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NATIONAL HOME AND GARDEN PESTICIDE USE SURVEY

FINAL REPORT, VOLUME II:

Survey Design, Implementation, and Analysis Methods

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ACKNOWLEDGMENTS

The RTI Project Director for the National Home and Garden Pesticide Use Survey was Dr. Roy W. Whitmore. Dr. Whitmore also served as task leader for sample selection, sample weighting, and statistical analysis. He was assisted by three task leaders: Ms. Nancy C. Monroe, Dr. Pamela L. Reading, and Ms. Janice E. Kelly. Ms. Monroe served as task leader for developing the survey instruments. Dr. Reading served as task leader for data processing. Ms. Kelly served as task leader for survey operations.

Dr. Whitmore was assisted primarily by Mr. Shelton M. Jones, Ms. Francine A. Burt, Ms. Sally L. Branson, and Ms. Brenda K. Porter. Mr. Jones provided computing support for sample selection. Ms. Burt prepared maps and segment kits for all sample areas. Ms. Branson provided computing support for sample weighting and statistical analysis. Ms. Porter provided secretarial support.

Ms. Monroe developed the study questionnaire and other data collection instruments in close consultation with the RTI project director. She was assisted primarily by Ms. Andrea F. Garner, who formatted the text of the survey instruments for printing.

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4. SAMPLING DESIGN

The NHGPUS was a one-time, cross-sectional survey of the use of pesticides in and around homes in the United States. The sampling design can be described as a stratified, three-stage probability sampling design. A probability sample is one in which all units in the population have a calculable, positive probability of being included in the sample. Probability sampling procedures were necessary for the NHGPUS because of the need to extend inferences from the sample to the target population.

Probability sampling requires the existence of sampling frames, or lists, from which elements of the target population can be selected into the sample. A multistage probability sampling procedure was used to select the NHGPUS sample for reasons of convenience and cost efficiency. Thus, counties were selected from a list of all counties and the District of Columbia at the first stage of sampling. Subcounty areas were selected at the second stage of sampling from lists of areas that completely covered the entire land area of the sample counties. Sample housing units were then selected from lists prepared by field staff that provided coverage of all housing units currently located in the second-stage sample areas.

The first- and second-stage samples were stratified by variables that are potentially related to household use of pesticides. Stratification refers to partitioning the sampling frame into disjoint subsets, called strata, and independently selecting a sample to represent each stratum. If the strata are related to the analysis variables, stratification can improve the precision of survey statistics. If they are unrelated, loss of precision due to stratification is virtually impossible (Cochran, 1977, Section 5.6). Moreover, selecting a sample from each stratum guarantees that the population subsets represented by the strata are all appropriately represented in the sample.

4.1 First-Stage Sample of Counties

A first-stage sample of counties was selected for the planned National Household Pesticide Usage Survey in 1981, but the survey was never implemented. Considerable effort was expended at that time to stratify the sampling frame by Census Division, an urbanization code, average annual precipitation, average annual temperature, and ethnic composition of the

population (as measured by percent black population).[1] The original sampling frame was not available for selecting the NHGPUS sample, but the sample of 180 county selections was available. To make efficient use of the previous stratification, a subsample of 60 selections was chosen for the current NHGPUS.

The sampling design for the first-stage sample selected in 1981 is presented in Appendix H. The remainder of this section discusses the process of selecting the subsample of 60 county selections for the 1990 NHGPUS sample.

The 1981 sample was stratified implicitly by sorting the sampling frame by the stratification variables and sequentially selecting counties using a probability minimum replacement (pmr) sampling algorithm (Chromy, 1979). This implicit stratification was preserved in the subsample by using the same pmr sampling algorithm to select the subsample from a frame consisting of the previous 180 county selections sorted in the order in which they were originally selected.

Counties were selected for the 1981 sample with probabilities proportional to the estimated number of non-farm housing units in each county because the target population at that time included only non-farm housing units. Because the current target population includes both farm and non-farm households, counties were selected for the subsample with probabilities proportional to the ratio of "the estimated number of occupied housing units in each county in December 1988" (obtained from Market Statistics, Inc.) divided by "the size measure used for the 1981 sample," which yields overall probabilities of selection proportional to the current estimates of total occupied housing units as shown below.

The 60 selections included two counties that, because of their large size, were selected twice: Los Angeles County, California and Cook County, Illinois. Thus, 58 distinct counties were selected. These 58 sample counties are located in 29 different States.

Letting $i=1,2,\ldots,N_1$ index the first-stage sampling units (FSUs) (counties on the original sampling frame), we define the following

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[1]Percent black population in the county was used at the fifth level of nested stratification for sampling counties (see Appendix A) and therefore had little actual effect. Race was not used to stratify the second-stage sample of subcounty areas (see Section 4.2).

notation.

$S(i)$ = the original size measure for the i-th FSU (estimated number of non-farm housing units in 1981).

$M_1(i)$ = the new size measure for the i-th FSU (estimated number of occupied housing units in December 1988).

$n(i)$ = number of selections of the i-th FSU in the 1981 sample.

$m_1(i)$ = number of selections of the i-th FSU for the current NHGPUS sample.

Then, the expected number of selections of the i-th FSU for the 1981 sample is

$$E[n(i)] = 180\ S(i) \Big/ \sum_{i=1}^{N_1} S(i) \qquad (4\text{-}1)$$

because there were 180 county selections at the first stage of sampling.

Since the 60 subsample FSUs were selected for the NHGPUS with probabilities proportional to the ratio of the new to the old size measures, the conditional expected number of selections for the i-th FSU, given that it was selected for the 1981 sample, S_1, is

$$E[m_1(i) \mid i \epsilon S_1] = \frac{60\ M_1(i) \,/\, S(i)}{\sum_{i=1}^{N_1} [M_1(i) \,/\, S(i)]\ I_{S_1}(i)} \qquad (4\text{-}2)$$

where I_{S_1} is a (0,1)-indicator of inclusion in the 1981 sample.

Therefore, the unconditional expected frequency of selection of the i-th FSU (county) selected into the NHGPUS sample is the product of (4-1) and (4-2), namely

$$E[m_1(i)] = \frac{60\ M_1(i)}{\left[\sum_{i=1}^{N_1} S(i)\right] \left\{\sum_{i=1}^{N_1} I_{S_1}(i)\ [M_1(i) \,/\, S(i)] \,/\, 180\right\}} \qquad (4\text{-}3)$$

As previously stated, the expected frequency of selection is proportional to the new size measure, $M_1(i)$.

4.2 Second-Stage Sample of Subcounty Areas

Five subcounty areas were selected at the second stage of sampling for each county selection at the first stage. The subcounty areas were defined

by Census blocks and enumeration districts (EDs) because they provide complete coverage of each sample county, and they are the smallest geographic areas for which Census data are available. Data were extracted from the 1980 Census Summary Tape File 1-A (STF 1-A) for all blocks and EDs in each sample county to construct a stratified sampling frame of subcounty areas.

Second-stage sampling units (SSUs) were created by combining blocks and EDs, as necessary, to form sampling units that had a minimum 1980 Census count of 35 occupied housing units. The block and ED records were combined in such a manner that the units combined were usually geographically proximate to each other to minimize field travel costs. The combining procedure was also designed to minimize the occurrence of large sampling units and units that cross Census block group boundaries and minor civil division (MCD) boundaries. Every block and ED in each sample county, including those that had no population in 1980, was included in an SSU to provide complete geographic coverage of each sample county at the second stage of sampling.

The SSUs had to be relatively large to protect against selecting areas that did not currently contain any occupied housing units and to facilitate selection of noncompact clusters of sample housing units at the third stage of sampling. Conversely, listing all current housing units is more costly for large sampling units. Therefore, the sampling units had to be kept as small as practically possible. After investigating the distributions of sampling unit sizes resulting from minima of 35, 50, and 65 occupied housing units (based on the 1980 Census counts), 35 housing units was selected as the most appropriate minimum size for the SSUs.

The second-stage sample of subcounty areas selected for each sample county was stratified by urbanicity, socioeconomic status, and proportion of multiple-family housing units. These stratification variables were thought to be potentially related to occurrence of pests and use of pesticides. To the extent that they are related, the stratification will result in more precise survey estimates.

The urbanicity code used for stratification was defined to have two levels: urban and rural. SSUs were coded as urban if most of the housing units in the SSU were in a Place (incorporated or Census-defined city or

town) or in a Census-defined urbanized area (the urban area surrounding a metropolitan area). All other SSUs were coded as rural.

The socioeconomic status of an SSU was measured by the average appraised value of the dwellings in the SSU, combining the 1980 Census data for owned and rented housing units. For rented dwellings, the appraised value was estimated as 100 times the monthly rent. The distribution of housing unit values was examined separately for urban and rural SSUs within each sample county to define high and low socioeconomic strata within each urbanicity stratum.

Likewise, the distribution of the proportion of multiple-family dwellings was examined for each socioeconomic stratum of each sample county and used to define strata with high and low proportions of multiple-family dwellings.

Having constructed the stratified second-stage sampling frame, five subcounty areas were selected for each first-stage county selection. Ten SSUs were selected for Los Angeles County, California and for Cook County, Illinois because each county received two independent selections at the first stage of sampling.

Within each sample county, the second-stage sampling units were selected with probabilities proportional to size using the same sequential probability minimum replacement (pmr) sampling algorithm that was used to select the first-stage sample of counties (Chromy, 1979). The size measure for each area was the 1980 Census count of occupied housing units for the area. The sampling frame for each county was sorted in a serpentine manner by the following variables:

(1) Type of community (urban or rural),

(2) Socioeconomic status (high or low),

(3) Proportion of multiple-family dwellings (high or low), and

(4) Size (1980 Census count of occupied housing units).

Sequential selection from the serpentine sorted sampling frame ensured proportional representation of the strata formed by the first three variables, as discussed by Williams and Chromy (1980). The final sort by size of the SSUs helped ensure that both large and small SSUs would be represented in the sample.

Five SSUs were selected for each fist-stage selection. A single sample of 10 SSUs was selected for each of the double-hit FSUs (Los Angeles

County, CA and Cook County, IL) to ensue that no SSUs in these counties would be selected more than once. One SSU (a large ED in Lipscomb County, TX) received two selections. Since there were 60 FSU selections at the first stage of sampling, the total number of distinct SSUs selected was 299. These sample SSUs are referred to as sample segments.

Letting $j=1,2,\ldots N_2(i)$ index the second-stage sampling units (SSUs) in the i-th county, we define the following notation.

$M_2(i,j)$ = the size measure for the j-th SSU in county "i" (1980 Census count of occupied housing units).

$m_2(i,j)$ = number of selections of the j-th SSU in county "i."

Then, since 5 SSUs were selected with probabilities proportional to size for each FSU selection, the conditional expected frequency of selection for the j-th SSU, given that county "i" is in the NHGPUS first-stage sample, S_1^*, is[2]

$$E[m_2(i,j) \mid i \epsilon S_1^*] = 5\, M_2(i,j) \,/\, \sum_{j=1}^{N_2(i)} M_2(i,j) \qquad (4\text{-}4)$$

The unconditional expected frequency of selection for the j-th SSU in county "i" is then given by the product of (4-3) and (4-4).

In May of 1990, approximately three months before beginning NHGPUS field data collection, field staff were sent to the sample segments (SSUs) to prepare lists of the current housing units to enable selection of the third and final stage of the sample. Their first task in each area was to make a quick count of the total housing units in each sample segment. If there were too many housing units present to efficiently list all of them (approximately 200 or more), the sample segment was divided into subsegments, a quick count of the current housing units was obtained for each subsegment, and one subsegment was selected with probability proportional to the quick count. In this case, only the housing units in the sample subsegment were listed (instead of all housing units in the sample SSU) for the third stage of sampling.

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[2]Technically, a single sample of 10 SSUs was selected for each of the double-hit FSUs (Los Angeles County, CA and Cook County, IL). In this case, the second-stage sample size is a random variable $[5\, m_1(i)]$, but the unconditional expected frequency of selection is still given by the product of (4-3) and (4-4).

Letting $k=1,2,\ldots,N_3(i,j)$ index the subsegments created for the j-th segment in county "i," define $M_3(i,j,k)$ to be the quick count of housing units in the (i,j,k)-th subsegment. Then, the conditional probability of selecting the (i,j,k)-th subsegment, given that the j-th segment was in the second-stage sample, S_2, is[3]

$$P_3(i,j,k|j\epsilon S_2) = \begin{cases} \dfrac{M_3(i,j,k)}{\sum_{k=1}^{N_3(i,j)} M_3(i,j,k)} & \text{if the (i,j)-th segment was subsegmented} \\ 1 & \text{if the (i,j)-th segment was not subsegmented.} \end{cases} \quad (4\text{-}5)$$

The unconditional probability of selection for the (i,j,k)-th subsegment is then given by the product of (4-3), (4-4), and (4-5).

4.3 Third-Stage Sample of Housing Units

Having located the sample segment or subsegment, the field staff listed all potential housing units in each selected area. The sample housing units were then selected from these lists at the third and final stage of sampling.[4] Two area segments did not currently contain any housing units, so lists of housing units were prepared for 298 sample segments.

When all housing units in the sample segments (or subsegments) had been listed, the sample was allocated to the segments to achieve approximately equal probabilities of selection for all housing units in the target population. This resulted in larger sample allocations to the areas that had grown the most since the 1980 Census. However, the sample allocation was constrained to be no more than 55 sample housing units for most sample counties because we believed that this was the maximum work load that could be completed by a single interviewer during the approximately six-week period of field data collection.

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[3]A single sample of two subsegments was selected from the Lipscomb County, TX, segment that received two selections at the second stage. In this case, the number of subsegments selected is a random variable equal to the number of second-stage selections. The unconditional probability of selection of the subsegments is, nevertheless, given by the product of (4-3), (4-4), and (4-5).

[4]Technically, this was the fourth stage of sampling for area segments that were subsegmented.

The sample was designed to yield complete data for 2,000 responding households. Assuming that 88 percent of the listed dwellings would be occupied housing units (based on recent RTI experience in national surveys) and that 85 percent of the households would respond, a primary sample of 2,674 sample housing units was selected. The average allocation to the 298 sample segments was nine sample housing units. Although the allocation to most segments was nine housing units, the allocation to the individual segments ranged from 2 to 22 housing units.

One additional sample line (potential housing unit) was selected from each of the 298 area segments as a reserve or "hold" sample. Ten percent of the sample lines in each segment were selected for validation interviews as a quality assurance measure. Two segments in each county, were randomly selected as an early report sample to be worked first. The field status of the early report sample was monitored regularly to determine if any lines from the hold sample should be worked. In fact, none of the hold sample lines were ever released for field data collection.

Letting $\ell=1,2,\ldots,N_4(i,j,k)$ index the potential housing units listed for the (i,j,k)-th sample segment (or subsegment), define $m_4(i,j,k)$ to be the final sample allocation to the (i,j,k)-th segment. Given the final sample allocation, an equal probability sample of housing units was selected from those listed for each segment using a sequential probability minimum replacement (pmr) selection algorithm (Chromy, 1979). Therefore, the conditional probability of selecting the (i,j,k,ℓ)-th listed housing unit, given that the k-th subsegment was selected into the sample S_3, is

$$P_4(i,j,k,\ell|k\epsilon S_3) = m_4(i,j,k) \;/\; N_4(i,j,k). \qquad (4\text{-}6)$$

A "missed housing unit procedure" was employed when sample housing units were identified in the field to ensure that all housing units that could be identified at the time of field data collection had a positive probability of being included in the sample. This procedure included in the sample not only the housing units listed on the selected sample lines, but also

- any non-listed housing units located within the selected sample housing units, and
- any non-listed housing units located between a selected sample housing unit and the next listed housing unit.

The probability of selection for each "added housing unit" is the same as that for the listed sample housing unit that resulted in its inclusion in the sample.

Characteristics of the final NHGPUS sample are presented in Table 4.1 by county. The Census Region and Census Division to which each county belongs is identified. In addition, the number of eligible and participating sample households is presented for each county. This table illustrates the geographic diversity of the NHGPUS sample. At the same time, it makes clear that the NHGPUS sample size is too small to make statistically defensible estimates for individual States or Census Regions. The survey was designed to support national-level statistical inferences.

Table 4.1 Characteristics of the NHGPUS Sample by County

Census Region	Census Division	State	County	No. Area Segments	Sample Households[a]	
					No. Eligible[b]	No. Participating
Northeast	New England	Maine	Kennebec	5	42	37
		New Hampshire	Rockingham	5	49	45
		Connecticut	New Haven	5	48	37
	Middle Atlantic	New York	Kings	5	32	30
			Monroe	5	39	33
			New York	5	36	29
			Queens	5	42	36
		New Jersey	Bergen	5	46	38
			Mercer	4[c]	28	20
			Morris	5	41	30
		Pennsylvania	Lackawanna	5	41	41
			Lawrence	5	42	41
North Central	East North Central	Ohio	Lake	5	36	33
			Summit	5	43	37
		Indiana	Hendricks	5	34	31
			La Porte	5	38	34
			Marion	5	38	26
		Illinois	Cook	10	83	71
		Michigan	Livingston	5	45	37
			Wayne	5	40	27
		Wisconsin	Wood	5	41	39
	West North Central	Minnesota	Anoka	5	53	50
		Missouri	Boone	5	45	42
			St. Louis	5	41	37
		North Dakota	Foster	5	43	39
		Nebraska	Madison	5	48	42

(continued)

Table 4.1 Characteristics of the NHGPUS Sample by County (cont.)

Census Region	Census Division	State	County	No. Area Segments	Sample Households[a]	
					No. Eligible[b]	No. Participating
South	South Atlantic	Maryland	Montgomery	5	36	26
			Prince George's	5	37	25
		South Carolina	Chester	5	41	41
		Georgia	Catoosa	5	33	29
			Fulton	5	44	42
			Treutlen	5	31	30
		Florida	Dade	4[c]	30	27
			Hernando	5	49	43
			Palm Beach	5	25	21
			Volusia	5	39	34
	East South Central	Kentucky	Jefferson	5	54	48
		Alabama	Dallas	5	39	37
			Jefferson	5	45	41
	West South Central	Arkansas	Jefferson	5	38	31
		Louisiana	De Soto	5	34	31
		Texas	Harris	5	46	11[d]
			Lipscomb	5	38	31
			Matagorda	5	30	29
			McLennan	5	50	46
			Randall	5	43	38
West	Mountain	Colorado	Denver	5	42	37
		Arizona	Yavapai	5	26	23
		Utah	Cache	5	44	42
			Salt Lake	5	39	37

(continued)

Table 4.1 Characteristics of the NHGPUS Sample by County (cont.)

Census Region	Census Division	State	County	No. Area Segments	Sample Households[a] No. Eligible[b]	Sample Households[a] No. Participating
West (cont.)	Pacific	Oregon	Multnomah	5	47	37
			Washington	5	44	38
		California	Contra Costa	5	35	29
			Los Angeles	10	87	66
			Orange	5	37	32
			San Diego	5	55	50
			San Francisco	5	44	24
			Santa Barbara	5	49	40
TOTAL				298	2,447	2,078

a Also see Table 8.1.

b All housing units occupied as permanent residences were eligible for the survey.

c One of the five area segments selected for this county did not contain any housing units at the time of the survey (Aug-Sept 1990).

d 27 completed interviews for Harris County, Texas, were lost in the mail when the interviewer mailed all of them to RTI in a single envelope, contrary to the established NHGPUS procedures. RTI verified by telephone that interviews were conducted for at least some of these sample households.

5. DEVELOPING SURVEY INSTRUMENTS

The primary survey instrument that had to be developed for the NHGPUS was the study questionnaire, which is discussed in Section 5.1. A notebook of pest sketches was also developed to assist the survey respondents with selecting the pest categories that represented the pests they were treating or with which they were having a problem. Development of the pest notebook is discussed in Section 5.2. In addition, a lead letter and study brochure were developed for an advance mailing to sample homes in an effort to achieve the highest possible response rate. Development of these materials is discussed in Section 5.3. Manuals for training interviewers and for interviewer reference during the study are discussed in Section 5.4.

5.1 Study Questionnaire

Development of the NHGPUS questionnaire began shortly after the project kickoff meeting late in March 1989. The Agency developed table shells for analyses that they would like to be able to conduct at the conclusion of the survey. RTI developed a list of data items from the table shells and a flow chart that attempted to put the data items in a logical sequence for data collection. The initial draft questionnaire was developed from that flow chart.

We commend the Agency for making a concerted effort to specify the analyses that they would like to be able to conduct. The table shells were effectively an analysis plan that gave focus to the questionnaire development process and provided a clear rationalization for each questionnaire item.

To the extent possible, data items were borrowed from tested questionnaires. Two questionnaires that were used as the primary resources were the one pilot-tested in 1981 for a National Household Pesticide Usage Survey (Berman, 1981) and the one used for the Agency's Nonoccupational Pesticide Exposure Survey (NOPES) from 1986 through 1988 (Immerman and Schaum, 1990). At the end of the NHGPUS questionnaire, a Bureau of the Census question was used to record the type of structure for each sample housing unit. The "new standard environmental inventory questionnaire" was also reviewed for input to the NHGPUS questionnaire (Lebowitz et al., 1989).

During the first few months following the project kickoff meeting, the draft analysis plans and questionnaire items were iteratively reviewed and revised through frequent consultation between RTI and the Agency. A first draft questionnaire and Information Collection Request (ICR) supporting statement were ready to be circulated for peer review in July 1989. This package was extensively reviewed by Agency staff in several divisions of the Office of Pesticide Programs, by the Office of Research and Development, and by the Statistical Policy Branch of the Office of Policy, Planning and Evaluation. Additional review was also provided by the U.S. Department of Agriculture's Economic Research Service. The reviewers provided extensive comments. All their comments were discussed in detail to determine the revisions that should be implemented, consistent with the study objectives and budget.

Extensive revisions based on the reviewer comments resulted in a second draft questionnaire that was ready for pilot testing and further peer review in September 1989. This questionnaire was sent for review to the National Pest Control Association, the Professional Lawn Care Association of America, the Chemical Manufacturers Association, and the Chemical Specialty Manufacturers Association. Their comments were mostly positive.

This questionnaire was also pilot tested in October 1989 in nine homes in the Raleigh/Durham area of North Carolina. Because we expected that different types of residences might reveal different difficulties with the instrument, the pilot test purposely included a variety of dwelling types: two farms, two mobile homes, one apartment, and four single-family detached dwellings. We also purposely included some homes with pets. The pilot test revealed that major revisions were needed. One major problem was that the questionnaire was awkward for the interviewer; it required too much paper shuffling. Another problem was that many questions regarding the pesticide products on-hand were not applicable for pesticides that either were in continuous use or had not been used in the past year.

The questionnaire used in the pilot test began the inventory of pesticide products on hand with a series of yes/no questions regarding the presence of pesticides to treat each pest in a rather long list, intended to be all-inclusive. The pilot test revealed that these questions were a burden to the respondents and would not guarantee that all pesticides would

be listed. Therefore, the final questionnaire begins the inventory of pesticides on-hand after a brief definition of what the EPA considers to be a pesticide. At the end of the inventory section, a few questions are asked to ensure that pesticides that are not normally thought of as such (e.g., repellents) are included in the inventory.

The pilot-tested questionnaire contained several questions about pest problems that occurred in the past year, irrespective of whether or not pesticides for treating those products were currently on hand. These questions were a burden to respondents because of perceived duplication with the questions asked for all products currently on hand. Therefore, this section was greatly shortened to ask only about the pest problems treated in the past year by pesticides that are no longer on hand and about the severity of the pest problems experienced in the past year.

This revised questionnaire was then pilot tested in five additional homes in the Raleigh/Durham area in November 1989. The types of residences selected for this second pilot test were two farms and three single-family detached residences. We purposely interviewed a few households with a relatively large number of pesticide products in this second pilot test. All these interviews proceeded smoothly.

Of course, a 1-year recall is too long for respondents to accurately remember all pest problems, all applications of pesticides, etc., but funding limitations resulted in a one-time survey with a 1-year recall period instead of a longitudinal study with multiple interviews throughout the year. Because most pest problems and pesticide use occur in the Spring and Summer, field data collection was scheduled for August and September. Thus, many of the events of interest in the 1-year recall period actually occurred in the months immediately preceding the interview.

The questionnaire and Information Collection Request (ICR) supporting statement were submitted to the Agency's Office of Policy, Planning and Evaluation for subsequent submittal to the Office of Management and Budget (OMB) in December 1989. OMB provided RTI with comments from the Chemical Specialties Manufacturers Association. OMB approved the ICR in May 1990 conditional on deletion of one question and revision of two others. The final questionnaire is shown in Appendix A of Volume I.

5.2 Notebook of Pest Sketches

The first pilot test of the NHGPUS questionnaire revealed that the general public could not easily classify their pest problems into the pest categories used in the questionnaire. Therefore, a notebook of pest sketches was developed for use with the questionnaire. The notebook was organized by the pest categories used in the questionnaire. For most pest categories it included several examples of pests belonging to the category. For most pests, it provided a black-and-white sketch of the pest, a short description of the pest and the damage it causes, and the size of the pest. The book was not intended to be a definitive identification tool. It was provided simply to help participants understand the pest categories being used and to determine the proper pest category when they only knew what their pest looked like.

RTI and the Agency collaborated closely on development of the pest notebook. RTI prepared an initial draft using materials provided by the Agency and other materials obtained from local libraries. The RTI draft contained only those pests expected to be difficult for the general public to identify. The Agency subsequently decided that the notebook should cover all pest categories contained in the questionnaire. They then prepared a much more extensive notebook using sketch materials and pest experts available at the Agency. The draft developed by the Agency was electronically transferred to RTI for final editing and printing late in July 1989. The final pest notebook is shown in Appendix I.

5.3 Lead Letter and Study Brochure

Achieving the highest possible response rate is important for all survey research because the only sure protection against nonresponse bias is to achieve a high response rate. In order to enhance the NHGPUS response rate, we attempted to mail a lead letter and a brochure explaining the study to every sample housing unit. Survey research has shown that such lead mailings usually increase the survey response rate (see Groves, 1989, Section 5.2.1).

Mailing labels were generated from the address lists prepared for the third stage of sampling (see Section 4.3). A few sample housing units did not have mailable addresses.

