.7	2.7	0.1
		s.e.	(10.9)	(5.1)	(4.0)	(2.6)	(0.1)

(continued)

Table 24. Continued

Analyte	Age of Housing Unit (years)		Mean concentration (ng/m³) Jacksonville Summer	Spring	Winter	Springfield/Chicopee Spring	Winter
Heptachlor	≤20	Mean	46.4	18.4	13.8	3.7	1.5
		s.e.	(23.0)	(15.0)	(2.9)	(0.8)	(0.2)
	21-40	Mean	237.0	171.6	38.3	64.6	5.1
		s.e.	(99.2)	(106.2)	(21.8)	(46.8)	(1.2)
	≥41	Mean	141.4	229.5	184.6	8.9	3.7
		s.e.	(40.4)	(77.2)	(34.4)	(5.1)	(1.8)
Hexachloro-benzene	≤20	Mean	0.8	0	0.0	0	0.3
		s.e.	(0.2)	-	(0.0)	-	(0.2)
	21-40	Mean	1.2	0.8	0.1	0	0
		s.e.	(0.6)	(0.4)	(0.1)	-	-
	≥41	Mean	2.7	0	0.8	0	0.1
		s.e.	(1.5)	-	(0.4)	-	(0.2)
Sample size	≤20		19[a]	13	15	13	9
	21-40		32[a]	37	37	16	22
	≥41		11[a]	21	19	19	20

[a]The sample sizes for bendiocarb were 14 "≤20," 26 "21-40," and 9 "≥41."

Sampler Location. The possibility that the indoor air concentration measurements were related to the room in which the fixed-site sampler was set up was examined by computing analyte mean concentrations for each room type. The only consistent differences observed were for bendiocarb, diazinon, and malathion, which all had lower mean concentrations in the kitchen, and propoxur, which had higher kitchen concentrations in Jacksonville and lower kitchen concentrations in Springfield/Chicopee (Table 26).

Potential Uses of Specific Analytes

Pesticide Inventory. A possible surrogate measure for actual use of an analyte in a home is whether or not pesticides containing the analyte are present in or around the home. This measure might in turn be expected to be correlated with analyte air concentrations. The NOPES pesticide inventory data were used to explore this possibility.

Active ingredients were identified for all pesticides reported with valid EPA registration numbers in the household pesticide inventories. For each NOPES analyte, respondents were categorized by whether or not the analyte was present in any of the pesticides in the household inventory. Mean indoor air concentrations were then computed for the two categories. The results for all detected analytes frequently present in the inventories are shown in Table 27.

Although none of the analytes had a completely consistent pattern of concentration differences, ortho-phenylphenol, chlordane (in Springfield/Chicopee), and dichlorvos (in Jacksonville) showed some evidence of having higher air concentrations when present in the household inventories. Carbaryl also displayed this pattern, but was rarely detected, despite being relatively common in the inventories. The low volatility of carbaryl probably accounts for its infrequent detection. The relationship between mean concentration and presence in inventories was variable for chlorpyrifos, diazinon, malathion, and propoxur, perhaps because of seasonal differences in use. For folpet, the observed relationship was the inverse of that expected; that is, indoor air means were consistently lower in households with folpet in their inventories. However, not much significance should be attributed to this finding given the rare occurrence of folpet in the inventories.

Termiticide Applications. All respondents were asked in both the screening questionnaire and the study questionnaire about the history of termiticide applications in their home. Their answers were used to classify the monitored homes as having or not having been treated with termiticides. Units in which the respondents did not know the termiticide history were included in the untreated category. Mean indoor air concentrations of analytes often used as termiticides were then computed for the two categories (Table 28).

Chlordane and heptachlor always displayed the expected pattern of higher concentrations in treated homes. Heptachlor epoxide, a degradation product of heptachlor, was detected infrequently and was not consistently higher in treated units.

In Jacksonville, aldrin and, to a lesser extent, dieldrin concentrations were higher in treated homes. However, in Springfield/ Chicopee, where both analytes were detected infrequently, their concentrations tended to be higher in homes in the untreated

Table 25. Indoor Air Concentration vs. Type of Housing Unit

Analyte	Type of Housing Unit		Jacksonville Summer	Jacksonville Spring	Jacksonville Winter	Springfield/Chicopee Spring	Springfield/Chicopee Winter
			Mean concentration (ng/m3)				
Aldrin	Unattached	Mean	53.6	9.3	8.4	0	0.5
	single unit	s.e.	(25.6)	(3.7)	(1.3)	-	(0.4)
	Attached single	Mean	0	0	0	0	0.0
	unit (e.g., duplex)	s.e.	-	-	-	-	(0.0)
	Multiunit	Mean	0	0	6.0	0	0
	(e.g., apartment)	s.e.	-	-	6.4	-	-
	Mobile home	Mean	0	2.4	0	0	0
		s.e.	-	(1.7)	-	-	-
alpha-BHC	Unattached	Mean	1.9	1.4	1.6	0.2	0
	single unit	s.e.	(0.7)	(0.4)	(0.9)	(0.2)	-
	Attached single	Mean	0.6	0	2.5	0	0
	unit (e.g., duplex)	s.e.	(0.2)	-	-	-	-
	Multiunit	Mean	0.1	1.0	0.2	0	0
	(e.g., apartment)	s.e.	(0.1)	(0.6)	(0.1)	-	-
	Mobile home	Mean	0	0	0	0	0
		s.e.	-	-	-	-	-
Chlordane	Unattached	Mean	444.9	308.8	295.3	293.2	36.8
	single unit	s.e.	(117.6)	(46.7)	(100.2)	(250.2)	(4.7)
	Attached single	Mean	405.2	779.0	417.0	24.8	40.1
	unit (e.g., duplex)	s.e.	(128.5)	(58.9)	-	(2.1)	(18.4)
	Multiunit	Mean	176.3	56.5	77.2	5.5	22.4
	(e.g., apartment)	s.e.	(56.5)	(47.3)	(11.0)	(6.9)	(2.6)
	Mobile home	Mean	2.9	0	14.8	41.0	206.0
		s.e.	(2.4)	-	(9.8)	-	-
4,4'-DDE	Unattached	Mean	-	0.4	0.3	1.3	1.1
	single unit	s.e.		(0.1)	(0.2)	(0.9)	(0.6)
	Attached single	Mean	-	0	0	0	0
	unit (e.g., duplex)	s.e.		-	-	-	-
	Multiunit	Mean	-	1.6	0	0	0.0
	(e.g., apartment)	s.e.		(1.5)	-	-	(0.0)
	Mobile home	Mean	-	0	0	0	0
		s.e.		-	-	-	-
4,4'-DDT	Unattached	Mean	-	1.1	0.9	0.0	0.7
	single unit	s.e.		(0.7)	(0.5)	(0.0)	(0.6)
	Attached single	Mean	-	0.3	0	0	0
	unit (e.g., duplex)	s.e.		(0.5)	-	-	-
	Multiunit	Mean	-	1.4	0	0	0.6
	(e.g., apartment)	s.e.		(1.3)	-	-	(0.9)
	Mobile home	Mean	-	0	0	0	0
		s.e.		-	-	-	-
Dieldrin	Unattached	Mean	20.0	10.4	8.8	1.5	6.0
	single unit	s.e.	(4.2)	(3.0)	(2.0)	1.7	(4.8)
	Attached single	Mean	13.0	30.3	18.0	0	1.7
	unit (e.g., duplex)	s.e.	(9.5)	(2.3)	-	-	(1.2)
	Multiunit	Mean	8.2	1.1	4.3	0	2.2
	(e.g., apartment)	s.e.	(3.4)	(1.0)	(1.7)	(-)	(0.9)
	Mobile home	Mean	2.2	0	0	0	0
		s.e.	(1.4)	-	-	-	-

(continued)

category. Possible explanations for the unexpected Springfield/Chicopee finding include sampling error, misclassification of the housing units, or use of aldrin and dieldrin for purposes other than termite control.

Mean chlorpyrifos concentrations were usually similar in the treated and untreated categories. This was probably due to the wide variety of uses of chlorpyrifos and its relatively limited use as a termiticide until recently.

Use of Other Household Insecticides. To examine the relationships between air concentrations and reported treatment for insects other than termites, homes were

Table 25. Continued

Analyte	Type of Housing Unit		Jacksonville Summer	Jacksonville Spring	Jacksonville Winter	Springfield/Chicopee Spring	Springfield/Chicopee Winter
			Mean concentration (ng/m3)				
Heptachlor	Unattached single unit	Mean	217.2	200.8	102.8	45.9	4.1
		s.e.	(76.7)	(69.8)	(35.5)	(34.8)	(0.6)
	Attached single unit (e.g., duplex)	Mean	236.2	470.6	156.0	10.7	4.8
		s.e.	(93.1)	(18.0)	-	(2.5)	(2.5)
	Multiunit (e.g., apartment)	Mean	99.7	6.8	9.1	0.5	1.2
		s.e.	(78.7)	(3.1)	(3.0)	(0.7)	(0.3)
	Mobile home	Mean	1.2	0.9	1.3	3.9	35.0
		s.e.	(1.0)	(0.8)	(0.9)	-	-
Sample size	Unattached single unit		40	57	53	35	36
	Attached single unit		3	2	1	6	5
	Multiunit		11	6	12	7	9
	Mobile home		8	7	5	1	1

Table 26. Indoor Air Fixed-Site Sampler Location Comparison

Analyte	Sample Location		Jacksonville Summer	Jacksonville Spring	Jacksonville Winter	Springfield/Chicopee Spring	Springfield/Chicopee Winter
Bendiocarb	Kitchen	Mean	15.3	5.8	0	0	0
		s.e.	(14.0)	(4.0)	-	-	-
	Family room	Mean	122.0	7.0	3.8	0.6	0.5
		s.e.	(89.5)	(3.5)	(1.2)	(0.8)	(0.5)
	Other	Mean	0	0	3.2	0	0
		s.e.	-	-	(3.4)	-	-
Diazinon	Kitchen	Mean	376.7	51.2	31.0	55.1	0.7
		s.e.	(221.2)	(8.5)	(14.2)	(77.2)	(0.4)
	Family room	Mean	519.7	138.7	90.7	118.0	3.3
		s.e.	(89.0)	(33.8)	(21.6)	(141.2)	(1.8)
	Other	Mean	35.0	72.4	159.9	8.2	0
		s.e.	(16.9)	(40.3)	(36.6)	(6.3)	-
Malathion	Kitchen	Mean	2.9	0	0	0	0
		s.e.	(2.0)	-	-	-	-
	Family room	Mean	29.9	11.2	23.5	17.4	0
		s.e.	(20.3)	(5.6)	(15.4)	(21.1)	-
	Other	Mean	0	3.7	0	0	0
		s.e.	-	(2.8)	-	-	-
Propoxur	Kitchen	Mean	1541.7	455.6	257.2	15.1	7.4
		s.e.	(1075.1)	(296.2)	(69.8)	(9.3)	(4.0)
	Family room	Mean	335.9	188.2	154.6	21.8	21.3
		s.e.	(42.5)	(68.6)	(63.8)	(21.1)	(6.5)
	Other	Mean	227.5	146.8	66.2	0	10.0
		s.e.	(16.3)	(108.6)	(17.7)	-	(4.7)
Sample size	Kitchen		15[a]	12	6	12	10
	Family room		41[a]	42	61	16	32
	Other		4[a]	13	3	2	5

[a]The sample sizes for bendiocarb, malathion, and propoxur were 9 "Kitchen," 35 "Family room," and 3 "Other."

categorized on the basis of responses to screening questions on the subject. Units in which respondents indicated that insecticides were applied at least once a year were classified as treated; all others were assigned to the untreated category. Table 29 presents the mean indoor air concentrations in the two categories for the commonly used or detected insecticides.

Table 27. Indoor Air Concentrations vs. Presence in Household Pesticide Inventory

			Mean concentration (ng/m³)				
			Jacksonville			Springfield/Chicopee	
Analyte	Present in Inventory		Summer	Spring	Winter	Spring	Winter
Carbaryl	Yes	Mean	330.0	ND[a]	ND	0.9	ND
		s.e.	(346.3)			(1.1)	
		n	9			17	
	No	Mean	4.3			0	
		s.e.	(2.6)			-	
		n	40			32	
Chlordane	Yes	Mean	NR[b]	78.0	324.2	683.5	51.1
		s.e.		0	(48.0)	(506.8)	(7.1)
		n		1	3	5	8
	No	Mean		246.6	217.4	30.9	31.3
		s.e.		(46.0)	(88.8)	(11.6)	(6.0)
		n		68	68	44	43
Chlorpyrifos	Yes	Mean	438.1	212.4	118.0	35.6	7.8
		s.e.	(60.3)	(55.6)	(22.1)	(25.4)	(6.5)
		n	20	18	22	6	7
	No	Mean	338.3	210.5	121.3	9.1	4.4
		s.e	(88.2)	(55.3)	(26.3)	5.8	(0.7)
		n	42	51	49	43	44
Diazinon	Yes	Mean	1034.3	76.0	175.9	90.4	0
		s.e.	(594.6)	(36.5)	(102.1)	47.6	-
		n	8	10	18	13	8
	No	Mean	370.5	115.7	61.5	40.9	2.9
		s.e.	(97.2)	(26.6)	14.4)	38.4	(1.9)
		n	54	59	53	36	43
Dichlorvos	Yes	Mean	200.8	191.3	46.4	0	0.9
		s.e.	(85.4)	(112.9)	(18.1)	(4.9)	(2.0)
		n	20	25	32	14	16
	No	Mean	80.9	52.2	8.3	4.7	1.7
		s.e.	(58.6)	(42.3)	(8.6)	(4.9)	(2.0)
		n	29	44	39	35	35
Folpet	Yes	Mean	0	0	0	0	ND
		s.e.	-	-	-	-	
		n	4	1	7	7	
	No	Mean	0.5	0.7	0.6	0.8	
		s.e.	(0.5)	(0.4)	(0.5)	(0.7)	
		n	45	68	64	42	

(continued)

Only chlorpyrifos was routinely at higher concentrations in treated homes than in untreated homes. Chlordane, diazinon, gamma-BHC, and carbaryl (when detected) were higher in treated units in Jacksonville, but the pattern did not hold up in Springfield/Chicopee. In contrast, bendiocarb and propoxur exhibited the expected pattern (i.e., treated higher than untreated) in Springfield/Chicopee, but not in Jacksonville. Dichlorvos and malathion displayed no evidence of a consistent pattern of variation.

Use of Pesticides on Pets. The household pesticide inventory data and the dermal exposure component of NOPES made it clear that some of the pesticides more commonly used by respondents were pet pesticides. The screening questionnaire responses were used to categorize households according to whether or not they reported any use of pet pesticides. Mean indoor air concentrations were calculated for seven analytes that are used in pet products (Table 30).

Table 27. Continued

Analyte	Present in Inventory		Jacksonville Summer	Jacksonville Spring	Jacksonville Winter	Springfield/Chicopee Spring	Springfield/Chicopee Winter
			Mean concentration (ng/m3)				
Malathion	Yes	Mean	2.6	13.9	66.9	24.0	ND
		s.e.	(2.2)	(8.6)	(57.3)	(11.7)	
		n	7	8	12	12	
	No	Mean	23.7	15.8	15.3	0	
		s.e.	(16.5)	(10.8)	(13.0)	-	
		n	42	61	59	37	
ortho-Phenyl-phenol	Yes	Mean	84.8	178,7	135.3	67.6	50.1
		s.e.	(29.7)	(47.4)	(50.8)	(24.0)	(15.2)
		n	9	17	24	18	12
	No	Mean	99.3	43.1	24.4	32.7	16.3
		s.e.	(24.2)	(9.9)	(7.8)	(7.1)	(8.1)
		n	40	52	47	31	39
Propoxur	Yes	Mean	854.8	191.3	135.4	25.5	17.1
		s.e.	(434.0)	(99.6)	(45.8)	(5.8)	(8.3)
		n	22	26	32	20	21
	No	Mean	215.0	229.7	182.4	27.1	17.0
		s.e.	(26.9)	(138.9)	(83.8)	(17.7)	(8.7)
		n	27	43	39	29	30

[a]ND = Not detected in indoor air, or estimated to be detectable in less than 1% of the population.
[b]NR = Not reported in any household pesticide inventories.

Classifying households according to reported pet pesticide use did not result in consistent patterns of variation in mean air concentrations for any of the analytes. One possible explanation for this result is that the analytes also had non-pet uses that overshadowed the effect of the pet applications. An alternative or contributing explanation could be that many of the pet pesticide products did not contain any of the NOPES target compounds. This possibility is borne out by the household inventory data. If the NOPES analytes were not very common in the pet pesticide products, the predictive power of the general screening questions on pet pesticide use has to be limited.

Summary. In summary, the exploratory analyses indicated the following:

- Termiticide air concentrations were related to reported termiticide treatment history, type of housing unit, and age of housing unit.
- Indoor air concentrations of older pesticides that are now banned or much less frequently used were related to the age of the housing unit.
- For some pesticides, presence of the pesticide in the household pesticide inventory was associated with higher indoor air concentrations.
- Very general information on indoor insecticide use was related to indoor air concentrations for a few pesticides.

Future Analyses. The exploratory analyses performed to date indicate that further investigation of the relationships between air concentrations and questionnaire data is warranted. The next generation of analyses should include:

- Review of reported pesticide use during or immediately preceding the monitoring period to assess the impact on air concentrations.
- Further analysis of termiticide and household insecticide concentrations using the detailed questionnaire information on frequency of application and type of applicator (e.g., professional service or householder).
- Assessment of the degree to which the assumptions underlying standard statistical

Table 28. Indoor Air Termiticide Concentrations vs. Reported Termiticide Use

Analyte	Termiticide Use		Mean concentration (ng/m3) Jacksonville Summer	Jacksonville Spring	Jacksonville Winter	Springfield/Chicopee Spring	Springfield/Chicopee Winter
Aldrin	Yes	Mean	81.5	11.7	8.9	0	0.1
		s.e.	(42.5)	(4.3)	(1.8)	-	0.0
	No[a]	Mean	0.6	0.5	5.8	0	0.4
		s.e.	(0.4)	(0.4)	(0.7)	-	(0.3)
Chlordane	Yes	Mean	473.1	309.7	248.8	470.5	54.6
		s.e.	(87.6)	(22.4)	(52.3)	(329.9)	(7.1)
	No[a]	Mean	232.6	162.3	204.5	20.2	26.0
		s.e.	(114.2)	(118.0)	(112.3)	(10.5)	(5.9)
Chlorpyrifos	Yes	Mean	343.1	190.9	117.0	19.2	4.0
		s.e.	(63.8)	(38.1)	(29.8)	(11.7)	(1.9)
	No[a]	Mean	381.0	224.1	122.2	3.6	5.5
		s.e.	(70.8)	53.7	(22.4)	(3.2)	(2.3)
Dieldrin	Yes	Mean	22.5	8.0	10.0	0	1.8
		s.e.	(4.0)	(2.0)	(2.2)	-	(0.7)
	No[a]	Mean	9.9	8.6	5.6	1.7	5.2
		s.e.	(2.3)	(4.2)	(1.8)	(1.8)	(4.1)
Heptachlor	Yes	Mean	216.3	184.8	83.8	75.1	8.0
		s.e.	(48.2)	(75.3)	(23.4)	(44.2)	(1.9)
	No[a]	Mean	130.9	113.9	65.8	2.3	1.7
		s.e.	(73.9)	(82.4)	(37.6)	(0.8)	(0.6)
Heptachlor epoxide	Yes	Mean	0.6	1.5	0.4	0	0
		s.e.	(0.4)	(1.1)	(0.3)	-	-
	No[a]	Mean	0.5	0	1.0	0	0
		s.e.	(0.3)	-	(0.5)	-	-
Sample sizes	Yes		31	50	31	33	21
	No[a]		31	22	40	16	30

[a]Includes households that did not provide information on termiticide use.

inference procedures are met by untransformed and transformed concentration data.

- Multivariate analyses to evaluate the explanatory power of more than one variable at a time, and to look for confounding effects or collinearities.

After these analyses are completed, quantitative regression models may be developed from the NOPES data for some analytes. The outlook is especially promising for the termiticides and some of the discontinued compounds, and it is hopeful for most of the other commonly detected analytes.

Potential Health Effects

The NOPES health effects evaluation concentrates on the air exposure route because air was the major focus of the NOPES sampling effort. The limited NOPES water sampling indicated that exposure from water ingestion in the two study areas appeared to be low for the pesticides studied. The dermal exposure data collected in NOPES were insufficient to support any comprehensive conclusions. The air data from the personal air samplers were used to estimate exposure, since these were considered most representative (if the air data from the general indoor air measurements had been used, very similar results would have been obtained).

It is not surprising that so many pesticides were detected in the indoor residential environment especially considering that the study was targeted toward commonly used household pesticides and employed sensitive analytical techniques (as low as 10^{-10} gm/m^3). The presence of these compounds is not necessarily synonymous with the advent of health effects. The following evaluation will describe the health risk implications of the NOPES air monitoring data.

