BIOLOGICAL MONITORING OF PESTICIDES, HEAVY METALS AND OTHER CONTAMINANTS AT ROCKY MOUNTAIN ARSENAL

PHASE I

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DEPARTMENT OF THE ARMY
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THE ECOLOGICAL SAMPLING PLAN WAS IMPLEMENTED TO ADDRESS THE ECOLOGICAL ASPECTS OF THE INSTALLATION RESTORATION PROGRAM AT RMA. THIS PLAN CONSIST OF TWO MAIN TASKS: ECOLOGICAL INVENTORIES, OR POPULATION STUDIES; AND ECOLOGICAL MONITORING FOR CONTAMINANTS. VERY LITTLE DEFINITIVE DATA WAS AVAILABLE REGARDING THE ACTUAL EXTENT OF CONTAMINATION AT RMA BY POLLUTANTS, AND PRACTICALLY NO INFORMATION EXISTED CONCERNING NATURAL BIOACCUMULATION OR FOOD CHAIN INVOLVEMENT OF THE POLLUTANTS UNIQUE TO RMA. THEREFORE, AN ECOLOGICAL MONITORING PROGRAM WAS INITIATED TO DETERMINE THE DISTRIBUTION OF CONTAMINANTS AND THEIR IMPACT ON THE ECOSYSTEM AT RMA. THE PROGRAM WAS DIVIDED INTO THREE PHASES. PHASE I OBJECTIVES WERE AS FOLLOWS: (1) ASSESS THE GENERAL EXTENT OF POLLUTION IN THE ECOSYSTEM ON RMA; (2) DETERMINE THE LEVELS OF POLLUTANTS IN THE TISSUES OF GAME ANIMALS REPRESENTATIVE OF THOSE OCCURRING ON RMA; (3) EVALUATE THE FEASIBILITY OF USING PLANTS AND ANIMALS AS A MONITORING TOOL FOR POLLUTANTS IN THE ENVIRONMENT; (4) PROVIDE DATA FOR SELECTING CONTAMINANTS, AREAS AND SPECIES FOR

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FOREWORD

This report was prepared by David S. Thorne and John K. McBride, Ecology Systems Division. Other Ecological Systems Division personnel who participated in the study are also included as authors. Acknowledgement is made to the US Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland, whose approval and funding made this study possible. The sentinel duck study was funded by Rocky Mountain Arsenal through the Wildlife Management Program.

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PREFACE

Over the years, environmental incidents involving suspected pollutants originating on Rocky Mountain Arsenal (RMA) have received considerable publicity. Large kills of fish and migratory ducks during the 1950's and 1960's led to a cleanup of Lake Ladora and Upper and Lower Derby Lakes by the US Army. Later, alleged damage to crops and death of livestock north of the Arsenal fostered numberous legal actions against RMA and its lessee, Shell Chemical Company (SCC), a manufacturer of pesticides. These events, plus the subsequent State of Colorado Cease and Desist Orders against RMA and SCC concerning migration of contaminants off the Arsenal, eventually led to the formulation of RMA's Installation Restoration (IR) Program.

The Ecological Sampling Plan was implemented to address the ecological aspects of the IR Program. This Plan consists of two main tasks: ecological inventories, or population studies; and ecological monitoring for contaminants.

The purposes of the monitoring task are as follows:

(1) To determine the extent that environmental pollutants on RMA are assimilated by the plants and animals of the area and the consequent impact on the ecosystem.

(2) To identify potential human health hazards associated with consumption of game animals harvested on the Arsenal.

(3) To determine the efficacy of using the contaminant content of plants and animals as a tool for the surveillance of environmental pollution originating on RMA.

(4) To continually monitor the status of environmental contamination in space and time.

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SECTION 1

INTRODUCTION

1.1 BACKGROUND

RMA has been used since 1942 for the production, testing, storage, and disposal of various toxic chemicals which are either proven or potential environmental pollutants. In 1974, a Dugway Proving Ground report (1)* estimated that some 1,400 acres on RMA, consisting of known or suspected dumping sites and implicated water bodies, were polluted to varying degrees. This estimate did not include possible migration paths of the chemicals in the soil or groundwater. Contamination of the industrial lakes with chlorinated pesticides was implicated in substantial waterfowl mortalities during the 1950's and 1960's (2). Miscellaneous plant and animal samples collected on RMA and analyzed by the Denver Wildlife Research Center from 1963 to 1966 showed significant levels of several chlorinated pesticides (3). In 1970, high levels of dieldrin in fish from Lake Ladora were confirmed by several laboratories (2). Hundreds of dead waterfowl were observed around the shoreline of Basin F by RMA and Dugway personnel in 1973 (4). Various soil, water, and animal samples collected on RMA and analyzed by the US Army Environmental Hygiene Agency during 1973, 1974, and 1975 showed significant concentrations of several chlorinated pesticides (5). Dugway personnel detected high levels of dieldrin in largemouth bass taken from Lake Ladora in 1975 (6).

Analyses by personnel of the US Army Environmental Hygiene Agency of dead starlings collected from an unexplained die-off of many of these birds near the RMA Headquarters Building in 1976 showed high tissue residues of dieldrin. Although dieldrin could not be pinpointed as the cause of death in these birds, it was concluded that abnormally high levels of the pesticide in the environment may have been a predisposing cause (7).

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* See bibliography, pg. 6-1.

Notwithstanding the above, very little definitive data was available regarding the actual extent of contamination at RMA by these pollutants, and practically no information existed concerning natural bioaccumulation or food chain involvement of the pollutants unique to RMA. Therefore, an ecological monitoring program was initiated to determine the distribution of contaminants and their impact on the ecosystem at RMA.

1.2 OBJECTIVES

The program was divided into three phases. Phase I objectives were as follows:

1. Assess the general extent of pollution in the ecosystem on RMA.

2. Determine the levels of pollutants in the tissues of game animals representative of those occurring on RMA.

3. Evaluate the feasibility of using plants and animals as a monitoring tool for pollutants in the environment.

4. Provide data for selecting contaminants, areas, and species for subsequent monitoring in Phases II and III.

1.3 SCOPE

This report covers Phase I of the Ecological Monitoring Program (8), which determined the relative uptake of a number of potential contaminants in a wide range of representative animal and plant species in five generally defined areas of RMA. (See par. 2.2 below.)

The selection of contaminants, species, and areas for study in Phases II and III will be based on the findings of the present study. Phase II will characterize the variation and range of contamination in selected species, and contaminants will be identified with specific locations on the Arsenal. Phase III will constitute annual sampling of a few selected species at a number of established locations to provide continual monitoring of the status of contamination in representative biota.

SECTION 2

STUDY APPROACH

2.1 GENERAL

Since soil and water contaminant data were to be collected in the pilot phase of the Comprehensive Survey (9) which was beginning at the time this study was undertaken, the opportunity was presented to correlate soil and water data with biological data obtained from the same locations. Therefore, the original plan was expanded to include intensive biological sampling near soil and water sampling points on the Comprehensive Survey Pilot Study site in Section 36.

A sentinel duck study was also included in the present work, in which captive-reared mallard ducks were placed on three of the water bodies of RMA to determine if contaminants were accumulated in their tissues and if so, the changes occurring over time.

2.2 STUDY AREAS

In addition to the Comprehensive Survey Pilot Study site and the sentinel duck study, five other surface areas were selected, based on type and degree of suspected contamination. (see Figure 2-1.)

Area A consists of Basin A and its immediate environs. This area has a history of extensive contamination and was expected to contain the highest concentrations of most contaminants.

Area B includes Basins B, C, D, and E; their immediate environs; and the area surrounding Basin F. These boundaries for Area B were selected because

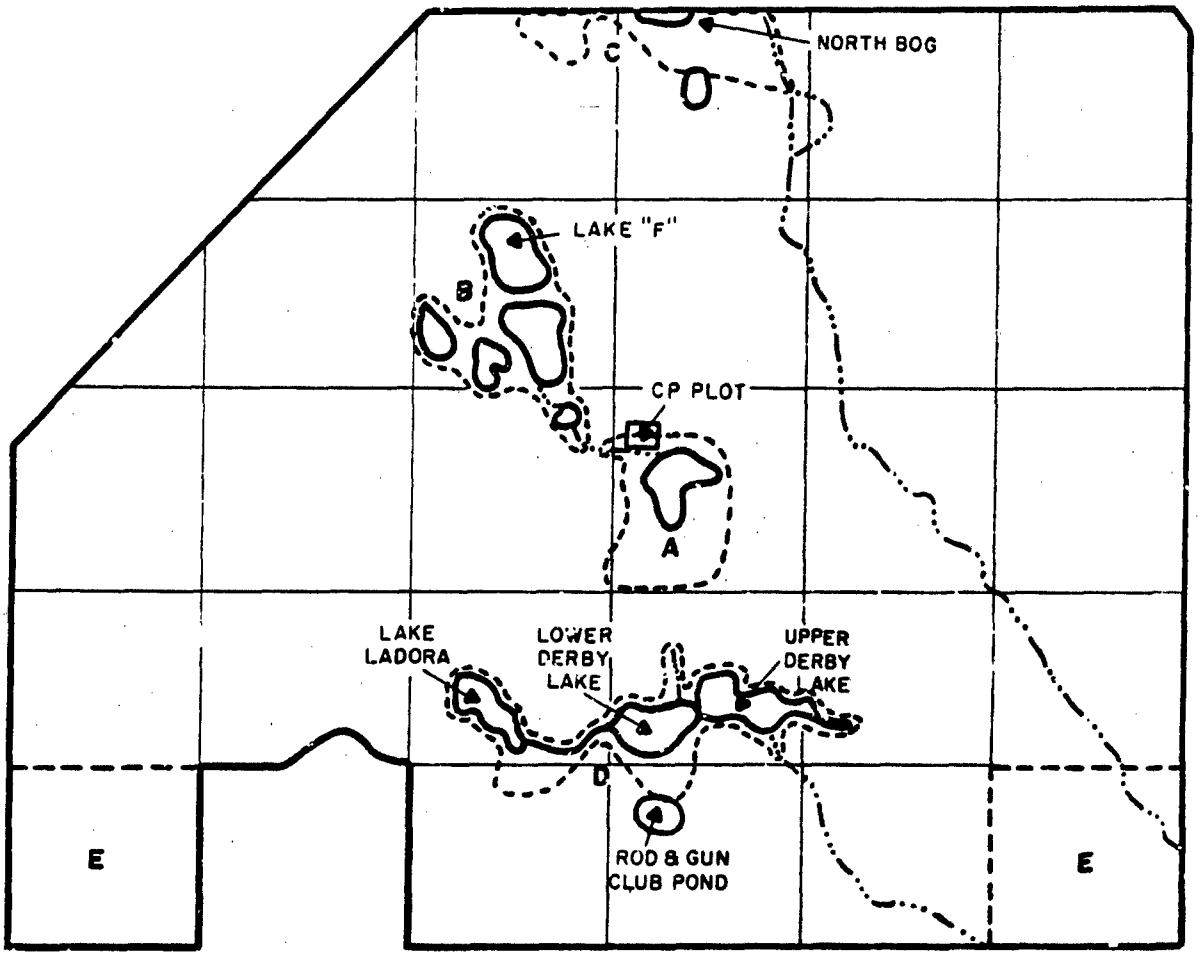


Fig. 2-1. Location of sampling areas on RMA.

Basins B, C, D, and E have periodically received overflow from Basin A and have additional contamination histories of a somewhat lesser extent. The area surrounding Basin F was included because it was potentially contaminated during the period when materials from it were sprayed to speed evaporation and also because leakage of the Basin has been suspected.

Area C encompasses the north bog area where the water table comes very near the surface and plant roots are expected to penetrate into the aquifer, at least seasonally. This area is also probably representative of the area immediately north of RMA.

Area D comprises Lakes Ladora, Lower Derby, and Upper Derby, which have a history of chlorinated pesticide contamination. In addition, the areas immediately south of the lakes, where pesticide-laden sediment dredged from the lakes was placed and buried in 1965, were also included. No other instances of contamination are known for these lakes, and they do not lie in the ascertained path of contaminant migration from other areas. Therefore, Area D was expected to contain only the chlorinated hydrocarbon family of contaminants.

Area E is a relatively clean area consisting of both southern corner sections of RMA. These have no implications of contamination but are similar and in close proximity to the other areas.

Area F was designated for animal specimens that were collected Arsenal-wide because of their relatively low numbers and wide-ranging habits; consequently, they were not collected independently in each of the other areas. Species relegated to Area F were the mule deer, American kestrel, and long-eared owl.

2.3 COMPOSITE SAMPLES

In order to adequately represent each area with the minimum number of samples, composite samples were utilized. Individual samples were collected from a number of points within each area and pooled for each sample type.

Whole-body animal samples, consisting of a number of individuals of the same species, were used in each composite sample. Annual and perennial terrestrial plant samples, as well as aquatic plant samples were chosen to consist of a composite of all of the dominant species of that group found at each sampling point. Each of these was divided into above-ground and root samples.

2.4 SPECIES

Table 2-1 lists the 20 species or groups of species monitored for contaminants. Representatives of the major classes of plants and animals on RMA and various trophic levels were included.

The first criterion for selection was a species potentially harvested as game. Representatives of each group of similar game species were selected; these included mule deer, cottontail, great blue heron (representative for fish-eating ducks), pheasant, mourning dove, large-mouth bass and black bullhead.

Selection of the remaining species or groups in Table 2-1 was based on their distribution, mobility, food habits, and availability. The prairie dog is the most conspicuous small mammal on RMA and is a strict herbivore that feeds on both above-ground plant parts and roots. The deer mouse is the most abundant mammal inhabiting RMA. It is widely distributed throughout the Arsenal, but occupies a small home range. It is omnivorous in its food habits,

TABLE 2-1

SPECIES OR GROUPS OF SPECIES MONITORED FOR CONTAMINANTS PHASE I

Mule Deer	Odocoileus hemionus
Desert Cottontail	Sylvilagus audubonii
Deer Mouse	Peromyscus maniculatus
Black-tailed Prairie Dog	Cynomys ludovicianus
Great Blue Heron	Ardea herodias
American Kestrel	Falco sparverius
Ring-necked Pheasant	Phasianus colchicus
Mourning Dove	Zanaida macroura
Long-eared Owl	Asio otus
Western Meadowlark	Sturnella neglecta
Bullsnake or Lesser-earless Lizard	Pituophis melanoleucus / Holbrookia maculata
Bullfrog or Plains Spadefoot Toad	Rana catesbiana / Scaphiopus bombifrons
Largemouth Bass	Micropterus salmoides
Black Bullhead	Ameiurus melas
Grasshoppers or Ground Beetles	Order Orthopetera / Order Coleoptera Family Carabidae
Leeches or Snails	Class Hirudinea / Class Gastropoda
Earthworms	Class Oligochaeta
Terrestrial Annual Plants	Various
Terrestrial Perennial Plants	Various
Aquatic Plants	Various

in contrast to the herbivorous food habits of the prairie dog. The meadowlark is the most abundant resident bird on RMA. It is widely distributed throughout the Arsenal and is highly territorial during the breeding season. It is primarily insectivorous (at least during the breeding season), placing it high in the food chain in relation to the terrestrial game birds. The American kestrel and long-eared owl are common on RMA and are representative of the two major groups of birds of prey, the hawks and owls. They occupy the top levels of the food chain. Since young birds in the nest would have been fed on resident prey, their tissue residues would be more representative of local contamination than those of their migratory parents; therefore, nestlings of these two species were taken. The bullsnake and lizard are representative of the reptiles on RMA. The bullsnake is a predator on small mammals, birds and other animals, and the lizard is a predator on insects, placing them both high in the food chain. They are abundant and widely distributed on RMA, except in moist habitats. The bullfrog and spadefoot toad are representative of the Class Amphibia. Their carnivorous food habits place them high in the food chain. The bullfrog is abundant in the marshes, ponds and lakes; and the spadefoot toad resides in the drier areas of RMA. Grasshoppers and ground beetles, both abundant and widely distributed, are representative of the terrestrial arthropods. The grasshopper is herbivorous, while the ground beetle is carnivorous, and both serve as major prey items for insectivorous vertebrates. Leeches and snails are representative of the aquatic invertebrates. These animals are common in the major water bodies of RMA and are important in aquatic and terrestrial food chains. Earthworms represent terrestrial invertebrates which live entirely within the soil and are confined to close proximity of the sampling point. They serve as a major prey item for many vertebrates.

Due to the great variety of plant life on RMA, terrestrial plants were lumped into two categories for this phase of the monitoring program. Annual and perennial plants were collected independently, since it was expected that contaminant uptake would differ between these groups. A cross-section of the

dominant species of each group within an area was collected and pooled for analysis. Similarly, aquatic plants of all major species were collected and pooled for analysis.

2.5 CONTAMINANTS

The initial list of 35 contaminants selected for screening (8) was reduced to a final list of 15, based on the likelihood of recovery and the availability of analysis procedures. These contaminants are listed in Table 2-2.

Aldrin, dieldrin, and endrin were manufactured on RMA at one time or another by SCC. DDT and DDE are widespread in the environment and have been identified on RMA in previous years by the US Fish and Wildlife Service (3) and the US Army Environmental Hygiene Agency (5). Isodrin was added since it accompanies the analyses of the other chlorinated pesticides.

Diisopropylmethylphosphonate (DIMP) is a by-product of nerve gas formerly manufactured at RMA. Chlorophenylmethyl sulfoxide (CPMSO) and chlorophenylmethyl sulfone (CPMO2) are oxidation products of chlorophenylmethyl sulfide, a compound used in the manufacture of a herbicide, Planavin, by SCC. Oxathiane and dithiane are by-products of mustard gas formerly manufactured at RMA. Similarly, arsenic was a by-product of the lewisite manufactured at RMA. Mercuric chloride, the precursor of mercury, was used as a catalyst in the manufacture of lewisite. Copper and cadmium were added since they were recovered in higher than normal concentrations from sampling wells on RMA.

TABLE 2-2

CONTAMINANTS SELECTED FOR SCREENING IN PHASE I

Chlorinated Hydrocarbon Pesticides

Contaminant	Symbol
Aldrin	ALDRN
Dieldrin	DLDRN
Isodrin	ISODR
Endrin	ENDRN
DDT	DDT
DDE	DDE

Organo-Sulfur Compounds

Diisopropylmethyl phosphonate	DIMP
Chlorophenylmethyl sulfoxide	CPMSO
Chlorophenyl methyl sulfone	CPMO2
Oxathiane	OXAT
Dithiane	DITH

Heavy Metals

Copper	Cu
Arsenic	As
Mercury	Hg
Cadmium	Cd

SECTION 3

METHODS

3.1 SAMPLE COLLECTION

A number of individuals of each animal species and a cross-section of all of the major plant species were sampled at a number of different points, depending on representativeness and availability, within each of the five areas. Not all species were available from all areas and sample size was limited in some cases.

In the Comprehensive Survey Pilot Study, eight 100 foot by 100 foot sampling plots were selected randomly within the 1,000 foot by 1,000 foot study site. Each plot for ecological sampling was selected so that it included two water-sampling wells, one of which was from the group of 16 systematically located wells. The plots were numbered according to the systematic well number (Figure 3-1).

Deer mice were trapped from 25 evenly spaced stations on each of the Comprehensive Survey plots and prairie dogs were trapped anywhere within the boundaries of each plot. Due to the bareness of the Comprehensive Survey site, grasshoppers were obtained from only three of the eight plots; and a reptile (lizard) sample was obtained from only one plot. Although the site is normally dry, a heavy summer thundershower created a temporary pond in one of the plots. This triggered the emergence of an abundance of spadefoot toads from estivation and gave the opportunity to obtain a sample of these toads.