The lead letter (see Appendix J) provided legitimacy for the study by introducing the sponsoring agency and the purpose of the study. Other

important features of the lead letter are that it:

- let the household know that an interviewer would be coming to the home,
- presented the survey burden (about a 45 minute interview) and the survey incentive ($5 and a copy of the EPA brochure "Citizen's Guide to Pesticide Use"), and
- ensured the sample subject that participation was voluntary and that all responses would be kept confidential.

Because the mailings could not be personalized (only addresses were available, not names), we prepared special envelopes designed to distinguish our mail from "junk" mail. The lead mailing was sent in an envelope with prepaid postage and a combined RTI/EPA return address (see Appendix J).

The study brochure was prepared in a question and answer format and printed in blue (see Appendix J). It explained the study and the agencies involved (both EPA and RTI) in more detail. It also provided names and telephone numbers of people who could be contacted to answer any other questions regarding the study. It also provided the toll-free telephone number of the EPA's National Pesticide Telecommunications Network to be contacted in case of pesticide poisoning, as a public service.

5.4 Field Interviewer's Manuals

Interviewers hired for counting and listing activities were provided with a copy of the RTI Counting and Listing General Manual. This manual describes how to conduct the task of counting and listing the housing units in the area segments selected at the second stage of sampling. Specific topics include: applicable definitions such as area, segment, household, living quarters, and group quarters; descriptions of the field sampling materials, including the segment sketches, maps, and lists of housing units; step-by-step procedures for counting the housing units within the segments; specifications for when to proceed with the listing and when to call RTI's sampling staff; step-by-step procedures for listing the segments; procedures for documenting unusual circumstances and referring them to the appropriate individual for resolution; reporting procedures; quality control procedures; and disposition of completed work.

RTI developed the NHGPUS Field Interviewer's Project Manual to direct and guide the field staff in collecting data from participants in the

study. Topics covered in the manual included: background of the survey; overview of the assignment; confidentiality of data collection; locating housing units; checking for missed housing units; contacting and screening sample households; explaining the survey and obtaining cooperation; information on pests, pesticides, and safety precautions; questionnaire administration; quality control procedures; and general administrative procedures. Appendices to the document included examples of product labels, study showcards, and a glossary of terms commonly used in the manual.

In addition to the manual prepared especially for the survey, a copy of the RTI Field Interviewer's General Manual was given to each interviewer. The manual provides basic information applicable to interviewer fieldwork for all RTI surveys and eliminated the need to provide intensive coverage of these topics in the project's field manual.

5.5 Training Materials

Development of training materials was a critical aspect of the study since multiple training sessions were being conducted simultaneously by different trainers. The training materials were designed to insure that the training of field staff, and ultimately, the collection of NHGPUS data, were conducted in a uniform and standard manner.

The Training Guide for Counting and Listing and the NHGPUS Training Guide were used by our trainers to prepare their training classes. These guides include: detailed instructions on presenting key training components through the use of verbatim lectures on special topics; instructions for using special training aids; and procedures for conducting demonstration mock survey interviews, classroom exercises, and written tests.

Some of the training components covered by the Training Guide for Counting and Listing are:

- welcoming the trainees and introducing the trainers and trainees;
- explaining the purposes, design, and terminology of the survey;
- reviewing responsibilities of Field Interviewers and Field Supervisors;
- reviewing, discussing, and conducting question and answer sessions on locating segments;

- reviewing, discussing, and conducting classroom exercises on counting and listing procedures;

- reviewing administrative duties.

Some additional training components covered by the NHGPUS Training Guide were:

- reviewing the agenda and rules for the training session;

- demonstrating how to make an initial contact, conduct screening, and perform data collection, including discussion of the demonstration;

- reviewing, discussing, and conducting exercises on locating, contacting, and screening sample housing units and looking for missed housing units;

- discussing terminology related to pests, pesticides, and safety precautions;

- reviewing, discussing, and conducting round-robin practice, and paired practice of techniques for completing the questionnaire and paying the incentive; and

- reviewing quality control and administrative procedures.

The guide also included examples and exercises on identifying pesticide containers and child resistant packaging.

A pretraining Home Study Exercise was developed to reinforce key points made in the interviewer's manual. The exercise was to be completed after reviewing the manual and prior to attending the training session. The exercise was reviewed during training and interviewers received individual feedback on problem areas.

Finally, a video tape was developed that showed various product packaging. We were concerned that interviewers would have trouble recording the appropriate container description and identifying child resistant packaging (Questions 24 and 25 of the study questionnaire). While this was addressed through examples shown at training, the video tape was prepared and distributed to each field interviewer at training to be used as a reference if they had problems classifying a container during data collection.

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6. FIELD OPERATIONS

Field operations for the NHGPUS were comprised of two distinct processes. The first process was counting and listing all potential housing units in the 300 sample areas, called area segments, selected at the second stage of sampling. These counting and listing activities are discussed in the first section of this chapter. The second field process was household interviewing or field data collection, which is discussed in the second section of the chapter.

6.1 Counting and Listing Activities

Counting and listing activities took place from April through June 1990. The following sections describe the activities associated with counting and listing.

6.1.1 Recruiting Field Supervisors

The field supervisors recruited for the study were used for both counting and listing and for data collection. As soon as the counties were selected for the study, their geographic distribution was studied and the number of field supervisors to be recruited was determined. The study area was divided into four regions, and a field supervisor (FS) was recruited for each region. FSs were recruited from RTI's active list of over 60 experienced FSs. FSs were selected based on their performance on previous studies, experience in counting and listing, availability during the data collection period, and geographic location.

6.1.2 Recruiting Field Interviewers

The field supervisors (FSs) were responsible for recruiting field interviewers (FIs) in each of their assigned counties. To assist the FSs in the recruiting activity, RTI's National Interviewer File was searched for persons in the sample counties who had previous survey data collection experience with RTI. A list of names for each county was generated containing the last known address, telephone number, and performance rating for each listed person. When the National Interviewer File listed no names for a county, the FS was required to check with other research companies, other RTI FSs who may have had previous experience or contacts in the area, and local employment agencies to identify and recruit FIs for that county. If this failed, the FS ran advertisements in the local newspapers to identify potential interviewers.

Our primary goal was to hire FIs who had good to excellent ratings and who lived in the county where they would be working. In counties where an experienced FI was not available, the FS tried to recruit an experienced FI who lived within one hour's driving time of the area. The guiding principle was that the additional cost of having an experienced FI drive into the study area was more than offset by the quality and expected efficiency of their work. A total of 47 field interviewers were hired to conduct the counting and listing.

6.1.3 Training

Four field supervisors were trained on April 23 and 24, 1990. Most of their field staff needed for counting and listing had been hired prior to that time. Prior to training, the FSs received a copy of the Counting and Listing Manual for review.

The training methodology included instructor demonstration, group discussion and interaction, and classroom exercises. The Training Guide for Counting and Listing described in Section 5.5 was used. A copy of the training agenda is shown in Exhibit 6.1. To standardize the training of field interviewers, each FS was provided with a copy of the training guide that outlined all the material they needed to cover when training their field interviewers.

In the two to three weeks following the training session, the FSs trained their staff individually and assigned the segments to be counted and listed to them. Most interviewers with previous counting and listing experience were trained in telephone conferences with their FS. The FSs traveled to the areas being worked by inexperienced interviewers to train each one in person.

6.1.4 Counting and Listing

Counting and listing is the process of enumerating the housing units in a well-defined geographic area selected through scientific sampling procedures. The product of counting and listing in each defined area (called a segment) is a complete list describing all housing units located within the segment boundaries. Counting and listing was completed for 300 segments in 58 counties for this study. A total of 47 field interviewers were used to conduct the counting and listing. The field supervisors did the counting and listing in some areas themselves. Counting and listing began in May 1990 and was completed by mid-June 1990.

Exhibit 6.1

TRAINING AGENDA FOR COUNTING AND LISTING

National Home and Garden Pesticide Use Survey

I. WELCOME AND INTRODUCTIONS

II. OVERVIEW OF SURVEY
- Sponsored by EPA
- Purpose and Background
- Data Collection Activities
- Schedule

III. FIELD INTERVIEWER AND SUPERVISOR RESPONSIBILITIES
- Field Interviewer
- Field Supervisor

IV. TERMINOLOGY
- NHGPUS
- Segment
- Subsegment
- Field Counting
- Listing

V. COUNTING AND LISTING
- Overview
- Materials
- Locating Segments
- Counting Procedures
- Subsegmenting
- Listing Procedures
- Changes to the Counting and Listing Manual

VI. ADMINISTRATIVE DUTIES
- Disposition of Completed Materials
- Segment Checklist
- Field Reporting and Expense Reporting
- Log of Counting and Listing Hours
- PT&E Reporting

FSs assigned FIs to work specific segments. Usually one FI was assigned to work all the segments in a set of nearby counties. FIs were requested to begin counting and listing immediately after receiving their assignments. FIs were required to send their first completed segment to their FS to be checked. If the FS determined that the FI's work was satisfactory, the FI was allowed to send the remainder of his/her completed work directly to RTI.

The FIs were instructed to work the segments with the largest number of estimated housing units first. (The estimated housing unit count was provided for each segment from 1980 Census data.) These segments were the most likely candidates for a subsegmenting procedure designed to improve the efficiency of the counting and listing process. Segments in rural areas with large numbers of housing units (200 or more) are generally very time-consuming to list. The subsegmenting process divides the original segment area into smaller subareas called subsegments using housing unit count information provided by the FI. Thus, for segments containing 200 or more actual housing units that could not be listed in a reasonable amount of time (as determined by the FI), the FI recorded housing unit counts along each street on the segment map and returned these segments with the housing unit counts to RTI for subsegmenting. Because this procedure delayed the listing of large segments until they had been sent to RTI, subsegmented, and returned to the FI, the FIs were instructed to work these larger segments first.

Segments received at RTI to be subsegmented were first divided into subsegments that generally contained about 30 to 50 housing units (HUs), using actual surface features to form new boundaries. A sampling worksheet provided guidance for appropriate subsegment sizes and was completed to determine which subsegment was selected to be listed. A segment kit was then assembled for the selected subsegment and sent back to the field interviewer to be listed.

When a counted and listed segment was received at RTI, it was logged in and edited. An edit checklist was completed for all segments. For those found to be in error, a copy of the checklist was sent to the FI, their FS, and to the RTI data collection supervisor. Minor errors were corrected in-house and were discussed with the FI. Any segment with errors that could not be corrected in-house was sent back to the FI for correction.

6.2 Primary Data Collection Activities

Data collection activities took place from mid-August through the first week of October 1990. The following sections describe the activities associated with data collection.

6.2.1 Recruiting Field Supervisors

The four field supervisors used for counting and listing were available for the primary data collection, therefore, no additional effort was required to recruit field supervisors.

6.2.2 Recruiting Field Interviewers

Most of the field interviewers (FIs) used for counting and listing were also available for primary data collection. Our goal was to hire one FI for each of the 60 PSUs. The same procedures used in recruiting FIs for counting and listing were followed in recruiting FIs for primary data collection. We recruited five bilingual interviewers to help reduce the number of interviews lost to language barriers. Table 6.1 provides a breakdown of the demographic characteristics of the 60 field interviewers used for data collection.

6.2.3 Training

Separate 2-day Field Interviewer Training sessions were conducted by RTI staff in Raleigh, NC, on August 7-8, 1990 and in Dallas, TX, on August 16-17, 1990. Approximately half of the FSs and their FI staff attended the Raleigh session and the other half attended the Dallas session. Prior to training, all field staff received a copy of the NHGPUS Field Interviewer's Project Manual, the RTI General Field Interviewers Manual, home-study exercises, and a copy of the EPA Citizen's Guide to Pesticides. Each trainee was required to review these materials prior to training and to complete the set of home-study exercises.

The day before Field Interviewer Training (August 6 and August 16, respectively), field supervisors were trained in the use of the NHGPUS Training Guide and on FS responsibilities.

Additionally, a 1-day training session was held on the day prior to the NHGPUS FI training sessions for interviewers with less than one year of experience or who had never worked for RTI. This session was designed to train interviewers in basic procedures and techniques employed by RTI in conducting surveys, and to instruct them on RTI administrative procedures and forms.

Table 6.1

CHARACTERISTICS OF FIELD INTERVIEWERS

National Home and Garden Pesticide Use Study

RACE & SEX	INTERVIEWER AGE				TOTAL
	18-34	35-44	45-54	55+	
White Females	6	11	6	24	47
Black Females	0	1	2	2	5
TOTAL FEMALES	6	12	8	26	52
White Males	1	3	3	1	8
Black Males	0	0	0	0	0
TOTAL MALES	1	3	3	1	8
TOTAL	7	15	11	27	60

The training methodology included instructor demonstration, group discussion and interaction, video demonstration, visual aids, round robin mock interviews, paired practice interviews, and classroom exercises. The NHGPUS Training Guide described in Section 5.5 was used by each trainer to help ensure that training was conducted in a uniform manner. Additionally, the RTI General Field Interviewing Training Guide was used at the 1-day session on basic interviewing, again to standardize the training of field interviewers.

The training agenda for Field Supervisor Training, General Field Interviewing Training, and NHGPUS Field Interviewer Training are shown in Exhibits 6.2, 6.3, and 6.4 respectively.

The Field Supervisor Training and the General Field Interviewing Training were conducted by RTI survey specialists. The NHGPUS Field Interviewer Training was conducted by the Field Supervisors and assisted by RTI project staff. Generally, each FS trained his or her own staff of FIs. The training sessions were conducted by the FSs to better establish their authority with their staff, to better determine their FIs' weaknesses and strengths, and to give each FS a better understanding of the project materials. An RTI project staff member was always present to answer questions and clarify material for the FSs. The RTI project director participated in the training by presenting an overview of the NHGPUS sample and a demonstration of examples of product packaging, emphasizing child resistant packaging. A representative from EPA observed each of the training sessions and presented background information on the NHGPUS.

6.2.4 Data Collection Activities

Field Interviewers were instructed to begin work on their assignments immediately following training. There were 298 segments assigned to the FIs (2 of the original 300 segments were found to have no housing units at the time of counting and listing). Of the 298 segments, 116 were designated as early report segments. Information on the progress of data collection in these segments allowed project staff to determine that the target response rates would be achieved without releasing a supplemental sample of housing units.

While the FIs attended training, a lead letter and a glossy study brochure (see Appendix J) were mailed from RTI to all cases in the early

Exhibit 6.2

FIELD SUPERVISOR TRAINING AGENDA

National Home and Garden Pesticide Use Study

1. OVERVIEW

   a. Review background of NHGPUS

   b. Review project schedule and production goals

2. REVIEW FS RESPONSIBILITIES

   a. FI training
      - Schedule/agenda/format
      - FS role - Lead Trainer
      - Home study

   b. Weekly conference with FIs
      - Set up Reporting Schedule
      - Take reports using ACF and FSSR
      - Monitor Early Report Segments Closely
      - Discuss problem cases
      - Discuss editing problems
      - Discuss verification problems
      - Discuss work plans for upcoming week
      - Discuss concerns from latest PT&E charge

   c. Weekly conference with FM
      - Must call at appointed time
      - Critical to monitoring field progress

   d. Editing completed work
      - General edits
      - Completeness of package

   e. Resolving Problems
      - Followup action on pending cases
      - Use of Law Enforcement Letter
      - Controlled Access Letter

Exhibit 6.2 (continued)

3. ADMINISTRATIVE PROCEDURES

   a. Reviewing PT&Es
      - Review points made in manual
      - Participant Incentive Receipts Attached
      - Use of log - must send regularly
      - Send weekly via Fed Ex to RTI

   b. Authorization Forms

   c. FS Travel

   d. Sending documents to RTI
      - Review groupings
      - Send weekly

   e. Quality Control
      - Edit reports from RTI
      - Verification reports from RTI

4. REVIEW OF TRAINING MATERIALS

   - Role of FS - lead trainer
   - Agenda
   - Guide - note corrections
   - Training materials
   - Hand out transparencies
   - Locating and contacting
   - Handling Pesticides
   - CRP examples
   - Q x Qs
   - Practice conducting practices
   - Administrative procedures

Exhibit 6.3

GENERAL FIELD INTERVIEWING TRAINING AGENDA

National Home and Garden Pesticide Use Survey

- Welcome and Introduction
- Video

- Overview of Survey Research Operations
  - What is a Sample Survey?
  - Examples of Sample Surveys
  - FI Procedures and Responsibilities
  - Professional Ethics and Respondents's Rights

- **BREAK**

- What Does a Field Interviewer Do?
  - Video
  - Techniques
  - Greeting and Introduction Examples
  - Obtaining Cooperation and Overcoming Objections
  - Role Play Exercises
  - Refusals
  - Conducting an Interview
  - Editing Requirements
  - Interviewer Efficiency and Performance

- **LUNCH**

- Questionnaire Administration
  - Basic Interviewing Skills
  - Bias Exercise (Written)
  - Trust the Instrument
  - Focusing the Respondent
  - Probing
  - Verbal and Written Probing Exercises
  - Recording Responses (Examples)

- **BREAK**

- Administrative Procedures
  - Employment with Powerforce
  - Supplies
  - PT&E
  - PT&E Exercises
  - Payment
  - Advances

- Practice Round Robin Mock Interview

- Summary Exercise

Exhibit 6.4

TRAINING AGENDA - August 1990

National Home and Garden Pesticide Use Survey

Day 1

BREAKFAST
Registration
Welcome and Introductions
The NHGPUS
Overview of the NHGPUS Sample
Training Session Protocol
Confidentiality and Data Collection Agreement
BREAK
Demonstration Interview
Locating Sample Housing Units
LUNCH
Contacting and Screening Sample Households
Contacting and Screening Practice Exercise
Pests and Pesticides
BREAK
Child Resistant Packaging Examples and Exercises
Take Pictures for ID Badges and Distribute Assignments

Day 2

BREAKFAST
Announcements, Questions, and Answers
Review Home Study Exercise
Questionnaire Administration
BREAK
Question-by-Question Review
Round Robin Practice Interview
LUNCH
Paired Practice Interviews
Quality Control Procedures
BREAK
Administrative Procedures
Wrap-Up & Distribute ID Badge, Paycheck, & Incentive Advance

report segments. These items explained the study, asked for cooperation, informed of pending contact by an RTI interviewer, and explained that an incentive of $5.00 and a copy of the EPA brochure "Citizen's Guide to Pesticide Use" would be given for participation in the study. Methodological studies have shown that such small incentives can produce 5 to 10 percent improvements in response rates (Groves, 1989, Section 5.2.3).

For the remaining cases, FIs were provided with a supply of preaddressed envelopes, containing the lead letter and glossy study brochure, and instructed to mail the materials to sample housing units approximately 3-5 days prior to working the segment. This methodology increases the likelihood that the household member will remember receiving the letter when the interviewer arrives.

During the initial contact at the sampled housing unit, a lead letter and glossy study brochure were given to the respondent if they did not remember receiving one. The Control Form (Appendix A of Volume I) was used to identify the case, to document its status, and to screen the household for eligibility. To be eligible for the survey, the housing unit had to be a permanent residence, not a vacation home, and not a group quarters.

When screening resulted in an eligible household, the interviewer immediately attempted to administer the questionnaire. The household members were rostered and the person(s) most knowledgeable about the pesticides and cleaning products used at the residence were identified. If more than one knowledgeable person was identified the interviewer tried to schedule the interview when all the knowledgeable individuals were available.

The interviewer then continued to administer the questionnaire, and asked to see all the pesticide products used in and around the home. At the conclusion of the interview, the FI completed an observation section identifying the principal respondent, describing the structure and location of the residence and indicating if continuation pages were included with the questionnaire. The FI then paid the $5.00 incentive, had the respondent sign an incentive receipt, left a copy of the EPA "Citizen's Guide to Pesticides," completed the record of calls section of the Control Form, informed the respondent that an RTI staff member might call them to verify that the interview had been conducted, and thanked the respondent for their participation. Upon returning home, the interviewers edited the

study instruments and sent them to their FS or to RTI. A minimum of the first five cases and the first two completed interviews were sent to the FS for review. If the FS determined that the FI's work was satisfactory, the FI was allowed to send the remainder of his/her completed work directly to RTI.

If the household member refused to participate in the interview, the FI attempted to overcome the objection and documented the results so a FS could evaluate the situation and recommend follow-up action. In most cases a refusal conversion letter (see Exhibit 6.5) was sent to the person requesting that they reconsider and informing them that they would be contacted again in the near future.

During the course of the data collection, neighbors were used as a source of information for sample housing units (SHUs) where the FI could not find anyone at home. The FI asked neighbors if they knew if the house was occupied and the best time to find the residents at home or to determine if the residents were away for an extended period. The FI was then required to enter the name and telephone number of the neighbor who provided this information in Part D of the Control Form.

Data collection began on August 9 and was completed on October 7, 1990. Table 6.2 presents the distribution of final interview results. Nine interviewers had no refusals. Seven interviewers achieved a completed interview for over 90 percent of their cases. An additional 22 interviewers achieved a completed interview for over 80 percent of their cases.

6.2.5 Validation Interviews

Ten percent of the SHUs in each segment were selected for validation. During each screening interview, the FI requested the respondent's telephone number and informed the respondent that they could be contacted later to verify the FI's work. Of the 267 cases selected for validation, 210 resulted in a completed interview and were eligible for validation. There were a few special non-interview cases that were validated as well, but generally, no attempt was made to validate non-interview cases.

RTI's Telephone Survey Unit conducted the validations. Their many years of validation interview experience made them well suited for this task. The validation telephone interviewers (TIs) were given the Control Form and questionnaire. The TI abstracted the housing unit ID number, FI

Exhibit 6.5

REFUSAL CONVERSION LETTER

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PESTICIDES AND TOXIC SUBSTANCES

Dear Respondent:

Recently one of our workers, <FI NAME>, came to your home and asked you to take part in the National Home and Garden Pesticide Use Survey. At that time, you were unwilling to participate in the survey. Please allow me to give you some background on the survey.

The survey provides the Federal Government with important information on the public's exposure to pesticides and on what pests are problems. The Environmental Protection Agency is mandated by congress (P.L. 92-516, as amended by P.L. 94-140, as amended by P.L. 95-396) to register pesticides used in the United States on the basis of a scientific evaluation of both the risks and the benefits that would result from the use of the product. Information on products used in and around the home is needed to support this congressional mandate. Respondent's answers and also the areas that are selected to be surveyed are kept strictly confidential, and data are presented only as summary statistics for the U.S.

We have selected a limited number of households and the participation of each and every person is important. Of course, participation by selected respondents is completely voluntary. However, high participation rates are necessary for valid survey results.

We have enclosed a question and answer brochure with more information about the survey. Please reconsider. We will be contacting you again in the near future. Your cooperation would be greatly appreciated. If you have any questions or would like to discuss the survey further, please feel free to call me at (703) 308-8050.

Sincerely yours,

Edward Brandt
Project Officer
National Home & Garden Pesticide Use Survey

Table 6.2

Distribution of Final Interview Results

Final Result	Number	Percent
Eligible sample housing unit	2,447	90.87
Completed interview	2,078	77.16
Refusal	209	7.76
Breakoff	3	0.11
No eligible respondent home	88	3.27
Language barrier	10	0.37
Physically/mentally incompetent	9	0.33
Other eligible	50	1.86
Ineligible sample housing unit	246	9.13
Vacant housing unit	167	6.20
Not a housing unit	42	1.56
Vacation/second home	33	1.23
Other ineligible	4	0.15
TOTAL	2,693	100.00

ID number, and interview date from the Control Form and entered it on the FI Validation Form (see Exhibit 6.6). They then looked at the questionnaire to determine if any pesticide products were reported and recorded either "yes" or "no" as appropriate on the validation form. They also abstracted the response to Question 5a of the questionnaire ("During the past year, did your household raise any crops or livestock for sale?") and entered it on the validation form.

For cases where phone numbers were available, the TI attempted the validation call. The first step was to determine if the respondent remembered being interviewed and if they had been asked about their use of pesticide products. The TI then validated two items from the questionnaire and verified that the field interviewer had looked at the cleaning products to see if any qualified as pesticides. The TI then asked if the field interviewer had been courteous and thanked the respondent. During the validation interview, if a respondent gave information that was different from the questionnaire data, the interviewer was trained to probe the respondent to clarify the discrepancy. This often resulted in a resolution of the problem.

In cases where an SHU selected for the validation did not have a telephone number or the wrong number was recorded on the Control Form, a validation letter (see Exhibit 6.7) was mailed to the address. The validation package included a postage paid envelope for return of the letter to RTI. Cases where the letter was not returned were not validated.

The results of the interview validation are as follows. Of the 210 completed interviews included in the validation sample, 30 (14 percent) either did not have a telephone, refused to provide a telephone number, gave us the wrong telephone number, or could not be contacted to validate the case after several attempts. We were able to successfully validate 176 (98 percent) of the remaining 180 cases, 162 by telephone and 14 by mail. The four cases in which the validation questions were not confirmed were scattered across four different interviewers and usually had a plausible reason for the discrepancy; most were elderly respondents who did not remember the study.

6.2.6 RTI Protection of Human Subjects Committee Review

Every project conducted by RTI requiring data collection from people must receive approval of the RTI Committee for the Protection of Human

Exhibit 6.6

FIELD INTERVIEW VALIDATION FORM

National Home and Garden Pesticide Use Survey

Verified By: _____ Date Verified: ___/___/___

A: ASSIGNMENT INFORMATION

1. HU ID Number: [ ][ ][ ][ ][ ][ ][ ] - [ ][ ]

2. FI ID Number: [ ][ ][ ][ ][ ][ ] Interview Date: [ ][ ]-[ ][ ]- 90

3. Look at the top of page 4 of the questionnaire. If the circled number at the top of the page is more than ZERO, enter YES on the line provided in Item 4 below. If the circled number is ZERO, enter NO on the line provided in Item 4 below.

4. Record the answer to Question 5a on page 1 of the questionnaire on the line provided in Item 6 below (YES, NO, or DK).

B: VALIDATION

1. Name of Person Contacted _____(required only if you have a problem flagged.)

READ THE FOLLOWING INTRODUCTION WHEN YOU CONTACT ELIGIBLE RESPONDENT TO CONDUCT VALIDATION.

"Hello, my name is _____ from the Research Triangle Institute in North Carolina. I am calling to verify that one of our staff recently contacted you about a survey we are conducting for the Environmental Protection Agency."

