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PESTICIDE-WILDLIFE STUDIES:

A Review of Fish and Wildlife Service Investigations

During 1961 and 1962

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WILDLIFE STUDIES, PATUXENT WILDLIFE RESEARCH CENTER

1961-1962

by

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Pesticide research at Patuxent had two principal objectives. One was to appraise new or accepted chemicals to which wildlife might be exposed. This objective was approached through tests of many chemicals on captive birds of selected wild species. Both chronic and acute tests were used. The long-term results of adding small amounts of pesticides to the diet were studied through measurements of growth and reproduction. Chemical analyses for residues in wild and experimental animals also contributed to the evaluation of chemicals, for persistence and accumulation in the body are especially dangerous traits of many chemicals.

The other objective was to study major problems that arose from field applications of pesticides. These problems were approached by the combination of methods that seemed most appropriate. The methods often involved both chemical and biological techniques in the field as well as in the laboratory. Enclosure studies that bridged the gap between field and laboratory studies became an important part of the program. Serious efforts were devoted to devising and testing better field and laboratory methods. The kinetics of pesticides--the relation of rates of assimilation and excretion to toxic action and residue levels--was given increased consideration in interpreting results and in planning research.

Results given here are, for the most part, in summary form, and some are compiled from research in progress, so that final tabulations may differ. For these reasons, the findings should not be quoted in technical publications without first communicating with the responsible investigator, who is designated for most studies.

Evaluation of Chemicals

Feeding tests designed to measure the effects of pesticides on mortality, growth, and reproduction of selected wild species were continued and expanded in 1961 and 1962. Tests of both herbicidal and insecticidal chemicals were included. These tests are a key part of the pesticides program in that they provide a relatively rapid method of detecting potential hazard, and hence are a way to obtain early information on the many new chemicals as they are introduced. This portion of the program is under the direction of James B. DeWitt with assistance from Harold Doty, James Spann, and Clyde Vance.

Bobwhite quail, ring-necked pheasants, and mallard ducks were used as subjects in the principal testing program. Tests also were made on certain other species, particularly red-winged blackbirds, cowbirds, grackles, and starlings. In 1962, experimentation was begun to determine the suitability of coturnix quail for use in the toxicological studies.

Bobwhite, Pheasants, and Mallards

More than 500 toxicological tests involving 42 pesticides were conducted at the Patuxent Wildlife Research Center during 1961 and 1962. Objectives of these tests were to determine: (a) quantities of test compounds producing acute poisoning and death of at least 50 percent of test animals within 10 days, (b) quantities producing chronic poisoning resulting in 50 percent mortality between the 10th and 100th days of the test period, (c) maximum quantities permitting survival for 100 or more days, and (d) effects of sublethal exposure upon growth and/or reproduction. Data from these tests are combined with results of earlier studies in table 1D.

Results of preliminary tests indicated that Zytron is moderately toxic to adult quail, but that the other herbicides tested have relatively low orders of toxicity. Amiben, casoron, diphenamid, and diphenatrile in diets did not result in as much as 50 percent mortality in any of the tests and body weights apparently were not affected. Effects of these compounds on reproduction were not determined. Amitrole, Amitrole-T, dacthal, dalapon, MCPA, and chlorinated phenoxy herbicides also had relatively low orders of toxicity, but sublethal exposures to these compounds had marked inhibitory effects upon reproduction. Quantities producing these inhibitory effects ranged from less than 10 to approximately 50 percent of the estimated lethal dose (table 3D).

Similar inhibitory effects upon reproduction resulted from feeding of diets containing 50 or 100 ppm of kepone prior to and during the breeding season. This lack of reproductive success was accompanied by changes in the feather pigmentation of males. Plumage of male quail fed at these levels resembled that of adult females, and male pheasants and ducks did not exhibit the usual characteristic coloration. The effects of kepone upon plumage and reproduction appeared to be reversible, and normal coloration and increased reproductive success began to appear within 60 to 90 days after the removal of kepone from the diets.

Blackbirds, Cowbirds, Grackles, and Starlings

Tests upon these species were initiated to obtain measures of relative susceptibility to different toxicants, and of the quantities stored in tissues following varying degrees of exposure. All test specimens were wild-trapped birds that had been adjusted to cage conditions prior to being placed on test. All tests were terminated at the end of 30 days.

Results of these studies are given in table 2D. Starlings appeared to be more susceptible than the other species to the effects of chlorinated compounds.

Measurement of Pesticidal Residues

Chemical analyses of pesticidal residues are made as part of specific research programs both in the field and laboratory. Often the determinations are basic to an understanding of the problems and results. Some analyses are made to learn the extent of contamination of wild animals in the field. Among field-collected specimens from all sources, residues of DDT, heptachlor, dieldrin, or toxaphene were found in approximately 68 percent of 1,794 specimens analyzed at Patuxent during 1961 and 1962. Data for DDT, heptachlor, and dieldrin are shown in tables 4D and 5D.

This work is under the direction of James B. DeWitt, with assistance from chemists Vyto A. Adomaitis, Calvin M. Menzie, and William L. Reichel.

Effects of Pesticides on Woodcock Populations

Woodcock populations are in a particularly critical position in relation to pesticidal treatments for several reasons. First, a major proportion of the continental population winters in the Gulf States, in the same area where the fire ant control program is underway. Second, woodcock food consists in large part of earthworms, which can accumulate considerable amounts of chlorinated hydrocarbon insecticides without themselves being killed. Third, woodcock undergo periods of food shortage and cold on the wintering grounds, on their early migration northward, and on the breeding grounds. In the northern areas they are exposed further to a variety of chemicals applied to areas where they feed.

Several interrelated studies have been directed toward understanding the hazards of pesticides to woodcock. Several of these were completed in 1961-1962, some by experiments conducted in those years and some by analyzing data of experiments conducted earlier.

Capsule Dosage Tests

A series of experiments was conducted at Amherst, Massachusetts, under the direction of W. G. Sheldon in 1959 and at the Patuxent Wildlife Research Center by W. H. Stickel in 1960. A manuscript draft, "Effects on Woodcock of Capsule Dosages of Heptachlor, Dieldrin, and DDT," was prepared in 1962. The response of woodcock to the toxicants varied markedly depending on condition of the birds, as shown by weight changes since capture. With underweight birds, nearly all woodcock died at heptachlor dosage levels well below those at which nearly all birds of normal weight lived. Similarly, birds in good condition could scarcely be killed with oral doses of DDT, even in massive quantities. Dieldrin was more toxic than heptachlor to two groups of underweight birds. The study also showed that large portions of the capsule dosages passed quickly through the digestive tract without being assimilated. It was concluded that other methods of appraising the field effects of toxicants on woodcock had to be sought. This conclusion led to further studies.