Animal specimens were always collected alive when possible. Small mammals were taken by live trapping. Birds, except for nestlings, required shooting. Nestling kestrels and owls were taken alive from the nests. Fish were caught by hook and line or by netting. Reptiles, amphibians, and terrestrial

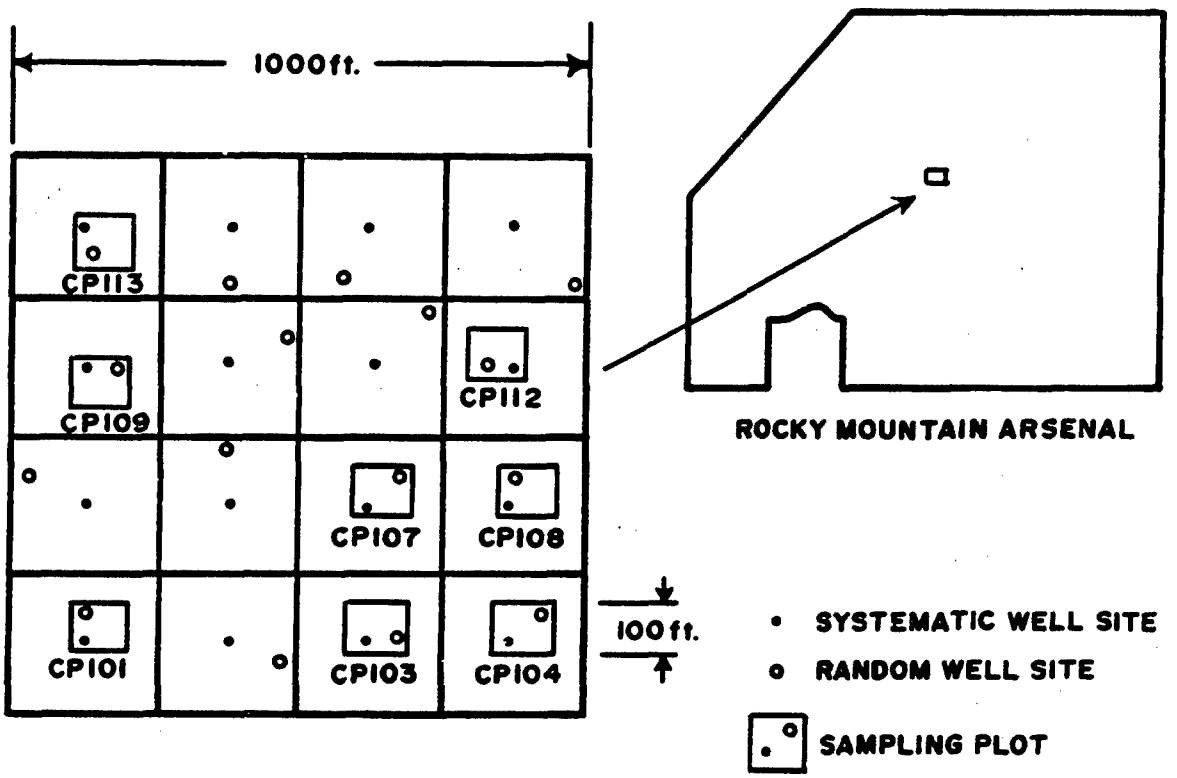


Fig. 3-1. Location of Comprehensive Survey Pilot Study sampling plots (CP plots) on RMA.

invertebrates were caught by hand or net. Aquatic invertebrates were dredged from the bottom of the ponds or lakes. Tissue samples were taken from mule deer at the place of kill during the 1977 hunting season.

Terrestrial plant samples were taken with the aid of a power "tree spade." At each sampling point, a number of plants of the major species of each category (annuals and perennials) were taken to their full root depth or to the depth limit of the tree spade (36 inches). Wetland and emergent aquatic plants along shorelines were dug with a hand shovel. Floating aquatic plants, except for roots, were collected from a boat.

On the Comprehensive Survey Pilot Study site, only terrestrial plants were obtained. An initial set of samples was taken before the water-sampling wells were drilled. A tree-spade plug was removed adjacent to the pin marking the location of the systematic well on each of the eight plots. Samples consisting of all plants of each category within the 42-inch diameter area were taken.

Later in the program, it was ascertained that improved recoveries of the compounds, DIMP, CPMSO, and CPMO2 could be obtained from fresh plant material, rather than from the previous dried samples. A second set of samples for analysis of these compounds was taken later in the season from all of the Comprehensive Survey Pilot Study plots. Since the plots had by then been disturbed by the drilling operations and much of the vegetation around the wells had been destroyed, it was necessary to take plants from a larger area of approximately 100 feet in radius from the well. A volume of plant material approximately equal to the initial sample was taken. An additional set of fresh plant samples was also taken from Area A (annuals and aquatic plants). The season was too far advanced before any other areas or plant types could be sampled.

Transport of samples from field to lab varied according to sample type. Plant samples were placed in stainless steel buckets and covered with aluminum foil for transport to the lab. The smaller animal specimens were placed in screw-capped jars and larger animals were wrapped in aluminum foil. When specimens could not be taken immediately to the lab, they were placed in an ice chest containing dry ice. Small mammals, trapped alive, were taken directly to the lab in the traps.

3.2 SENTINEL DUCK STUDY

Adult (four years old and older) and four-week-old, pen reared mallard ducks were obtained from the Federal Wildlife Research Center, Denver, Colorado. Four adults (two of each sex) and four juveniles (two of each sex) were killed and reserved for controls at the start of the study. The remaining ducks were pinion-clipped on one wing to limit flight and appropriately labeled with leg bands and wing tags.

Twelve adults and either 17 or 18 juveniles were placed in a holding pen on each of three water bodies on RMA. After two weeks of acclimation in the holding pens, the ducks were released onto the respective lake or pond.

A composite sample of three ducks was taken from each water body after one month and three months. At six months, a sample of three ducks was obtained from Lower Derby Lake and a sample of two ducks from the Rod and Gun Club Pond, but none could be found on Ladora Lake. A 12-month sample was intended; however, no ducks survived the intervening winter due to the severe weather and hunting pressure. Ducks were captured alive with a net and placed in clean cages for transport to the lab.

3.3 SAMPLE PREPARATION AND STORAGE

Mammals and birds brought to the lab alive were humanely dispatched with carbon dioxide, in accordance with the recommendations of the committee on the Guide for Laboratory Animals Facilities and Care, National Research Council (10). If specimens could not be processed on the day of collection, they were placed in screw-capped jars or wrapped in aluminum foil and stored at -20° to -23°C.

The following specimens were first rinsed with deionized, distilled water to remove most of the external soil: entire plants, entire bodies of all animals except deer, a section of skin with adhering hair of deer (approximately 15 by 15 cm), and the feathers of all birds.

This was accomplished by placing the specimen in an appropriate size jar, adding a pre-measured amount of water sufficient to thoroughly drench the specimen, and shaking vigorously for several seconds. The rinse water was then poured off and saved for future analysis in order to identify external contamination which might contribute to analysis of the tissue, in the event the specimen was positive. The rinsed specimen was allowed to drain and dry at room temperature.

All vertebrates were eviscerated and all but the fish were skinned. The skin and hair of the mammals were reserved for heavy metal analysis. Wing feathers were removed from the birds for heavy metal analysis; the skin, feet, and beak were discarded. The gastrointestinal tracts of all vertebrates were discarded, but the remainder of the internal organs were combined with the rest of the body. The recombined body and organs were then designated as a "whole-body" sample for the analysis of all contaminants except the heavy metals. The entire body of the invertebrates was prepared for analyses of all the contaminants.

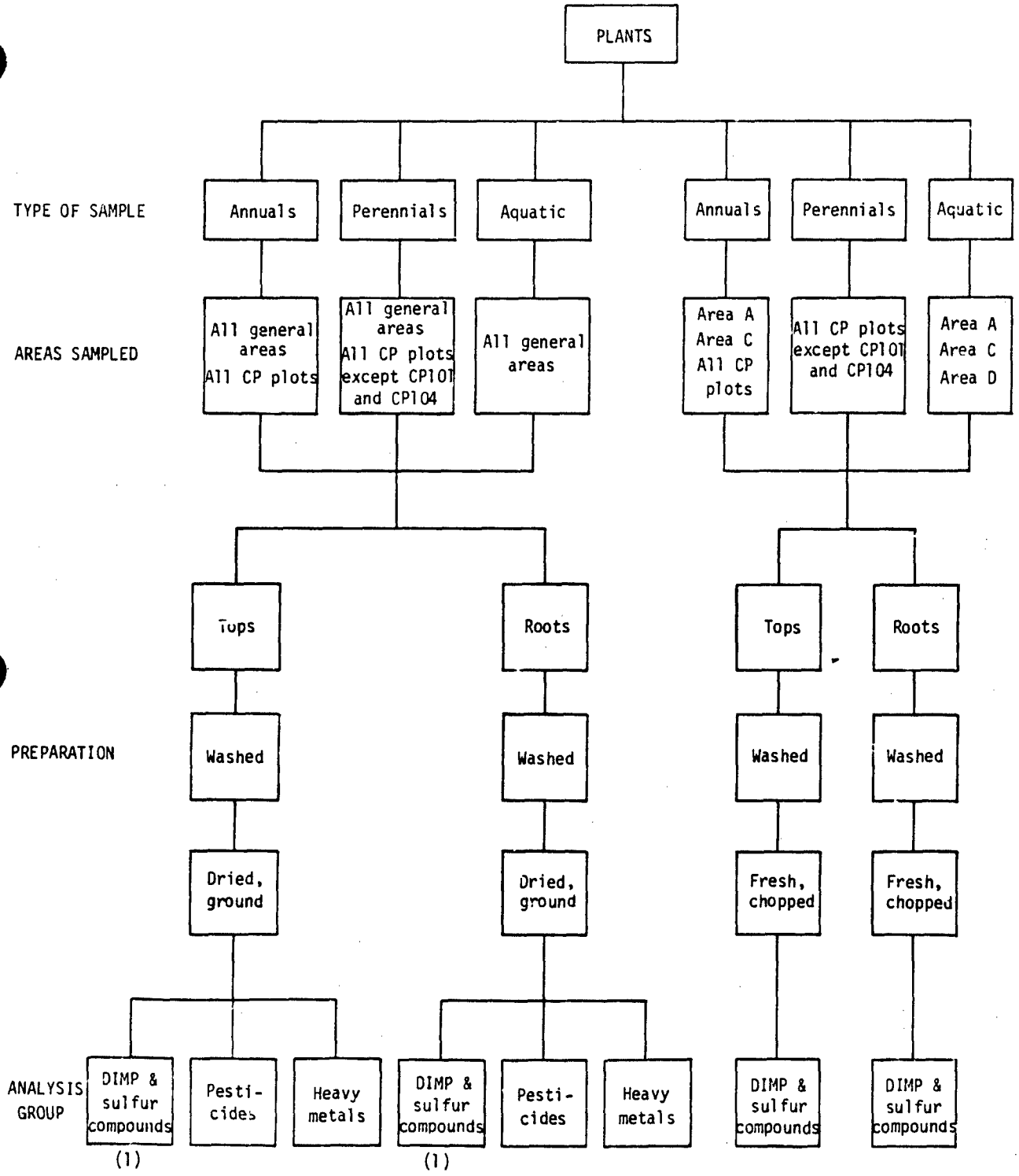
All of the whole-body animal specimens making up a composite sample were ground together to a homogenous mixture in an appropriate size chopper or blender. A subsample of the ground tissue, of at least 20 grams whenever possible, was mixed with six times its weight of granular, anhydrous, reagent-grade, sodium sulfate. This mixture was again blended to a homogenous mixture. Sodium sulfate preparations were analyzed for the chlorinated pesticides, DIMP, and the organo-sulfur compounds.

For heavy metal analyses, skin and hair samples were cut into small pieces and minced with hand shears. Feather samples were chopped in the Wiley mill. In the cases of fish, amphibians, and reptiles in which the skin was not reserved for heavy metal analyses, a subsample of the ground, whole-body tissue was used for these analyses.

For some of the sample areas, fresh plant material was taken for the analysis of DIMP and the organo-sulfur compounds. (See Para 3.1 above.) The fresh plant material was finely chopped for these samples. Small samples of the softer plants could be chopped directly in a blender. Small samples of tough or fibrous plants were first cut into small pieces with hand shears and then finished in the blender. Larger samples of fresh plant material were first chopped in a large Hobart cutter-mixer; and if necessary, a subsample of this was more finely chopped in the blender.

For dried plant samples, the vegetation was placed in stainless steel pans and air-dried at room temperature in a drying cabinet for several days, until it could be crumbled in the hand. The material was then chopped in a Wiley mill using a screen with 1 mm holes.

Prepared samples were stored in screw-capped jars at -20 to -23°C pending extraction and analysis. (See Appendix A for extraction and analysis procedures.) Figure 3-2 diagrams the various sample treatments.



(1)-DIMP and sulfur compounds were analyzed on dried plant material for Area B, Area C (except aquatics), Area D and Area E).

Fig. 3-2. Sample T treatments - plants (sh. 1 of 2)

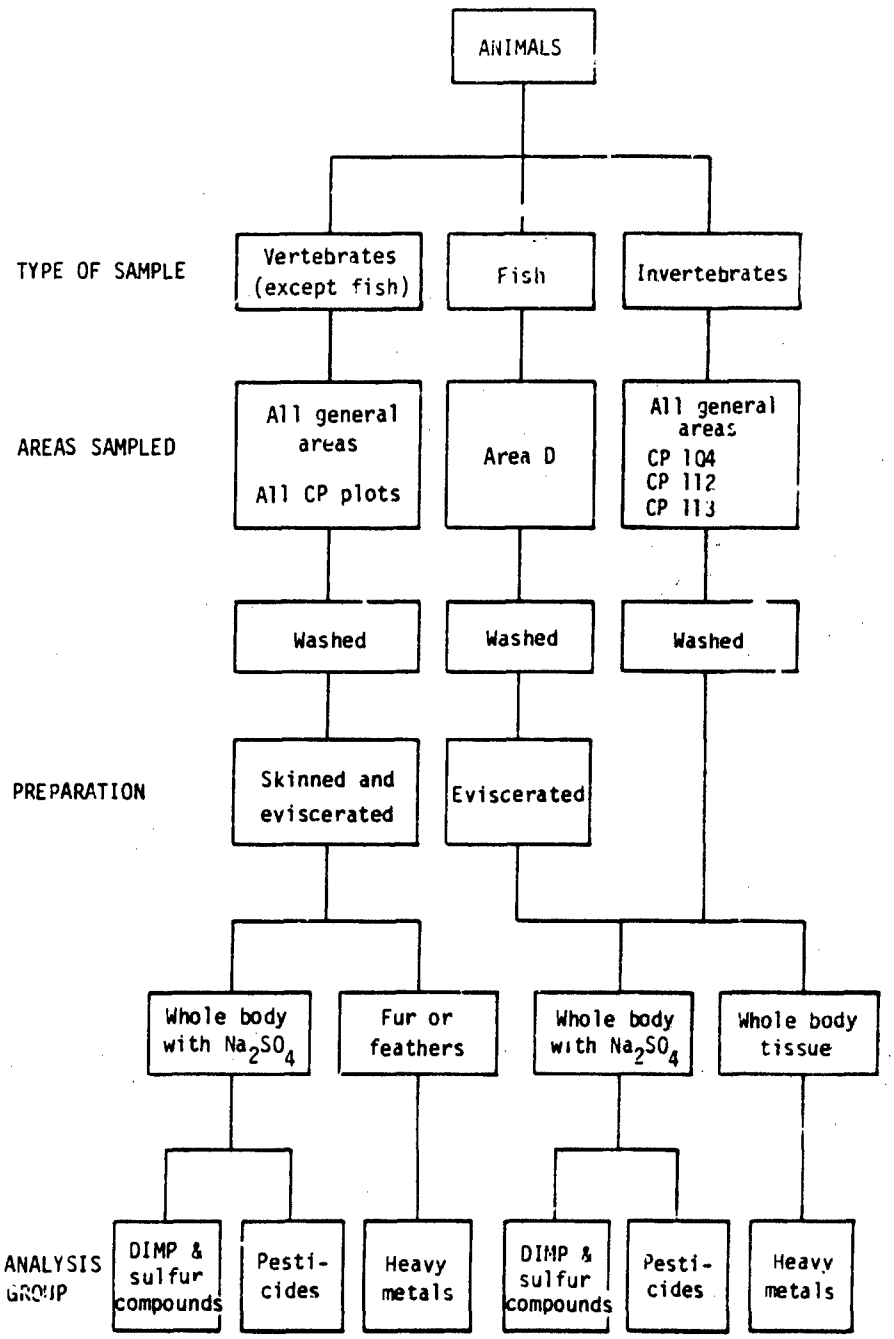


Fig. 3-2. Sample treatments - animals (sh 2 of 2)

3.4 DATA RECORDING

In order to make the data adaptable to automatic data processing and to make relevant information readily accessible to all participants in the IR Program, all pertinent data relating to each sample was recorded on computer coding work sheets. This data was then transcribed into permanent files in the master computer (Tier 2) at Edgewood Arsenal, where it is instantly available for retrieval or analysis. A sample of the coding work sheet is reproduced as Figure 3-3.

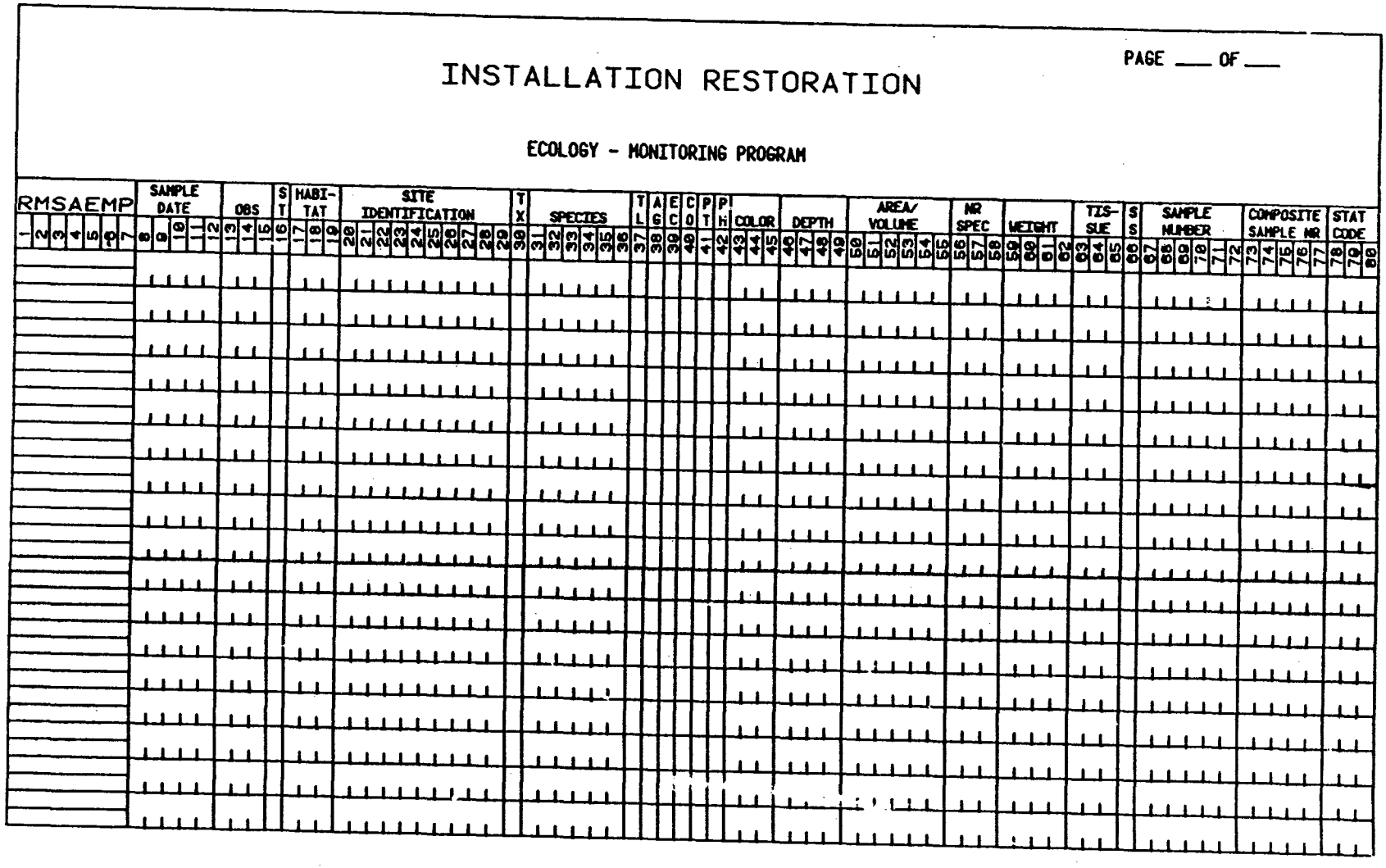


Fig. 3-3. Monitoring program computer coding work sheet (sh 1 of 2)

EXPLANATION OF HEADINGS

JULIAN DATE	Julian date sample was collected.
OBS (Observer)	Initials of person who collected sample.
ST (Stratum)	Area location of sample; general areas (A,B,C,D,E, or F); or comprehensive survey pilot area (X).
HABITAT	Code for general habitat type where sample was collected: weedy area, marshy area, lake, etc.
SITE IDENTIFICATION	Code for location within sampling area: section and cell (each square mile section was divided into 16 equal "cells"); or CP plot (CP 101, etc).
TX	Code for taxon of sample specimen (amphibian, bird, fish, invertebrate, mammal or reptile).
SPECIES	Code for species of specimen.
TL	Code for taxon level of specimen (Family, Order or Class).
AG	Code for age of specimen (adult or juvenile).
EC	Code for relative number of ectoparasites found on specimen (none, few or many).
CO	Code for condition of specimen (normal, stunted, wilted, robust, sick or dead).
TY	Code for type of plant (annual, biennual, perennial or aquatic).
PH	Code for phenological state of plant specimens.
COLOR	Code for color of plant specimens.
DEPTH	Code for depth of root samples (cm).
AREA/VOLUME	Code for sampling area or volume (cm^2 or cm^3).
NR SPEC	Number of specimens making up sample.
WEIGHT	Weight of sample (g).
TISSUE	Code for tissue type (whole-body, tops, roots, etc).
SS	Sample subprogram; "M" used for the monitoring program.
SAMPLE NUMBER	Number assigned to sample.
COMPOSITE SAMPLE NR	Number assigned to a sample composed of a number of selected specimens or tissues (not used in Phase I).
STATE CODE	Reference to a notebook containing additional information concerning the sample

Fig. 3-3. Monitoring program computer coding work sheet (sh 2 of 2)

SECTION 4

RESULTS AND DISCUSSION

4.1 EXTENT OF CONTAMINATION

Tables B-1 through B-14 (Appendix B) show, for each area, the contaminants found in the various plants and animals. Concentration of contaminants is given on a dry-weight basis for plants and on a wet-weight basis for animals. A minus sign signifies no recovery (below the detection limit). A blank indicates no sample was obtained at that location.

