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VOLUME III
ORIGINAL

U.S. ARMY
MATERIEL COMMAND

— COMMITTED TO PROTECTION OF THE ENVIRONMENT —

Biota Remedial Investigation
Final Report
(Version 3.2)
Volume III

May 1989
Contract Number DAAK11-84-D0016
Task Number 9

Environmental Science And Engineering, Inc.

Rocky Mountain Arsenal
Information Center
Commerce City, Colorado

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OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data source gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of th collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferso Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY (*Leave blank*)

2. REPORT DATE: 05/00/89

3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE

BIOTA REMEDIAL INVESTIGATION, TASK 9, FINAL REPORT, VERSION 3.2 √3

5. FUNDING NUMBERS

DAAK11 84 D 0016

6. AUTHOR(S)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

ENVIRONMENTAL SCIENCE AND ENGINEERING

8. PERFORMING ORGANIZATION REPORT NUMBER

89173R02

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

ROCKY MOUNTAIN ARSENAL (CO.). PMRMA

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

THE PURPOSE OF THE BIOTA REMEDIAL INVESTIGATION REPORT IS TO PRESENT THE CURRENT NATURE AND EXTENT OF CONTAMINATION IN BIOTA ON RMA. THE REPORT INTEGRATES KNOWN HISTORICAL INFORMATION, THE RESULTS OF PREVIOUS INVESTIGATIONS, AND RESULTS OF CURRENT PROGRAMS.

THE REPORT IS DIVIDED INTO THE FOLLOWING SECTIONS:

1. GENERAL BACKGROUND INFORMATION ON RMA CONTAMINATION AND PAST INVESTIGATIONS
2. DESCRIPTION OF THE PHYSICAL ENVIRONMENT, REGIONAL BIOTA, AND BIOTA WITHIN THE ARSENAL; IDENTIFICATION OF IMPORTANT BIOLOGICAL COMPONENTS AS A BASIS FOR EVALUATING CONTAMINATION
3. SUMMARY OF THE METHODS USED IN THIS ASSESSMENT
4. DATA ON THE TYPES AND CONCENTRATIONS OF CONTAMINANTS IN RMA BIOTA
5. ASSESSMENT OF THE DISTRIBUTION AND CONCENTRATION OF CONTAMINANTS IN BIOTA AND ASSOCIATED ENVIRONMENT TO EVALUATE PATHWAYS FOR CONTAMINANT MOVEMENT

14. SUBJECT TERMS

TOXICOLOGY, FAUNA, FLORA

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED			

89173R02
VOLUME III
ORIGINAL

LITIGATION TECHNICAL SUPPORT AND SERVICES

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Availability Codes	
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Prepared by
ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Prepared for
OFFICE OF THE PROGRAM MANAGER
ROCKY MOUNTAIN ARSENAL CONTAMINATION CLEANUP

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APPENDIX A

PLANT AND ANIMAL SPECIES WHICH INHABIT OR POTENTIALLY OCCUR ON ROCKY MOUNTAIN ARSENAL

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 1 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
PLANTS					
Aceraceae	Acer	saccharinum	Silver-leaf maple		
Aceraceae	Negundo	aceroides	Boxelder		
Algae	Chara	kieneri	Muskgrass		X
Alismataceae	Alisma	plantagoaquatica	Water-plaintain		X
Alismataceae	Sagittaria	cuneata	Arrowhead		X
Amaranthaceae	Amaranthus	albus	Tumble pigweed		X
Amaranthaceae	Amaranthus	arenicola	Rope-spike pigweed		X
Amaranthaceae	Amaranthus	graecizans	Prostrate pigweed		X
Amaranthaceae	Amaranthus	retroflexus	Rough pigweed		X
Amaranthaceae	Froelichia	gracilis	Froelichia		X
Anacardiaceae	Rhus	trilobata	Skunkbrush		X
Apocynaceae	Apocynum	sibiricum	Siberian dogbane		X
Asclepiadaceae	Asclepias	incarnata	Marsh milkweed		X
Asclepiadaceae	Asclepias	pumilus	Little milkweed		X
Asclepiadaceae	Asclepias	speciosa	Showy milkweed		X
Asclepiadaceae	Asclepias	subverticillata	Whorled milkweed		X
Asclepiadaceae	Asclepias	viridiflora	Green milkweed		X
Asparagaceae	Asparagus	officinalis	Asparagus		X
Bignoniaceae	Catalpa	speciosa	Snowy catalpa		X
Boraginaceae	Cryptantha	fendleri	Fendler's cryptantha		X
Boraginaceae	Cryptantha	minima	Small cryptantha		X
Boraginaceae	Lappula	redowskii	Stickweed		X
Boraginaceae	Lithospermum	incisum	Narrow-leaf puccoon		X
Cactaceae	Coryphantha	vivipara	Ball cactus		X
Cactaceae	Echinocereus	viridiflorus	Hen and chickens		X
Cactaceae	Opuntia	compressa	Prickly pear		X
Cactaceae	Opuntia	polyacantha	Plains prickly pear		X
Capparidaceae	Cleome	serrulata	Beeweed		X
Capparidaceae	Polanisia	dodecandra	Clammy weed		X
Caprifoliaceae	Symphoricarpos	occidentalis	Snowberry		X
Caryophyllaceae	Gypsophila	paniculata	Baby's breath		X
Caryophyllaceae	Saponaria	officinalis	Bouncing Bet		X
Ceratophyllaceae	Cectoplyllum	demersum	Hornwort		X

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 2 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Chenopodiaceae	Atriplex	hastata	Spear orache		X
Chenopodiaceae	Bassia	hyssopifolia	Bassia		X
Chenopodiaceae	Ceratoides	lanata	Winterfat		X
Chenopodiaceae	Chenopodium	album	Pigweed		X
Chenopodiaceae	Chenopodium	leptophylm	Narrow-leaf goosefoot		X
Chenopodiaceae	Chenopodium	rubrum	Red goosefoot		X
Chenopodiaceae	Cycloloma	atriplicifolium	Winged pigweed		X
Chenopodiaceae	Kochia	iranica	Kochia		X
Chenopodiaceae	Salsola	collina	Russian thistle		X
Chenopodiaceae	Salsola	iberica	Russian thistle		X
Commelinaceae	Tradescantia	occidentalis	Western spiderwort		X
Compositae	Ambrosia	acanthicarpa	Sand bur		X
Compositae	Ambrosia	psilostachya	Western ragweed		X
Compositae	Ambrosia	tomentosa	Spiny bursage		X
Compositae	Ambrosia	trifida	Giant ragweed		X
Compositae	Anaphalis	margaritacea	Pearly everlasting		X
Compositae	Antennaria	rosea	Pussy-toes		X
Compositae	Artemesia	tridentata	Big sagebrush		X
Compositae	Artemisia	biennis	Biennial wormwood		X
Compositae	Artemisia	dracunculus	Green sage		X
Compositae	Artemisia	filifolia	Sand sagebrush		X
Compositae	Artemisia	frigida	Fringed sagebrush		X
Compositae	Artemisia	ludoviciana	Prairie sage		X
Compositae	Aster	ericoides	Heath aster		X
Compositae	Aster	falcatus	White prairie aster		X
Compositae	Aster	hesperius	Aster		X
Compositae	Bidens	cernua	Nodding bur-marigold		X
Compositae	Bidens	gracilis	Beggars ticks		X
Compositae	Carduus	nutans	Musk thistle		X
Compositae	Centaurea	repens	Russian knapweed		X
Compositae	Chrysothamnus	nauseosus	Rabbitbrush		X
Compositae	Cirsium	arvense	Canadian thistle		X
Compositae	Cirsium	canescens	Hoary thistle		X
Compositae	Cirsium	undulatum	Wavy-leaved thistle		X
Compositae	Cirsium	vulgare	Bull thistle		X

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 3 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Compositae	Conyza	canadensis	Horseweed		X
Compositae	Dyssodia	papposa	Fetid marigold		X
Compositae	Erigeron	divergens	Spreading fleabane		X
Compositae	Erigeron	pumilus	Low daisy		X
Compositae	Euthamia	occidentalis	Bushy goldenrod		X
Compositae	Evax	prolifera	Fluffweed		X
Compositae	Gnaphalium	chilense	Yellow cudweed		X
Compositae	Gnaphalium	exilifolium	Cudweed		X
Compositae	Gnaphlium	wrightii	Everlasting		X
Compositae	Grindelia	squarrosa	Gumweed		X
Compositae	Gutierrezia	sarothrae	Snakeweed		X
Compositae	Haplopappus	spinulosus	Spiny goldenweed		X
Compositae	Helianthus	annuus	Common sunflower		X
Compositae	Helianthus	petiolaris	Prairie sunflower		X
Compositae	Heterotheca	villosa	Hairy golden aster		X
Compositae	Iva	xanthifolia	Tall marsh elder		X
Compositae	Kuhnia	eupatorioides	False boneset		X
Compositae	Lactuca	serriola	Prickly lettuce		X
Compositae	Lactuca	tatarica	Large flower blue lettuce		X
Compositae	Liatris	punctata	Blazing star		X
Compositae	Lygodesmia	juncea	Rush skeleton weed		X
Compositae	Machaeranthera	canescens	Silvery aster		X
Compositae	Machaeranthera	pattersoni	Patterson aster		X
Compositae	Machaeranthera	pinnatifida	Ironplant goldenweed		X
Compositae	Nothocalais	cuspidata	False dandelion		X
Compositae	Onopordum	acanthium	Scotch thistle		X
Compositae	Picradeniopsis	oppositifolia	Plains bahia		X
Compositae	Podospermum	laciniatum	Podospermum		X
Compositae	Ratibida	columnifera	Prairie coneflower		X
Compositae	Senecio	plattensis	Platte groundsel		X
Compositae	Senecio	spartioides	Butterweed		X
Compositae	Senecio	tridenticulatus	3-toothed butterweed		X
Compositae	Solidago	altissima	Tall goldenrod		X
Compositae	Solidago	canadensis	Canada goldenrod		X
Compositae	Solidago	gigantea	Giant goldenrod		X

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 4 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Compositae	Solidago	missouriensis	Missouri goldenrod		X
Compositae	Solidago	mollis	Soft goldenrod		X
Compositae	Solidago	speciosa	Showy goldenrod		X
Compositae	Sonchus	asper	Spiny Sow-thistle		X
Compositae	Sonchus	uliginosus	Sow thistle		X
Compositae	Stephanomeria	pauciflora	Wire lettuce		X
Compositae	Taraxacum	officinale	Dandelion		X
Compositae	Thelesperma	megapotamicum	Greenthread		X
Compositae	Tragopogon	dubius	Yellow salsify		X
Compositae	Verbesina	encelioides	Crownbeard		X
Compositae	Xanthium	strumarium	Cocklebur		X
Convolvulaceae	Convolvulus	arvensis	Morning glory		X
Convolvulaceae	Evolvulus	nuttallianus	Bindweed		X
Convolvulaceae	Ipomoea	leptophylla	Bush morning glory		X
Cruciferae	Alyssum	desertorum	Desert Alyssum		X
Cruciferae	Alyssum	minus	Alyssum		X
Cruciferae	Cardaria	draba	Hoary cress		X
Cruciferae	Chorispora	tenella	Common blue mustard		X
Cruciferae	Descurainia	pinnata	Tansy mustard		X
Cruciferae	Descurainia	richardsonii	Western tansy mustard		X
Cruciferae	Descurainia	sophia	Tansy mustard		X
Cruciferae	Draba	reptans	White draba		X
Cruciferae	Eleocharis	acicularis	Slender spikerush		X
Cruciferae	Eleocharis	macrostachya	Common spikerush		X
Cruciferae	Erysimum	asperum	Western wallflower		X
Cruciferae	Lepidium	densiflorum	Prairie peppergrass		X
Cruciferae	Lepidium	perfoliatum	Peppergrass		X
Cruciferae	Lesquerella	ludoviciana	Bladderpod		X
Cruciferae	Nasturtium	officinale	Watercress		X
Cruciferae	Rorippa	palustris	Cress		X
Cruciferae	Rorippa	sinuata	Yellow-cress		X
Cruciferae	Rorippa	teres	Cress		X
Cruciferae	Sisymbrium	altissimum	Tumble mustard		X
Cruciferae	Sisymbrium	officinale	Hedge mustard		X
Cruciferae	Thlaspi	arvense	Penny-cress		X

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 5 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Cucurbitaceae	Cucurbita	foetidissima	Wild gourd		X
Cucurbitaceae	Echinocystis	labata	Mock cucumber		X
Cyperaceae	Carex	filifolia	Threadleaf sedge		X
Cyperaceae	Carex	heliophila	Sun sedge		X
Cyperaceae	Carex	nebraskensis	Nebraska sedge		X
Cyperaceae	Carex	praegracilis	Sedge		X
Cyperaceae	Cyperus	erythrorhizos	Calingale		X
Cyperaceae	Eleocharis	acicularis	Slender spikerush		X
Cyperaceae	Eleocharis	macrostachya	Common spikerush		X
Cyperaceae	Mariscus	schweinitzii	Mariscus		X
Cyperaceae	Scirpus	acutus	Compact bullrush		X
Cyperaceae	Scirpus	americanus	American bullrush		X
Cyperaceae	Scirpus	lacustria	Tule		X
Cyperaceae	Scirpus	paludosus	Alkali bullrush		X
Eleagnaceae	Eleagnus	angustifolia	Russian olive		X
Equisetaceae	Hippochaete	laevigata	Scouring rush		X
Euphorbiaceae	Chamaesyce	glyptosperma	Corrugate-seed spurge		X
Euphorbiaceae	Chamaesyce	missurica	Narrow-leave spurge		X
Euphorbiaceae	Chamaesyce	serpyllifolia	Thyme-leaved spurge		X
Euphorbiaceae	Croton	texensis	Croton		X
Euphorbiaceae	Euphorbia	esula	Spurge		X
Euphorbiaceae	Euphorbia	marginata	Snow-on-the-mountain		X
Euphorbiaceae	Euphorbia	spathulata	Spurge		X
Geraniaceae	Erodium	cicutarium	Filaree		X
Gramineae	Agropyron	cristatum	Crested wheatgrass		X
Gramineae	Agropyron	desertorum	Crested wheatgrass		X
Gramineae	Agropyron	elongatum	Tall wheatgrass		X
Gramineae	Agropyron	intermedium	Intermed. wheatgrass		X
Gramineae	Agropyron	repens	Quack grass		X
Gramineae	Agropyron	smithii	Western wheatgrass		X
Gramineae	Agropyron	trachycaulum	Slender wheatgrass		X
Gramineae	Agrostis	gigantea	Redtop		X
Gramineae	Andropogon	hallii	Sandhills bluestem		X
Gramineae	Aristida	fendleriana	Fendler three-awn		X
Gramineae	Aristida	longiseta	Red three-awn		X