As prerequisites to the capsule-dosage studies, methods of care of woodcock in captivity had to be developed. A draft manuscript, "Care of Woodcock in Captivity," was prepared in 1962. Another manuscript, "Some Diseases and Parasites of Captive Woodcock," was prepared as a result of studies made on these same birds by Louis N. Locke.

Feeding Experiments with Contaminated Earthworms

The second, and more critical, experimental studies were made in Louisiana in 1961 by W. H. Stickel, with woodcock caught on their winter feeding grounds. The purpose of these experiments was to measure the mortality effects of heptachlor presented in the food. Since woodcock accept only living earthworms, this entailed preliminary experiments in which methods were developed for contaminating worms. Woodcock were fed worms containing heptachlor residues in two concentrations; control birds were fed untreated worms.

Fifty percent of the birds (6 of 12) that fed on worms containing an average of 3 ppm (parts per million) of heptachlor residues died within 34 days. Four more birds died by the 51st day, and the two remaining were killed for chemical analysis. Worms collected in areas treated with 2 pounds per acre of heptachlor often contain more toxicant than the worms fed to the experimental birds.

Birds fed worms with an average residue content of about 0.65 ppm did not die during 60 days on full rations. The residue content of birds fed at this lower rate was of the same magnitude as that found in wild-caught birds in the same area. Birds fed untreated worms for an average of 98 days contained less toxicant in their tissues than did wild-caught birds, indicating loss of heptachlor residues with time.

Results of this study, including mortality under normal feeding and starvation rations of treated and untreated food, residue content, food consumption, and weight changes have been prepared in manuscript draft: "Effects on Woodcock of Feeding on Worms Contaminated with Heptachlor." Development of this study also entailed consideration of the effects of pesticides on earthworms. One aspect of this work resulted in a manuscript, "Effects of Chemicals on Earthworms: A Review of the Literature," by S. P. Davey.

Wing Survey

A woodcock wing survey was initiated during the 1959-1960 hunting season, with the view that age ratios shown by the wings might make it possible to detect any marked changes in reproductive success. Weighted age ratios shown by the wings received in 3 years (approximately 30,000 wings in all) were very similar: 1.8 immatures per adult female in 1959-1960 and 1960-1961 and 1.9 in 1961-1962. Sex ratios also were remarkably uniform each year. Although it seems likely that drastic changes in woodcock breeding success would have been noted, one cannot say that no changes occurred, for there was considerable variation in age and sex ratios shown by wings sent from different States and Provinces.

A manuscript has been prepared giving detailed results and discussion of the first 3 years' study, "Results of the 1959, 1960, and 1961 Woodcock Wing Collection Survey," by F. W. Martin, A. D. Geis, and W. H. Stickel. In the second year of the survey, F. W. Martin developed a new color-pattern method for determining age from wings. This method permits very rapid reading of age without microscopic examination of feathers. Further, it is applicable to late-season birds, which the microscopic method was not, and thus permits wing study of the wintering population. The manuscript describing this method is entitled, "Age and Sex Determination of Woodcock from Wings."

Residues in Field-Collected Woodcock

Woodcock have been collected from both southern and northern areas for determination of heptachlor residues; the first collections were made in 1958, and additional collections were made in subsequent years. Some analyses also have been made to determine DDT residues. The numbers analyzed in 1961 and 1962, proportions that contained residues, and average residue content are shown in table 4D. This study has been under the direction of James B. DeWitt. Summary and analysis of the data are underway.

Effects of DDT on Bald Eagles

People concerned with birds have feared for years that our national emblem, the bald eagle, is becoming increasingly scarce in the United States and that its reproductive success is low. Information on numbers, breeding success, and population trends is now being sought through surveys made annually by the National Audubon Society with the cooperation of the Fish and Wildlife Service.

According to the most recent report of these surveys (Sprunt and Cunningham, 1962), only 3,807 eagles were found in the January 1962 survey, which included all States other than Alaska. Immatures constituted 24 percent of the population. The 1962 breeding survey provided data on 515 nests, of which 257 were in Florida. Overall nesting success was 44 percent and at least 228 young eagles were added to the population. But no nests were reported for New England south of Maine, and nesting success was exceedingly poor in the central Atlantic States. In New Jersey, one nest in six produced young. In Maryland, not one of the 15 nests under observation was successful. In Virginia, two of 18 nests succeeded.

The marked lack of breeding success in coastal areas that are treated frequently for mosquito control has led some conservationists to suspect that since fish are a major item in the eagle's diet, eagle reproduction has been inhibited by DDT residues accumulated by feeding on contaminated fish. Other workers have felt that a more probable explanation was intensified human disturbance, for few areas of the East Coast are now free of houses and motor boats.

As the first step in resolving this question, the Fish and Wildlife Service asked to have all bald eagles that were found dead sent to the Patuxent Wildlife Research Center for DDT analysis. Analyses, reported below, quickly proved that some eagles did contain many parts per million of DDT. But what did such residues mean in relation to eagle mortality? What degree of contamination of fish was necessary to produce such residues? These questions required experimentation.

Alaskan Experimental Studies

The necessary tests were begun at Petersburg, Alaska, in the winter of 1961-1962. Alaska was selected because eagles were still abundant there and because DDT levels were still low in Alaskan animals. Availability of the facilities of the experimental fur farm operated by the University of Alaska made Petersburg the best place for the work.

Sheltered perches for 10 eagles were built. Eagles were captured near Haines, Alaska, by men of the Service's Alaskan Regional Office. They were fed ground fish supplemented with vitamins. DDT dissolved in edible oil was mixed with the feed. Two of the birds were fed clean food; both lived through the 112-day experiment. Two were fed 10 ppm (parts per million) of DDT, 2 were fed 160 ppm, 2 were fed 800 ppm, and 2 were fed 4,000 ppm. The objectives were to find approximately where the lethal level lay, to learn what residues occurred in birds killed by DDT, and to learn how rapidly residues accumulated in eagles feeding on fish containing relatively small amounts (10 ppm) of DDT, such as could occur in nature.

The birds on 4,000 ppm soon died, and a replacement quickly died at the same level. Birds on 800 ppm died a little later. One of the birds on 160 ppm lived throughout the experiment, but the other died after severe tremors. It is likely, therefore, that the lethal level is of the general magnitude of 160 ppm.

As a wild eagle would rarely if ever obtain food contaminated at a level approaching 160 ppm, it seems that an eagle in the wild would die of DDT poisoning only if its system accumulated DDT for long periods. But over long periods the bird would also be excreting DDT or its metabolites, and excretion might well come into balance with intake. It therefore became necessary to learn about the rates of assimilation and excretion of DDT at low levels.

Unfortunately, one of the experimental eagles on 10 ppm languished and died early in the test and the other escaped near the end of the test. Thus no data were gained on residue buildup at low levels. Work was resumed in 1962-1963, with the aim of studying accumulation and loss of DDT in eagles fed 10 ppm of DDT. This work was in early stages at the time of writing and results will not be known before late 1963.