Table 4-1 is a summary of the data in Tables B-1 to B-14 for those areas where a minimum, or greater, amount of contaminant was found. It gives the total number of samples taken in those areas; the percent of samples which contained the minimum, or greater, amount of contaminant; and the mean concentration and range of the positive samples. The minimum concentration for the chlorinated pesticides (detection limits = 0.02 ug/g) was set at 0.05 ug/g; for DIMP and the organo-sulfur compounds (detection limits = 0.05 ug/g), at 0.10 ug/g. The minimum level for copper was set at 20 ug/g. The average level of copper in normal plant and animal tissues is about 15 ug/g (12). The minimum concentrations for arsenic, cadmium, and mercury were set at their detection limits, since these limits were rather high and represent significant levels for these metals.

Except for arsenic, all of the contaminants were found in the biota in significant amounts in the Comprehensive Survey Pilot Study area and in at least two of the other areas.

Dieldrin, DDT, and chlorophenylmethyl sulfone (CPM02) were the most widespread, being found in all areas sampled. Endrin was also encountered in all areas except Area E. It is evident that the chlorinated pesticides have been

TABLE 4-1

CONTAMINANTS IN THE BIOTA ON RMA

AREA	ALDRN	DLDRN	ISODR	ENDRN	PPDDT	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
CP101		X		X	X		X		X	X					
CP103		X		X	X		X		X	X				X	
CP104		X		X	X		X	X	X						X
CP107		X		X	X		X		X						X
CP108		X		X	X	X	X		X						
CP109	X	X	X	X	X	X	X		X	X	X				
CP112	X	X		X	X	X	X	X	X			X			
CP113		X	X	X	X	X	X		X		X			X	X
A	X	X	X	X	X	X	X	X	X	X		X		X	X
B	X	X	X	X	X	X	X	X	X		X	X		X	X
C	X	X	X	X	X	X	X	X	X	X		X	X	X	X
D	X	X	X	X	X	X		X	X		X	X		X	X
E	X	X	X		X	X		X	X		X	X		X	X
F	X	X	X	X		X		X	X		X			X	
No. Samples	127	161	127	145	149	141	104	135	171	50	102	96	14	114	107
No. Positive	24	110	25	48	44	44	40	10	21	5	8	29	1	17	14
% Positive	18.9	68.3	19.7	33.1	29.5	31.2	38.5	7.4	12.3	10.0	7.8	30.2	7.1	14.9	13.1
Min. Concentration*	0.05	0.05	0.05	0.05	0.05	0.05	0.10	0.10	0.10	0.10	0.10	20.0	5.00	0.20	1.00
Meas. Concentration															
Mean	1.83	1.52	0.81	0.39	0.43	1.21	2.11	0.55	0.78	0.29	0.26	29.9	6.00	0.55	1.86
Range(min./ max.)	0.05/ 21.00	0.05/ 49.40	0.05/ 7.830	0.05/ 2.340	0.06/ 2.070	0.05/ 30.60	0.11/ 21.20	0.17/ 1.110	0.10/ 2.940	0.12/ 0.480	0.10/ 0.840	20.0/ 90.90	-	0.20/ 2.200	1.00/ 3.630

* - Indicates concentration (in ug/g) equal to or greater than the minimums indicated.

widely distributed over the Arsenal; and due to their persistent nature and ability to bioaccumulate, can be detected in one form or another in all areas and biological species. Since DDT is rapidly converted to DDE in the living organism, the high incidence of DDT that was encountered in plants and animals suggests that the biota is currently exposed to this pesticide in the environment. CPMO2, another Shell Company product, was frequently encountered in the CP plots and Area C, but only occasionally in the other areas. Although CPMO2 apparently does not bioaccumulate in animals to any significant degree, its presence in plants in all areas indicate its wide distribution.

DIMP was found frequently in the CP plots and Areas A, B, and C. The absence of DIMP in Area D supports the contention that the industrial lakes area does not lie in the migration path of this contaminant.

Oxathiane and dithiane, both decomposition products of mustard gas, occurred infrequently in various areas of the Arsenal. It was found in no more than one sample from any one area (except for dithiane occurring in two of the seven deer samples from the Arsenal-wide sampling area).

Copper is the only substance on the contaminant list that is an essential element in living organisms. Normal tissue levels of copper in plants and animals vary widely, depending on the species, the average being roughly in the neighborhood of 15 ug/g (12). Therefore, the minimum cutoff limit in Table 4-1 was set above this level (20 ug/g). Although 20 ug/g, or somewhat more, would not necessarily constitute an excessive amount of copper in many biological tissues, consistent levels of this magnitude in all organisms from a given area might reflect higher than average exposure to this element. The highest levels of copper in biota were found in Area D, where about 45 percent of the samples contained 20 ug/g or more.

A copper deficiency in the organism may constitute a more adverse condition than an elevated level. Copper was conspicuous for its absence above or near 15 ug/g in biota from the Comprehensive Survey Pilot Study site. (The average copper concentration over all CP plots was 6.8 ug/g.) This may reflect a soil condition that limits the availability of copper to plants in this area.

Mercury occurred in only one of the CP plots; but it was also found in all the other areas, being most frequent in Area D.

Cadmium was found in all areas, although infrequently.

Arsenic was encountered in only one sample from the entire Arsenal (an aquatic root sample from the north bog, Area C).

4.2 INTERACTION OF CONTAMINANTS AND SPECIES

Tables B-15 through B-37 (Appendix B) summarize the data in Tables B-1 through B-14 for each plant type or animal species versus contaminant, based on the minimum concentrations and areas indicated in Table 4-1. Mean concentration and range are given for positive samples.

Tables B-38 through B-52 (Appendix B) are the converse of Tables B-15 through B-37 (i.e., each contaminant versus plant type or animal species).

From the data collected, it appears animals higher in the food chain do not, as a rule, contain these contaminants more frequently or at higher levels (except for dieldrin and mercury) than do strictly herbivorous animals.

Dieldrin was found in all biological species except kestrels. It occurred in 100 percent of the samples of fish, amphibians/reptiles, meadowlarks, mourning

doves, and long-eared owls. It was present more than 41 percent of the time in all other species, except mule deer (29 percent) and annual plant tops (17 percent).

Animals, in general, contained mercury more often than did plants, with herons, bass, and meadowlarks showing mercury in 100 percent of the samples. Terrestrial plants contained mercury 29 percent of the time, but mercury was not detected in aquatic plants.

Grasshoppers were always better detectors for the contaminants than were predaceous beetles, which are higher in the food chain. While the beetles contained only the chlorinated pesticides, grasshoppers contained these as well as DIMP (5 out of 7 samples), CPMO2 (6/7), CPMSO (5/7), and dithiane (1/7).

Plants proved to be much better detectors of DIMP than were animals, especially the tops of annual plants. All annual plant-top samples from those areas containing DIMP were positive at levels exceeding 0.1 ug/g.

Of the animals, prairie dogs were generally better than deer mice in exhibiting DIMP (6/10 compared to 1/11). Grasshoppers also frequently contained DIMP (5/7).

Plants and grasshoppers frequently contained CPMO2. In these respects, CPMO2 followed a pattern similar to that of DIMP.

Earthworms were the only animal in which cadmium occurred. Cadmium in earthworms might possibly be discounted because of ingested soil, but it is interesting that it occurred in all earthworm samples and at nearly the same level (average - 2.77 ug/g). Cadmium was also found in all plant types.

4.3 WASH SAMPLES

Table B-53 (Appendix B) shows the contaminants recovered from the distilled water washings from most of the specimens which were positive for the indicated contaminants.

Assuming a conservative washing efficiency of 75 percent (25 percent of any surface contamination remaining on the specimen), then a concentration equivalent to one-third of the amount recovered in the wash will be contributed to the total specimen concentration by surface contamination. In only 10 cases did this amount exceed five percent of the total specimen concentration. These 10 samples did not enter into the data included in Table 4-1, since the concentration of the contaminant in the specimen, in each case, was below the minimum concentration level indicated in Table 4-1.

Copper was high in several of the wash samples, indicating the presence of this element in high concentration in the soil and, consequently, adhering to the fur or feathers of animals and to the roots of plants. Several of the contaminants were present in rather high concentrations in the wash samples of roots, indicating the importance of washing root specimens prior to further processing. Only the wash samples listed in Table B-53 were analyzed.

4.4 SENTINEL DUCK STUDY

Tables 4-2 and 4-3 summarize the results of the sentinel duck study. Samples were made up of three-duck composites, except the Rod and Gun Club six-month sample, which consisted of only two ducks.

Figures 4-1, 4-2, and 4-3 show the recoveries of dieldrin, DDT, and DDE, respectively, from ducks retrieved from the three water bodies at one, three, and six months. Unfortunately, no ducks were recovered from Lake Ladora after three months and none from Lower Derby or the Rod and Gun Club ponds after six months.

TABLE 4-2

CONTAMINANTS RECOVERED FROM SENTINEL MALLARD DUCKS
HELD ON 3 WATER BODIES AT RMA

	Lower Derby Lake	Lake Ladora	Rod & Gun Club
Ducks Set Out	2 Adult Males 10 Adult females 12 Juvenile Males 6 Juvenile Males	2 Adult Males 10 Adult Females 11 Juvenile Males 6 Juvenile Females	2 Adult Males 10 Adult Females 12 Juvenile Males 6 Juvenile Females
Ducks Recovered (1 Month)	2 Adult Females 1 Juvenile Male	1 Adult Female 2 Juvenile Females	1 Adult Male 2 Juvenile Females
Condition*	- All Poor -	- All Good -	- All Poor -
Analyses (ug/g)			
DLDRN	1.30	0.37	0.09
DDT	0.13	0.10	
DDE	0.23	0.35	0.16
ENDRN		0.24	
Cu	16.9	8.6	10.4
Ducks Recovered (3 Months)	1 Adult Male 2 Adult Females	1 Adult Female 2 Juvenile Males	2 Juvenile Males 1 Juvenile Female
Condition*	- All Very Poor -	- All Good -	- All Good -
Analyses (ug/g)			
DLDRN	4.27	0.40	0.08
DDT	0.96	0.08	
DDE	0.47	0.39	0.14
ENDRN		0.15	
ALDRN	0.20		
ISODR	0.13		
Cu	31.5	9.4	9.6
Ducks Recovered (6 Months)	2 Juvenile Males 1 Juvenile Female	- No Survivors -	1 Adult Female 1 Juvenile Female
Condition*	- All Good -		- All Good -
Analyses (ug/g)			
DLDRN	2.22		0.09
DDT	0.10		
DDE	0.36		0.30
ENDRN			0.17
ALDRN	0.02		
Cu	16.8		14.4
Hg			0.57
Ducks Recovered (12 Months)	0 -No Survivors -	0 - No Survivors -	0 - No Survivors -

*Condition based on appearance and amount of fatty tissue.

TABLE 4-3

CONTAMINANT LEVELS IN SENTINEL MALLARD CONTROL SAMPLES

Sample No.		Average Concentration of Contaminant (ug/g)*					
		DLDRN	DDE	ENDRN	CU	ALDRN	DIMP
1	2 Adult Females	0.04	0.06	0.10	18.1	0.02	0.05
2	2 Adult Males	0.17	0.32	0.60	18.3	BDL	BDL
3	2 Juvenile Females	0.06	0.10	0.10	12.0	0.03	0.07
4	2 Juvenile Males	BDL	0.07	0.06	14.4	BDL	0.06
	A V E R A G E	0.07	0.14	0.22	15.7	0.01	0.045

* - Isodr, DDT, CPMO2, Oxat, Dith, As, Hg and Cd were below detectable limits in all ducks.

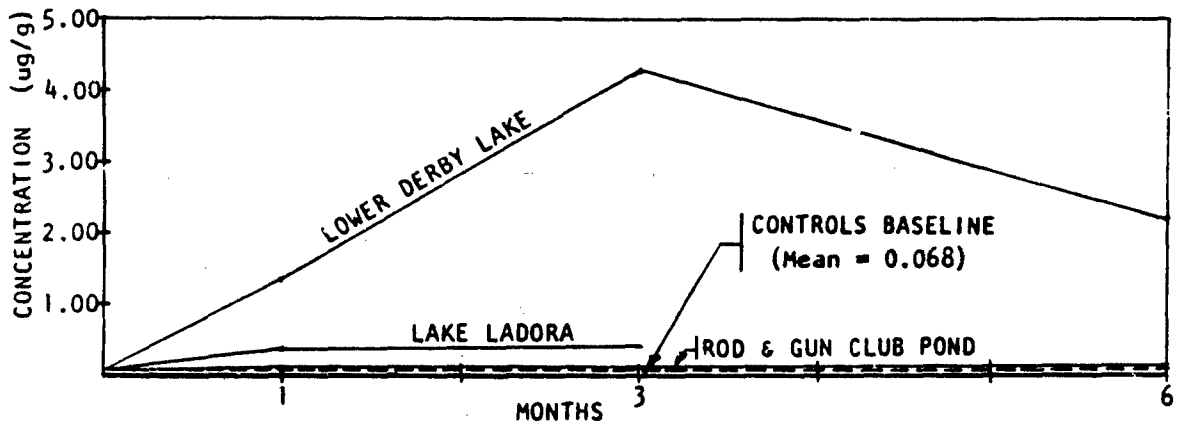


Fig. 4-1. Recovery of Dieldrin from Sentinel Ducks Held on Three Water Bodies at RMA.

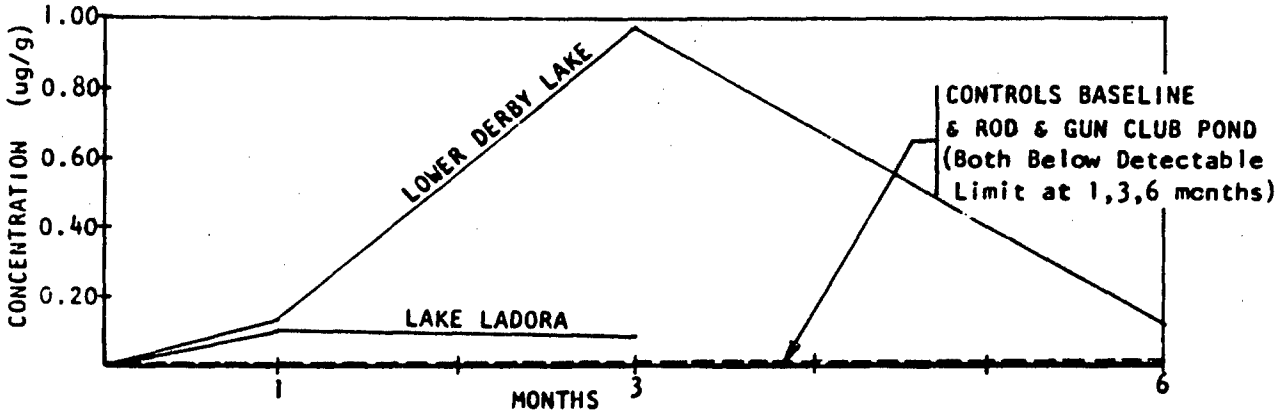


Fig. 4-2. Recovery of DDT from Sentinel Ducks Held on Three Water Bodies at RMA.

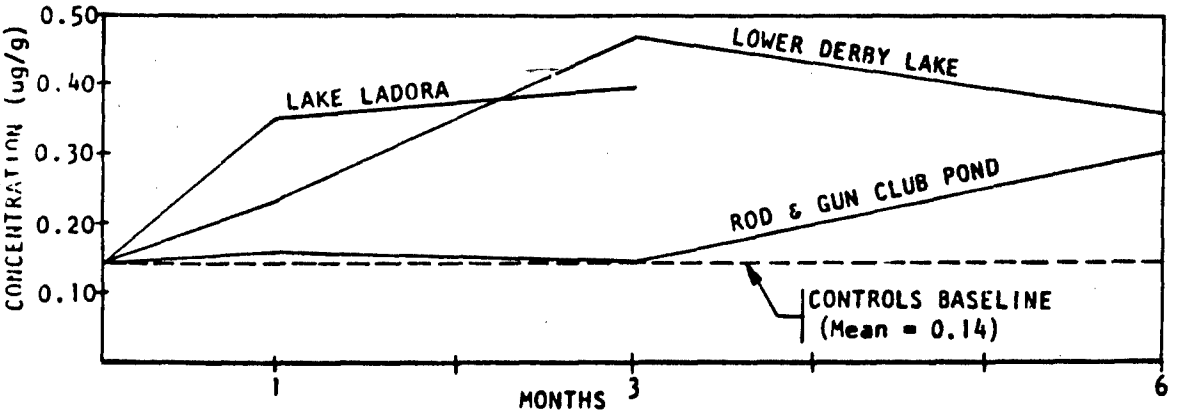


Fig. 4-3. Recovery of DDE from Sentinel Ducks Held on Three Water Bodies at RMA.

The increased recovery over the controls (Table 4-3) of dieldrin, DDT, and DDE in the ducks held on Lake Ladora and Lower Derby for one and three months, and the increased recovery of DDE in the Rod and Gun Club ducks after six months, illustrate the ability of ducks to take up these pollutants from these lakes. The much greater recoveries of these contaminants in the three-month sample from Lower Derby than in the three-month sample from Lake Ladora might reflect a difference in the degree of pollution of the two lakes.

The apparent decrease of the three pesticides in ducks on Lower Derby between three and six months (July - November) might have resulted from selective mortality. Ducks harboring higher tissue residues of the pesticides might have succumbed during the molt, due to mobilization of the pesticides into the blood stream during this stressful period with fatal consequences. Therefore, such ducks would not be available for subsequent sampling.

4.5 FISH AND GAME ANIMALS

Table 4-4 shows contaminant residues in the fish and game animals. The data for mallard ducks was taken from the sentinel duck study. Great blue herons were used as representative of fish-eating ducks. Such birds are not residents on the Arsenal and may contain pollutants picked up off-post.

The data indicates that consumption of some of these game species, such as fish, from RMA poses a potential health hazard. The FDA limit for aldrin and dieldrin, in edible portions of raw fish, is 0.3 ppm (13).