	YES	NO	
2. Do you remember someone from Research Triangle Institute coming to your home?	01	02-->PROBE OR STOP!	
3. Did the person ask you questions about your use of pesticide products?	01	02	
4. Did you have any stored pesticide products for home use at the time the interview was conducted?	01	02	___QUEX
5. Did the interviewer look at your cleaning products to see if any of them qualified as pesticides?	01	02	
6. During the past year, did your household raise any crops or livestock for sale? (Q5a)	01	02	___QUEX
7. Was the interviewer courteous?	01	02	

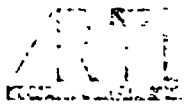
8. THANK THE RESPONDENT.

9. FLAG/PULL PROBLEMS: B4 response not equal to QUEX response on line.
B6 response not equal to QUEX response on line for Q5a.
B7 = no.

Exhibit 6.7

VALIDATION LETTER
National Home and Garden Pesticide Use Study

RESEARCH TRIANGLE INSTITUTE



HU ID # [ ][ ][ ][ ][ ][ ]-[ ][ ] FI ID # [ ][ ][ ][ ][ ]

October 19, 1990

Dear Respondent,

During the past month, the Research Triangle Institute has been conducting a nationwide survey on the use of pesticides sponsored by the United States Environmental Protection Agency. Our records indicate that you were interviewed. We would appreciate it if you would take a moment to complete the questions listed below and return them in the enclosed pre-addressed postage paid envelope. This information helps us to verify our records, and the quality of our interviewer's performance.

Please answer the following questions by circling the appropriate response.

1.	Do you remember someone coming to your home collecting information on the use of pesticides in your home?	Yes	No	If No, Go to Question 6.
2.	Did you have any stored pesticide products for home use at the time the interview was conducted?	Yes	No	
3.	Did the interviewer look at your cleaning products to see if any of them qualified as pesticides?	Yes	No	
4.	During the past year, did your household raise any crops or livestock for sale?	Yes	No	
5.	Was the interviewer courteous?	Yes	No	

6. Thank you for your participation in our survey. We look forward to your response.

Sincerely,

Janice Kelly

Post Office Box 12194 Research Triangle Park, North Carolina 27709-2194 Telephone 919-541-6000

Subjects before any data collection can begin. This committee reviews the entire study protocol, all data collection instruments and forms, and all data collection procedures. In June 1990, we presented final drafts of the lead letter, informational brochure, questionnaire, control form, and showcards to the committee along with the complete study protocol. The committee expressed greatest concern over interviewers not being trained to detect potentially dangerous use or storage of pesticides. This concern was overcome by pointing out that each respondent would receive a copy of the EPA "Citizen's Guide to Pesticides," which covers alternatives to chemical pesticides, tips for handling pesticides, correct storage and disposal of pesticides, reducing exposure to pesticides, what to do in a pesticide emergency, and other topics. On July 19, 1990, the committee approved implementation of the study.

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7. DATA PROCESSING

All data collection instruments used in this study that contained respondent data were submitted to manual editing and data entry. These processes are discussed in the first two sections of this chapter. Additional computerized data editing was also performed for the two primary data collection instruments (the questionnaire and Card A) as discussed in Section 7.3. The final section of this chapter discusses a computerized survey control system, which was used to ensure that all data processing steps were executed, and executed in the proper order, for every data collection instrument for every household.

7.1 Manual Editing

Every data collection instrument that contained respondent-provided data was manually edited after it was received at RTI. Six editors and one supervisor were trained and began manual editing on September 5, 1990. This manual edit was conducted using edit specifications developed for each instrument. General edits included a check of the legibility of entries, a check of the housing unit identification information to ensure its consistency for all associated survey materials, a check for completeness of designated key items in the instrument, and a check for proper use of skip patterns in the instrument. The number of pesticide products was counted and verified, and Table B continuation sheets were stapled to the questionnaire to facilitate data entry. Any items that failed to meet the edit criteria were documented. Problems that could not be resolved by project staff using other data sources from the project were resolved via a followup telephone call from RTI project staff to the data collector responsible for the completed instrument.

The instruments that were manually edited at RTI were the Control Form, Card A, and the questionnaire. Data collectors were also instructed to edit all these instruments before mailing them to RTI. Interviewer editing and Field Supervisor review are discussed in Section 6.2.4.

7.2 Data Entry

Data entry programs were developed for each of the three separate documents: the Control Form, the household questionnaire, and Card A. The product information in the household questionnaire was developed as a

"repeating screen" for data entry, which resulted in variable length data files, depending on the number of products reported.

Data entry programs were developed in Easy Entry, which allowed imbedded quality-control checks in the data-entry process. The data-entry programs performed the following quality-control checks:

- checked all items for permissible ranges and codes
- verified all digits on the critical IDs to ensure consistent entry
- verified that any items defined as critical were not blank.

In order to produce data of high quality, all data were keyed twice. Any discrepancies between the two keyings were detected by the software and corrected by the second data entry operator.

Because the data-entry files are organized in the same format as the data-collection instruments to simplify data entry, the files were reformatted and combined to produce raw analysis files. These raw files were then read into SAS data sets. During this SAS input step, product-level data in the repeating screen was removed from the questionnaire data file and placed in a separate file along with appropriate identifying data.

7.3 Computerized Editing

The NHGPUS data were analyzed for automated editing as four separate files: 1) Control Form items, 2) household-level questionnaire items (Questions 1-16, 34, and 40-54), 3) Card A data (Questions 35-39), and 4) product-level items (Questions 17-33 for each pesticide product found in storage at the home). Because the Control Form was not a primary data collection instrument, no computerized editing was necessary for that form. The data bases for all other forms were subjected to extensive computerized editing.

The primary purposes of computerized data editing were: 1) to find and correct inconsistencies and errors, and 2) to replace missing data with "consistency codes" to explain why the data were missing. The computerized editing process was begun by generating unweighted frequency tabulations of the data items. For most variables, multi-way tabulations were examined to simultaneously check for: 1) illegal codes, 2) inconsistencies, and 3) skip pattern violations. Virtually all of the problem situations were checked against the hard-copy questionnaires to determine the best possible

resolution. Telephone calls to the respondents to resolve problems were not attempted primarily because the majority of the data collected concerned the pesticide products in storage at the time of the interview. Problems with these data generally could not be resolved by recontacting the respondents.

After resolving as many inconsistencies as possible, missing data fields were replaced with consistency codes that explained the reasons why the data were missing. Table 7.1 explains the consistency codes. For example, for a two-digit numeric field, a code of "94" represents a response of "I don't know;" a code of "98" means that the item was left blank but should have been completed; and a code of "99" means that the item was legitimately skipped based on the responses to previous questions.

The consistency code for "not applicable" (93 for numeric fields and NA for alphabetic fields) was used for blank entries in fields that allowed multiple responses and had a non-blank entry for at least one of the potential response fields. For example, this code was used for the name, age, and sex variables that extended beyond the number of members in the household. Another example is Question 22. The uncircled responses to Question 22, type of product, were coded 93 when at least one of the type of product responses had been circled.

7.4 Data Processing Management

During data collection, an RTI-developed control program on a personal computer system maintained records that indicated the current status of each sample household. The record for each sample member contained location and sampling information as well as codes indicating each action or event that occurred for the sample household member. Information recorded by the system included:

- receipt by RTI of completed forms
- final result code from each screening form
- status of editing and coding operations
- data-entry status

Programs were developed on RTI's VAX system to allow Data Preparation staff to quickly enter (using bar-coded ID labels) all forms received and edited. The transaction files produced by these programs were then loaded

Table 7.1

STANDARD RTI CONSISTENCY CODES
FOR SURVEY DATA BASES

Alpha Field Code[a]	Numeric Field Code[b]	Description
NK	91	Never know. Respondent doesn't know now and never will; therefore, do not attempt to update the data later.
IL	92	Illegible. This code is used only for those questions in which the response could not be determined.
NA	93	Not applicable.
DK	94	Don't know. This code indicates a written response by the interviewer indicating that the respondent did not know the answer.
BD	95	Out-of-range response. This code is used when the response or transcription exceeds the specified field width or allowable value range (e.g., cannot have a month = 13).
MR	96	Multiple response. This code is used when the respondent gave more than one answer to a question that called for only one response, and the multiple response could not be resolved.
RE	97	Refusal. This code is used when the respondent refused to answer the item.
BL	98	Blank or nonresponse. This code is used for all cases in which there was no response for an item, other than legitimate nonresponse (see below).
LS	99	Legitimate nonresponse. This code is used when the respondent should not have answered the question (i.e., was routed around the item).

[a]All alphabetic data, including consistency codes, are left-justified and filled with rightmost blanks.

[b]All numeric consistency codes are left-filled with 9s for field widths greater than two.

into the PC system and processed. The update process checked each transaction according to pre-determined logical rules before updating the system. Therefore, for example, an edit event would not be allowed before a receipt event. These checks prevented keying errors and other mistakes from producing inconsistent status codes in the control system.

The control system was used to track progress in receiving forms from the field and to monitor production in editing and keying operations. Reports were run at least weekly and delivered to the project director and the data collection task manager. The system was also used to locate particular forms when questions arose.

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8. SAMPLING WEIGHTS

A properly designed sample survey is based on sampling units selected with known probabilities of selection. Design-unbiased estimates of linear statistics are then achieved by weighting the observations for each sampling unit inversely to the probabilities of selection (Cochran, 1977; Kish, 1965). Analytical expressions for the NHGPUS sampling weights are presented in this chapter.

The NHGPUS sampling design can be described briefly as a three-stage probability sampling design. As discussed in Chapter 4, counties were selected at the first stage of sampling, subcounty areas were selected within the sample counties at the second stage, and individual housing units were selected from the sample areas at the third stage. The first section of this chapter discusses the sampling weights based on the probabilities of selection at the three stages of sampling.

The sampling weights based on the probabilities of selection would enable unbiased estimation of population characteristics if data were successfully collected for all units selected into the sample. In practice, however, virtually all surveys experience some level of nonresponse (e.g., some randomly selected sample subjects refuse to participate). When nonresponse occurs, the sampling weights enable unbiased estimation of linear statistics only for the population of units that would have responded to a census (a sample in which all members of the population were surveyed). Therefore, statistical nonresponse adjustments are generally performed to extend inferences from the respondents to the entire survey population.

Survey nonresponse can be dichotomized as unit-level nonresponse and item-level nonresponse. The former occurs when no data are collected for a sampling unit (e.g., when a person refuses to participate), and the latter occurs when a participating sample member fails to provide data for an individual survey item (e.g., when the participant doesn't know how often a pesticide product was used during the past year). Weight adjustment procedures are generally used to compensate for unit-level nonresponse. Adjustments for item-level nonresponse include both weight adjustments and imputations (substitution of estimates for the missing data). The

nonresponse adjustment procedures are generally designed to compensate, to the extent possible, for the potential bias that could occur because of differences between the responding and nonresponding members of the population. An overview of survey nonresponse adjustment procedures is provided by Madow et al. (1983).

The weight adjustment procedures used to compensate for unit nonresponse in the NHGPUS are discussed in the second section of this chapter. The third section discusses the nonresponse adjustment procedures employed to compensate for item nonresponse.

8.1 Weights Based on the Sampling Design

This section discusses the NHGPUS sampling weights based on the three stages of the probability sampling design described in Chapter 4.

8.1.1 First-Stage Sample of Counties

When first-stage sampling units (FSUs) are selected with probabilities proportional to size, as they were for the NHGPUS design, the weight component for each sample FSU selection is normally the reciprocal of the expected frequency of selection. Moreover, the sum of the products of these weights times the size measures is normally the estimated total number of units in the target population based on the sampling frame size measures. For example, using the expected frequency of selection (4-1) for the 1981 sample,

$$\sum_{i \epsilon S_1} \left[\frac{\sum_{i'=1}^{N_1} S(i')}{180\ S(i)} \right] S(i) = \sum_{i'=1}^{N_1} S(i') \ . \qquad (8\text{-}1)$$

However, for the NHGPUS sample, the expected frequency of selection for the i-th FSU (county) is given by (4-3). The denominator of (4-3) is an estimate of the December 1988 household population computed as if this information were available only for the 180 counties in the 1981 sample. Because the December 1988 projections from Market Statistics, Inc. were available for <u>all</u> counties in the target population, the sampling weights given by the reciprocal of (4-3) were poststratified by multiplying them by the following ratio-adjustment factor,

$$R(i) = \frac{\sum_{i=1}^{N_1} M_1(i)}{\left[\sum_{i=1}^{N_1} S(i)\right] \left\{\sum_{i=1}^{N_1} I_{S_1}(i) \left[M_1(i) / S(i) / 180\right\}\right.} \qquad (8\text{-}2)$$

Therefore, the first-stage weight component for the i-th FSU (county) in the NHGPUS sample is

$$W_1(i) = \sum_{i=1}^{N_1} M_1(i) / 60\, M_1(i) \; . \qquad (8\text{-}3)$$

The sum of the products of these weights times the county size measures, $M_1(i)$, estimates the total number of households in the NHGPUS population in December 1988, i.e.,

$$\sum_{i \epsilon S_1}^{*} W_1(i)\, M_1(i) = \sum_{i=1}^{N_1} M_1(i) \; . \qquad (8\text{-}4)$$

8.1.2 Second-Stage Sample of Subcounty Areas

An implicitly stratified sample of five area segments was selected at the second stage of sampling for each first-stage FSU selection. Thus, the weight component for the second stage of sampling is the reciprocal of the conditional expected frequency of selection given by (4-4). Therefore, the conditional weight component for the j-th second-stage sampling unit in the i-th county is

$$W_2(i,j) = \sum_{j=1}^{N_2(i)} M_2(i,j) / 5\, M_2(i,j) \; . \qquad (8\text{-}5)$$

For large area segments (generally those containing 200 or more housing units), an additional stage of sampling, called subsegmenting, was imbedded into the second-stage sample selection process. The weight component for this stage of sampling is the reciprocal of the probability of selection of the subsegment, given by (4-5). Therefore, the conditional weight component for the (i,j,k)-th subsegment is

$$W_3(i,j,k) = \begin{cases} \dfrac{\sum_{k=1}^{N_3(i,j)} M_3(i,j,k)}{M_3(i,j,k)} & \text{if the } (i,j)\text{-th segment was subsegmented} \\ 1 \text{ if the } (i,j)\text{-th segment was not subsegmented.} \end{cases} \quad (8\text{-}6)$$

When the sample segment contained many more housing units than expected based on the second-stage size measure, $M_2(i,j)$, this weight component compensates for the unanticipated growth.

8.1.3 Third-Stage Sample of Housing Units

An equal probability sample of housing units was selected from those listed for the (i,j,k)-th area segment (or subsegment). The weight component for this stage of sampling is then the reciprocal of the third-stage probability of selection (4-6). Therefore, the conditional third-stage weight component for the (i,j,k,ℓ)-th housing unit is

$$W_4(i,j,k,\ell) = N_4(i,j,k) \;/\; m_4(i,j,k). \quad (8\text{-}7)$$

Given the weight components for all stages of sampling, the final sampling weight for the (i,j,k,ℓ)-th housing unit based on the sampling design is the product of the weight components for all stages of sampling. Therefore, the final design-based sampling weight for the (i,j,k,ℓ)-th housing unit is

$$W_4^*(i,j,k,\ell) = W_1(i)\, W_2(i,j)\, W_3(i,j,k)\, W_4(i,j,k,\ell). \quad (8\text{-}8)$$

Because sampling units were selected with probabilities proportional to size at the first and second stages of sampling, and the third-stage allocation was designed to yield approximately equal probabilities, the final sampling weights (8-8) are approximately equal for most sample housing units. They are not identically equal primarily because the size measures used for the second stage of sampling (1980 Census counts of housing units) were somewhat inaccurate due to being out of date. They were, however, the best size measures available at the time that the sample was selected.

8.2 Weighting-Class Adjustment for Unit Nonresponse

Nonresponse inevitably occurs in all sample surveys. The NHGPUS was designed to collect data from all sample housing units that were occupied as permanent residences. Failure to collect data for any eligible sample housing units (e.g., because no one was found at home or because of refusal) results in the possibility of bias due to differences between the respondents and nonrespondents.

The best protection against nonresponse bias is a high survey response rate, generally 80 percent or better. Since the NHGPUS achieved an 84.9 percent response rate, the potential for nonresponse bias is low. Nevertheless, compensation for unit nonresponse is necessary to enable estimation of population totals and to compensate for differential rates of nonresponse.

Weighting-class weight adjustment procedures were used to compensate for unit nonresponse. These procedures categorize the sample housing units into categories called weighting classes that are defined so that respondents and nonrespondents are more alike within classes with respect to their survey responses and/or their propensity to respond than between classes. The sampling weights of the respondents are then ratio-adjusted to the sum of the sampling weights for all eligible sampling units within each weighting class. For estimation of linear statistics (e.g., population totals), this weight adjustment procedure is equivalent to substituting the mean response of the respondents for the missing observations within each weighting class. Therefore, each weighting class is generally required to contain at least 20 to 30 respondents.

Survey response rates were examined with respect to several potential weighting-class variables: Census Division, State, county, county-level and ED/block-level urbanization variables used for stratifying the sample, and the average dwelling value and percent multi-family dwelling variables used to stratify the second-stage sample. Weighting classes based on Census Divisions and the urbanization variable used to stratify the first-stage sample of counties were determined to be the most effective weighting-class variables. The NHGPUS response rates are presented by weighting classes in Table 8.1. In most Census Divisions, higher response rates were achieved in predominantly rural counties than in predominantly

Table 8.1 Response Rates by Weighting Classes

Census Division[a]	County Urbanicity	No. Eligible Households[b]	No. Responding Households	Response Rate
1. New England	Urban	97	82	84.5%
	Rural	42	37	88.1
2. Middle Atlantic	Urban	305	257	84.3
	Rural	42	41	97.6
3. East North Central	Urban	319	262	82.1
	Rural	81	73	90.1
4. West North Central	Urban	139	129	92.8
	Rural	91	81	89.0
5. South Atlantic	Urban	244	204	83.6
	Rural	121	114	94.2
6. East South Central	Urban	99	89	89.9
	Rural	39	37	94.9
7. West South Central	Urban	177	126[c]	71.2[c]
	Rural	102	91	89.2
8. Mountain	Urban	81	74	91.4
	Rural	70	65	92.9
9. Pacific	Urban	398	316	79.4
	Rural	-[d]	-[d]	-[d]
Total		2,447	2,078	84.9

[a]See Table 1.2 of Volume I for definition of the Census Divisions.

[b]All housing units occupied as permanent residences were eligible for the survey.

[c]The forms for all 36 sample housing units worked by one interviewer in Harris County, Texas were lost in the mail. The interviewer claimed to have completed 27 interviews. RTI verified by telephone that interviews were conducted for at least some of these sample households. Another four completed interviews were lost in the mail for three other sample areas.

[d]No counties classified as rural were selected for the Pacific Division.

urban counties. Although Census Divisions are fairly broad categories, they were sufficient to capture some major response rate differences. More narrowly-defined weighting classes could potentially remove more nonresponse bias, but they could also reduce precision by increasing unequal weighting.

The weighting-class weight adjustment factor for the (i,j,k,ℓ)-th sample housing unit was computed as follows:

$$W5(i,j,k,\ell) = \frac{\Sigma_c \; W_4^*(i,j,k,\ell) \; I_E(i,j,k,\ell)}{\Sigma_c \; W_4^*(i,j,k,\ell) \; I_R(i,j,k,\ell)} \qquad (8\text{-}9)$$

where Σ_c denotes summation over all sample housing units that belong to the same weighting class "c" as the (i,j,k,ℓ)-th housing unit, I_E is a (0,1)-indicator of eligibility for the (i,j,k,ℓ)-th sample housing unit, and I_R is a (0,1)-indicator of response for that housing unit. Therefore, the final analysis weight for the (i,j,k,ℓ)-th housing unit is given by

$$W6(i,j,k,\ell) = W_4^*(i,j,k,\ell) * W_5(i,j,k,\ell) * I_R(i,j,k,\ell). \qquad (8\text{-}10)$$

The sum of these analysis weights over all households in the NHGPUS sample is 84,572,672, which is the survey estimate of the size of the NHGPUS target population of households at the time that the survey was conducted (August and September 1990). Considering differences in definitions of the survey populations, this estimate is consistent with the Census Bureau's estimate of 94,596,000[5] occupied housing units in the United States in the third quarter of 1990 based on the Current Population Survey. The Census Bureau estimate includes the following domains that do not belong to the NHGPUS survey population: the states of Alaska and Hawaii, vacation homes (non-permanent residences), homes on military reservations, and homes on Indian reservations.

8.3 Compensating for Item Nonresponse

Item nonresponse occurs when the survey respondent does not provide a response for some individual data items, such as the number of times a product was used in the past year. The strategies available to compensate for item nonresponse include statistical imputation and weight adjustments.

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[5]Personal communication with Bob Callis, (301) 763-8165, at the U.S. Bureau of the Census on October 31, 1990.

Both imputation and weight adjustment procedures begin by partitioning the sample into classes so that respondents and nonrespondents are more alike within classes than between classes, as discussed previously for weighting-class adjustments for unit nonresponse.

Imputation procedures replace missing item data values with data values selected from members of the same imputation class who responded to the item. Imputations simplify analyses because the analyses can proceed as if complete data were obtained. However, sampling variances tend to be underestimated when the imputed values are treated as actual responses (Rubin, 1987). Moreover, relational analyses based on imputation-completed data can be misleading because the relationships between variables may be affected in unexpected ways (Lepkowski et al., 1984). Imputations were not used for any of the NHGPUS analyses.

Weighting-class weight adjustment procedures were used when adjustments were considered necessary for item nonresponse in the NHGPUS analyses (e.g., for estimating the total number of single-family and multi-family households in the target population). The nonresponse adjustment factors were computed exactly as described in Section 8.2 for unit nonresponse, except that only the households for which data were available for the item(s) in the specific analysis were treated as the respondents. The weighting classes established to compensate for unit nonresponse were also used for item-level weight adjustments for all estimates of population totals. New weighting classes were not created for the item nonresponse adjustments to save time and expense and because the rate of occurrence of item nonresponse was usually low.

8.4 Quality Assurance Procedures

The correctness of sampling and analysis weights is of such fundamental importance for correct statistical analyses that RTI routinely performs quality assurance checks for all weight files. For example, the products of the first-stage weights and size measures are summed to verify that they sum to the total size measure for the sampling frame. When weighting-class weight adjustments are performed, the initial weights for all eligibles and the final weights for all respondents are summed to verify that they are identical for every weighting class.

Weight checks were implemented for the NHGPUS for every stage of sampling and every stage of weight adjustment. The weight checks were

reviewed and certified by a senior sampling statistician not directly involved in the project.

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9. STATISTICAL ANALYSIS METHODS

Because a stratified, multistage sampling design was used to select an efficient sample for the NHGPUS, analysis procedures that account for the complex sampling design must be used to properly analyze the survey data. The sampling weights discussed in Chapter 6 must be used to compute design-unbiased point estimates of population parameters. The sampling variances of survey statistics must also account for the stratification and multistage sampling (Wolter, 1985). Therefore, special-purpose software developed by RTI over the past 15 years for analysis of complex sample survey data was used to analyze the NHGPUS data base (Shah et al., 1989). RTI's software has been tested and reviewed by many independent researchers and found to produce accurate results efficiently (Francis and Sedransk, 1979; Kaplan et al., 1983; Cohen et al., 1986).

Estimation of population totals and their variances provides the basis for variance estimation for other population parameters such as means and proportions. Therefore, this chapter begins with a discussion of the NHGPUS estimation procedures for population totals.

9.1 Estimating Totals and Associated Variances

The sampling distribution of a statistic based on a probability sample from a finite population is the distribution induced by the sampling design: the strata, clusters, and probabilities of selection. Therefore, the choice of appropriate estimators of sampling variance is linked directly to the sampling design.

The sample design for the NHGPUS was a stratified, three-stage design. The 60 first-stage sampling units were selected with probabilities proportional to size (pps) using a sequential probability minimum replacement (pmr) algorithm (Chromy, 1979). The size measure for each FSU was a current estimate of the number of occupied housing units in the county.

Variance estimation procedures for the sequential pmr sampling algorithm are discussed by Chromy (1981). He recommends any of three alternative estimators: an assumed replacement estimator, a successive difference estimator, and a collapsed stratum estimator. The successive difference and collapsed stratum estimators make use of the implicit

stratification that results from sequential sampling from an ordered list. The NHGPUS variance estimates were computed using a collapsed stratum estimator that assumes sampling with replacement at the first stage of sampling.

When the 60 FSUs were selected at the first stage of sampling, the sequential pmr algorithm created 60 sampling zones or strata of equal size (equal expected numbers of housing units) and selected one FSU to represent each zone. Stratification of the sample resulted from sorting the sampling frame by the stratification variables discussed in Appendix A. A sample of 58 distinct counties was selected, two large counties having been selected to represent two zones each. Collapsed strata were defined for variance estimation by first sorting the 58 sample counties in exactly the same order as used for sample selection (i.e., by the first-stage sampling strata). The first pair of sample counties was then assigned to Analysis Stratum 1, the next pair to Analysis Stratum 2, and so on through Analysis Stratum 29 for the last pair of sample counties.

Using the collapsed strata and assuming replacement sampling at the first stage results in estimates of sampling variances with small positive bias. The bias results from collapsing strata and from ignoring the covariances induced by sampling without replacement from a finite population. Such estimates are conservative in the sense that interval estimates based upon them (e.g., for means or proportions) will be slightly wider in expectation (or, on the average, over all possible samples) than intervals based on an unbiased estimator. Estimates of population totals are of interest for the NHGPUS primarily because estimates of population proportions are actually ratios of estimated totals. For example, the estimated proportion of households that disposed of a pesticide container with the regular household trash in the past year is the ratio of the estimated number of such households divided by the estimated number of households in the NHGPUS target population.