Concentrations of DDT in livers of the experimental birds were as follows: Untreated (fed no DDT), 0.4 to 1.0 ppm (parts per million); fed 10 ppm, 40.5 ppm; fed 160 ppm, 43.3 and 43.8 ppm; fed 800 ppm, 57.8 and 280 ppm; fed 4,000 ppm, 390 and 714 ppm.

Residues in Field-Collected Eagles

Twenty-five of the 26 bald eagles examined contained residues of DDT in amounts ranging from traces in one or more organs up to amounts comparable to those found in experimentally dosed birds that died of DDT poisoning. Three eagle eggs, taken from two unsuccessful nests following abnormally long incubation periods, also contained relatively high concentrations of DDT. An interim report concerning the eagle studies was published (DeWitt and Buckley, 1962).

Effects of Heptachlor on Bobwhite and Songbirds

Aerial applications of heptachlor to large portions of the Southeast in the range of the imported fire ant were initiated in 1957-1958, with treatments at the rate of 2 pounds per acre. Rate recommendations subsequently were reduced to 1¼ pounds per acre, and toward the end of 1960, recommendations were changed to ½ pound per acre, to be applied in two treatments of ¼ pound each. Although many extensive treatments in 1962 were made with a new chemical, Mirex, hundreds of thousands of acres in Louisiana alone were planned for heptachlor treatment at the rate of ½ pound per acre in the winter and spring of 1962-1963.

Enclosure Studies of Bobwhite

Experimental data on effects of heptachlor on bobwhite were obtained from enclosure studies conducted at Patuxent under the direction of James B. DeWitt. Adult birds were confined in 20 x 50-foot wire-covered pens enclosing areas where the ground had been treated with the insecticide. Application rates were those which have been used for control of imported fire ants: 2.0 pounds per acre (6 pens); 1.25 pounds per acre (6 pens); and 0.25 pound per acre (12 pens). Eight other pens remained untreated, and served as controls or check areas. One pair of birds was placed in each pen immediately after application of the insecticide. When mortality occurred in any pen, the surviving member of the pair was sacrificed, and a new pair was placed in the pen.

Results of these tests are given in table 6D. Mortality occurred in 20 of the 22 pairs placed in pens treated with 2.0 pounds per acre, and the survival times for these birds were approximately equal to those of birds fed diets containing 100 or 200 ppm of heptachlor. The two surviving hens produced a total of 7 chicks. Sixteen pairs were started in pens treated with 1.25 pounds per acre, but only four pairs survived. Times of death in these pens were approximately equal to those of birds fed 50 or 100 ppm. All 4 of the surviving hens produced eggs, and 19 chicks were hatched from the two successful nests.

Mortality rates and survival times for birds in pens treated with 0.25 pound per acre were similar to those of quail fed diets containing 10 or 25 ppm of heptachlor. One bird was killed by a predator, and six of the remaining 18 pairs survived. All of the surviving hens produced eggs, and 24 chicks were hatched in the three successful nests.

Eleven pairs were started in the control pens, but 1 bird was killed by a predator. Five of the remaining 10 pairs survived, and produced 21 chicks from the three successful nests.

Toxicological Studies and Residue Determinations

Tests with heptachlor and heptachlor epoxide made at Patuxent are summarized in tables 1D and 2D. Results of residue analyses are shown in table 4D. For discussion of experiments, see pages 74-76.

An account of the heptachlor residue content of quail and other animals collected or found dead on treated and untreated land was published (Rosene, et al., 1962).

Bobwhite Populations in Georgia

Quail populations in heptachlor-treated areas in Georgia and on an untreated area in Alabama have been studied by whistling cock counts and covey counts each year since 1958. The work has been conducted by Walter Rosene, who reported early results (Rosene, 1958). Field work was discontinued after covey counts were made in early 1962. On one tract, treated at the rate of 2 pounds per acre in 1957-1958, the quail counts were very low after treatment and increased gradually throughout the study. Populations in the untreated area in Alabama remained essentially constant. Portions of another area were treated with different amounts of heptachlor at various dates, and certain portions remained untreated. On this area, sharp initial population decline and subsequent gradual increase have been followed, with particular consideration of the relationships between treated and untreated portions. Statistical analyses of the data and preparation of a report for publication are well underway.

Songbirds in Alabama

Effects on birds of a 2-pound per acre application of heptachlor were studied for 2 years on a 2,400-acre cattle farm in Alabama. In 1962, data from this study were assembled in a report of 198 pages and 22 tables, "Mortality and Repopulation of Birds Following a Field Application of Heptachlor," by Paul A. Stewart. This report shows that there was heavy mortality of birds of many species, and that all individuals of some species were lost. Many of the missing birds were found dead. Reproductive success of birds on the treated area was lower than that on the control area. Certain species did not succeed in reestablishing their populations on the treated area by the end of the study.

Birds in Arkansas

Effects of ¼-pound applications of heptachlor in Union County were studied by University of Arkansas students under the direction of Dr. Douglas James. Bird population studies and systematic searches for dead animals were made on two treated and two untreated areas. The study was initiated and supported by the Bureau. A report is being prepared by Dr. James.

Effects of Mirex on Wildlife

In 1962, Mirex (Compound GC 1283) became the chemical most generally used for control of fire ants. Some extensive acreages were treated with two applications of ¼-pound of heptachlor per acre, and various industrial or commercial areas were treated with 1¼- or 2-pound applications of heptachlor. Mirex, however, was used on more extensive areas and was expected to gain even wider use in the future.

Mirex, an analog of kepone, is applied at the rate of only 4 grams per acre. It is dissolved in soy-bean oil and is distributed on ground corn cobs. Ants are attracted to this oily bait. Some highly successful examples of control are reported by the U. S. Department of Agriculture.

Laboratory Studies

In studies made at Patuxent, Mirex had no apparent effects upon reproduction or secondary sex characteristics of quail or pheasants. The compound has a relatively low order of toxicity to these species, and both young and adult birds survived for extended periods when fed diets containing 200 ppm. Feeding at higher levels (500 to 5,000 ppm) resulted in the appearance of typical symptoms of chlorinated hydrocarbon poisoning, including tremors, loss of coordination, and death within 48 or 72 hours after the onset of these symptoms.

Field Studies

Little wildlife damage in the field was anticipated, because of the low toxicity and low rate of application of the compound. Mirex bait is applied blanket-wise, however, over woods, waters, and fields, so it was desirable to see what actually happened in the field.

The study method selected consisted of systematic, periodic observations over large areas of animal-rich habitats. Observers searched for dead animals and for any other indications of damage to animal populations or alterations of behavior. This approach was followed by Clark Webster and Enos Mellinger, Branch of Refuges, near Savannah, Georgia; by Ralph Andrews, near Baton Rouge, Louisiana; and by Walter Rosene, Jr., in northeastern Mississippi.