4.6 CORRELATION OF BIOTA WITH SOIL AND WATER

Factor analyses conducted by Timofeeff (9) on data from the Comprehensive Survey Pilot Study site, where intensive biota sampling was done in

TABLE 4-4

CONTAMINANTS IN FISH AND GAME ANIMALS ON RMA

	ALDRN (1)	DLDRN (1)	ISODR (1)	ENDRN (1)	PPDDT (1)	PPDDE (1)	DIMP (2)	CPMSO (2)	CPMO2 (2)	OXAT (2)	DITH (2)	CU (3)	AS (4)	HG (5)	CD (6)
Mule Deer															
No. Contam/ No. Samples	1/7	2/7	0/7	0/7	0/7	2/7	0/7	0/7	1/7	0/7	2/7	0/7	0/7	0/6	0/
Percent Contam.	14	29	0	0	0	29	0	0	14	0	29	0	0	0	0
Aver. Concen. (ug/g)	0.100	0.345				0.280			0.250		0.115				
Cottontails															
No. Contam/ No. Samples	0/4	3/4	0/4	0/3	0/4	0/4	0/2	0/4	0/4	0/1	0/3	1/4	0	0/4	0/4
Percent Contam.	0	75	0	0	0	0	0	0	0	0	0	25		0	0
Aver. Concen. (ug/g)		0.340										25.00			
Bass															
No. Contam/ No. Samples	0/2	2/2	0/2	0/2	0/2	2/2	0	0/2	0/2	0	0/2	0/1	0	1/1	0/1
Percent Contam.	0	100	0	0	0	100		0	0		0	0		100	0
Aver. Concen. (ug/g)		0.700				0.135								0.400	
Bullheads															
No. Contam/ No. Samples	2/2	2/2	0/2	2/2	0/2	2/2	0	0/2	0/2	0	0/2	1/2	0	0/2	0/2
Percent Contam.	100	100	0	100	0	100		0	0		0	50		0	0
Aver. Concen. (ug/g)	0.175	1.940		0.125		0.105						90.90			
Pheasants															
No. Contam/ No. Samples	0/5	3/5	0/5	2/4	2/5	2/5	0/3	0/5	0/5	0/2	0/3	0/5	0/1	2/5	0/5
Percent Contam.	0	60	0	50	40	40	0	0	0	0	0	0	0	40	0
Aver. Concen. (ug/g)		0.160		0.345	0.095	0.270								0.200	
Mourning Doves															
No. Contam/ No. Samples	0/5	5/5	0/5	1/4	0/5	1/5	0/3	0/5	0/5	0/2	0/3	0/5	0/1	0/5	0/5
Percent Contam.	0	100	0	25	0	20	0	0	0	0	0	0	0	0	0
Aver. Concen. (ug/g)		0.598		0.140		0.170									
Herons(/)															
No. Contam/ No. Samples	0/3	2/3	1/3	3/3	3/3	3/3	0	1/3	0/3	0	0/3	3/3	0	3/3	0/3
Percent Contam.	0	67	33	100	100	100		33	0		0	100		100	0
Aver. Concen. (ug/g)		3.715	0.090	0.867	0.813	1.620		0.240				27.20		1.733	
Mallards/Lower Derby(8)															
No. Contam/ No. Samples	1/1	1/1	1/1	0/1	1/1	1/1	0/1	0/1	0/1	0/1	0/1	1/1	0/1	0/1	0/1
Percent Contam.	100	100	100	0	100	100	0	0	0	0	0	100	0	0	0
Aver. Concen. (ug/g)	0.200	4.270	0.130		0.960	0.470						31.50			
Mallards/Lake Ladora(8)															
No. Contam/ No. Samples	0/1	1/1	0/1	1/1	1/1	1/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
Percent Contam.	0	100	0	100	100	100	0	0	0	0	0	0	0	0	0
Aver. Concen (ug/g)		0.400		0.150	0.080	0.390									
Mallards/R&G Club Pond(8)															
No. Contam./ No Samples	0/1	1/1	0/1	0/1	0/1	1/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
Percent Contam	0	100	0	0	0	100	0	0	0	0	0	0	0	0	0
Aver. Concen. (ug/g)		0.080				0.140									

(1) - Minimum Concentration 0.05 ug/g
(2) - Minimum Concentration 0.10 ug/g
(3) - Minimum Concentration 20 ug/g
(4) - Minimum Concentration 5 ug/g
(5) - Minimum Concentration 0.20 ug/g
(6) - Minimum Concentration 1.0 ug/g
(7) - Substitute for fish - eating duck
(8) - Sentinel ducks, 3-month samples

conjunction with soil and groundwater sampling, showed the following positive correlations for DIMP:

1. Perennial plants and surface soil, 99 percent confidence level.

2. Perennial plants and groundwater, 99 percent.

3. Annual plants and surface soil, 95 percent.

4. Annual plants and groundwater, 95 percent.

5. Deer mice and groundwater, 95 percent.

No significant correlation was obtained for deer mice and surface soil. Furthermore, it was found that DIMP in the surface soil, in groundwater, in annual plants, and in perennial plants are all interrelated and have the same spatial pattern of distribution (9).

Correlation analyses were not done for the other contaminants or biological species due to paucity of data. The reader is referred to the report by Timofeeff (9) for more details.

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The results of Phase I show:

1. Many of the pollutants that have been deposited in the environment on RMA are assimilated into plants and animals of the region.

2. Chlorinated pesticides, of one or more kinds, are present in all areas and biological species studied.

3. Dieldrin, DDT, and chlorophenylmethyl sulfone (CPMO2) are widespread in the biota on RMA, being found in all areas studied.

4. Diisopropylmethylphosphonate (DIMP) is present in high levels in the biota of the basins area and in lesser amounts around the north boundary. It is virtually absent in the region of the industrial lakes. This distribution pattern supports the supposed migration path of DIMP in groundwater.

5. Chlorophenylmethyl sulfoxide (CPMSO), oxathiane, and dithiane occur infrequently in the biota.

6. Low levels of copper in the biota in the Comprehensive Survey Pilot Study area may indicate a soil condition in this area that limits the availability of copper to plants.

7. Mercury was encountered frequently in the feathers of birds.

8. Cadmium was recovered from earthworms from most of the areas.

9. Recovery of arsenic from the biota was insignificant.

10. Plants and animals are effective tools for monitoring the status of environmental pollution.

11. Plants in general are better surveillance tools than animals.

12. High levels of several contaminants were found in fish and game animals.

13. Consumption of fish and game animals harvested on RMA presents a health risk.

14. Continuing surveillance of the game animals on RMA is warranted.

5.2 RECOMMENDATIONS

Based on the results of Phase I, the following recommendations are made for implementation of Phase II:

1. Limit routine monitoring to plants and grasshoppers when they are available. Plants have shown as many (or more) contaminant residues as any of the animals that could be used for routine sampling. Plants are also available in all areas; and being sessile, are confined to the immediate area sampled. Grasshoppers, exhibiting the chlorinated pesticides, are also good sensors of DIMP and chlorophenylmethyl sulfone (CPMO2).

2. Sample individual plant species to determine those most suitable for using in Phase III.

3. Take replicate plant samples in a statistical design at each sampling point to determine the sampling variation.

4. Sample each plant species at various times during the year to ascertain whether contaminant uptake is related to phenological cycle and to determine the optimum times for sampling in Phase III.

5. Take biota monitoring samples in proximity to water and soil sampling sites of the containment program to obtain additional data for correlation of biota with soil and water.

6. Continue monitoring all the game animals in Table 4-4. Limit analyses to the edible portions of these animals. Although fishing on RMA is limited to sport only, limited hunting for mourning doves, pheasants, and rabbits is still allowed; and it behooves us to be cognizant of the status of pollution of these animals.

7. Evaluate the feasibility of using prairie dogs as sentinel terrestrial animals for monitoring changes in the contamination status of given areas.

8. Add dibromochloropropane (DBCP, nemagon) to the list of contaminants for analysis. Dibromochloropropane is currently important and known as a migrating contaminant which causes sterility in human males.

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APPENDIX A

SAMPLE EXTRACTION AND ANALYSIS PROCEDURES

SECTION 1

PROCEDURE FOR CHLORINATED PESTICIDES, DIMP, AND ORGANO-SULFUR COMPOUNDS

1-1. Extraction Procedures

With slight modifications, the simplified extraction and clean-up method of Peterson (11), employing simple shake extraction, micropartition, and florisil adsorption cleanup in a test tube, was used.

Ten grams of a fresh or dried vegetation sample or a sodium sulfate animal preparation was extracted by vigorous shaking for 10 minutes with 100 ml of 20 percent acetone in isooctane (v/v). After solids had settled, an aliquot of the extract was clarified by centrifugation at 1,800 rpm for 3 to 4 minutes. Four ml of the clarified extract was transferred to a 15 x 100 mm culture tube; 7 ul of mineral oil was then added; and all water was evaporated with a gentle stream of clean, dry nitrogen.

To the tube containing the dried residue and mineral oil, 4 ml of isooctane-saturated acetonitrile and 2 ml of acetonitrile-saturated isooctane were added. The tube was then shaken vigorously for 10 minutes and centrifuged at 1,800 rpm for 3 to 4 minutes until phase separation was complete. The entire lower layer of acetonitrile was withdrawn with a Pasteur pipet and placed in a 20 x 125 mm culture tube. The isooctane layer was partitioned, as before, with another 4 ml of isooctane-saturated acetonitrile. This acetonitrile layer was then combined with the first. To the 8 ml of combined acetonitrile solution, isooctane was added at a volume determined by the room (solvent) temperature: 3.3 ml was added at 17 to 21°C; 3.2 ml at 22 to 26°C; and 3.1 ml at 27 to 28°C. The tube was then nearly filled with a solution of 0.5 percent sodium sulfate in water (w/v); capped and shaken vigorously for 3 to 4 minutes; and centrifuged at 1,800 rpm for 3 to 4 minutes until phase separation was complete. Two ml of the upper layer, containing

exactly 4 ml of isooctane, were carefully withdrawn with a Pasteur pipet and transferred to a 15 x 100 mm culture tube. Seven ul of mineral oil was added to the tube, and the solvent was evaporated with a gentle stream of clean, dry nitrogen.

To the tube containing the dry residue and mineral oil, 1 ml of 5 percent methanol in isooctane (v/v) was added. To this solution, 0.2 g of florisil was added and swirled in the solvent for a few seconds and then coalesced by immersing the tube in an ultrasonic bath for one minute. After standing for a few minutes, the clear solution was ready for chromatographic analysis. The final sample equivalent was 0.2 gram of tissue per ml of final extract.

1-2. Analytical Equipment and Conditions

A Hewlett-Packard Model 5710A Chromatograph with automatic sampler and computer-assisted integration by a Hewlett-Packard 3354 data system was used.

Chlorinated pesticides were analyzed with the electron-capture detector. DIMP was analyzed using the flame photometric detector (FPD) with phosphorous filter. Organo-sulfur compounds were analyzed using the FPD with sulfur filter.

Chlorinated pesticides were analyzed using a column containing GP 1.5 percent SP-2250/1.95 percent SP-2401 on 100/120 mesh Supelcoport packed in a 3.25 mm I.D. x 6.5 mm O.D. x 1.85 m glass column. Organo-sulfur compounds were analyzed using a column containing 5.1 percent FFAP on chromosorb WHP 100/120 mesh packed in a 3.25 mm I.D. x 6.5 mm O.D. x 1.85 m glass column. DIMP was analyzed using a column containing 5 percent OV-17/5 percent Reoplex 400 on chromosorb WHP 100/120 mesh mixed in a ratio of 5 parts OV-17 to 3 parts Reoplex 400 packed in a 3.25 mm I.D. x 6.5 mm O.D. x 1.85 m glass column.

Chlorinated pesticides used 5 percent methane in argon at 58 psi and 30 ml/minute at the detector. Sulfur compounds used hydrogen, 70 ml/min; oxygen 15 to 18 ml/min; air 60 ml/min, and nitrogen (carrier) 30 ml/min. DIMP used

hydrogen, 150 ml/min; oxygen 20 ml/min; air 50 ml/min, and nitrogen (carrier) 30 ml/min.

The injection port was maintained at 200°C for all analyses. Detector and oven temperatures, respectively, for the various compounds were: chlorinated pesticides, 300°C and 200°C; sulfur compounds, 250°C and 90 to 230°C (programmed at 32°/min); DIMP, 200°C and 140 to 190°C (programmed at 32°/min).

Relative retention times in minutes $\pm$ 0.05 min were: aldrin, 1.35; dieldrin, 2.79; isodrin, 1.68; endrin, 3.34; DDE, 2.60; DDT, 4.54; oxathiane, 2.69; dithiane, 4.64; CPMSO, 8.80; CPMO2, 10.09; and DIMP, 1.47.

The polychlorinated biphenyl, AR 1254 (retention times relative to above 1.35, 1.57, 4.49, among others) interferes with the analyses for aldrin, isodrin, and DDT. This was corrected for by determining the ratio of noninterferring peaks of known concentrations of AR 1254 to those in the analysis and subtracting the appropriate value from the combined peaks.

Reference standards were obtained from the following sources: chlorinated pesticides, Research Triangle Park, North Carolina; Arochlor (AR 1254), Analabs, Inc.; DIMP and organo-sulfur compounds, Standard Analytical References, Edgewood Arsenal, Maryland.

1-3. Analytical Procedures

Calibration curves for each compound were constructed daily using working standards prepared from stock solutions of the reference standards noted above. Peak areas vs concentration were plotted.

Vials containing the working standards, sample extracts, spiked samples, and appropriate blanks were loaded in a sequential sampler; and 2.6 ul of each

solution was injected automatically into the gas chromatograph. Peak areas were integrated by the computerized data system.

The concentration of the compound in the sample extract, in ng/ml was read from the calibration curve using the integrated peak area obtained. If necessary, sample extracts were diluted with hexane in order to obtain readings within the effective range of the working standards.

For fresh plant samples, the percent moisture content was determined; and concentrations of contaminants were computed on a dry-weight basis. Concentrations in animal tissues were computed on a fresh-weight basis.

The sample concentration, in ng/ml, obtained from the standard curve (multiplied by the appropriate dilution factor, if the extract required dilution) was adjusted for the average recovery efficiency (percent) determined from the spiked samples. The resulting concentration (ng/ml) was multiplied by the volume of the original extract (ml) and divided by the equivalent weight of tissue extracted to obtain the concentration of the compound (per unit weight of tissue).

$$\frac{(\text{ng/ml}) \times 1.0 \text{ ml (original vol of extract)}}{\text{equivalent wt of tissue extracted (g)}} = \frac{\text{conc (ng)}}{\text{gram of tissue}}$$

where the equivalent weight of tissue extracted:

a) For dried plant tissue = 0.2 g

b) For fresh plant tissue = $0.2 \text{ g} \times \frac{(100 - \% \text{ moisture})}{100}$

c) For $NaSO_4$ animal preparations = 0.2 g x 1/7 (ratio of tissue to total preparation)

The minimum detection limits achieved in biological samples using these extraction and analysis procedures were 0.02 ug/g for the chlorinated pesticides and 0.05 ug/g for DIMP and the organo-sulfur compounds.

SECTION 2

PROCEDURES FOR MERCURY, ARSENIC, COPPER, AND CADMIUM

2-1. Reagents Used

A sodium molybdate working solution, consisting of 2 grams of $Na_2MoO_4 \cdot 2 H_2O$ was dissolved in 50 ml H_2O. Fifty ml concentrated H_2SO_4 was added (with cooling), then 10 ml of 70 percent $HClO_4$ was added. One percent $NaBH_4$ solution (2 grams of $NaBH_4$ dissolved in 200 ml H_2O) and 1 g KOH were added as a preservative.

2-2. Digestion of Samples

For analyses of arsenic, copper, and cadmium, samples were oxidized with a mixture of nitric, sulfuric, and perchloric acids. One gram of an animal or dried plant sample was weighed to the nearest hundredth of a gram and placed in a 400 ml beaker. Fifteen ml of HNO_3 and 18 ml of Na_2MoO_4 mixture were added, and the beaker placed on a hot plate inside a fume hood and allowed to boil slowly. Whenever the solution turned brown, 1 to 2 ml HNO_3 was added. When the solution no longer turned brown, 1 ml of 70 percent $HClO_4$ was added and the solution allowed to boil and evaporate to dryness. The beaker was then cooled to room temperature; then 20 ml of HCl and 80 ml H_2O were added to the residue to bring the volume to 100 ml. This solution was then ready for analysis for arsenic, copper, or cadmium on the atomic absorption spectrophotometer.

For analysis of mercury, samples were oxidized with potassium permanganate, nitric acid, sulfuric acid, and $(NH_4)_2S_2O_8$. One gram of an animal or dried plant sample was weighed to the nearest one-hundredth gram and placed in a 500 ml Erlenmeyer flask. To the flask were added 50 ml of 5 percent $KMnO_4$, 20 ml HNO_3, 20 ml H_2SO_4 (with cooling in an ice bath), and 10 ml of 5 percent $(NH_4)_2S_2O_8$.

The flask was fitted with a vented stopper and placed on an oscillating shaker for two hours. Whenever the permanganate color began to deteriorate, additional 5 percent $KMnO_4$ solution was added in 10 ml increments. When the mixture no longer turned brown, digestion was complete. Then, just enough hydroxylamine hydrochloride crystals were added to decolorize any excess permanganate. The final volume of the solution was then measured, and the extract was ready for analysis for mercury on the atomic absorption spectrophotometer.

2-3. Analytical Equipment

All metals were analyzed on an Instrumentation Laboratories Model 251 Atomic Absorption-Emission Spectrophotometer. The unit was operated in the automatic background-correction mode utilizing a hydrogen continuum light source.

2-4. Analytical Procedures for Mercury

Mercury in the digested sample is reduced to elemental mercury with $SnCl_2$. The elemental mercury, being volatile under the operating conditions, is swept by a purge gas through an absorption cell situated in the light path of the spectrophotometer. A sensitivity of 2×10^{-9} grams has been achieved with this technique (Instrumentation Laboratories publ. #79333).

The AA-spectrophotometer was equipped with a generator flask, a flow-through absorption cell and a source of purge gas connected in a closed system and evacuated to a chemical fume hood.

Working standards of 0.002 to 0.10 mg/Hg/l were made by dilution with 0.02N HNO3 of a stock solution of a mercury reference standard.

Ten ml of a blank (0.02N HNO_3), standard, or sample extract was pipetted into the generator flask. While stirring the sample in the flask with a magnetic

stirrer, 2.5 ml of 25 percent $SnCl_2$ solution was introduced into the flask. After 1.5 minutes, any mercury vapor was purged through the absorption cell and a reading was taken from the digital display. The value obtained from the blank was subtracted from all other readings. A calibration curve was then constructed using the values obtained with the standards. The concentration of mercury in the test sample was read directly from this calibration curve. This concentration (in mg/l) was multiplied by the final volume of the digest (in liters) and divided by the weight of tissue digested (in grams) to give the concentration of mercury (in mg per gram of tissue):

$$\frac{\text{conc in mg/l (from curve) x final vol of digest (l)}}{\text{wt of tissue digested (g)}} = \frac{\text{mg Hg}}{\text{g of tissue}}$$

A minimum detection limit of 0.2 ug of Hg per gram of tissue was achieved using these digestion and analysis techniques.

2-5. Analytical Procedures for Arsenic

Pentavalent arsenic in the digested sample is reduced to the trivalent state with KI and $SnCl_2$ and then allowed to react with $NaBH_4$ and HCl to form the arsine hydride. The arsine hydride is then flushed with argon through the hydrogen flame of the AA-spectrophotmeter. A sensitivity of 5×10^{-8} g has been achieved with this method.

The AA-spectrophotometer was equipped with a high-solids head and a generator flask and purge system.

Working standards of 0.02 to 1.0 mg As/l were made by dilution of a stock solution of an arsenic reference standard with distilled water.

Twenty-five ml of a blank (distilled water), standard, or sample extract was pipetted into a 100 ml beaker. One ml of 20 percent KI solution and 0.5 ml of 20 percent $SnCl_2$ solution were added. The contents of the beaker were mixed and

allowed to stand for 10 minutes. Then 3.0 ml of the solution was pipetted into the generator flask. While stirring with a magnetic stirrer, 1 ml of HCl and 2 ml of 1 percent $NaBH_4$ solution were added to the flask. After 45 seconds, the flask was purged with argon into the Hydrogen flame of the AA-spectrophotometer and a reading was taken from the digital display. The generator flask was then flushed with three successive rinses of distilled water and the next sample was run. The value of the blank was subtracted from all other readings. A calibration curve was constructed using the values obtained with the standards, and the concentration of arsenic in the test sample was read directly from the curve. This concentration (in mg/l) was multiplied by the final volume of digest (0.1 l) and divided by the weight of tissue digested (1.0 g) to give the concentration of arsenic (in mg per gram of tissue):

$$\frac{\text{conc in mg/l (from curve) x 0.10 l (final vol of digest)}}{\text{1.0 g (wt of tissue digested)}} = \frac{\text{mg As}}{\text{g of tissue}}$$

A minimum detection limit of 5.0 ug of arsenic per gram of tissue was achieved using these digestion and analysis techniques.

2-6. Analytical Procedures for Copper

The sample digest solution was aspirated directly into the acetylene flame of the AA-spectrophotometer. The spectrophotometer was equipped with a Boling burner head. The sample was aspirated from a glass nebulizer.

Working standards of 0.05 to 20.00 mg Cu/l were made by dilution of a stock solution of a copper reference standard with distilled water.