If we let y represent any household characteristic for which the population total is of interest (e.g., a (0,1)-indicator of whether or not the household disposed of a pesticide container with the regular household trash), the total number of households in the survey population with that characteristic can be estimated as

$$\hat{Y} = \sum_{r=1}^{29} \sum_{i=1}^{2} \hat{Y}(r,i) \qquad (9\text{-}1)$$

where $\hat{Y}(r,i)$ is the estimated total of the characteristic y over all households in the i-th sample county of analysis stratum "r." This county total, $\hat{Y}(r,i)$, can be estimated as

$$\hat{Y}(r,i) = \Sigma\ W6(i,j,k,\ell)\ y(i,j,k,\ell), \qquad (9\text{-}2)$$

where the summation, Σ, is over all responding sample housing units in the i-th sample county and W6 is the final analysis weight discussed in Section 8.2

The sampling variance of the estimated population total, Equation (9-1), was then calculated for NHGPUS estimates as follows:

$$\hat{V}(\hat{Y}) = 2 \sum_{r=1}^{29} \sum_{i=1}^{2} \left\{ \hat{Y}(r,i) - \hat{\bar{Y}}(r) \right\}^2 , \qquad (9\text{-}3)$$

where

$$\hat{\bar{Y}}(r) = [\hat{Y}(r,1) + \hat{Y}(r,2)] \ / \ 2 \ . \qquad (9\text{-}4)$$

As noted previously, the importance of the procedures for estimating NHGPUS population totals and their sampling variances is primarily the role they play in estimation of population proportions, which is explicitly formulated in the next section.

9.2 Estimating Means, Proportions, and Associated Variances

The parameters of primary interest for the NAWWS are population proportions (e.g., the proportion of households that disposed of a pesticide container with the regular household trash in the past year). Both means and proportions in the survey population can be expressed as the ratio of two population totals. In general, the population ratios can be expressed as

$$R = Y_n \ / \ Y_d \ , \qquad (9\text{-}5)$$

where Y_n and Y_d denote the population totals of numerator and denominator variates y_n and y_d, respectively. For example, if R is the conditional proportion of all households that used a commercial lawn care service in the past year who were informed in writing about the chemicals used on their lawn, then Y_n would be the total number of households so informed, Y_d

would be the total number of households that used such a service, and y_n and y_d would be (0,1)-indicators of these conditions for each household in the population.

A consistent estimator for R (i.e., one that converges to R as the sample and population sizes become infinite) is

$$\hat{R} = \hat{Y}_n \; / \; \hat{Y}_d \quad , \tag{9-6}$$

where $\hat{Y}_n$ and $\hat{Y}_d$ are the estimated population totals as calculated from Equation (9-1) for the numerator and denominator variates y_n and y_d, respectively. $\hat{R}$ is a slightly biased estimator for R, but the bias is on the order of 1/n, where n is the number of sample households that contribute to the estimated domain total $\hat{Y}_d$. Hence, the bias is generally negligible for reasonably large analysis domains (e.g., with 30 or more sample observations).

Ratio estimates are nonlinear functions of the observations. The sampling variance induced by the sampling design cannot generally be expressed in closed form for nonlinear statistics. A frequently used approximation for the variance of an estimated ratio is based on the first term of a Taylor series expansion of the ratio (Cochran, 1977). A computationally convenient way to express this variance calculation is to first define a new "linearized" variable, as follows:

$$z(i,j,k,\ell) = [y_n(i,j,k,\ell) - \hat{R}\, y_d(i,j,k,\ell)] \; / \; \hat{Y}_d \; . \tag{9-7}$$

The estimated variance of the ratio statistic, $\hat{R}$, can then be expressed as

$$\hat{V}(\hat{R}) = \hat{V}(\hat{Z}) \tag{9-8}$$

where $\hat{Z}$ is the estimated population total, given by Equation (9-1) for the linearized statistic, z, and $\hat{V}(\hat{Z})$ is calculated from Equation (9-3).

Cochran (1977) discusses the accuracy of Equation (9-8) for estimating the variance of the ratio statistic, Equation (9-6). He notes that omitting the second and higher order terms of the Taylor series expansion generally results in Equation (9-8) being an underestimate of the true variance. A guideline suggested by Cochran is that Equation (9-8) will generally yield satisfactory results if the ultimate sample size exceeds 30 units and the coefficients of variation (CVs) for the estimates of $\bar{Y}_n$ and

Y_d are both less than 10 percent. In practice, if the ratio estimate is a domain mean or proportion, the number of domain members in the sample contributing to Y_n and Y_d should be at least 30.

9.3 Suppression Rule

The survey estimates presented in the next chapter are footnoted as having poor precision whenever the relative standard error of the estimate exceeds 50 percent. The relative standard error, RSE, of an estimated population proportion, $\hat{P}$, can be represented as

$$RSE(\hat{P}) = \sqrt{\hat{V}(\hat{P})} / \hat{P} , \qquad (9\text{-}9)$$

where $\hat{P}$ is calculated from Equation (7-6) and $\hat{V}(\hat{P})$ is calculated from Equation (9-8).

However, as noted in Section 9.2, the linearization method of variance estimation for ratio statistics such as proportions can produce underestimates. This occurs primarily for very small domains and for very small proportions. To guard against reporting unreasonably small standard errors, the variance expected using a simple random sample of the same size was substituted in the tables and in Equation (9-9) for the design-based variance calculated from Equation (9-8) whenever the simple random sampling variance was larger. For estimates of population proportions, the simple random sampling variance was calculated as

$$\hat{V}_{SRS}(\hat{P}) = \hat{P}(1 - \hat{P}) / n , \qquad (9\text{-}10)$$

where n is the number of sample units contributing to the denominator of the proportion. This variance estimate is a logical upper bound for the variance of $\hat{P}$ under the survey design because the clustering involved in multistage sampling almost always results in positive intracluster correlations.

Many estimates in the analysis tables have RSEs that are approximately 100 percent. These estimates are usually based on only a single observation. This observation could represent a rare event that was observed only once in the survey or could be the result of interviewer error, data entry error, etc. Such estimates should be regarded with considerable skepticism. Generally, estimates with RSEs less than 30 percent are quite reliable; estimates with RSEs between 30 and 50 percent

are acceptable; estimates with RSEs between 50 and 100 percent are quite unreliable; and estimates with RSEs of 100 percent or more are totally unreliable.

9.4 Statistical Inferences

Two statistical inference procedures were used in analysis of the NHGPUS data base: confidence interval estimation and testing for significant differences between population proportions. These inference procedures are discussed in the context of the complex probability sampling design utilized for the NHGPUS in the subsections that follow.

9.4.1 Confidence Interval Estimates

The proportion of the NHGPUS target population, or of any analysis domain (e.g., households that used a commercial lawn care service in the past year), that had a given characteristic (e.g., received written safety precautions) is estimated as a ratio statistic computed using Equation (9-6). So long as the denominator of the ratio or proportion is based on a reasonably large sample size (e.g., 50 or more observations), the sampling distribution of the estimated population proportion is approximately the normal probability distribution. Therefore, an approximate 95 percent confidence interval estimate of a population proportion, P, is given by

$$\hat{P} \pm \sqrt{\hat{V}(\hat{P})} \qquad (9\text{-}11)$$

where $\hat{P}$ and $\hat{V}(\hat{P})$ are the point estimate of P and its sampling variance computed from Equations (9-6) and (9-8), respectively.

9.4.2 Testing for Significant Differences in Proportions

Letting $\hat{P}_1$ and $\hat{P}_2$ represent the ratio estimates calculated from Equation (7-6) for two NHGPUS population proportions P_1 and P_2, respectively, the difference, D, between the population proportions is estimated by

$$\hat{D} = \hat{P}_1 - \hat{P}_2 \qquad (9\text{-}12)$$

The sampling variance for the difference in proportions is computed using the "linearized" difference, z_D, defined as

$$z_D = z_1(i,j,k,\ell) - z_2(i,j,k,\ell) \qquad (9\text{-}13)$$

where z_1 and z_2 are the linearized variables computed from Equation (9-7) for the ratio statistics $\hat{P}_1$ and $\hat{P}_2$, respectively. The sampling variance of the estimated difference, $\hat{D}$, is then computed as

$$\hat{V}(\hat{D}) = \hat{V}(\hat{Z}_D) \ , \tag{9-14}$$

where $\hat{Z}_D$ is the estimated population total calculated using Equation (9-1) for the linearized difference, z_D, and $\hat{V}(\hat{Z}_D)$ is calculated from Equation (9-3).

A test statistic, T_1, for the null hypothesis of no difference in the population proportions P_1 and P_2 can then be calculated as

$$T_1 = \frac{\hat{D}}{\sqrt{\hat{V}(\hat{D})}} \ . \tag{9-15}$$

This test statistic is a classical "t-statistic" as used for traditional statistical sampling inferences except that the sampling variance in the denominator is based on the sampling distribution induced by the stratified, multistage NHGPUS sampling design. Thus, as is true for traditional statistical inferences, if the null hypothesis of no difference between the population proportions is true, the sampling distribution of T_1 is approximately the standard normal probability distribution (see Section 2.4 of Skinner et al., 1989). The null hypothesis is rejected if the ratio, T_1, is large relative to that probability distribution. The normal probability distribution is the appropriate reference distribution, rather than the Student's t distribution, because of the large size of the NHGPUS sample.

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REFERENCES

Berman, P. L. (1981). National Survey of Household Pesticide Usage Pilot Study Final Report, RTI/1864/18-01F. Research Triangle Institute, Research Triangle Park, NC.

Chromy, J. R. (1979). Sequential Sample Selection Methods. Proceedings of the American Statistical Association Section on Survey Research Methods, 401-406.

Chromy, J. R. (1981). Variance Estimators for a Sequential Sample Selection Procedure. In: Current Topics in Survey Sampling, D. Krewski, R. Platek, and J.N.K. Rao, eds., Academic Press, New York, NY, 329-347.

Cochran, W. G. (1977). Sampling Techniques, 3rd ed. Wiley, New York, NY.

Cohen, S. B., Burt, V. L., and Jones, G. K. (1986). Efficiencies in Variance Estimation for Complex Survey Data. The American Statistician 40:2, 157-163.

Francis, I., and Sedransk, J. (1979). A Comparison of Software for Processing and Analyzing Survey Data. Bulletin of the International Statistical Institute 48, 1-31.

Groves, Robert M. (1989). Survey Errors and Survey Costs. Wiley, New York, NY.

Immerman, F. W. and Schaum, J. L. (1990). Nonoccupational Pesticide Exposure Study (NOPES) Final Report, EPA/600/3-90/003. U.S. Environmental Protection Agency, Washington, D.C.

Kaplan, B., Francis, I., and Sedransk, J. (1983). A Comparison of Methods and Programs for Computing Variances of Estimators from Complex Sample Surveys. Proceedings of the American Statistical Association Section on Survey Research Methods, 97-100.

Kish, L. (1965). Survey Sampling. Wiley, New York, NY.

Lebowitz, M. D., Quackenboss, J. J., Kollander, M., Soczek, M. L., and Colome, S. (1989). The New Standard Environmental Inventory Questionnaire for Estimation of Indoor Concentrations. Journal of the Air and Waste Management Association 39:11, 1411-1419.

Lepkowski, J. M., Stehouwer, S. A., and Landis, J. R. (1984). Strategies for the Analysis of Imputed Data in a Sample Survey. Proceedings of the American Statistical Association Section on Survey Research Methods, 622-627.

Lynch, J. T., Drummond, D. J., and Waddell, R. (1981). National Household Pesticide Usage Survey California Pretest Final Report, RTI/1864/20-04F. Research Triangle Institute, Research Triangle Park, NC.

Madow, W. G., Olkin, I., Rubin, D. B., eds. (1983). Incomplete Data in Sample Surveys, Volume 2: Theory and Bibliographies. Academic Press, New York, NY.

Rubin, D. A. (1987). Multiple Imputation for Nonresponse in Surveys. Wiley, New York, NY.

Shah, B. V., LaVange, L. M., Barnwell, B. G., Killinger, J. E., and Wheeless, S. C. (1989). SUDAAN: Procedures for Descriptive Statistics, User's Guide. Research Triangle Institute, Research Triangle Park, NC.

Williams, R. L. and Chromy, J. R. (1980). SAS Sample Selection MACROS. Proceedings of the Fifth Annual SAS Users Group International Conference, 392-396.

Wolter, K. M. (1985). Introduction to Variance Estimation. Springer-Verlag, New York, NY.

APPENDIX H

FIRST-STAGE SAMPLING DESIGN FOR THE 1981 NATIONAL HOUSEHOLD PESTICIDE USAGE SURVEY

H.1 The Primary Sampling Frame

The primary sampling frame included all of the county units (counties, parishes, and independent cities) in the 48 coterminous States and the District of Columbia. Size-measures assigned were 1980 estimated numbers of non-farm housing units, computed by subtracting estimated 1978 numbers of farms from 1980 U.S. Census total numbers of housing units. Numbers of farms were estimated from 1978 U.S. Census of Agriculture data; for each county unit the number of farms that reported in the mail survey was adjusted by adding a proportionate share of the State estimate of non-reporting farms, derived from the area segment survey. It was assumed that numbers of farms had not changed appreciably from 1978 to 1980, and that only a very small proportion of farms would have more than one farm housing unit.

So that large enough samples could be selected at the second stage, small county units were combined so that all sampling units had a size measure of 600 or more non-farm housing units. In every case the units involved were contiguous rural counties in the same State climatic division. As a result, the primary sampling frame consisted of 3,062 sampling units, of which 3,017 were individual counties, 43 were made up of two counties, and two included three counties, thereby including all of the 3,109 primary governmental units outside of Hawaii and Alaska.

H.1.1. Stratification of the Primary Frame

In preparation for selecting the sample, the 3,062 sampling units were grouped or stratified into 83 primary strata. Stratification is the grouping together of units to improve the precision of population estimates (make sampling errors smaller) and to ensure a representative spread of the

sample across the range of values for the stratification variables. For the pesticide use sample, census geographic division codes are an example of a stratification variable. Ideally, from a statistical viewpoint, counties that have about the same use of pesticides should be included in the same stratum; however this is impractical to achieve in the actual design of the sample. Consequently, stratification variables are selected that are thought to produce strata that are relatively homogeneous in pesticide use.

Stratification of the primary sampling frame was carried out on the basis of geographical area, urbanization, precipitation, temperature, and ethnic composition of population. First, it appeared obvious that in different parts of the United States there are various kinds of insects, and it also seemed logical to assume that different kinds of pesticides are used to combat some of the same pests in different areas. The use of a particular pesticide might be legal in some States but not in others. For the first level of stratification it was therefore decided to assign to each primary sampling unit its census geographic division (CGD) code. The makeup of the CGDs is shown in Table H.1.

Secondly, it was considered that in rural areas there would be more pests per household than in urban locations, some of them attracted by livestock, crops, and marshy areas. In addition,less community spraying would be expected, so that more of the responsibility for pest control would fall on the residents themselves. For the second level of stratification an "urbanization code" (UC) was therefore assigned to each unit. If a county unit either (a) was part of a standard metropolitan

Table H.1. The 48 Coterminous States and the District of Columbia by Census Geographical Divisions

Code	Division	States
1	New England	Maine, New Hampshire, Vermont, Massachusetts Rhode Island, Connecticut
2	Middle Atlantic	New York, New Jersey, Pennsylvania
3	East North Central	Ohio, Indiana, Illinois, Michigan, Wisconsin
4	West North Central	Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas
5	South Atlantic	Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida
6	East South Central	Kentucky, Tennessee, Alabama, Mississippi
7	West South Central	Arkansas, Louisiana, Oklahoma, Texas
8	Mountain	Montana, Idaho, Wyoming, Colorado, New Mexico Arizona, Utah, Nevada
9	Pacific	Washington, Oregon, California

statistical area (SMSA)[1] with a central city of 200,000 or more population or (b) contained all or part of a city of 25,000 or more, it was assigned the value "2"; otherwise the value was "1".

It also appeared logical that numbers of pests are related to average temperature and annual precipitation, and it was known that within some of the census divisions rather wide ranges of one or both occur. Accordingly, a code for the third level of stratification was assigned to reflect differences in long-term average temperature, average annual precipitation or both. It was not possible to obtain data for individual county units, but average temperature and precipitation data for the period 1949-70 were obtained for State climatic divisions, made up of contiguous areas having fairly uniform conditions.[2] In most of the States the boundaries were found to follow county lines, and each county unit was assigned the data for its division; in the remaining States the data for the division containing the largest share of the county unit were applied. Average Farenheit temperatures were converted to codes representing two-degree intervals, and average annual precipitation data to codes representing two inch intervals, and, using size-measures as weights, a frequency distribution of the

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[1]Except in New England, a standard metropolitan statistical area is defined by the Office of Management and Budget publication Standard Metropolitan Statistical Areas: 1967, U.S. Government Printing Office, Washington, DC, 20402, as "a county or group of contiguous counties which contains at least one city of 50,000 inhabitants or more, or 'twin cities' with a combined population of at least 50,000 ... contiguous counties are included if they are socially and economically integrated with the central city." In New England the units are cities and towns instead of counties.

[2]Monthly Averages of Temperature and Precipitation for State Climatic Divisions 1941-70, Climatography of the United States No. 85 (By State), U.S. Department of Commerce, National Oceanic and Atmospheric Administration Environmental Data Service, National Climatic Center, Asheville, NC, July 1973.

primary listing units was run by census division code, urbanization code, temperature code, and precipitation code. The pattern for each of the CGD-UC combinations was carefully examined, and on the basis of the ranges and the distribution, the units were assigned codes for two or three strata based on one or both of the climatic factors. The ranges of the distribution are shown in Table H.2; the values used in defining the strata are shown in Table H.3.

Finally, it appeared logical that within an area with fairly uniform urbanization and climatic conditions different use of pesticides might be made by population groups with different ethnic backgrounds and/or different levels of income. It was decided to carry out a fourth level of stratification on the basis of 1980 Census percentage of the black population because it could be expected to reflect both of those factors. Accordingly, a weighted frequency distribution of the listing units was run by census division code, urbanization code, climatic code, and percentage black population, using five-percent intervals for the latter. Then 26 of the 47 strata that had been developed by the use of the first three stratification factors were each divided into two or three final strata, depending on the percentage range and the distribution of the size-measures. The 83 strata are described in Table H.3.

H.2 Allocation and Selection of the Primary Sample

It would have been possible to allocate the desired 180 primary sample selections explicitly to the 83 strata on the basis of their size-measures, the estimated numbers of nonfarm housing units. That would, however, have resulted in considerable variable from pps (probability proportional to size) selection as a result of the necessary rounding of the allocations to integers. For that reason an alternative procedure was used, whereby it

Table H.2 Minimum and Maximum Average Annual Precipitation and Mean Temperature, by Census Divison and Urbanization Code

Census Division	Urbanization Code	Precipitation, in.		Temperature, °F	
		Min.	Max.	Min.	Max.
1	1	36.47	44.23	40.0	49.1
1	2	40.16	44.23	43.8	50.4
2	1	32.13	44.98	41.5	54.1
2	2	32.86	44.98	45.0	54.1
3	1	28.68	43.95	40.8	56.7
3	2	28.68	43.76	41.1	56.7
4	1	15.44	46.30	38.6	58.8
4	2	18.77	43.78	38.6	57.0
5	1	34.30	59.86	47.5	74.7
5	2	38.67	59.86	53.0	74.7
6	1	44.20	62.05	55.3	67.4
6	2	44.20	64.62	55.3	67.6
7	1	11.57	61.14	57.2	73.8
7	2	11.57	61.14	58.2	73.8
8	1	4.13	28.12	37.1	71.3
8	2	6.96	20.86	43.6	68.9
9	1	7.41	94.62	43.3	64.2
9	2	9.73	62.36	45.2	60.7

Table H.3 Description of Primary Strata

Stratum #	Stratification Codes[a]	Average Annual Precipitation (in.)	Average Temperature (°F)	Percent Black	Estimated No. of NonFarm Housing Units
1	1111	less than 42	-	-	635,640
2	1121	42 or more	-	-	407,003
3	1211	-	below 48	-	376,352
4	1221	-	48 or above	less than 10	3,125,719
5	1222	-	48 or above	10 or more	276,724
6	2111	less than 38	-	-	503,528
7	2121	38 or more	below 50	-	799,916
8	2131	38 or more	50 or above	-	803,544
9	2211	less than 38	-	less than 10	451,274
10	2212	less than 38	-	10 or more	650,933
11	2221	38 or more	below 50	less than 10	1,230,653
12	2222	38 or more	below 50	10 to 34.99	316,469
13	2223	38 or more	below 50	35 or more	451,050
14	2231	38 or more	50 or above	less than 10	3,740,301
15	2232	38 or more	50 or above	10 to 34.99	3,287,633
16	2233	38 or more	50 or above	35 or more	1,883,800
17	3111	-	below 48	-	1,364,198
18	3121	-	48 to 51.9	-	1,367,181
19	3131	-	52 or above	-	1,047,132
20	3211	-	below 48	less than 15	753,530
21	3212	-	below 48	15 or more	455,327
22	3221	-	48 to 51.9	less than 15	4,145,102
23	3222	-	48 to 51.9	15 or more	4,158,234
24	3231	-	52 or above	less than 15	1,252,017
25	3232	-	52 or above	15 or more	973,722
26	4111	-	below 46	-	799,994
27	4121	-	46 to 51.9	-	944,315
28	4131	-	52 or above	-	1,163,236
29	4211	-	below 46	-	1,035,437
30	4221	-	46 to 51.9	less than 10	548,427
31	4222	-	46 to 51.9	10 or more	155,389
32	4231	-	52 or above	less than 10	733,391
33	4232	-	52 or above	10 or more	889,578
34	5111	-	below 58	less than 5	853,159
35	5112	-	below 58	5 to 14.99	373,234
36	5113	-	below 58	15 or more	429,448
37	5121	-	58 to 65.9	less than 20	602,164
38	5122	-	58 to 65.9	20 to 34.99	837,352
39	5123	-	58 to 65.9	35 or more	675,734
40	5131	-	66 or above	less than 15	428,978
41	5132	-	66 or above	15 or more	497,183
42	5211	-	below 58	less than 10	1,411,739
43	5212	-	below 58	10 to 39.99	819,266
44	5213	-	below 58	40 or more	693,254
45	5221	-	58 to 65.9	less than 20	920,784
46	5222	-	58 to 65.9	20 to 29.99	991,414
47	5223	-	58 to 65.9	30 or more	1,026,936
48	5231	-	66 or above	less than 10	963,486
49	5232	-	66 or above	10 to 14.99	1,488,609
50	5233	-	66 or above	15 or more	1,355,761
51	6111	-	below 60	less than 5	782,098
52	6112	-	below 60	5 or more	471,005
53	6121	-	60 or above	less than 30	568,614
54	6122	-	60 or above	30 or more	562,272
55	6211	-	below 60	less than 10	625,454
56	6212	-	below 60	10 to 19.9	530,133
57	6213	-	below 60	20 or more	502,489

Table H.3 Description of Primary Strata (cont.)

Stratum #	Stratification Codes[1]	Average Annual Precipitation (in.)	Average Temperature (°F)	Percent Black	Estimated No. of NonFarm Housing Units
58	6221	-	60 or above	less than 30	567,534
59	6222	-	60 or above	30 or more	570,681
60	7111	less than 40	-	less than 5	784,984
61	7112	less than 40	-	5 or more	282,775
62	7121	40 or more	-	less than 15	625,340
63	7122	40 or more	-	15 or more	892,770
64	7211	less than 40	-	less than 10	1,781,144
65	7212	less than 40	-	10 to 14.99	805,821
66	7213	less than 40	-	15 or more	812,675
67	7221	40 or more	-	less than 10	580,883
68	7222	40 or more	-	10 to 14.99	1,181,241
69	7223	40 or more	-	15 or more	1,107,375
70	8111	-	below 46	-	748,181
71	8121	-	46 to 55.9	-	613,183
72	8131	-	56 or above	-	330,408
73	8211	-	below 48	less than 10	617,809
74	8212	-	below 48	10 or more	227,458
75	8221	-	48 to 59.9	-	1,042,671
76	8231	-	60 or above	-	825,729
77	9111	less than 26	-	-	658,002
78	9121	26 or more	-	-	985,409
79	9211	less than 28	-	less than 10	4,348,673
80	9212	less than 28	-	10 or more	3,614,110
81	9221	28 to 45.9	-	less than 5	1,002,231
82	9222	28 to 45.9	-	5 or more	591,653
83	9231	46 or more	-	-	700,981

[a]First digit - U.S. Census Division Code
Second digit - Urbanization code (1 = rural, 2 = urbanized)
Third digit - Precipitation and/or temperature code
Fourth digit - Percentage black code

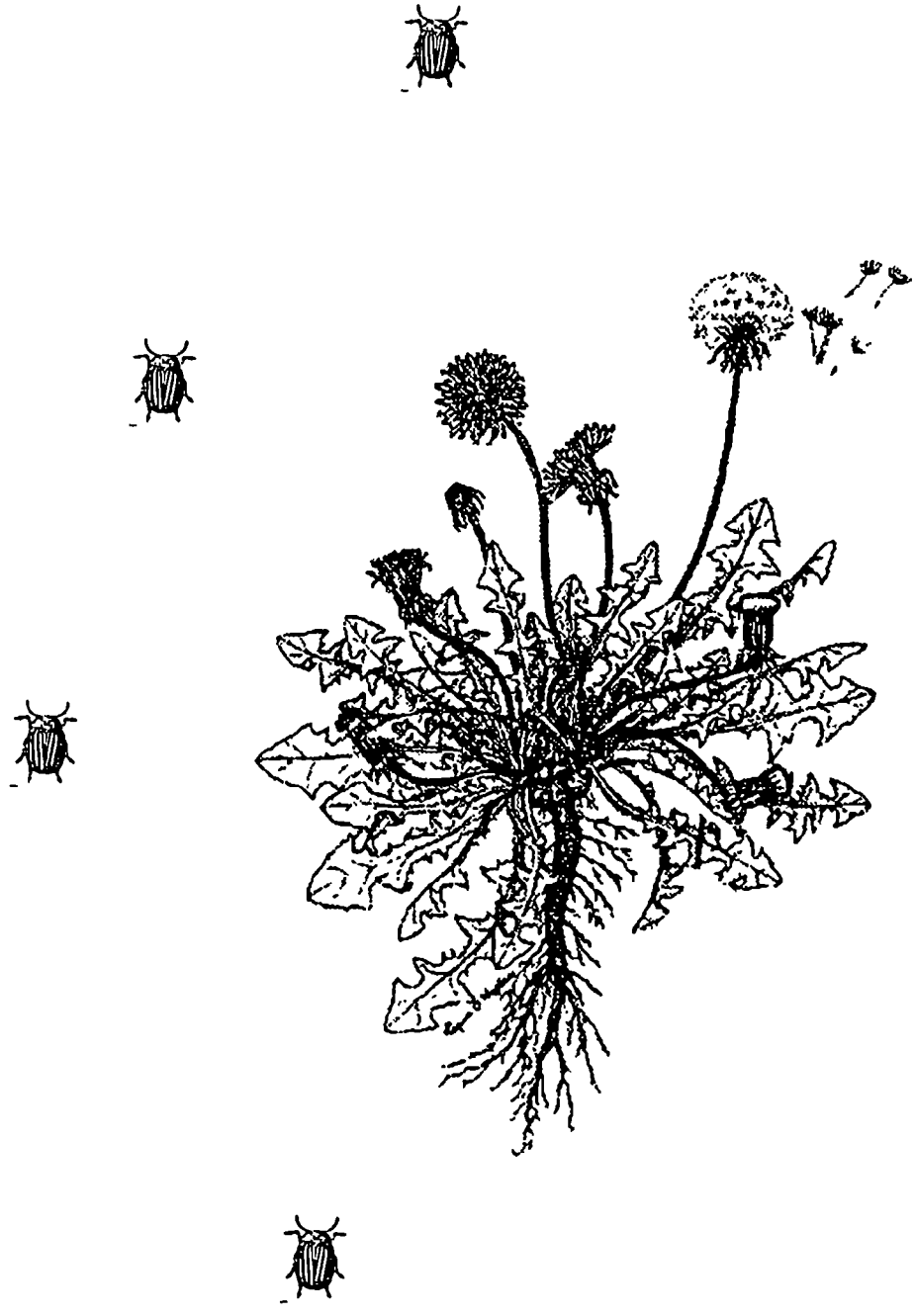
was possible to have all selections made so that (1) all selections of non-certainty units would be made with probability exactly proportional to size and (2) each certainty unit (i.e., unit with an expected number of selection hits equal to or greater than unity) (a) would definitely be selected the number of times corresponding to the integer part of the expected number and (b) would be selected an additional time with probability proportional to the fractional part of the number. In order to retain most of the intended effect of the stratification, the listing units were ordered serpentinely by the four stratification codes and by size-measure. First, ordering was done by census division code, in ascending order. Then alternate divisions were ordered by urbanization code in ascending and descending order. Next, within each CDC x UC group ordering was done by climatic codes in alternating directions, followed by similar ordering by black percentage code within each of the resulting three-way groups. Finally, the units within the four-way groups were ordered by size-measure in alternating directions. The sampling frame as so ordered was then divided into 180 "zones" of equal widths in terms of size-measures, and one selection was made from each zone. As a result of these procedures, all selections were made with the desired probabilities from equal-sized strata, each of which tended to be homogeneous for most of the ordering factors. The selections were made using the probability minimum replacement sampling procedure (pmr) developed by Chromy (1979). As desired, 180 selections were made; because several "certainty" units were hit more than once, the number of distinct units selected was 166. The combined use of hierarchical serpentine ordering and the sequential sample selection method is described in Williams and Chromy (1980).