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 6 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Gramineae	Beckmannia	syzigachne	Sloughgrass		X
Gramineae	Bouteloua	curtipendula	Side-oats grama		X
Gramineae	Bouteloua	gracilis	Blue grama		X
Gramineae	Bromus	inermis	Smooth brome		X
Gramineae	Bromus	japonicus	Japanese brome		X
Gramineae	Bromus	tectorum	Cheatgrass		X
Gramineae	Buchloe	dactyloides	Buffalo grass		X
Gramineae	Calamovilfa	longifolia	Prairie sandreed		X
Gramineae	Cenchrus	longispinus	Sand bur		X
Gramineae	Chloris	virgata	Windmill grass		X
Gramineae	Cynodon	dactylon	Bermuda grass		X
Gramineae	Distichlis	spicata	Alkali saltgrass		X
Gramineae	Echinochlos	crus-galli	Barnyard grass		X
Gramineae	Elymus	canadensis	Canadian wild rye		X
Gramineae	Eragrostis	cilianensis	Stinkgrass		X
Gramineae	Eragrostis	diffusa	Spreading Love-grass		X
Gramineae	Festuca	pratensis	Meadow fescue		X
Gramineae	Hordeum	jubatum	Foxtail barley		X
Gramineae	Hordeum	pusillum	Little barley		X
Gramineae	Leersia	oryzoides	Rice Cut-grass		X
Gramineae	Lolium	multiflorum	Italian rye-grass		X
Gramineae	Monroa	squarrosa	False buffalo grass		X
Gramineae	Muhlenbergia	asperifolia	Alkali muhly		X
Gramineae	Muhlenbergia	racemosa	Marsh muhly		X
Gramineae	Muhlenbergia	torreyi	Ring muhly		X
Gramineae	Oryzopsis	hymenoides	Indian ricegrass		X
Gramineae	Panicum	capillare	Witchgrass		X
Gramineae	Panicum	virgatum	Switchgrass		X
Gramineae	Phalaris	arundinacea	Reed canarygrass		X
Gramineae	Phleum	pratense	Timothy		X
Gramineae	Poa	agassizensis	Mountain bluegrass		X
Gramineae	Poa	pratensis	Kentucky bluegrass		X
Gramineae	Poa	sandbergii	Sandberg Bluegrass		X
Gramineae	Polypogon	monspeliensis	Rabbitfoot grass		X
Gramineae	Puccinellia	nuttalliana	Alkali grass		X

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 7 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Gramineae	Schedonnardus	paniculatus	Tumble grass		X
Gramineae	Secale	cereale	Rye		X
Gramineae	Setaria	viridis	Green foxtail		X
Gramineae	Sitanion	longifolium	Squirrel tail		X
Gramineae	Sorghastrum	avenaceum	Indian-grass		X
Gramineae	Spartina	pectinata	Prairie cordgrass		X
Gramineae	Sphenopholis	obtusata	Prairie wedge-grass		X
Gramineae	Sporobulus	airoides	Alkali sacaton		X
Gramineae	Sporobolus	cryptandrus	Sand dropseed		X
Gramineae	Stipa	comata	Needle and thread		X
Gramineae	Stipa	viridula	Green needle grass		X
Gramineae	Vulpia	octoflora	Six-weeks fescue		X
Gramineae	Zea	mays	Corn		X
Haloragaceae	Myriophyllum	exalbescens	Water-molfoil		X
Hypericaceae	Hypericum	perforatum	Klamath weed, St. Johnswort		X
Juncaceae	Juncus	arcticus	Creeping rush		X
Juncaceae	Juncus	bufonius	Toad Rush		X
Juncaceae	Juncus	marginatus	Rush		X
Juncaceae	Juncus	interior	Rush		X
Juncaceae	Juncus	torreyi	Rush		X
Labiatae	Hedeoma	hispidum	False pennyroyal		X
Labiatae	Lycium	halimifolium	Water horehound		X
Labiatae	Lycopus	americanus	Water horehound		X
Labiatae	Mentha	arvensis	Field mint		X
Labiatae	Mentha	spicata	Spearmint		X
Labiatae	Monarda	pectinata	Horse mint		X
Labiatae	Nepeta	cataria	Catnip		X
Labiatae	Salvia	reflexa	Salvia		
Labiatae	Scutellaria	galericulata	Marsh skullcap		X
Labiatae	Stadys	palustris	Hedgenettle		X
Labiatae	Teucrium	canadense	Germander		X
Leguminosae	Astragalus	bisulcatus	Two-grooved milk-vetch		X
Leguminosae	Astragalus	ceramicus	Potshard milk-vetch		X
Leguminosae	Astragalus	crassicarpus	Ground plum		X
Leguminosae	Astragalus	dasyglottis	Purple milk-vetch		X

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 8 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Leguminosae	Astragalus	lotiflorus	Lotus milk-vetch		X
Leguminosae	Astragalus	missouriensis	Missouri milk-vetch		X
Leguminosae	Catalpa	speciosa	Catalpa		X
Leguminosae	Dalea	aurea	Prairie clover		X
Leguminosae	Gleditsia	triacanthos	Honey locust		X
Leguminosae	Glycyrrhiza	lepidota	Wild licorice		X
Leguminosae	Lupinus	argenteus	Lupine		X
Leguminosae	Lupinus	plattensis	Lupine		X
Leguminosae	Medicago	sativa	Alfalfa		X
Leguminosae	Melilotus	alba	White sweet clover		X
Leguminosae	Melilotus	officinalis	Yellow sweet clover		X
Leguminosae	Oxytropis	lambertii	Colorado locoweed		X
Leguminosae	Petalostemon	compactus	Compact prairie clover		X
Leguminosae	Psoralea	lanceolata	Narrowleaf scurf-pea		X
Leguminosae	Psoralea	tenuiflora	Slender scurf-pea		X
Leguminosae	Robinia	neomexicana	New Mexico locust		X
Leguminosae	Robinia	pseudoacacia	Black locust		X
Leguminosae	Sophora	nuttalliana	Sophora		X
Leguminosae	Vicia	villosa	Vetch		X
Lemnaceae	Lemna	minor	Duckweed		X
Lemnaceae	Spirodela	polyrhiza	Duckweed		X
Liliaceae	Leucocrinum	montanum	Sand lily		X
Liliaceae	Smilacina	racemosa	False solomon's seal		X
Liliaceae	Yucca	glauca	Spanish bayonet		X
Liliaceae	Zygadenus	venenosus	Death camus		X
Loasaceae	Mentzelia	nuda	Evening star		X
Malvaceae	Malva	neglecta	Cheeseweed		X
Malvaceae	Sphaeralcea	coccinea	Scarlet globemallow		X
Najadaceae	Najas	quadalupensis	Water-nymph		X
Nyctaginaceae	Oxybaphus	linearis	Narrowleaf umbrella wort		X
Nyctaginaceae	Oxybaphus	nyctagineus	Umbrella wort		X
Oleaceae	Fraxinus	pennsylvanica	Green ash		X
Oleaceae	Syringa	vulgaris	Common lilac		X
Onagraceae	Calylophus	serrulata	Serrate evening primrose		X
Onagraceae	Epilobium	adenocaulon	Willow-herb		X

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 9 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Onagraceae	Epilobium	glandulosum	Northern willow-herb		X
Onagraceae	Epilobium	paniculatum	Willow herb		X
Onagraceae	Gaura	coccinea	Scarlet gaura		X
Onagraceae	Gaura	parviflora	Tall gaura		X
Onagraceae	Gayophytum	ramosissimum	Ground smoke		X
Onagraceae	Oenothera	albicaulis	White-throated primrose		X
Onagraceae	Oenothera	caespitosa	Stemless primrose		X
Onagraceae	Oenothera	coronopifolia	Cut-leaf primrose		X
Onagraceae	Oenothera	nuttallii	Nuttall's primrose		X
Onagraceae	Oenothera	strigosa	Yellow primrose		X
Onegraceae	Gaura	neomexicana	Tall gaura		X
Papaveraceae	Argemone	polyanthemos	Prickly poppy		X
Pinaceae	Juniperus	scopulorum	Rocky Mountain juniper		X
Pinaceae	Picea	pungens	Colorado blue spruce		X
Pinaceae	Pinus	nigra	Austrian black pine		X
Pinaceae	Pinus	ponderosa	Ponderosa pine		X
Pinaceae	Pinus	sylvestris	Scotch pine		X
Pinaceae	Pseudotsuga	menziesii	Douglas fir		X
Plantaginaceae	Plantago	patagonica	Wooly plantain		X
Polemoniaceae	Ipomopsis	laxiflora	Loose-flowered gilia		X
Polemoniaceae	Leptodactylon	pungens	Prickly gilia		X
Polygonaceae	Eriogonum	annuum	Tall eriogonum		X
Polygonaceae	Eriogonum	effusum	Bushy eriogonum		X
Polygonaceae	Fallopia	convolvulus	Black bindweed		X
Polygonaceae	Persicaria	malculata	Lady's thumb		X
Polygonaceae	Persicaria	amphibia	Water smartweed		X
Polygonaceae	Persicaria	lapathifolia	Smartweed		X
Polygonaceae	Persicaria	coccinia	Scarlet smartweed		X
Polygonaceae	Persicaria	pennsylvanica	Smartweed		X
Polygonaceae	Polygonum	aviculare	Devil's shoestring		X
Polygonaceae	Polygonum	ramosissiumum	Bushy knotweed		X
Polygonaceae	Rumex	crispus	Curly dock		X
Polygonaceae	Rumex	salicifolius	Willowleaf dock		X
Polygonaceae	Rumex	venosus	Veiny dock		X
Portulacaceae	Portulaca	oleracea	Common purslane		X

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 10 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Potamogetonaceae	Potamogeton	nodosus	Pondweed		X
Potamogetonaceae	Potamogeton	pusillus	Pondweed		X
Potamogetonaceae	Potamogeton	pectinatus	Pondweed		X
Potamogetonaceae	Potamogeton	gramineum	Pondweed		X
Primulaceae	Lysimachia	ciliata	Fringed loosestrife		X
Ranunculaceae	Clemantis	ligusticifolia	Western virgin's bower		X
Ranunculaceae	Delphinium	virescens	Larkspur		X
Ranunculaceae	Myosurus	minimus	Mousetail		X
Ranunculaceae	Ranunculus	trichophyllus	Water crawfoot		X
Ranunculaceae	Ranunculus	macounii	Macoun's buttercup		X
Rosaceae	Potentilla	norvegica	Cinquefoil		X
Rosaceae	Potentilla	paradoxa	Cinquefoil		X
Rosaceae	Prunus	americana	Wild plum		X
Rosaceae	Prunus	virginiana	Choke cherry		X
Rosaceae	Pyrus	malus	Apple		X
Rosaceae	Rosa	arkansana	Prairie rose		X
Rosaceae	Rosa	woodsii	Wood's rose		X
Ruppiaceae	Ruppia	maritima	Wigeon-weed		X
Salicaceae	Populus	alba	White poplar		X
Salicaceae	Populus	deltoides	Plains cottonwood		X
Salicaceae	Salix	amygdaloides	Peach-leaved willow		X
Salicaceae	Salix	exigua	Sandbar willow		X
Salicaceae	Salix	interior	Sandbar willow		X
Salicaceae	Salix	alba var. vetillina	Golden osier		X
Santalaceae	Comandra	umbellata	Bastard toadflax		X
Saururaceae	Anemopsis	california	Yerba Mansa		X
Saxifragaceae	Ribes	aureum	Golden currant		X
Scrophulariaceae	Limosella	aquatica	Mudwort		X
Scrophulariaceae	Penstemon	albidus	White penstemon		X
Scrophulariaceae	Penstemon	angustifolius	Narrow-leaf penstemon		X
Scrophulariaceae	Verbascum	thapsus	Great mullein		X
Scrophulariaceae	Veronica	americana	American brooklime		X
Scrophulariaceae	Veronica	anagallis	Water speedwell		X
Solanaceae	Lycium	halimifolium	Matrimony bush		X

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 11 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Solanaceae	Physalis	hederaefolia	Ground cherry		X
Solanaceae	Physalis	heterophylla	Ground cherry		X
Solanaceae	Physalis	virginiana	Ground cherry		X
Solanaceae	Solanum	rostratum	Buffalo-bur		X
Solanaceae	Solanum	triflorum	Cut-leaf nightshade		X
Tamaricaceae	Tamarix	pentandra	Tamarisk		X
Tiliaceae	Tilia	americana	American linden		X
Typhaceae	Typha	angustifolia	Narrow-leaf cattail		X
Typhaceae	Typha	latifolia	Broad-leaf cattail		X
Ulmaceae	Celtis	reticulata	Hackberry		X
Ulmaceae	Ulmus	americana	American elm		X
Ulmaceae	Ulmus	parvifolia	Chinese elm		X
Umbelliferae	Berula	erecta	Water parsnip		X
Umbelliferea	Conium	maculatum	Poison hemlock		X
Umbelliferae	Cymopterus	montanus	Biscuit root		X
Umbelliferae	Lomatium	orientale	Biscuit root		X
Urticaceae	Urtica	dioica	Stinging nettle		X
Verbenaceae	Abronia	fragrans	Prairie snowball		X
Verbenaceae	Phyla	cuneifolia	Fog fruit		X
Verbenaceae	Verbena	bracteata	Bracted verbena		X
Violaceae	Viola	nuttallii	Nuttall's violet		X
Vitaceae	Parthenocissus	inserta	Virginia creeper		X
Zannechelliaceae	Zannechellia	palustris	Horned pondweed		X
Zygophyllaceae	Tribulus	terrestris	Puncture vine		X

FISH

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Ameiuridae	Fundulus	kansae	Plains killifish		X
Ameiuridae	Fundulus	sciadicus	Plains top minnow		
Ameiuridae	Ictalurus	melas	Black bullhead		X
Ameiuridae	Ictalurus	punctatus	Channel catfish	I	X
Catostomidae	Catostomus	catostomusi	Longnose sucker		
Catostomidae	Catostomus	commersoni	White sucker		X
Centrarchidae	Lepomis	cyanellus	Green sunfish		X
Centrarchidae	Lepomis	gibbosus	Pumpkin seed		X