None of these studies revealed any wildlife damage that could be attributed to Mirex. Vertebrate populations appeared to remain normal in all respects. As a more rigorous test, experiments are underway in which bobwhite quail are held on ground treated at far heavier levels of Mirex than are used operationally. Preliminary reports from Dr. Maurice Baker, who is conducting this work at Auburn University, indicated that quail held on heavily treated land suffered no visible damage during the first month and that the experiment would be continued.

Effects on Birds and Small Mammals of DDT Used for Elm Spanworm Control

The U. S. Forest Service, faced with an outbreak of elm spanworm, *Ennomos subsignarius* (Hbn.), that was threatening to kill many trees of the deciduous forest at the Coweeta Hydrological Station, North Carolina, decided to make an aerial application of 1 pound of DDT per acre in oil solution. The U. S. Fish and Wildlife Service was invited to study the effects on wildlife. Teams of men led by Frank M. Johnson and James S. Lindzey trapped and marked songbirds and small mammals before treatment, which was in late May of 1961, then a week after treatment, and again a month after treatment. Two treated areas and two untreated areas were studied. Birds were taken in grids of mist nets, marked, and released in 3-day study periods. Small mammals were taken in lines of live traps, marked, and released. Each trap was open for 3 days, but was closed on alternate days, so each trapping period was of 6 days.

No mortality that could be attributed to the treatment was detected. Results were clear in the small mammal work, for as large a proportion of marked mice (Peromyscus) was recaptured in treated as in untreated areas. Data for birds were less satisfactory, for although 797 birds of 43 species were caught, recaptures were too few to provide good comparative data.

Deaths of birds and mammals would not have been expected from 1 pound per acre of DDT, and in the present study the amount reaching the ground was considerably less than 1 pound per acre at most spots, as shown by oil-sensitive dye-cards. The chief values of the study, therefore, were in affording opportunity to make practical tests of certain study methods and in obtaining animals for residue analysis. Chemical analyses are underway.

Effects of Pesticides Applied to Aquatic Areas

Herbicides Used for Control of Eurasian Watermilfoil

Studies were initiated in cooperation with personnel of the Chesapeake Biological Laboratory of the University of Maryland Natural Resources Institute and the Virginia Institute of Marine Science. In first tests, granular formulations of 2,4-D esters and salt were applied experimentally for control of Eurasian watermilfoil in Chesapeake Bay, the Potomac River, and tributaries at rates of 10-120 pounds acid equivalent per acre in plots ranging from 1/10 to 6 acres in size. In one instance the dying vegetation in a plot treated with 60 pounds per acre in an area with poor water circulation caused an anaerobic condition that killed oysters, crabs, and fish confined in cages, and free-living clams, worms, and other invertebrate bottom life. A later effort to create an anaerobic condition for study of the factors contributing to this situation was unsuccessful.

DDT Used for Mosquito Control

An agreement was entered into with the University of Minnesota to study the effect of DDT applications for mosquito control on the aquatic life of waterfowl ponds. Bioassays showed no detectable DDT in aquatic invertebrates or vegetation collected in late September from ponds treated in early spring at the rate of approximately 1 pound of chemical per acre. Small quantities of DDT were recovered in the bottom mud. Radioactive DDT is being introduced into mud samples to determine the best methods of recovery.

Methods of Measuring Effects of Pesticides on Wildlife

Measurement of changes in animal populations is extremely difficult; some of the generally accepted methods are largely untested. The necessity of assigning causes to observed changes, as in the evaluation of pesticidal treatments, makes the problem even more severe. Several studies in 1961 and 1962 were directed toward an understanding of the meaning of measurement methods or development of new methods.

Carcass Disappearance Rates

Consideration of the implications of finding carcasses in the field was begun in studies in Alabama and Texas (Rosene and Lay, 1963). Subsequently, quail disappearance rates were studied at Patuxent by James Cross. In all three areas, all carcasses were at least partially eaten within 48 hours. The proportions completely gone within 4 days were 90 percent of 21 carcasses at Patuxent, 47 percent of 30 carcasses in Alabama, and 13 percent of 30 carcasses in Texas. Judging from the distances carcasses could be seen, and the distances a man could walk in a day of searching, Rosene and Lay concluded that failure to find dead quail is poor evidence that no quail died and that finding even a small number of dead quail may suggest considerable mortality.

Carcass Search Technique

Other studies at Patuxent have been aimed at appraisal of the carcass-search technique as a practical field method. The first exploratory trial showed that a high efficiency of search was possible in relatively small areas with ample time. A human searcher found all the birds in the section of hedge-border searched and 75 percent of those in the field. A man and dog team searched immediately thereafter and found 81 percent of all birds present in field and borders, but in a much shorter time. Two further studies, experimentally designed, showed great variation among individual searchers in their ability to find small dead birds. In one set of four independent searches, one biologist found more than three-fourths of the carcasses present, whereas the other found less than one-third. In another search, involving 36 persons, individual success again varied greatly, but the overall success was 60 percent.

Small-Mammal Census with Live Traps

Two extensive field tests were made of the reliability of standard census techniques in detecting losses in wild populations. The first test involved live trapping Peromyscus populations. It was conducted by Don W. Hayne and Mary F. Myers. Four areas of 4 acres each were trapped simultaneously, using grids of live traps. One-third of the mice were then removed from two of the areas and trapping was continued on all four areas as before. Estimates from the comparative data indicated a mortality of 37 percent in the areas from which mice were removed, surprisingly close to the real value of 33 percent. This demonstrated that population changes in Peromyscus, such as the changes caused by insecticide applications or rodent control operations, can be measured quite accurately by standard mark-and-recovery methods that employ live traps on a grid. Peromyscus is especially suitable for such work because of its dependable trap response. It is not likely that many other kinds of small mammals would yield equally clear-cut results. Fortunately, Peromyscus is the most abundant mouse in many habitats and is one of the chief mammals involved in problems of forest reseeding.

Bird Census by Two Methods

The second test was a detailed quantitative comparison of the territorial-male census (Williams method) and the mist-net census, in which mortality up to 50 percent was imposed on netted birds of common species to see how well and how long this mortality was reflected in censuses of both types. C. S. Robbins conducted the study with assistance from others, especially James Cross and David Bridge. The study was made on a 100-acre tract of moist deciduous forest at the Patuxent Wildlife Research Center in the summer of 1962. Data have not been completely analyzed, but preliminary tabulations show that the Williams method detected a loss, but estimated it at only about one-fourth of the actual reduction. Repopulation occurred so rapidly that it masked the reduction. This phenomenon is just one of several variables that make it extremely difficult to obtain close measurements of changes in bird populations.

Table 1D. Quantities of pesticides causing 50 percent mortality of bobwhite, ring-necked pheasants, and mallards

Mg/kg eaten indicates the average amount of toxicant that had been consumed (milligrams of toxicant per kilogram of bird) by the time 50 percent of the birds had died; ppm indicates parts per million of toxicant in the diet; the symbol < means "less than"; the symbol > means "greater than", and in the body of the table indicates that the dietary concentrations and total toxicant consumption so marked did not produce 50 percent mortality in the test period.