Estimation Procedures

The health risk estimates were derived using average personal air concentrations. The seasonal daily mean air concentrations in Tables 12 and 13 were averaged using a seasonal weighting that provides an approximation of the annual average of daily mean

Table 29. Indoor Air Concentrations vs. Indoor Household Insecticide Use

Analyte	Household Insecticides Used		Mean concentration (ng/m³) Jacksonville Summer	Jacksonville Spring	Jacksonville Winter	Springfield/Chicopee Spring	Springfield/Chicopee Winter
Bendiocarb	Yes	Mean	72.8	5.4	3.2	0.6	2.0
		s.e.	(52.0)	(2.4)	(1.0)	(0.5)	(2.2)
	No	Mean	0	5.9	4.3	0	0
		s.e.	-	(6.1)	(3.0)	-	-
Carbaryl	Yes	Mean	58.1	0.6	0	0	0
		s.e.	(54.6)	(0.4)	-	-	-
	No	Mean	0	0	0	0.4	0
		s.e.	-	-	-	(0.4)	-
Chlordane	Yes	Mean	340.6	269.0	243.5	40.5	33.2
		s.e.	(93.9)	(64.1)	(99.3)	(13.5)	(12.4)
	No	Mean	21.4	162.7	33.3	271.3	33.8
		s.e.	(16.5)	(64.5)	(9.3)	(250.2)	(6.8)
Chlorpyrifos	Yes	Mean	382.1	208.4	125.3	25.8	15.5
		s.e.	(66.4)	(43.8)	(16.7)	(11.0)	(6.8)
	No	Mean	85.0	194.8	80.1	2.5	2.1
		s.e.	(54.7)	(97.3)	(40.3)	(2.3)	(0.8)
Diazinon	Yes	Mean	441.4	133.1	94.7	154.5	2.2
		s.e.	(131.3)	(21.4)	(19.0)	(108.0)	(0.9)
	No	Mean	42.7	24.6	13.8	0.4	2.6
		s.e.	(10.5)	(10.7)	(3.9)	(0.4)	(2.0)
Dichlorvos	Yes	Mean	111.8	110.6	27.6	13.9	1.1
		s.e.	(55.2)	(68.2)	(8.7)	(14.6)	(1.0)
	No	Mean	455.3	0	0	0	1.6
		s.e.	(350.7)	-	-	-	(2.0)
gamma-BHC	Yes	Mean	21.3	15.8	6.6	0	0.2
		s.e.	(9.7)	(7.3)	(2.4)	-	(0.1)
	No	Mean	0	4.8	1.0	0.7	12.2
		s.e.	-	(2.0)	(0.7)	(0.7)	(15.1)
Malathion	Yes	Mean	18.3	5.6	22.9	15.9	0
		s.e.	(12.7)	(1.7)	(14.7)	(16.6)	-
	No	Mean	0	47.8	0	0	0
		s.e.	-	(29.9)	-	-	-
Propoxur	Yes	Mean	309.3	189.0	157.9	39.1	21.6
		s.e.	(35.9)	(46.9)	(62.4)	(7.9)	(11.0)
	No	Mean	3616.7	339.8	200.0	21.1	15.7
		s.e.	(2770.7)	(303.3)	(118.6)	(17.8)	(6.7)
Sample sizes	Yes		60[a]	64	66	38	33
	No		2[a]	8	5	11	18

[a]The sample sizes for bendiocarb, carbaryl, dichlorvos, malathion, and propoxur were 47 "Yes" and 2 "No."

concentrations. The annual average daily air concentration (Ca) was estimated for Jacksonville as

$$Ca = (Summer + 2 * Spring + Winter) / 4$$

and for Springfield/Chicopee as

$$Ca = (3 * Spring + Winter) / 4.$$

The annual average may be underestimated for Springfield/Chicopee because this site was not monitored in the summer season, which generally had the highest concentrations in Jacksonville.

Where pesticides were never found above the detection limit, an upper bound risk was calculated using the maximum detection limit encountered in this study. In none of these cases did the cancer risks exceed 3 x 10^{-6} or the hazard index exceed 1 x 10^{-1}. This demonstrates that even if these pesticides were present at just below the detection limit, they would

Table 30. **Indoor Air Concentrations vs. Pesticide Use on Pets**

Analyte	Pesticides Used on Pets		Mean concentration (ng/m^3) Jacksonville Summer	Jacksonville Spring	Jacksonville Winter	Springfield/Chicopee Spring	Springfield/Chicopee Winter
Carbaryl	Yes	Mean	6.0	1.0	0	0.9	0
		s.e.	(5.6)	(0.7)	-	(1.0)	-
	No	Mean	83.8	0	0	0	0
		s.e.	(85.9)	-	-	-	-
Chlorpyrifos	Yes	Mean	421.6	283.1	128.1	8.0	5.1
		s.e.	(78.3)	(39.1)	(29.1)	(3.2)	(3.3)
	No	Mean	335.8	146.2	115.3	10.6	5.1
		s.e.	(89.6)	(49.2)	(23.7)	(8.1)	(1.6)
Diazinon	Yes	Mean	663.2	92.0	80.1	42.8	0.4
		s.e.	(290.2)	(28.0)	(27.1)	(33.6)	(0.2)
	No	Mean	284.7	122.2	89.4	51.0	4.5
		s.e.	(32.6)	(31.9)	(34.1)	(47.2)	(4.1)
Dichlorvos	Yes	Mean	125.3	86.9	49.8	13.8	2.9
		s.e.	(70.6)	(62.3)	(25.4)	(15.1)	(2.3)
	No	Mean	140.1	85.7	8.2	0	0.0
		s.e.	(78.9)	(69.3)	(5.4)	-	(0.0)
Malathion	Yes	Mean	45.8	4.0	18.5	0	0
		s.e.	(30.8)	(2.0)	(16.5)	-	-
	No	Mean	2.1	23.3	21.7	7.2	0
		s.e.	(0.7)	(16.6)	(19.2)	(7.2)	-
Methoxychlor	Yes	Mean	0.4	0.7	0.1	0	0
		s.e.	(0.2)	(0.6)	(0.1)	-	-
	No	Mean	0.1	0	0.2	0	0
		s.e.	(0.1)	-	(0.2)	-	-
Propoxur	Yes	Mean	267.3	168.5	136.3	29.6	14.2
		s.e.	(45.8)	(72.5)	(44.0)	(8.2)	(4.7)
	No	Mean	686.0	263.2	179.4	25.4	19.8
		s.e.	(345.7)	(115.5)	(93.7)	(18.9)	(7.0)
Sample sizes	Yes		33[a]	51	40	32	36
	No		29[a]	21	31	17	15

[a]The sample sizes for propoxur, dichlorvos, and malathion were 27 "yes" and 22 "No."

have associated risks in a range that the Agency generally considers negligible.

The administered dose, as calculated using the "lifetime average daily exposure" or LADE (mg/kg-day) from inhalation was estimated as:

$$LADE = Ca * IR / BW$$

where

Ca = air concentration (ng/m^3) * (1×10^{-6} mg/ng),

IR = inhalation rate (20 m^3/day), and

BW = body weight (70 kg).

The individual excess lifetime cancer risk or ELCR was calculated as:

$$ELCR = LADE * q1^*$$

where q1* is the potency-slope factor $(mg/kg\text{-}day)^{-1}$ for the analyte. The noncancer risk was calculated as a hazard index defined as the ratio of the LADE divided by the Reference Dose or RfD (mg/kg-day).

Discussion of Results

Tables 31a, 31b, 32a and 32b summarize the risk estimates due to inhalation of pesticide vapors in nonoccupational settings in Jacksonville and Springfield/Chicopee. Table 31a presents the risks for pesticides other than the cyclodiene termiticides in Jacksonville and Table 31b presents the risks for the cyclodiene termiticides (chlordane, heptachlor, aldrin, and dieldrin) in Jacksonville. Similarly, Table 32a presents the risks for the pesticides other than the cyclodiene termiticides in Springfield/Chicopee and Table 32b presents the risks for the cyclodiene termiticides in Springfield/Chicopee. The cyclodiene termiticides were separated from the other pesticides due to the fact that their registrations have been cancelled, suspended or withdrawn (Velsicol voluntarily withdrew chlordane and heptachlor in an August 1987 agreement with the Agency).

These estimates were derived assuming an inhalation rate of 20 m^3/day and 70 years exposure at the average concentrations. They should be interpreted as general indications of risk levels, not precise values because of major sources of uncertainties. To better understand these risk estimates, one should consider the key assumptions and associated uncertainties.

Where available, the risk estimates were based on the cancer potencies and reference doses presented in the Integrated Risk Information System (IRIS). All values in IRIS have been rigorously reviewed and officially accepted by the Agency. Unfortunately 13 of the 32 pesticides studied are not currently included in IRIS. For 12 of these 13 pesticides, the cancer potencies and reference doses were based on assessments from EPA's Office of Pesticide Programs (OPP). The OPP values were derived from their review of the open literature and proprietary data from pesticide manufacturers. No risk estimate could be made for oxychlordane because toxicity values were not available from IRIS or OPP.

The cancer risk estimates indicate that the four pesticides which present the highest risks in both areas were the cyclodiene termiticides (chlordane, heptachlor, aldrin, and dieldrin), which have either been cancelled, suspended or voluntarily withdrawn. None of the other pesticides were estimated to present cancer risks exceeding 2 x 10^{-6} in either area. The Agency generally considers risks less than about 10^{-6} as negligible.

The estimated hazard indices for noncancer risks were less than one for all pesticides in both areas. However, several approached one including chlordane, aldrin and diazinon. The RfD is a peer-reviewed estimate of the time-weighted average daily lifetime exposure that is likely to occur without appreciable risk of deleterious effects. The Agency generally considers hazard indices less than one as low.

Discussion of Uncertainty

The key assumption in this assessment is that the concentration averages represent the true average of levels to which a person is exposed over a 70 year lifetime. The seasonal weighting scheme results in an annual average that at least partially accounts for seasonal changes in pesticide use. However, averages of 24-hour samples collected during two or three seasons in one year is an uncertain basis for deriving an average representative of a 70 year period. Such short term surveys cannot account for all changes that occur over time. For example, the introduction of new pesticides or registration changes could affect current residential practices and resulting exposure levels. The highest risks were associated with four cyclodiene termiticides (chlordane, heptachlor, aldrin and dieldrin) that have been cancelled, suspended or withdrawn. Although these chemicals are highly persistent, slow degradation or dilution (due to physical processes such as leaching or diffusion) will occur over 70 years resulting in some reduction in exposures. No reliable data could be found on the degradation rates that may occur for these termiticides when applied in and around foundations. The possible reductions in risks corresponding to a range of half-life assumptions are shown below (assuming degradation does occur and proceeds according to first order kinetics):

Half-Life (years)	Factor by Which 70 Year Risk is Reduced
2	25
4	12
10	4.8
20	2.7
30	2.0
50	1.6

Moves to other homes (within the target areas) or differences in personal pesticide use habits introduce variability. This variability was accounted for by sampling a large number of homes in each city -- 173 in Jacksonville and 86 in Springfield/Chicopee.

Because the NOPES surveys were limited to Jacksonville, Florida and Springfield/Chicopee, Massachusetts, the results cannot be directly extrapolated to other areas. Pesticide use and home ventilation systems vary across the country and are likely to lead to different exposure levels. Considering the widespread use of pesticides and the frequency with which they were detected, it does suggest some exposure will occur in other areas.

Inhalation rates vary with body size and activity level. The assumed 20 m^3/day is a widely accepted average for the adult population and is probably not an important source of uncertainty.

Table 31a. Weighted Estimate of Annual Average Daily Concentrations, Cancer Risk and Hazard Index for Jacksonville Air (Pesticides other than Cyclodiene Termiticides)

Analyte	Annual Avg. Daily Concen. (ng/cu.m.)	Slope Factor (kg-day/mg)	Excess Lifetime Cancer Risk	Reference Dose (mg/kg-day)	Hazard Index
Dichlorvos	62.4			0.0008[c]	2E-02
alpha-BHC	0.8	6.3[a]	2E-06		
Hexachlorobenzene	0.5			0.0008[c]	2E-04
gamma-BHC	11.2			0.0003[a]	1E-02
Chlorothalonil	0.8	0.011[b]	3E-09	0.015[c]	2E-05
Ronnel[f]	<2.5			0.015[c]	<5E-05[f]
Chloropyrifos	191.1			0.003[a]	2E-02
Dacthal	0.2			0.5[a]	1E-07
Captan	0.1	0.0023[b]	7E-11	0.13[c]	2E-07
Folpet	0.5	0.0035[a]	5E-10	0.1[c]	1E-06
2,4-D ester[d]	1.1	0.019[b]	6E-09	0.01[a]	2E-06
Methoxychlor	0.3			0.05[c]	2E-06
Dicofol[f]	<33	0.34[b]	<3E-06[f]	0.001[c]	<1E-02[f]
cis-Permethrin	0.9	0.022[b]	6E-09	0.005[a]	5E-05
trans-Permethrin	0.3	0.022[b]	2E-09	0.05[c]	2E-06
4,4'-DDT[e]	0.5	0.34[a]	5E-08	0.0005[a]	3E-04
4,4'-DDD[f]	<3.1	0.34[b]	<3E-07[f]		
4,4'-DDE[e]	0.6	0.34[b]	6E-08		
ortho-Phenylphenol	57.7	0.0016[b]	3E-08		
Propoxur	185.2	0.0079[b]	4E-07	0.004[a]	1E-02
Bendiocarb	15.9			0.005[c]	9E-04
Atrazine	0.1	0.22[b]	6E-09	0.005[a]	6E-06
Diazinon	159			0.00009[c]	5E-01
Carbaryl	7.5			0.1[a]	2E-05
Malathion	11.6			0.02[a]	2E-04
Resmethrin	0.1			0.03[a]	1E-06

[a]Source: Integrated Risk Information System (IRIS)
[b]Source: Memorandum from Reto Engler to Health Effects Division Branch Chiefs and Selected OPP Division Directors, US EPA, October 27, 1989.
[c]Source: Reference Dose Tracking Report, Health Effects Division, Office of Pesticides, US EPA, October 12, 1989.
[d]Methyl ester in summer, butoxyethyl ester in spring and winter.
[e]Concentration calculated as (3 * spring + winter)/4 because this analyte was not measured in the summer season.
[f]Not found above detection limit. Concentration listed is the maximum detection limit encountered in this study. The corresponding risk estimate represents an upper limit.

The chemical toxicity assumptions also play a major role in risk estimation. These assumptions are chemical-specific and normally derived from animal studies which are outside the purview of this study. However, they also introduce substantial uncertainty and must be considered in interpreting the risks. The major sources of uncertainty concern the validity of extrapolating animal data to humans and extrapolating high dose animal experiments to low dose relationships.

The dose response relationships for cancer risks are expressed as slope factor values which are estimated as 95th percentile confidence limits using the linearized multistage model. As such, they are conservative estimates of the chemical's hazard or potential to cause cancer. Risks estimated by combining these slope factors with exposure estimates are commonly referred to as upper bound risks. It should be recognized, however, that the exposure estimates used in this assessment are believed to represent average conditions. Accordingly the risk estimates resulting from a combination of an upper bound slope factor and average exposure estimates cannot be characterized as an upper bound risk nor an average. Some individuals may be exposed to concentrations that are higher than the mean throughout their lifetime and have greater risk than those presented in Tables 31 and 32.

Table 31b. Weighted Estimate of Annual Average Daily Concentrations, Cancer Risk and Hazard Index for Jacksonville Air (Cyclodiene Termiticides)

Analyte	Annual Avg. Daily Concen. (ng/cu.m.)	Slope Factor (kg-day/mg)	Excess Lifetime Cancer Risk	Excess Lifetime Cancer Risk	Reference Dose (mg/kg-day)	Hazard Index	Hazard Index
Heptachlor	115.2	4.5[a]	2E-04[c]	6E-06[d]	0.0005[b]	7E-02[c]	3E-03[d]
Aldrin	26	17[a]	1E-04[c]	5E-06[d]	0.00003[b]	3E-01[c]	1E-02[d]
Dieldrin	6.4	16[a]	3E-05[c]	1E-06[d]	0.00005[b]	4E-02[c]	1E-03[d]
Chlordane	197.1	1.3[a]	7E-05[c]	3E-06[d]	0.00006[a]	1E+00[c]	4E-02[d]
Heptachlor Epoxide[e]	0.4	9.1[a]	1E-06[c]	4E-08[d]	0.00001[b]	1E-02[c]	5E-04[d]
Oxychlordane[e,f]	<2						

[a]Source: Integrated Risk Information System (IRIS)
[b]Source: Reference Dose Tracking Report, Health Effects Division, Office of Pesticides, US EPA, October 12, 1989.
[c]The risk estimates presented in this table assume that the concentrations remain constant over 70 years. Since all have been cancelled or withdrawn, some reduction in risk will occur due to degradation. Although these degradation rates are not known, possible reductions based on halflife assumptions are presented in the text.
[d] These risk estimates were computed assuming that the pesticide degrades with a 2 year half life. As explained in the text, no reliable degradation data are available and these estimates are included as an example of the possible reductions in risk due to degradation.
[e]These pesticides are included in this table because they are breakdown products of the cyclodiene termiticides.
[f] Not found above detection limit. Concentration listed is the maximum detection limit encountered in this study.

Another source of uncertainty concerns the application of toxicity values derived from animal experiments using oral administration and applying them to human inhalation scenarios. For the carcinogens, this uncertainty has been reduced by using cancer slope factors that have been either adjusted for application to inhalation exposures or deemed applicable without adjustment. The reference doses used for the noncarcinogens are all based on ingestion and were simply assumed to apply equally to inhalation. This assumption can be a significant source of uncertainty for these compounds, due to differences in the absorption between the routes and possibility of direct effects at the point of entry.

The risk estimates account for the air pathway only. Additional exposure will occur as a result of ingestion and dermal contact. Contamination of food and water results from residues from agricultural practices or contact with pesticides used in the home. Hand to mouth activity can also cause ingestion exposure at homes, especially among young children. These contributions could not be quantified.

Finally, although the risks were presented as average values, it should be understood that they will vary significantly across the population. The measured concentrations varied substantially; lifestyle, personal pesticide use, etc. will all contribute to the variability. Much more data are needed to estimate exposure levels other than the mean, especially data near the tails of the distribution.

Summary

In summary, this assessment provides a reasonable indication of the possible risks due to inhalation of pesticide vapors in nonoccupational settings, but has some important limitations and uncertainties. The most important limitations are the consideration of only the air pathway and evaluation of the risks only under average exposure conditions. The major sources of uncertainty are the assumption that the estimated air concentrations represent true averages for lifetime exposures and the validity of the toxicity standards. Bearing these points in mind, the assessment showed that the noncancer risks were generally low, and the cancer risks were in a range the Agency generally considers negligible with the possible exception of heptachlor and aldrin in Jacksonville. The estimated risks for these two compounds were on the order of 10^{-6} to 10^{-4}, depending on degradation. As noted above, the registration of both of these compounds has been cancelled, suspended, or withdrawn; and, although they are very persistent, some degradation will occur over time.

An earlier assessment of the risks posed by the cyclodiene termiticides concluded that each individual's chances of developing symptoms are low and because of the large numbers of people exposed to the cyclodienes the aggregate risk is a real one for the U. S. population as a whole (US EPA, 1988, Termiticides - Consumer Information, OPA-87-014). This document also describes techniques

Table 32a. Weighted Estimate of Annual Average Daily Concentrations, Cancer Risk and Hazard Index for Springfield/Chicopee Air (Pesticides other than Cyclodiene Termiticides)

Analyte	Annual Avg. Daily Concen. (ng/cu.m.)	Slope Factor (kg-day/mg)	Excess Lifetime Cancer Risk	Reference Dose (mg/kg-day)	Hazard Index
Dichlorvos	3.3			0.0008[c]	1E-03
alpha-BHC	0.2	6.3[a]	4E-07		
Hexachlorobenzene[f]	<2.2			0.0008[c]	<8E-04[f]
gamma-BHC	1.9			0.0003[a]	2E-03
Chlorothalonil	0.6	0.011[b]	2E-09	0.015[c]	<1E-05
Ronnel	0.1			0.015[c]	2E-06
Chloropyrifos	7.1			0.003[a]	7E-04
Dacthal	2			0.5[a]	1E-06
Captan	0.1	0.0023[b]	7E-11	0.13[c]	2E-07
Folpet	0.5	0.0035[a]	5E-10	0.1[c]	1E-06
2,4-D ester[d,f]	<30	0.019[b]	<2E-07[f]	0.01[a]	<9E-04[f]
Methoxychlor[f]	<7.8			0.05[c]	<5E-05[f]
Dicofol	5.3	0.34[b]		0.001[c]	2E-03
cis-Permethrin[f]	<53	0.022[b]	<3E-07[f]	0.005[a]	<3E-03[f]
trans-Permethrin[f]	<38	0.022[b]	<2E-07[f]	0.05[c]	<2E-04[f]
4,4'-DDT[e]	0.9	0.34[a]	9E-08	0.0005[a]	5E-04
4,4'-DDD[f]	<5.3	0.34[b]	<5E-07[f]		
4,4'-DDE[e]	3.8	0.34[b]	4E-07		
ortho-Phenylphenol	39.4	0.0016[b]	2E-08		
Propoxur	15	0.0079[b]	3E-08	0.004[a]	1E-03
Bendiocarb	0.3			0.005[c]	2E-05
Atrazine[f]	<45	0.22[b]	<3E-06[f]	0.005[a]	<3E-03[f]
Diazinon	7.9			0.00009[c]	3E-02
Carbaryl	0.1			0.1[a]	3E-07
Malathion	0.4			0.02[a]	6E-06
Resmethrin[f]	<25			0.03[a]	<2E-04[f]

[a]Source: Integrated Risk Information System (IRIS)
[b]Source: Memorandum from Reto Engler to Health Effects Division Branch Chiefs and Selected OPP Division Directors, US EPA, October 27, 1989.
[c]Source: Reference Dose Tracking Report, Health Effects Division, Office of Pesticides, US EPA, October 12, 1989
[d]Methyl ester in summer, butoxyethyl ester in spring and winter.
[e]Concentration calculated as (3 * spring + winter)/4 because this analyte was not measured in the summer season.
[f]Not found above detection limit. The concentration shown is the highest detection limit encountered in this study and corresponding risk is an upper bound.

homeowners can use to improve indoor air quality such as increasing the air exchange rate, sealing treated areas and installing outside air supplies to appliances.