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FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Centrarchidae	Lepomis	macrochirus	Northern bluegill		X
Centrarchidae	Lepomis	miggolophys	Red-ear sunfish		X
Centrarchidae	Micropterus	salmoides	Largemouth bass	G	X
Centrarchidae	Pomoxis	nigromaculatus	Black crappie		X
Cyprinidae	Campostoma	anomalum	Plains stoneroller		
Cyprinidae	Cyprinus	carpio	Carp		X
Cyprinidae	Hybrognathus	placita	Plains minnow		
Cyprinidae	Notropis	cornutus	Common shiner		
Cyprinidae	Notropis	deliciousus	Plains sand shiner		
Cyprinidae	Notropis	dorsalis	Bigmouth shiner		
Cyprinidae	Notropis	lutensis	Plains red shiner		
Cyprinidae	Pimephales	notatus	Bluntnose minnow		X
Cyprinidae	Pimephales	promelas	Fathead minnow		X
Cyprinidae	Rhinichthys	cattaraceae	Longnose dace		
Cyprinidae	Semotilus	atromaculatus	Northern creek chub		
Esocidae	Esox	lucius	Northern pike	I	X
Percidae	Perca	flavescens	Yellow perch		X
Salmonidae	Salmo	gairdneri	Rainbow trout	I	X
REPTILES					
Chelydridae	Chelydra	serpentina	Snapping turtle	b	
Colubridae	Coluber	constrictor	Racer	B	X
Colubridae	Heterodon	nasicus	Western hognose snake	B	X
Colubridae	Lampropeltis	triangulum	Milk snake	B	
Colubridae	Masticophis	flagellum	Coachwhip	B	
Colubridae	Nerodia	sipedon	Northern water snake	B	
Colubridae	Opheodrys	vernalis	Smooth green snake	B	
Colubridae	Pituophis	melanoleucus	Bullsnake	B	X
Colubridae	Thamnophis	elegans	Western Terrestrial garter	B	
Colubridae	Thamnophis	radix	Plains garter snake	B	X
Colubridae	Thamnophis	sirtalis	Common garter snake	B	X
Colubridae	Tropidoclonion	lineatum	Lined snake	B	
Emydidae	Chrysemys	picta	Western Painted turtle	B	

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FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Emydidae	Terrapene	ornata	Western box turtle	B	
Iguanidae	Holbrookia	maculata	Lesser earless lizard	B	X
Iguanidae	Phrynosoma	douglassi	Short-horned lizard	B	X
Iguanidae	Sceloporus	undulatus eryt.	Eastern fence lizard	B	
Iguanidae	Sceloporus	undulatus garm.	Northern fence lizard	B	
Scincidae	Eumeces	multivirgatus	Many-lined skink	B	X
Scincidae	Eumeces	obsoletus	Great Plains skink		
Teiidae	Cnemidophorus	sexlineatus	Six-lined racerunner	B	
Trionychidae	Trionyx	spiniferus	SpinySoft-shelled turtle	b	
Viperidae	Crotalus	viridis	Prairie rattlesnake	B	X
AMPHIBIANS					
Ambystomatidae	Ambystoma	tigrinum	Tiger salamander	B	X
Bufonidae	Bufo	cognatus	Great Plains toad	B	X
Bufonidae	Bufo	woodhousei	Woodhouse's toad	B	X
Hylidae	Pseudacris	triseriata	Chorus frog	B	X
Pelobatidae	Scaphiopus	bombifrons	Plains spadefoot	B	X
Ranidae	Rana	catesbiana	Bullfrog	B	X
Ranidae	Rana	pipiens	Northern leopard frog	B	X
MAMMALS					
Antilocapridae	Antilocapra	americana	Pronghorn	B	
Canidae	Canis	latrans	Coyote	B	X
Canidae	Urocyon	cinereoargenteus	Gray fox	B	X
Canidae	Vulpes	velox	Swift fox	B	
Canidae	Vulpes	vulpes	Red fox	B	X
Castoridae	Castor	canadensis	Beaver	B	
Cervidae	Odocoileus	hemionus	Mule deer	B	X
Cervidae	Odocoileus	virginianus	White-tailed deer	B	X
Cricetidae	Microtus	ochrogaster	Prairie vole	B	X
Cricetidae	Microtus	pennsylvanicus	Meadow vole	B	X
Cricetidae	Ondatra	zibethicus	Muskrat	B	X
Cricetidae	Onychomys	leucogaster	Northern grasshopper		

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FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
			mouse	B	X
Cricetidae	Peromyscus	maniculatus	Deer mouse	B	X
Cricetidae	Reithrodontomys	megalotis	Western harvest mouse	B	X
Cricetidae	Reithrodontomys	montanus	Plains harvest mouse	B	X
Didelphidae	Didelphis	virginiana	Opossum	B	
Erethizontidae	Erethizon	dorsatum	Porcupine	B	
Felidae	Lynx	rufus	Bobcat	B	
Geomyidae	Geomys	bursarius	Plains pocket gopher	B	X
Geomyidae	Thomomys	talpoides	Northern pocket gopher	B	
Heteromyidae	Dipodomys	ordii	Ord's kangaroo rat	B	X
Heteromyidae	Perognathus	fasciatus	Olive-backed pocket mouse	B	X
Heteromyidae	Perognathus	flavescens	Plains pocket mouse	B	
Heteromyidae	Perognathus	flavus	Silky pocket mouse	B	X
Heteromyidae	Perognathus	hispidus	Hispid pocket mouse	B	X
Leporidae	Lepus	californicus	Black-tailed jackrabbit	B	X
Leporidae	Lepus	townsendii	White-tailed jackrabbit	B	X
Leporidae	Sylvilagus	audubonii	Desert cottontail	B	X
Leporidae	Sylvilagus	floridanus	Eastern cottontail	B	X
Muridae	Mus	musculus	House mouse	B,I	X
Muridae	Rattus	norvegicus	Norway rat	B,I	
Mustelidae	Mephitis	mephitis	Striped skunk	B	X
Mustelidae	Mustela	erminea	Short-tailed weasel		
Mustelidae	Mustela	frenata	Long-tailed weasel	B	X
Mustelidae	Mustela	nigripes	Black-footed ferret	E	
Mustelidae	Mustela	vison	Mink	b	
Mustelidae	Spilogale	putorius	Spotted skunk	B	
Mustelidae	Taxidea	taxus	Badger	b	X
Procyonidae	Procyon	lotor	Raccoon	B	X
Sciuridae	Cynomys	ludovicianus	Black-tailed prairie dog	B	X
Sciuridae	Eutamias	minimus	Least chipmunk	B	
Sciuridae	Sciurus	niger	Fox squirrel	B	X
Sciuridae	Spermophilus	spilosoma	Spotted ground squirrel	B	X
Sciuridae	Spermophilus	tridecemlineatus	13-lined		

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 15 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
			ground squirrel	B	X
Sciuridae	Spermophilus	variegatus	Rock squirrel	B	
Soricidae	Cryptotis	parva	Least shrew	B	
Soricidae	Sorex	cinereus	Masked shrew	B	
Soricidae	Sorex	merriami	Merriam's shrew	B	
Vespertilionidae	Eptesicus	fuscus	Big brown bat		
Vespertilionidae	Lasionycteris	noctivagans	Silver-haired bat		
Vespertilionidae	Myotis	lucifugus	Little brown myotis		
Vespertilionidae	Myotis	sublatus	Small-footed myotis		
Vespertilionidae	Nycteris	borealis	Red bat		
Vespertilionidae	Nycteris	cinerea	Hoary bat		
Zapodidae	Zapus	hudsonius	Meadow jumping mouse	B	
BIRDS					
Accipitridae	Accipiter	cooperii	Cooper's hawk	B	X
Accipitridae	Accipiter	gentilis	Northern goshawk	B	X
Accipitridae	Accipiter	striatus	Sharp-shinned hawk	B	X
Accipitridae	Aquila	chrysaetos	Golden eagle	R	X
Accipitridae	Buteo	jamaicensis	Red-tailed hawk	R	X
Accipitridae	Buteo	lagopus	Rough-legged hawk	W	X
Accipitridae	Buteo	lineatus	Red-shouldered hawk	M	
Accipitridae	Buteo	platypterus	Broad-winged hawk	M	
Accipitridae	Buteo	regalis	Ferruginous hawk	R	X
Accipitridae	Buteo	swainsoni	Swainson's hawk	B	X
Accipitridae	Circus	cyaneus	Northern Harrier	R	X
Accipitridae	Haliaeetus	leucocephalus	Bald eagle	W,E	X
Aegithalidae	Psaltriparus	minimus	Bushtit		
Alaudidae	Eremophila	alpestris	Horned lark	R	X
Alcedinidae	Ceryle	alcyon	Belted kingfisher	R	
Alcidae	Synthliboramphus	antiquus	Ancient murrelet		
Anatidae	Aix	sponsa	Wood duck	R	X
Anatidae	Anas	acuta	Northern Pintail	R	X
Anatidae	Anas	americana	American wigeon	R	X
Anatidae	Anas	clypeata	Northern shoveler	R	X

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FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Anatidae	Anas	crecca	Green-winged teal	R	X
Anatidae	Anas	cyanoptera	Cinnamon teal	B	X
Anatidae	Anas	diazi	Mexican duck		
Anatidae	Anas	discors	Blue-winged teal	B	X
Anatidae	Anas	fulvigula	Mottled duck		
Anatidae	Anas	platyrhynchos	Mallard	R	X
Anatidae	Anas	rubripes	American Black duck	M	
Anatidae	Anas	strepera	Gadwall	R	X
Anatidae	Anser	albifrons	Greater White-fronted goose	M	
Anatidae	Aythya	affinis	Lesser scaup	W	X
Anatidae	Aythya	americana	Redhead	R	X
Anatidae	Aythya	collaris	Ring-necked duck	W	X
Anatidae	Aythya	marila	Greater scaup	M	
Anatidae	Aythya	valisineria	Canvasback	N	X
Anatidae	Branta	bernicla	Brant	M	
Anatidae	Branta	canadensis	Canada goose	R	X
Anatidae	Bucephala	albeola	Bufflehead	W	X
Anatidae	Bucephala	clangula	Common goldeneye	W	X
Anatidae	Bucephala	islandica	Barrows goldeneye	W	X
Anatidae	Chen	caerulescens	Snow goose	M	X
Anatidae	Chen	rossii	Ross's goose	M	
Anatidae	Clangula	hyemalis	Oldsquaw	M	
Anatidae	Cygnus	columbianus	Whistling swan		
Anatidae	Lophodytes	cucullatus	Hooded merganser	W	X
Anatidae	Melanitta	fusca	White-winged scoter	M	
Anatidae	Melanitta	nigra	Black scoter	M	
Anatidae	Melanitta	perspicillata	Surf scoter	M	
Anatidae	Mergus	merganser	Common merganser	W	
Anatidae	Mergus	serrator	Red-breasted merganser	M	
Anatidae	Oxyura	jamaicensis	Ruddy duck	B	X
Anatidae	Somateria	mollissima	Common eider		
Anhingidae	Anhinga	anhinga	Anhinga		
Apodidae	Chaetura	pelagica	Chimney swift	B	
Ardeidae	Ardea	herodias	Great blue heron	R	X

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FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Ardeidae	Botaurus	lentiginosus	American bittern	b	
Ardeidae	Bubulcus	ibis	Cattle egret	n	
Ardeidae	Butorides	striatus	Green-backed heron	M	
Ardeidae	Casmerodius	albus	Great egret	n	
Ardeidae	Egretta	caerulea	Little blue heron	M	
Ardeidae	Egretta	thula	Snowy egret	B	
Ardeidae	Egretta	tricolor	Tri-colored heron	M	
Ardeidae	Ncyticorax	violaceus	Yellow crowned night heron	b	
Ardeidae	Nycticorax	nycticorax	Black crowned night heron	B	X
Bombycillidae	Bombycilla	cedrorum	Cedar waxwing	W	X
Bombycillidae	Bombycilla	garrulus	Bohemian waxwing	W	
Caprimulgidae	Chordeiles	minor	Common nighthawk	B	X
Caprimulgidae	Phalaenoptilus	nuttalii	Common poorwill	B	
Cathartidae	Cathartes	aura	Turkey vulture	B	X
Charadriidae	Charadrius	alexandrinus	Snowy plover	M	
Charadriidae	Charadrius	melodus	Piping plover	E	
Charadriidae	Charadrius	montanus	Mountain plover	b	
Charadriidae	Charadrius	semipalmatus	Semipalmated plover	M	
Charadriidae	Charadrius	vociferus	Killdeer	R	X
Charadriidae	Pluvialis	dominica	American golden plover	M	
Charadriidae	Pluvialis	squatarola	Black-bellied plover	M	
Ciconiidae	Mycteria	americana	Wood stork		
Cinclidae	Cinclus	mexicanus	American dipper	W	
Columbidae	Columba	fasciata	Band-tailed pigeon	B	
Columbidae	Columba	livia	Rock dove	R	X
Columbidae	Zenaida	macroura	Mourning dove	R	X
Corvidae	Corvus	brachyrhynchos	Common crow	R	X
Corvidae	Corvus	corax	Common raven	W	
Corvidae	Corvus	cryptoleucus	Chihuahuan raven	M	
Corvidae	Cyanocitta	cristata	Blue jay	R	
Corvidae	Gymnorhinus	cyanocephalus	Pinyon jay	M	
Corvidae	Nucifraga	columbiana	Clark's nutcracker	M	
Corvidae	Pica	pica	Black-billed magpie	R	X

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 18 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Cuculidae	Coccyzus	americanus	Yellow-billed cuckoo	b	
Cuculidae	Coccyzus	erythropthalmus	Black-billed cuckoo	b	
Emberizidae	Agelaius	phoeniceus	Red-winged blackbird	R	X
Emberizidae	Aimophila	cassinii	Cassin's sparrow	b	X
Emberizidae	Aimophila	ruficeps	Rufous-crown sparrow		
Emberizidae	Ammodramus	bairdii	Baird's sparrow	M	
Emberizidae	Ammodramus	leconteii	Le Conte's sparrow		
Emberizidae	Ammodramus	savannarum	Grasshopper sparrow	B	X
Emberizidae	Amphispiza	belli	Sage sparrow	M	
Emberizidae	Amphispiza	bilineata	Black-throated sparrow	M	
Emberizidae	Calamospiza	melanocorys	Lark bunting	B	X
Emberizidae	Calcarius	lapponicus	Lapland longspur	W	
Emberizidae	Calcarius	mccownii	McCown's longspur	M X	
Emberizidae	Calcarius	ornatus	Chestnut-sided longspur		
Emberizidae	Cardinalis	cardinalis	Northern cardinal	N	
Emberizidae	Chondestes	grammacus	Lark sparrow	B	X
Emberizidae	Dendroica	caerulescens	Black-throated Blue warbler	M	
Emberizidae	Dendroica	castanea	Bay-breasted warbler	B	
Emberizidae	Dendroica	cerulea	Cerulean warbler		
Emberizidae	Dendroica	coronata	Yellow-rumped warbler	M	X
Emberizidae	Dendroica	dominica	Yellowthroat warbler	M	
Emberizidae	Dendroica	fusca	Blackburnian warbler	M	X
Emberizidae	Dendroica	graciae	Grace's warbler		
Emberizidae	Dendroica	magnolia	Magnolia warbler	M	
Emberizidae	Dendroica	nigrescens	Black-throated gray warbler	M	
Emberizidae	Dendroica	palmarum	Palm warbler	M	
Emberizidae	Dendroica	pensylvanica	Chestnut-sided warbler	M	X
Emberizidae	Dendroica	petchnia	Yellow warbler	B	X
Emberizidae	Dendroica	pinus	Pine warbler		
Emberizidae	Dendroica	striata	Blackpoll warbler	M	X
Emberizidae	Dendroica	townsendi	Townsend's warbler	M	
Emberizidae	Dendroica	virens	Black-throated green warbler	M	