Compound	Test period (days)	Bobwhite				Ring-necked pheasants				Mallards			
		Young		Adult		Young		Adult		Young		Adult	
		ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten
Aldrin	<10	10	4.5	10	3.5	10	6.5	50	4.3	100	190	1000	105
	<100	2	9.5	2	6.5	5	11.5	5	18	50	540	200	285
Amiben	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	-	-	>1000	>7800	-	-	-	-	-	-	-	-
Amitrole	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	5000	26000	5000	200000	5000	35500	>5000	>13600	5000	15750	5000	>80000
Amitrole-T	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	>5000	>78000	>5000	>51500	5000	16100	>1500	>12500	>2500	>17500	>2500	>13565
Bayer 22408	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	200	3265	-	-	-	-	-	-	-	-	-	-
Bayer 22684	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	200	1920	-	-	-	-	-	-	-	-	-	-
Bayer 25141	<10	25	263	25	16	50	160	-	-	-	-	-	-
	<100	5	42	5	64	-	-	-	-	-	-	-	-
Bayer 29493	<10	25	24	-	-	200	400	-	-	100	120	2500	2
	<100	10	29	25	76	50	410	-	-	>10	>140	500	85
Bayer 38920	<10	250	150	-	-	100	270	-	-	250	320	-	-
	<100	100	300	-	-	25	155	-	-	100	900	1000	780
BHC	<10	1000	400	-	-	250	150	-	-	500	480	-	-
	<100	100	950	100	230	>100	>1200	>100	>800	-	-	2500	1850
Casoron	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	-	-	>1000	>9000	-	-	-	-	-	-	-	-
Ceresan	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	-	-	100	190	-	-	100	1700	-	-	50	80
Chlordane	<10	250	700	1000	90	500	550	-	-	-	-	-	-
	<100	100	500	250	730	50	170	200	340	-	-	-	-
Chlorobenzilate	<10	-	-	-	-	5000	7100	-	-	-	-	-	-
	<100	-	-	-	-	-	-	-	-	-	-	-	-
Chlorthion	<10	5000	1000	-	-	-	-	-	-	-	-	-	-
	<100	-	-	-	-	-	-	-	-	-	-	-	-
Co-Ral	<10	100	90	-	-	500	650	1000	160	250	65	-	-
	<100	10	75	>50	>600	200	1700	250	250	50	385	-	-
2,4-D acetamide	<10	2500	1825	-	-	1000	3000	-	-	2500	3400	-	-
	<100	-	-	>2500	>37600	-	-	>2500	16000	>500	>5700	>2500	>35700
2,4-D dimethyl amine salt	<10	5000	8250	-	-	-	-	-	-	-	-	-	-
	<100	-	-	-	-	5000	19780	>5000	>6500	2500	22100	-	-
2,4-D butoxy-ethanol ester	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	5000	37900	5000	40760	5000	29430	-	-	5000	1485	>5000	>33000
Dacthal	<10	5000	5500	-	-	-	-	-	-	-	-	-	-
	<100	-	-	-	-	-	-	-	-	-	-	5000	35775
Dalapon	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	5000	39566	>5000	>69500	-	-	>5000	>40000	5000	15100	>2500	>26000

(continued)

Table 1D. Quantities of pesticides causing 50 percent mortality of bobwhite, ring-necked pheasants, and mallards (Continued)

Compound	Test period (days)	Bobwhite				Ring-necked pheasants				Mallards			
		Young		Adult		Young		Adult		Young		Adult	
		ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten
DDT	<10	1000	1480	2500	880	1000	2600	1000	225	500	1630	-	-
	<100	400	3200	1000	1000	100	650	>100	>570	>200	>4250	1000	>3800
DDVP	<10	5000	1700	-	-	-	-	-	-	-	-	-	-
	<100	-	-	-	-	-	-	-	-	-	-	-	-
Delnav	<10	100	250	-	-	-	-	-	-	-	-	-	-
	<100	-	-	500	2140	5000	15400	>1000	>5500	-	-	-	-
Dexon	<10	250	475	-	-	2500	140	-	-	-	-	-	-
	<100	-	-	-	-	1000	160	-	-	-	-	-	-
Diazinon	<10	100	360	-	-	-	-	-	-	-	-	-	-
	<100	-	-	-	-	-	-	-	-	-	-	-	-
Dibrom	<10	250	640	1250	420	5000	10670	-	-	5000	6750	-	-
	<100	>100	>1100	>100	>1000	1000	2300	>5000	>12000	2500	15800	-	-
Dieldrin	<10	20	10	50	4.2	100	90	-	-	100	40	-	-
	<100	50	47	10	40	5	35	50	75	-	-	50	420
Dimethoate	<10	100	665	250	95	200	585	-	-	-	-	-	-
	<100	50	180	>25	>250	50	425	5000	2875	-	-	5000	340
Diphenamid	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	-	-	>1000	>9600	-	-	-	-	-	-	-	-
Dipterex	<10	750	425	-	-	5000	2500	-	-	-	-	-	-
	<100	250	215	>100	>4000	1000	2680	>100	>560	-	-	-	-
Diphenatrile	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	-	-	>1000	>8400	-	-	-	-	-	-	-	-
Disyston	<10	1000	800	-	-	-	-	-	-	-	-	-	-
	<100	-	-	-	-	-	-	-	-	-	-	-	-
Dyrene	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	>5000	>63000	>5000	>83000	>5000	>5000	-	-	-	-	-	-
Endrin	<10	10	12	10	1	5	3	50	7	25	25	-	-
	<100	5	8	2	10	-	-	5	21	-	-	-	-
EPN	<10	200	220	-	-	-	-	-	-	-	-	-	-
	<100	100	1200	-	-	-	-	-	-	-	-	-	-
GC-3707	<10	1000	1600	-	-	-	-	-	-	-	-	-	-
	<100	-	-	-	-	-	-	-	-	-	-	-	-
Guthion	<10	-	-	-	-	5000	2000	-	-	-	-	-	-
	<100	250	5500	>500	>5000	1000	6600	>50	>350	-	-	-	-
Heptachlor	<10	50	45	200	55	100	305	>500	>200	200	590	1000	200
	<100	>10	>160	25	90	50	140	100	180	100	425	100	410
Heptachlor	<10	50	55	-	-	-	-	-	-	-	-	-	-
epoxide	<100	5	40	10	110	-	-	-	-	-	-	-	-
Kelthane	<10	1000	2060	-	-	2000	1750	-	-	-	-	-	-
	<100	250	410	-	-	-	-	-	-	-	-	-	-
Kepone	<10	400	460	500	225	500	1290	500	130	200	620	-	-
	<100	100	1600	250	250	100	615	150	590	100	850	200	435