APPENDIX I

SURVEY PEST NOTEBOOK

National Home and Garden Pesticide Use Survey

Pest Examples and Descriptions for Card A Pest Categories



INTRODUCTION

At various points throughout the survey the respondent is asked to identify the categories of pests with which they have had problems. Card A lists these categories along with examples of the pests which fall into each category.

The pictures and descriptions in this book are meant to clarify the terms used on Card A. Sizes given are approximate for full grown pest unless noted otherwise. This information is intended to be helpful when a respondent is familiar with the appearance of a pest or the damage it causes but does not know the name of the pest or uses a name different from the one used in the list.

CAUTION: This book should NOT be used as a definitive identification tool. While the pictures shown are representative of the pest named, there are often many varieties of the same pest, each differing in appearance and habits. There are also many more pests than those listed on Card A or in this book. Survey respondents should be referred to their county extension agents for positive pest identification and suggestions for appropriate pest control methods.

Keep in mind that the goal is simply to record the pest category. The specific pests are provided only to guide you into the correct category. Do not spend too much time identifying specific pests.

Note on terminology:

Various terms are used to describe the young of insects including larvae, nymphs, grubs, maggots, and juveniles.

TABLE OF CONTENTS

Microorganisms

Insects

Plants

Animals

Mildew, Mold

Caused by fungi; may result in decay and discoloration

Bacteria, Virus

May cause diseases

Wood Decay or Rot

May result when wood is exposed to damp conditions; caused by mold, fungi, or bacteria

Plant Diseases

Plant diseases are usually caused by bacteria, fungi, mycoplasma, and viruses and tend to be associated with specific environmental conditions (eg. temperature, humidity), insect infestations, or plant stress. Diseases often produce a characteristic pattern of colors, spots, growths, or rot. Treatment depends on the specific disease.

While exact diagnosis is best left to experts, a few diseases are easily recognized:

Powdery mildew

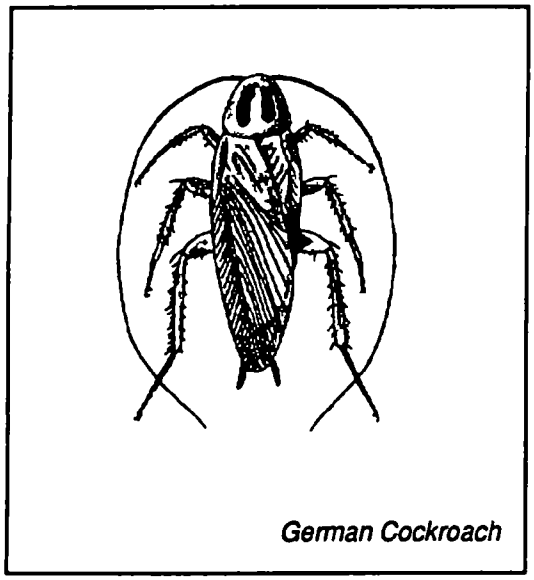
Very common, especially on squash, roses, zinnias, lilac; looks like powdery white to gray covering on leaves

Black spot

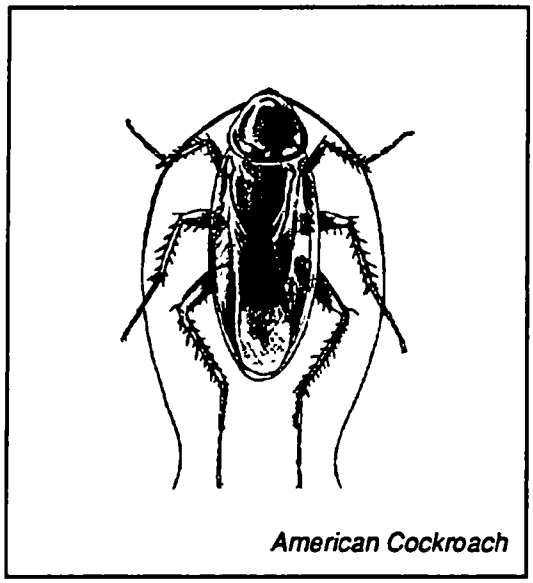
Common, especially on roses; large, circular black spots on leaves

Brown patch

Turf disease; circular, small to large brown areas; darker at edges; grass may regrow green from center of circle



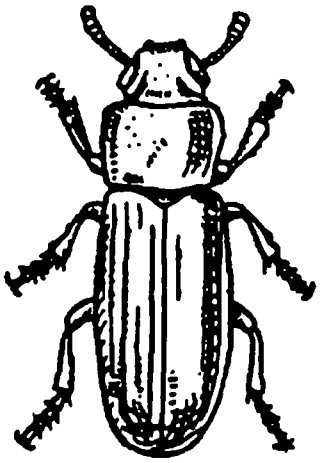
German Cockroach



American Cockroach

Cockroaches (roaches, waterbugs)

Fast moving, flat, oval, usually brown; prefer dark, warm, moist places
(size: 1/8"-1 1/2" depending on species and stage of development)



Confused flour beetle

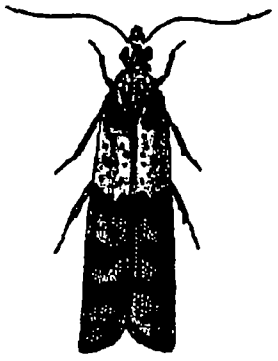
Note: Use Pest 19 for fruit/vinegar fly found on fresh fruit

Grain/flour/meal beetles

Various small beetles (and their larvae) found in grain and flour products; adults often brown, hard; larvae often light colored, soft
(size: larva & adult 1/10"-1/4")

Saw toothed beetle

Stored Food Insect Pests



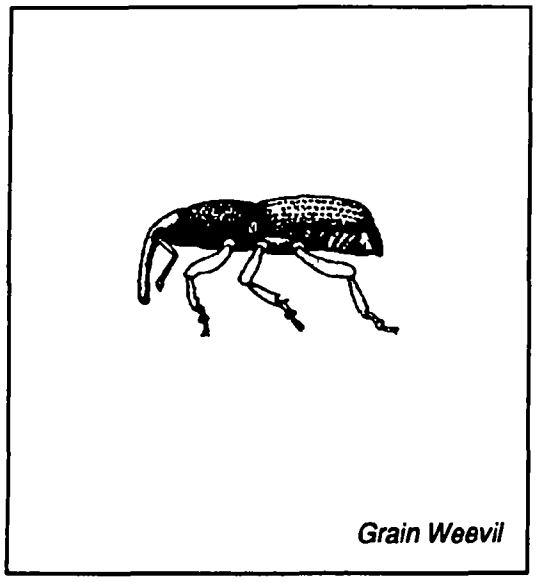
Indian Meal Moth

Grain/flour/meal moths

Some caterpillars live inside kernels, others feed in ground grain leaving web of silk threads; adults tan, some with stripes or fringe on wings (size: larvae 1/4" - 3/4", adults 2/3" - 3/4")

Angoumois Grain Moth

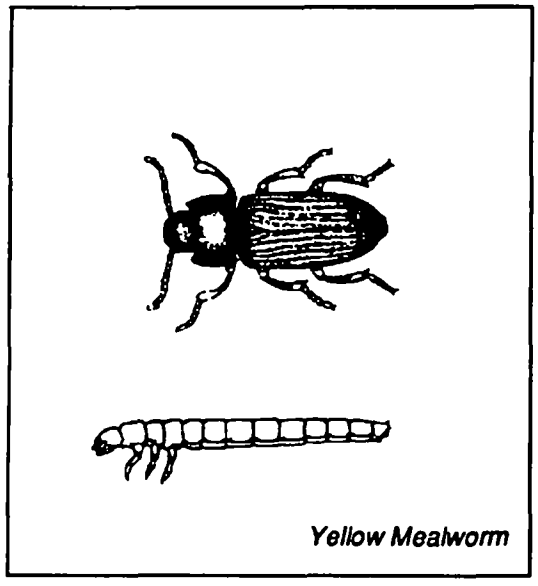
Grain Moth Larva



Grain Weevil

Grain weevils

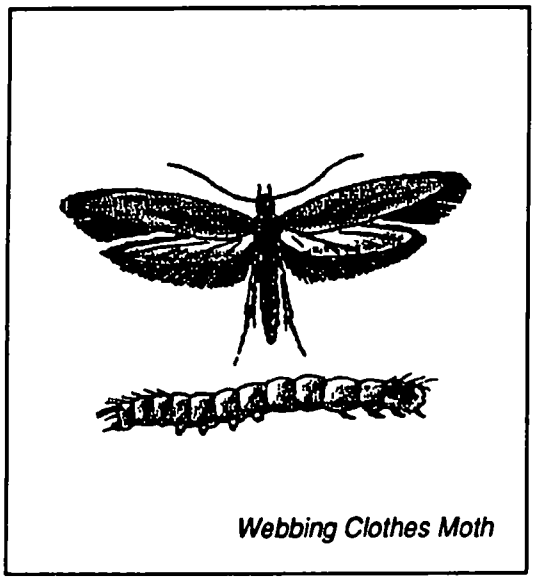
Characteristic weevil snout; adult brown; larvae of stored grain weevils live inside grain kernels
(size: adult 1/8")



Yellow Mealworm

Mealworms

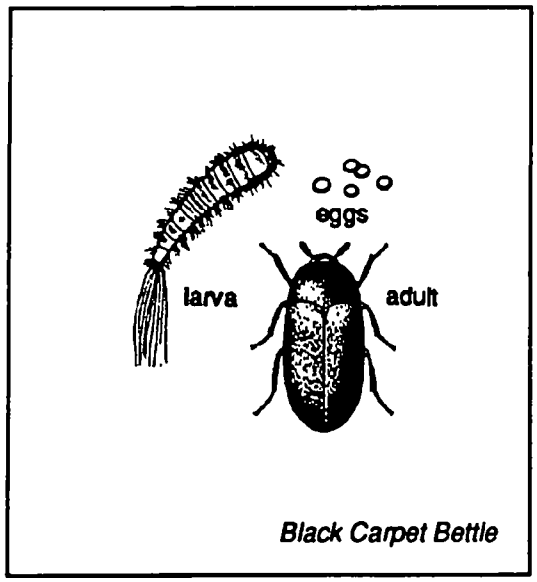
Larvae yellow or brown, "skin" is stiff, not soft; adults brown, slow moving
(size: larva to 1"; beetles to 3/4")



Webbing Clothes Moth

Clothes Moths

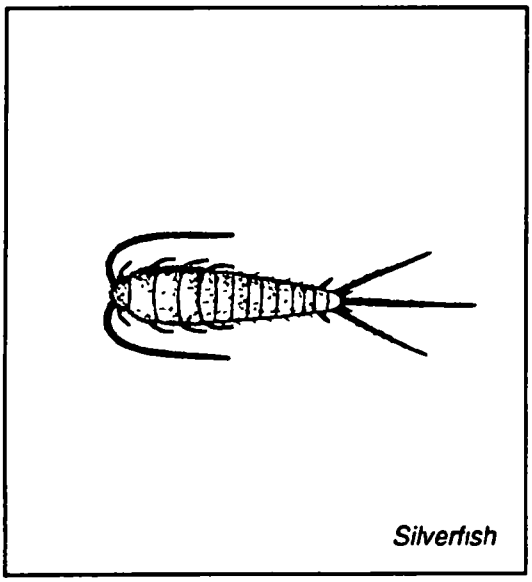
Small, light colored caterpillars that eat fabric made of animal fibers (wool, fur, silk, feathers) producing holes in fabric; adults are small brown moths with fringed wings
(size: larva to 1/2"; adult 1/2")



Black Carpet Bettle

Carpet beetles

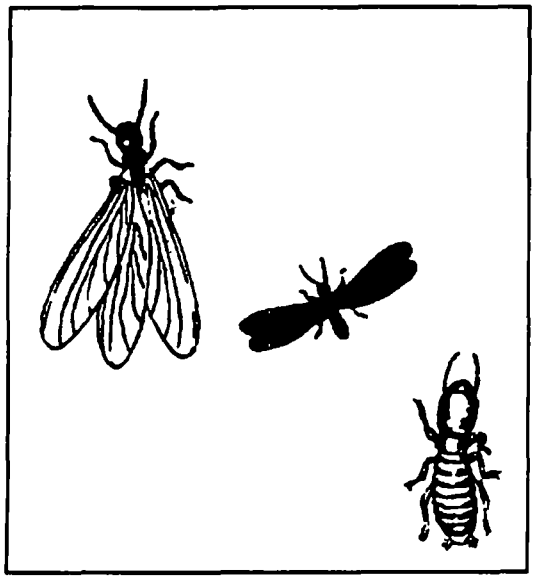
Small, round, dark-colored beetles found in fabrics, carpeting, upholstered furniture; larvae brownish, hairy
(size: adult 1/10"-1/5", larvae to 1/3")



Silverfish

Silverfish and firebrats

Fast moving, silver colored, torpedo shaped; eat starch in glue, fabric, paper
(size: to 1/2")



Termites

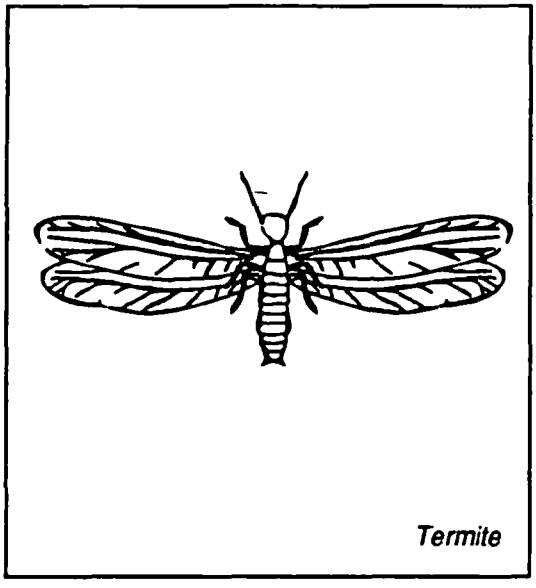
Wood eating insects; some live in soil, others in wood; soft bodied; require moisture
(size: worker 1/10"-1/2"; soldier and winged 1/2"-1")

NOTE: Termites are not the same as flying ants. Certain life stages and species of both termites and flying ants may have wings and are often confused by the public.

Note: Record Flying ants under Pest 10

Termite

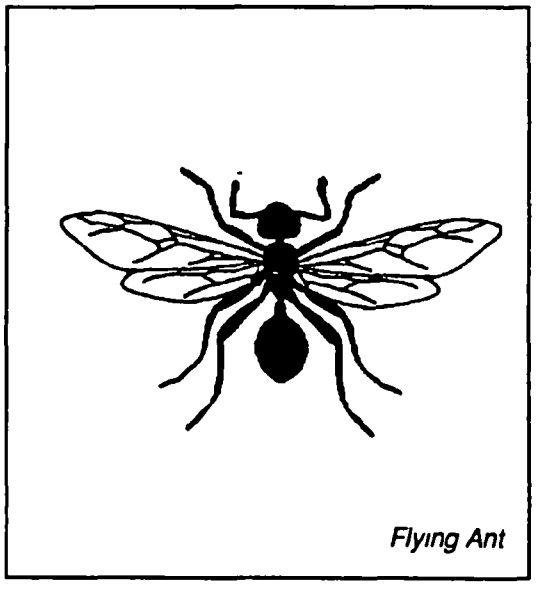
Thick waist
all four wings same length
wings much longer than body
antennae straight



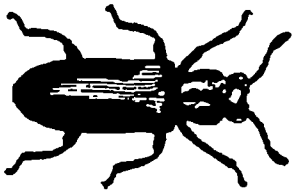
Termite

Flying Ant

Very thin waist
front wings longer than hind wings
front wings about length of body
antennae elbowed



Flying Ant



Powderpost Beetle

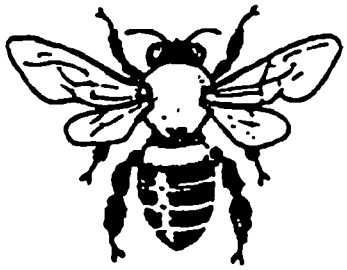
Powderpost beetles

Small red, brown, or black oblong beetles; damage visible in wood as pinholes oozing sawdust
(size: adult 1/8"-1/4")

Black Carpenter Ant

Carpenter ants

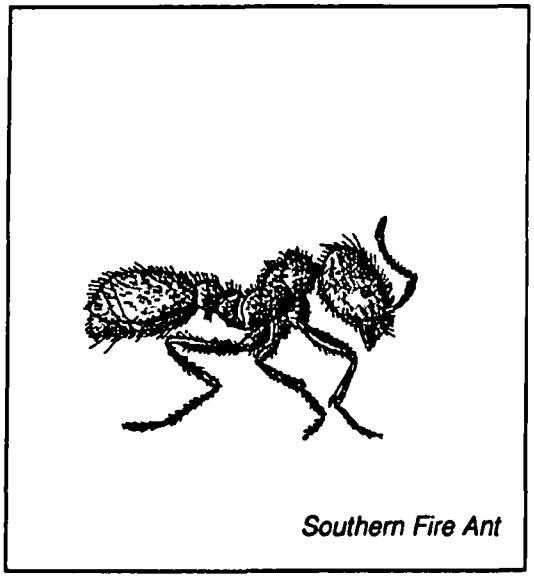
Large black (sometimes reddish) ants found both inside and outside home; "sawdust" may indicate work area
(size: 1/4"-1/2")



Carpenter Bee

Carpenter bees

Large; similar to bumble bee but with dark metallic abdomen; bores 1/2" holes in unpainted wood
(size: to 3/4" long)



Southern Fire Ant

Fire ants

Aggressive; red or black ants; painful sting; can build large mounds; only found from Carolinas to Texas to Florida (size: 1/4" or less)

Fire Ant Mound

Ant

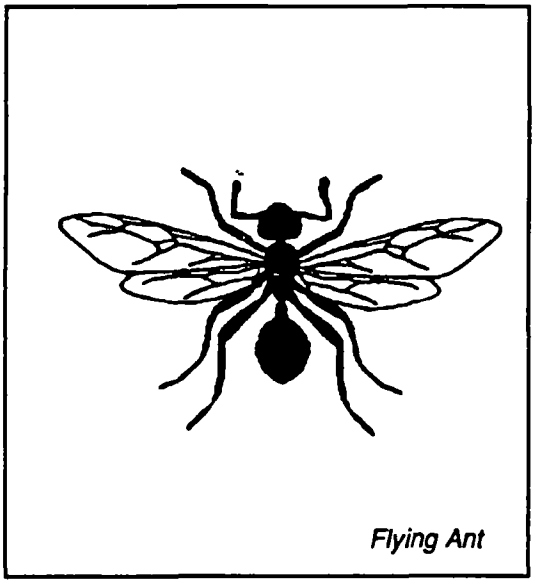
Many species; live both indooors and outdoors; may become pest when they invade houses or when they create mounds in gardens or lawns

NOTE: Termites are not the same as flying ants. Certain life stages and species of both termites and flying ants may have wings and are often confused by the public.

Note: Record Termites under Pest 7

Flying ant

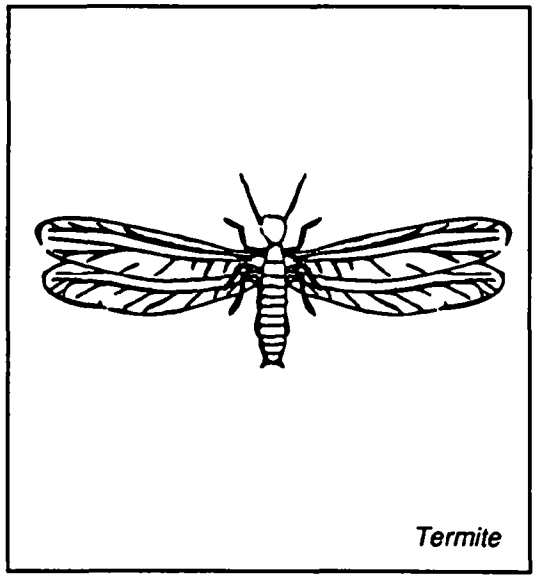
Very thin waist
front wings longer than hind wings
front wings about length of body
antennae elbowed



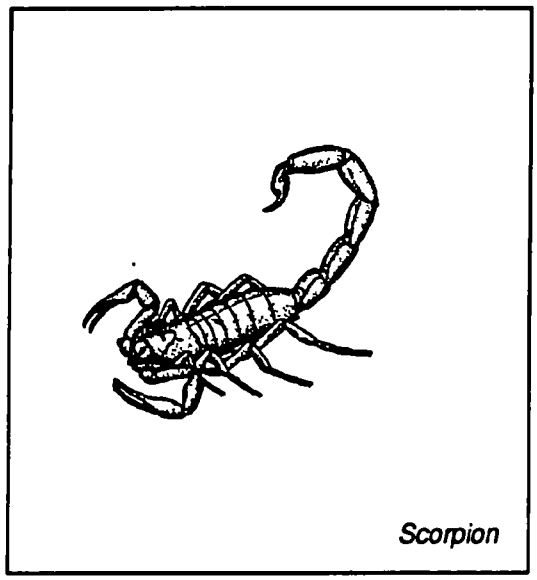
Flying Ant

Termite

Thick waist
all four wings same length
wings much longer than body
antennae straight



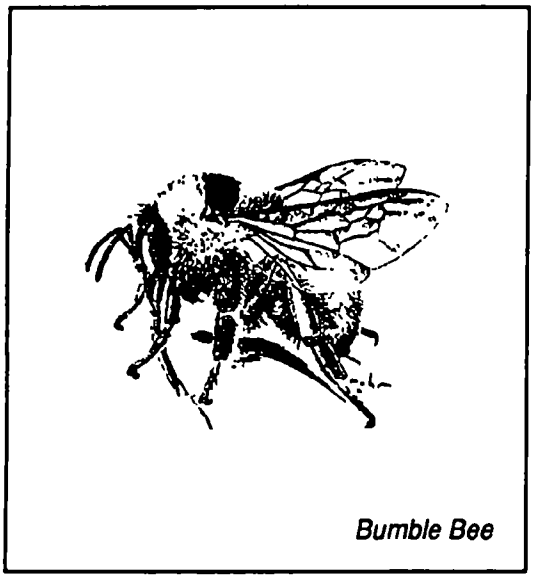
Termite



Scorpion

Scorpions

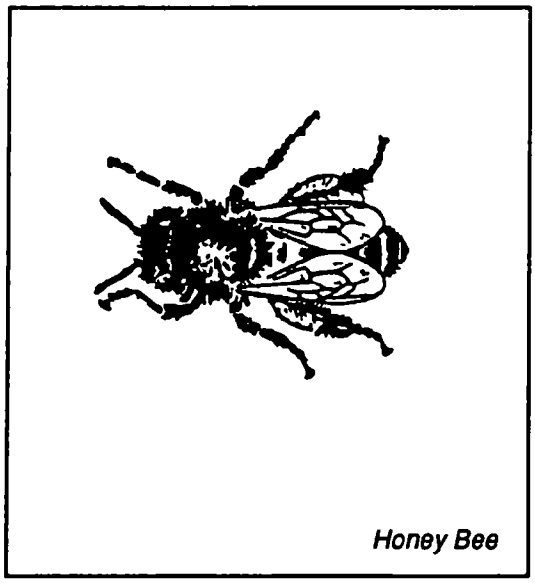
8 legs; painful sting; venom of some species can be dangerous; common in South and Southwest
(size: to 3" long)