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FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Emberizidae	Dolichonyx	oryzivorus	Bobolink	B	X
Emberizidae	Euphagus	carolinus	Rusty blackbird	W	
Emberizidae	Euphagus	cyanocephalus	Brewer's blackbird	R	X
Emberizidae	Geothlypis	trichas	Common yellowthroat	B	X
Emberizidae	Guiraca	caerulea	Blue grosbeak	B	X
Emberizidae	Helmitheros	vermivorus	Worm-eating warbler	M	
Emberizidae	Icteria	virens	Yellow-breasted chat	B	
Emberizidae	Icterus	galbula	Northern oriole	B	X
Emberizidae	Icterus	spurius	Orchard oriole	B	
Emberizidae	Junco	hyemalis	Dark-eyed junco	W	X
Emberizidae	Melospiza	georgiana	Swamp sparrow	W	
Emberizidae	Melospiza	lincolnii	Lincoln's sparrow	M	X
Emberizidae	Melospiza	melodia	Song sparrow	R	X
Emberizidae	Mniotilta	varia	Black & white warbler	M	X
Emberizidae	Molothrus	ater	Brown-headed cowbird	B	X
Emberizidae	Oporornis	tolmiei	MacGillivray warbler	M	X
Emberizidae	Parula	americana	Northern parula	M	X
Emberizidae	Passerculus	sandwichensis	Savannah Sparrow	B	X
Emberizidae	Passerella	iliaca	Fox sparrow	W	X
Emberizidae	Passerina	amoena	Lazuli bunting	B	
Emberizidae	Passerina	ciris	Painted bunting	M	
Emberizidae	Passerina	cyanea	Indigo bunting	B	X
Emberizidae	Pheucticus	ludovicianus	Rose-breasted grosbeak	M	X
Emberizidae	Pheucticus	melanocephalus	Blackheaded grosbeak	B	X
Emberizidae	Pipilo	chlorurus	Green-tailed towhee	b	
Emberizidae	Pipilo	erythrophthalmu	Rufous-sided towhee	B	X
Emberizidae	Pipilo	fuscus	Brown towhee		
Emberizidae	Piranga	ludoviciana	Western tanager	B	
Emberizidae	Piranga	olivacea	Scarlet tanager	M	
Emberizidae	Piranga	rubra	Summer tanager	M	
Emberizidae	Plectrophenax	nivalis	Snow bunting	W	
Emberizidae	Pooecetes	gramineus	Vesper sparrow	B	X
Emberizidae	Protonotaria	citrea	Prothonotary warbler	M	
Emberizidae	Quiscalus	quiscula	Common grackle	B	X
Emberizidae	Seiurus	aurocapillus	Ovenbird	B	X

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FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*		OBSERVED ON RMA
Emberizidae	Seiurus	noveboracensis	Northern waterthrush	M		
Emberizidae	Setophaga	ruticilla	American redstart	B		X
Emberizidae	Spiza	americana	Dickcissel	B		X
Emberizidae	Spizella	arborea	American tree sparrow	W		X
Emberizidae	Spizella	breweri	Brewer's sparrow	B		X
Emberizidae	Spizella	pallida	Clay-colored sparrow	M		X
Emberizidae	Spizella	passerina	Chipping sparrow	B		X
Emberizidae	Spizella	pusilla	Field sparrow	M		
Emberizidae	Sturnella	neglecta	Western meadowlark	R		X
Emberizidae	Vermivora	celata	Orange-crown warbler	M		X
Emberizidae	Vermivora	chrysoptera	Golden-wing warbler	M		
Emberizidae	Vermivora	peregrina	Tennessee warbler	M		X
Emberizidae	Vermivora	pinus	Blue-winged warbler	M		
Emberizidae	Vermivora	ruficapilla	Nashville warbler	M		X
Emberizidae	Vermivora	virginiae	Virginia's warbler	B		
Emberizidae	Wilsonia	canadensis	Canada warbler	M		
Emberizidae	Wilsonia	citrina	Hooded warbler	M		X
Emberizidae	Wilsonia	pusilla	Wilson's warbler	M		X
Emberizidae	Xanthocephalus	xanthocephalus	Yellow-headed blackbird	B		X
Emberizidae	Zonotrichia	leucophrys	White-crowned sparrow	W		X
Emberizidae	Zonotrichia	querula	Harris's sparrow	W		
Falconidae	Falco	columbarius	Merlin	W		
Falconidae	Falco	mexicanus	Prairie falcon	R		X
Falconidae	Falco	peregrinus	Peregrine falcon	M	X	
Falconidae	Falco	rusticolus	Gyrfalcon	M		
Falconidae	Falco	sparverius	American kestrel	R		X
Fringillidae	Carduelis	flammea	Common redpoll	W		
Fringillidae	Carduelis	pinus	Pine siskin	R		X
Fringillidae	Carduelis	psaltria	Lesser goldfinch	B		X
Fringillidae	Carduelis	tristis	American goldfinch	R		X
Fringillidae	Carpodacus	cassinii	Cassin's finch	W		
Fringillidae	Carpodacus	mexicanus	House finch	R		X
Fringillidae	Carpodacus	purpureus	Purple finch	W		
Fringillidae	Coccothraustes	vespertinus	Evening grosbeak	R		
Fringillidae	Leucosticte	arctoa	Rosy finch	W		

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 21 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Fringillidae	Leucosticte	atrata	Black rosy finch		
Fringillidae	Leucosticte	australis	Brown-cap rosy finch		
Fringillidae	Loxia	curvirostra	Red crossbill	R	
Fringillidae	Loxia	leucoptera	White-wing crossbill	W	
Fringillidae	Pinicola	enucleator	Pine grosbeak	W	
Gaviidae	Gavia	arctica	Arctic loon	M	
Gaviidae	Gavia	immer	Common loon	M	
Gaviidae	Gavia	stellata	Red-throated loon	M	
Gruidae	Grus	americana	Whooping crane	E	
Gruidae	Grus	canadensis	Sandhill crane	M	
Hirundinidae	Hirundo	pyrrhonota	Cliff swallow	B	X
Hirundinidae	Hirundo	rustica	Barn swallow	B	X
Hirrundinidae	Riparia	riparia	Bank swallow	B	
Hirundinidae	Stelgidopteryx	serripennis	Northern Rough-winged swallow	B	X
Hirundinidae	Tachycineta	bicolor	Tree swallow	B	X
Hirundinidae	Tachycineta	thalassina	Violet-green swallow	M	X
Laniidae	Lanius	excubitor	Northern shrike	W	X
Laniidae	Lanius	ludovicianus	Loggerhead shrike	B	X
Laridae	Chlidonias	niger	Black tern	B	
Laridae	Larus	argentatus	Herring gull	W	X
Laridae	Larus	atricilla	Laughing gull	M	
Laridae	Larus	californicus	California gull	N	
Laridae	Larus	delawarensis	Ring-billed gull	N	X
Laridae	Larus	glaucoides	Iceland gull		
Laridae	Larus	hyperboreus	Glaucous gull	W	
Laridae	Larus	marinus	Green black-backed gull	W	
Laridae	Larus	minutus	Little gull	M	
Laridae	Larus	philadelphia	Bonaparte's gull	M	
Laridae	Larus	pipixcan	Franklin's gull	M	X
Laridae	Larus	thayeri	Thayer's gull	W	
Laridae	Pagophila	eburnea	Ivory gull		
Laridae	Rissa	tridactyla	Black legged kittiwake	M	
Laridae	Sterna	antillarum	Least tern		
Laridae	Sterna	forsteri	Forster's tern	B	

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FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Laridae	Sterna	hirundo	Common tern	M	
Laridae	Sterna	paradisaea	Arctic tern		
Laridae	Xema	sabini	Sabine's gull	M	
Meleagrididae	Meleagris	gallopavo	Wild turkey	R	X
Mimidae	Dumetella	carolinensis	Gray catbird	B	X
Mimidae	Mimus	polyglottos	Northern mockingbird	R	X
Mimidae	Oreoscoptes	montanus	Sage thrasher	B	
Mimidae	Toxostoma	curvirostre	Curved-bill thrasher		
Mimidae	Toxostoma	rufum	Brown thrasher	B	X
Motacillidae	Anthus	spinoletta	Water pipit	M	X
Motacillidae	Anthus	spraguei	Sprague's pipit	M	
Muscicapidae	Catharus	fuscescens	Veery	B	
Muscicapidae	Catharus	minimus	Gray-cheeked thrush	M	
Muscicapidae	Catharus	ustulatus	Swainson s thrush	B	X
Muscicapidae	Hylocichla	mustelina	Wood thrush	M	
Muscicapidae	Myadestes	townsendii	Townsend's solitaire	W	X
Muscicapidae	Polioptila	caerulea	Bluegray gnatcatcher	M	
Muscicapidae	Regulus	calendula	Ruby-crowned kinglet	M	X
Muscicapidae	Regulus	satrapa	Golden-crown kinglet	W	
Muscicapidae	Sialia	currucoides	Mountain bluebird	B	X
Muscicapidae	Sialia	mexicana	Western bluebird	B	
Muscicapidae	Sialia	sialis	Eastern bluebird	M	
Muscicapidae	Turdus	migratorius	American robin	R	X
Pandionidae	Pandion	haliaetus	Osprey	M	X
Paridae	Parus	atricapillus	Black-capped chickadee	R	X
Paridae	Parus	gambeli	Mountain chickadee	W	
Passeridae	Passer	domesticus	House sparrow	R,I	X
Pe.ecanidae	Pelecanus	erythrorhynchos	American White pelican	n	X
Phalacrocoracidae	Phalacrocorax	auritus	Double-crowned cormorant	B	X
Phalacrocoracidae	Phalacrocorax	olivaceus	Olivaceous cormorant	M	
Phalaropodidae	Phalaropus	fulicaria	Red phalarope	M	
Phalarcpodidae	Phalaropus	lobatus	Northern phalarope	M	
Phalaropodidae	Phalaropus	tricolor	Wilson's phalarope	B	X
Phasianidae	Alectoris	chukar	Chukar	N	X

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 23 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Phasianidae	Callipepla	squamata	Scaled quail	b	
Phasianidae	Colinus	virginianus	Northern bobwhite	R	X
Phasianidae	Phasianus	colchicus	Ring-necked pheasant	R	X
Picidae	Colaptes	auratus	Northern flicker	R	X
Picidae	Melanerpes	carolinus	Red-belly woodpecker	M	
Picidae	Melanerpes	erythrocephalus	Red-headed woodpecker	B	X
Picidae	Melanerpes	lewis	Lewis's woodpecker	R	
Picidae	Picoides	pubescens	Downy woodpecker	R	X
Picidae	Picoides	villosus	Hairy woodpecker	R	
Picidae	Sphyrapicus	varius	Yellow-bellied sapsucker	N	
Podicipedidae	Aechmophorus	occidentalis	Western grebe	B	X
Podicipedidae	Podiceps	auritus	Horned grebe	M	
Podicipedidae	Podiceps	grisegena	Red-necked grebe	M	
Podicipedidae	Podiceps	nigricollis	Eared grebe	b	X
Podicipedidae	Podilymbus	podiceps	Pied-billed grebe	R	X
Ptilogonatidae	Phainopepla	nitens	Phainopepla		
Rallidae	Coturnicops	noveboracensis	Yellow rail		
Rallidae	Fulica	americana	American coot	R	X
Rallidae	Gallinula	chloropus	Common gallinule		
Rallidae	Laterallus	jamaicensis	Black rail		
Rallidae	Porzana	carolina	Sora	B	X
Rallidae	Rallus	limicola	Virginia rail	R	X
Recurvirostridae	Himantopus	mexicanus	Black-necked stilt	M	
Recurvirostridae	Recurvirostra	americana	American avocet	B	X
Scolopacidae	Arenaria	interpres	Ruddy turnstone	M	
Scolopacidae	Bartramia	longicauda	Upland sandpiper	b	X
Scolopacidae	Calidris	alba	Sanderling	M	
Scolopacidae	Calidris	alpina	Dunlin	M	
Scolopacidae	Calidris	bairdii	Baird's sandpiper	M	
Scolopacidae	Calidris	canutus	Red knot	M	
Scolopacidae	Calidris	fuscicollis	White-rumped sandpiper	M	
Scolopacidae	Calidris	himantopus	Stilt sandpiper	M	X
Scolopacidae	Calidris	mauri	Western sandpiper	M	X
Scolopacidae	Calidris	melanotos	Pectoral sandpiper	M	X
Scolopacidae	Calidris	minutilla	Least sandpiper	M	X

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FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Scolopacidae	Calidris	pusilla	Semipalm.sandpiper	M	
Scolopacidae	Catoptrophorus	semipalmatus	Willet	M	X
Scolopacidae	Gallinago	gallinago	Common snipe	R	X
Scolopacidae	Limnodromus	griseus	Short-billed dowitcher	M	
Scolopacidae	Limnodromus	scolopaceus	Long-billed dowitcher	M	X
Scolopacidae	Limosa	fedoa	Marbled godwit	M	
Scolopacidae	Limosa	haemastica	Hudsonian godwit	M	
Scolopacidae	Numenius	americanus	Long-billed curlew	M	
Scolopacidae	Numenius	phaeopus	Whimbrel	M	
Scolopacidae	Scolopax	minor	American woodcock		
Scolopacidae	Tringa	flavipes	Lesser yellowlegs	M	X
Scolopacidae	Tringa	melanoleuca	Greater yellowlegs	M	X
Scolopacidae	Tringa	solitaria	Solitary sandpiper	M	X
Scolopacidae	Tryngites	subruficollis	Buffbreast sandpiper	M	
Sittidae	Certhia	americana	Brown creeper	R	X
Sittidae	Sitta	canadensis	Red-breasted nuthatch	R	X
Sittidae	Sitta	carolinensis	White-breasted nuthatch	R	X
Solopacidae	Actitis	macularia	Spotted sandpiper	B	X
Stercorariidae	Stercorarius	parasiticus	Parasitic jaeger	M	
Stercorariidae	Stercorarius	pomarinus	Pomarine jaeger	M	
Strigidae	Aegolius	acadicus	Northern Saw-whet owl	R	
Strigidae	Asio	flammeus	Short-eared owl	R	X
Strigidae	Asio	otus	Long-eared owl	R	X
Strigidae	Athene	cunicularia	Burrowing owl	B	X
Strigidae	Bubo	virginianus	Great horned owl	R	X
Strigidae	Glaucidium	gnoma	Pygmy owl	W	
Strigidae	Nyctea	scandiaca	Snowy owl	W	
Strigidae	Otus	asio	Eastern screech owl	R	
Strigidae	Otus	kennicottii	Western screech owl	R	
Strigidae	Strix	occidentalis	Spotted owl	M	
Sturnidae	Sturnus	vulgaris	Starling	R,I	X
Tetraonidae	Tympanuchus	phasianellus	Sharp-tailed grouse	R,E	
Threskiornithidae	Plegadis	chihi	White-faced ibis	M	X
Trochilidae	Archilochus	alexandri	Black-chined hummingbird		
Trochilidae	Selasphorus	platycercus	Brown-tailed hummingbird	B	