(continued)

Table 1D. Quantities of pesticides causing 50 percent mortality of bobwhite, ring-necked pheasants, and mallards (Continued)

Compound	Test period (days)	Bobwhite				Ring-necked pheasants				Mallards			
		Young		Adult		Young		Adult		Young		Adult	
		ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten
Lindane	<10	500	1070	-	-	250	175	-	-	500	415	2500	1000
	<100	200	930	1000	1050	>100	>1800	>100	>630	-	-	-	-
Malathion	<10	1000	780	-	-	1000	550	-	-	-	-	-	-
	<100	100	400	250	5400	-	-	>500	>2800	-	-	-	-
MCPA	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	5000	19200	5000	47150	-	-	>5000	>85000	5000	1070	-	-
Methoxychlor	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	5000	15000	1000	3500	>2500	>23000	>2500	>15000	-	-	-	-
Mirex	<10	1500	4900	>5000	>5400	500	350	-	-	-	-	-	-
	<100	300	1550	500	2050	100	540	>300	>2300	1000	10400	-	-
Parathion	<10	100	145	-	-	-	-	-	-	-	-	-	-
	<100	50	140	-	-	25	3	-	-	-	-	-	-
Perthane	<10	5000	9200	-	-	-	-	-	-	-	-	-	-
	<100	-	-	-	-	-	-	-	-	-	-	-	-
Phosdrin	<10	-	-	1000	90	-	-	-	-	-	-	-	-
	<100	-	-	-	-	-	-	-	-	-	-	-	-
Phosphamidon	<10	5	4	50	6	500	315	250	90	500	430	>200	>120
	<100	1	3	10	80	-	-	>200	>270	>100	>2125	100	220
Rhothane	<10	2500	2350	5000	260	500	1100	5000	380	5000	1530	-	-
	<100	1000	6000	2500	2830	100	700	1000	470	1000	14800	2500	7500
Semesan	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	-	-	-	-	-	-	-	-	-	-	>500	>1000
Sevin	<10	>5000	>30000	-	-	-	-	-	-	-	-	-	-
	<100	2500	10850	>1000	>13700	5000	20550	>5000	>31600	-	-	-	-
Strobane	<10	500	225	-	-	-	-	-	-	-	-	-	-
	<100	200	400	500	3600	500	1600	>300	2150	-	-	-	-
Systox	<10	1000	680	-	-	-	-	-	-	-	-	-	-
	<100	-	-	-	-	-	-	-	-	-	-	-	-
Thimet	<10	200	830	-	-	500	350	>100	>100	-	-	-	-
	<100	-	-	-	-	-	-	-	-	-	-	-	-
Thiodan	<10	300	270	-	-	500	620	-	-	1000	200	>5000	>750
	<100	100	380	>250	>2600	>300	>1400	1000	850	-	-	1000	310
Toxaphene	<10	1000	500	-	-	500	300	-	-	1000	2000	-	-
	<100	250	1500	>250	>2100	100	450	>100	>600	-	-	-	-
2,4,5-TP butoxy-	<10	5000	9350	-	-	-	-	-	-	-	-	-	-
ethanol ester	<100	-	-	-	-	5000	9240	-	-	5000	21000	5000	41600
Zectran	<10	250	100	-	-	1000	1470	-	-	-	-	-	-
	<100	-	-	-	-	500	7000	-	-	-	-	2500	300
Zytron	<10.	-	-	-	-	-	-	-	-	-	-	-	-
	<100	-	-	1000	680	-	-	-	-	-	-	-	-
Lead nitrate	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	-	-	-	-	-	-	-	-	>500	>10000	>50	>1000
Sodium arsenite	<10	-	-	-	-	-	-	-	-	-	-	-	-
	<100	-	-	-	-	-	-	-	-	>100	>1600		

Table 2D. Quantities of pesticides causing 50 percent mortality to the red-winged blackbird, brown-headed cowbird, common grackle, and starling[1/]

Compound	Test period (days)	Blackbirds		Cowbirds		Grackles		Starlings	
		ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten	ppm in diet	mg/kg eaten
Aldrin	<10	-	-	100	140	-	-	-	-
	<30	-	-	-	-	-	-	-	-
Chlordane	<10	-	-	500	850	-	-	-	-
	<30	-	-	-	-	-	-	-	-
Co-Ral	<10	25	55	25	35	-	-	50	120
	<30	10	35	10	50	-	-	25	80
DDT	<10	1000	1700	-	-	-	-	-	-
	<30	500	700	-	-	-	-	-	-
Dibrom	<10	1000	1250	250	520	250	540	250	600
	<30	250	200	-	-	-	-	-	-
Dieldrin	<10	-	-	50	100	100	60	25	45
	<30	-	-	5	25	10	55	5	35
Dimethoate	<10	-	-	200	70	-	-	-	-
	<30	-	-	-	-	-	-	-	-
Heptachlor	<10	100	480	-	-	100	140	10	30
	<30	25	140	50	330	25	180	5	35
Kepone	<10	200	210	-	-	-	-	-	-
	<30	50	135	-	-	-	-	-	-
Phosphamidon	<10	50	20	25	12	-	-	10	30
	<30	10	20	10	25	-	-	-	-
Rhothane	<10	-	-	5000	3460	-	-	-	-
	<30	-	-	-	-	-	-	-	-
Thiodan	<10	-	-	1000	1200	-	-	-	-
	<30	-	-	-	-	-	-	-	-
Zectran	<10	-	-	2500	2050	-	-	-	-
	<30	-	-	-	-	-	-	-	-

1/ See headnote in table 1D.

Table 3D. Effects of pesticides on survival and reproduction of bobwhite, ring-necked pheasants, and mallards. Summary of tests at Patuxent during 1961 and 1962.

Compound	Level in diet (ppm)	Survival, percent (100 days)						Chicks per hen		
		Bobwhite		Pheasants		Mallards		Bob-white	Pheasants	Mal-lards
		Young	Adult	Young	Adult	Young	Adult			
[Controls]	-	75.3	97.0	79.7	92.0	89.4	92.0	29.1	10.7	12.4
Amitrole	5000	20.0	85.0	37.0	90.0	12.0	100.0	0.25	-	0
	2500	-	-	-	-	-	55.0	-	-	0
	1000	-	-	-	-	96.0	100.0	-	-	0
Amitrole-T	5000	52.0	89.0	0	-	-	-	-	-	-
	2500	-	-	-	-	-	75.0	-	-	0
	1000	-	-	-	-	76.0	83.0	-	-	0
Dacthal	5000	0	-	-	-	-	75.0	-	-	-
Dalapon	5000	40.0	95.0	-	79.0	24.0	-	42.0	6.3	-
	2500	-	-	-	-	-	85.0	-	-	2.6
	1000	-	-	-	-	68.0	94.0	-	-	4.7
2,4-D acetamide	5000	0	-	12.0	-	-	-	-	-	-
	2500	28.0	100.0	0	89.0	0	100.0	2.3	5.1	0
	1000	-	-	0	-	-	95.0	-	-	1.3
	500	-	-	-	-	89.0	100.0	-	-	10.7
2,4-D dimethyl amine salt	5000	0	-	0	-	-	-	-	-	-
	2500	-	-	-	-	-	35.0	-	-	0
	1250	-	-	-	-	-	95.0	-	-	0
	500	-	-	-	-	76.0	100.0	-	-	5.1
2,4-D butoxy-ethanol ester	5000	32.0	35.0	8.0	-	45.0	92.0	-	-	0
	2500	-	-	-	-	55.0	81.0	-	-	0
	1000	-	-	-	-	88.0	95.0	-	-	1.3
MCPA	5000	24.0	69.0	-	100.0	0	-	-	2.9	-
2,4,5-TP butoxy-ethanol ester	5000	12.0	-	8.0	-	0	42.0	-	-	0
	2500	-	-	-	-	47.0	25.0	-	-	0
	1000	-	-	-	-	88.0	100.0	-	-	5.3