Follow-up studies are recommended to determine a more comprehensive analysis of the risks. Research is planned to develop guidance for conducting exposure monitoring studies and associated methodology for assessing human non-dietary exposure to pesticides in a residential setting.

Reports to Participants

An individualized report of the NOPES findings will be provided to each respondent who completed the monitoring phase of the study. The intent of the report is to inform participants of their measured analyte concentrations and to discuss the significance of themeasurements. In addition to presenting the concentrations for the particular respondent and housing unit, each report will present summary statistics for each study area, so that the respondent can assess his or her concentrations relative to those

Table 32b. Weighted Estimate of Annual Average Daily Concentrations, Cancer Risk and Hazard Index for Springfield/Chicopee Air (Cyclodiene Termiticides)

Analyte	Annual Avg. Daily Concen. (ng/cu.m.)	Slope Factor (kg-day/mg)	Excess Lifetime Cancer Risk	Excess Lifetime Cancer Risk	Reference Dose (mg/kg-day)	Hazard Index	Hazard Index
Heptachlor	27.2	4.5[a]	4E-05[c]	1E-06[d]	0.0005[b]	2E-02[c]	6E-04[d]
Aldrin	0.1	17[a]	5E-07[c]	2E-08[d]	0.00003[b]	1E-03[c]	4E-05[d]
Dieldrin	0.8	16[a]	4E-06[c]	1E-07[d]	0.00005[b]	5E-03[c]	2E-04[d]
Chlordane	198.7	1.3[a]	7E-05[c]	3E-06[d]	0.00006[a]	1E+00[c]	4E-02[d]
Heptachlor Epoxide[e,f]	<3.3	9.1[a]	<1E-06[c]	<4E-08[d]	0.00001[b]	<1E-02[c]	<5E-04[d]
Oxychlordane[e,f]	<3.3						

[a]Source: Integrated Risk Information System (IRIS)
[b]Source: Reference Dose Tracking Report, Health Effects Division, Office of Pesticides, US EPA, October 12, 1989.
[c]The risk estimates presented in this table assume that the concentrations remain constant over 70 years. Since all have been cancelled, suspended or withdrawn, some reduction in risk will occur due to degradation. Although these degradation rates are not known, possible reductions based on halflife assumptions are presented in the text.
[d]These risk estimates were computed assuming that the pesticide degrades with a 2 year half life. As explained in the text, no reliable degradation data are available and these estimates are included as an example of the possible reductions in risk due to degradation.
[e]These pesticides are included in this table because they are breakdown products of the cyclodiene termiticides.
[f]Not found above detection limit. Concentration listed is the maximum detection limit encountered in this study.

of the study area population. The reports will then discuss the potential health implications of the findings, and describe how participants can reduce their exposure through proper use, storage, and disposal of the target pesticides.

Development of the specific format and content of the reports will follow standard EPA review procedures. The participant reports will be prepared and distributed soon after the release of this report.

Consumer Awareness

Although NOPES was not designed to provide an in-depth look at consumer awareness about pesticides and their safe use, the study yielded some anecdotal information on the subject. Respondents' comments, interviewers' observations, and questionnaire data provide insight on how pesticides are used in nonoccupational settings, and they indicate areas in which exposure could be reduced by alternative practices.

In general, respondents seemed to be using appropriate pesticides given their pest problems, although a few instances of questionable use were observed. Label directions on mixing and applying the pesticide were usually not read just before the application, but were generally followed.

Of more concern from an exposure standpoint was the lack of precautions taken by some respondents to limit their exposure during or after pesticide applications. Few respondents wore gloves, other than those provided for the dermal sampling. Many did not wash their hands or change clothes after an application. Previous work (Lewis, 1988) suggests that acute dermal exposure could be reduced through the use of these precautions.

Air and chronic dermal exposure might be reduced by decreasing the amount of pesticides stored in and around the home. The pesticide inventory data indicate that some respondents kept large inventories of pesticides, some of which were rarely used. DDT was found in a few homes, despite having been banned for use by the general public for years. A few respondents asked about how they could safely dispose of unused pesticides, and indicated that they had previously been unsuccessful at identifying safe disposal methods. Making safe disposal methods widely available and encouraging the sale of pesticides in small amounts for home use could lead to a desirable decrease in household pesticide inventories.

Data Quality

Throughout NOPES, quality assurance and quality control activities were an integral part of data collection and laboratory procedures. These activities provided an ongoing review of field and laboratory practices, and they permit assessment of the quality of the NOPES data.

System and Performance Audits

System audits designed to review the overall measurement process and evaluate its ability to yield accurate data were performed several times over the course of the study. EPA and EMSI conducted external system audits, and SwRI performed internal audits in Phases II and III. The early audits identified several areas in both the field procedures and laboratory protocols where corrective actions were needed. For example, a recommendation was made in the audit following Phase I to label each PUF cartridge, in addition to its container, with a unique identifier so as to improve sample tracking and reduce the risk of sample misidentification. Such actions were taken prior to the subsequent rounds of sample collection and analysis. Few problems were noted in the later audits.

Field performance audits were conducted in each study area each season to check the flow rates of theair sampling pumps. In the majority of cases, the difference between the audit standard and the pump flow rate was less than 5%. Those few pumps with flow rates that differed by more than 10% from the audit standard were all checked and either recalibrated or taken out of service.

Analytical Data Quality

A number of steps were taken to assess and quantify analytical precision and accuracy. Laboratory and field blanks were analyzed to check for contamination. An octachloronaphthalene (OCN) spike was added to each sample to evaluate the recovery efficiency of the analytical system. Matrix spikes were run with each extraction batch of samples to assess the accuracy of the laboratory measurement process. Duplicate samples were collected and analyzed so that the precision of the measurement process could be quantified. To assess the laboratory component of measurement error, some samples and standards were analyzed by laboratories other than SwRI. The findings of each of these activities are summarized below.

Blanks. Laboratory solvent blanks and laboratory water blanks were analyzed in each extraction batch. Only two instances of contamination were found, and both involved very low levels of single analytes.

Air, water, and glove field blanks were also collected and analyzed each season. The PUF cartridge used as an air field blank was taken to the home at the end of the sampling period, opened, and assembled as if for use. No contamination was found in 28 of the 31 air field blanks. The sources of the low level of a single contaminant in the other three blanks were apparent. The propoxur and ortho-phenylphenol found in two blanks represented about five percent of the amount sampled in the indoor air. An air field blank contained a low level of methoxychlor because its storage jar broke during shipment, and the shipment included a methoxychlor-laden glove sample. All five water field blanks were clean. All the glove field blanks, which were opened in the vicinity of the pesticide application, contained low levels of one or two contaminants. Because the field blanks were contaminated only infrequently and at low levels that were often attributable to a known causative factor, no adjustment of the data for contamination or background levels was performed.

OCN Recovery Efficiency. The OCN mean recoveries for the matrix spike samples ranged from 86% for Springfield/Chicopee in Phase II to 97% for Jacksonville in Phase I, with coefficients of variation (CVs) of 11% to 18%. Recoveries from gloves tended to be lower than air and water sample recoveries. Overall, 94% of Jacksonville samples (777/829) and 93% of Springfield/Chicopee samples (413/444) had OCN recoveries within the 75% to 125% advisory limits specified in the NOPES Quality Assurance Project Plan.

Matrix Spike Recovery. The mean, range, and standard deviation of recoveries over extraction batches for the matrix spikes are summarized in Table 33. Coefficients of variation for the spike recoveries ranged from 15% to 35% in the summer, 6% to 39% in the spring, and 9% to 27% in the winter. Because of coelution problems, the gamma-BHC and chlorothalonil components of the spike mixture were replaced with alpha-BHC and hexachlorobenzene during the summer season analysis.

The matrix spike data indicate that the mean recoveries were good for most analytes, but the range was larger than desirable. Propoxur was the only analyte with consistently low recoveries. Analyte concentrations were not adjusted for recovery efficiency because of the variations in matrix spike recoveries were so dramatic.

Elevated and variable recoveries for heptachlor prompted a change to using the DB-5 column for quantification of this analyte in Phase III. Low matrix spike recoveries for two summer season extraction batches alerted SwRI to the problem caused by switching to Boileezer[R] boiling chips, which resulted in rectification of the problem before subsequent batches were extracted. The inaccurate data resulting from this problem were excluded from all statistical analyses presented in this report.

Duplicates. Table 34 summarizes the percent relative differences (defined in Table 34) observed for the duplicate samples. This is an effective method of expressing the pairwise deviation between duplicate measurements when collectively summarizing many different constituents where the deviations are a function of level. However, caution must be used when dealing with individual compounds on a seasonal basis at different sites for both outdoor and indoor locations. A close examination of the data revealed that for most constituents the variability between duplicates was not clearly a function of concentration levels across all seasons and even within a season.

Small sample sizes and low detection frequency of many analytes prohibited exact quantification of precision by using duplicates. The tabled results do, however, indicate that the paired values were often similar. Differences are believed mainly to be due to field and laboratory measurement error, although the possibility of some contribution from microspatial variation cannot be discounted. Comparison of Table 34 and Table 19 confirms the earlier conclusion (see

Table 33. Matrix Spike Percent Recoveries

Analyte[a]	Jacksonville			Springfield/Chicopee	
	Summer	Spring	Winter	Spring	Winter
alpha-BHC[b]					
mean	-	80	80	79	78
s.d.	-	5	16	7	9
range	-	71-87	33-113	73-98	65-96
n	-	24	32	21	22
Chlorothalonil[b]					
mean	62	-	-	-	-
s.d.	19	-	-	-	-
range	38-89	-	-	-	-
n	7	-	-	-	-
Chlorpyrifos[b]					
mean	87	93	83	92	88
s.d.	15	6	11	7	8
range	69-113	81-105	50-108	82-111	76-105
n	8	24	32	21	22
Diazinon[c]					
mean	70	75	79	73	70
s.d.	19	11	11	9	7
range	31-92	52-88	48-104	60-96	56-84
n	8	24	32	21	22
Dieldrin[b]					
mean	89	85	99	97	96
s.d.	24	13	16	15	10
range	46-124	75-101	70-138	85-155	84-116
n	8	24	32	21	22
gamma-BHC[b]					
mean	108	-	-	-	-
s.d.	33	-	-	-	-
range	73-163	-	-	-	-
n	7	-	-	-	-
Heptachlor[b]					
mean	107	117	83	103	88
s.d.	24	23	12	20	9
range	69-133	70-118	45-107	82-126	74-102
n	8	24	32	21	22
Hexachlorobenzene[b]					
mean	96	95	73	86	73
s.d.	13	5	10	7	7
range	86-111	91-109	44-91	73-107	60-86
n	3	24	32	21	22
Propoxur[c]					
mean	52	53	67	56	66
s.d.	20	21	11	16	18
range	18-80	8-76	44-88	31-84	36-108
n	8	24	32	21	22

[a]Blank PUF plugs and gloves and split water samples were spiked with a solution containing the analytes listed, which were selected to be representative of the different structural classes covered by the GC/ECD and GC/MS analyses and to cover the chromatographic range.
[b]Analyzed by GC/ECD.
[c]Analyzed by GC/MS.

Table 34. Duplicate Relative Percent Differences[a]

	Number (and Percent) of Duplicate Pairs					
	Relative Percent Difference[b]					
	<41%	41-67%	>67%	Only Detected in One Sample	Not Detected in Either Sample	Total[c]
Jacksonville						
Indoor air						
Summer	26 (17%)	1 (1%)	2 (1%)	10 (7%)	115 (74%)	154 (100%)
Spring	61 (19%)	7 (2%)	10 (3%)	3 (1%)	249 (75%)	330 (100%)
Winter	64 (21%)	2 (1%)	2 (1%)	8 (3%)	221 (74%)	297 (100%)
Outdoor air						
Summer	8 (6%)	0 (0%)	1 (1%)	9 (7%)	119 (86%)	137 (100%)
Spring	9 (3%)	4 (1%)	1 (0%)	7 (2%)	309 (94%)	330 (100%)
Winter	9 (3%)	2 (1%)	2 (1%)	8 (2%)	276 (93%)	297 (100%)
Springfield/Chicopee						
Indoor air						
Spring	17 (6%)	1 (0%)	5 (2%)	8 (3%)	233 (89%)	264 (100%)
Winter	17 (7%)	1 (1%)	1 (1%)	11 (5%)	200 (86%)	230 (100%)
Outdoor air						
Spring	10 (4%)	4 (2%)	0 (0%)	4 (2%)	246 (92%)	264 (100%)
Winter	1 (0%)	0 (0%)	0 (0%)	2 (1%)	228 (99%)	231 (100%)

[a]Relative percent difference, computed for pairs with detected values for both samples,calculated as 100* |primary value - duplicate value|/(mean of the two values).

[b]Relative differences of 40% or less indicate that the paired values differed by a factor of 1.5 or less whereas relative differences greater than 67% indicate that paired values differ by a factor of two or more.

[c]Total for up to 10 households and 33 analytes (including pentachlorophenol, for which all values were non-detect)

pg. 33) that the variability represented by the duplicate pairs (measurement error) was less than the short-term temporal variation addressed by the replicate pairs.

Laboratory Comparisons. Several types of samples were independently analyzed by SwRI and EMSI. Triplicate air samples collected by SwRI in Phase II were analyzed by EMSI, and the data was compared with the corresponding primary and duplicate sample data developed by SwRI. Split extracts prepared by SwRI were analyzed by both laboratories. Both laboratories also analyzed a standard reference material provided by EPA, as well as two sets of blind spike samples, one prepared by EMSI and the other prepared by another EPA contractor.

The results of the laboratory comparisons indicate that both laboratories generally achieved the desired accuracy and precision limits defined for NOPES. In most cases, differences between the laboratories were relatively minor compared to other sources of variability. More substantial interlaboratory differences were evident for heptachlor and, to a lesser extent, propoxur. This may reflect the analytical difficulties associated with these analytes.

Detection Limits. Detection limits for NOPES target compounds were estimated for each sampling season. The actual limits of detection varied between analytical batches within sampling seasons, being higher in batches in which the instrument gave less response to the standard. Limits of detection were also higher for "dirty" samples than for "clean" samples. Moreover, the procedures used to calculate detection limits were different for GC/ECD and GC/MS compounds because of differences in these two analytical techniques. Therefore, ranges of estimated limits of detection are presented in Table 35 for NOPES target compounds quantitated using the GC/ECD technique and in Table 36 for those quantitated using GC/MS.

Inspection of Table 35 reveals that the detection limits for many GC/ECD target compounds were lower in Season 1 (Summer, Jacksonville) than in the other seasons. This occurred because of a change from a labor-intensive, manual method of interpreting the GC/ECD chromatographs in Season 1 to a more automated procedure for the second two seasons. Using the more labor-intensive procedures in Season 1, the analytical chemists could detect lower levels of occurrence for many compounds than was possible in the other two seasons, especially in clean samples. Although the detection limits vary across seasons, the chemists consistently attempted to ensure that levels of the analytes exceeding the QA goals established in the QA Project Plan (see Table 8) were accurately quantitated.

Table 35. Ranges of Estimated Limits of Detection[a] for GC/ECD Target Compounds by Site and Season (ng/m³)

	Summer	Spring		Winter	
Analyte	Jacksonville	Jacksonville	Springfield	Jacksonville	Springfield
Dichlorvos	1.5 - 2.2	39 - 49	56 - 79	31 - 35	40 - 45
alpha-BHC	0.5	1.6 - 2.0	2.7 - 3.0	1.0 - 1.3	1.3 - 1.5
Hexachlorobenzene	0.5	1.1 - 1.3	1.9 - 2.2	1.0 - 1.1	1.2 - 1.4
gamma-BHC	0.5	1.7 - 1.8	2.9 - 3.1	1.2 - 1.4	1.5 - 1.7
Chlorothalonil	0.5	1.2 - 1.4	2.3 - 2.5	1.3 - 1.9	1.3 - 1.4
Heptachlor	0.5	1.7 - 2.4	2.8 - 3.1	1.2 - 1.4	1.4 - 1.6
Ronnel	0.5	2.2 - 2.5	4.1 - 4.4	1.7 - 2.2	2.2 - 2.4
Chlorpyrifos	0.5	2.4 - 2.7	4.1 - 4.5	2.5 - 3.1	3.3 - 3.5
Aldrin	0.5	1.7 - 2.0	2.9 - 3.2	1.2 - 1.5	1.7 - 1.9
Dacthal	0.5	1.7 - 1.8	2.7 - 3.1	1.8 - 2.1	2.4 - 2.6
Heptachlor epoxide	0.5	1.8 - 2.0	3.1 - 3.3	1.5 - 1.9	2.3 - 2.5
Oxychlordane	0.5	1.7 - 2.0	3.0 - 3.3	1.4 - 1.7	1.8 - 2.1
Captan	1.6 - 2.5	2.5 - 3.5	5.4 - 7.8	6.1 - 14	4.5 - 13
Folpet	0.5 - 3.1	3.6 - 5.1	7.5 - 11	4.7 - 10	11 - 37
2,4-D butoxyethyl ester[b]	0.5 - 0.8	15 - 17	24 - 30	11 - 14	14 - 16
Dieldrin	0.5	1.7 - 2.0	3.0 - 3.3	1.3 - 1.6	1.9 - 2.1
Methoxychlor	1.0 - 2.7	4.2 - 5.1	7.2 - 7.8	3.6 - 5.1	4.5 - 5.0
Dicofol	18	18 - 33	46 - 74	10 - 25	9 - 10
cis-Permethrin	2.2 - 3.6	29 - 38	43 - 53	20 - 23	28 - 31
trans-Permethrin	2.0 - 4.2	19 - 22	30 - 38	14 - 16	19 - 21
Chlordane	20 - 40	35 - 50	24 - 33	4 - 13	5 - 11
4,4'-DDT		2.2 - 2.5	3.8 - 4.1	1.9 - 2.9	2.1 - 2.3
4,4'-DDD		2.7 - 3.1	4.7 - 5.3	1.8 - 2.7	2.3 - 2.6
4,4'-DDE		2.0 - 2.9	3.3 - 3.6	1.4 - 1.7	1.8 - 2.0

[a]Lowest value normally detectable.
[b]Analyte was the methyl ester for the Jacksonville summer season.

Table 36. Ranges of Estimated Limits of Detection[a] for GC/MS Target Compounds by Site and Season (ng/m³)

	Summer	Spring		Winter	
Analyte	Jacksonville	Jacksonville	Springfield	Jacksonville	Springfield
ortho-Phenylphenol	5 - 15	13	12	7 - 22	5 - 20
Propoxur	3 - 9	8	7	4 - 16	4 - 12
Bendiocarb	13 - 38	22	20	7 - 38	9 - 30
Atrazine	12 - 42	32	45	14 - 40	11 - 45
Diazinon	11 - 22	48	22	16 - 45	13 - 42
Carbaryl	9 - 28	25	25	8 - 42	11 - 32
Malathion	11 - 48	60	25	11 - 42	10 - 45
Resmethrin	12 - 28	48	16	10 - 35	8 - 25

[a]Conservative estimate -- lower values detectable in clean samples.

The detection limits shown in Table 35 for GC/ECD target compounds were calculated in such a manner that they estimate the minimum possible detection limits across sample batches. Because of differences in the analytic methods, a slightly different estimation procedure was necessary for the GC/MS compounds. The detection limits shown in Table 36 for the GC/MS compounds are more conservative and estimate the analyte level that could be consistently detected across batches. Lower levels could often be detected in clean samples. Details of the methods used to estimate the detection limits are provided in Hsu et al. (1988).

Questionnaire Data Quality

Questionnaire data from any survey is affected to some degree by nonsampling error. Below are listed some of the sources that can contribute to inaccuracies in the data:

1. Respondents may not understand a question and therefore are unable to answer. This is particularly true if the question contains technical terms or addresses a complex subject.
2. Respondents can misinterpret a question, and then inadvertently provide an incorrect response.
3. Even if a respondent correctly understands a question, he or she may not know the answer, or may provide an inaccurate response.
4. Respondents may refuse to answer a question. This is often because the question deals with a sensitive subject, or because of the time needed to provide an answer.
5. Interviewers can make mistakes when reading the questions or when recording the responses.
6. Errors can be introduced when transferring the questionnaire data from hard copy to machine-readable format. Illegible responses, mistakes in editing or coding, and keying errors may all result in inaccuracies in the questionnaire data file used for analysis.