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 25 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Trochilidae	*Selasphorus*	*rufus*	Rufous hummingbird	M	
Trochilidae	*Stellula*	*calliope*	Calliope hummingbird	B	
Troglodytidae	*Cistothorus*	*palustris*	Long-bill marsh wren		X
Troglodytidae	*Salpinctes*	*obsoletus*	Rock wren	b	
Troglodytidae	*Thryothorus*	*ludovicianus*	Carolina wren	M	
Troglodytidae	*Troglodytes*	*aedon*	House wren	B	X
Troglodytidae	*Troglodytes*	*troglodytes*	Winter wren	W	
Tvoglodytidae	*Thryomanes*	*bewickii*	Bewick's wren	W	
Tyrannidae	*Contopus*	*borealis*	Olive-sided flycatcher	M	
Tyrannidae	*Contopus*	*sordidulus*	Western wood pewee	B	
Tyrannidae	*Contopus*	*virens*	Eastern wood pewee		
Tyrannidae	*Empidonax*	*alnorum*	Alder flycatcher		
Tyrannidae	*Empidonax*	*difficilis*	Western flycatcher	M	X
Tyrannidae	*Empidonax*	*hammondii*	Hammond's flycatcher	M	
Tyrannidae	*Empidonax*	*minimus*	Least flycatcher	M	
Tyrannidae	*Empidonax*	*oberholseri*	Dusky flycatcher	M	X
Tyrannidae	*Empidonax*	*traillii*	Willow flycatcher	M	X
Tyrannidae	*Myiarchus*	*cinerascens*	Ashthroat flycatcher	M	
Tyrannidae	*Myiarchus*	*crinitus*	Green-crested flycatcher	M	
Tyrannidae	*Pyrocephalus*	*rubinus*	Vermillion flycatcher	M	
Tyrannidae	*Sayornis*	*phoebe*	Eastern phoebe	M	
Tyrannidae	*Sayornis*	*saya*	Say's phoebe	B	X
Tyrannidae	*Tyrannus*	*forficatus*	Scissortail flycatcher	M	
Tyrannidae	*Tyrannus*	*tyrannus*	Eastern kingbird	B	X
Tyrannidae	*Tyrannus*	*verticalis*	Western kingbird	B	X
Tyrannidae	*Tyrannus*	*vociferans*	Cassin's kingbird	b	

Table A-1. Plants and Animals Species Which Inhabit or Potentially Occur on Rocky Mountain Arsenal (Page 26 of 26)

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS*	OBSERVED ON RMA
Tytonidae	*Tyto*	*alba*	Common barn owl	R	X
Vireonidae	*Vireo*	*bellii*	Bell's vireo		
Vireonidae	*Vireo*	*flavifrons*	Yellow-throated vireo		
Vireonidae	*Vireo*	*gilvus*	Warbling vireo	B	X
Vireonidae	*Vireo*	*olivaceus*	Red-eyed vireo	B	X
Vireonidae	*Vireo*	*philadelphicus*	Philadelphia vireo	M	
Vireonidae	*Vireo*	*solitarius*	Solitary vireo	B	X

* Status: B=Definite breeder, C=Game, n=Non-breeder, b=Likely breeder, I=Introduced, R=Resident, E=Endangered, M=Migrant, W=Winter visitor

References: see APPENDIX A, REFERENCES

Source: ESE, 1988.

APPENDIX B

STATISTICAL ANALYSES

APPENDIX B
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1.0 STATISTICAL ANALYSES FOR CURRENT EXTENT OF CONTAMINATION IN BIOTA

1.1 INTRODUCTION

Nonparametric statistical methods were used for all analyses of tissue concentration data because variances were consistently heteroscedastic and markedly non-normal. The general analytical approach for each species was the same in that a separate Kruskal-Wallis one-way ANOVA by ranks (Siegel, 1957) for each dependent variable (i.e., arsenic, mercury, aldrin, dieldrin, endrin, DDE, and DDT) initially was used to evaluate if at least one treatment group differed from the others. This preliminary analysis was then followed by a set of hierarchical or orthogonal a priori contrasts that were specific for the particular experimental design or species of concern. The experimental design for each species is illustrated by a dendogram in which compared groups (vertical lines) are united by a horizontal bar. The results of the statistical analysis for each variable are then superimposed on a dendogram along with descriptive statistics (mean, standard error of the mean, and sample size) for each treatment group. Samples sizes were insufficient for statistical comparisons involving sunflowers or morning glories. Means were calculated substituting zero (0) for levels below detection limits.

1.2 EARTHWORMS

Rationale

Data were available for seven contaminants. Three sites (onsite controls, offsite controls, and onsite contaminated areas) yielded specimens for statistical analyses. A priori contrasts included a comparison of onsite controls with offsite controls and a comparison of pooled controls with onsite contaminated areas.

Results

Only comparisons for arsenic yielded significant differences (Figure B.1-1). The preliminary ANOVA indicated significance differences among the three sites. Onsite controls differed from offsite controls, and the comparison of pooled controls with contaminated areas approached significance ($0.10 > p > 0.05$). Many potential differences between control and contaminated

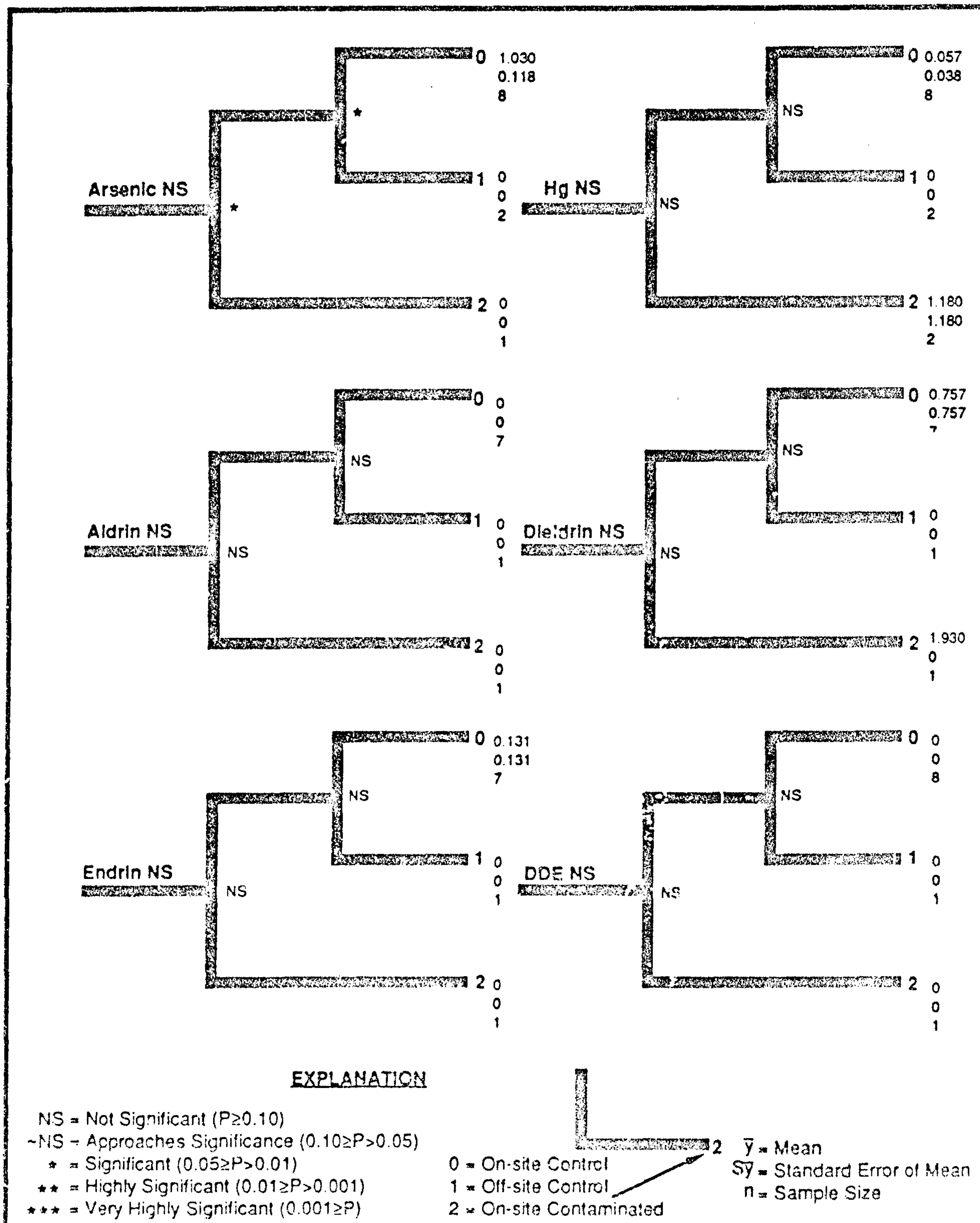

Figure B.1-1 (1 of 2)
STATISTICAL ANALYSIS OF CONTAMINANTS IN EARTHWORMS

SOURCE: ESE, 1988

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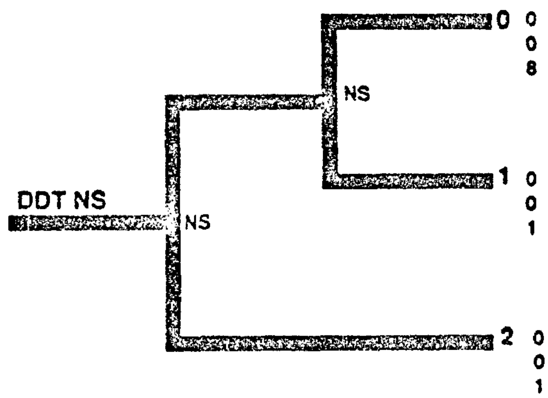
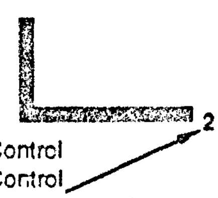


EXPLANATION

NS = Not Significant (P≥0.10)
~NS = Approaches Significance (0.10≥P>0.05)
* = Significant (0.05≥P>0.01)
** = Highly Significant (0.01≥P>0.001)
*** = Very Highly Significant (0.001≥P)

0 = On-site Control
1 = Off-site Control
2 = On-site Contaminated



$\bar{y}$ = Mean
$S\bar{y}$ = Standard Error of Mean
n = Sample Size

Figure B.1-1 (2 of 2)
STATISTICAL ANALYSIS OF CONTAMINANTS IN EARTHWORMS

SOURCE: ESE, 1988

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sites may have remained undetected because of low sample sizes, especially for the contaminated site (n = 2).

1.3 GRASSHOPPERS

Rationale

Specimens were categorized according to site of capture from two contaminated areas (1 = RMA Section 36, 2 = RMA Section 26) and two control areas (3 = onpost control, 4 = offpost control). The hierarchical analyses included (1) contrast of Section 36 with Section 26, (2) contrast of the offpost control with the onpost control, and (3) contrast of the pooled data from control sites with the pooled data from contaminated sites. Sample sizes were small for each of the four groups. Data for all seven contaminants were available for analysis.

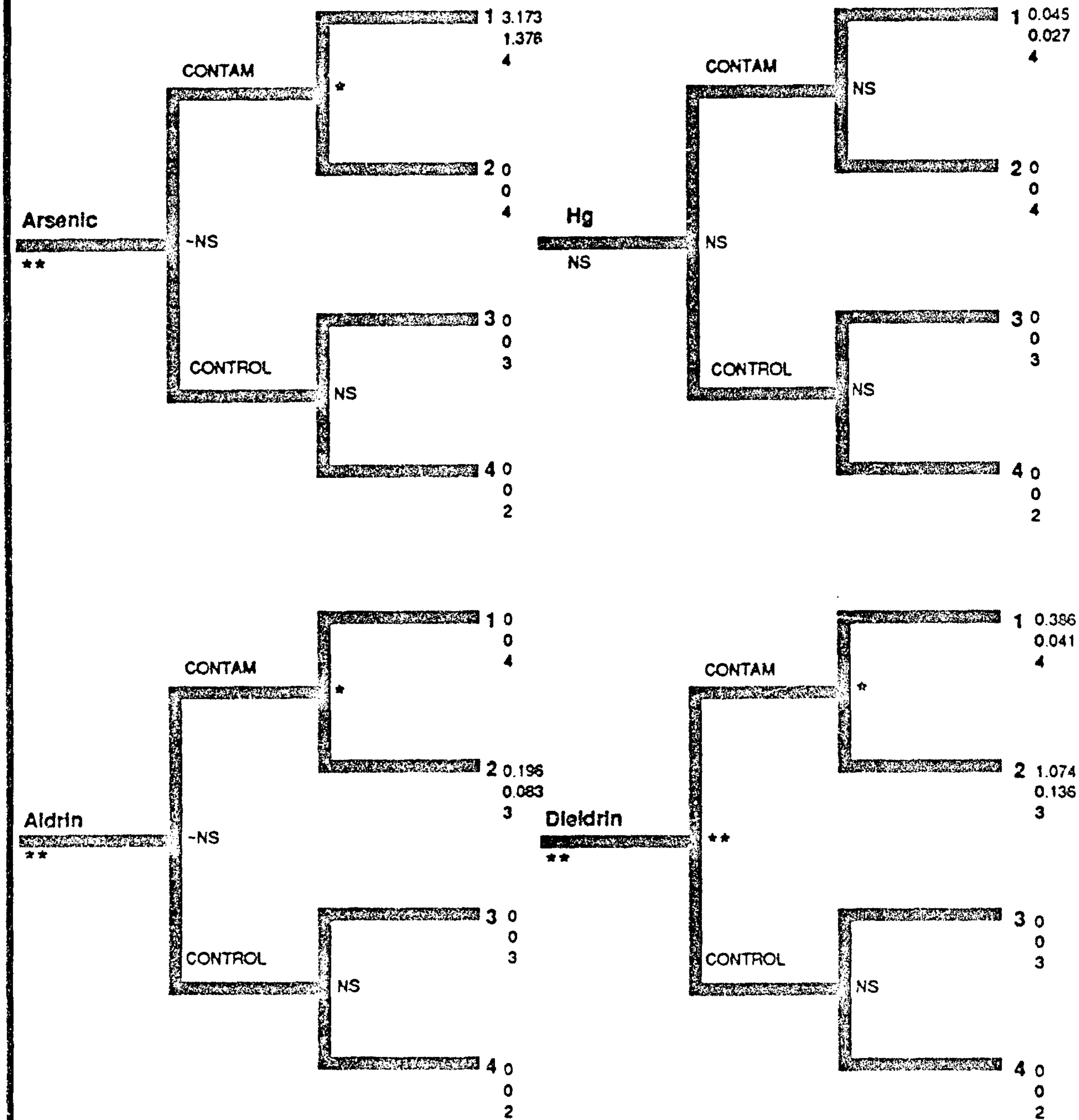
Results

Statistical results are summarized in Figure B.1-2. Mercury, DDE, and DDT failed to yield any significant differences. In addition to significance in the preliminary ANOVA, a significant difference in level of arsenic contamination was detected between contaminated sites and was approached ($0.10 > p > 0.05$) for the comparison of pooled contaminated and pooled control sites. Significant differences in levels of aldrin were detected in the preliminary ANOVA as well as between contaminated sites; significance was approached ($0.10 > P > 0.05$) for a difference between pooled contaminated and pooled control sites. Significance was obtained for all comparisons of dieldrin levels, except that between onpost and offpost controls. For endrin, differences among sites were significant among the four treatment groups in the preliminary ANOVA, as well as between the two contaminated sites.