Table 4D. Pesticide residues in field specimens found dead or collected and analyzed at Patuxent during 1961 and 1962

Entire carcass, exclusive of skin, feathers, fur, feet, and gastrointestinal tract, analyzed. Minus indicates no detectable residues by methods employed. Averages based on all specimens analyzed, counting minus as zero.

Species	Toxicant								
	Heptachlor epoxide			Dieldrin			DDT		
	No. Analyzed		ppm	No. Analyzed		ppm	No. Analyzed		ppm
	Minus	Plus	(Average)	Minus	Plus	(Average)	Minus	Plus	(Average)
Birds									
Blackbird, red-winged	4	17	4.1	-	-	-	-	-	-
Bluebird	1	1	2.9	0	2	2.5	-	-	-
Bunting, indigo	-	-	-	-	-	-	0	4	7.6
Cardinal	5	4	3.3	1	4	4.7	0	2	7.9
Catbird	-	-	-	-	-	-	0	1	21.1
Chickadee	0	1	1.2	-	-	-	-	-	-
Cowbird, brown-headed	5	8	2.3	-	-	-	-	-	-
Creeper, brown	-	-	-	0	1	9.4	-	-	-
Crow	1	0	0	0	1	4.4	-	-	-
Dove, mourning	11	17	2.2	-	-	-	-	-	-
Duck, fulvous tree	-	-	-	0	1	Trace	-	-	-
Duck, blue-winged teal	1	0	0	-	-	-	-	-	-
Flicker	-	-	-	1	0	0	-	-	-
Flycatcher, Acadian	-	-	-	-	-	-	0	1	6.7
Flycatcher, crested	-	-	-	-	-	-	0	1	14
Flycatcher, yellow-bellied	-	-	-	-	-	-	0	1	26.4
Grackle	0	1	8.1	-	-	-	-	-	-
Hawk, sparrow	0	1	15	-	-	-	-	-	-
Jay, blue	1	3	1	0	11	3.6	-	-	-
Junco	0	2	3.8	6	19	12.6	-	-	-
Killdeer	1	3	3.7	1	0	0	-	-	-
Kingbird	1	0	0	-	-	-	-	-	-
Martin, purple	1	0	0	-	-	-	-	-	-
Meadowlark, eastern	6	15	2.7	0	1	2	-	-	-
Mockingbird	3	1	9.8	1	0	0	-	-	-
Ovenbird	-	-	-	-	-	-	1	10	4.3

(Continued)

Table 4D. Pesticide residues in field specimens found dead or collected and analyzed at Patuxent during 1961 and 1962 (continued)

Species	Toxicant								
	Heptachlor epoxide			Dieldrin			DDT		
	No. Analyzed		ppm	No. Analyzed		ppm	No. Analyzed		ppm
	Minus	Plus	(Average)	Minus	Plus	(Average)	Minus	Plus	(Average)
Owl, barred	1	0	0	-	-	-	-	-	-
Owl, screech	0	1	6.8	0	1	2.5	-	-	-
Pigeon	-	-	-	1	0	0	-	-	-
Pipit	3	2	1.2	-	-	-	-	-	-
Quail, bobwhite	11	40	2.1	7	17	1.2	-	-	-
Rail, king	0	1	<1	-	-	-	-	-	-
Rail, sora	0	1	1.6	-	-	-	-	-	-
Rail, Virginia	0	2	7.6	-	-	-	-	-	-
Robin	10	16	4.2	19	5	2.7	-	-	-
Shrike, loggerhead	0	1	<1	-	-	-	-	-	-
Snipe, common	5	13	4.1	1	2	2.9	0	4	9.4
Sparrow, chipping	1	0	0	1	0	0	-	-	-
Sparrow, English	6	10	7.1	1	9	10	-	-	-
Sparrow, field	1	0	0	2	1	<4	-	-	-
Sparrow, savannah	3	2	8.9	-	-	-	-	-	-
Sparrow, song	2	4	<2	-	-	-	-	-	-
Sparrow, swamp	2	0	0	-	-	-	-	-	-
Sparrow, vesper	1	4	5.9	-	-	-	-	-	-
Sparrow, white-throated	2	11	6.8	6	7	12	-	-	-
Starling	0	1	Trace	1	1	6.6	-	-	-
Tanager, scarlet	-	-	-	-	-	-	0	4	9.4
Thrasher, brown	4	9	4	2	7	2.9	-	-	-
Thrush, Louisiana water	-	-	-	-	-	-	0	1	12.7
Thrush, Swainson's	-	-	-	0	1	3.7	-	-	-
Thrush, wood	-	-	-	-	-	-	0	7	7.7
Titmouse, tufted	-	-	-	-	-	-	0	1	10
Towhee, rufous-sided	1	4	3.4	1	0	0	6	32	7.3
Veery	-	-	-	-	-	-	0	2	8.1
Vireo, solitary	-	-	-	-	-	-	0	2	13.5
Vireo, red-eyed	-	-	-	-	-	-	0	2	3

(Continued)

Table 4D. Pesticide residues in field specimens found dead or collected and analyzed at Patuxent during 1961 and 1962 (continued)