Bumble Bee

Bumble bees

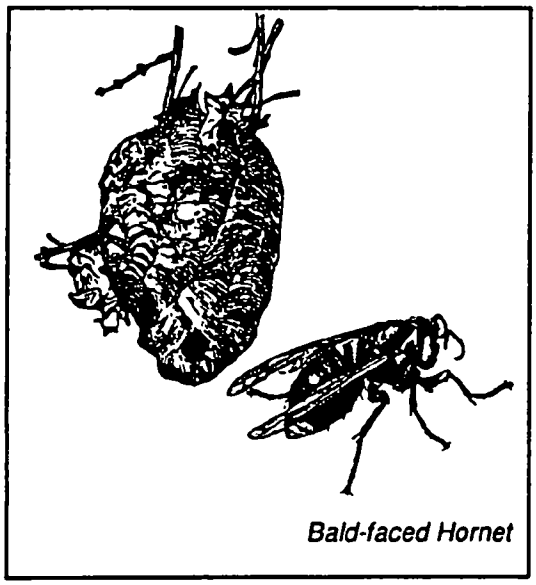
Large; hairy; usually black & yellow
(size: adult to 1")"



Honey Bee

Honey Bees

Yellowish brown; live in large colonies which may be problem when built inside building walls; not likely to sting unless handled
(size: worker 2/3")

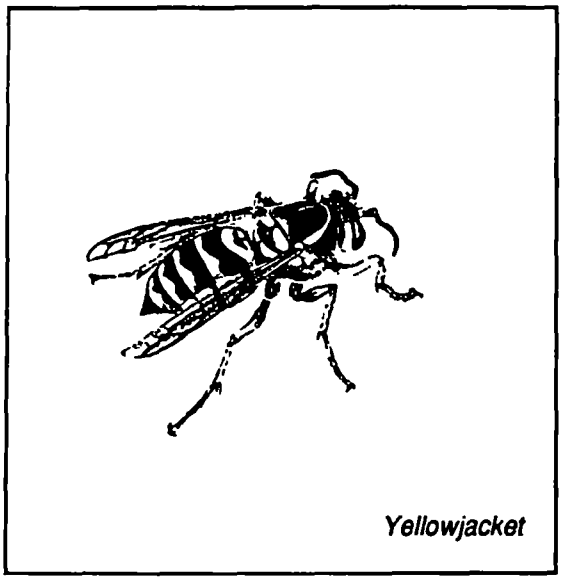


Bald-faced Hornet

Hornets

Large wasps; dark colored; some with yellow–orange markings; build large, oval paper nests hanging from trees
(size: adult to 1 1/2")

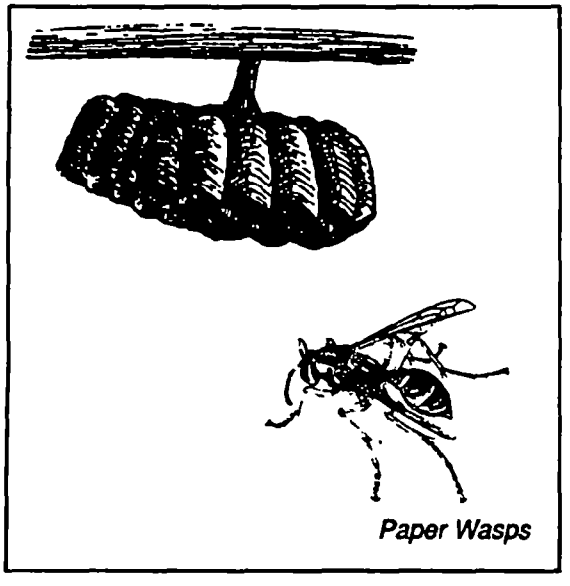
Bees, Hornets, Wasps



Yellowjacket

Yellowjackets

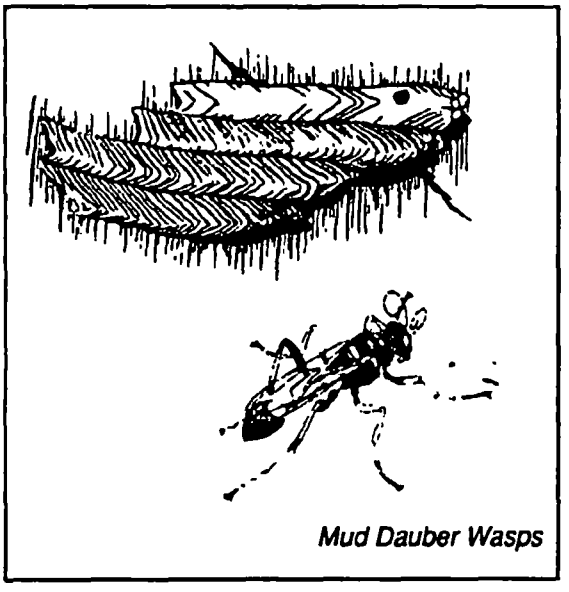
Wasp; black with yellow stripes; attracted to soda and food outdoors; often aggressive and may sting with little provocation
(size: adult 1/2")



Paper Wasps

Paper wasps

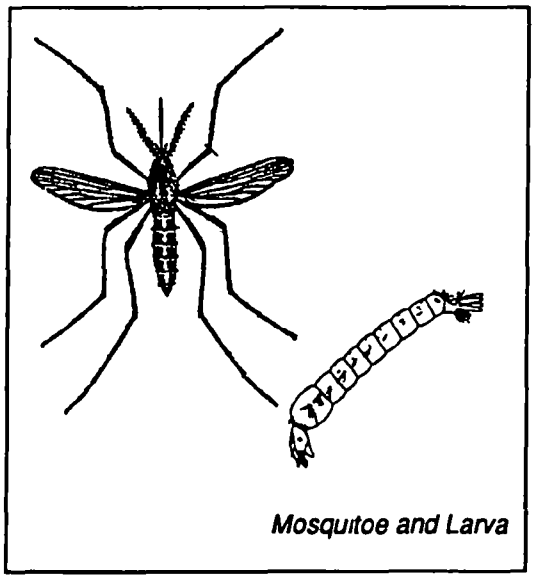
Medium size wasps; dark colored often with yellow–orange markings; build single layer paper combs hanging from ceilings or rafters
(size: adult 1")



Mud Dauber Wasps

Mud dauber wasps

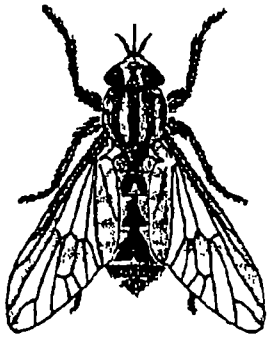
Build nests from mud on walls and rafters; usually avoid humans
(size: adult 1")



Mosquitoe and Larva

Mosquitoes

Numerous species; larvae (wigglers) develop in water; females drink blood; some species can spread certain disease organisms (size: 1/4")



Deer fly

Flies

Some produce painful bites (not stings) and may spread disease; all flies only have 1 pair of wings (versus 2 pairs for bees); larvae (maggots) have no legs; the term "gnat" refers to various tiny flies

Note:Use Pest 19 (Plant-Chewing Insects) for Fruit/Vinegar Flies which are found on fruit, not on people or animals

Deer flies

Large flies; painful bites; attack wild and domestic mammals, man
(size: to 1/2")

House Fly

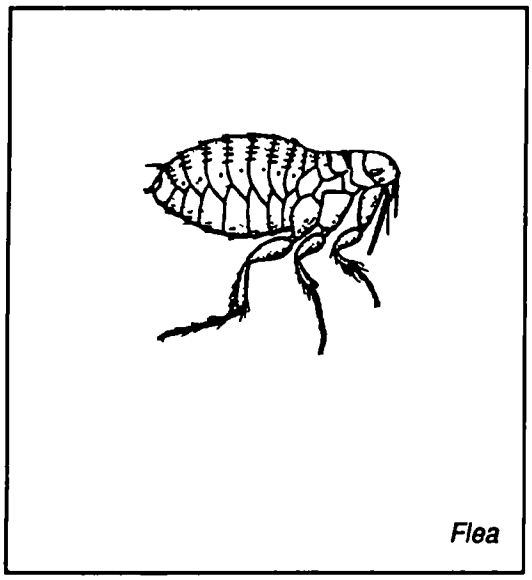
House flies

Gray with stripes; live both indoors and outdoors; very common; do not bite but may spread disease when they land on food
(size: adult 1/4")

Biting Midge

Black flies & biting midges (no-see-ums)

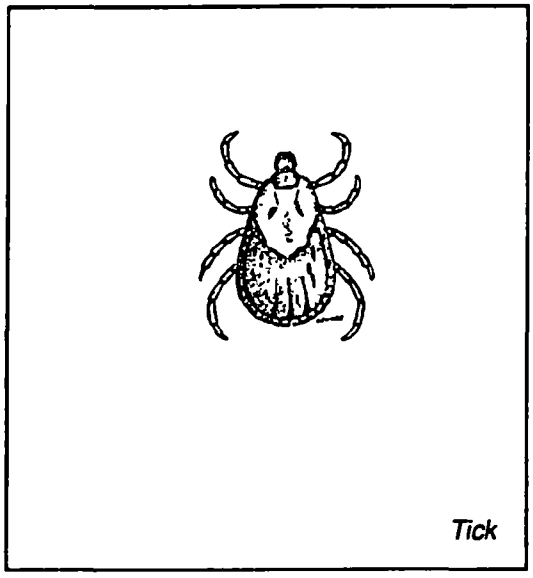
Small; painful bite; can be major nuisance in recreational areas
(size: adult to 1/8")



Flea

Fleas

Small, reddish brown to black; flattened sideways; strong jumpers; drink blood
(size: 1/10")



Tick

Ticks

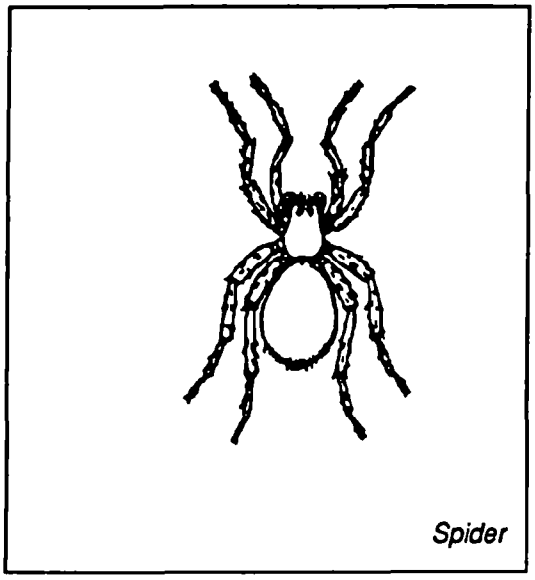
8 legs; oval shaped; small head; drinks blood
(size varies from size of pin head to 1/4", larger when filled with blood or eggs)

Chigger
Too small to see

Chiggers

Barely visible biting mites that cause severe itching in man and animals
(size: 5/1000")

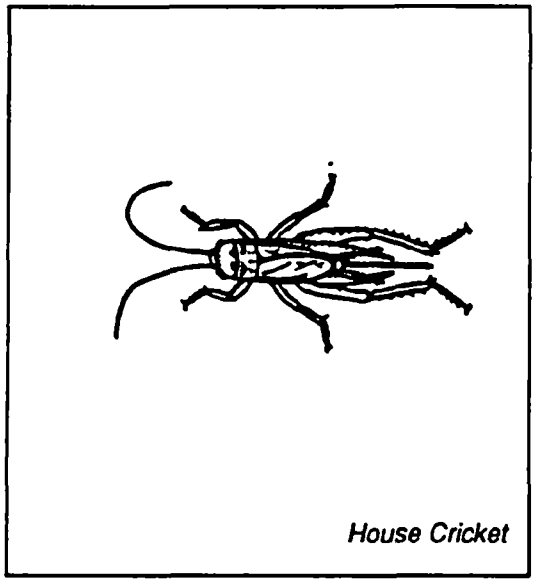
Spiders, Crickets, Sowbugs/Pillbugs, Millipedes, Centipedes



Spider

Spiders

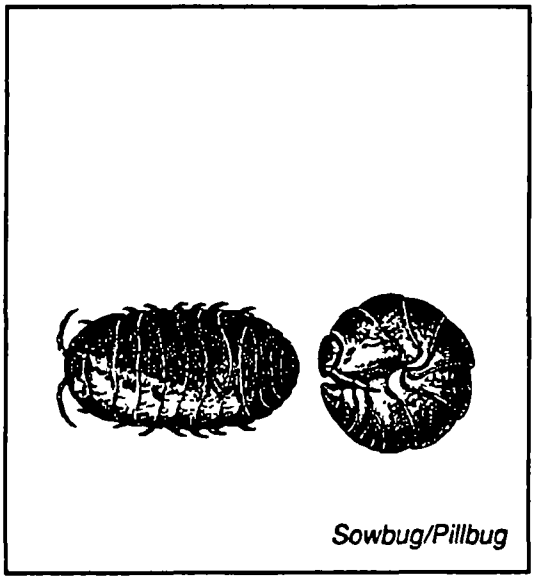
8 legs; most produce silk but many do not spin webs; some bite, a fewer are poisonous
(size: varies up to 1" or larger)



House Cricket

Crickets

Large hind legs; yellow- brown to black; may be noisy; often invades houses, especially in Fall; may eat fabrics and fruits
(size: to 1")

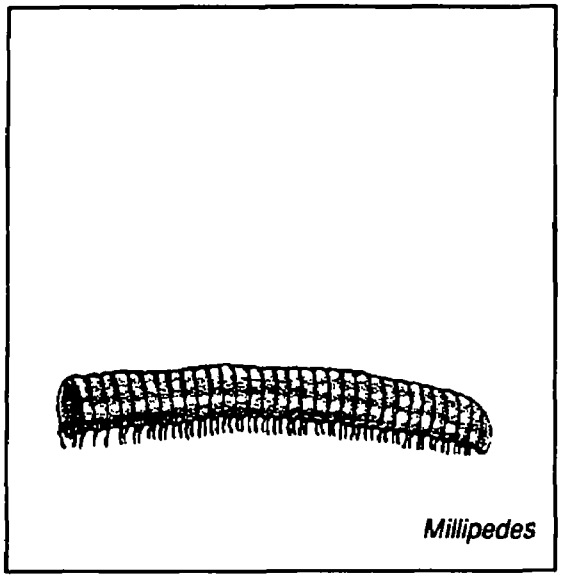


Sowbug/Pillbug

Sowbugs/pillbugs

Gray; 7 pairs of legs; found in damp, dark places (often under pots, rocks, in greenhouse); often roll into ball when disturbed
(size: 1/4" - 3/4")

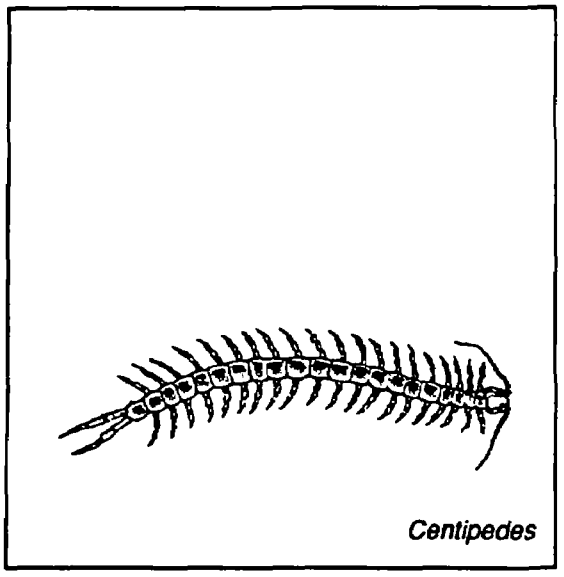
Spiders, Crickets, Sowbugs/Pillbugs, Millipedes, Centipedes



Millipedes

Millipedes

Up to 40-60 pairs of short legs (2 pairs per body segment); slow moving; short antennae; usually found outside in dark, damp places but may enter home
(size: 1/2" to 1 1/2" or larger)



Centipedes

Centipedes

Up to 15-30 pairs of long legs (1 pair per body segment); fast moving; long antennae; prefers dark, damp places; may be found in houses; may bite
(size: 1"-1 1/2" or larger)

Nematodes
Too small to See

Nematodes

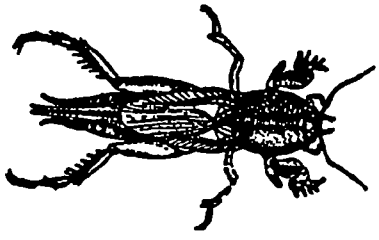
Microscopic, worm-like; usually live in soil; feed on plant tissue causing stress which may result in stunted and deformed growth

White Grub

White grubs (grubworms)

General term that applies to larvae of various scarab beetles; fleshy, whitish body with yellow to brown head; 6 true legs; found in soil especially under turf
(size: to 1 1/2")

Use Pest 19 for Adults which are Beetles that Chew Foliage

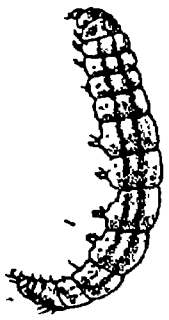


Northern Mole Cricket

Mole crickets

Soil dwelling crickets with large paddles on front legs; light brown to black; eats roots
(size: 1")

Soil-Dwelling Insects, Nematodes



Black Cutworm

Cutworms

Caterpillars that cut off young plant shoots at or below soil surface; also climb to feed on foliage of larger plants; hide in soil during day then emerge at night to feed
(size: larva 1" - 2")

Use Pest 19 for Caterpillars which are usually found on Plants

Southern Corn Rootworm

Rootworms

Larva of various beetles (including cucumber beetles); feed on roots or bore into stalks at soil line
(size: larva to 1/2")

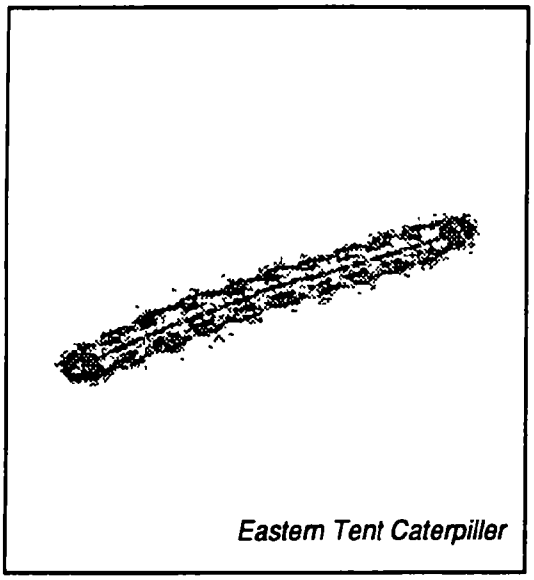
Use Pest 19 for Adults which are Beetles that Chew Foliage

Wireworm

Wireworms

Yellow to brown; "skin" is stiff, not soft; feed on roots of grass and root vegetables; adults are click beetles (if placed on their backs these beetles will snap body with a clicking sound to pop into air and flip over)
(size: larva to 1 1/4")

Use Pest 19 for Adults which are Beetles that Chew Foliage



Eastern Tent Caterpiller

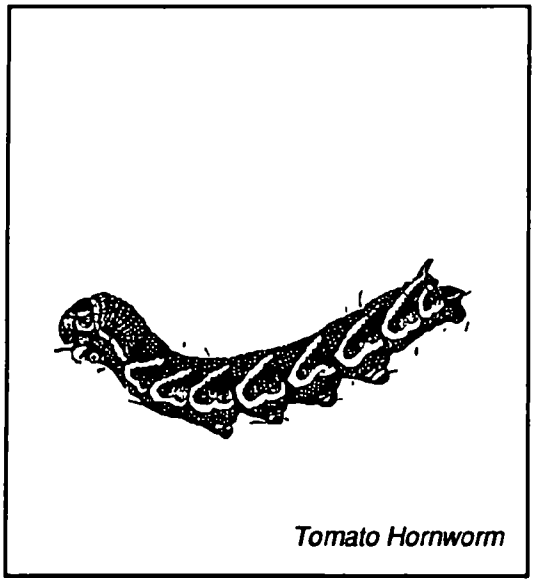
Caterpillers

(such as tent caterpillar, tomato hornworm, sod webworm; also gypsy moth, and (not shown)cabbage looper)
General term referring to the larva of butterflies and moths; 6 true legs at head end

Use Pest 18 for any Caterpillers that are Usually Found in the Soil

Tent caterpillars

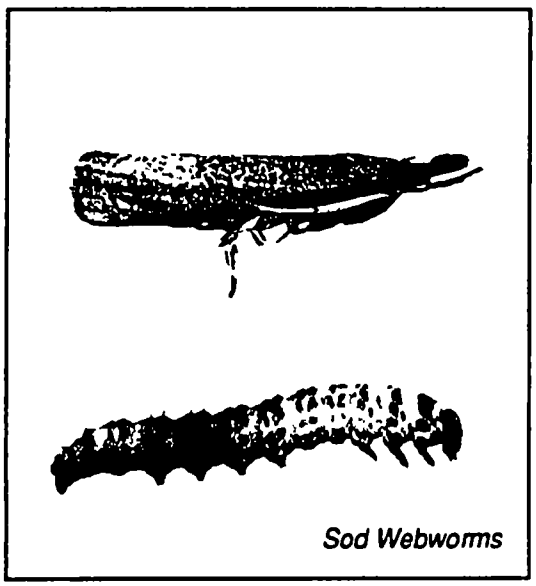
Hairy, black caterpillars with various blue, white, yellow, orange markings; defoliate many trees, esp. apples and cherries; several species spin tent in branches while others spin mat on trunk
(size: larva to 2", adult moth 1"-1 1/2")



Tomato Hornworm

Tomato Hornworm

Large caterpillar; green (usually) with white diagonal stripes and black horn at rear
(size: larva to 4", adult moth 4"-5")

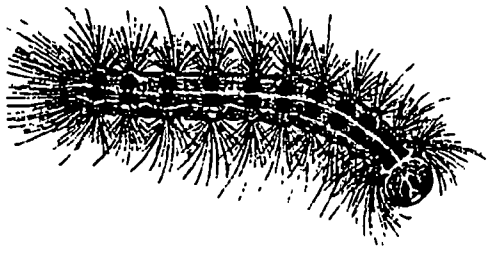


Sod Webworms

Sod webworms (lawn moths)

Larvae build silk tunnels above ground near base of turfgrass; adults small tan to brown moths with wings held in pleated peak over back
(size: larva to 3/4", adult moth 3/4"-1")

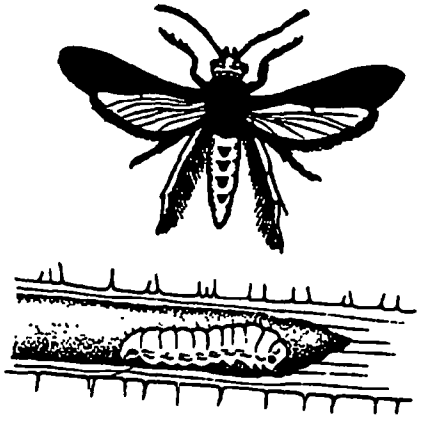
Plant Chewing Insects



Gypsy Moth Larva

Gypsy Moth

Hairy, dark caterpillars with blue and red spots; can occur in huge numbers and defoliate trees over large areas; Northeast US west to MI, south to VA and spreading
(size: larva to 2", adult 1 1/2"-2")

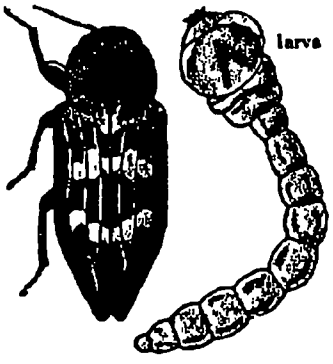


Squash Vine Borer

Borers

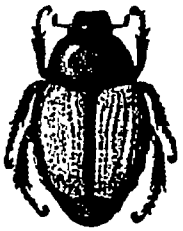
This term refers to two types of insects, both of which chew plants:

A) the larva (caterpillars) of moths which feed inside stems, trunks, or other plant parts of various plants (eg. squash, peaches); may cause stem to wither, break, or may allow entry for disease
(size: larva to 1 1/2", adult moth to 1 1/2")



Flatheaded Apple Tree Borer

B) the larva (grubs) of various beetles which feed on the inner bark and sapwood of various trees and shrubs (eg. elm, apple, palm)
(size: larva to 1", adult to 3/4")



Japanese Beetle

Beetles

(such as Japanese beetle, Colorado potato beetle, cucumber beetle)

Large order of insects; beetles have a hard shell on their backs covering a pair of wings underneath; beetles chew their food

Japanese beetles

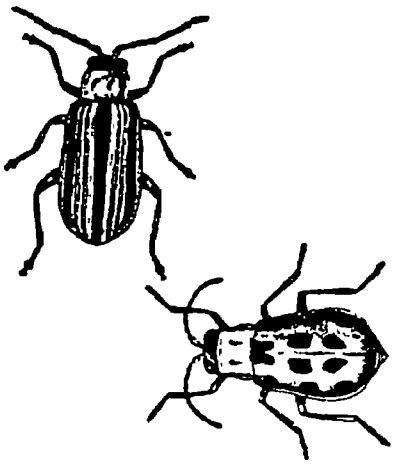
Adults metallic green and bronze; feed on foliage, fruit, flowers (esp. roses)
(size: adult 1/3"-1/2")

Use Pest 18 if Pest is Larval Stage (White Grub)

Colorado Potato Beetle

Colorado potato beetles

Adults striped yellow and black; larvae red or orange with black spots on sides; both larva and adult eat foliage of potatoes, eggplant, tomato
(size: adult 3/8", larva to 1/2")

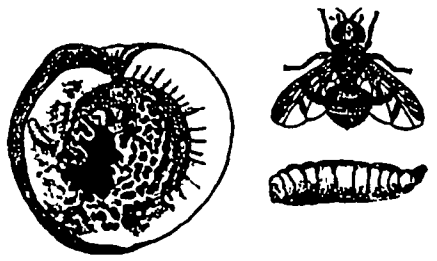


Cucumber Beetle

Cucumber Beetle

both spotted and striped species; yellow and black; adults attack melons, cucumbers, squash, and many ornamental flowers
(size: adult 1/4"-1/3")

Use Pest 18 if Pest is Larval Stage (Rootworm)

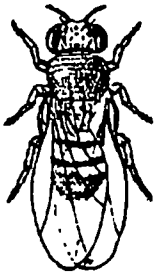


Mediterranean Fruit Fly

Fruit flies

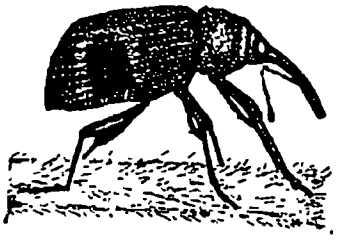
This term is often used for two different types of flies; both are included in the plant chewing category:

A) Small; adult fly often dark with yellow markings; very destructive; young maggots tunnel throughout flesh of growing fruit; examples include Mediterranean fruit fly and apple maggot
(size: larva & adult to 1/4")



Vinegar Fly

B) More properly called vinegar flies; tiny; common on harvested fruit; reproduce quickly so often found in large numbers
(size: adult 1/10")



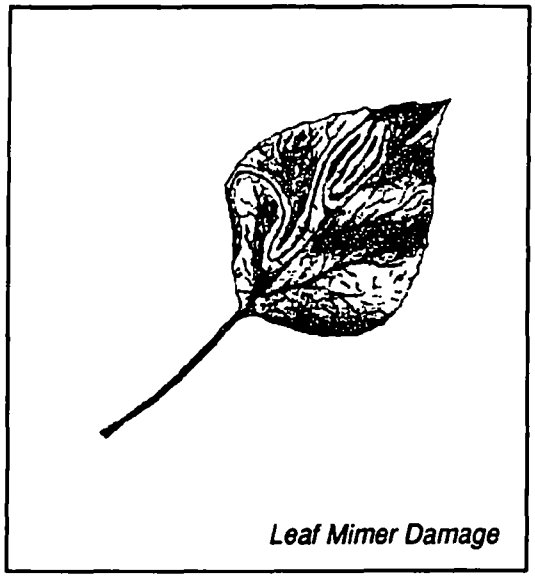
Strawberry Weevil

Weevils (snout beetles, billbugs)

Family of beetles all with characteristic elongated snout; attack flowers and fruit; larvae usually live in soil and feed on roots
(size: 1/10"-1/2")

Use Pest 18 if Pest is Larval Stage in Soil

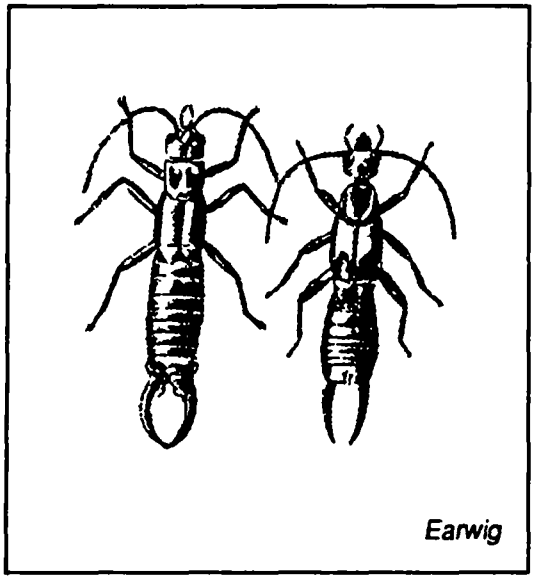
Use Pest 5 if Weevil is found in Stored Food



Leaf Mimer Damage

Leafminers

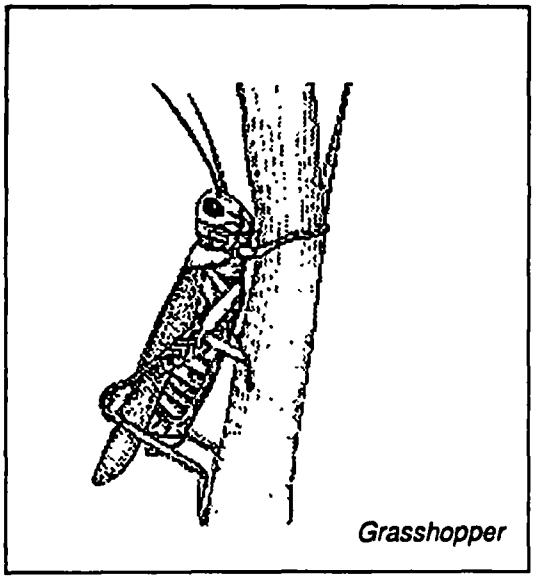
Larvae of various flies, moths, beetles; feed between the upper and lower surface of a leaf leaving light colored tunnels or blotches visible on leaves
(size: larva tiny to 1/4")



Earwig

Earwigs

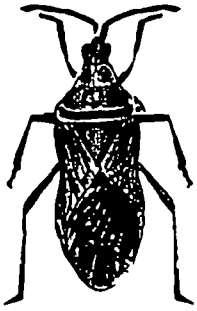
Pinchers or forceps at tail; dark colored; bad odor when crushed; usually outside but may wander into house; may bite or pinch
(size: to 1")



Grasshopper

Grasshoppers, locusts

Large hind legs; voracious plant eaters; many species
(size: to 2")



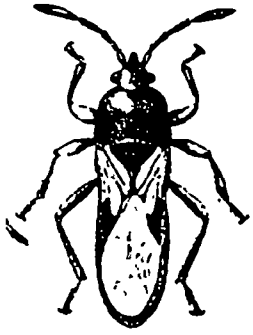
Squash Bug

True Bugs

In scientific use, this term refers to a specific order of insects; bugs have wings which fold over their backs but do not have the hard wing coverings seen in beetles; bugs use their piercing mouthparts to suck juices from plant.

Squash Bugs

Adults dark brown; nymphs grayish; prefer squash and pumpkins, will eat cucumbers, melons
(size: 3/4")



Chinch Bug

Chinch Bugs

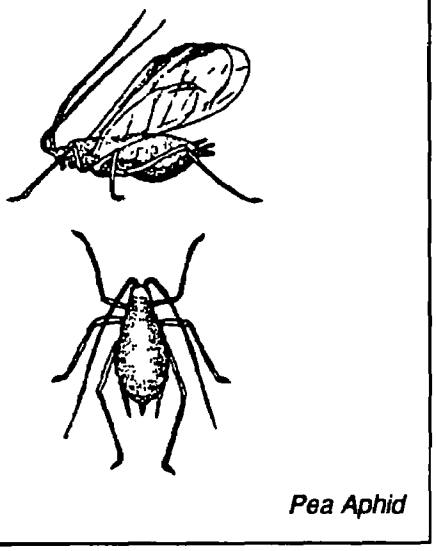
Adults black and white with red legs and base of antennae; young all red; attack turf and grains
(size: 1/8")

Boxelder Bug

Boxelder Bug

Black and red; live outside but may enter house in large numbers to hibernate; bad odor when crushed
(size: 1/2")

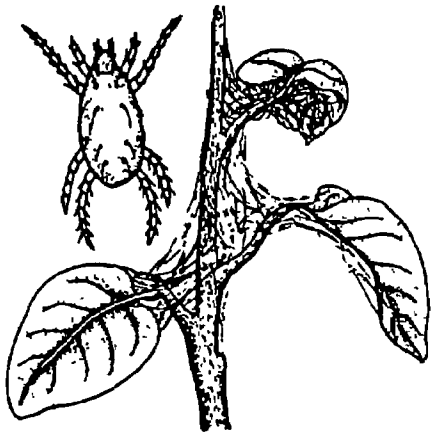
Plant-Sucking Insects and Mites



Pea Aphid

Aphids

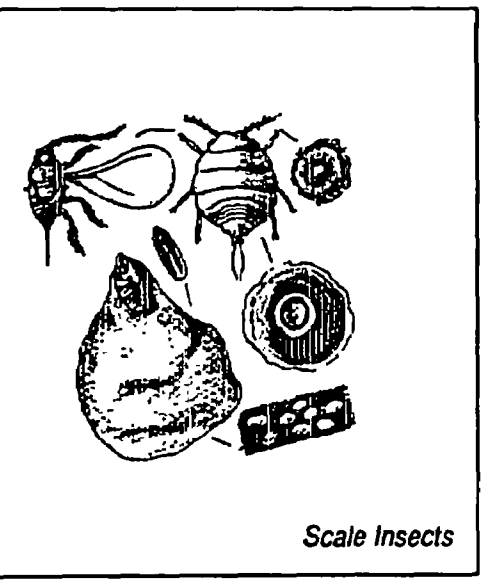
Small, soft bodied, with or without wings; many species, attack many plants; often seen on rose buds; may be green, yellow, red, black; reproduce quickly, so often seen in large numbers
(size: to 1/5")



Mite

Mites

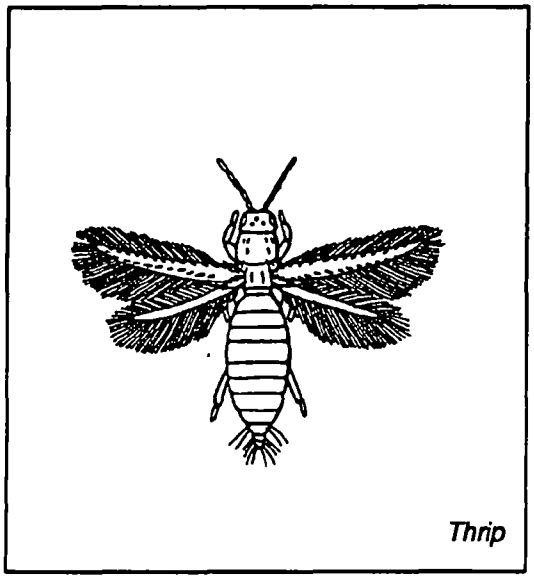
Barely visible; 8 legs; often red but many other colors; damage on leaves appears as tiny white or yellow dots; some produce fine webs; common in hot, dry weather
(size: 1/100")



Scale Insects

Scale insects (scales, soft scales, armored scales)

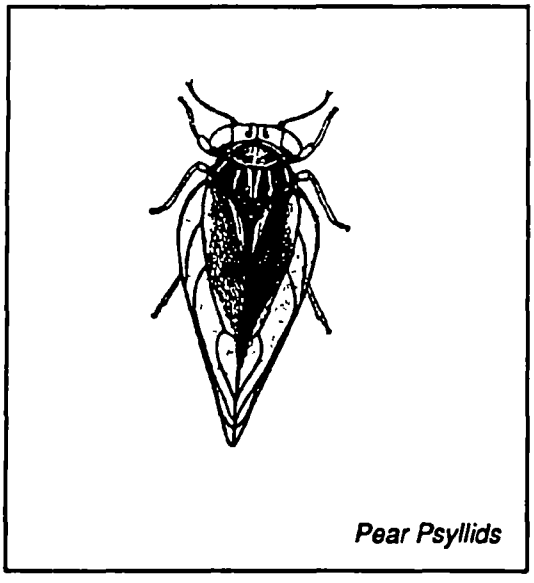
While some stages look like whiteflies, the stage most often seen does not move and looks like a bump on a stem, twig, or fruit; on some, a shell covers the back; colors include white, gray, brown, black
(size: 1/10"-1/4")



Thrip

Thrips

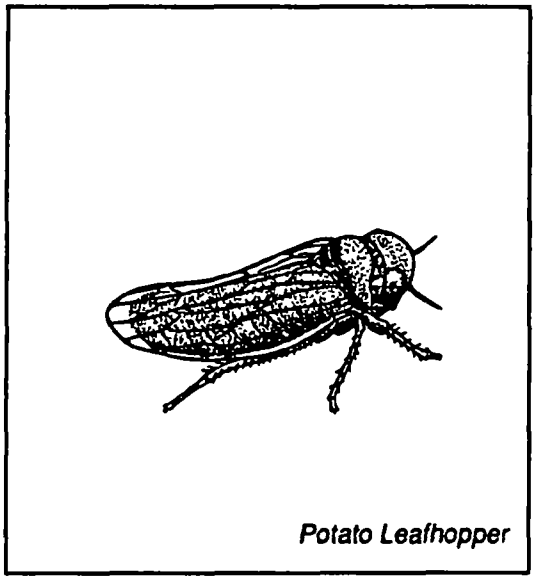
Barely visible; fringed wings; attack buds, flowers, fruit, foliage
(size: to 1/10")



Pear Psyllids

Psyllids (psylla)

Look like tiny cicadas; active
(size: adult to 1/8")

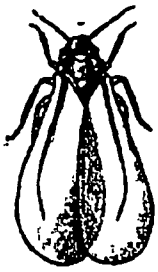


Potato Leafhopper

Leafhoppers

Small; fast; characteristic triangular body shape; many species; many colors, often with bright stripes or spots
(size: 1/8" - 1/4")

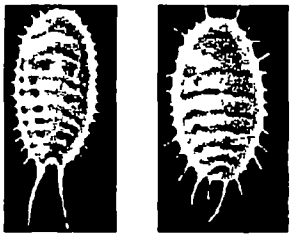
Plant-Sucking Insects and Mites



Greenhouse Whitefly

Whiteflies

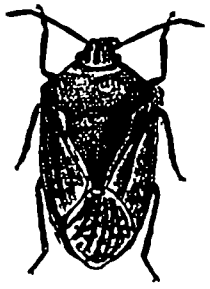
Small; winged adults fly; immatures attach to underside of foliage; numerous; frequent pest of house and greenhouse plants in North, also outside in South; discarded shells of nymphs litter leaf surfaces
(size: to 1/8")



Mealybugs

Mealybugs

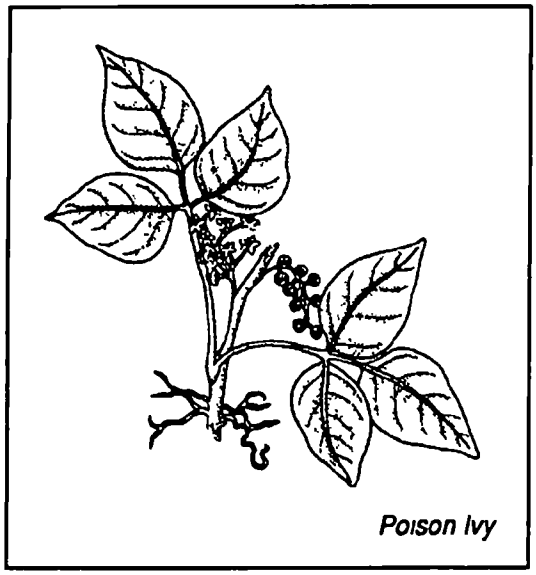
Small; sluggish; have powdery appearance, look like fluffs of cotton
(size: to 1/4")



Green Stink Bug

Stink Bugs

Shield-shaped green or brown; attack peas, beans, fruit; bad odor when crushed
(size: 1/2")



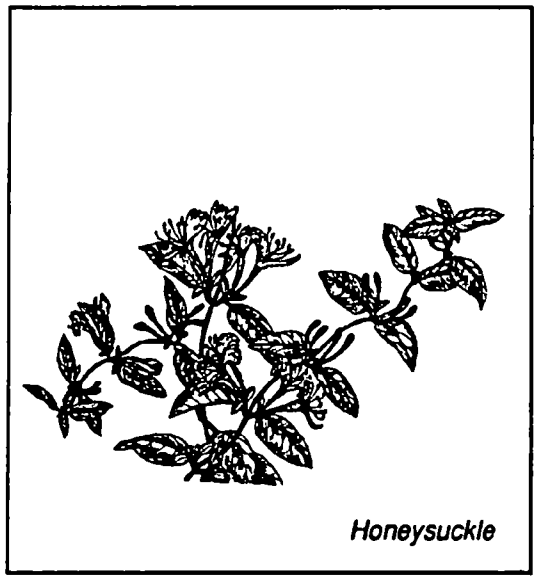
Poison Ivy

Brush

General term referring to woody or semi-woody vines, shrubs, small trees; usually perennial

Poison Ivy

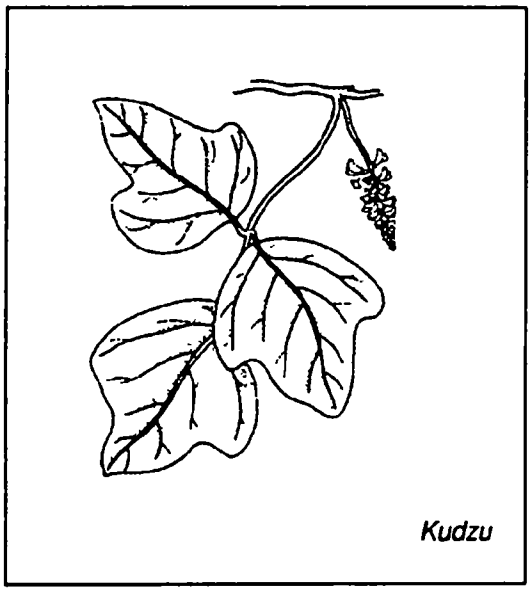
Smooth, often shiny leaves in groups of 3; leaf edge smooth or toothed; both bush and climbing forms
(size: leaf 3"; plant 6" to tall vine)



Honeysuckle

Honeysuckle

Woody vine with fragrant flowers in late spring to summer; Mid-Atlantic to South only
(size: leaf 1"; plant large vine)

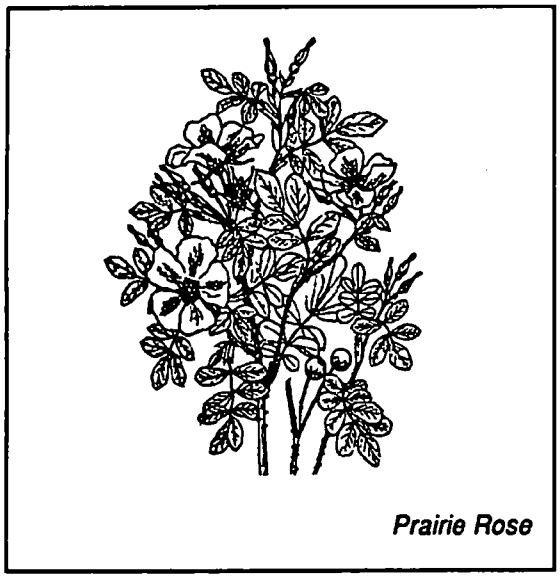


Kudzu

Kudzu

Large 3-lobed leaf; smothering vine; Southeast to Mid-Atlantic only
(size: leaf 4"-6"; plant trails to 100')

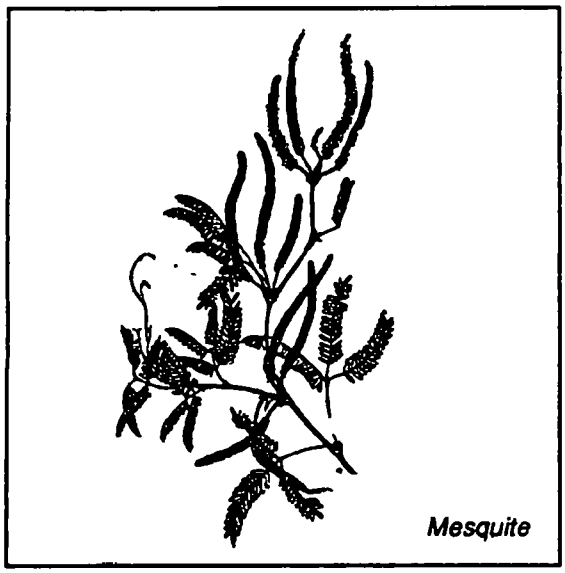
Brush



Prairie Rose

Brier

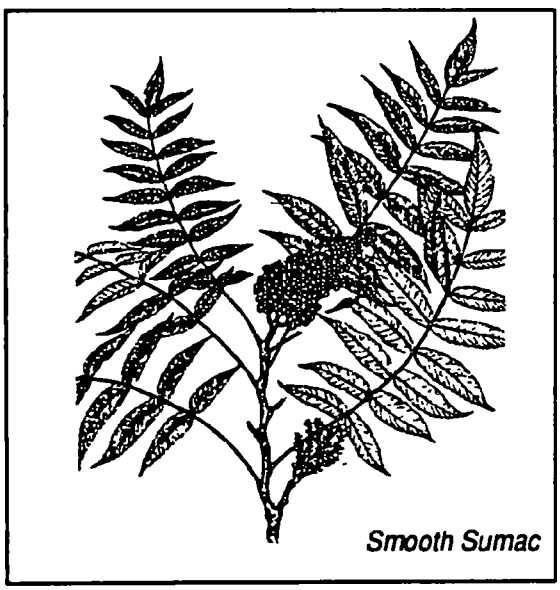
General term referring to various thorny shrubs and vines such as wild roses, blackberries, green brier



Mesquite

Mesquite

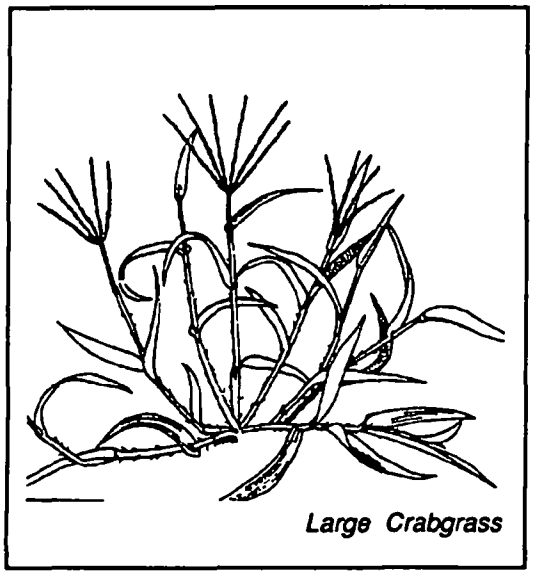
Shrub or small tree; pinnate compound leaf; Southwest only
(size: leaflet to 1/2", plant 3' - 36')



Smooth Sumac

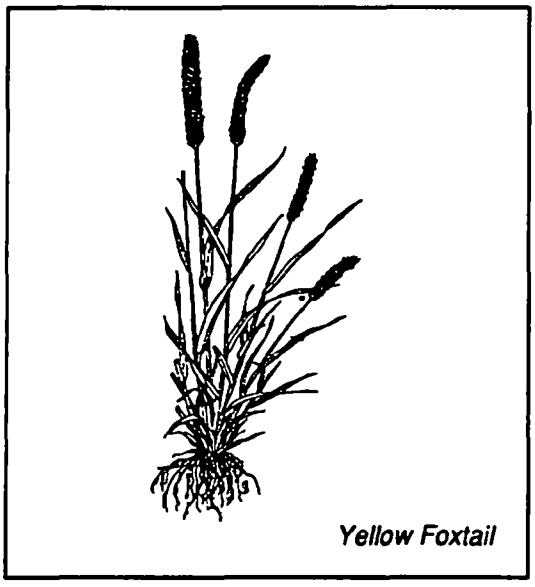
Sumac

Shrub or small tree; pinnate compound leaf; fruit cluster pyramid-shaped; fruit covered with reddish hairs
(size: leaflet to 4" long, plant 2' - 20')


Large Crabgrass

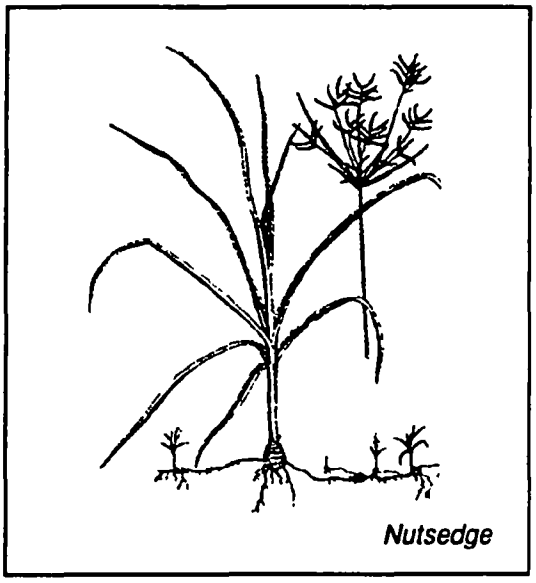
Crabgrass

Annual; characteristic finger-like flower head; forms clumps
(size: plant 6" - 12")


Yellow Foxtail

Foxtail

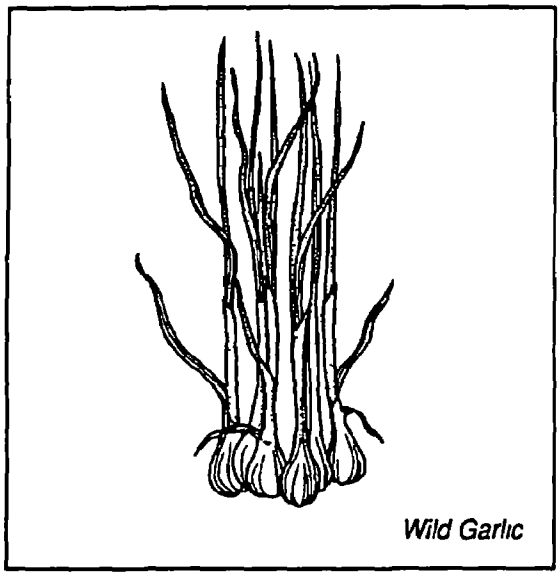
Characteristic bristly spike flower head (straight or drooping)
(size: plant 1' - 3')


Nutsedge

Nutsedge (nutgrass)

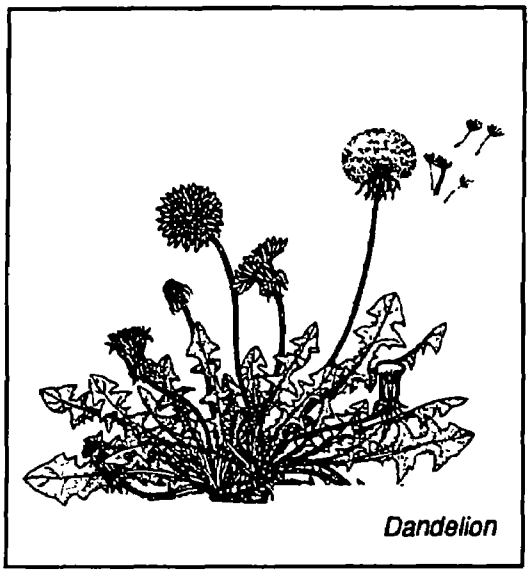
Stem triangular in cross-section; prefers moist to wet soil
(size: plant 1' - 2')