All of these sources were recognized during the development phase of NOPES as potential contributors to nonsampling error, and steps were taken to minimize their impact. Questionnaire wordings were tested in the pilot study and revised when necessary to improve respondent understanding. Prompts were used in the questionnaires and by the interviewers to promote complete and accurate response. Some questions, such as those on termiticide use and age of home, were asked in both the screening questionnaire and the study questionnaire so that responses could be compared. Accurate questionnaire administration and response recording were stressed during interviewer training. Completed questionnaires went through a field-edit before being sent to RTI, where they were manually edited again for legibility, completeness, andlogical consistency prior to keying. Questionnaire data were keyed twice to minimize the incidence of keying errors.

Despite the above actions, some nonsampling error was unavoidable, and was present in the questionnaire data file used in the analyses. Most of the error is believed to be relatively minor. The area in which the nonsampling error is of more concern is the reported history of termiticide use in the monitored housing units.

The primary sources of problems in the termiticide use data were respondent misinterpretation and lack of knowledge. The potential for misinterpretation was recognized during the pilot study, when some respondents indicated that they did not differentiate between inspection visits by pest control professionals and actual treatment of their homes with termiticides. As a result, the questionnaire wording was changed to at least partially alleviate this problem. In addition, interviewers were instructed on how to clarify questions for respondents that expressed confusion about what was being asked. Nonetheless, the occasional dissimilarity between screening and study questionnaire responses may have been caused in part by misinterpretation by either the screening respondent or the monitored individual.

Lack of knowledge about a housing unit's termiticide history is a more difficult problem to overcome. Because termiticides are applied infrequently, people who have lived in a unit for only a few years or less often will not know if the unit has been treated. This is especially true in rental units. Overcoming this lack of knowledge would be a resource-intensive activity, requiring the identification of and contact with previous owners or landlords, and was not attempted for this study.

The exploratory analyses of termiticide air concentrations versus reported termiticide use have yielded promising results. However, nonsampling error may limit the degree of precision that can be ultimately expected from models that predict termiticide air concentrations from questionnaire data.

Comparisons to Other Studies

This study was the first to examine the nonoccupational indoor air concentrations for many of the target compounds. However, some of the NOPES analytes, including chlordane, heptachlor, aldrin, dieldrin, chlorpyrifos, diazinon, propoxur, dichlorvos, malathion, and ronnel, have been addressed by other studies. Lewis (1988) provides an overview of the indoor air concentrations observed in a variety of studies.

Comparison to data produced by other studies provides an independent assessment of the quality of the NOPES data, although caution must be exercised when comparing the findings of a general-purpose, probability-based study like NOPES to results from special-purpose or non-probability studies. None of the other studies examined were designed to produce probability sampling estimates of the mean concentrations experienced by a specific population. Comparisons of the ranges of concentrations observed in the studies are not as greatly affected by differences in the study designs as other statistics. Therefore, Table 37 summarizes the maximum concentrations observed in studies reported in the literature.

Termiticides, especially chlordane and heptachlor, are the most widely studied of the NOPES analytes. Several studies (Wright and Leidy, 1982; EPA, 1983) focused on concentration profiles over time in homes treated as part of the study. Sample sizes in these studies were relatively small. Sample sizes in two other studies (Olds, 1987; Lillie and Barnes, 1987) were much larger, but only military housing units were examined. Variation in housing unit age and types as limited in the two military studies, which were prompted by earlier reports of health problems related to high pesticide concentrations in some military dwellings.

Given the focus of studies other than NOPES, the maximum concentrations observed in such studies might be expected, *a priori*, to be higher than those in a general-purpose survey, such as NOPES. For chlordane and aldrin, this expected outcome was observed in some, but not all, studies. NOPES maxima were similar to those observed in other studies for heptachlor and dieldrin.

Chlorpyrifos and diazinon have been the subjects of several studies, including military housing studies and temporal profile studies. The *a priori* expectation, given the study populations, was for higher maxima in these studies than in NOPES, which was generally observed.

Comparisons for the remaining analytes were limited to single studies. Some of these involved a limited number of homes, while others (propoxur) were based on observations from single rooms or dwellings. NOPES maxima for these analytes were within an order of magnitude of the maxima observed in the other studies.

In summary, the NOPES findings are similar to those of earlier studies. NOPES confirmed earlier observations that indoor air pesticide concentrations are commonly substantially higher than outdoor air concentrations (Lewis and Lee, 1976; Lewis and MacLeod, 1982). The ranges of indoor air concentrations observed in NOPES were usually comparable to those measured in other studies.

Table 37. Comparison of Maximum Indoor Air Concentrations

Analyte	Study	Maximum Concentration (µg/m³)
Chlordane	Lillie (1981)	37.8
	Livingston and Jones (1981)	264
	Wright and Leidy (1982)	5.8
	Lewis and MacLeod (1982)	5.5
	EPA (1983)	3.6
	Leidy et al. (1985)	9.9
	Olds (1987)	130
	Qazi (1987)	52
	Lillie and Barnes (1987)	>5
	NOPES	4.4
Heptachlor	Wright and Leidy (1982)	1.8
	EPA (1983)	0.6
	Jurinski (1984)	14.8
	Leidy et al. (1985)	2.0
	NOPES	2.4
Aldrin	EPA (1983)	7
	Olds (1987)	1.6
	Jacquith et al. (1987)	5
	NOPES	1.8
Dieldrin	EPA (1983)	0.17
	NOPES	0.18
Chlorpyrifos	Lewis and MacLeod (1982)	7.0
	EPA (1983)	37
	Leidy and Wright (1987)	8.5
	Bush et al. (1987)	4.5
	Olds (1987)	11.9
	NOPES	4.4
Diazinon	Leidy et al. (1982)	38
	Lewis and Macleod (1982)	2.0
	Leidy et al. (1984)	149
	Olds (1987)	34.6
	NOPES	13.7
Propoxur	Jackson and Lewis (1981)	0.79
	NOPES	7.9
Dichlorvos	Lewis and MacLeod (1982)	28
	NOPES	2.9
Malathion	Lewis and MacLeod (1982)	1.0
	NOPES	1.9
Ronnel	Lewis and MacLeod (1982)	10
	NOPES	0.0016

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Appendix A
NOPES Survey Instruments

O.M.B. No. 2080-0022
Expires 9/30/88
7/86

HOUSEHOLD SCREENING QUESTIONNAIRE
NOPES STUDY/RTI PROJECT 3620

FOR OFFICIAL USE ONLY

A. HOUSEHOLD IDENTIFICATION		
Segment No. [ ][ ][ ]	STREET ADDRESS	TELEPHONE NUMBER
SHU No. [ ][ ][ ]		Obtained: [ ][ ][ ] - [ ][ ][ ][ ]
	City State Zip Code	NO PHONE . . . . 00 REFUSED 01

B. RECORD OF SCREENING CALLS

DAY OF WEEK	DATE	TIME	RESULTS	CODE	FI ID No.
		am/pm			
		am/pm			
		am/pm			
		am/pm			
		am/pm			
		am/pm			

C. FINAL SCREENING RESULT	D. INFORMANT ID	FS USE ONLY
SAMPLE DROP: (CIRCLE ONE) Vacant . . . . 01 Not an HU . . . . 02 SECTION D Temporary/vacation home 03	NAME: ADDRESS: CITY STATE ZIP	FS Approval: ______ Verified? Yes . . . . 01 No. 02
SCREENING NOT COMPLETED: Refusal . . . . 04 No one at home (after repeated visits) . . . . 05 No eligible respondent (after repeated visits) . . . . 06 HOLD FOR APPROVAL BY FS Language barrier . . . . 07 Other (SPECIFY). . . . . 08 ______ ______	RELATIONSHIP/TITLE: TELEPHONE NUMBER: NO PHONE . . . . 00 REFUSED 01	Date of Verification ______
SCREENING COMPLETED . . . 09	COMMENTS:	

NOTES:

A. HOUSEHOLD ROSTER

Hello, I'm (NAME) from the Research Triangle Institute. (THEN, AFTER IDENTIFYING THE HEAD OF HOUSEHOLD, SPOUSE OF HEAD, OR OTHER RESPONSIBLE ADULT, SAY). We are conducting a research study for the U.S. Environmental Protection Agency. Here is a letter that explains the study. (HAND LETTER AND ALLOW TIME FOR READING.)

1. First, how many people 16 years of age or older (including friends or roomers) live in this household? How many younger than 16?

   a. ________ HOUSEHOLD MEMBERS 16 OR OLDER   b. ______ HOUSEHOLD MEMBERS UNDER 16

2. What is the name of the head of this household? ENTER NAME IN FIRST COLUMN OF THE ROSTER: TOP OF PAGE 3.

3 What are the names of all other persons 16 years of age or older who live here? Let's list them in order of age, beginning with the oldest. ENTER NAME(S) AND RELATIONSHIP TO THE HEAD OF HOUSEHOLD IN ROSTER.

NOTE: IF THERE ARE MORE THAN FOUR HOUSEHOLD MEMBERS 16 OR OLDER, USE ANOTHER SCREENING QUESTIONNAIRE TO COMPLETE THE ROSTER AND APPROPRIATE QUESTIONS ABOUT EACH OF THE INDIVIDUALS. (INSERT THE SECOND SCREENER INSIDE THE FIRST SCREENER UPON COMPLETION.) IF THERE ARE MORE THAN 10 HOUSEHOLD MEMBERS, CONSIDER THE UNIT TO BE GROUP QUARTERS RATHER THAN A HOUSEHOLD. STOP INTERVIEW AND EXCUSE YOURSELF.

CHECKPOINT:

DOES NUMBER OF NAMES LISTED IN ROSTER EQUAL NUMBER OF HOUSEHOLD MEMBERS RECORDED IN Q. 1a?

[1] YES (GO TO QUESTION 5)

[2] NO (RECONCILE DISCREPANCY WITH RESPONDENT AND CORRECT Q. 1a OR ROSTER AS NECESSARY.)

Name of Person Interviewed: ______________________

B. PERSONAL DATA (FOR EACH PERSON LISTED BELOW, ASK Q's 4-12)				
4. ROSTER NAMES FIRST NAME				
LAST NAME				
RELATIONSHIP TO HEAD OF HH				
PERSON NUMBER	01	02	03	04
5. Is (PERSON) male or female? CIRCLE CODE	M F	M F	M F	M F
6. In what range is (PERSON'S) age? 1. 16-25 2. 26-45 3. 46-60 4. Over 60 (RECORD PROPER CODE)				
7. Is (PERSON) presently employed in any capacity? IF "NO", SKIP TO Q. 10	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
8. Is (PERSON) employed in any of the jobs listed on this card? (HAND RESPONDENT CARD A) RECORD PROPER CODE				
9. In (PERSON'S) current job, does he/she use or handle any insecticides, fungicides or herbicides such as weed killers, wood preservatives or insect/pest killers?	☐ Yes ☐ No ☐ Don't know SKIP TO Q. 11	☐ Yes ☐ No ☐ Don't know SKIP TO Q. 11	☐ Yes ☐ No ☐ Don't know SKIP TO Q. 11	☐ Yes ☐ No ☐ Don't know SKIP TO Q. 11
10. Which of the following best describes (PERSON'S) status? CIRCLE ONE Other (Specify)	01 Housewife 02 Student 03 Unemployed 04 Retired 05 Disabled ______	01 Housewife 02 Student 03 Unemployed 04 Retired 05 Disabled ______	01 Housewife 02 Student 03 Unemployed 04 Retired 05 Disabled ______	01 Housewife 02 Student 03 Unemployed 04 Retired 05 Disabled ______
1. Is (PERSON) involved in any of the following activities at any time of year? CIRCLE ALL THAT APPLY IF "NONE", SKIP TO Q. 13	01 Outdoor/Gardening lawnwork 02 Indoor flower or plant care 03 None of these 08 Don't know	01 Outdoor/Gardening lawnwork 02 Indoor flower or plant care 03 None of these 08 Don't know	01 Outdoor/Gardening lawnwork 02 Indoor flower or plant care 03 None of these 08 Don't know	01 Outdoor/Gardening lawnwork 02 Indoor flower or plant care 03 None of these 08 Don't know
12. In that activity does (PERSON) use any insecticides, fungicides or herbicides such as weed killers, flower/plant sprays, or insect/pest killers?	☐ Yes ☐ No ☐ Don't know	☐ Yes ☐ No ☐ Don't know	☐ Yes ☐ No ☐ Don't know	☐ Yes ☐ No ☐ Don't know

C. HOUSEHOLD DATA

The next few questions are about this household in general.

13. Does this household have any cats or dogs?

    [1] Yes

    [2] No (SKIP TO Q. 18)

14. How many cats and/or dogs does this household have?

    a. Cats ________

    b. Dogs ________

15. Are any of the following used on your cats and/or dogs to control fleas or ticks at any time of year? (CHECK ALL THAT APPLY)

    a. [ ] Flea/tick shampoos or dips

    b. [ ] Flea powders

    c. [ ] Flea collars

    d [ ] None of these } SKIP TO Q. 18

    e. [ ] Don't know } SKIP TO Q. 18

16. Are the treatments, shampoos, or sprays usually done inside or outside your home, or are they done at a veterinarian's or professional pet groomer's?

    [1] Inside

    [2] Outside

    [3] Veterinarian or professional pet groomer

    [8] Don't know

17. At this time of year, how often (generally) are the treatments, shampoos, or sprays performed?

    [1] At least once a month

    [2] Less than once a month

    [8] Don't know

18. How old is this house/building?____________________

19. What type of foundation does this house/building have?

- [1] Slab
- [2] Crawl space
- [3] Combination crawl space/basement
- [4] Full basement
- [5] Oher (Specify)__________________________
- [8] Don't know

20. Since this house/building was built, have pesticides or chemicals ever been used to control a termite problem in it?

- [1] Yes
- [2] No (SKIP TO Q. 22)
- [8] Don't know (SKIP TO Q. 22)

21. When was the last time pesticides or chemicals were used to control termites in this house/building?

- [1] Less than 1 year ago
- [2] More than 1 year ago
- [8] Don't know

22. Excluding termite treatments, are insecticides ever applied in this home/apartment for roaches, ants, silverfish, fleas, or other household insect pests?

- [1] Yes
- [2] No (SKIP TO Q. 25)
- [8] Don't know (SKIP TO Q. 25)

23. How often is this home/apartment usually treated for these pests?

- [1] Every month or more often
- [2] Every 2-4 months
- [3] Every 5-11 months
- [4] Every year
- [5] Less frequently than every year
- [8] Don't know

24. Who usually treats this home/apartment for these pests? (READ CATEGORIES-CHECK <u>ONE</u> BOX)

- [1] A professional service
- [2] Someone in the household (PERSON NUMBER(S) FROM ROSTER _______
- [3] Both professional service and one or more household members
- [4] Other (SPECIFY)_______________________
- [8] Don't know

25. Does this house (or apartment/mobile home) have air conditioning?

- [1] Central air conditioning
- [2] Window unit(s)
- [3] No air conditioning (SKIP TO Q.27)

26. How often, if ever, are the windows or doors opened and left open for several hours at this time of year?

- 1 Less than once a week
- 2 More than once a week
- 8 Don't know

27. What is your primary source of drinking water?

- 1 City Water
- 2 Private company
- 3 Private well
- 4 Bottled water

28. What is your home telephone number, starting with your area code?

☐☐☐ ☐☐☐ ☐☐☐☐

☐ Check if no home phone.

29. Is this phone number unlisted?

- 1 Yes
- 2 No

D. RECORD BY OBSERVATION: (if unable to accurately record by observation, BE SURE TO ASK THE RESPONDENT.)

30. Type of structure in which the Housing Unit is located

- [1] Unattached single unit
- [2] Attached single unit (e.g., duplex, row house)
- [3] Multi-unit building (e.g., apartment building)
- [4] Mobile home
- [5] Other (SPECIFY)________________________

31. Outdoor area around the structure

- [1] Private yard area with lawn, trees, and/or shrubs
- [2] Private yard *without* lawn, trees, or shrubs
- [3] Common area with lawn, trees and/or shrubs
- [4] Common area *without* lawn, trees, or shrubs
- [5] Other (SPECIFY)________________________

(END OF QUESTIONNAIRE. THANK RESPONDENT FOR HIS/HER TIME AND COOPERATION.)

Response Card A

CARD A

OCCUPATIONS

1. Pest control operator (PCO)/ professional pesticide applicator
2. Construction worker
3. Employee at a facility where items such as furniture or garments are fumigated
4. Landscaper or nursery worker
5. Employee at a golf course
6. Maintenance worker such as building janitor or groundskeeper
7. Food processing plant employee
8. Veterinarian, veterinary assistant or worker at a zoo
9. Agricultural worker
10. Employee at a facility that manufactures, formulates, or distributes pesticides
11. Chemist or chemical laboratory technician
12. None of the above occupations

Study Questionnaire

OMB No. 2080-0022
Expires: 9/30/88

STUDY QUESTIONNAIRE
NON-OCCUPATIONAL PESTICIDE EXPOSURE SURVEY

First, I would like to ask some general questions about you.

1. Sex (by observation):

   [1] Male [2] Female

2. Race (by observation):

   [1] Black [3] American Indian/Alaskan Native
   [2] White [4] Asian/Pacific Islander
   [5] Other (specify) ____________________

3. What was your age in years on your last birthday?

   [|] Years

   IF AGED 15 YEARS OR LESS, ASK:

   Previously, when I was asking questions about people in your household, I was told that you were older than 15. Just to make sure I have this right, are you presently ______ years old?

   IF AGED 15 YEARS OR LESS, SELECT ALTERNATE RESPONDENT WITHIN THE HOUSEHOLD, IF POSSIBLE. NOTE IDENTITY OF THE ALTERNATE ON THE COVER SHEET. IF NO ALTERNATE RESPONDENT IS AVAILABLE, THANK RESPONDENT FOR HIS/HER COOPERATION AND END INTERVIEW.

Next, I would like to ask some questions about your occupation.

4. Are you presently employed in any capacity?

   [1] Yes (CONTINUE) [2] No (SKIP TO QUESTION 10)

5. Do any of the jobs on this list describe your current occupation or occupations?

   HAND RESPONDENT SHOW CARD A

   [|] RECORD PRIMARY OCCUPATION CODE
   [|] RECORD SECONDARY OCCUPATION CODE, IF ANY

IF OCCUPATION CODE = 1 (e.g., PCO), THANK RESPONDENT AND TERMINATE INTERVIEW.

I am interested in finding out whether you use or handle any pesticides in your current job.

A pesticide is a chemical used to destroy, prevent, control or repel pests. By pests I mean such things as insects, spiders, fleas, fungus, mildew, and weeds.

HAND RESPONDENT SHOW CARD B AND READ EXAMPLES

Weed killers
Wood preservatives
Lawn sprays
Fruit and vegetable sprays or dusts
Rose sprays
Insect killers or repellants
Mold inhibitors
Flea or tick treatments

6. Do you ever use or handle any of these types of pesticides in your job?

   [1] Yes (CONTINUE) [2] No (SKIP TO QUESTION 11)

7. Does your *primary* activity at work involve using or handling pesticides?

   [ ] YES (THANK RESPONDENT AND TERMINATE INTERVIEW)

   [ ] NO (CONTINUE)

8. I would like to find out some more details about the pesticides you use or handle in your job.

Could you please tell me the brand names of the pesticides you use or handle?

1 Yes (CONTINUE)

2 No/Don't Know (SKIP TO QUESTION 9)

ENTER PESTICIDES IN COLUMN 1 AND FOR EACH PESTICIDE ASK:

What is this pesticide used for? ENTER IN COLUMN 2.

How often do you use or handle this pesticide? ENTER CODE IN COLUMN 3.

PESTICIDE NAME	DESCRIPTION OF USE	DAILY .... 01 WEEKLY .... 02 MONTHLY .... 03 LESS FREQUENTLY THAN MONTHLY 04
Column 1	Column 2	Column 3

AFTER COMPLETING COLUMNS 1, 2, AND 3 FOR ALL PESTICIDES MENTIONED, SKIP TO QUESTION 11.

9. Please describe in what ways you use or handle these pesticides in your job. (For example, use them for weed control or to control ants.)

____

____

SKIP TO QUESTION 11

10. Which of the following best describes your status?

[1] Housewife

[3] Unemployed

[2] Student

[4] Retired

[5] Disabled

The next set of questions are about this household in general.

11. Do you have any of the following at this home? (CHECK ALL THAT APPLY.)

Lawn or yard (By observation)	[1]
Ornamental shrubs and/or fruit or flowering trees	[2]
Vegetable garden	[3]
Flower garden/other outdoor plants	[4]
Indoor plants	[5]
Detached greenhouse	[6]
Attached greenhouse	[7]
Detached garage, shed or other buildings	[8]
Attached garage or storage room	[9]
Household pets	[10]

12. When was this house/building built?

____

13. Since this house/building was built, have pesticides or chemicals ever been used to control a termite problem in it?

[1] Yes (CONTINUE)

[2] No

[3] Don't Know

(No / Don't Know) } SKIP TO DIETARY INTAKE RECORD

14. When was the last time pesticides or chemicals were used to treat this house/building for termites?

- [1] Less than 1 year ago
- [2] 1 - 5 years ago
- [3] More than 5 years ago
- [4] Don't know

15. At that time, who treated this home for termites? (READ CATEGORIES)

- [1] A professional service
- [2] Yourself
- [3] Someone else in the household
- [4] Other (specify)____

GO TO DIETARY INTAKE RECORD.