1.4 MALLARDS

Rationale

Specimens were categorized into six groups according to age (egg, fledgling, adult) and site (contaminated and control). Four a priori contrasts were conducted and included (1) eggs from control versus contaminated sites, (2) fledglings from control versus contaminated sites, (3) adults from control



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* = Significant (0.05≥P>0.01)
** = Highly Significant (0.01≥P>0.001)
*** = Very Highly Significant (0.001≥P)

1 = Section 36, RMA
2 = Section 26, RMA
3 = On-site Control
4 = Off-site Control

$\bar{y}$ = Mean
$S\bar{y}$ = Standard Error of Mean
n = Sample Size

Figure B.1-2 (1 of 2)
STATISTICAL ANALYSIS OF CONTAMINANTS IN GRASSHOPPERS

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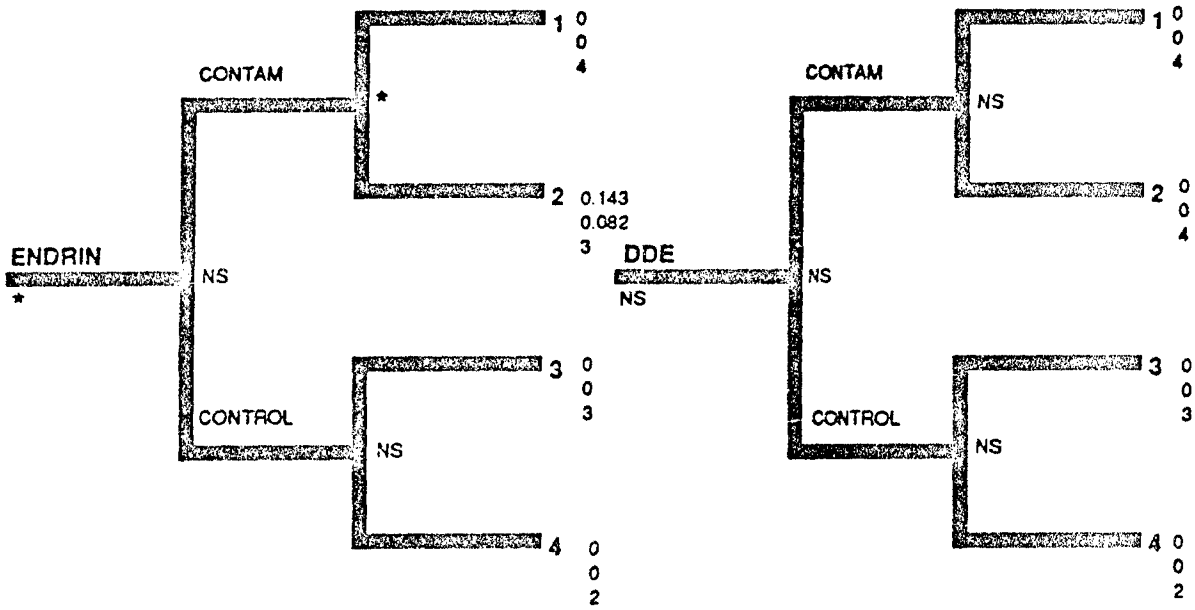

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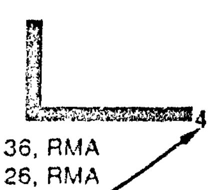
* = Significant (0.05≥P>0.01)
** = Highly Significant (0.01≥P>0.001)
*** = Very Highly Significant (0.001≥P)

1 = Section 36, RMA
2 = Section 26, RMA
3 = On-site Control
4 = Off-site Control



$\bar{y}$ = Mean
$S\bar{y}$ = Standard Error of Mean
n = Sample Size

Figure B.1-2 (2 of 2)
STATISTICAL ANALYSIS OF CONTAMINANTS IN GRASSHOPPERS

SOURCE: ESE, 1988

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versus contaminated sites, and (4) among age class comparisons in which the sites were pooled.

Results

Data were available for all 7 dependent variable except arsenic. The results of the Kruskal-Wallis ANOVAs for each variable are presented in Figure B.1-3. For mercury, highly significant differences existed among the six treatment groups, and the a priori contrasts identified differences between fledglings from control and contaminated sites, as well as differences among age groups when contaminated and control sites were pooled. For eggs, significance was approached ($0.10 > p > 0.05$) for differences in mercury content between control and contaminated sites. For dieldrin, significant differences were identified between control and contaminated sites for eggs ($p < 0.001$) and fledglings ($0.05 > p > 0.01$); moreover, differences between control and contaminated sites approached significance ($0.10 > p > 0.05$) for adults. When sites were combined for each age group, no differences were detected among age groups. Although none of the statistical tests for DDE revealed significant differences among treatment groups, significance was approached ($0.10 > p > 0.05$) in the initial comparison of the six groups, as well as in the a priori contrasts of control and contaminated sites for eggs, and the comparison among age groups when sites were combined. Aldrin, endrin, and DDT were never detected in any tissues and all statistical comparisons were nonsignificant.

1.5 PHEASANT

Rationale

Specimens were categorized according to site of capture (offpost control versus onsite contaminated areas) and age (egg, fledgling, or adult) into six groups (1 = onpost eggs, 2 = onpost fledglings, 3 = onpost adults, 4 = control eggs, 5 = control fledglings, and 6 = control adults). Few adult birds were obtained, especially from control areas (maximum n = 2). A priori contrasts included (1) comparison of onpost and control eggs, (2) comparison of onpost and control fledglings, (3) comparison of onpost and control adults, and (4) comparisons among the three age classes regardless of site of capture. Data were available for all seven contaminants.

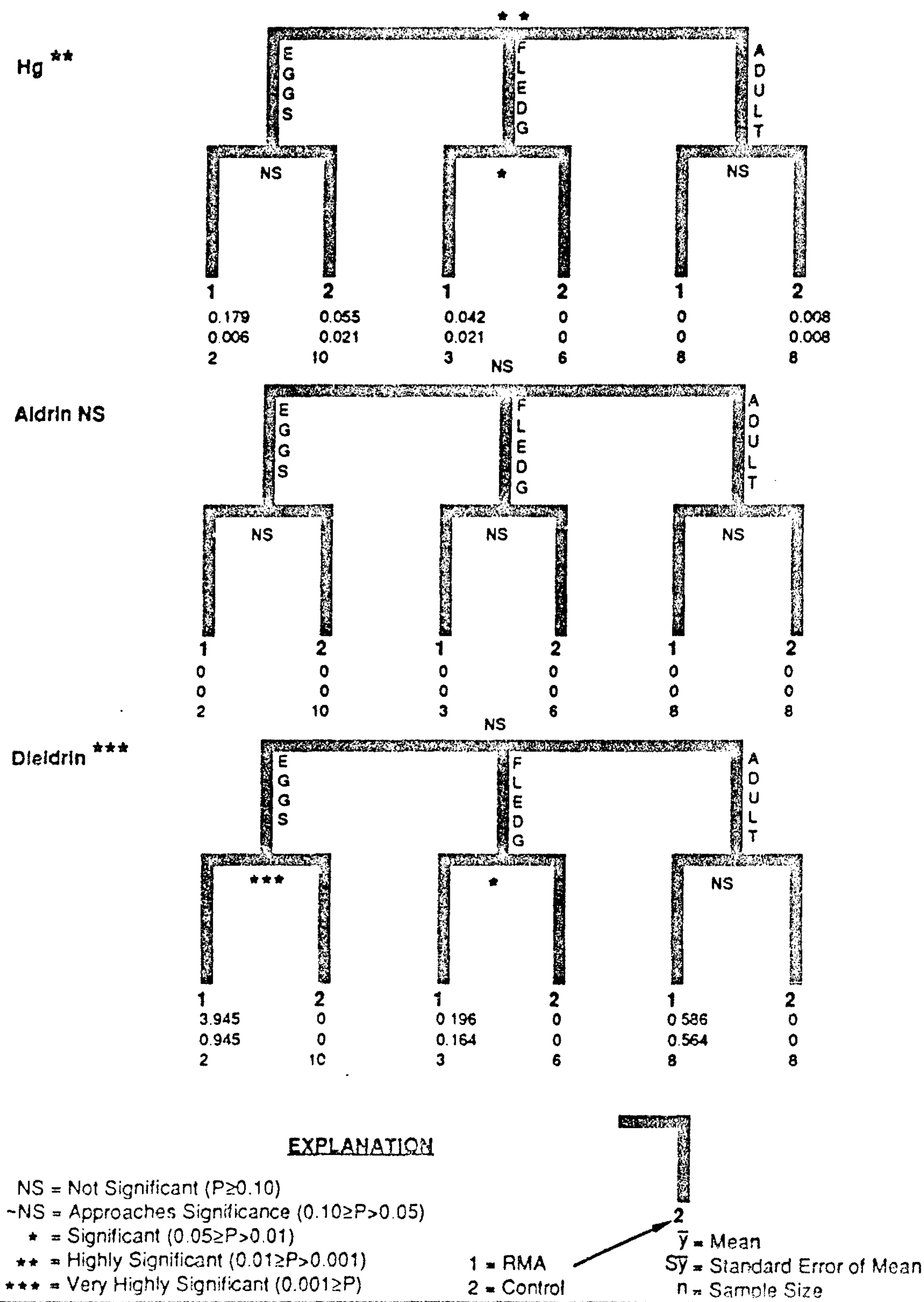

Figure B.1-3 (1 of 2)
STATISTICAL ANALYSIS OF CONTAMINANTS IN MALLARDS

SOURCE ESE, 1988

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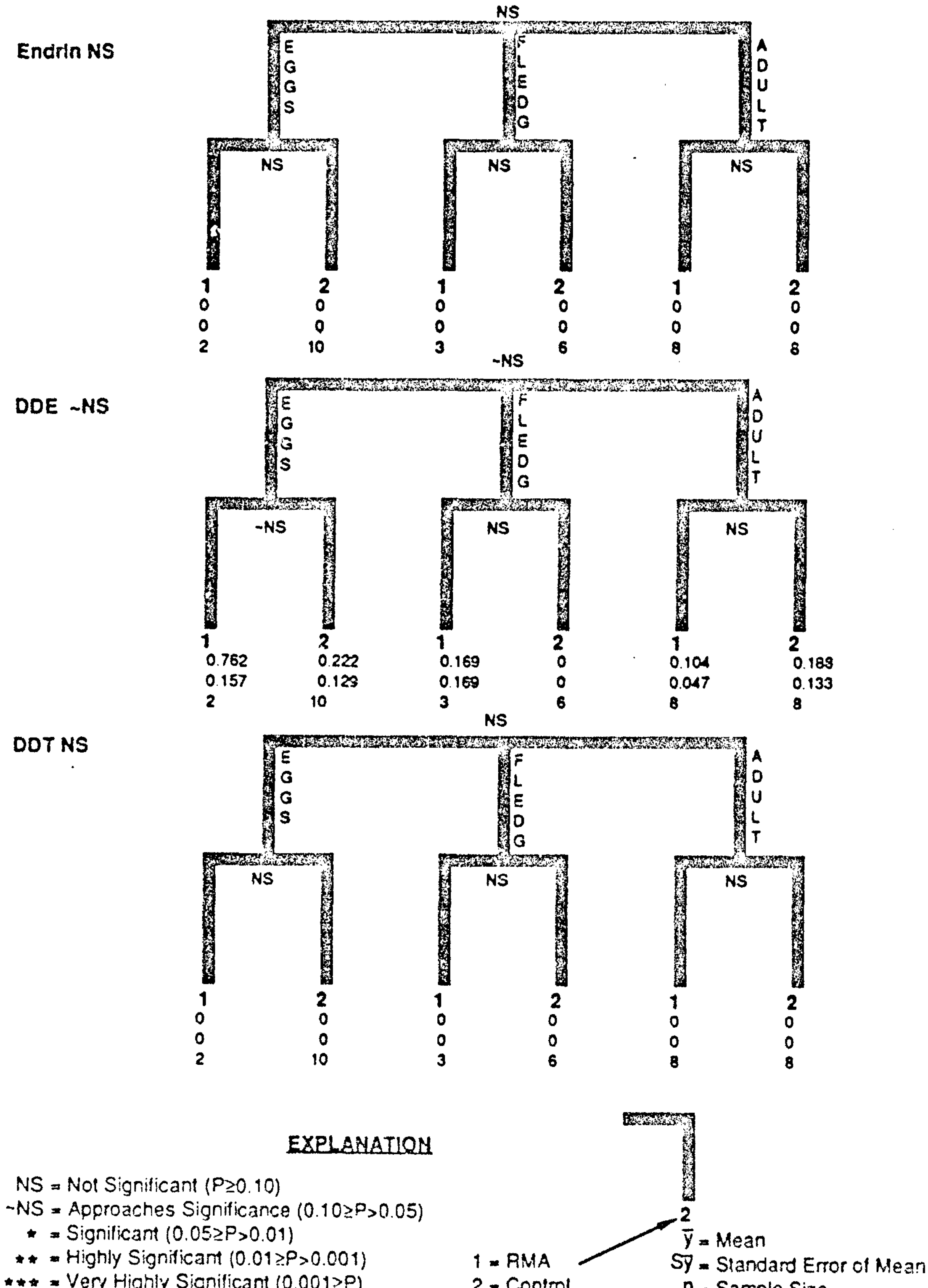

Figure B.1-3 (2 of 2)
STATISTICAL ANALYSIS OF CONTAMINANTS IN MALLARDS

SOURCE: ESE, 1988

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Results

Statistical results are summarized in Figure B.1-4. No significant differences in levels of mercury, aldrin, endrin, DDE, or DDT were obtained for any contrasts. Although no significant differences in levels of arsenic Figure B.1-3 were detected between control and contaminated sites within any of the three age groups, significant differences were revealed among age groups, as well as in the preliminary ANOVA. In contrast, significant differences between control and onpost sites for eggs and for fledglings (but not for adults, probably due to small sample sizes) were obtained for dieldrin. The preliminary ANOVA was also significant for dieldrin.