Species	Toxicant								
	Heptachlor epoxide			Dieldrin			DDT		
	No. Analyzed		ppm	No. Analyzed		ppm	No. Analyzed		ppm
	Minus	Plus	(Average)	Minus	Plus	(Average)	Minus	Plus	(Average)
Warbler	2	1	18	-	-	-	-	-	-
Warbler, black-and-white	-	-	-	-	-	-	1	3	5.1
Warbler, black-throated blue	-	-	-	-	-	-	0	2	21.5
Warbler, Canada	-	-	-	-	-	-	0	2	13.4
Warbler, chestnut-sided	-	-	-	-	-	-	0	2	11.3
Warbler, hooded	-	-	-	-	-	-	0	3	17.3
Warbler, Kentucky	-	-	-	-	-	-	0	2	13.1
Warbler, myrtle	1	1	Trace	-	-	-	1	1	4.8
Warbler, worm-eating	-	-	-	-	-	-	0	1	8
Woodcock	90	190	1.6	-	-	-	91	129	1.7
Woodpecker, red-bellied	2	1	3.9	-	-	-	-	-	-
Woodpecker, red-headed	1	0	0	-	-	-	-	-	-
Wren, Carolina	0	1	<4						
<u>Mammals</u>									
Bat, brown	-	-	-	-	-	-	0	1	21.1
Bat, hoary	-	-	-	-	-	-	0	1	22
Mouse, cotton	1	2	5.1	-	-	-	-	-	-
Mouse, deer	-	-	-	1	5	13.9	-	-	-
Mouse, fulvous harvest	8	9	6.4	0	10	8.4	-	-	-
Mouse, harvest	2	8	20.5	-	-	-	-	-	-
Mouse, house	4	4	4.7	-	-	-	-	-	-
Mouse, oldfield	0	3	3.5	-	-	-	-	-	-
Mouse, white-footed	4	5	4.9	-	-	-	-	-	-
Opossum	1	0	0	-	-	-	-	-	-
Rabbit, cottontail	0	5	1.2	0	4	1.4	-	-	-
Rat, cotton	7	23	2.9	1	0	0	-	-	-
Rat, rice	4	15	3.2	-	-	-	-	-	-
Vole, pine	6	12	2	1	0	0	-	-	-

(Continued)

Table 4D. Pesticide residues in field specimens found dead or collected and analyzed at Patuxent during 1961 and 1962 (continued)

Species	Toxicant								
	Heptachlor epoxide			Dieldrin			DDT		
	No. Analyzed		ppm	No. Analyzed		ppm	No. Analyzed		ppm
	Minus	Plus	(Average)	Minus	Plus	(Average)	Minus	Plus	(Average)
Amphibians									
Bullfrog	-	-	-	1	0	0	-	-	-
Frog, leopard	-	-	-	1	1	Trace	-	-	-
Frog, unidentified	1	0	0	-	-	-	-	-	-
Reptiles									
Snake, black racer	1	0	0	-	-	-	-	-	-
Snake, hognose	0	1	2	-	-	-	-	-	-
Snake, ribbon	2	0	0	1	0	0	-	-	-
Turtle, red-eared	1	1	172	-	-	-	-	-	-
Fish									
Bass, largemouth	-	-	-	3	0	0			
Bluegill	5	3	4.5	-	-	-	-	-	-
Catfish	0	2	0.5	1	2	7.1	-	-	-
Chub, S. E. Creek	-	-	-	0	1	Trace	-	-	-
Pickerel, chain	-	-	-	0	1	11.4	-	-	-
Miscellaneous									
Crayfish	0	1	1.6	-	-	-	-	-	-
Crickets	2	1	3.4	-	-	-	-	-	-
Earthworms	2	5	2	-	-	-	-	-	-
Millipede	-	-	-	1	1	<4	-	-	-

Table 5D. Pesticide residues in tissues of field specimens analyzed at Patuxent during 1961 and 1962

Species	Toxicant	Tissues Analyzed														
		Liver			Kidney			Heart			Muscle			Brain		
		No. Analyzed		ppm	No. Analyzed		ppm	No. Analyzed		ppm	No. Analyzed		ppm	No. Analyzed		ppm
		Minus	Plus	(Av.)	Minus	Plus	(Av.)	Minus	Plus	(Av.)	Minus	Plus	(Av.)	Minus	Plus	(Av.)
<u>Birds</u>	DDT															
Duck, mallard		2	0	0	1	1	6.4	2	0	0	-	-	-	1	0	0
Eagle, bald		1	25	9.6	3	20	13.9	1	23	9.7	1	22	8.0	5	6	21.6
Eagle, golden		1	1	2.5	1	1	2.2	0	2	4.0	0	2	1.6	1	0	0
<u>Mammals</u>	Heptachlor epoxide															
Rabbit, cottontail		5	15	5.7	9	5	11.0	14	1	11.0	-	-	-	4	2	17.3
Rabbit, swamp		0	2	6.3	2	0	0	1	1	6.1	-	-	-	-	-	-
Raccoon		2	3	4.1	0	3	3.7	1	2	3.0	-	-	-	2	0	0
Rat, Norway		8	3	7.1	6	5	55.0	9	2	54.0	-	-	-	-	-	-
Skunk, spotted		0	1	3.1	0	1	19.0	1	0	0	-	-	-	-	-	-
Skunk, striped		0	3	3.0	1	1	18.7	2	1	Tr.	-	-	-	1	1	18.0
Squirrel, fox		1	0	0	1	0	0	1	0	0	-	-	-	1	0	0
Squirrel, gray		0	2	29.0	0	1	Tr.	-	-	-	-	-	-	-	-	-
<u>Reptiles</u>																
Snake, coachwhip		0	1	9.1	-	-	-	1	0	0	-	-	-	-	-	-

Table 6D. Mortality and reproduction of bobwhite confined in 20' x 50' pens treated with granular heptachlor[1]

Experimental details	Treatment (pounds per acre)			
	0	0.25	1.25	2.0
A. Birds placed in pens on May 2 or 7.				
No. pairs started	8	12	6	9
No. pairs in which mortality occurred[2]	4	8	6	9
Total mortality	4/16	8/24	8/12	12/18
Average days survival	65.5	18.3	7.5	6.4
No. hens producing eggs	6	4	0	0
No. hens dying during reproduction period	3	0	-	-
No. hens abandoning nests	1	1	-	-
No. successful nests	2	3	-	-
Total chicks produced	16	24	-	-
B. Birds placed in pens on May 17 or 31.				
No. pairs started	1[3]	6[3]	9	10
No. pairs in which mortality occurred	-	4	6	9
Total mortality	-	4/10	6/18	9/20
Average days survival	-	87.5	23.2	18.9
No. hens producing eggs	-	4	3	1
No. hens dying during reproduction period	-	3	0	0
No. hens abandoning nests	-	1	2	0
No. successful nests	-	0	1	1
Total chicks produced	-	0	12	3
C. Birds placed in pens on June 8 or 27.				
No. pairs started	2	1	1	3
No. pairs in which mortality occurred	1	0	0	2
Total mortality	1/4	0	0	2/6
Average days survival	3	-	-	15.0
No. hens producing eggs	1	1	1	1
No. hens dying during reproduction period	0	0	0	0
No. hens abandoning nests	0	1	0	0
No. successful nests	1	0	1	1
Total chicks produced	5	0	7	4

1/ Treatment applied May 2, 1962. Observation period ended September 15, 1962.
2/ Test in any pen terminated on date one or both birds died. Survivors sacrificed for chemical analysis.
3/ Bird killed by predator.