OMB No. 2080 -0022
Expires: 9/30/88

DIETARY RECALL INTERVIEW

DATE COMPLETED: [ ][ ] MONTH [ ][ ] DAY [ ][ ] YEAR

ID LABEL:

Day of Week

Monday	01
Tuesday	02
Wednesday	03
Thursday	04
Friday	05
Saturday	06
Sunday	07

OPENING

"Now I need to know everything you ate or drank yesterday from midnight of ________________ to midnight of ________________. Please try to remember *everything* you *ate or drank* during the night and day no matter how much or how little you had. Include food or drink you had at home or away from home. As you tell me what you had, I will ask you how the food or drink was prepared. For example, if you ate eggs, I will need to know if they were scrambled, fried, poached or hard cooked. I will also need to know the amount you ate or drank. I will help you use these models to describe how large the portions were that you had. I will also ask if you added anything to the foods or drinks. Now starting with midnight of ________________, what was the first thing you ate or drank?"

DIETARY INTAKE LISTING

Line Number	Name of Food or Drink	Amount Consumed	For Office Use Only
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			

Line Number	Name of Food or Drink	Amount Consumed	For Office Use Only
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			
41			
42			
43			
44			
45			
46			
47			
48			
49			
50			

MEASUREMENT CONVERSIONS

3 teaspoons = 1 tablespoon
2 tablespoons = 1 fluid ounce
4 tablespoons = 1/4 cup
5 1/3 tablespoons = 1/3 cup
16 tablespoons = 1 cup = 8 ounces = 1/2 pint
2 cups = 1 pint
2 pints = 1 quart
4 quarts = 1 gallon

DECIMAL CONVERISON

1 = 1.00
1/2 = 0.50
1/3 = 0.33
1/4 = 0.25
1/8 = 0.13

NOTES: ____________________

HOUSEHOLD PESTICIDE INVENTORY

Now I'd like to ask you about pesticides you have around the house. I am going to read a list of some common househould pests and mention examples of products that may be used to control the pests. This list was designed to help you remember what products you have here and help identify items not usually thought of by most people as pesticides. For each pest I mention, please tell me if you *currently* have any products here that can be used to control that pest. It doesn't matter if you've ever used the product.

Please take your time as you consider each pest problem, and think carefully if you have any products that could be used for the problem.

23.* Do you currently have any products that can be used to control:	YES	NO
a. Ants, cockroaches, or other crawling insects; products such as Raid and Black Flag bug sprays?	01	02
b. Flies, gnats, and other flying insects; products such as Raid and Black Flag bug sprays?	01	02
c. Bees, hornets, or wasps; products such as Raid Wasp and Hornet Killer or Ortho Hornet and Wasp Killer?	01	02
d. Spiders and mites; products such as Defend?	01	02
e. Fleas; products such as Holiday or Four-Gone foggers?	01	02
--Do you have any products that can be used to:		
f. Treat or prevent indoor plant insects or diseases; products such as Ortho Indoor Plant Spray?	01	02
g. Treat or prevent termites; products such as Chlordane?	01	02
h. Preserve wood; products such as Capernol or Creosote?	01	02
--Do you have any products to control or prevent:		
i. Outdoor plant insects or diseases; products such as Sevin, Malathion, rose dust, or tomato dust?	01	02
j. Weeds; products such as crabgrass killers, dandelion killers, and chickweed killers?	01	02
k. Tree diseases; products such as orchard or fruit tree sprays?	01	02
l. Fleas and ticks on pets; products such as soaps, shampoos, dips,or powders?	01	02
--Do you have any:		
m. Outdoor foggers; products such as Raid Yard Guard and Ortho Yard and Patio Insect Spray?	01	02

*NOTE: QUESTIONS 16-23 were originally included in the Dietary Intake Questionnaire but were deleted following the pilot testing.

n. Continuous use products, such as flea and tick collars, no-pest strips, ant traps, or roach baits? 01 02

o. Lysol disinfectant spray? 01 02

--Do you have any pesticides that the Health Department or any other government agency gave you? 01 02

24. Do you have any other products here that might be considered pesticides that you haven't already told me about?

Yes . . . . 1 (CONTINUED)

No . . . . 2 (SKIP TO QUESTION 26)

25. What are they? LIST BELOW

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

26. <u>INVENTORY SECTION</u>

Now let's talk about the products you have here. I'll need to see the containers to copy down the exact name and EPA registration number of each one. I would like to go to the places where you store your pest products; but if you prefer, you can collect them and bring them to me.

IF RESPONDENT ELECTS TO BRING PESTICIDES TO YOU, SAY:

If you would like, you can use this bag or these gloves to carry the containers. As you go through your storage areas, please check for any products you may have forgotten. Thanks.

	Complete Product Name	EPA Reg. Number	Formulation Ready to use dust :1 Ready to use liquid :2 Granular or pelleted :3 Liquid concentrate: :4 Dust or powder that gets mixed with water :5 Aerosol spray :6 Other: :7	Storage Area Kitchen :1 Bathroom :2 Basement :3 Garage :4 Outside shed :5 Other :6	Time of Last Use Within last 48 hours :1 Within last week :2 Within last month :3 Within last year :4 More than 1 year ago :5 Don't know :8
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

Response Card B

CARD B

Weed killers

Wood preservatives

Lawn sprays

Fruit and vegetable sprays or dusts

Rose sprays

Insect killers or repellants

Mold inhibitors

Flea or tick treatments

24-Hour Activity Log

OMB No. 2080-0022
Expires: 9/30/88

24-HOUR ACTIVITY LOG

The following questions are designed to find out about the activities you were involved in during the 24-hour monitoring period you have just completed. For some questions, you will also be asked to report on activities during the 24 hours *before* the monitoring period. Please be certain to answer separately for both time periods.

Please answer Yes or No for whether you were involved in each activity I read to you during 24 hours before the start of the monitoring period and/or during the monitoring period.

		24 HOURS BEFORE START OF MONITORING		MONITORING PERIOD	
1.	a) First, were you involved in gardening/lawn plant care?	YES	NO	YES	NO
	IF YES,				
	b) About how much time did you spend in this activity?	☐☐ HRS.	☐☐ MINS.	☐☐ HRS.	☐☐ MINS.
2.	a) Were you involved in pet handling/brushing/bathing?	YES	NO	YES	NO
	IF YES,				
	b) About how much time did you spend in this activity?	☐☐ HRS.	☐☐ MINS.	☐☐ HRS.	☐☐ MINS.

IF NOT CURRENTLY EMPLOYED, SKIP TO QUESTION 4.

		24 HOURS BEFORE START OF MONITORING		MONITORING PERIOD	
3.	a) Were you involved in using or handling pesticides, insecticides, fungicides or herbicides in your current job?	YES	NO	YES	NO
	IF YES,				
	b) About how much time did you spend in this activity?	☐☐ HRS.	☐☐ MINS.	☐☐ HRS.	☐☐ MINS.

4. Now I would like to read a list of different sorts of pesticides you may have used or handled at work, home, or somewhere else. Please answer YES or NO to whether or not you have used or handled any of these products in the last 48 hours.

Did you use or handle any products to control ....

a. Ants, cockroaches, or other crawling insects; products such as Raid and Black Flag bug sprays? .... YES NO

b. Flies, gnats, and other flying insects; products such as Raid and Black Flag bug sprays? .... YES NO

c. Bees, hornets, or wasps; products such as Raid Wasp and Hornet Killer or Ortho Hornet and Wasp Killer? .... YES NO

d. Spiders and mites; products such as Defend? .... YES NO

Did you use or handle any products to ...

e. Treat or prevent indoor plant insects or diseases; products such as Ortho Indoor Plant Spray? .... YES NO

f. Treat or prevent termites; products such as Chlordane? .... YES NO

g. Preserve wood; products such as Capernol and Creosote .... YES NO

Did you use or handle any products to control or prevent ...

h. Outdoor plant insects or diseases; products such as Sevin, Malathion, rose dust, or tomato dust? .... YES NO

i. Weeds; products such as crabgrass killers, dandelion killers, and chickweed killers .... YES NO

j. Tree diseases; products such as orchard or fruit tree sprays? ...... YES NO

k. Fleas and ticks on pets; products such as soaps, shampoos, dips, or powders? .... YES NO

Did you use or handle any ...

l. Indoor foggers to control fleas; products such as Holiday or Four-Gone foggers? .... YES NO

m. Outdoor foggers; products such as Raid Yard Guard and Ortho Yard and Patio Insect Spray? .... YES NO

n. Lysol disinfectant spray? .... YES NO

5. NOW FOR EACH PESTICIDE YOU SAID YOU USED OR HANDLED IN THE LAST 48 HOURS, I WOULD LIKE TO KNOW THE PRODUCT NAME, WHERE YOU USED IT, WHEN YOU USED IT, METHOD OF APPLICATION AND ANY PRECAUTIONARY ACTIONS YOU TOOK WHILE USING IT.

	1	2
a. Product Name		

b. Where did you use it?	1: 24 Hours Before Monitoring	1: During Monitoring	2: 24 Hours Before Monitoring	2: During Monitoring
Home, Indoor	☐	☐	☐	☐
Home, Outdoor	☐	☐	☐	☐
Work, Indoor	☐	☐	☐	☐
Work, Outdoor	☐	☐	☐	☐
Elsewhere, Indoor	☐	☐	☐	☐
Elsewhere, Outdoor	☐	☐	☐	☐

c. What method of application did you use? (CHECK ALL THAT APPLY)

	1	2
Handsprayer	☐	☐
Pressurized/Hose Sprayer	☐	☐
Brush or Cloth	☐	☐
Lawn or Garden Spreader	☐	☐
Hand Duster or Shaker Container	☐	☐
Aerosol Can	☐	☐
Other	☐	☐

d. What precautionary actions did you take while using it? (CHECK ALL THAT APPLY)

	1	2
Wore Protection Clothing (e.g. Gloves, Apron, Boots, or Mask)	☐	☐
Held Breath	☐	☐
Covered or Removed Food and/or Furniture	☐	☐
Washed Hands or Showered	☐	☐
Changed Clothes	☐	☐
None	☐	☐

	3	4
a. Product Name		

b. Where did you use it?	24 Hours Before Monitoring	During Monitoring	24 Hours Before Monitoring	During Monitoring
Home, Indoor	☐	☐	☐	☐
Home, Outdoor	☐	☐	☐	☐
Work, Indoor	☐	☐	☐	☐
Work, Outdoor	☐	☐	☐	☐
Elsewhere, Indoor	☐	☐	☐	☐
Elsewhere, Outdoor	☐	☐	☐	☐

c. What method of application did you use? (CHECK ALL THAT APPLY)

	3	4
Handsprayer	☐	☐
Pressurized/Hose Sprayer	☐	☐
Brush or Cloth	☐	☐
Lawn or Garden Spreader	☐	☐
Hand Duster or Shaker Container	☐	☐
Aerosol Can	☐	☐
Other	☐	☐

d. What precautionary actions did you take while using it? (CHECK ALL THAT APPLY)

	3	4
Wore Protection Clothing (e.g. Gloves, Apron, Boots, or Mask)	☐	☐
Held Breath	☐	☐
Covered or Removed Food and/or Furniture	☐	☐
Washed Hands or Showered	☐	☐
Changed Clothes	☐	☐
None	☐	☐

		5		6	
a.	Product Name				
b.	Where did you use it?	24 Hours Before Monitoring	During Monitoring	24 Hours Before Monitoring	During Monitoring
	Home, Indoor	☐	☐	☐	☐
	Home, Outdoor	☐	☐	☐	☐
	Work, Indoor	☐	☐	☐	☐
	Work, Outdoor	☐	☐	☐	☐
	Elsewhere, Indoor	☐	☐	☐	☐
	Elsewhere, Outdoor	☐	☐	☐	☐

c. What method of application did you use? (CHECK ALL THAT APPLY)

	5	6
Handsprayer	☐	☐
Pressurized/Hose Sprayer	☐	☐
Brush or Cloth	☐	☐
Lawn or Garden Spreader	☐	☐
Hand Duster or Shaker Container	☐	☐
Aerosol Can	☐	☐
Other	☐	☐

d. What precautionary actions did you take while using it? (CHECK ALL THAT APPLY)

	5	6
Wore Protection Clothing (e.g. Gloves, Apron, Boots, or Mask)	☐	☐
Held Breath	☐	☐
Covered or Removed Food and/or Furniture	☐	☐
Washed Hands or Showered	☐	☐
Changed Clothes	☐	☐
None	☐	☐

6. a) To your knowledge, did anyone else in your household apply any pesticides in or around your home during or in the 24 hours before the monitoring period?

YES ☐

NO ☐ **(SKIP TO QUESTION 8)**

7. For each such application, please describe the product used, when it was applied, the general location of the application, and how the product was applied.

		1		2	
a.	Product				
b.	Where was it used?	24 Hours Before Monitoring	During Monitoring	24 Hours Before Monitoring	During Monitoring
	Home, Indoor	☐	☐	☐	☐
	Home, Outdoor	☐	☐	☐	☐
	Work, Indoor	☐	☐	☐	☐
	Work, Outdoor	☐	☐	☐	☐
	Elsewhere, Indoor	☐	☐	☐	☐
	Elsewhere, Outdoor	☐	☐	☐	☐

c. What method of application was used? (CHECK ALL THAT APPLY)

	1	2
Handsprayer	☐	☐
Pressurized/Hose Sprayer	☐	☐
Brush or Cloth	☐	☐
Lawn or Garden Spreader	☐	☐
Hand Duster or Shaker Container	☐	☐
Aerosol Can	☐	☐
Other	☐	☐

	3		4	
a. Product				
b. Where was it used?	24 Hours Before Monitoring	During Monitoring	24 Hours Before Monitoring	During Monitoring
Home, Indoor	☐	☐	☐	☐
Home, Outdoor	☐	☐	☐	☐
Work, Indoor	☐	☐	☐	☐
Work, Outdoor	☐	☐	☐	☐
Elsewhere, Indoor	☐	☐	☐	☐
Elsewhere, Outdoor	☐	☐	☐	☐

c. What method of application was used? (CHECK ALL THAT APPLY)

	3	4
Handsprayer	☐	☐
Pressurized/Hose Sprayer	☐	☐
Brush or Cloth	☐	☐
Lawn or Garden Spreader	☐	☐
Hand Duster or Shaker Container	☐	☐
Aerosol Can	☐	☐
Other	☐	☐

	5		6	
a. Product				
b. Where was it used?	24 Hours Before Monitoring	During Monitoring	24 Hours Before Monitoring	During Monitoring
Home, Indoor	☐	☐	☐	☐
Home, Outdoor	☐	☐	☐	☐
Work, Indoor	☐	☐	☐	☐
Work, Outdoor	☐	☐	☐	☐
Elsewhere, Indoor	☐	☐	☐	☐
Elsewhere, Outdoor	☐	☐	☐	☐

c. What method of application was used? (CHECK ALL THAT APPLY)

	5	6
Handsprayer	☐	☐
Pressurized/Hose Sprayer	☐	☐
Brush or Cloth	☐	☐
Lawn or Garden Spreader	☐	☐
Hand Duster or Shaker Container	☐	☐
Aerosol Can	☐	☐
Other	☐	☐

8. Were any of the following products in use in or around your home or job during the monitoring period?

CHECK YES OR NO FOR EACH.

	HOME		WORKSITE	
	YES	NO	YES	NO
a) flea/tick collars	☐	☐	☐	☐
b) no-pest strips	☐	☐	☐	☐
c) ant or roach baits	☐	☐	☐	☐

9. During the 24-hour monitoring period, in your home, how much time was spent with ......

ENTER HOURS AND MINUTES

	HRS.	MINS.	NONE
a) central heat or air conditioning in operation?	☐	☐	☐
b) window air conditioner in operation?	☐	☐	☐
c) windows or doors open?	☐	☐	☐
d) windows and doors shut, no air conditioner in operation	☐	☐	☐

10. About how much time during the past 24-hour monitoring period did you spend ......

ENTER HOURS AND MINUTES

	HRS.	MINS.	NONE
a) indoors at home	☐	☐	☐
b) indoors at work	☐	☐	☐
c) indoors at other locations	☐	☐	☐
d) outdoors	☐	☐	☐

11. During the time you spent indoors at home during the monitoring period, how much time was spent with .....

ENTER HOURS AND MINUTES

	HRS.	MINS.	NONE
a) any heating or air conditioning in operation?	☐	☐	☐
b) windows or doors open?	☐	☐	☐
c) windows and doors shut, no heating or air conditioning in operation?	☐	☐	☐

12. During the past 24-hour monitoring period, did you spend any time in areas where fruit or vegetable crops are currently being grown? If so, how much time did you spend there?

☐ YES ☐ HRS. ☐ MINS.

☐ NO

13. At any time during the montioring period, were you in an area that was bneing sprayed for mosquitoes or other insect pests? If so, how long were you in the area?

☐ YES ☐ HRS. ☐ MINS.

☐ NO

14. Please indicate any OTHER things that you did or that happened to you which brought you into contact with pesticides, insecticides, fungicides, or herbicides during the 24-hour monitoring period, and the length of time involved.

____

____

____

15. Do you plan to make any application of pesticides in the next several days?

☐ YES → When? ☐ ☐ → GO TO Q. 16

☐ NO → THANK RESPONDENT FOR THEIR COOPERATION AND END THE INTERVIEW.

16. Would you be willing to allow us to observe you during that application and wear a pair of cotton gloves that we will provide to you to measure what gets on your hands?

☐ YES → MAKE THE APPOINTMENT

Month: ☐ Day: ☐

Time: __________ a.m. p.m.

☐ NO → THANK RESPONDENT AND END INTERVIEW.

17. Would you like to receive a copy of the results of your monitoring sample analyses?

☐ YES

☐ NO

THANK YOU FOR YOUR COOPERATION.