1.6 COTTONTAIL RABBITS

Rationale

Specimens were obtained from one contaminated area (1 = RMA Section 36) and from two control sites (2 = onpost control and 3 = offpost control). A priori contrasts included comparison of onpost and offpost controls, and comparisons of pooled controls with the contaminated site. Contaminant levels were obtained for arsenic, mercury, aldrin, dieldrin, and endrin.

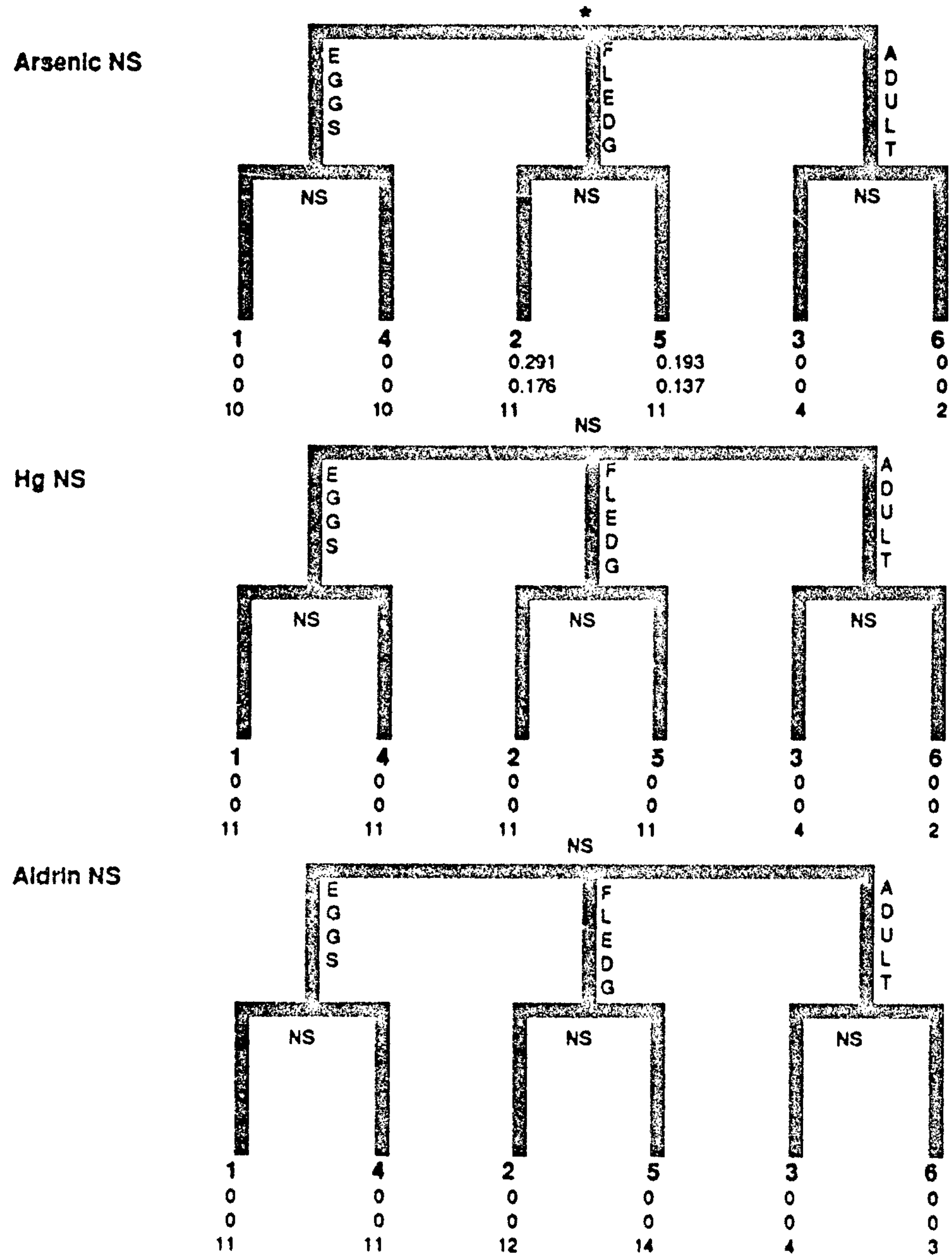
Results

Statistical results are summarized in Figure B.1-5. No significant differences were obtained for any comparison of arsenic, mercury, aldrin, or endrin. Significance was approached ($0.10 > p > 0.05$) in the preliminary comparison of dieldrin levels among the three groups; the a priori contrast between pooled control sites and the contaminated site was significant.

1.7 DEER

Rationale

Levels of contamination for arsenic, mercury, aldrin, dieldrin, and endrin were obtained from muscle and liver of specimens from contaminated sites and offpost control sites. Data were analyzed separately for liver and muscle to avoid problems of psuedoreplication (a liver and muscle sample was analyzed from each specimen). Moreover, a priori contras s were not conducted because only two groups were distinguished in each analysis.



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* = Significant (0.05≥P>0.01)
** = Highly Significant (0.01≥P>0.001)
*** = Very Highly Significant (0.001≥P)

1, 2, or 3 = On-site Contaminated
4, 5, or 6 = Off-site Controls

2
$\bar{y}$ = Mean
$S\bar{y}$ = Standard Error of Mean
n = Sample Size

Figure B.1-4 (1 of 3)
STATISTICAL ANALYSIS OF CONTAMINANTS IN RING-NECKED PHEASANTS

SOURCE: ESE, 1989

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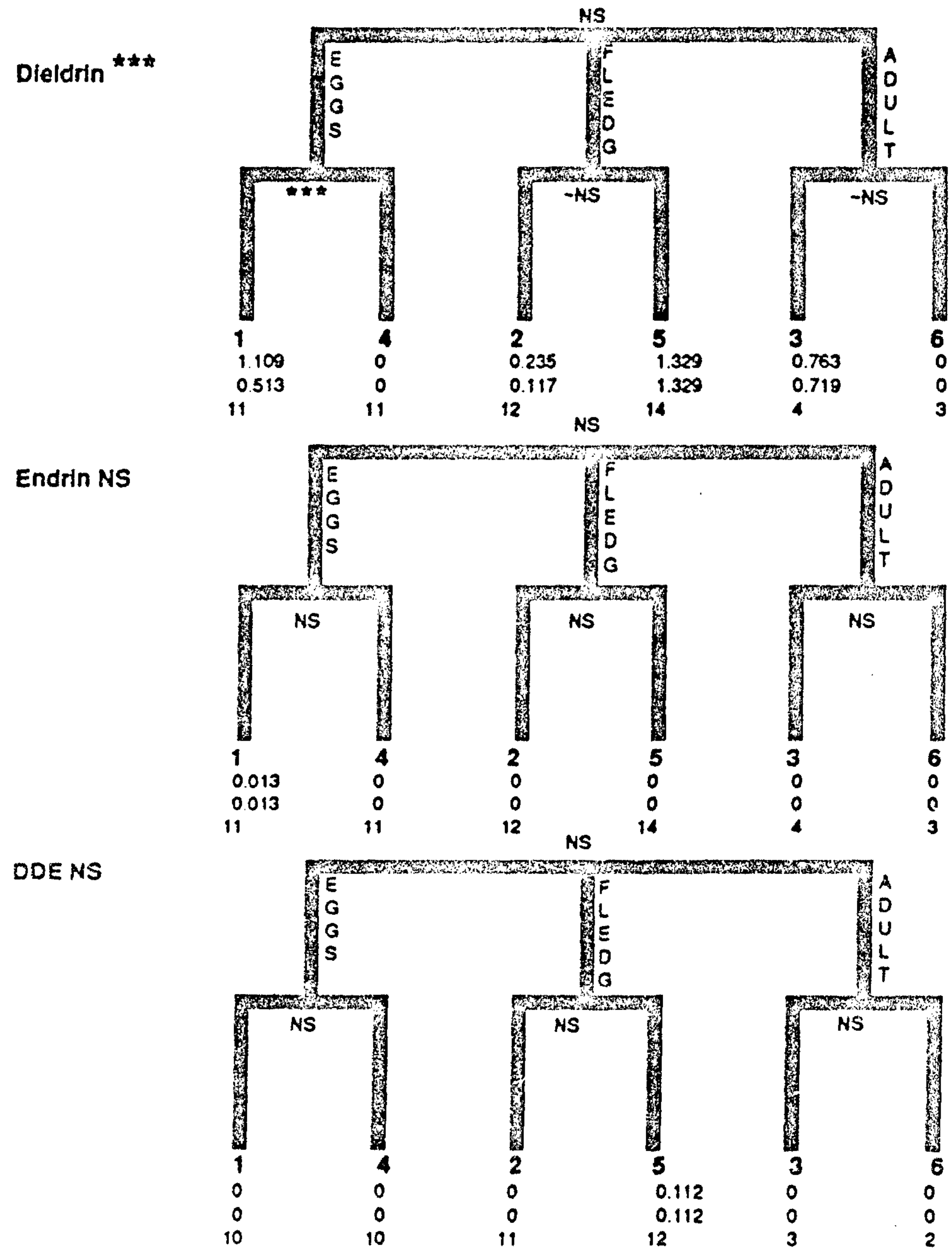

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*** = Very Highly Significant (0.001≥P)

1, 2, or 3 = On-site Contaminated
4, 5, or 6 = Off-site Controls

$\bar{y}$ = Mean
$S\bar{y}$ = Standard Error of Mean
n = Sample Size

Figure B.1-4 (2 of 3)
STATISTICAL ANALYSIS OF CONTAMINANTS IN RING-NECKED PHEASANTS

SOURCE: ESE, 1988

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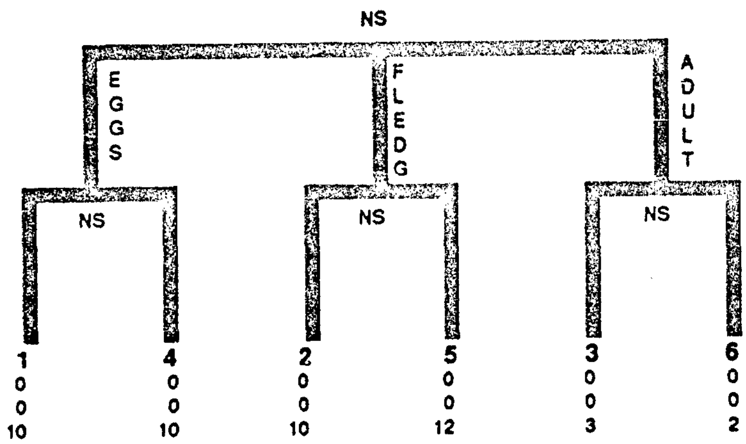
DDT NS



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*** = Very Highly Significant (0.001≥P)

1, 2, or 3 = On-site Contaminated
4, 5, or 6 = Off-site Controls

$\bar{y}$ = Mean
$S\bar{y}$ = Standard Error of Mean
n = Sample Size

Figure B.1-4 (3 of 3)
STATISTICAL ANALYSIS OF CONTAMINANTS IN RING-NECKED PHEASANTS

SOURCE: ESE, 1988

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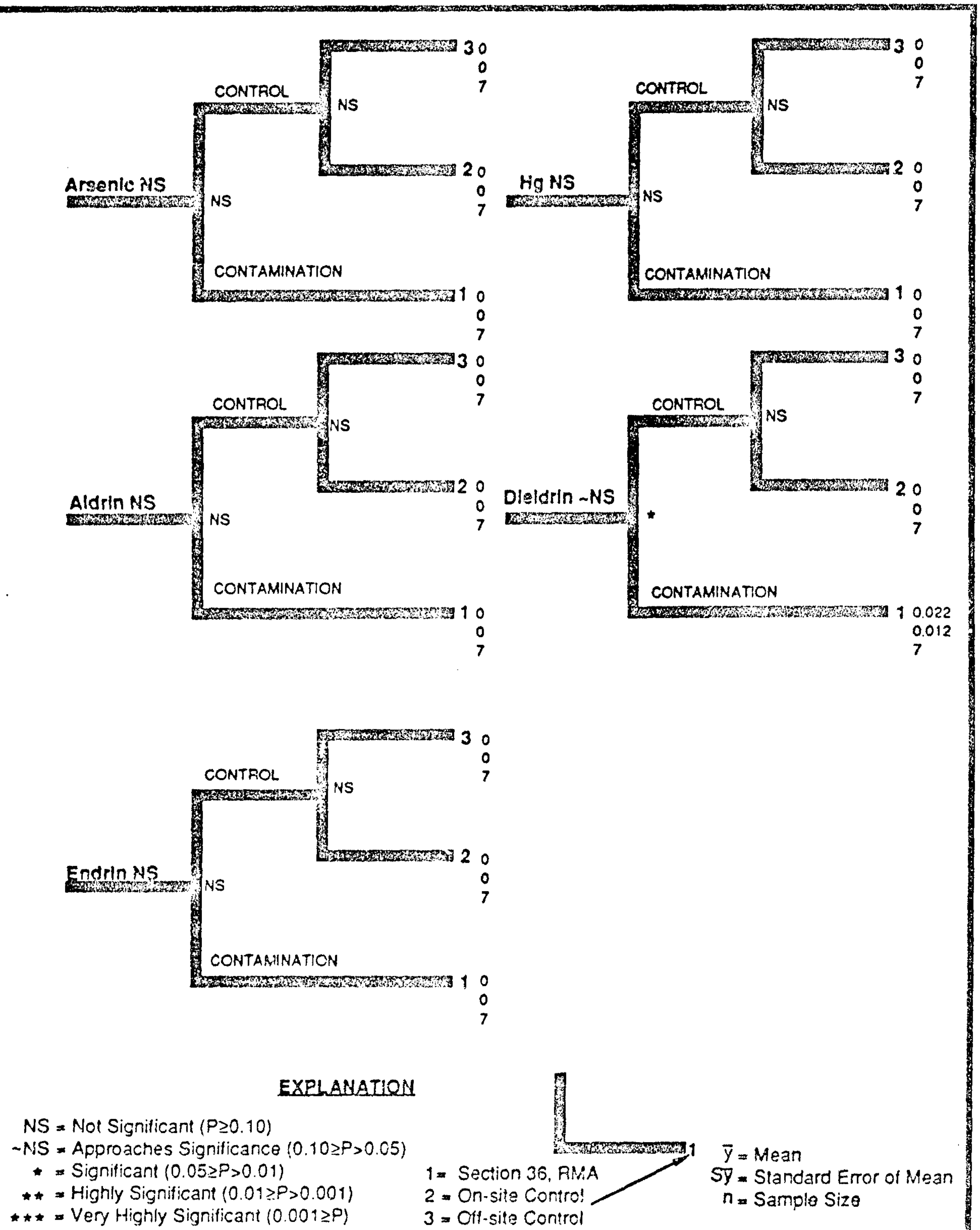

Figure B.1-5
STATISTICAL ANALYSIS OF CONTAMINANTS IN COTTONTAIL RABBITS

SOURCE: ESE, 1988

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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

Results

Statistical results are summarized in Table B.1-1. No significant differences in levels of contamination in the liver were detected for any comparisons of control and contaminated sites. In fact, only dieldrin was detected at a measurable level in the liver of deer.