The digital readout was adjusted to read "0.050" with the 0.05 mg/l standard using the "scale expand" control, and "2.000" with the 2.00 mg/l standard using the "curve correct" control. Zero was reset using a blank (distilled water). The sample extract solution was then aspirated into the flame of the spectrophotometer

and the concentration was read directly, in mg/l, from the digital display. This concentration was multiplied by the final volume of the digest (in liters) and divided by the weight of tissue digested (in grams) to give the concentration of copper (in mg per gram of tissue):

$$\frac{\text{conc in mg/l (from readout) x final vol of digest (l)}}{\text{wt of tissue digested (g)}} = \frac{\text{mg Cu}}{\text{g of tissue}}$$

A minimum detection limit of 4.0 ug of copper per gram of tissue was achieved using these digestion and analysis techniques.

2-7. Analytical Procedures for Cadmium

The sample extract solution was aspirated directly into the acetylene flame of the AA-spectrophotometer. The AA-spectrophotometer was equipped with a Boling burner head. The sample was aspirated from a glass nebulizer.

Working standards of 0.05 to 2.00 mg Cd/l were made by dilution of a stock solution of a cadmium reference standard with distilled water.

The digital readout was adjusted to read "0.050" with the 0.05 mg/l standard using the "scale expand" control and "2.000" with the 2.00 mg/l standard using the "curve correct" control. Zero was reset using a blank (distilled water). The sample extract solution was then aspirated; and the concentration of Cd, in mg/l, was read directly from the digital display. This concentration was multiplied by the final volume of the digest (in liters) and divided by the weight of tissue digested (in grams) to give the concentration of cadmium (in mg per gram of tissue):

$$\frac{\text{conc in mg/l (from readout) x final vol of digest (l)}}{\text{wt of tissue digested (g)}} = \frac{\text{mg/Cd}}{\text{g of tissue}}$$

A minimum of detection limit of 1.0 ug of cadmium per gram of tissue was achieved using these digestion and analysis techniques.

SECTION 3

PROCEDURES FOR RINSE-WATER SAMPLES

3-1. Extraction and Ana ysis for Chlorinated Pesticides

Using 2-liter separatory funnels, 100 ml of the rinse-water sample was extracted twice with 60 ml of 15 percent dichloromethanehexane solution (v/v) and a third time with 60 ml of hexane. The three extract fractions were combined in a 250 ml flask containing enough anhydrous Na_2SO_4 to cover the bottom. The flask was swirled several times and allowed to stand for 10 minutes. The liquid was then concentrated to less than 2 ml in a Kuderna-Danish (K-D) apparatus and then brought to 5.0 ml with hexane.

This extract was then cleaned up in a 3/8 - inch I.D. alumina column prepared with 30 ml of 10 percent H_2O/Woelm alumina and one inch of anhydrous Na_2SO_4 packed on top. The extract was allowed to sink to the top of the Na_2SO_4 layer; the column was then eluted with 100 ml of hexane and then with 100 ml of 2-percent ethyl acetate in hexane. The two fractions were combined and concentrated to 10 ml in a K-D apparatus.

The cleaned-up extract from the above procedure was analyzed for the chlorinated pesticides by gas chromatography using electron capture as in paragraph 1-3 above.

The concentration obtained from the standard curve (ng/ml) was multiplied by the final volume of the extract (10 ml) and divided by the volume of rinse-water used (100 ml) to give the concentration of the pesticide (in ng per ml) in the rinse water:

$$\frac{\text{ng/ml (from std curve)} \times \text{10.0 ml (vol of extract)}}{\text{100.0 ml (vol of rinse-water sample)}} = \frac{\text{ng of pesticide}}{\text{ml of rinse water sample}}$$

The minimum detection limit for all chlorinated pesticides in rinse-water samples using these procedures was 0.30 ng/ml.

3-2. Extraction and Analysis for DIMP and Organo-Sulfur Compounds

Using 2-liter separatory funnels, 100 ml of the rinse-water sample was extracted twice with 60 ml of 15 percent dichloromethane-hexane solution (v/v) and a third time with 60 ml of hexane. The three fractions were combined in a 250 ml flask containing enough anhydrous Na_2SO_4 to cover the bottom. The flask was swirled several times and allowed to stand for 10 minutes. The liquid was then drawn off and concentrated to less than 2 ml in a K-D apparatus and then brought up to a volume of 5.0 ml with hexane. No cleanup of the extract was required.

The extract was analyzed for DIMP and the organo-sulfur compounds by gas chromatography using the flame photometric detector as in paragraph 1-3 above.

The concentration obtained from the standard curve (ng/ml) was multiplied by the final volume of the extract (5 ml) and divided by the volume of rinse water used (100 ml) to give the concentration of the compound (in ng per ml) in the rinse water:

$$\frac{\text{ng/ml (from std curve)} \times \text{5.0 ml (vol of extract)}}{\text{100.0 ml (vol of rinse-water sample)}} = \frac{\text{ng of compound}}{\text{ml of rinse water sample}}$$

The minimum detection limit for DIMP and all the organo-sulfur compounds using these procedures was 0.05 ng/ml.

3-3. Digestion and Analysis for Mercury

Fifty ml of the rinse sample were measured into a 250 ml flask. Five ml H_2SO_4, 5 ml HNO_3, 2 ml 5 percent $KMnO_4$, and 2 ml 5 percent $(NH_4)_2S_2O_8$ were added, mixed by swirling and allowed to stand for at least 30 minutes. Whenever

the permanganate color began to deteriorate, 1 to 2 ml $KMnO_4$ solution was added. After at least 30 minutes, enough hydroxylamine hydrochloride crystals were added to just decolorize the excess $KMnO_4$. The solution was then ready for mercury analysis on the AA-spectrophotometer as in paragraph 2-4 above.

$$\frac{\text{mg/l (from std curve) x final vol of sample sol (l)}}{\text{50 ml (original vol of rinse sample)}} = \frac{\text{mg of Hg}}{\text{ml of rinse water sample}}$$

The minimum detection limit for mercury using these procedures was 2.0 ng/ml.

3-4. Digestion and Analysis for Arsenic, Copper, and Cadmium

Twenty-five ml of the rinse-water sample were measured into a 100 ml beaker containing porcelain boiling chips, and the level of the sample was marked on the beaker. Four ml HNO_3 and 4 ml Na_2MoO_4 mixture (see paragraph 2-1 above) were added. This mixture was heated to 200°C until fumes of SO_3 were evolved for 1 to 2 minutes. The mixture was allowed to cool, and the volume restored to 25 ml with distilled water. The solution was then ready for analysis on the AA-spectrophotometer for arsenic, copper, and cadmium as in paragraphs 2-5 through 2-7 above.

The concentration of the metal (in mg/l) in the rinse-water sample was read directly from the digital display of the AA-spectrophotometer. No computations were necessary unless dilutions were made.

The minimum detection limits using these procedures were 20 ng/ml for arsenic, 40 ng/ml for copper, and 30 ng/ml for cadmium.

APPENDIX B

TABLE B-1

CONTAMINANTS IN BIOTA FROM COMPREHENSIVE PILOT PLOT CP 101
(in ug/g)

		ALDRN	DLDRN	ISODR	ENDRN	PPDDT	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops							4.48	-	2.83	-	-				
	Annual Roots							3.08	-	1.47	.360	-				
	Perennial Tops															
	Perennial Roots															
	Aquatic Tops															
	Aquatic Roots															
Dried Plants	Annual Tops															
	Annual Roots	-	.360	-	180	.550	-						6.70	-	-	-
	Perennial Tops															
	Perennial Roots															
	Aquatic Tops															
	Aquatic Roots															
Other	Earthworms															
	Grasshoppers/Beetles															
	Leeches/Snails															
	Bullheads															
	Bass															
	Frogs/Toads															
	Snakes/Lizards															
Mammals	Deer Mice	-	.070	-	-	-	.020	-	-	-	-	-	-	-	-	-
	Prairie Dogs	-	.060	-	-	-	.020	.200	-	.220	-	-	-	-	-	-
	Cottontails															
	Mule Deer															
Birds	Mourning Doves															
	Meadowlarks															
	Pheasants															
	Kestrels															
	Long-Eared Owls															
	Herons															

TABLE B-2

CONTAMINANTS IN BIOTA FROM COMPREHENSIVE PILOT PLOT CP 103
(in ug/g)

		ALDRN	DLDRN	ISODR	ENDRN	PPDDT	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops							3.69	-	-	-	-				
	Annual Roots							.580	-	-	-	-				
	Perennial Tops															
	Perennial Roots							.340	-	1.21	-	-				
	Aquatic Tops							-	-	-	-	-				
	Aquatic Roots															
Dried Plants	Annual Tops	-	-	-	-	-	-						6.30	-	-	-
	Annual Roots	-	-	-	.140	.610							6.50	-	-	-
	Perennial Tops	-	.190	.020	.030	.350	-						5.00	-	6.00	-
	Perennial Roots	-	.410	-	.140	.600	-						12.6	-	-	-
	Aquatic Tops															
	Aquatic Roots															
Other	Earthworms															
	Grasshoppers/Beetles															
	Leeches/Snails															
	Bullheads															
	Bass															
	Frogs/Toads															
	Snakes/Lizards															
Mammals	Deer Mice	-	.130	-	-	-	-	-	-	-	-	-	-	-	-	-
	Prairie Dogs	-	-	-	-	-	-	-	-	.120		-	-			
	Cottontails															
	Mule Deer															
Birds	Mourning Doves															
	Meadowlarks															
	Pheasants															
	Kestrels															
	Long-Eared Owls															
	Herons															

TABLE B-3

CONTAMINANTS IN BIOTA FROM COMPREHENSIVE PILOT PLOT CP104

(in ug/g)

		ALDRN	DLDRN	ISODR	ENDRN	PPDDT	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops							21.2	-	-	-	-				
	Annual Roots							.400	-	-	-	-				
	Perennial Tops															
	Perennial Roots															
	Aquatic Tops															
	Aquatic Roots															
Dried Plants	Annual Tops	-	-	-	-	-	-						6.70	-	-	-
	Annual Roots	-	.390	-	.110	.410	-						6.70	-	-	1.00
	Perennial Tops															
	Perennial Roots															
	Aquatic Tops															
	Aquatic Roots															
Other	Earthworms															
	Grasshoppers/Beetles	-	.078	-	-	-	.021	.710	1.11	.950	-	-	17.6	-	-	-
	Leeches/Snails															
	Bullheads															
	Bass															
	Frogs/Toads															
	Snakes Lizards															
Mammals	Deer Mice	-	.060	-	-	-	-	.090	-	-	-	-	-	-	-	-
	Prairie Dogs	-	110	-	-	-	-	.220	-	-	-	-	-	-	-	-
	Cottontails															
	Mule Deer															
Birds	Mourning Doves															
	Meadowlarks															
	Pheasants															
	Kestrels															
	Long-Eared Owls															
	Herons															

TABLE B-4

CONTAMINANTS IN BIOTA FROM COMPREHENSIVE PILOT PLOT CP107

(in ug/g)

		ALDRN	DLDRN	ISODR	ENDRN	PPL	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops							.300	-	-	-	-				
	Annual Roots							-	-	-	-	-				
	Perennial Tops							.170	-	.860	-	-				
	Perennial Roots							-	-	-	-	-				
	Aquatic Tops															
	Aquatic Roots															
Dried Plants	Annual Tops	-	-	-	-	-	-						10.2	-	-	1.70
	Annual Roots	-	.410	-	.280	2.07	-						6.00	-	-	-
	Perennial Tops	-	.040	.020	.130	1.00	-						5.00	-	-	-
	Perennial Roots	-	.090	-	.280	.210	-						8.40	-	-	-
	Aquatic Tops															
	Aquatic Roots															
Other	Earthworms															
	Grasshoppers/Beetles															
	Leeches/Snails															
	Bullheads															
	Bass															
	Frogs/Toads															
	Snakes/Lizards															
Mammals	Deer Mice	-	.020	-	-	-	.020	.070	-	-	-	-				
	Prairie Dogs	-	-	-	-	-	-	1.52	-	-	-	-	-	-	-	-
	Cottontails															
	Mule Deer															
Birds	Mourning Doves															
	Meadowlarks															
	Pheasants															
	Kestrels															
	Long-Eared Owls															
	Herons															

TABLE B-5

CONTAMINANTS IN BIOTA FROM COMPREHENSIVE PILOT PLOT CP108

(in ug/g)

		ALDRN	DLDRN	ISODR	ENDRN	PPDDT	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops							15.3	-	-	-	-				
	Annual Roots							.070	-	-	-	-				
	Perennial Tops							5.15	-	.530	-	-				
	Perennial Roots							-	-	-	-	-				
	Aquatic Tops															
	Aquatic Roots															
Dried Plants	Annual Tops	-	-	-	-	-	-						5.60	-	-	-
	Annual Roots	-	.100	-	.110	.500	.310						6.90	-	-	-
	Perennial Tops	-	.160	-	.060	.440	-						5.40	-	-	-
	Perennial Roots	-	5.60	.020	.130	1.01	-						8.00	-	-	-
	Aquatic Tops															
	Aquatic Roots															
Other	Earthworms															
	Grasshoppers/Beetles															
	Leeches/Snails															
	Bullheads															
	Bass															
	Frogs/Toads															
	Snakes/Lizards															
Mammals	Deer Mice	-	.150	-	-	-	.020	.060	-	-	-	-	-	-	-	-
	Prairie Dogs	-	.040	-	-	-	.020	.290	-	-	-	-				
	Cottontails															
	Mule Deer															
Birds	Mourning Doves															
	Meadowlarks															
	Pheasants															
	Kestrels															
	Long-Eared Owls															
	Herons															

TABLE B-6

CONTAMINANTS IN BIOTA FROM COMPREHENSIVE PILOT PLOT CP109

(in ug/g)

		ALDRN	DLDRN	ISODR	ENDRN	PPDDT	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops							1.89	-	-	-	-				
	Annual Roots							-	-	-	-	-				
	Perennial Tops							090	-	.450	.080	-				
	Perennial Roots							-	-	-	-	-				
	Aquatic Tops															
	Aquatic Roots															
Dried Plants	Annual Tops	-	-	-	-	-	-						5.70	-	-	-
	Annual Roots	-	.060	-	.050	.140	.130						5.20	-	-	-
	Perennial Tops	.110	.150	.050	.090	.130	-						5.20	-	-	-
	Perennial Roots	.060	.330	.030	.040	.110	-						8.00	-	-	-
	Aquatic Tops															
	Aquatic Roots															
Other	Earthworms															
	Grasshoppers/Beetles															
	Leeches/Snails															
	Bullheads															
	Bass															
	Frogs/Toads															
	Snakes/Lizards															
Mammals	Deer Mice	-	.080	-	-	-	.020	-	-	-	-	-	-	-	-	-
	Prairie Dogs	-	-	-	-	-	-	-	-	-	.120	.130	-	-	-	-
	Cottontails															
	Mule Deer															
Birds	Mourning Doves															
	Meadowlarks															
	Pheasants															
	Kestrels															
	Long-Eared Owls															
	Herons															

TABLE B-7

CONTAMINANTS IN BIOTA FROM COMPREHENSIVE PILOT PLOT CP112

(in ug/g)

		ALDRN	DLDRN	ISODR	ENDRN	PPDDT	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops							1.66	-	-	-	-				
	Annual Roots							-	-	-	-	-				
	Perennial Tops							1.85	-	-	-	-				
	Perennial Roots							-	-	-	-	-				
	Aquatic Tops															
	Aquatic Roots															
Dried Plants	Annual Tops	-	-	-	-	-	-						5.60	-	-	-
	Annual Tops	-	.450	-	-	.290	-						7.40	-	-	-
	Perennial Tops	-	-	-	-	-	-						6.50	-	-	-
	Perennial Roots	-	.240	-	.350	2.07	.730						11.6	-	-	-
	Aquatic Tops															
	Aquatic Roots															
Other	Earthworms															
	Grasshoppers/Beetles	-	-	-	-	-	.060	.380	.990	.600	-	-	20.4	-	-	-
	Leeches/Snails															
	Bullheads															
	Bass															
	Frogs/Toads															
	Snakes/Lizards	.070	1.33	-	-	-	-	-	-	-	-	-				
Mammals	Deer Mice	-	.130	-	-	-	.020	.110	-	-	-	-				
	Prairie Dogs	-	-	-	-	-	-	3.72	-	-	-	-	-	-	-	-
	Cottontails															
	Mule Deer															
Birds	Mourning Doves															
	Meadowlarks															
	Pheasants															
	Kestrels															
	Long-Eared Owls															
	Herons															

TABLE B-8

CONTAMINANTS IN BIOTA FROM COMPREHENSIVE PILOT PLOT CP113

(in ug/g)

		ALDRN	DLDRN	ISODR	ENDRN	PPDDT	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops							.990	-	-	-	-				
	Annual Roots							.880	-	-	-	-				
	Perennial Tops							.190	-	.300	-	-				
	Perennial Roots							-	-	-	-	-				
	Aquatic Tops															
	Aquatic Roots															
Dried Plants	Annual Tops	-	-	-	-	-	-						7.50	-	-	1.10
	Annual Roots	-	.260	-	.070	.320	-						9.90	-	.250	-
													6.00	-	-	-
	Perennial Tops	.030	.200	.030	.140	.430	-						11.3	-	-	1.10
	Perennial Roots	-	.340	-	.060	.240	-									
	Aquatic Tops															
	Aquatic Roots															
Other	Earthworms															
	Grasshoppers/Beetles	-	-	-	-	-	-	-	-	2.94	-	.350				
	Leeches/Snails															
	Bullheads															
	Bass															
	Frogs/Toads	.600	.230	.220	-	-	.090	-	-	-	-	-	7.10	-	-	-
	Snakes/Lizards															
Mammals	Deer Mice	-	.050	-	-	-	-	.070	-	-	-	.840	-	-	-	-
	Prairie Dogs	-	.100	-	-	-	.040	.730	-	-	-	-	-	-	-	-
	Cottontails															
	Mule Deer															
Birds	Mourning Doves															
	Meadowlarks															
	Pheasants															
	Kestrels															
	Long-Eared Owls															
	Herons															

TABLE B-9

CONTAMINANTS IN BIOTA FROM AREA A
(in ug/g)

		ALDRN	DLDRN	ISODR	ENDRN	PPDDT	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops							4.90	-	-	-	-				
	Annual Roots							-	-	-	-	-				
	Perennial Tops															
	Perennial Roots															
	Aquatic Tops							-	-	-	-	-				
	Aquatic Roots							-	-	-	-	-				
Dried Plants	Annual Tops	.040	.540	.020	-	.290	.020	.290	-	-	-	-	19.8	-	-	1.60
	Annual Roots	-	2.39	-	.550	100	110	-	-	-	-	-	10.8	-	-	1.30
	Perennial Tops	-	.970	.070	-	.230	260	.090	-	-	-	-	9.70	-	.240	-
	Perennial Roots	-	12.0	2.00	-	2.00	4.00	.050	-	-	-	-	10.4	-	-	-
	Aquatic Tops	.080	1.25	030	.160	-	-						8.70	-	-	-
	Aquatic Roots	.620	-	-	1.91	-	-						22.3	-	-	-
Other	Earthworms	020	6.57	.020	.760	.180	-	-	-	-	-	-	46.0	-	-	3.63
	Grasshoppers/Beetles	.705	1.38	.167	-	-	.030	.170	.270	.110	-	-				
	Leeches/Snails															
	Bullheads															
	Bass															
	Frogs/Toads	.070	3.19	.110	.170	.080	.060	-	-	-	.480	-	19.8	-	-	-
	Snakes/Lizards	-	2.37	-	.120	-	-	.310								
Mammals	Deer Mice	-	.490	-	-	-	-	-	-	-	-	-	5.30	-	-	-
	Prairie Dogs	-	.570	-	-	-	.130	-	-	-	-	-	8.50	-	-	-
	Cottontails	-	.210	-	-	-	-	-	-	-	-	-	14.1	-	-	-
	Mule Deer															
Birds	Mourning Doves	-	.530	-	-	-	.040	-	-	-	-	-	6.3	-	-	-
	Meadowlarks	-	.990	-	-	-	-	-	-	-	-	-	25.3	-	.330	-
	Pheasants	-	.200	-	.370	.110	.220	-	-	-	-	-	8.10	-	.200	-
	Kestrels															
	Long-Eared Owls															
	Herons															

TABLE B-10

CONTAMINANTS IN BIOTA FROM AREA B
(in ug/g)