Appendix B
Summary Statistics for All Analytes

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN JACKSONVILLE AIR

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
DICHLORVOS										
Detectable	%	32.9	13.9	9.5	0.0	0.0	2.5	34.8	10.9	16.0
	s.e.	8.1	8.6	2.8	0.0	0.0	2.0	7.5	5.3	6.2
Undetectable	%	67.1	86.1	90.5	100.0	100.0	97.5	65.2	89.1	84.0
	s.e.	8.1	8.6	2.8	0.0	0.0	2.0	7.5	5.3	6.2
	(n)	49	72	71	47	72	70	50	71	71
ALPHA-BHC										
Detectable	%	24.7	23.0	22.3	2.8	0.0	2.2	25.9	19.3	26.6
	s.e.	8.6	4.7	5.6	2.6	0.0	2.0	5.2	2.1	8.8
Undetectable	%	75.3	77.0	77.7	97.2	100.0	97.8	74.1	80.7	73.4
	s.e.	8.6	4.7	5.6	2.6	0.0	2.0	5.2	2.1	8.8
	(n)	62	72	71	60	72	70	63	71	71
HEXACHLOROBENZENE										
Detectable	%	49.9	5.6	7.0	10.1	0.0	0.0	44.8	6.0	6.5
	s.e.	5.2	2.6	4.0	3.9	0.0	0.0	4.0	3.0	4.0
Undetectable	%	50.1	94.4	93.0	89.9	100.0	100.0	55.2	94.0	93.5
	s.e.	5.2	2.6	4.0	3.9	0.0	0.0	4.0	3.0	4.0
	(n)	62	72	71	60	72	70	63	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN JACKSONVILLE AIR (continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
GAMMA-BHC										
Detectable	%	34.0	47.0	67.5	14.2	12.2	23.9	34.1	32.4	70.1
	s.e.	8.5	5.6	10.7	3.7	2.5	6.2	10.2	6.1	12.9
Undetectable	%	66.0	53.0	32.5	85.8	87.8	76.1	65.9	67.6	29.9
	s.e.	8.5	5.6	10.7	3.7	2.5	6.2	10.2	6.1	12.9
	(n)	62	72	71	60	72	70	63	71	71
CHLOROTHALONIL										
Detectable	%	9.4	12.8	19.7	3.7	8.6	8.6	7.0	0.3	18.9
	s.e.	4.3	4.3	6.0	2.4	4.8	2.4	4.6	0.3	5.6
Undetectable	%	90.6	87.2	80.3	96.3	91.4	91.4	93.0	99.7	81.1
	s.e.	4.3	4.3	6.0	2.4	4.8	2.4	4.6	0.3	5.6
	(n)	49	72	71	47	72	70	50	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS
FOR DETECTABLE LEVELS IN JACKSONVILLE AIR
(continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
HEPTACHLOR										
Detectable	%	58.3	70.8	92.2	21.0	21.9	47.1	41.0	68.1	89.7
	s.e.	5.2	5.1	4.4	7.1	3.4	7.6	9.4	6.5	6.8
Undetectable	%	41.7	29.2	7.8	79.0	78.1	52.9	59.0	31.9	10.3
	s.e.	5.2	5.1	4.4	7.1	3.4	7.6	9.4	6.5	6.8
	(n)	62	72	71	60	72	70	63	71	71
RONNEL										
Detectable	%	3.4	0.0	0.0	0.9	0.0	0.0	1.9	0.0	0.8
	s.e.	2.6	0.0	0.0	0.9	0.0	0.0	1.8	0.0	0.9
Undetectable	%	96.6	100.0	100.0	99.1	100.0	100.0	98.1	100.0	99.2
	s.e.	2.6	0.0	0.0	0.9	0.0	0.0	1.8	0.0	0.9
	(n)	62	72	71	60	72	70	63	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS
FOR DETECTABLE LEVELS IN JACKSONVILLE AIR
(continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
CHLORPYRIFOS										
Detectable	%	100.0	88.2	96.3	94.7	32.3	30.0	96.7	83.3	97.2
	s.e.	0.0	2.5	2.7	1.3	5.1	5.0	3.1	7.7	3.0
Undetectable	%	0.0	11.8	3.7	5.3	67.7	70.0	3.3	16.7	2.8
	s.e.	0.0	2.5	2.7	1.3	5.1	5.0	3.1	7.7	3.0
	(n)	62	72	71	60	72	70	63	71	71
ALDRIN										
Detectable	%	21.5	19.3	31.3	7.4	0.0	5.3	36.6	19.6	36.2
	s.e.	7.6	4.8	4.2	2.9	0.0	2.6	8.4	3.7	8.5
Undetectable	%	78.5	80.7	68.7	92.6	100.0	94.7	63.4	80.4	63.8
	s.e.	7.6	4.8	4.2	2.9	0.0	2.6	8.4	3.7	8.5
	(n)	62	72	71	60	72	70	63	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN JACKSONVILLE AIR (continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
DACTHAL										
Detectable	%	1.4	0.0	9.2	0.0	0.0	0.0	4.6	0.0	8.1
	s.e.	1.2	0.0	4.4	0.0	0.0	0.0	3.2	0.0	3.8
Undetectable	%	98.6	100.0	90.8	100.0	100.0	100.0	95.4	100.0	91.9
	s.e.	1.2	0.0	4.4	0.0	0.0	0.0	3.2	0.0	3.8
	(n)	62	72	71	60	72	70	63	71	71
HEPTACHLOR EPOXIDE										
Detectable	%	16.6	2.7	5.5	30.3	0.7	0.0	14.8	2.7	2.1
	s.e.	5.7	2.4	1.8	6.7	0.6	0.0	4.3	2.4	2.0
Undetectable	%	83.4	97.3	94.5	69.7	99.3	100.0	85.2	97.3	97.9
	s.e.	5.7	2.4	1.8	6.7	0.6	0.0	4.3	2.4	2.0
	(n)	62	72	71	60	72	70	63	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN JACKSONVILLE AIR (continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
OXYCHLORDANE										
Detectable	%	2.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
	s.e.	1.7	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Undetectable	%	98.0	100.0	99.2	100.0	100.0	100.0	100.0	100.0	100.0
	s.e.	1.7	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0
	(n)	62	72	71	60	72	70	63	71	71
CAPTAN										
Detectable	%	4.2	4.9	0.4	0.0	0.0	0.0	0.0	2.4	0.8
	s.e.	4.1	4.2	0.4	0.0	0.0	0.0	0.0	2.3	0.6
Undetectable	%	95.8	95.1	99.6	100.0	100.0	100.0	100.0	97.6	99.2
	s.e.	4.1	4.2	0.4	0.0	0.0	0.0	0.0	2.3	0.6
	(n)	49	72	71	47	72	70	50	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS
FOR DETECTABLE LEVELS IN JACKSONVILLE AIR
(continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
FOLPET										
Detectable										
	%	2.1	1.1	3.1	6.9	1.8	0.0	2.1	1.5	2.2
	s.e.	2.1	0.4	2.0	5.2	1.5	0.0	2.1	0.7	2.0
Undetectable										
	%	97.9	98.9	96.9	93.1	98.2	100.0	97.9	98.5	97.8
	s.e.	2.1	0.4	2.0	5.2	1.5	0.0	2.1	0.7	2.0
	(n)	49	72	71	47	72	70	50	71	71
2,4-D *										
Detectable										
	%	8.4	0.0	9.7	1.8	0.0	2.7	6.5	0.0	14.7
	s.e.	5.2	0.0	2.7	1.6	0.0	1.8	6.9	0.0	3.2
Undetectable										
	%	91.6	100.0	90.3	98.2	100.0	97.3	93.5	100.0	85.3
	s.e.	5.2	0.0	2.7	1.6	0.0	1.8	6.9	0.0	3.2
	(n)	49	72	71	47	72	70	50	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN JACKSONVILLE AIR (continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
DIELDRIN										
Detectable	%	79.2	37.1	61.9	38.9	0.5	19.0	69.6	21.8	51.2
	s.e.	7.5	6.5	8.7	5.8	0.5	6.4	3.8	4.7	3.1
Undetectable	%	20.8	62.9	38.1	61.1	99.5	81.0	30.4	78.2	48.8
	s.e.	7.5	6.5	8.7	5.8	0.5	6.4	3.8	4.7	3.1
	(n)	62	72	71	60	72	70	63	71	71
METHOXYCHLOR										
Detectable	%	7.3	0.9	2.9	0.0	0.0	1.8	12.1	0.5	3.1
	s.e.	1.7	0.9	2.1	0.0	0.0	1.8	1.9	0.5	2.0
Undetectable	%	92.7	99.1	97.1	100.0	100.0	98.2	87.9	99.5	96.9
	s.e.	1.7	0.9	2.1	0.0	0.0	1.8	1.9	0.5	2.0
	(n)	62	72	71	60	72	70	63	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN JACKSONVILLE AIR (continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
DICOFOL										
Detectable	%	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	s.e.	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Undetectable	%	100.0	95.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	s.e.	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(n)	49	72	71	47	72	70	50	71	71
CIS-PERMETHRIN										
Detectable	%	2.8	3.0	2.2	0.0	0.0	0.0	1.4	2.8	2.2
	s.e.	0.5	0.8	2.0	0.0	0.0	0.0	1.6	1.1	2.0
Undetectable	%	97.2	97.0	97.8	100.0	100.0	100.0	98.6	97.2	97.8
	s.e.	0.5	0.8	2.0	0.0	0.0	0.0	1.6	1.1	2.0
	(n)	62	72	71	60	72	70	63	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN JACKSONVILLE AIR (continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
TRANS-PERMETHRIN										
Detectable	%	1.4	3.0	2.2	0.0	0.0	0.0	2.8	0.8	2.2
	s.e.	1.3	0.8	2.0	0.0	0.0	0.0	0.4	0.8	2.0
Undetectable	%	98.6	97.0	97.8	100.0	100.0	100.0	97.2	99.2	97.8
	s.e.	1.3	0.8	2.0	0.0	0.0	0.0	0.4	0.8	2.0
	(n)	62	72	71	60	72	70	63	71	71
CHLORDANE										
Detectable	%	60.7	53.6	94.0	23.5	12.4	72.7	53.4	50.3	92.5
	s.e.	7.2	5.5	4.2	7.9	5.6	4.1	7.5	6.1	3.3
Undetectable	%	39.3	46.4	6.0	76.5	87.6	27.3	46.6	49.7	7.5
	s.e.	7.2	5.5	4.2	7.9	5.6	4.1	7.5	6.1	3.3
	(n)	62	72	71	60	72	70	63	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN JACKSONVILLE AIR (continued)

Analyte			Indoor			Outdoor			Personal		
			Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
4,4'-DDT**											
	Detectable	%	.	13.6	9.4	.	0.0	0.0	.	8.5	6.1
		s.e.	.	6.5	5.8	.	0.0	0.0	.	4.0	4.0
	Undetectable	%	.	86.4	90.6	.	100.0	100.0	.	91.5	93.9
		s.e.	.	6.5	5.8	.	0.0	0.0	.	4.0	4.0
		(n)	0	72	71	0	72	70	0	71	71
4,4'-DDD**											
	Detectable	%	.	0.0	0.0	.	0.0	0.0	.	0.0	0.0
		s.e.	.	0.0	0.0	.	0.0	0.0	.	0.0	0.0
	Undetectable	%	.	100.0	100.0	.	100.0	100.0	.	100.0	100.0
		s.e.	.	0.0	0.0	.	0.0	0.0	.	0.0	0.0
		(n)	0	72	71	0	72	70	0	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN JACKSONVILLE AIR (continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
4,4'-DDE**										
Detectable	%	.	5.7	3.0	.	0.0	0.0	.	4.6	12.1
	s.e.	.	3.7	2.1	.	0.0	0.0	.	3.9	5.0
Undetectable	%	.	94.3	97.0	.	100.0	100.0	.	95.4	87.9
	s.e.	.	3.7	2.1	.	0.0	0.0	.	3.9	5.0
	(n)	0	72	71	0	72	70	0	71	71
ORTHO-PHENYLPHENOL										
Detectable	%	85.1	83.5	79.3	9.7	0.7	2.3	89.6	73.0	70.6
	s.e.	1.2	6.4	4.5	3.7	0.8	1.8	5.6	3.0	4.1
Undetectable	%	14.9	16.5	20.7	90.3	99.3	97.7	10.4	27.0	29.4
	s.e.	1.2	6.4	4.5	3.7	0.8	1.8	5.6	3.0	4.1
	(n)	49	72	71	47	72	70	50	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN JACKSONVILLE AIR (continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
PROPOXUR										
Detectable	%	98.0	93.1	94.8	26.5	7.4	20.6	91.6	93.6	88.3
	s.e.	1.3	3.1	4.1	6.1	3.5	9.1	2.8	4.4	4.9
Undetectable	%	2.0	6.9	5.2	73.5	92.6	79.4	8.4	6.4	11.7
	s.e.	1.3	3.1	4.1	6.1	3.5	9.1	2.8	4.4	4.9
	(n)	49	72	71	47	72	70	50	71	71
BENDIOCARB										
Detectable	%	22.7	20.0	20.0	0.0	0.0	0.0	14.5	20.9	25.9
	s.e.	6.5	4.2	4.2	0.0	0.0	0.0	7.2	2.7	4.7
Undetectable	%	77.3	80.0	80.0	100.0	100.0	100.0	85.5	79.1	74.1
	s.e.	6.5	4.2	4.2	0.0	0.0	0.0	7.2	2.7	4.7
	(n)	49	72	71	47	72	70	50	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS
FOR DETECTABLE LEVELS IN JACKSONVILLE AIR
(continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
ATRAZINE										
Detectable	%	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0
Undetectable	%	100.0	100.0	100.0	100.0	100.0	100.0	97.9	100.0	100.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0
	(n)	49	72	71	47	72	70	50	71	71
DIAZINON										
Detectable	%	83.3	82.9	82.6	39.0	9.2	11.2	79.4	82.5	87.1
	s.e.	2.9	4.5	6.5	8.7	4.4	4.3	3.5	7.0	3.9
Undetectable	%	16.7	17.1	17.4	61.0	90.8	88.8	20.6	17.5	12.9
	s.e.	2.9	4.5	6.5	8.7	4.4	4.3	3.5	7.0	3.9
	(n)	62	72	71	60	72	70	63	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN JACKSONVILLE AIR (continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
CARBARYL										
Detectable	%	17.0	0.7	0.0	2.1	0.0	0.0	2.0	1.5	0.0
	s.e.	5.5	0.4	0.0	2.2	0.0	0.0	2.1	0.9	0.0
Undetectable	%	83.0	99.3	100.0	97.9	100.0	100.0	98.0	98.5	100.0
	s.e.	5.5	0.4	0.0	2.2	0.0	0.0	2.1	0.9	0.0
	(n)	49	72	71	47	72	70	50	71	71
MALATHION										
Detectable	%	26.8	32.2	17.3	2.8	0.0	4.2	15.0	20.7	11.3
	s.e.	3.3	7.2	5.4	1.5	0.0	3.5	5.6	7.0	5.6
Undetectable	%	73.2	67.8	82.7	97.2	100.0	95.8	85.0	79.3	88.7
	s.e.	3.3	7.2	5.4	1.5	0.0	3.5	5.6	7.0	5.6
	(n)	49	72	71	47	72	70	50	71	71

TABLE B-1. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN JACKSONVILLE AIR (continued)

Analyte		Indoor			Outdoor			Personal		
		Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
RESMETHRIN										
Detectable										
	%	0.7	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0
	s.e.	0.8	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0
Undetectable										
	%	99.3	100.0	100.0	100.0	100.0	100.0	97.7	100.0	100.0
	s.e.	0.8	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0
	(n)	62	72	71	60	72	70	63	71	71

* Different ester measured in the Summer season.

** These analytes were not measured in the Summer season.

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
DICHLORVOS							
Detectable	%	1.7	1.3	0.0	0.0	1.5	2.2
	s.e.	1.8	1.2	0.0	0.0	1.6	1.6
Undetectable	%	98.3	98.7	100.0	100.0	98.5	97.8
	s.e.	1.8	1.2	0.0	0.0	1.6	1.6
	(n)	49	51	49	50	48	52
ALPHA-BHC							
Detectable	%	2.0	0.0	0.0	0.0	2.0	0.0
	s.e.	1.9	0.0	0.0	0.0	1.9	0.0
Undetectable	%	98.0	100.0	100.0	100.0	98.0	100.0
	s.e.	1.9	0.0	0.0	0.0	1.9	0.0
	(n)	49	51	49	50	48	52
HEXACHLOROBENZENE							
Detectable	%	0.0	3.6	0.0	0.0	0.0	1.0
	s.e.	0.0	3.0	0.0	0.0	0.0	1.0
Undetectable	%	100.0	96.4	100.0	100.0	100.0	99.0
	s.e.	0.0	3.0	0.0	0.0	0.0	1.0
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
GAMMA-BHC							
Detectable	%	9.9	20.8	0.0	0.0	10.3	8.2
	s.e.	10.0	14.8	0.0	0.0	10.2	9.3
Undetectable	%	90.1	79.2	100.0	100.0	89.7	91.8
	s.e.	10.0	14.8	0.0	0.0	10.2	9.3
	(n)	49	51	49	50	48	52
CHLOROTHALONIL							
Detectable	%	0.5	2.4	11.7	1.3	11.9	2.0
	s.e.	0.2	0.7	9.8	1.0	13.0	0.6
Undetectable	%	99.5	97.6	88.3	98.7	88.1	98.0
	s.e.	0.2	0.7	9.8	1.0	13.0	0.6
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
HEPTACHLOR							
Detectable	%	50.2	69.6	8.3	2.3	49.7	65.5
	s.e.	14.0	11.1	3.9	1.8	17.5	8.9
Undetectable	%	49.8	30.4	91.7	97.7	50.3	34.5
	s.e.	14.0	11.1	3.9	1.8	17.5	8.9
	(n)	49	51	49	50	48	52
RONNEL							
Detectable	%	2.0	0.4	0.0	0.0	2.0	0.4
	s.e.	1.9	0.4	0.0	0.0	1.9	0.4
Undetectable	%	98.0	99.6	100.0	100.0	98.0	99.6
	s.e.	1.9	0.4	0.0	0.0	1.9	0.4
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
CHLORPYRIFOS							
Detectable	%	28.9	30.5	52.1	0.1	29.8	40.0
	s.e.	14.6	9.1	7.1	0.1	15.1	9.1
Undetectable	%	71.1	69.5	47.9	99.9	70.2	60.0
	s.e.	14.6	9.1	7.1	0.1	15.1	9.1
	(n)	49	51	49	50	48	52
ALDRIN							
Detectable	%	0.0	12.3	0.0	0.0	0.0	11.6
	s.e.	0.0	9.3	0.0	0.0	0.0	9.5
Undetectable	%	100.0	87.7	100.0	100.0	100.0	88.4
	s.e.	0.0	9.3	0.0	0.0	0.0	9.5
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
DACTHAL							
Detectable	%	20.6	4.7	17.5	0.0	25.5	4.6
	s.e.	13.8	3.4	10.2	0.0	15.9	1.7
Undetectable	%	79.4	95.3	82.5	100.0	74.5	95.4
	s.e.	13.8	3.4	10.2	0.0	15.9	1.7
	(n)	49	51	49	50	48	52
HEPTACHLOR EPOXIDE							
Detectable	%	0.0	0.0	0.0	0.0	0.0	0.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
Undetectable	%	100.0	100.0	100.0	100.0	100.0	100.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
OXYCHLORDANE							
Detectable	%	0.0	0.0	0.0	0.0	0.0	0.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
Undetectable	%	100.0	100.0	100.0	100.0	100.0	100.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
	(n)	49	51	49	50	48	52
CAPTAN							
Detectable	%	0.3	0.6	0.0	0.0	2.0	0.0
	s.e.	0.3	0.5	0.0	0.0	1.9	0.0
Undetectable	%	99.7	99.4	100.0	100.0	98.0	100.0
	s.e.	0.3	0.5	0.0	0.0	1.9	0.0
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
FOLPET							
Detectable	%	2.0	0.0	2.2	0.0	2.0	0.3
	s.e.	1.9	0.0	2.0	0.0	1.9	0.3
Undetectable	%	98.0	100.0	97.8	100.0	98.0	99.7
	s.e.	1.9	0.0	2.0	0.0	1.9	0.3
	(n)	49	51	49	50	48	52
2,4-D							
Detectable	%	2.0	0.0	0.0	0.0	0.0	0.0
	s.e.	1.9	0.0	0.0	0.0	0.0	0.0
Undetectable	%	98.0	100.0	100.0	100.0	100.0	100.0
	s.e.	1.9	0.0	0.0	0.0	0.0	0.0
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
DIELDRIN							
Detectable	%	11.6	33.8	0.0	0.0	12.0	18.4
	s.e.	12.8	9.2	0.0	0.0	13.0	5.1
Undetectable	%	88.4	66.2	100.0	100.0	88.0	81.6
	s.e.	12.8	9.2	0.0	0.0	13.0	5.1
	(n)	49	51	49	50	48	52
METHOXYCHLOR							
Detectable	%	0.0	0.0	0.0	0.0	0.0	0.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
Undetectable	%	100.0	100.0	100.0	100.0	100.0	100.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
DICOFOL							
Detectable							
	%	0.0	0.0	0.0	0.0	11.9	0.0
	s.e.	0.0	0.0	0.0	0.0	13.0	0.0
Undetectable							
	%	100.0	100.0	100.0	100.0	88.1	100.0
	s.e.	0.0	0.0	0.0	0.0	13.0	0.0
	(n)	49	51	49	50	48	52
CIS-PERMETHRIN							
Detectable							
	%	0.0	0.0	0.0	0.0	0.0	0.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
Undetectable							
	%	100.0	100.0	100.0	100.0	100.0	100.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
TRANS-PERMETHRIN							
Detectable	%	0.0	0.0	0.0	0.0	0.0	0.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
Undetectable	%	100.0	100.0	100.0	100.0	100.0	100.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
	(n)	49	51	49	50	48	52
CHLORDANE							
Detectable	%	50.4	83.2	8.3	15.8	49.7	87.0
	s.e.	14.1	8.8	3.9	5.8	17.5	6.9
Undetectable	%	49.6	16.8	91.7	84.2	50.3	13.0
	s.e.	14.1	8.8	3.9	5.8	17.5	6.9
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
4,4'-DDT							
Detectable	%	0.2	8.4	0.0	1.2	12.0	18.8
	s.e.	0.2	5.0	0.0	1.0	13.0	9.0
Undetectable	%	99.8	91.6	100.0	98.8	88.0	81.2
	s.e.	0.2	5.0	0.0	1.0	13.0	9.0
	(n)	49	51	49	50	48	52
4,4'-DDD							
Detectable	%	0.0	1.1	0.0	0.0	0.0	0.0
	s.e.	0.0	1.3	0.0	0.0	0.0	0.0
Undetectable	%	100.0	98.9	100.0	100.0	100.0	100.0
	s.e.	0.0	1.3	0.0	0.0	0.0	0.0
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
4,4'-DDE							
Detectable	%	12.9	20.1	0.0	0.0	22.7	18.8
	s.e.	10.2	8.2	0.0	0.0	12.5	15.5
Undetectable	%	87.1	79.9	100.0	100.0	77.3	81.2
	s.e.	10.2	8.2	0.0	0.0	12.5	15.5
	(n)	49	51	49	50	48	52
ORTHO-PHENYLPHENOL							
Detectable	%	90.1	71.8	6.9	0.0	81.9	85.7
	s.e.	1.8	8.5	2.2	0.0	6.0	7.5
Undetectable	%	9.9	28.2	93.1	100.0	18.1	14.3
	s.e.	1.8	8.5	2.2	0.0	6.0	7.5
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
PROPOXUR							
Detectable	%	48.9	38.1	4.0	1.3	31.7	38.3
	s.e.	17.0	10.2	2.4	1.0	14.8	6.6
Undetectable	%	51.1	61.9	96.0	98.7	68.3	61.7
	s.e.	17.0	10.2	2.4	1.0	14.8	6.6
	(n)	49	51	49	50	48	52
BENDIOCARB							
Detectable	%	1.8	1.2	0.0	0.0	2.0	1.2
	s.e.	1.9	1.1	0.0	0.0	1.9	0.9
Undetectable	%	98.2	98.8	100.0	100.0	98.0	98.8
	s.e.	1.9	1.1	0.0	0.0	1.9	0.9
	(n)	49	46	49	46	48	47