Grass-like Weeds


Wild Garlic

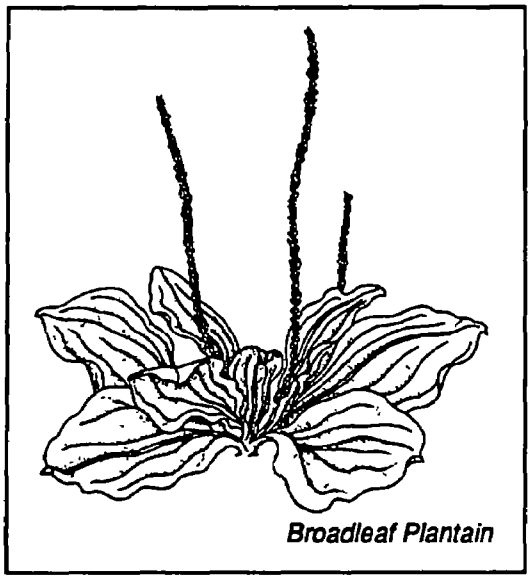
Wild garlic/onion

Tubular leaves; grows from bulb
(size: plant 1' - 3')


Dandelion

Dandelion

Toothed leaf in basal rosette; yellow flower; fluffy seedhead
(size: leaf 3" - 18")


Broadleaf Plantain

Plantain

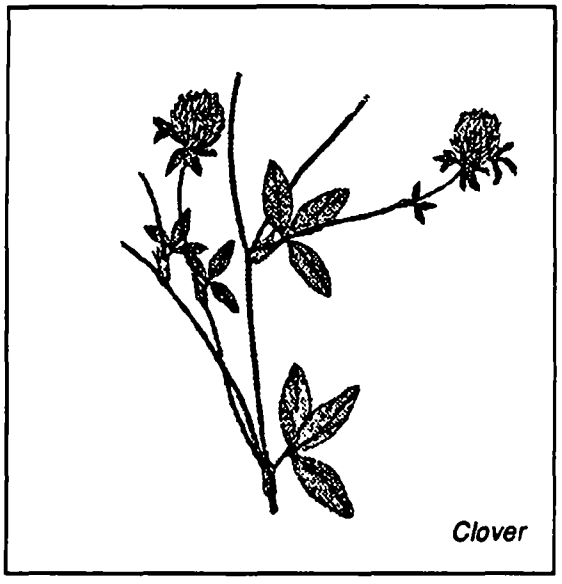
2 common forms each with characteristic flowerhead:

(A) Broad oval leaf
(leaf size: 4" wide by 8" long)


Buckhorn Plantain

(B) Long narrow leaf
(leaf size: 1" wide by 12" long)

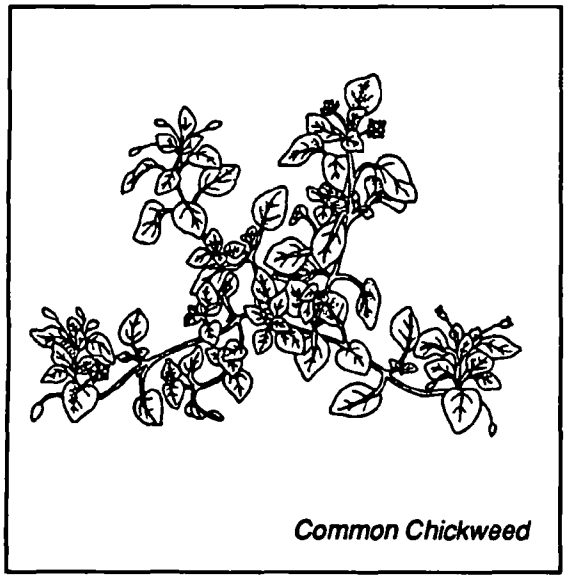
Broadleaf Weeds



Clover

Clover

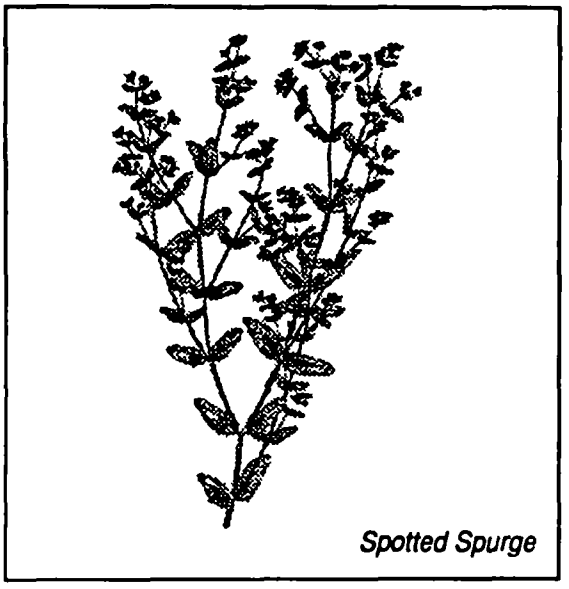
Leaves in groups of 3; globular flowerhead; many species
(size: plant 3" to 16")



Common Chickweed

Chickweed

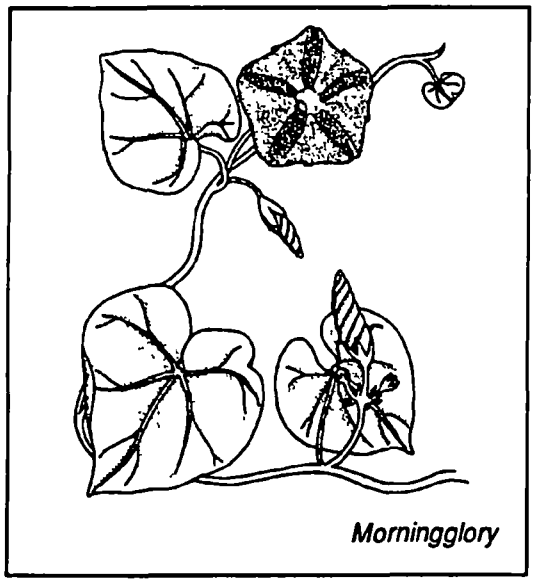
Small pointed leaves; small white flowers; grows during cool season
(size: leaf to 1/2"; plant sprawls 6" - 24")



Spotted Spurge

Spurge

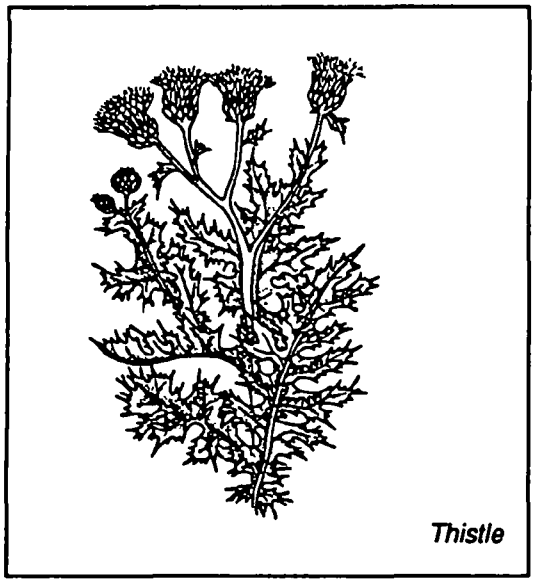
Grows flat on ground; milky sap; small oval leaves often with dark splotch in center
(size: leaf to 1/3"; plant sprawls to 12")



Morningglory

Morningglory

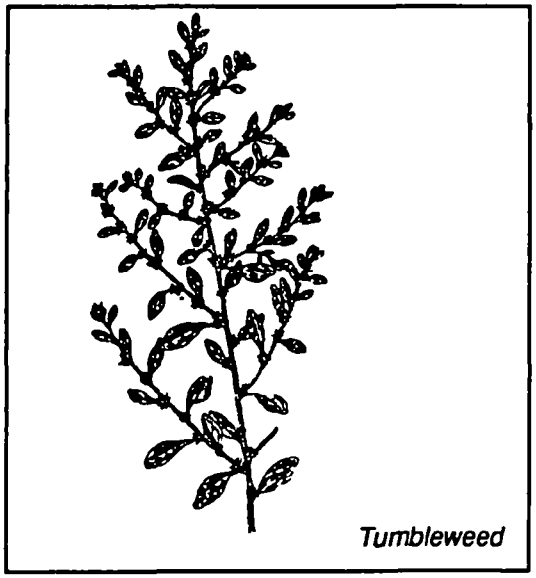
Leaf heart-shaped to ivy-like; showy, tubular flowers
(size: leaf 3"; plant vines to 15')



Thistle

Thistle

Spiny, toothed leaves; characteristic flower shape
(size: plant 1' - 10')

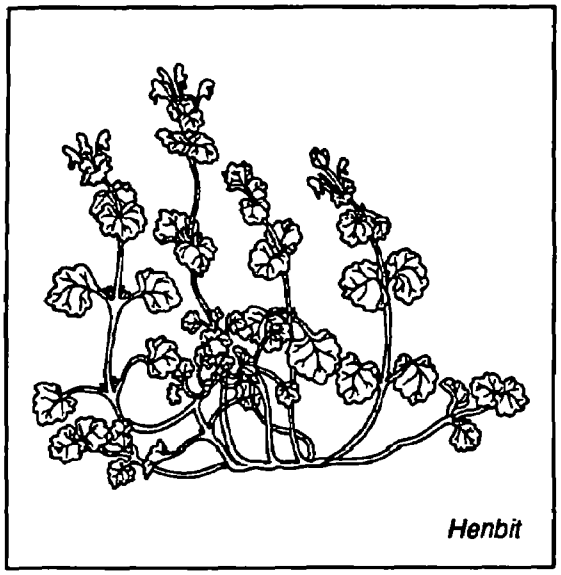


Tumbleweed

Tumbleweed

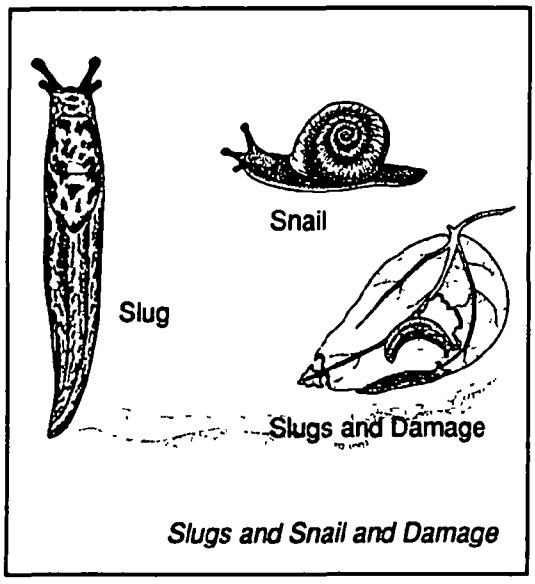
Oval leaves; densely branched plant; when mature, stem breaks at base and plant blows across ground often piling up at fences or other obstructions
(size: leaf to 2 1/2", plant to 3')

Broadleaf Weeds



Henbit

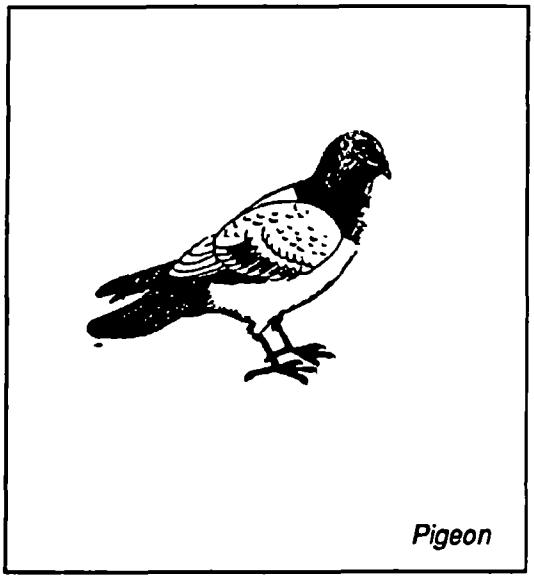
Square stem; leaves attached directly to upper stem; purple flowers; grows during cool season
(size: leaf 1/2"; plant 6"-12")



Slugs and Snail and Damage

Slugs,Snails

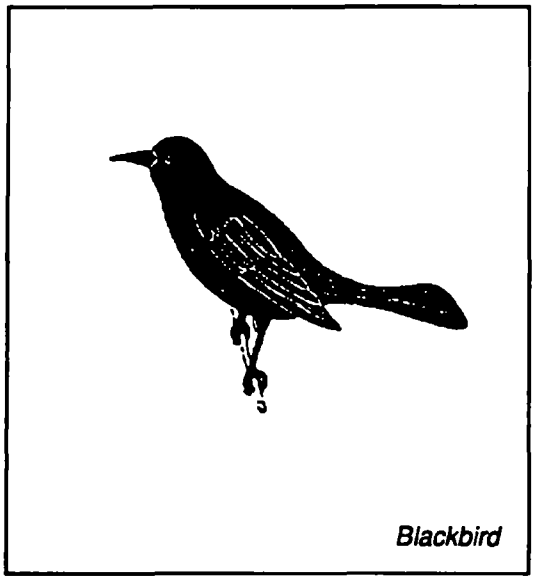
Soft; slimy; leave silvery trails on sidewalks and foliage when mucous dries; snails have shells, slugs do not have shells; eat foliage
(size: 1/4" to several inches depending on species)



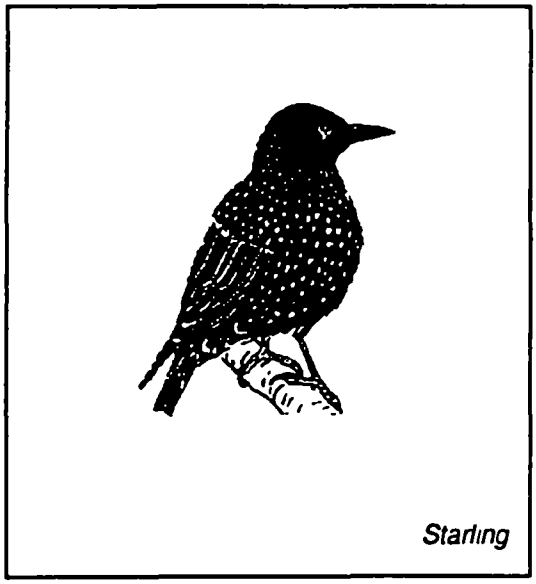
Pigeon

Birds

May be nuisance when they nest in or on buildings, eat seeds, or eat crops

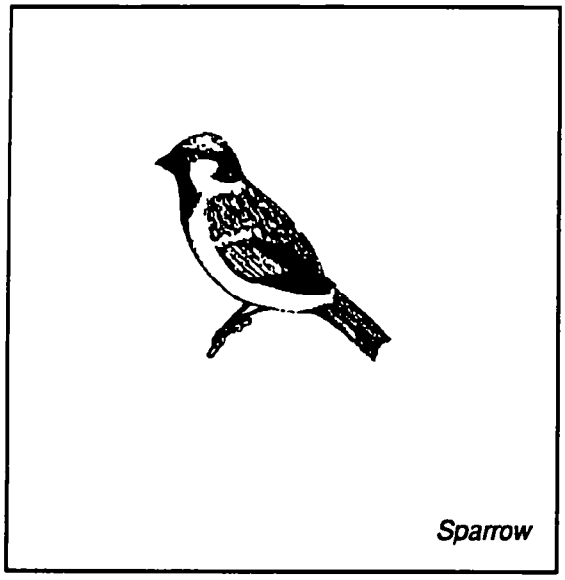


Blackbird

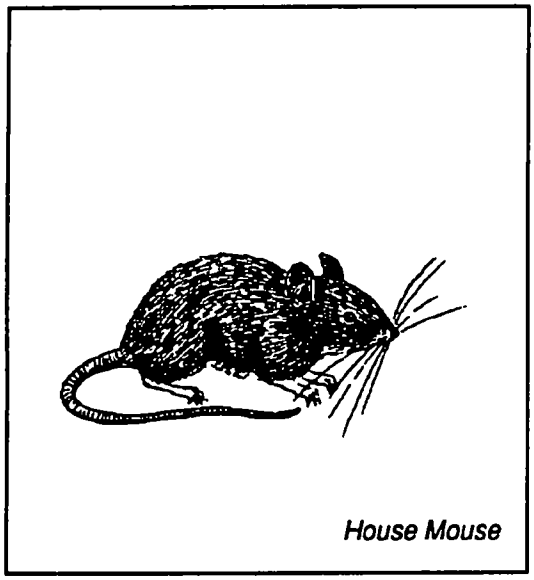


Starling

Birds



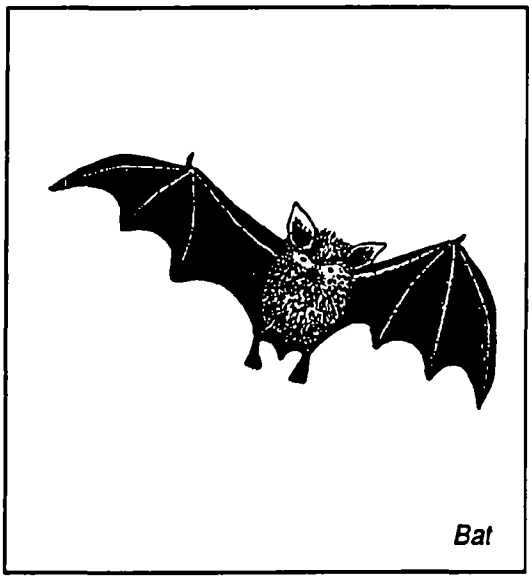
Sparrow



House Mouse

Mice,rats

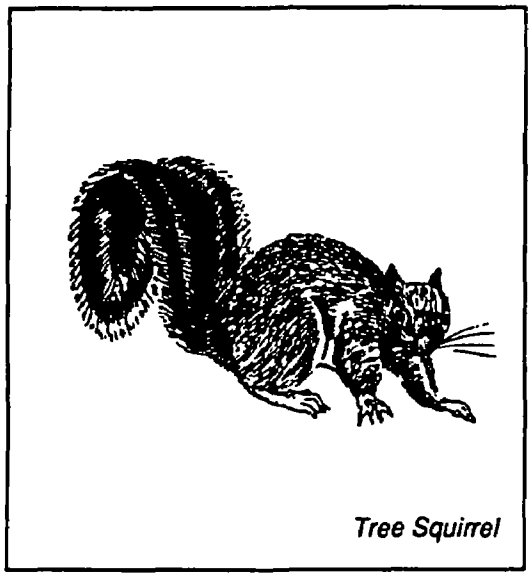
Rodents; found in fields and structures (especially where food products are stored)
(size: 1" - 12")



Bat

Bats

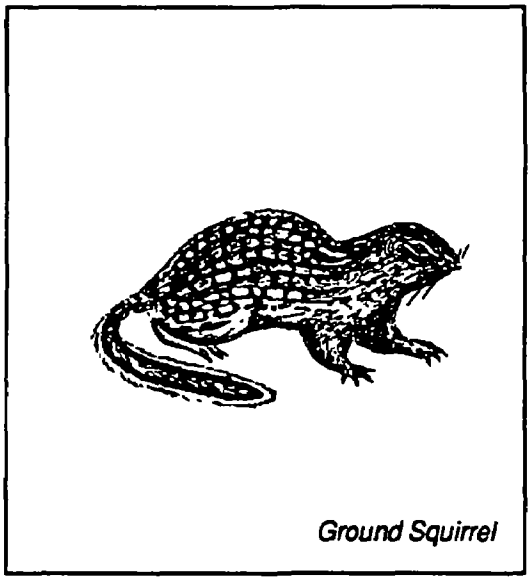
Nocturnal, winged mammals; eat insects, fruit; can be nuisance if they nest in buildings
(size: body to 4" with wingspan to 14")



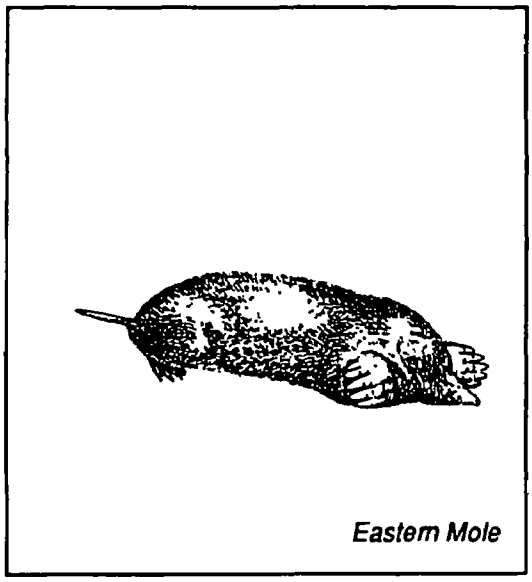
Tree Squirrel

Squirrels

Both tree and ground dwelling species; tree types may nest in buildings; holes of ground types are hazardous to livestock
(size: adult to 27" (tree) or 12" (ground))



Ground Squirrel



Eastern Mole

Moles

Smooth, short fur; large front claws; tunnel underground eating insects and plant roots
(size: adult 5" to 8")

Striped Skunk

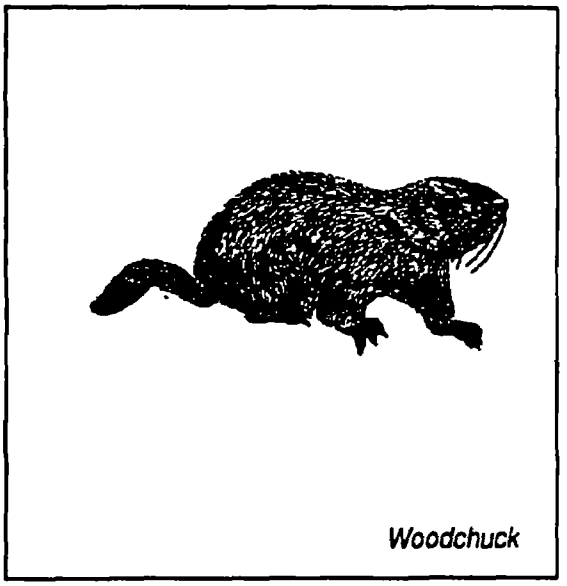
Skunks

Nocturnal; usually eat insects and small rodents; nuisance when eat poultry or vegetables, excavate under buildings, or spray people or pets
(size: adult to 18")

Black-tailed Prairie Dog

Prairie Dogs

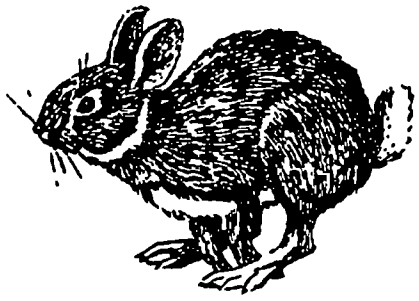
Large, stocky rodents; coarse brown fur; eat vegetation; burrows create rough ground surface
(size: adults to 18")



Woodchuck

Woodchucks (goundhogs,marmots)

Large, stock, short legs; eat plants; dig underground dens
(size: adult to 20")



Eastern Cottontail

Rabbits

Large ears; powerful hind legs; eat vegetation; two main groups: cottontails and jackrabbits (hares)
(size: adult to 22")

Leaflet 21152, 1980, Weed Control in the Home Landscape, Cooperative Extension Service, Univ. of California, Berkeley, CA.

Ball, Jeff, 1988, Rodale's Garden Problem Solver, Rodale Press, Emmaus, PA.

Fichter, George S., et al, 1966, Insect Pests, Golden Press, NY.

Davidson, Ralph H. and William F. Lyon, 1979, Insect Pests, John Wiley & Sons, NY.

ENT-29, 1985, Household Insect Control, Cooperative Extension Service, Univ. of Kentucky, Lexington, KY.

NA Swan, Lester A. and Charles S. Papp, 1972, The Common Insects of North America, Harper & Row, NY.

Public Health Service Publication 1955, 1969, Pictorial Keys to Arthropods, Reptiles, Birds and Mammals of Public Health Significance, US Public Health Service of the US Dept. of Health, Education, and Welfare, Government Printing Office, Washington, DC.

Prevention and Control of Wildlife Damage, 1983, Cooperative Extension Service, Univ. of Nebraska, Lincoln, NE.

Bulletin 512 (Agdex 670), 1987, Pesticides for Household and Structural Pests, Cooperative Extension Service, Ohio State Univ., Columbus, OH.

Bennett, Gary W., et al, 1988, Pest Control Operations, Edgell Communications, Duluth, MN

Training Manual for the Structural Pesticide Applicator, 1976, Environmental Protection Agency/Office of Pesticide Programs, Washington, DC.

Circular 718, 1974, Weeds of the North Central States, Univ. of Illinois, Urbana, IL.

Hanson, A. A. and F. V. Juska, 1969, Turfgrass Science, American Society of Agronomy, Madison, WI.

Fact Sheet 242, 1988, The Gypsy Moth and the Homeowner, Cooperative Extension Service, Univ. of Maryland, College Park, MD.

WL 2, Moles, Cooperative Extension Service, Univ. of Vermont, Burlington, VT.

G3096, Bats: Information for Wisconsin Homeowners, Cooperative Extension Service, Univ. of Wisconsin, Madison, WI.

Agricultural Handbook 366, 1970, Selected Weed of the United States, US Department of Agriculture, Government Printing Office, Washington, DC.

APPENDIX J

ADVANCE MAILING MATERIALS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PESTICIDES AND TOXIC
SUBSTANCES

Dear Resident:

I am asking you to take part in the U.S. Environmental Protection Agency's (EPA) National Home and Garden Pesticide Use Survey. The term "pesticide" includes many products including weed killers, disinfectants, and insecticides. In order to ensure the continued safety of these products used in an around the home, EPA needs information from you, the consumer, about the products you use and how you use them.

In the near future, an interviewer from Research Triangle Institute (RTI), the firm helping EPA with the survey, will come to your home and ask you to answer some questions. The interviewer will have an identification badge and will carry a letter of introduction. Feel free to ask to see these if they are not presented at the door.

The typical interview will take 45 minutes, and the interviewer will need to see the pesticide product containers you have on hand. While your participation is voluntary, your cooperation is very important because you and other survey participants across the nation have been selected on the basis of a scientifically designed plan. You cannot be replaced. For your help with the survey, you will receive $5.00 and a copy of the EPA brochure "Citizen's Guide to Pesticide Use." Please read the enclosed brochure for more information about the study and the importance of your cooperation.

To protect your privacy, your identity is known only to RTI and will not be released to EPA or anyone else. Our reports describing the survey's results will not identify your home or any other specific home.

Thank you in advance for your help in this important survey.

Yours truly,

Allen L. Jennings, Director
Biological and Economic
Analysis Division