		ALDRN	DLDRN	ISODR	ENDRN	PPDDT	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops															
	Annual Roots															
	Perennial Tops															
	Perennial Roots															
	Aquatic Tops															
	Aquatic Roots															
Dried Plants	Annual Tops	.120	-	.260	.040	-	.320	1.47	-	-	-	-	11.5	-	-	-
	Annual Roots	-	3.33	.270	.620	.090	-	.060	-	-	-	-	11.7	-	-	-
	Perennial Tops	-	.070	.060	-	.170	.210	.090	-	-	-	-	14.6	-	-	-
	Perennial Roots	2.00	2.00	.200	.900	.200	1.00	.060	-	-	-	-	14.1	-	-	-
	Aquatic Tops	-	070	-	-	.140	.050	.060	-	-	-	-	15.9	-	-	-
	Aquatic Roots	-	100	-	.030	-	.030	-	-	-	-	-	28.1	-	-	-
Other	Earthworms	.030	7.30	.320	.390	-	-	-	-	-	-	-	31.0	-	-	2.57
	Grasshoppers/Beetles	-	-	.090	970	-	-	-	.510	.510	-	-	34.4	-	-	-
		-	550	-	-	-	-	360	-	-	-	-	37.6	-	-	-
		.390	.540	-	-	-	-	.170	-	-	-	-	7.10	-	-	-
		-	5.34	-	.050	-	-	-	.360	.360	-	-				
		.169	1.75	-	-	-	-	-	-	-	-	-				
	Leeches/Snails															
	Bullheads															
	Bass															
	Frogs/Toads	.590	2.02	-	.130	-	-	-	-	-	-	-	19.2	-	-	-
	Snakes/Lizards	-	040	-	-	-	-	-	-	-	-	-	20.0	-	-	-
Mammals	Deer Mice	-	4.10	-	-	-	-	-	-	-	-	.170	6.80	-	-	-
	Prairie Dogs	-	-	-	-	-	-	-	-	-	-	-	5.40	-	-	-
	Cottontails	-	.370	-	-	-	-	-	-	-	-	-	13.5	-	-	-
	Mule Deer															
Birds	Mourning Doves	-	1.01	-	.140	-	-	-	-	-	-	-	14.2	-	-	-
	Meadowlarks	-	2.44	-	.020	-	-	-	-	-	-	-	29.8	-	.260	-
	Pheasants	-	.170	-	.320	.080	.320	-	-	-	-	-	5.70	-	.200	-
	Kestrels															
	Long-Eared Owls															
	Herons															

TABLE B-11

CONTAMINANTS IN BIOTA FROM AREA C
(in ug/g)

		ALDRN	DLDRN	ISODR	ENDRN	PPDDT	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops							5.53	-	-	-	-				
	Annual Roots							3.84	-	-	-	-				
	Perennial Tops															
	Perennial Roots															
	Aquatic Tops							3.70	-	.870	-	-				
	Aquatic Roots							.080	-	.210	-	-				
Dried Plants	Annual Tops	-	-	1.58	.490	.080	1 28	.370	-	-	-	-	15.5	-	-	-
	Annual Roots	-	.120	-	-	.290	.350	.090	.720	-	-	-	11.9	-	-	-
	Perennial Tops	-	-	.090	.270	.160	.430	.130	-	-	-	-	11.9	-	-	-
	Perennial Roots	-	-	-	-	-	.100	.590	.170	.100	-	-	12.7	-	-	-
	Aquatic Tops	-	.870	.040	.510	-	.030						8.40	-	-	-
	Aquatic Roots	-	.260	-	.150	-	.210						15.1	6.00	-	2.00
Other	Earthworms	-	1.27	-	.340	-	.150	-	-	-	-	-	2.60	-	-	2.45
	Grasshoppers/Beetles															
	Leeches/Snails	.030	2.20	.050	2.34	-	-	-	-	-	-	-	13.4	-	-	-
	Bullheads	.330	3.90	-	-	-	.160	.190	-	-	.360	-				
	Bass															
	Frogs/Toads	-	5.20	-	.030	-	-	-	-	-	-	-	17.3	-	-	-
	Snakes/Lizards	-	3.78	-	-	.090	-	-	-	-	-	-	20.0	-	-	-
Mammals	Deer Mice	-	.080	-		-	.050	-	-	-	-	-	5.50	-	-	-
	Prairie Dogs															
	Cottontails															
	Mule Deer															
Birds	Mourning Doves	-	1.23	-	-	-	.030	-	-	-	-	-	18.5	-	-	-
	Meadowlarks	-	.050	-	-	-	.040	-	-	-	-	-	25.9	-	.370	-
	Pheasants	-	.040	-	-	-	.040	-	-	-	-	-	12.9	-	-	-
	Kestrels															
	Long-Eared Owls															
	Herons															

TABLE B-12

CONTAMINANTS IN BIOTA FROM AREA Q
(in ug/g)

		ALDRN	DLDRN	ISODR	ENDRN	PPDDT	PPDDE	DIMP	CPMSO	CPM02	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops							-	-	-	-	-				
	Annual Roots							-	-	-	-	-				
	Perennial Tops							-	-	-	-	-				
	Perennial Roots							-	-	-	-	-				
	Aquatic Tops							-	-	-	-	-				
	Aquatic Roots							-	-	-	-	-				
Dried Plants	Annual Tops	-	.740	-	-	-	.630	-	-	-	-	-	11.5	-	-	-
	Annual Roots	15.6	49.4	5 60			30 6						11.1	-	.220	-
	Perennial Tops	.030	.050	.060	-	-	100	-	-	-	-	.220	15.4	-	-	-
	Perennial Roots	-	.260	-	-	-	-	-	-	.740	-	.080	18 5			
	Aquatic Tops	.050	-	-		.020	-	-	-	-	-	-	21.5	-	-	-
		-	.060	.020	-	-	-	-	-	-	-	-	22.5	-	-	-
		-	.100	-	-	-	-	-	-	-	-	-	25.3	-	-	-
	Aquatic Roots	-	.080	-	-	.020	-	-	-	-	-	-	28.8	-	-	-
		-	-	-	.050	-	-	-	-	-	-	-	23 2	-	-	-
		-	-	-	-	-	.020	-	-	-	-	-	38.0	-	-	-
Other	Earthworms	-	.220	-	.020	.090	.090	-	-	-	-	-	29.0	-	-	2.65
		-	.560	.090	.040	.060	.030	-	-	-	-	-			.230	
	Grasshoppers/Beetles	-	1.73	-	-	-	.082	-	-	-	-	-				
	Leeches/Snails	21.0	.160	-	1.41	-	-	-	-	-	-	-				
		.100	.040	.840	-	-	-	-	-	-	-	-				
	Bullheads	.060	.690	-	.170	-	.110	.060	-	-	-	-	-	-	-	-
		.290	3.19	-	.080	.030	.100	.090	-	-	-	-	90.9	-	-	-
	Bass	-	.510	-	-	-	.150	.030	-	-	-	-	-	-	.400	-
		.040	.890			-	.120	.060	-	-	-	-				
	Frogs/Toads	-	.150	-	-	040	-	-	-	-	-	-	14.1	-	-	-
		-	.080	-	.020	-	-	-	-	-	-	-	9.70	-	-	-
		1.16	3.95	.040	-	-	-	.090	-	-	-	-	17.5	-	-	-
		-	.700	-	.020	-	.020	-	-	-	-	-	13.1	-	-	-
		-	.070	-	-	.020	-	-	-	-	-	-	15.9	-	-	-
	Snakes/Lizards	.060	.360	-	.030	.090	.040	-	-	-	-	-	16.0	-	-	-
Mammals	Deer Mice	-	3.60	-	-	-	3.60	-	-	-	-	-	5.80	-	-	-
	Prairie Dogs	-	140	.090	.070	.090	.030	-	-	-	-	-	26.0	-	-	-
	Cottontails	-	.440	-	-	-	-	-	-	-	-	-	12.6	-	-	-
	Mule Deer															
Birds	Mourning Doves	-	.080	-	-	-	.030	-	-	-	-	-	13.6	-	-	-
	Meadowlarks	-	.180	-	-	-	.030	-	-	-	-	-	26.4	-	.330	-
	Pheasants	-	.110	-	-	-	.030	-	-	-	-	-	12.1	-	-	-
	Kestrels															
	Long-Eared Owls															
	Herons	-	-	.090	1.54	1.54	2.91	.050	.240	-	-	-	30.9	-	.002	-
		-	1.23	-	.290	.200	1.43	.060	-	-	-	-	26.8	-	.001	-
		-	6.20	-	.770	.700	.520	.050	-	-	-	-	23.9	-	.002	-

TABLE B-13

CONTAMINANTS IN BIOTA FROM AREA E

(in ug/g)

		ALDRN	DLDRN	ISODR	ENDR.	PPDDT	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops															
	Annual Roots															
	Perennial Tops															
	Perennial Roots															
	Aquatic Tops															
	Aquatic Roots															
Dried Plants	Annual Tops	-	-	.020	.040	.040	.150	.050	-	-	-	-	9.70	-	-	1.10
	Annual Roots	-	-	7.83	-	.090	.100	.060	-	-	-	-	11.0	-	-	1.30
	Perennial Tops	.060	-	.060	-	-	-	-	.430	-	-	-	13.6	-	-	-
	Perennial Roots	-	.040	-	-	-	-	-	-	.260	-	.100	13.1	-	-	-
	Aquatic Tops	.070	-	-	-	-	-	-	-	-	-	-	19.2	-	-	-
	Aquatic Roots	-	.020	-	-	-	-	-	-	-	-	-	25.2	-	-	-
Other	Earthworms	-	.040	.060	.020	.250	-	-	-	-	-	-	36.0	-	-	2.54
	Grasshoppers/Beetles	-	-	-	-	-	-	-	-	-	-	-				
	Leeches/Snails															
	Bullheads															
	Bass															
	Frogs/Toads	-	.040	-	.020	.020	-	-	-	-	-	-	15.2	-	-	-
	Snakes/Lizards	-	.060	-	-	-	-	-	-	-	-	-	15.0	-	-	-
Mammals	Deer Mice	-	.050	-	-	-	-	-	-	-	-	-	16.4	-	-	-
	Prairie Dogs	-	-	-	-	-	-	-	-	-	-	-	6.40	-	-	-
	Cottontails	-	.040	-	-	-	-	-	-	-	-	-	25.0	-	-	-
	Mule Deer															
Birds	Mourning Doves	-	.140	-	-	-	.170	-	-	-	-	-	7.70	-	-	-
	Meadowlarks	-	.050	-	.020	-	.030	-	-	-	-	-	19.6	-	.260	-
	Pheasants	-	.040	-	-	-	-	-	-	-	-	-	9.90	-	-	-
	Kestrels															
	Long-Eared Owls															
	Herons															

TABLE 8-14

CONTAMINANTS IN BIOTA FROM AREA F

(in ug/g)

		ALDRN	DLDRN	ISODR	ENDRN	PPDDT	PPDDE	DIMP	CPMSO	CPMO2	OXAT	DITH	CU	AS	HG	CD
Fresh Plants	Annual Tops															
	Annual Roots															
	Perennial Tops															
	Perennial Roots															
	Aquatic Tops															
	Aquatic Roots															
Dried Plants	Annual Tops															
	Annual Roots															
	Perennial Tops															
	Perennial Roots															
	Aquatic Tops															
	Aquatic Roots															
Other	Earthworms															
	Grasshoppers/Beetles															
	Leeches/Snails															
	Bullheads															
	Bass															
	Frogs/Toads															
	Snakes Lizards															
Mammals	Deer Mice															
	Prairie Dogs															
	Cottontails															
	Mule Deer	.100	-	-	-	-	.220	-	-	-	-	-	6.90	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	.80	-	-	-
		-	.210	-	-	-	.340	-	-	-	-	-	8.00	-	-	-
		-	-	-	-	-	-	-	-	.250	-	.060	8.40	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	8.80	-	-	-
		-	.480	-	-	-	-	-	-	-	-	.100			-	
		-	-	-	-	-	-	-	-	-	-	.130				
Birds	Mourning Doves															
	Meadowlarks															
	Pheasants															
	Kestrels	-	-	.070	070	-	-	-	-	-	-	-	15.5	-	-	-
		-	-	-	.110	-	-	.070	-	.400	-	-	16.2	-	-	-
		.020	-	.020	.090	-	-	.090	.740	-	-	-	12.6	-	.220	-
	Long Eared Owls	-	.170	-	.040	-	.170	-	-	-	-	-	15.8	-	-	-
	Herons	-	.110	-	-	-	.030	.070	-	-	-	-	14.1	-	-	-

TABLE B-15

CONTAMINANTS IN AMERICAN KESTRELS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE
ENDRIN	3/3	0.090	0.07 - 0.11
CPMSO	1/3	0.74	
CPMO2	1/3	0.400	
HG	1/3	0.220	
ISODR	1/3	0.070	
ALDRIN	0/3	LT 0.05	
DLDRN	0/3	LT 0.05	
PPDDE	0/3	LT 0.05	
DITH	0/3	LT 0.10	

TABLE B-1

CONTAMINANTS IN ANNUAL PI

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES
DIMP	13/13
CD	4/8
PPDDE	4/9
ISODR	2/7
DLDRN	2/12
PPDDT	2/12
ALDRN	1/7
ENDRN	1/11
CPMO2	1/15
CPMSO	0/9
OXAT	0/7
HG	0/7
CU	0/6
DITH	0/5
AS	0/1

* See Table 4-1 for minimum concentrat

TABLE B-17

CONTAMINANTS IN ANNUAL PLANT ROOTS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE
PPDDT	12/13	0.459	0.09 - 2.07
DLDRN	11/13	5.206	0.06 - 49.40
ENDRN	9/12	0.236	0.06 - 0.62
PPDDE	6/9	5.417	0.11 - 30.60
ISODR	3/7	4.567	0.27 - 7.83
DIMP	5/13	1.756	0.40 - 3.84
CD	3/8	1.200	1.00 - 1.30
HG	2/7	0.235	0.22 - 0.25
ALDRN	1/7	15.600	
OXAT	1/7	0.360	
CPMSO	1/9	0.720	
CPMOE	1/15	1.470	
CU	0/6	LT 20.00	
DITH	0/5	LT 0.10	
AS	0/1	LT 5.00	

TABLE B-18

CONTAMINANTS IN AQUATIC PLANT TOPS ON RMA *

NO. POSITIVE/ NO. SAMPLES	CONCEN[illegible] MEAN

TABLE B-19

CONTAMINANTS IN AQUATIC PLANT ROOTS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE
AS	1/1	6.000	
CU	6/7	27.600	22.30 - 38.00
ENDRN	3/6	0.703	0.05 - 1.91
DLDRN	3/7	0.147	0.08 - 0.26
CD	1/7	2.000	
ALDRN	1/7	0.620	
PPDDE	1/7	0.210	
CPMO2	1/10	0.210	
CPMSO	0/10	LT 0.10	
DITH	0/8	LT 0.10	
ISODR	0/7	LT 0.05	
PPDDT	0/7	LT 0.05	
HG	0/7	LT 0.20	
DIMP	0/3	LT 0.10	
OXAT	0/2	LT 0.10	

TABLE B-20

CONTAMINANTS IN BLACK BULLHEADS ON RMA *

CONTAMINANT	NO POSITIVE/ NO SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE
DLDRN	2/2	1.940	0.69 - 3.19
ALDRN	2/2	0.175	0.06 - 0.29
ENDRN	2/2	0.125	0.08 - 0.17
PPDDE	2/2	0.105	0.10 - 0.11
CU	1/2	90.900	
ISODR	0/2	LT 0.05	
PPDDT	0/2	LT 0.05	
CPMSO	0/2	LT 0.10	
CPMO2	0/2	LT 0.10	
DITH	0/2	LT 0.10	
HG	0/2	LT 0.20	
CD	0/2	LT 1.00	

* See Table 4-1 for minimum concentrations and areas.

TABLE B-21

CONTAMINANTS IN BLACK-TAILED PRAIRIE DOGS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE
DIMP	6/10	1.113	0.20 - 3.72
OXAT	2/4	0.120	
DLDRN	5/12	0.196	0.06 - 0.57
CU	1/5	26.000	
DITH	1/5	0.130	
ISODR	1/6	0.090	
PPDDE	1/8	0.130	
ENDRN	1/11	0.070	
CPMO2	1/12	0.220	
PPDDT	1/12	0.090	
CD	0/7	LT 1.00	
ALDRN	0/6	LT 0.05	
CPMSO	0/6	LT 0.10	
HG	0/5	LT 0.20	

TABLE B-22

CONTAMINANTS IN SPADEFOOT TOADS AND BULLFROGS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE
DLDRN	9/10	1.212	0.07 - 3.95
OXAT	1/2	0.480	
ALDRN	3/9	0.607	0.07 - 1.16
ENDRN	2/9	0.150	0.13 - 0.17
ISODR	2/10	0.165	0.11 - 0.22
PPDDE	2/10	0.075	0.06 - 0.09
PPDDT	1/10	0.080	
CPMO2	0/10	LT 0.10	
HG	0/10	LT 0.20	
CD	0/10	LT 1.00	
CPMSO	0/9	LT 0.10	
CU	0/9	LT 20.00	
DITH	0/8	LT 0.10	
DIMP	0/4	LT 0.10	
AS	0/1	LT 5.00	

* See Table 4-1 for minimum concentrations and areas.

TABLE B-23

CONTAMINANTS IN LIZARDS AND BULLSNAKES ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES		CONCENTRATION (UG/G) MEAN	RANGE
DLDRN	6/6		1.423	0.06 - 3.78
CU	2/4		20.000	
PPDDT	2/6		0.090	
ALDRN	2/6		0.065	0.06 - 0.07
DIMP	1/4		0.310	
ENDRN	1/5		0.120	
PPDDE	0/6	LT	0.05	
ISODR	0/5	LT	0.05	
CPMSO	0/5	LT	0.10	
CPMO2	0/5	LT	0.10	
HG	0/4	LT	0.20	
CD	0/4	LT	1.00	
DITH	0/3	LT	0.10	
OXAT	0/1	LT	0.10	
AS	0/1	LT	5.00	

TABLE B-24

CONTAMINANTS IN DEER MICE ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES		CONCENTRATION (UG/G) MEAN	RANGE
DLDRN	12/13		1.117	0.05 - 4.90
DITH	2/5		0.505	0.17 - 0.84
PPDDE	3/9		1.233	0.05 - 3.60
DIMP	1/11		0.110	
PPDDT	0/13	LT	0.05	
CPMO2	0/13	LT	0.10	
ENDRN	0/12	LT	0.05	
ALDRN	0/7	LT	0.05	
ISODR	0/7	LT	0.05	
CPMSO	0/7	LT	0.10	
HG	0/7	LT	0.20	
CD	0/7	LT	1.00	
OXAT	0/5	LT	0.10	
CU	0/5	LT	20.00	
AS	0/1	LT	5.00	

* See Table 4-1 for minimum concentrations and areas.

TABLE B-25

CONTAMINANTS IN DESERT COTTONTAILS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES		CONCENTRATION (UG/G) MEAN	RANGE
DLDRN	3/4		0.340	0.21 - 0.44
CU	1/4		25.000	
ALDRN	0/4	LT	0.05	
ISODR	0/4	LT	0.05	
PPDDT	0/4	LT	0.05	
PPDDE	0/4	LT	0.05	
CPMSO	0/4	LT	0.10	
CPMO2	0/4	LT	0.10	
HG	0/4	LT	0.20	
CD	0/4	LT	1.00	
ENDRN	0/3	LT	0.05	
DITH	0/3	LT	0.10	
DIMP	0/2	LT	0.10	
OXAT	0/1	LT	0.10	

TABLE B-26

CONTAMINANTS IN EARTHWORMS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES		CONCENTRATION (UG/G) MEAN	RANGE
CU	5/5		33.600	26.00 - 46.00
CD	5/5		2.768	2.45 - 3.63
DLDRN	5/6		3.124	0.22 - 7.00
PPDDT	4/6		0.145	0.06 - 0.25
ENDRN	3/5		0.860	0.76 - 0.98
ISODR	3/6		0.157	0.06 - 0.32
PPDDE	2/6		0.120	0.09 - 0.15
HG	1/6		0.230	
ALDRN	0/6	LT	0.05	
CPMSO	0/6	LT	0.10	
CPMO2	0/6	LT	0.10	
DITH	0/4	LT	0.10	
DIMP	0/3	LT	0.10	
OXAT	0/2	LT	0.10	
AS	0/1	LT	5.00	

* See Table 4-1 for minimum concentrations and areas.