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
ATRAZINE							
Detectable							
	%	0.0	0.0	0.0	0.0	0.0	0.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
Undetectable							
	%	100.0	100.0	100.0	100.0	100.0	100.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
	(n)	49	51	49	50	48	52
DIAZINON							
Detectable							
	%	16.4	10.4	12.2	8.0	16.6	9.8
	s.e.	5.6	5.0	6.0	6.7	5.7	6.2
Undetectable							
	%	83.6	89.6	87.8	92.0	83.4	90.2
	s.e.	5.6	5.0	6.0	6.7	5.7	6.2
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
CARBARYL							
Detectable	%	1.8	0.0	0.0	0.0	2.0	0.0
	s.e.	1.8	0.0	0.0	0.0	1.9	0.0
Undetectable	%	98.2	100.0	100.0	100.0	98.0	100.0
	s.e.	1.8	0.0	0.0	0.0	1.9	0.0
	(n)	49	51	49	50	48	52
MALATHION							
Detectable	%	1.8	0.0	5.3	0.0	3.6	0.0
	s.e.	1.8	0.0	1.7	0.0	0.6	0.0
Undetectable	%	98.2	100.0	94.7	100.0	96.4	100.0
	s.e.	1.8	0.0	1.7	0.0	0.6	0.0
	(n)	49	51	49	50	48	52

TABLE B-2. WEIGHTED ESTIMATES AND STANDARD ERRORS FOR DETECTABLE LEVELS IN SPRINGFIELD/CHICOPEE AIR (continued)

Analyte		Indoor		Outdoor		Personal	
		Spring	Winter	Spring	Winter	Spring	Winter
RESMETHRIN							
Detectable	%	0.0	0.0	0.0	0.0	0.0	0.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
Undetectable	%	100.0	100.0	100.0	100.0	100.0	100.0
	s.e.	0.0	0.0	0.0	0.0	0.0	0.0
	(n)	49	51	49	50	48	52

TABLE B-3. WEIGHTED SUMMARY STATISTICS
FOR JACKSONVILLE AIR CONCENTRATIONS
(ng/cubic meter)

Analyte	Indoor			Outdoor			Personal		
	Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
DICHLORVOS									
Mean	134.54	86.21	24.51	0.00	0.00	3.22	147.60	40.15	21.38
S.E.	46.91	61.47	8.01	0.00	0.00	2.85	36.32	29.21	6.47
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	2280.00	2910.00	1090.00	0.00	0.00	148.00	2460.00	836.00	911.00
(n)	49	72	71	47	72	70	50	71	71
ALPHA-BHC									
Mean	1.20	1.17	1.13	0.02	0.00	0.03	0.88	0.84	0.73
S.E.	0.54	0.28	0.64	0.02	0.00	0.03	0.28	0.26	0.26
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	32.00	28.00	32.00	0.70	0.00	1.50	28.00	27.00	16.00
(n)	62	72	71	60	72	70	63	71	71
HEXACHLOROBENZENE									
Mean	1.26	0.37	0.30	0.22	0.00	0.00	0.94	0.35	0.39
S.E.	0.37	0.17	0.19	0.13	0.00	0.00	0.23	0.24	0.29
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	21.00	7.70	5.30	13.00	0.00	0.00	8.00	12.00	9.80
(n)	62	72	71	60	72	70	63	71	71

TABLE B-3. WEIGHTED SUMMARY STATISTICS
FOR JACKSONVILLE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor			Outdoor			Personal		
	Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
GAMMA-BHC									
Mean	20.16	13.40	5.98	1.31	0.49	0.60	22.06	7.02	8.52
S.E.	9.57	5.58	2.30	0.26	0.11	0.26	10.21	3.93	5.80
Median	0.00	0.00	2.10	0.00	0.00	0.00	0.00	0.00	1.90
Maximum	245.00	1530.00	75.00	28.00	19.00	6.30	412.00	774.00	276.00
(n)	62	72	71	60	72	70	63	71	71
CHLOROTHALONIL									
Mean	5.25	2.21	6.73	0.22	0.30	0.57	0.49	0.03	2.54
S.E.	4.25	0.80	3.35	0.15	0.19	0.24	0.33	0.03	1.36
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	264.00	51.00	523.00	13.00	5.70	13.00	8.40	10.00	88.00
(n)	49	72	71	47	72	70	50	71	71
HEPTACHLOR									
Mean	163.39	153.93	72.21	30.23	10.72	2.75	129.11	133.65	64.18
S.E.	60.11	50.42	31.48	20.63	3.84	0.96	39.64	39.30	35.43
Median	10.00	17.00	8.40	0.00	0.00	0.00	0.00	10.00	10.00
Maximum	1600.00	2370.00	684.00	627.00	220.00	24.00	1610.00	1530.00	655.00
(n)	62	72	71	60	72	70	63	71	71
RONNEL									
Mean	0.16	0.00	0.00	0.06	0.00	0.00	0.08	0.00	0.03
S.E.	0.12	0.00	0.00	0.05	0.00	0.00	0.06	0.00	0.03
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	20.00	0.00	0.00	6.20	0.00	0.00	13.00	0.00	3.90
(n)	62	72	71	60	72	70	63	71	71

TABLE B-3. WEIGHTED SUMMARY STATISTICS
FOR JACKSONVILLE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor			Outdoor			Personal		
	Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
CHLORPYRIFOS									
Mean	366.60	205.36	120.32	16.69	3.45	2.49	280.38	182.75	118.15
S.E.	64.77	40.59	14.78	3.34	0.53	0.24	50.10	35.49	27.06
Median	182.00	79.00	69.00	8.80	0.00	0.00	160.00	85.00	56.00
Maximum	2170.00	4350.00	1043.30	206.00	84.00	26.00	2770.00	5150.00	1520.00
(n)	62	72	71	60	72	70	63	71	71
ALDRIN									
Mean	31.34	6.80	6.90	0.18	0.00	0.10	19.89	38.54	5.86
S.E.	18.40	3.00	1.25	0.09	0.00	0.06	10.81	31.40	1.58
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	1840.00	320.00	106.00	3.90	0.00	3.00	1020.00	2520.00	68.00
(n)	62	72	71	60	72	70	63	71	71
DACTHAL									
Mean	0.17	0.00	0.29	0.00	0.00	0.00	0.63	0.00	0.23
S.E.	0.15	0.00	0.14	0.00	0.00	0.00	0.47	0.00	0.10
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	12.00	0.00	3.20	0.00	0.00	0.00	37.00	0.00	3.20
(n)	62	72	71	60	72	70	63	71	71
HEPTACHLOR EPOXIDE									
Mean	0.53	0.84	0.80	0.73	0.06	0.00	0.61	0.51	0.06
S.E.	0.11	0.61	0.30	0.31	0.05	0.00	0.23	0.35	0.06
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	11.00	160.00	30.00	11.00	12.00	0.00	22.00	67.00	3.10
(n)	62	72	71	60	72	70	63	71	71

TABLE B-3. WEIGHTED SUMMARY STATISTICS
FOR JACKSONVILLE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor			Outdoor			Personal		
	Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
OXYCHLORDANE									
Mean	0.07	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
S.E.	0.06	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	5.20	0.00	6.50	0.00	0.00	0.00	0.00	0.00	0.00
(n)	62	72	71	60	72	70	63	71	71
CAPTAN									
Mean	1.85	2.20	0.08	0.00	0.00	0.00	0.00	0.07	0.10
S.E.	1.83	1.42	0.08	0.00	0.00	0.00	0.00	0.07	0.07
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	44.00	254.00	21.00	0.00	0.00	0.00	0.00	3.10	16.00
(n)	49	72	71	47	72	70	50	71	71
FOLPET									
Mean	0.48	0.66	0.61	0.32	0.36	0.00	0.41	0.40	0.80
S.E.	0.49	0.32	0.48	0.31	0.30	0.00	0.43	0.22	0.74
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	23.00	65.00	24.00	13.00	21.00	0.00	20.00	37.00	37.00
(n)	49	72	71	47	72	70	50	71	71
2,4-D *									
Mean	1.80	0.00	2.54	0.02	0.00	0.80	0.72	0.00	3.47
S.E.	1.29	0.00	0.81	0.02	0.00	0.44	0.77	0.00	0.71
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	48.00	0.00	58.00	1.20	0.00	44.00	25.00	0.00	40.00
(n)	49	72	71	47	72	70	50	71	71

TABLE B-3. WEIGHTED SUMMARY STATISTICS FOR JACKSONVILLE AIR CONCENTRATIONS (ng/cubic meter) (continued)

Analyte	Indoor			Outdoor			Personal		
	Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
DIELDRIN									
Mean	14.65	8.26	7.16	0.68	0.03	0.78	10.11	5.36	4.78
S.E.	2.41	2.53	1.85	0.14	0.03	0.35	1.47	1.34	0.77
Median	5.60	0.00	3.70	0.00	0.00	0.00	4.40	0.00	1.70
Maximum	177.00	61.00	57.00	12.00	5.60	20.00	71.00	82.00	46.00
(n)	62	72	71	60	72	70	63	71	71
METHOXYCHLOR									
Mean	0.22	0.29	0.18	0.00	0.00	0.13	0.27	0.10	0.60
S.E.	0.10	0.27	0.14	0.00	0.00	0.13	0.12	0.09	0.46
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	17.00	55.00	7.00	0.00	0.00	7.40	6.10	55.00	80.00
(n)	62	72	71	60	72	70	63	71	71
DICOFOL									
Mean	0.00	10.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S.E.	0.00	5.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	581.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(n)	49	72	71	47	72	70	50	71	71
CIS-PERMETHRIN									
Mean	0.53	1.91	1.34	0.00	0.00	0.00	0.07	1.26	0.82
S.E.	0.34	0.51	1.24	0.00	0.00	0.00	0.07	0.23	0.76
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	33.00	153.00	62.00	0.00	0.00	0.00	4.60	67.00	38.00
(n)	62	72	71	60	72	70	63	71	71

TABLE B-3. WEIGHTED SUMMARY STATISTICS
FOR JACKSONVILLE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor			Outdoor			Personal		
	Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
TRANS-PERMETHRIN									
Mean	0.43	1.07	0.80	0.00	0.00	0.00	0.15	0.28	0.50
S.E.	0.39	0.13	0.74	0.00	0.00	0.00	0.07	0.30	0.46
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	31.00	56.00	37.00	0.00	0.00	0.00	7.00	37.00	23.00
(n)	62	72	71	60	72	70	63	71	71
CHLORDANE									
Mean	324.00	245.55	220.31	38.43	9.47	27.35	211.98	190.72	194.77
S.E.	86.40	40.18	87.10	21.57	1.93	5.91	39.52	40.04	95.70
Median	84.00	51.00	71.00	0.00	0.00	20.00	65.00	35.00	70.00
Maximum	3020.00	4380.00	2050.00	628.00	266.00	175.00	1340.00	2990.00	2200.00
(n)	62	72	71	60	72	70	63	71	71
4,4'-DDT **									
Mean	.	1.01	0.54	.	0.00	0.00	.	0.53	0.35
S.E.	.	0.54	0.36	.	0.00	0.00	.	0.29	0.23
Median	.	0.00	0.00	.	0.00	0.00	.	0.00	0.00
Maximum	.	13.00	11.00	.	0.00	0.00	.	7.00	11.00
(n)	0	72	71	0	72	70	0	71	71
4,4'-DDD **									
Mean	.	0.00	0.00	.	0.00	0.00	.	0.00	0.00
S.E.	.	0.00	0.00	.	0.00	0.00	.	0.00	0.00
Median	.	0.00	0.00	.	0.00	0.00	.	0.00	0.00
Maximum	.	0.00	0.00	.	0.00	0.00	.	0.00	0.00
(n)	0	72	71	0	72	70	0	71	71

TABLE B-3. WEIGHTED SUMMARY STATISTICS FOR JACKSONVILLE AIR CONCENTRATIONS (ng/cubic meter) (continued)

Analyte	Indoor			Outdoor			Personal		
	Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
4,4'-DDE **									
Mean	.	0.55	0.17	.	0.00	0.00	.	0.44	0.77
S.E.	.	0.29	0.12	.	0.00	0.00	.	0.36	0.38
Median	.	0.00	0.00	.	0.00	0.00	.	0.00	0.00
Maximum	.	15.00	8.80	.	0.00	0.00	.	12.00	15.00
(n)	0	72	71	0	72	70	0	71	71
ORTHO-PHENYLPHENOL									
Mean	96.04	70.43	58.99	1.23	0.02	0.09	79.74	55.57	39.68
S.E.	16.39	15.87	26.20	0.58	0.03	0.07	16.91	12.39	11.37
Median	72.00	43.00	20.00	0.00	0.00	0.00	58.00	32.00	20.00
Maximum	1040.00	1240.00	1440.00	27.00	3.40	4.00	990.00	460.00	521.00
(n)	49	72	71	47	72	70	50	71	71
PROPOXUR									
Mean	528.46	222.28	162.52	10.21	0.83	2.49	315.60	141.09	142.83
S.E.	207.79	92.84	59.06	6.21	0.50	1.61	97.74	51.53	45.43
Median	113.00	65.00	52.00	0.00	0.00	0.00	122.00	46.00	37.00
Maximum	7920.00	2030.00	1370.00	286.00	20.00	65.00	3930.00	1260.00	1740.00
(n)	49	72	71	47	72	70	50	71	71
BENDIOCARB									
Mean	85.73	5.46	3.36	0.00	0.00	0.00	51.40	4.40	3.50
S.E.	59.76	2.68	1.02	0.00	0.00	0.00	37.37	1.04	1.17
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	1500.00	89.00	68.00	0.00	0.00	0.00	948.00	55.00	76.00
(n)	49	72	71	47	72	70	50	71	71

TABLE B-3. WEIGHTED SUMMARY STATISTICS
FOR JACKSONVILLE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor			Outdoor			Personal		
	Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
ATRAZINE									
Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00
S.E.	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	16.00	0.00	0.00
(n)	49	72	71	47	72	70	50	71	71
DIAZINON									
Mean	420.71	109.16	85.73	12.57	1.10	13.75	321.64	112.65	88.99
S.E.	127.15	21.56	19.00	5.67	0.38	13.42	50.26	23.11	29.20
Median	73.00	39.00	21.00	0.00	0.00	0.00	62.00	36.00	27.00
Maximum	13700	2370.00	1080.00	292.00	35.00	646.00	4650.00	1660.00	1330.00
(n)	62	72	71	60	72	70	63	71	71
CARBARYL									
Mean	68.11	0.43	0.00	0.23	0.00	0.00	28.30	0.76	0.00
S.E.	66.50	0.30	0.00	0.24	0.00	0.00	30.42	0.49	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	3190.00	97.00	0.00	11.00	0.00	0.00	1420.00	141.00	0.00
(n)	49	72	71	47	72	70	50	71	71
MALATHION									
Mean	20.84	14.95	20.40	0.31	0.00	0.19	9.17	10.14	16.77
S.E.	14.30	10.09	12.66	0.16	0.00	0.13	5.97	6.32	13.52
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	1890.00	240.00	1660.00	21.00	0.00	13.00	709.00	156.00	392.00
(n)	49	72	71	47	72	70	50	71	71

TABLE B-3. WEIGHTED SUMMARY STATISTICS
FOR JACKSONVILLE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor			Outdoor			Personal		
	Summer	Spring	Winter	Summer	Spring	Winter	Summer	Spring	Winter
RESMETHRIN									
Mean	0.14	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00
S.E.	0.15	0.00	0.00	0.00	0.00	0.00	0.39	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	19.00	0.00	0.00	0.00	0.00	0.00	21.00	0.00	0.00
(n)	62	72	71	60	72	70	63	71	71

*
Different ester measured in the two seasons
**
These analytes were not measured in the Summer season.

TABLE B-4. WEIGHTED SUMMARY STATISTICS
FOR SPRINGFIELD/CHICOPEE AIR CONCENTRATIONS
(ng/cubic meter)

Analyte	Indoor		Outdoor		Personal	
	Spring	Winter	Spring	Winter	Spring	Winter
DICHLORVOS						
Mean	4.34	1.45	0.00	0.00	3.71	2.10
s.e.	4.42	1.28	0.00	0.00	3.77	1.56
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	324.00	158.00	0.00	0.00	241.00	105.00
(n)	49	51	49	50	48	52
ALPHA-BHC						
Mean	0.16	0.00	0.00	0.00	0.03	0.00
s.e.	0.15	0.00	0.00	0.00	0.03	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	8.00	0.00	0.00	0.00	1.50	0.00
(n)	49	51	49	50	48	52
HEXACHLOROBENZENE						
Mean	0.00	0.12	0.00	0.00	0.00	0.03
s.e.	0.00	0.10	0.00	0.00	0.00	0.03
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	5.70	0.00	0.00	0.00	2.70
(n)	49	51	49	50	48	52

TABLE B-4. WEIGHTED SUMMARY STATISTICS
FOR SPRINGFIELD/CHICOPEE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor		Outdoor		Personal	
	Spring	Winter	Spring	Winter	Spring	Winter
GAMMA-BHC						
Mean	0.50	9.51	0.00	0.00	0.71	5.42
s.e.	0.50	11.08	0.00	0.00	0.70	6.40
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	5.00	118.00	0.00	0.00	12.00	70.00
(n)	49	51	49	50	48	52
CHLOROTHALONIL						
Mean	0.09	0.09	0.40	0.76	0.83	0.08
s.e.	0.05	0.02	0.27	0.46	0.91	0.03
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	35.00	9.20	44.00	142.00	7.00	9.00
(n)	49	51	49	50	48	52
HEPTACHLOR						
Mean	31.26	3.64	0.26	0.08	34.75	4.58
s.e.	24.47	0.89	0.16	0.05	32.18	0.80
Median	3.40	1.30	0.00	0.00	0.00	3.70
Maximum	253.00	152.00	7.20	41.00	313.00	137.00
(n)	49	51	49	50	48	52
RONNEL						
Mean	0.18	0.02	0.00	0.00	0.14	0.01
s.e.	0.16	0.02	0.00	0.00	0.13	0.01
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	8.80	4.80	0.00	0.00	6.90	3.60
(n)	49	51	49	50	48	52

TABLE B-4. WEIGHTED SUMMARY STATISTICS
FOR SPRINGFIELD/CHICOPEE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor		Outdoor		Personal	
	Spring	Winter	Spring	Winter	Spring	Winter
CHLORPYRIFOS						
Mean	9.79	5.05	13.90	0.01	7.50	5.87
s.e.	5.73	1.59	10.17	0.01	3.79	1.35
Median	0.00	0.00	2.70	0.00	0.00	0.00
Maximum	252.00	291.00	523.00	7.50	189.00	210.00
(n)	49	51	49	50	48	52
ALDRIN						
Mean	0.00	0.28	0.00	0.00	0.00	0.22
s.e.	0.00	0.21	0.00	0.00	0.00	0.18
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	3.90	0.00	0.00	0.00	2.10
(n)	49	51	49	50	48	52
DACTHAL						
Mean	1.60	0.34	0.89	0.00	2.60	0.25
s.e.	0.91	0.24	0.56	0.00	1.94	0.12
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	32.00	15.00	26.00	0.00	13.00	16.00
(n)	49	51	49	50	48	52
HEPTACHLOR EPOXIDE						
Mean	0.00	0.00	0.00	0.00	0.00	0.00
s.e.	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00
(n)	49	51	49	50	48	52

TABLE B-4. WEIGHTED SUMMARY STATISTICS
FOR SPRINGFIELD/CHICOPEE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor		Outdoor		Personal	
	Spring	Winter	Spring	Winter	Spring	Winter
OXYCHLORDANE						
Mean	0.00	0.00	0.00	0.00	0.00	0.00
s.e.	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00
(n)	49	51	49	50	48	52
CAPTAN						
Mean	0.05	0.03	0.00	0.00	0.13	0.00
s.e.	0.04	0.03	0.00	0.00	0.12	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	22.00	6.40	0.00	0.00	8.20	0.00
(n)	49	51	49	50	48	52
FOLPET						
Mean	0.72	0.00	0.46	0.00	0.66	0.01
s.e.	0.67	0.00	0.43	0.00	0.60	0.01
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	36.00	0.00	21.00	0.00	32.00	3.90
(n)	49	51	49	50	48	52
2,4-D						
Mean	2.09	0.00	0.00	0.00	0.00	0.00
s.e.	1.93	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	104.00	0.00	0.00	0.00	0.00	0.00
(n)	49	51	49	50	48	52

TABLE B-4. WEIGHTED SUMMARY STATISTICS
FOR SPRINGFIELD/CHICOPEE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor		Outdoor		Personal	
	Spring	Winter	Spring	Winter	Spring	Winter
DIELDRIN						
Mean	1.02	4.17	0.00	0.00	0.82	0.75
s.e.	1.12	2.91	0.00	0.00	0.89	0.28
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	8.80	40.00	0.00	0.00	7.00	5.50
(n)	49	51	49	50	48	52
METHOXYCHLOR						
Mean	0.00	0.00	0.00	0.00	0.00	0.00
s.e.	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00
(n)	49	51	49	50	48	52
DICOFOL						
Mean	0.00	0.00	0.00	0.00	6.99	0.00
s.e.	0.00	0.00	0.00	0.00	7.68	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	59.00	0.00
(n)	49	51	49	50	48	52
CIS-PERMETHRIN						
Mean	0.00	0.00	0.00	0.00	0.00	0.00
s.e.	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00
(n)	49	51	49	50	48	52

TABLE B-4. WEIGHTED SUMMARY STATISTICS
FOR SPRINGFIELD/CHICOPEE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor		Outdoor		Personal	
	Spring	Winter	Spring	Winter	Spring	Winter
TRANS-PERMETHRIN						
Mean	0.00	0.00	0.00	0.00	0.00	0.00
s.e.	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00
(n)	49	51	49	50	48	52
CHLORDANE						
Mean	199.34	34.75	3.14	2.02	252.91	35.87
s.e.	174.47	5.91	1.40	0.56	230.81	7.73
Median	29.00	25.00	0.00	0.00	0.00	25.00
Maximum	1700.00	735.00	75.00	89.00	2220.00	467.00
(n)	49	51	49	50	48	52
4,4'-DDT						
Mean	0.01	0.55	0.00	0.23	0.90	0.74
s.e.	0.01	0.16	0.00	0.18	0.98	0.36
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	6.30	15.00	0.00	19.00	7.50	6.20
(n)	49	51	49	50	48	52
4,4'-DDD						
Mean	0.00	0.01	0.00	0.00	0.00	0.00
s.e.	0.00	0.01	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.80	0.00	0.00	0.00	0.00
(n)	49	51	49	50	48	52

TABLE B-4. WEIGHTED SUMMARY STATISTICS
FOR SPRINGFIELD/CHICOPEE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor		Outdoor		Personal	
	Spring	Winter	Spring	Winter	Spring	Winter
4,4'-DDE						
Mean	0.85	0.60	0.00	0.00	4.91	0.50
s.e.	0.65	0.30	0.00	0.00	3.69	0.42
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	8.40	3.50	0.00	0.00	38.00	3.60
(n)	49	51	49	50	48	52
ORTHO-PHENYLPHENOL						
Mean	44.53	22.84	1.55	0.00	43.38	27.34
s.e.	7.78	7.66	0.98	0.00	10.53	7.00
Median	25.00	11.00	0.00	0.00	30.00	15.00
Maximum	560.00	286.00	52.00	0.00	383.00	625.00
(n)	49	51	49	50	48	52
PROPOXUR						
Mean	26.70	17.00	0.78	0.07	16.24	11.28
s.e.	12.80	6.04	0.61	0.04	8.83	4.21
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	505.00	669.00	33.00	23.00	271.00	183.00
(n)	49	51	49	50	48	52
BENDIOCARB						
Mean	0.18	0.43	0.00	0.00	0.26	0.16
s.e.	0.19	0.43	0.00	0.00	0.25	0.11
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	10.00	38.00	0.00	0.00	13.00	15.00
(n)	49	46	49	46	48	47

TABLE B-4. WEIGHTED SUMMARY STATISTICS
FOR SPRINGFIELD/CHICOPEE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor		Outdoor		Personal	
	Spring	Winter	Spring	Winter	Spring	Winter
ATRAZINE						
Mean	0.00	0.00	0.00	0.00	0.00	0.00
s.e.	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00
(n)	49	51	49	50	48	52
DIAZINON						
Mean	48.43	2.48	8.21	9.23	10.07	1.43
s.e.	34.31	1.42	7.13	7.82	6.48	0.69
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	1810.00	27.00	391.00	116.00	318.00	65.00
(n)	49	51	49	50	48	52
CARBARYL						
Mean	0.29	0.00	0.00	0.00	0.13	0.00
s.e.	0.29	0.00	0.00	0.00	0.12	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	16.00	0.00	0.00	0.00	6.20	0.00
(n)	49	51	49	50	48	52
MALATHION						
Mean	4.96	0.00	0.82	0.00	0.48	0.00
s.e.	5.00	0.00	0.32	0.00	0.28	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	275.00	0.00	24.00	0.00	20.00	0.00
(n)	49	51	49	50	48	52

TABLE B-4. WEIGHTED SUMMARY STATISTICS
FOR SPRINGFIELD/CHICOPEE AIR CONCENTRATIONS
(ng/cubic meter)
(continued)

Analyte	Indoor		Outdoor		Personal	
	Spring	Winter	Spring	Winter	Spring	Winter
RESMETHRIN						
Mean	0.00	0.00	0.00	0.00	0.00	0.00
s.e.	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00
(n)	49	51	49	50	48	52

Appendix C
Weighted Percentiles for All Analytes

NOPES Weighted Percentiles - Jacksonville
(ng/m^3)

Analyte	Percentile	Summer			Spring			Winter		
		Indoor	Outdoor	Personal	Indoor	Outdoor	Personal	Indoor	Outdoor	Personal
alpha-BHC	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	1	0	0	0	0	0	1
	90	2	0	3	4	0	2	3	0	3
	95	8	0	4	6	0	3	4	0	4
	99	32	1	28	15	0	16	22	2	7
Aldrin	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	2	0	0	0	12	0	11
	90	23	0	16	16	0	10	19	0	18
	95	76	2	41	18	0	10	29	1	22
	99	835	4	705	199	0	2,520	87	3	62
Atrazine	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	0	0	0	0	0	0	0	0	0
	95	0	0	0	0	0	0	0	0	0
	99	0	0	16	0	0	0	0	0	0
Bendiocarb	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	3
	90	80	0	120	20	0	19	11	0	15
	95	735	0	369	43	0	21	25	0	21
	99	1,500	0	948	89	0	55	66	0	51
Captan	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	0	0	0	0	0	0	0	0	0
	95	0	0	0	0	0	0	0	0	0
	99	44	0	0	30	0	3	0	0	0

(continued)

NOPES Weighted Percentiles - Jacksonville (Continued)
(ng/m^3)

Analyte	Percentile	Summer Indoor	Summer Outdoor	Summer Personal	Spring Indoor	Spring Outdoor	Spring Personal	Winter Indoor	Winter Outdoor	Winter Personal
Carbaryl	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	13	0	0	0	0	0	0	0	0
	95	46	0	0	0	0	0	0	0	0
	99	3,190	11	1,420	0	0	29	0	0	0
Chlordane	25	0	0	0	0	0	0	35	0	28
	50	84	0	65	51	0	35	71	20	70
	75	307	0	186	227	0	203	180	36	144
	90	1,020	72	855	823	50	515	584	66	346
	95	1,720	244	1,060	1,700	55	1,140	956	96	955
	99	3,020	628	1,340	1,910	194	1,500	2,050	175	2,200
Chlorothalonil	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	0	0	0	6	0	0	7	0	7
	95	4	0	7	19	2	0	31	6	11
	99	264	13	8	38	5	0	139	11	88
Chlorpyrifos	25	61	5	66	28	0	29	24	0	33
	50	182	9	160	79	0	85	69	0	56
	75	573	14	437	244	4	225	169	3	148
	90	909	38	614	566	9	328	262	8	235
	95	1,070	46	738	905	17	429	395	13	277
	99	1,600	206	1,910	1,400	44	2,580	981	26	1,520
cis-Permethrin	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	0	0	0	0	0	0	0	0	0
	95	0	0	0	0	0	0	0	0	0
	99	33	0	5	89	0	38	62	0	38

(continued)

NOPES Weighted Percentiles - Jacksonville (Continued)
(ng/m^3)

Analyte	Percentile	Summer Indoor	Summer Outdoor	Summer Personal	Spring Indoor	Spring Outdoor	Spring Personal	Winter Indoor	Winter Outdoor	Winter Personal
Dacthal	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	0	0	0	0	0	0	0	0	0
	95	0	0	0	0	0	0	3	0	3
	99	12	0	37	0	0	0	3	0	3
Diazinon	25	17	0	14	13	0	19	7	0	11
	50	73	0	62	39	0	36	21	0	27
	75	208	8	268	114	0	134	130	0	84
	90	673	23	831	408	0	429	204	4	150
	95	2,180	54	1,860	490	8	497	321	25	454
	99	5,400	292	2,460	527	21	541	1,080	646	1,330
Dichlorvos	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	65	0	194	0	0	0	0	0	0
	90	565	0	544	166	0	35	0	0	38
	95	693	0	603	613	0	424	126	0	104
	99	1,000	0	1,290	1,510	0	734	479	148	394
Dicofol	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	0	0	0	0	0	0	0	0	0
	95	0	0	0	73	0	0	0	0	0
	99	0	0	0	581	0	0	0	0	0
Dieldrin	25	1	0	0	0	0	0	0	0	0
	50	6	0	4	0	0	0	4	0	2
	75	18	1	13	12	0	0	8	0	9
	90	38	2	30	29	0	20	18	2	13
	95	51	3	58	36	0	43	33	4	14
	99	177	8	71	61	0	82	57	20	46

(continued)

NOPES Weighted Percentiles - Jacksonville (Continued)
(ng/m^3)

Analyte	Percentile	Summer Indoor	Summer Outdoor	Summer Personal	Spring Indoor	Spring Outdoor	Spring Personal	Winter Indoor	Winter Outdoor	Winter Personal
Folpet	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	0	0	0	0	0	0	0	0	0
	95	0	4	0	0	0	0	0	0	0
	99	23	13	20	52	20	24	24	0	37
gamma-BHC	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	2	0	2
	75	12	0	5	10	0	4	4	0	5
	90	88	5	39	23	2	12	11	2	7
	95	173	10	166	30	3	14	24	4	24
	99	245	23	412	129	7	107	75	6	276
Heptachlor	25	0	0	0	0	0	0	4	0	4
	50	10	0	0	17	0	10	8	0	10
	75	64	0	110	84	0	88	38	3	30
	90	699	50	298	368	32	376	156	8	143
	95	1,170	195	835	1,220	94	1,090	551	16	615
	99	1,560	627	1,610	2,370	136	1,530	649	24	655
Heptachlor epoxide	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	1	0	0	0	0	0	0	0
	90	1	1	1	0	0	0	0	0	9
	95	4	4	4	0	0	0	7	0	0
	99	11	11	22	11	0	11	30	0	3
Hexachlorobenzene	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	1	0	1	0	0	0	0	0	0
	90	4	1	4	0	0	0	0	0	0
	95	5	1	5	6	0	2	4	0	3
	99	21	13	6	8	0	8	5	0	10

(continued)

NOPES Weighted Percentiles - Jacksonville (Continued)
(ng/m^3)

Analyte	Percentile	Summer			Spring			Winter		
		Indoor	Outdoor	Personal	Indoor	Outdoor	Personal	Indoor	Outdoor	Personal
Malathion	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	6	0	0	7	0	0	0	0	0
	90	15	0	17	30	0	26	6	0	6
	95	20	0	20	109	0	72	11	0	25
	99	38	6	48	240	0	156	342	4	392
Methoxychlor	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	0	0	1	0	0	0	0	0	0
	95	1	0	3	0	0	0	0	0	0
	99	2	0	4	0	0	0	7	7	6
ortho-Phenylphenol	25	17	0	29	13	0	0	7	0	0
	50	72	0	58	43	0	32	20	0	20
	75	108	0	93	67	0	65	47	0	46
	90	189	0	171	123	0	133	101	0	96
	95	235	11	198	243	0	140	190	0	169
	99	1,040	27	252	610	0	460	1,440	4	521
Oxychlordane	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	0	0	0	0	0	0	0	0	0
	95	0	0	0	0	0	0	0	0	0
	99	3	0	0	0	0	0	0	0	0
Propoxur	25	36	0	42	22	0	14	14	0	11
	50	113	0	122	65	0	46	52	0	37
	75	535	6	385	171	0	118	122	0	94
	90	931	15	722	502	0	432	509	5	576
	95	1,100	52	751	1,220	9	489	903	9	751
	99	7,920	286	3,930	2,030	15	1,260	903	65	943

(continued)

NOPES Weighted Percentiles - Jacksonville (Continued)
(ng/m3)

Analyte	Percentile	Summer			Spring			Winter		
		Indoor	Outdoor	Personal	Indoor	Outdoor	Personal	Indoor	Outdoor	Personal
Resmethrin	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	0	0	0	0	0	0	0	0	0
	95	0	0	0	0	0	0	0	0	0
	99	0	0	21	0	0	0	0	0	0
Ronnel	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	0	0	0	0	0	0	0	0	0
	95	0	0	0	0	0	0	0	0	0
	99	3	0	2	0	0	0	0	0	0
trans-Permethrin	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	0	0	0	0	0	0	0	0	0
	95	0	0	0	0	0	0	0	0	0
	99	31	0	7	49	0	0	37	0	23
2,4-D (butoxyethyl ester)*	25	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0
	90	0	0	0	0	0	0	0	0	21
	95	18	0	6	0	0	0	26	0	27
	99	48	1	25	0	0	0	39	24	40
4,4'-DDD	25	-	-	-	0	0	0	0	0	0
	50	-	-	-	0	0	0	0	0	0
	75	-	-	-	0	0	0	0	0	0
	90	-	-	-	0	0	0	0	0	0
	95	-	-	-	0	0	0	0	0	0
	99	-	-	-	0	0	0	0	0	0

(continued)

NOPES Weighted Percentiles - Jacksonville (Continued)
(ng/m³)

Analyte	Percentile	Summer			Spring			Winter		
		Indoor	Outdoor	Personal	Indoor	Outdoor	Personal	Indoor	Outdoor	Personal
4,4'-DDE	25	-	-	-	0	0	0	0	0	0
	50	-	-	-	0	0	0	0	0	0
	75	-	-	-	0	0	0	0	0	0
	90	-	-	-	0	0	0	0	0	4
	95	-	-	-	8	0	0	0	0	6
	99	-	-	-	15	0	12	6	0	15
4,4'-DDT	25	-	-	-	0	0	0	0	0	0
	50	-	-	-	0	0	0	0	0	0
	75	-	-	-	0	0	0	0	0	0
	90	-	-	-	7	0	0	0	0	0
	95	-	-	-	7	0	6	5	0	2
	99	-	-	-	17	0	7	10	0	11

*The methyl ester was tested for in the summer season.

NOPES Weighted Percentile - Springfield/Chicopee
(ng/m^3)

Analyte	Percentile	Spring Indoor	Spring Outdoor	Spring Personal	Winter Indoor	Winter Outdoor	Winter Personal
alpha-BHC	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	8	0	2	0	0	0
Aldrin	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	2	0	2
	95	0	0	0	2	0	2
	99	0	0	0	2	0	2
Atrazine	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	0	0	0	0	0	0
Bendiocarb	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	10	0	13	38	0	13
Captan	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	0	0	6	0	0	0
Carbaryl	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	16	0	6	0	0	0
Chlordane	25	0	0	0	14	0	16
	50	29	0	0	25	0	25
	75	70	0	99	45	0	37
	90	544	0	2,220	62	8	85
	95	1,700	35	2,220	76	10	103
	99	1,700	43	2,220	206	40	298

(continued)

NOPES Weighted Percentile - Springfield/Chicopee (Continued)
(ng/m^3)

Analyte	Percentile	Spring Indoor	Spring Outdoor	Spring Personal	Winter Indoor	Winter Outdoor	Winter Personal
Chlorothalonil	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	3	7	0	0	0
	95	0	3	7	0	0	0
	99	0	3	7	3	40	3
Chlorpyrifos	25	0	0	0	0	0	0
	50	0	3	0	0	0	0
	75	13	9	15	7	0	7
	90	19	12	17	11	0	9
	95	38	34	25	38	0	9
	99	179	523	92	45	0	186
cis-Permethrin	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	0	0	0	0	0	0
Dacthal	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	2	0	0	0
	90	5	2	13	0	0	0
	95	6	4	13	0	0	0
	99	32	26	13	8	0	5
Diazinon	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	20	7	19	7	0	0
	95	45	14	26	27	116	8
	99	1,810	391	318	27	116	20
Dichlorvos	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	241	0	241	115	0	96
Dicofol	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	59	0	0	0
	95	0	0	59	0	0	0
	99	0	0	59	0	0	0

(continued)

NOPES Weighted Percentile - Springfield/Chicopee (Continued)
(ng/m^3)

Analyte	Percentile	Spring Indoor	Spring Outdoor	Spring Personal	Winter Indoor	Winter Outdoor	Winter Personal
Dieldrin	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	4	0	0
	90	9	0	7	6	0	4
	95	9	0	7	40	0	6
	99	9	0	7	40	0	6
Folpet	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	36	21	32	0	0	0
gamma-BHC	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	7	2	0	0
	95	5	0	7	118	0	70
	99	5	0	7	118	0	70
Heptachlor	25	0	0	0	0	0	0
	50	3	0	0	1	0	4
	75	6	0	6	3	0	7
	90	231	0	313	8	0	9
	95	253	2	313	17	0	12
	99	253	5	313	35	3	23
Heptachlor epoxide	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	0	0	0	0	0	0
Hexachlorobenzene	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	0	0	0	6	0	3
Malathion	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	11	0	0	0	0
	99	275	24	20	0	0	0

(continued)

NOPES Weighted Percentile - Springfield/Chicopee (Continued)
(ng/m^3)

Analyte	Percentile	Spring Indoor	Spring Outdoor	Spring Personal	Winter Indoor	Winter Outdoor	Winter Personal
Methoxychlor	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	0	0	0	0	0	0
ortho-Phenylphenol	25	15	0	17	0	0	9
	50	25	0	30	11	0	15
	75	79	0	81	15	0	24
	90	126	0	128	87	0	50
	95	126	10	128	96	0	133
	99	181	52	177	96	0	133
Oxychlordane	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	0	0	0	0	0	0
Propoxur	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	33	0	13	20	0	9
	90	111	0	79	53	0	39
	95	111	0	79	53	0	47
	99	121	33	79	129	4	61
Resmethrin	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	0	0	0	0	0	0
Ronnel	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	9	0	7	0	0	0
trans-Permethrin	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	0	0	0	0	0	0

(continued)

NOPES Weighted Percentile - Springfield/Chicopee (Continued)
(ng/m^3)

Analyte	Percentile	Spring Indoor	Spring Outdoor	Spring Personal	Winter Indoor	Winter Outdoor	Winter Personal
2,4-D (butoxyethyl ester)	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	104	0	0	0	0	0
4,4'-DDD	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	0	0	0	0
	95	0	0	0	0	0	0
	99	0	0	0	1	0	0
4,4'-DDE	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	6	0	38	4	0	2
	95	6	0	38	4	0	4
	99	8	0	38	4	0	4
4,4'-DDT	25	0	0	0	0	0	0
	50	0	0	0	0	0	0
	75	0	0	0	0	0	0
	90	0	0	8	0	0	2
	95	0	0	8	5	0	6
	99	0	0	8	15	19	6

Appendix D
Glossary of Statistical and NOPES Terms

area householding sampling - a standard survey sampling method in which sample households or people are chosen from sample areas selected at a previous stage of sampling. The sample areas are selected from a sampling frame that provides complete geographic coverage of the area in which the target population resides.

bias - the difference between the expected value of a sample statistic and the corresponding population parameter. The expected value of a statistic is the average value of the statistic over all possible samples.

census - a survey of all units in the target population.

detection limit - the minimum analyte concentration that consistently produces responses above the instrument background signal under typical operating conditions. Defined in NOPES as three to five times the instrument background signal.

duplicate air sample - an air sample collected for essentially the same time and space as the primary air sample. Duplicate samples were collected both indoors and outdoors in a subsample of households.

measurement error - error that occurs because the measurement process, including environmental sampling, laboratory analysis, sample identification, questionnaire administration, and data entry, yields an incorrect result for the characteristic being measured.

multiseason respondents - sample members that participated in more than one of the NOPES phases. Prior to initial contact in a study area, a subset of the sample was randomly selected to be recruited as multiseason participants.

population parameter - a characteristic based on or calculated from all units in the target population.

probability sample - a sample for which every unit on the sampling frame has a known, positive probability of being selected into the sample. The terms "probability sampling" and "random sampling" are some times used interchangeably.

quantitation limit - the minimum analyte concentration that yields relatively precise response values under typical operating conditions. Defined in NOPES as approximately five times the detection limit.

replicate air sample - an air sample collected from a household or for an individual that had provided a primary air sample three to ten days earlier. Replicate samples were collected for a subset of sample members. Indoor, outdoor, and personal replicate air samples were collected.

sample (statistical) - a set of units selected from the target population.

sampling design - the method used to select a sample of units from the target population.

sampling error - error that occurs because inferences are made from a sample rather than from a census of the entire population.

sampling frame - a list from which a sample is selected. An ideal sampling frame contains one and only one entry for each member of the target population. In practice, sampling frames usually miss some members of the target population, and include some individuals who are not members of the target population.

sampling variance (of a statistic) - the variance of the sampling distribution of the statistic, which is generated by the sampling design.

sampling weights - factors used to compute design-unbiased population estimates from sample data. For probability sampling designs, a unit's sampling weight is the reciprocal of its probability of selection. Adjustments of sampling weights are often made to partially compensate for the potential bias due to nonresponse. If the sampling design results in unequal probabilities of selection for sample members, sampling weights must be used to compute unbiased population estimates.

standard error (of a statistic) - the square root of the sampling variance of the statistic.

statistic - a sample-based estimate of a population parameter.

stratified sample - a sample selected from a sampling frame which is partitioned into disjoint subsets called strata, and composed of subsamples selected independently from each stratum.

target population - the set of units or elements for which a sample survey is designed to provide statisitical inferences. The target population is sometimes simply referred to as the population or universe of inferential interest.

triplicate air sample - an air sample collected for essentially the same time and space as the primary and duplicate air samples. Triplicate samples were collected from a small subset of sample households, and were collected both indoors and outdoors.

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