TABLE B-27

CONTAMINANTS IN BEETLES AND GRASSHOPPERS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES		CONCENTRATION (UG/G) MEAN	RANGE
CU	3/4		30.800	20.40 - 37.60
DLDRN	7/11		1.630	0.08 - 5.38
DIMP	5/9		0.358	0.17 - 0.71
CPMO2	6/11		0.930	0.11 - 2.94
CPMSO	5/10		0.648	0.27 - 1.11
ALDRN	3/9		0.421	0.17 - 0.70
ISODR	2/9		0.128	0.09 - 0.17
PPDDE	2/10		0.071	0.06 - 0.08
ENDRN	2/10		0.060	0.05 - 0.07
DITH	1/8		0.350	
PPDDT	0/11	LT	0.05	
CD	0/4	LT	1.00	
HG	0/3	LT	0.20	
OXAT	0/1	LT	0.10	

TABLE B-28

CONTAMINANTS IN GREAT BLUE HERONS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES		CONCENTRATION (UG/G) MEAN	RANGE
CU	3/3		27.200	23.90 - 30.90
HG	3/3		1.733	1.00 - 2.20
PPDDE	3/3		1.620	0.52 - 2.91
ENDRN	3/3		0.867	0.29 - 1.54
PPDDT	3/3		0.813	0.20 - 1.54
DLDRN	2/3		3.715	1.23 - 6.20
CPMSO	1/3		0.240	
ISODR	1/3		0.090	
ALDRN	0/3	LT	0.05	
CPMO2	0/3	LT	0.10	
DITH	0/3	LT	0.10	
CD	0/3	LT	1.00	

* See Table 4-1 for minimum concentrations and areas.

TABLE B-29

CONTAMINANTS IN LARGEMOUTH BASS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE
DLDRN	2/2	0.700	0.51 - 0.89
HG	1/1	0.400	
PPDDE	2/2	0.135	0.12 - 0.15
ALDRN	0/2	LT 0.05	
ISODR	0/2	LT 0.05	
ENDRN	0/2	LT 0.05	
PPDDT	0/2	LT 0.05	
CPMSO	0/2	LT 0.10	
CPMO2	0/2	LT 0.10	
DITH	0/2	LT 0.10	
CU	0/1	LT 20.00	
CD	0/1	LT 1.00	

TABLE B-30

CONTAMINANTS IN SNAILS AND LEECHES ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE
ALDRN	3/4	7.143	0.10 - 21.00
DLDRN	3/4	2.087	0.16 - 3.90
ENDRN	2/4	1.875	1.41 - 2.34
ISODR	2/4	0.445	0.05 - 0.84
OXAT	1/2	0.360	
DIMP	1/2	0.190	
PPDDE	1/4	0.160	
PPDDT	0/4	LT 0.05	
CPMSO	0/4	LT 0.10	
CPMO2	0/4	LT 0.10	
DITH	0/2	LT 0.10	
CU	0/1	LT 20.00	
AS	0/1	LT 5.00	
HG	0/1	LT 0.20	
CD	0/1	LT 1.00	

* See Table 4-1 for minimum concentrations and areas.

TABLE B-31
CONTAMINANTS IN LONG-EARED OWLS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES		CONCENTRATION (UG/G) MEAN	RANGE
DLDRN	2/2		0.140	0.11 - 0.17
PPDDE	1/2		0.170	
ALDRN	0/2	LT	0.05	
ISODR	0/2	LT	0.05	
ENDRN	0/2	LT	0.05	
CPMSO	0/2	LT	0.10	
CPMO2	0/2	LT	0.10	
DITH	0/2	LT	0.10	
HG	0/2	LT	0.20	

TABLE B-32
CONTAMINANTS IN MOURNING DOVES ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES		CONCENTRATION (UG/G) MEAN	RANGE
DLDRN	5/5		0.598	0.08 - 1.23
ENDRN	1/4		0.140	
PPDDE	1/5		0.170	
ALDRN	0/5	LT	0.05	
ISODR	0/5	LT	0.05	
PPDDT	0/5	LT	0.05	
CPMSO	0/5	LT	0.10	
CPMO2	0/5	LT	0.10	
CU	0/5	LT	20.00	
HG	0/5	LT	0.20	
CD	0/5	LT	1.00	
DIMP	0/3	LT	0.10	
DITH	0/3	LT	0.10	
OXAT	0/2	LT	0.10	
AS	0/1	LT	5.00	

* See Table 4-1 for minimum concentrations and areas.

TABLE B-33

CONTAMINANTS IN MULE DEER ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES		CONCENTRATION (UG/G) MEAN	RANGE
DLDRN	2/7		0.345	0.21 - 0.48
PPDDE	2/7		0.280	0.22 - 0.34
DITH	2/7		0.115	0.10 - 0.13
CPMO2	1/7		0.250	
ALDRN	1/7		0.100	
ISODR	0/7	LT	0.05	
ENDRN	0/7	LT	0.05	
CPMSO	0/7	LT	0.10	
HG	0/6	LT	0.20	

TABLE B-34

CONTAMINANTS IN PERENNIAL PLANT TOPS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES		CONCENTRATION (UG/G) MEAN	RANGE
ISODR	6/7		0.065	0.05 - 0.09
PPDDT	8/11		0.364	0.13 - 1.00
DIMP	6/9		1.305	0.13 - 5.15
DLDRN	7/11		0.256	0.05 - 0.97
ENDRN	5/10		0.126	0.06 - 0.21
CPMO2	5/11		0.670	0.30 - 1.21
PPDDE	4/9		0.250	0.10 - 0.43
HG	2/7		0.420	0.24 - 0.60
ALDRN	2/7		0.085	0.06 - 0.11
DITH	1/5		0.220	
CPMSO	1/6		0.430	
CD	0/7	LT	1.00	
CU	0/6	LT	20.00	
OXAT	0/4	LT	0.10	
AS	0/1	LT	5.00	

* See Table 4-1 for minimum concentrations and areas.

TABLE B-35

CONTAMINANTS IN PERENNIAL PLANT ROOTS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE
DLDRN	9/11	1.693	0.20 - 12.00
PPDDT	8/11	0.805	0.11 - 2.07
ENDRN	6/10	0.310	0.06 - 0.90
PPDDE	4/9	1.457	0.10 - 4.00
ISODR	2/7	1.100	0.20 - 2.00
ALDRN	2/7	1.030	0.06 - 2.00
CPMO2	3/11	0.367	0.10 - 0.74
DITH	1/5	0.100	
CPMSO	1/6	0.170	
CD	1/7	1.100	
DIMP	1/9	0.590	
HG	0/7	LT 0.20	
CU	0/6	LT 20.00	
OXAT	0/4	LT 0.10	
AS	0/1	LT 5.00	

TABLE B-36

CONTAMINANTS IN RING-NECKED PHEASANTS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE
DLDRN	3/5	0.160	0.11 - 0.20
ENDRN	2/4	0.345	0.32 - 0.37
PPDDE	2/5	0.270	0.22 - 0.32
HG	2/5	0.200	
PPDDT	2/5	0.095	0.08 - 0.11
ALDRN	0/5	LT 0.05	
ISODR	0/5	LT 0.05	
CPMSO	0/5	LT 0.10	
CPMO2	0/5	LT 0.10	
CU	0/5	LT 20.00	
CD	0/5	LT 1.00	
DIMP	0/3	LT 0.10	
DITH	0/3	LT 0.10	
OXAT	0/2	LT 0.10	
AS	0/1	LT 5.00	

* See Table 4-1 for minimum concentrations and areas.

TABLE B-37

CONTAMINANTS IN WESTERN MEADOWLARKS ON RMA *

CONTAMINANT	NO. POSITIVE/ NO. SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE
DLDRN	5/5	0.742	0.05 - 2.44
HG	5/5	0.310	0.26 - 0.37
CU	4/5	26.850	25.30 - 29.80
ALDRN	0/5	LT 0.05	
ISODR	0/5	LT 0.05	
PPDDT	0/5	LT 0.05	
PPDDE	0/5	LT 0.05	
CPMSO	0/5	LT 0.10	
CPMO2	0/5	LT 0.10	
CD	0/5	LT 1.00	
ENDRN	0/4	LT 0.05	
DIMP	0/3	LT 0.10	
DITH	0/3	LT 0.10	
OXAT	0/2	LT 0.10	
AS	0/1	LT 5.00	

* See Table 4-1 for minimum concentrations and areas.

TABLE B-38
ALDRIN IN THE BIOTA ON RMA*

SPECIMEN	NO. POSITIVE/ NO. OF SAMPLES	CONCENTATION UG/G MEAN	RANGE (MIN/MAX)
Bullheads	2/2	0.175	0.06 - 0.29
Leeches/Snails	3/4	7.143	0.10 - 21.0
Aquatic Plant Tops	3/7	0.067	0.05 - 0.08
Frogs/Toads	3/9	0.607	0.07 - 1.16
Grasshoppers/Beetles	3/9	0.421	0.17 - 0.70
Snakes/Lizards	2/6	0.065	0.06 - 0.07
Perennial Plant Roots	2/7	1.030	0.06 - 2.00
Perennial Plant Tops	2/7	0.085	0.06 - 0.11
Annual Plant Roots	1/7	15.600	
Aquatic Plant Roots	1/7	0.620	
Annual Plant Tops	1/7	0.120	
Mule Deer	1/7	0.100	
Deer Mice	0/7	LT 0.05	
Earthworms	0/6	LT 0.05	
Prairie Dogs	0/6	LT 0.05	
Mourning Doves	0/5	LT 0.05	
Meadow Larks	0/5	LT 0.05	
Pheasants	0/5	LT 0.05	
Cottontails	0/4	LT 0.05	
Kestrels	0/3	LT 0.05	
Herons	0/3	LT 0.05	
Bass	0/2	LT 0.05	
Long-Eared Owls	0/2	LT 0.05	
Totals	24/127	1.828	0.05 - 21.00

*See Table 4-1 for minimum concentration and areas.

TABLE B-39
ARSENIC IN THE BIOTA ON RMA*

SPECIMEN	NO. POSITIVE/ NO. OF SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE (MIN/MAX)
Aquatic Plant Roots	1/1	6.000	
Annual Plant Tops	0/1	LT 5.00	
Annual Plant Roots	0/1	LT 5.00	
Perennial Plant Tops	0/1	LT 5.00	
Perennial Plant Roots	0/1	LT 5.00	
Aquatic Plant Tops	0/1	LT 5.00	
Earthworms	0/1	LT 5.00	
Leeches/Snails	0/1	LT 5.00	
Frogs/Toads	0/1	LT 5.00	
Snakes/Lizards	0/1	LT 5.00	
Mourning Doves	0/1	LT 5.00	
Meadow Larks	0/1	LT 5.00	
Pheasants	0/1	LT 5.00	
Deer Mice	0/1	LT 5.00	
Total	1/14	6.000	

*See Table 4-1 for minimum concentration and areas.

TABLE B-40
CADMIUM IN THE BIOTA ON RM.

SPECIMEN	NO. POSITIVE/ NO. OF SAMPLES		MEAN	
Earthworms	5/5		2.768	
Annual Plant Tops	4/8		1.375	1.10 - 1.70
Annual Plant Roots	3/8		1.200	1.00 - 1.30
Aquatic Plant Roots	1/7		2.000	
Perennial Plant Roots	1/7		1.100	
Frogs/Toads	0/10	LT	1.00	
Perrennial Plant Tops	0/7	LT	1.00	
Aquatic Plant Tops	0/7	LT	1.00	
Deer Mice	0/7	LT	1.00	
Prairie Dogs	0/7	LT	1.00	
Mourning Doves	0/5	LT	1.00	
Meadow Larks	0/5	LT	1.00	
Pheasants	0/5	LT	1.00	
Grasshoppers/Beetles	0/4	LT	1.00	
Snakes/Lizards	0/4	LT	1.00	
Cottontails	0/4	LT	1.00	
Herons	0/3	LT	1.00	
Bullheads	0/2	LT	1.00	
Leeches/Snails	0/1	LT	1.00	
Bass	0/1	LT	1.00	
Totals	14/107		1.860	1.00 - 3.63

*See Table 4-1 for minimum concentration and areas.

Perennial Plant Roots	3/11			
Mule Deer	1/7		0.250	
Aquatic Plant Tops	1/10		0.870	
Aquatic Plant Roots	1/10		0.210	
Prairie Dogs	1/12		0.220	
Annual Plant Tops	1/15		2.830	
Annual Plant Roots	1/15		1.470	
Deer Mice	0/13	LT	0.10	
Frogs/Toads	0/10	LT	0.10	
Earthworms	0/6	LT	0.10	
Snakes/Lizards	0/5	LT	0.10	
Mourning Doves	0/5	LT	0.10	
Meadow Larks	0/5	LT	0.10	
Pheasants	0/5	LT	0.10	
Leeches/Snails	0/4	LT	0.10	
Cottontails	0/4	LT	0.10	
Herons	0/3	LT	0.10	
Bullheads	0/2	LT	0.10	
Bass	0/2	LT	0.10	
Long-Eared Owls	0/2	LT	0.10	
Totals	21/171		0.775	0.10 - 2.94

*See Table 4-1 for minimum concentration and areas.

TABLE B-42

CHLOROPHENYLMETHYL SULFOXIDE (CPMSO) IN THE BIOTA AT RMA *

SPECIMEN	NO. POSITIVE/ NO. OF SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE (MIN/MAX)
Grasshoppers/Beetles	5/10	0.648	0.27 - 1.11
Kestrels	1/3	0.740	
Herons	1/3	0.240	
Perennial Plant Tops	1/6	0.430	
Perennial Plant Roots	1/6	0.170	
Annual Plant Roots	1/9	0.720	
Aquatic Plant Tops	0/10	LT 0.100	
Aquatic Plant Roots	0/10	LT 0.100	
Annual Plant Tops	0/9	LT 0.100	
Frogs/Toads	0/9	LT 0.100	
Deer Mice	0/7	LT 0.100	
Mule Deer	0/7	LT 0.100	
Earthworms	0/6	LT 0.100	
Prairie Dogs	0/6	LT 0.100	
Snakes/Lizards	0/5	LT 0.100	
Mourning Doves	0/5	LT 0.100	
Meadow Larks	0/5	LT 0.100	
Pheasants	0/5	LT 0.100	
Leeches/Snails	0/4	LT 0.100	
Cottontails	0/4	LT 0.100	
Bullheads	0/2	LT 0.100	
Bass	0/2	LT 0.100	
Long-eared Owls	0/2	LT 0.100	
Totals	10/135	0.554	0.17 - 1.11

*See Table 4-1 for minimum concentration and areas.

TABLE B-43
COPPER IN THE BIOTA ON RMA*

SPECIMEN	NO. POSITIVE/ NO. OF SAMPLES		CONCENTATION (UG/G) MEAN	RANGE (MIN/MAX)
Earthworms	5/5		33.600	26.00 - 46.00
Herons	3/3		27.200	23.90 - 30.90
Aquatic Plant Roots	6/7		27.600	22.30 - 38.00
Meadow Larks	4/5		26.850	25.30 - 29.80
Grasshoppers/Beetles	3/4		30.800	20.40 - 37.60
Bullheads	1/2		90.900	
Snakes/Lizards	2/4		20.000	
Aquatic Plant Tops	3/7		23.200	21.50 - 25.80
Cottontails	1/4		25.000	
Prairie Dogs	1/5		26.000	
Frogs/Toads	0/9	LT	20.00	
Annual Plant Tops	0/6	LT	20.00	
Annual Plant Roots	0/6	LT	20.00	
Perennial Plant Tops	0/6	LT	20.00	
Perennial Plant Roots	0/6	LT	20.00	
Mourning Doves	0/5	LT	20.00	
Pheasants	0/5	LT	20.00	
Deer Mice	0/5	LT	20.00	
Leeches/Snails	0/1	LT	20.00	
Bass	0/1	LT	20.00	
Totals	29/96		29.879	20.00 - 90.90

*See Table 4-1 for minimum concentration and areas.

TABLE B-44
P,P-DDE IN THE BIOTA ON RMA*

SPECIMEN	NO. POSITIVE/ NO. OF SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE (MIN/MAX)
Herons	3/3	1.620	0.52 - 2.91
Bass	2/2	0.135	0.12 - 0.15
Bullheads	2/2	0.105	0.10 - 0.11
Annual Plant Roots	6/9	5.417	0.11 - 30.60
Long-Eared Owls	1/2	0.170	
Perennial Plant Roots	4/9	1.457	0.10 - 4.00
Annual Plant Tops	4/9	0.595	0.15 - 1.28
Perennial Plant Tops	4/9	0.250	0.10 - 0.43
Pheasants	2/5	0.270	0.22 - 0.32
Deer Mice	3/9	1.233	0.05 - 3.60
Earthworms	2/6	0.120	0.09 - 0.15
Mule Deer	2/7	0.280	0.22 - 0.34
Leeches/Snails	1/4	0.160	
Mourning Doves	1/5	0.170	
Frogs/Toads	2/10	0.075	0.06 - 0.09
Grasshoppers/Beetles	2/10	0.071	0.06 - 0.08
Aquatic Plant Roots	1/7	0.210	
Aquatic Plant Tops	1/7	0.050	
Prairie Dogs	1/8	0.130	
Snakes/Lizards	0/6	LT 0.05	
Meadow Larks	0/5	LT 0.05	
Cottontails	0/4	LT 0.05	
Kestrels	0/3	LT 0.05	
Totals	44/141	1.211	0.05 - 30.60

*See Tables 4-1 for minimum concentration and areas.

TABLE B-45
P,P-DDT IN THE BIOTA ON RMA*

SPECIMEN	NO. POSITIVE/ NO. OF SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE (MIN/MAX)
Herons	3/3	0.813	0.20 - 1.54
Annual Plant Roots	12/13	0.459	0.09 - 2.07
Perennial Plant Roots	8/11	0.805	0.11 - 2.07
Perennial Plant Tops	8/11	0.364	0.13 - 1.00
Earthworms	4/6	0.145	0.06 - 0.25
Pheasants	2/5	0.095	0.08 - 0.11
Snakes/Lizards	2/6	0.090	
Annual Plant Tops	2/12	0.185	0.08 - 0.29
Aquatic Plant Tops	1/7	0.140	
Frogs/Toads	1/10	0.080	
Prairie Dogs	1/12	0.090	
Deer Mice	0/13	LT 0.05	
Grasshoppers/Beetles	0/11	LT 0.05	
Aquatic Plant Roots	0/7	LT 0.05	
Mourning Doves	0/5	LT 0.05	
Meadow Larks	0/5	LT 0.05	
Leeches/Snails	0/4	LT 0.05	
Cottontails	0/4	LT 0.05	
Bullheads	0/2	LT 0.05	
Bass	0/2	LT 0.05	
Total	44/149	0.430	0.06 - 2.07

*See Table 4-1 for minimum concentration and areas.

TABLE B-46
DIELDRIN IN THE BIOTA ON RMA*

SPECIMEN	NO. POSITIVE/ NO. OF SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE (MIN/MAX)
Bullheads	2/2	1.940	0.69 - 3.19
Snakes/Lizards	6/6	1.423	0.06 - 3.78
Meadow Larks	5/5	0.742	0.05 - 2.44
Bass	2/2	0.700	0.51 - 0.89
Mourning Doves	5/5	0.598	0.08 - 1.23
Long-Eared Owls	2/2	0.140	0.11 - 0.17
Deer Mice	12/13	1.117	0.05 - 4.90
Frogs/Toads	9/10	1.212	0.07 - 3.95
Annual Plant Roots	11/13	5.206	0.06 - 49.40
Earthworms	5/6	3.124	0.22 7.00
Perennial Plant Roots	9/11	1.693	0.20 - 12.00
Leeches/Snails	3/4	2.087	0.16 - 3.90
Cottontails	3/4	0.340	0.21 - 0.44
Aquatic Plant Tops	5/7	0.470	0.06 - 1.25
Herons	2/3	3.715	1.23 - 6.20
Grasshoppers/Beetles	7/11	1.630	0.08 - 5.38
Perennial Plant Tops	7/11	0.256	0.05 - 0.97
Pheasants	3/5	0.160	0.11 - 0.20
Aquatic Plant Roots	3/7	0.147	0.08 - 0.26
Prairie Dogs	5/12	0.196	0.06 - 0.57
Mule Deer	2/7	0.345	0.21 - 0.48
Annual Plant Tops	2/12	0.640	0.54 - 0.74
Kestrels	0/3	LT 0.05	
Totals	110/161	1.522	0.05 - 49.40

*See Table 1-1 for minimum concentration and areas.

TABLE B-47

DIISOPROPYLMETHYL PHOSPHONATE (DIMP) IN THE BIOTA ON RMA*

SPECIMEN	NO. POSITIVE/ NO. OF SAMPLES	CONCENTRATION UG/G) MEAN	RANGE (MIN/MAX)
Annual Plant Tops	13/13	4.435	0.29 - 21.20
Perennial Plant Tops	6/9	1.305	0.13 - 5.15
Prairie Dogs	6/10	1.113	0.20 - 3.72
Grasshoppers/Beetles	5/9	0.358	0.17 - 0.71
Leeches/Snails	1/2	0.190	
Annual Plant Roots	5/13	1.756	0.40 - 3.84
Aquatic Plant Tops	1/3	0.370	
Snakes/Lizards	1/4	0.310	
Perennial Plant Roots	1/9	0.590	
Deer Mice	1/11	0.110	
Frogs/Toads	0/4	LT 0.10	
Aquatic Plant Roots	0/3	LT 0.10	
Earthworms	0/3	LT 0.10	
Mourning Doves	0/3	LT 0.10	
Meadow Larks	0/3	LT 0.10	
Pheasants	0/3	LT 0.10	
Cottontails	0/2	LT 0.10	
Totals	40/104	2.108	0.11 - 21.20

*See Table 4-1 for minimum concentation and areas.

TABLE B-48
DITHIANE IN THE BIOTA ON RMA*

SPECIMEN	NO. POSITIVE/ NO. OF SAMPLES		CONCENTRATION (UG/G) MEAN	RANGE (MIN/MAX)
Deer Mice	2/5		0.505	0.17 - 0.84
Mule Deer	2/7		0.115	0.10 - 0.13
Perennial Plant Tops	1/5		0.220	
Prairie Dogs	1/5		0.130	
Perennial Plant Roots	1/5		0.100	
Grasshoppers/Beetles	1/8		0.350	
Aquatic Plant Tops	0/8	LT	0.10	
Aquatic Plant Roots	0/8	LT	0.10	
Frogs/Toads	0/8	LT	0.10	
Annual Plant Tops	0/5	LT	0.10	
Annual Plant Roots	0/5	LT	0.10	
Earthworms	0/4	LT	0.10	
Snakes/Lizards	0/3	LT	0.10	
Mourning Doves	0/3	LT	0.10	
Meadow Larks	0/3	LT	0.10	
Pheasants	0/3	LT	0.10	
Kestrels	0/3	LT	0.10	
Herons	0/3	LT	0.10	
Cottontails	0/3	LT	0.10	
Leeches/Snails	0/2	LT	0.10	
Bullheads	0/2	LT	0.10	
Bass	0/2	LT	0.10	
Long-Eared Owls	0/2	LT	0.10	
Totals	8/102		0.255	0.10 - 0.84

*See Table 4-1 for minimum concentation and areas.

TABLE B-49
ENDRIN IN THE BIOTA ON RMA*

SPECIMEN	NO. POSITIVE/ NO. OF SAMPLES	CONCENTRATION (UG/G) MEAN	RANGE (MIN/MAX)
Herons	3/3	0.867	0.29 - 1.54
Bullheads	2/2	0.125	0.08 - 0.17
Sentinels	3/3	0.090	0.07 - 0.11
Annual Plant Roots	9/12	0.236	0.06 - 0.62
Earthworms	3/5	0.860	0.76 - 0.98
Perennial Plant Roots	6/10	0.310	0.06 - 0.90
Leeches/Snails	2/4	1.875	1.41 - 2.34
Aquatic Plant Roots	3/6	0.703	0.05 - 1.91
Pheasants	2/4	0.345	0.32 - 0.37
Perennial Plant Toos	5/10	0.126	0.06 - 0.21
Aquatic Plant Tops	2/6	0.335	0.16 - 0.51
Mourning Doves	1/4	0.140	
Frogs/Toads	2/9	0.150	0.13 - 0.17
Snakes/Lizards	1/5	0.120	
Grasshoppers/Beetles	2/10	0.060	0.05 - 0.07
Annual Plant Tops	1/11	0.490	
Prairie Dogs	1/11	0.070	
Deer Mice	0/12	LT 0.05	
Mule Deer	0/7	LT 0.05	
Meadow Larks	0/4	LT 0.05	
Cottontails	0/3	LT 0.05	
Bass	0/2	LT 0.05	
Long-Eared Owls	0/2	LT 0.05	
Total	48/145	0.391	0.05 - 2.34

*See Table 4-1 for minimum concentration and areas.

TABLE B-50
ISODRIN IN THE BIOTA ON RMA*

SPECIMEN	NO. POSITIVE/ NO OF SAMPLES		CONCENTRATION (UG/G) MEAN	RANGE (MIN/MAX)
Perennial Plant Tops	6/7		0.065	0.05 - 0.09
Leeches/Snails	2/4		0.445	0.05 - 0.84
Earthworms	3/6		0.157	0.06 - 0.32
Annual Plant Roots	3/7		4.567	0.27 - 7.83
Herons	1/3		0.090	
Kestrels	1/3		0.070	
Perennial Plant Roots	2/7		1.100	0.20 - 2.00
Annual Plant Tops	2/7		0.920	0.26 - 1.58
Grasshoppers/Beetles	2/9		0.128	0.09 - 0.17
Frogs/Toads	2/10		0.165	0.11 - 0.22
Prairie Dogs	1/6		0.090	
Aquatic Plant Tops	0/7	LT	0.05	
Aquatic Plant Roots	0/7	LT	0.05	
Deer Mice	0/7	LT	0.05	
Mule Deer	0/7	LT	0.05	
Snakes/Lizards	0/5	LT	0.05	
Mourning Doves	0/5	LT	0.05	
Meadow Larks	0/5	LT	0.05	
Pheasants	0/5	LT	0.05	
Cottontails	0/4	LT	0.05	
Bullheads	0/2	LT	0.05	
Bass	0/2	LT	0.05	
Long-Eared Owls	0/2	LT	0.05	
Totals	25/127		0.813	0.05 - 7.83

*See Table 4-1 for minimum concentration and areas.

TABLE B-51
MERCURY IN THE BIOTA ON RMA*

SPECIMEN	NO. POSITIVE/ NO. OF SAMPLES		CONCENTRATION (UG/G) MEAN	RANGE (MIN/MAX)
Herons	3/3		1.733	1.00 - 2.20
Bass	1/1		0.400	
Meadow Larks	5/5		0.310	0.26 - 0.37
Pheasants	2/5		0.200	
Kestrels	1/3		0.220	
Perennial Plant Tops	2/7		0.420	0.24 - 0.60
Annual Plant Roots	2/7		0.235	0.22 - 0.25
Earthworms	1/6		0.230	
Frogs/Toads	0/10	LT	0.20	
Annual Plant Tops	0/7	LT	0.20	
Perennial Plant Roots	0/7	LT	0.20	
Aquatic Plant Tops	0/7	LT	0.20	
Aquatic Plant Roots	0/7	LT	0.20	
Deer Mice	0/7	LT	0.20	
Mule Deer	0/6	LT	0.20	
Mourning Doves	0/5	LT	0.20	
Prairie Dogs	0/5	LT	0.20	
Snakes/Lizards	0/4	LT	0.20	
Cottontails	0/4	LT	0.20	
Grasshoppers/Beetles	0/3	LT	0.20	
Bullheads	0/2	LT	0.20	
Long-Eared Owls	0/2	LT	0.20	
Leeches/Snails	0/1	LT	0.20	
Totals	17/114		0.548	0.20 - 2.20

*See Table 4-1 for minimum concentration and areas.

TABLE B-53
CONTAMINANTS RECOVERED FROM WASH WATER SAMPLES

SPECIMEN					WASH WATER				
SPECIES/TISSUE	WEIGHT (GRAMS)	CONTAM	CONC (UG/G)	TOT. CONC (UG)	VOL (ML)	CONC (UG/ML)	TOTAL CONC (UG)	1/3 TOTAL CONC (UG)	1/3 WASH TTL/ SPEC TTL - %
Annuals/Tops	94.7	Aldrin	0.12	11.36	500	BDL **			
		Isodr	0.26	24.62		BDL			
		Endrn	0.04	3.79		0.0005	0.25	0.083	2.2
		DDE	0.32	30.30		BDL			
		DIMP	1.47	139.21		BDL			
Annuals/Tops	132	Aldrn	0.04	5.28	500	0.0013	0.65	0.22	4.2
		Dldrn	0.54	71.28		0.0013	0.65	0.22	0.3
		Isodr	0.02	2.64		0.0034	1.70	0.57	21.6 *
		DDT	0.29	38.28		BDL			
		DDE	0.02	2.64		BDL			
		DIMP	0.29	38.28		BDL			
		Cd	1.6	211.20		BDL			
Annuals/Tops	145	Isodr	1.58	229.00	500	BDL			
		Endrn	0.49	71.00		BDL			
		DDT	0.08	11.60		BDL			
		DDE	1.28	186.00		BDL			
		DIMP	0.37	53.60		BDL			
		Cu	15.5	2248.0		0.1670	83.5	27.83	1.2
Annuals/Tops	44	Cd	1.7	74.80	200	BDL			
Annuals/Tops	69	Cd	1.10	75.90	200	BDL			
		Cu	7.50	518.00		BDL			
Annuals/Roots	4.8	Dldrn	0.41	1.97	200	BDL			
		Endrn	0.28	1.34		BDL			
		DDT	2.07	9.94		BDL			
Annuals/Roots	14.9	Dldrn	0.10	1.49	200	BDL			
		Endrn	0.11	1.64		BDL			
		DDT	0.55	8.20		BDL			
		DDE	0.31	4.62		0.0034	0.68	0.23	4.9
Annuals/Roots	4.6	Dldrn	0.06	0.28	200	BDL			
		Endrn	0.06	0.28		BDL			
		DDT	0.14	0.64		BDL			
		DDE	0.13	0.60		0.00043	0.086	0.029	4.8
Annuals/Roots	5.0	Dldrn	0.45	2.25	200	BDL			
		DDT	0.29	1.45		BDL			
Annuals/Roots	18.6	Dldrn	2.39	44.45	500	0.0012	0.60	0.20	0.45
		Endrn	0.55	10.23		0.0010	0.50	0.17	1.67
		DDT	0.10	1.86		BDL			
		DDE	0.11	2.05		BDL			
		Cu	10.8	200.90		0.14	70.0	23.33	11.6*
		Cd	1.30	24.18		BDL			
Annuals/Roots	22.0	Aldrin	11.7	257.40	500	0.0015	0.75	0.25	0.09
		Dldrn	3.33	73.26		0.0038	1.90	0.63	0.86
		Isodr	0.27	5.94		0.0003	0.15	0.05	0.84
		Endrn	0.62	13.64		0.0019	0.95	0.32	2.35
		DDT	0.09	1.98		BDL			
		DIMP	0.60	13.20		BDL			
Annuals/Roots	32.6	Isodr	7.83	255.26	500	BDL			
		DDT	0.09	2.93		BDL			
		DDE	1.00	32.60		BDL			
		DIMP	0.06	1.96		BDL			
		Cu	11.0	358.60		0.1000	50.0	16.67	4.65
		Cd	1.30	42.38		BDL			

*Over 5% was considered a significant amount of contaminant.

**BDL = Below Detectable limits

TABLE B-53
CONTAMINANTS RECOVERED FROM WASH WATER SAMPLES

SPECIMEN					WASH WATER				
SPECIES/TISSUE	WEIGHT (UG)	CONTAM	CONC (UG/G)	TOT. CONC (UG)	VOL (ML)	CONC (UG/ML)	TOTAL CONC (UG)	1/3 TOTAL CONC (UG)	1/3 WASH TTL/ SPEC TTL - %
Annuals/Roots	41.6	Aldrin	15.6	649.00	500	0.0867	43.35	14.45	2 20
		Dldrn	49.4	2055.00		0.1200	60.00	20.00	0.97
		Isodr	5.60	233.00		0.0029	1.460	0.49	0.21
		DDE	30.6	1273.0		0.0017	0.835	0.28	0.02
		Hg	0.22	9.20		ND***			
Perennials/Tops	18.2	Dldrn	0.04	0.73	200	BDL			
		Isodr	0.02	0.36		BDL			
		Endrn	0.13	2.37		BDL			
		DDT	1.00	18.20		BDL			
Perennials/Tops	4.6	Dldrn	0.16	0.74	200	BDL			
		Endrn	0.06	0.23		BDL			
		DDT	0.44	2.02		BDL			
Perennials/Tops	9.7	Dldrn	0.19	1.80	200	0.0003	0.060	0.02	1.10
		Isodr	0.02	0.19		BDL			
		Endrn	0.03	0.29		BDL			
		DDT	0.35	3.40		BDL			
		Hg	0.60	5.80		BDL			
Perennials/Tops	140	Isodr	0.09	12.60	500	BDL			
		Endrn	0.21	29.40		BDL			
		DDT	0.16	22.40		BDL			
		DDE	0.43	60.20		BDL			
		DIMP	0.13	18.20		BDL			
		Cu	11.9	1666.0		0.4000	200.0	66.7	4.00
Perennials/Roots	158	DDE	0.10	15.8	500	BDL			
		DIMP	0.59	93.2		BDL			
		CPMSO	0.17	26.9		BDL			
		CPMO2	0.10	15.8		BDL			
		Cu	12.7	2007.0		0.26	130.0	43.3	2.2
Perennials/Roots	54.5	Dldrn	0.90	49.1	200	0.00033	0.066	0.022	0.45
		Eldrn	0.20	10.9		BDL			
		DDT	0.20	10.9		BDL			
		Cu	8.4	457.8		0.37	74.0	24.7	5.4*
Perennials/Roots	75	Dldrn	0.040	3.0	500	BDL			
		CPMO2	0.26	19.5		BDL			
		DITH	0.10	7.5		BDL			
		Cu	13.1	982.5		0.077	38.5	12.8	1.3
Perennials/Roots	4.9	Dldrn	0.56	2.74	200	0.0014	0.28	0.093	3.4
		Isodr	0.020	0.98		0.0019	0.38	0.13	13.3*
		Endrn	0.13	0.64		0.00030	0.060	0.02	3.1
		DDT	1.01	4.95		0.00030	0.060	0.02	0.40
		Cu	8.0	39.2		ND			
Aquatic Plants/ Tops	65	Aldrn	0.08	5.2	500	0.0010	0.50	0.17	3.3
		Dldrn	1.25	81.3		0.0032	1.60	0.53	0.65
		Isodr	0.03	1.95		BDL			
		Endrn	0.16	10.4		0.00090	0.45	0.15	1.4
Aquatic Plants/ Tops	114	Dldrn	0.87	99.2	1000	BDL			
		Isodr	0.040	4.6		BDL			
		Endrn	0.51	58.1		BDL			
		DDE	0.030	3.4		BDL			
		DIMP	0.37	42.2		0.00088	0.88	0.29	0.68
		CPMO2	0.87	99.2		BDL			
Aquatic Plants/ Tops	41	Dldrn	0.060	2.46	500	BDL			
		Cu	22.3	914.0		0.064	32.0	10.7	1.2

***ND = No Data

TABLE B-53
CONTAMINANTS RECOVERED FROM WASH WATER SAMPLES

SPECIMEN					WASH WATER				
SPECIES/TISSUE	WEIGHT (UG)	CONTAM	CONC (UG/G)	TOT. CONC (UG)	VOL (ML)	CONC (UG/ML)	TOTAL CONC (UG)	1/3 TOTAL CONC (UG)	1/3 WASH TTL/ SPEC TTL - %
Aquatic Plants/ Roots	29	Aldrn	0.62	18.0	500	0.0013	0.65	0.22	1.2
		Dldrn	22.3	646.7		0.0057	3.35	1.12	0.17
		Endrn	1.91	55.4		0.0022	1.10	0.37	0.67
Aquatic Plants/ Roots	44	Dldrn	0.26	11.4	500	BDL			
		Endrn	0.15	6.6		BDL			
		DDE	0.21	9.2		BDL			
		DIMP	0.080	3.5		BDL			
		CPMO2	0.21	9.2		BDL			
		Cu	15.	660.0		0.23	115.0	38.3	5.8*
		Cd	2.0	88.0		BDL			
		As	6.0	264.0		0.060	30.	10.	3.8
Aquatic Plants/ Roots	176	Cu	28.8	5069.0	1000	0.110	110	36.7	0.72
Grasshoppers/ Body	51	Dldrn	0.078	3.978	125	0.00035	0.044	0.015	0.38
		DDE	0.021	1.071		BDL			
		DIMP	0.710	36.21		0.00156	0.195	0.065	0.18
		CPMSO	1.110	56.61		BDL			
		CPMO2	0.950	48.45		BDL			
		Cu	17.6	897.6		0.31	38.75	12.92	1.44
Bullheads/Body	338	Aldrn	0.29	98.0	200	BDL			
		Dldrn	3.19	1078.0		0.0033	0.66	0.22	0.02
		Endrn	0.17	57.5		BDL			
		DDT	0.03	10.1		BDL			
		DDE	0.11	37.2		BDL			
		DIMP	0.06	20.3		BDL			
Bullheads/Body	361	Dldrn	0.20	72.2	200	0.0023	0.46	0.153	0.21
		Endrn	0.04	14.4		0.0003	0.06	0.02	0.14
		DDT	0.02	7.22		BDL			
		DDE	0.03	10.8		BDL			
		Cu	15.5	5596.0		BDL			
Bass/Body	747	Dldrn	0.26	194.0	200	0.0014	0.28	0.093	0.05
		Endrn	0.04	29.9		0.0004	0.08	0.027	0.09
		DDT	0.02	14.9		0.0004	0.08	0.027	0.18
		Cu	13.3	9935.0		BDL			
		Hg	0.38	284.0		BDL			
Meadowlarks/ Feathers	8.4	Cu	19.6	165.0	200	0.09	18	6	3.64
		Hg	0.26	1.84		BDL			
Meadowlarks/ Feathers	9.7	Cu	26.4	256.0	200	0.08	16	5.33	2.08
		Hg	0.33	3.2		BDL			
Meadowlarks/ Feathers	8.6	Cu	25.9	223.0	200	0.06	12	4	1.79
		Hg	0.37	3.18		BDL			
Meadowlarks/ Feathers	10.2	Cu	29.8	304.0	200	0.08	16	5.33	1.75
		Hg	0.26	2.65		BDL			
Meadowlarks/ Feathers	9.8	Cu	25.3	248.0	200	0.07	14	4.67	1.88
		Hg	0.33	3.23		BDL			
Pheasants/ Feathers	16	Cu	8.1	130.0	200	0.07	14	4.67	3.59
		Hg	0.2	3.2		BDL			
Kestrel/ Feathers	7.1	Cu	16.2	115.0	200	0.25	50	16.67	14.49*
		Hg	0.22	1.56		BDL			

TABLE B-53
CONTAMINANTS RECOVERED FROM WASH WATER SAMPLES

SPECIMEN					WASH WATER				
SPECIES/TISSUE	WEIGHT (UG)	CONTAM	CONC (UG/G)	TOT. CONC (UG)	VOL (ML)	CONC (UG/ML	TOTAL CONC (UG)	1/3 TOTAL CONC (UG)	1/3 WASH TTL/ SPEC TTL - %
Kestrel/ Feathers	4.3	Cu Hg	13.6 0.39	58.48 1.68	200	0.26 BDL	52	17.33	29.63*
Heron/Feathers	19.5	Cu Hg	30.9 2.2	603.0 43.29	200	0.13 BDL	26	8.67	1.43
Heron/Feathers	23.3	Cu Hg	26.8 2.0	624.0 46.6	200	0.20 BDL	40	13.33	2.14
Heron/Feathers	30.2	Cu Hg	23.9 1.0	722.0 30.2	200	0.21 BDL	42	14	1.94
Deer Mice/Fur	3	As	110	330.0	150	BDL			
Prairie Dog/ Fur	181	Cu	26.0	4706.0	200	0.066	13.2	4.40	0.09
Cottontail/Fur	224	Cu	25.0	5600.0	200	0.086	17.2	5.73	0.10
Mule Deer/Hair	0.6	Aldrn DDE Dith	0.10 0.20 0.10	0.06 0.12 0.06	100	BDL BDL BDL			
Mule Deer/Hair	1.4	DDE Cu	0.34 8.0	0.48 11.2	100	BDL 0.11	11	3.67	32.77*
Mule Deer/Hair	0.5	Dldrn	0.21	0.10	100	BDL			
Mule Deer/Hair	1.2	CPMO2 Cu	0.25 8.4	0.30 10.1	100	BDL 0.09	9	3	29.70*
Mule Deer/Hair	1.5	Dldrn Dith Cu	0.48 0.13 6.9	0.72 0.19 10.4	100	0.0003 BDL 0.11	0.03 11	0.01 3.67	35.28*