1.8 PRAIRIE DOGS

Rationale

Specimens were categorized by site and season, three samples represented control areas (i.e., summer onpost control = 2, summer offpost control = 3, winter onpost control = 6) and three represented contaminated areas (i.e., summer RMA Section 36 = 1, winter RMA Section 36 = 4, winter toxic yard = 6). The a priori contrasts included (1) comparison of summer and winter RMA 36, (2) comparison of pooled RMA data with the toxic storage yard data (3) comparison of winter and summer onpost controls (4) comparison of pooled onpost controls with summer offpost control, and (5) comparison of pooled control sites with pooled contaminated sites. Data for all dependent variables except DDE and DDT were available for statistical analysis.

Results

Statistical results are summarized in Figure B.1-6. Comparisons for mercury, aldrin, and endrin failed to yield any significant differences. Similarly, none of the comparisons for arsenic were significant; however, significance was approached ($0.10 > p > 0.05$) for the comparison of pooled control sites with pooled contaminated sites. In contrast, all comparisons were significant for dieldrin.

1.9 AMERICAN KESTREL

Rationale

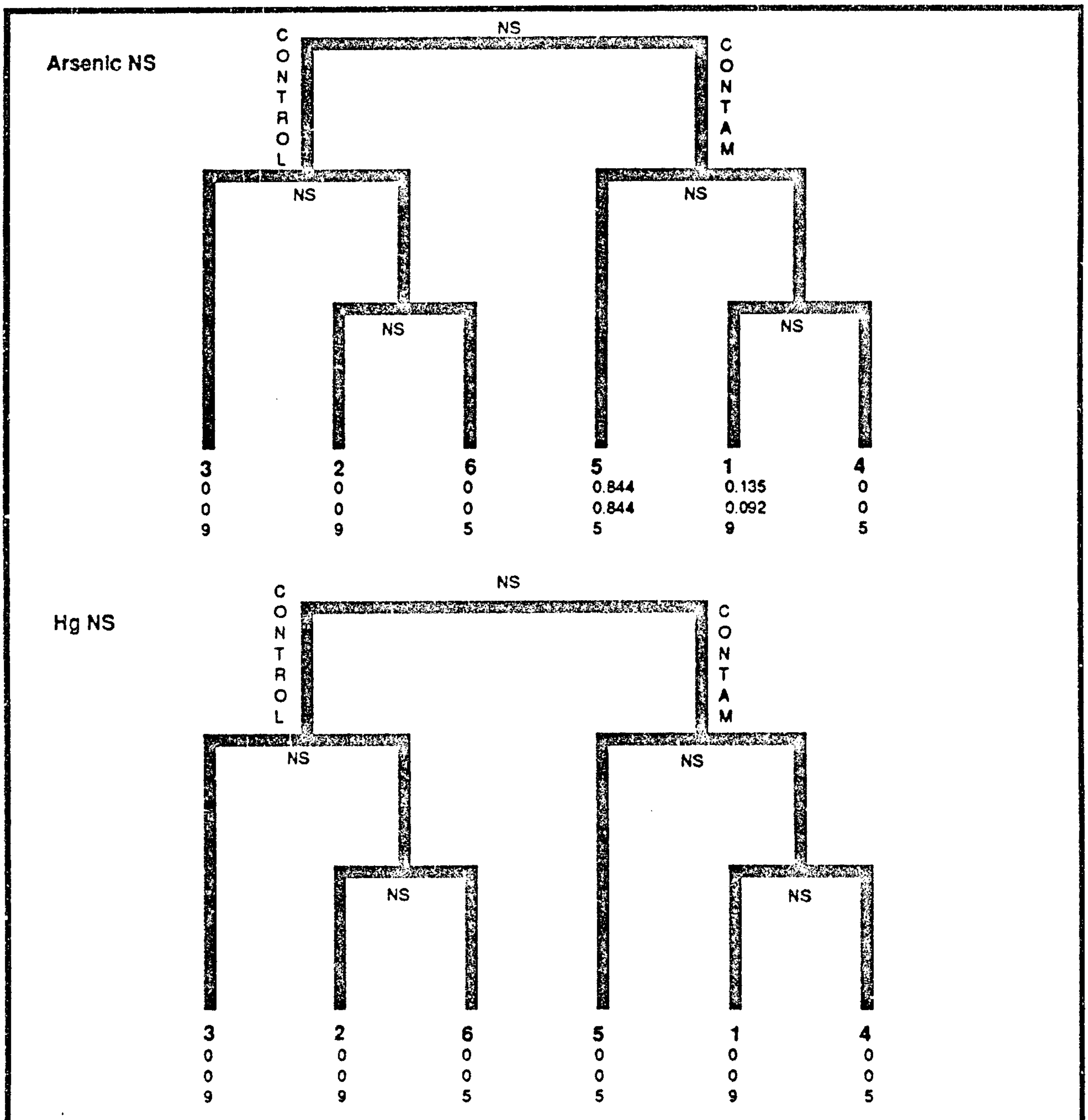
Specimens were categorized by site of collection (1 = contaminated sites on RMA and 2 = offpost control areas) and age (egg or fledgling). A priori contrasts included (1) comparison of eggs from control and contaminated sites, (2) comparison of fledglings from control and contaminated sites, and (3) comparison of eggs to fledglings regardless of site of collection. Data were available for all contaminants except arsenic.

Table B.1-1. Statistical Analyses of Contamination in Mule Deer. No sigificant differences (Kruskal-Wallis one-way ANOVA by ranks) were obtained for differences between sites (control versus RMA) for any of the contaminants, regardless of tissue source.

	Muscle						Liver					
	RMA			Control			RMA			Control		
	Ȳ	Sȳ	N	Ȳ	Sȳ	N	Ȳ	Sȳ	N	Ȳ	Sȳ	N
Arsenic	0	0	14	0	0	2	0	0	14	0	0	2
Mercury	.001	.001	14	0	0	2	0	0	14	0	0	2
Aldrin	0	0	14	0	0	2	0	0	14	0	0	2
Dieldrin	0	0	14	0	0	2	.013	.013	14	0	0	2
Endrin	0	0	14	0	0	2	0	0	14	0	0	2

Ȳ = Mean
Sȳ = Square of Mean
N = Sample Size

Source: ESE, 1988.



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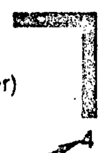
* = Significant (0.05≥P>0.01)
** = Highly Significant (0.01≥P>0.001)
*** = Very Highly Significant (0.001≥P)

1 = Section 36, RMA (Summer)
2 = On-site Control (Summer)
3 = Off-site Control (Summer)
4 = Section 36, RMA (Winter)
5 = Toxic Storage Yard (Winter)
6 = On-site Control Winter)



$\bar{y}$ = Mean
$S\bar{y}$ = Standard Error of Mean
n = Sample Size

Figure B.1-6 (1 of 3)
STATISTICAL ANALYSIS OF CONTAMINANTS IN BLACK-TAILED PRAIRIE DOGS

SOURCE ESE, 1988

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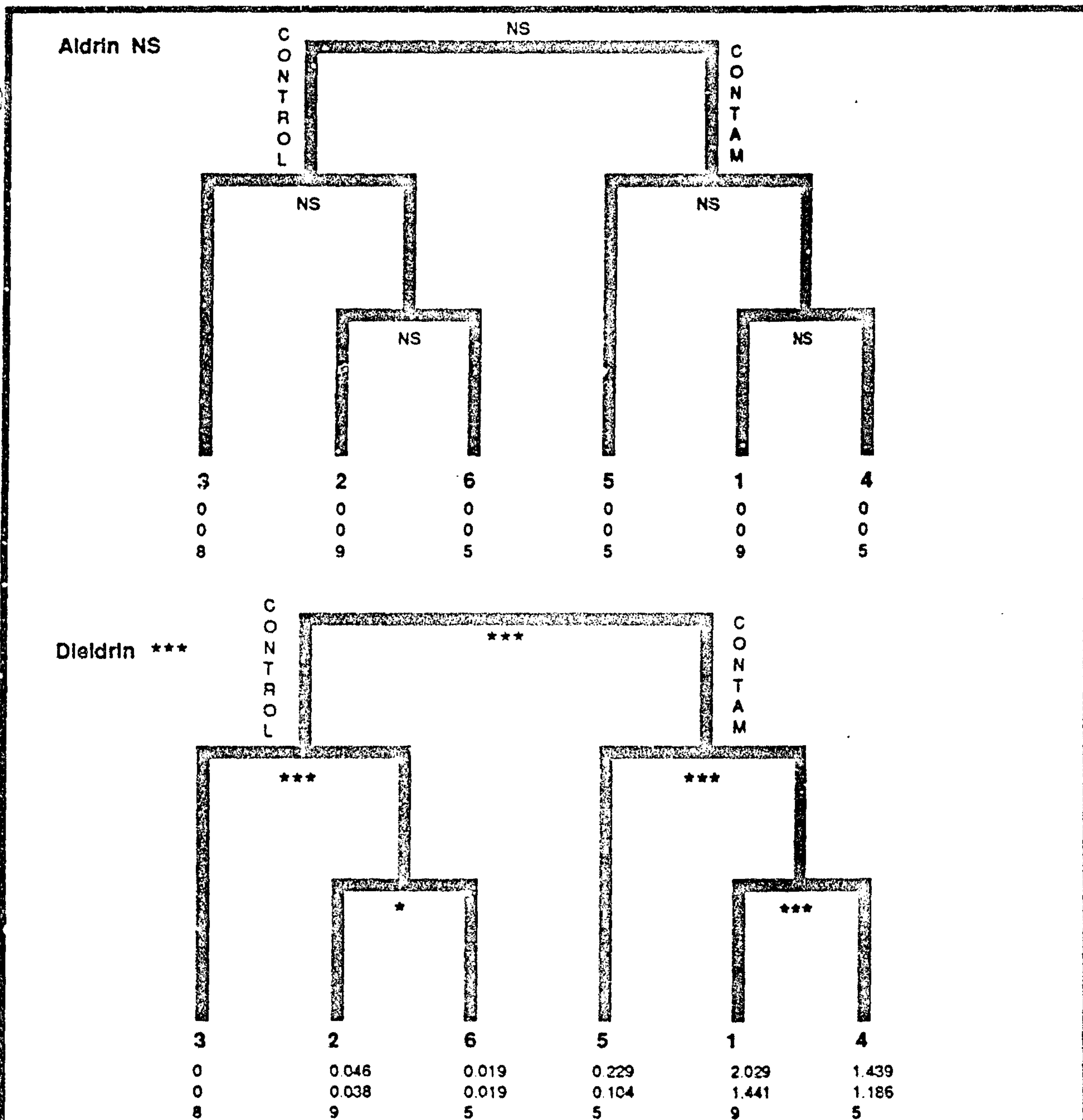
Aberdeen Proving Ground, Maryland



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* = Significant (0.05≥P>0.01)
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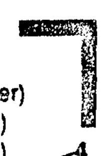
*** = Very Highly Significant (0.001≥P)

1 = Section 36, RMA (Summer)
2 = On-site Control (Summer)
3 = Off-site Control (Summer)
4 = Section 36, RMA (Winter)
5 = Toxic Storage Yard (Winter)
6 = On-site Control Winter)



ȳ = Mean
Sȳ = Standard Error of Mean
n = Sample Size

Figure B.1-6 (2 of 3)
STATISTICAL ANALYSIS OF CONTAMINANTS IN BLACK-TAILED PRAIRIE DOGS

SOURCE: ESE, 1988

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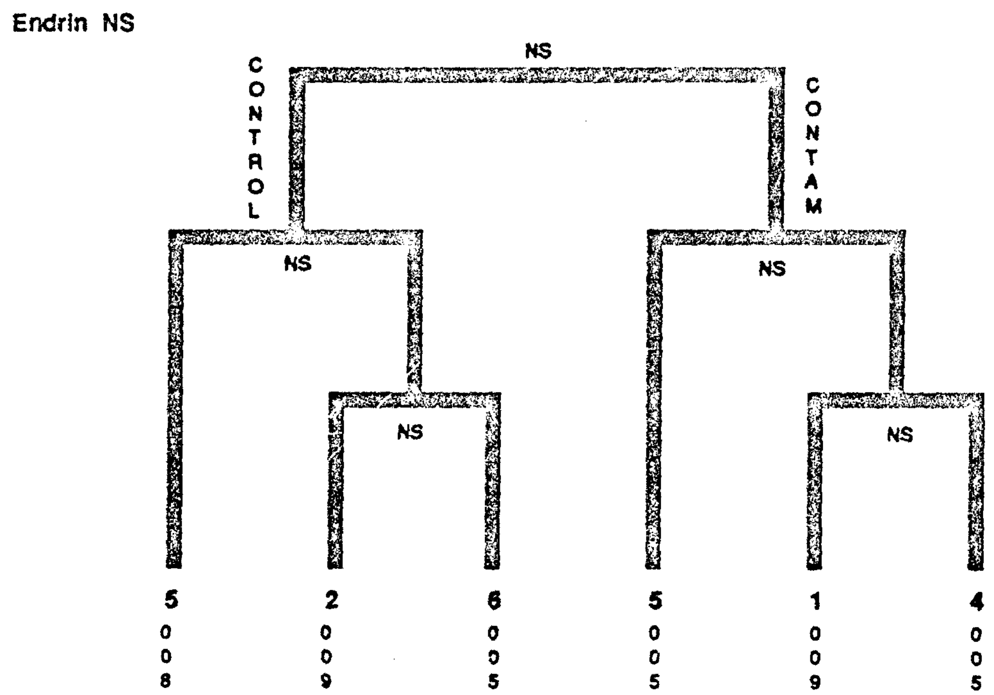
U.S. Army Program Manager's Office For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

NS = Not Significant (P≥0.10)
~NS = Approaches Significance (0.10≥P>0.05)
* = Significant (0.05≥P>0.01)
** = Highly Significant (0.01≥P>0.001)
*** = Very Highly Significant (0.001≥P)

1 = Section 36, RMA (Summer)
2 = On-site Control (Summer)
3 = Off-site Control (Summer)
4 = Section 36, RMA (Winter)
5 = Toxic Storage Yard (Winter)
6 = On-site Control Winter)

4
$\overline{y}$ = Mean
$S\overline{y}$ = Standard Error of Mean
n = Sample Size

Figure B.1-6 (3 of 3)
STATISTICAL ANALYSIS OF CONTAMINANTS IN BLACK-TAILED PRAIRIE DOGS

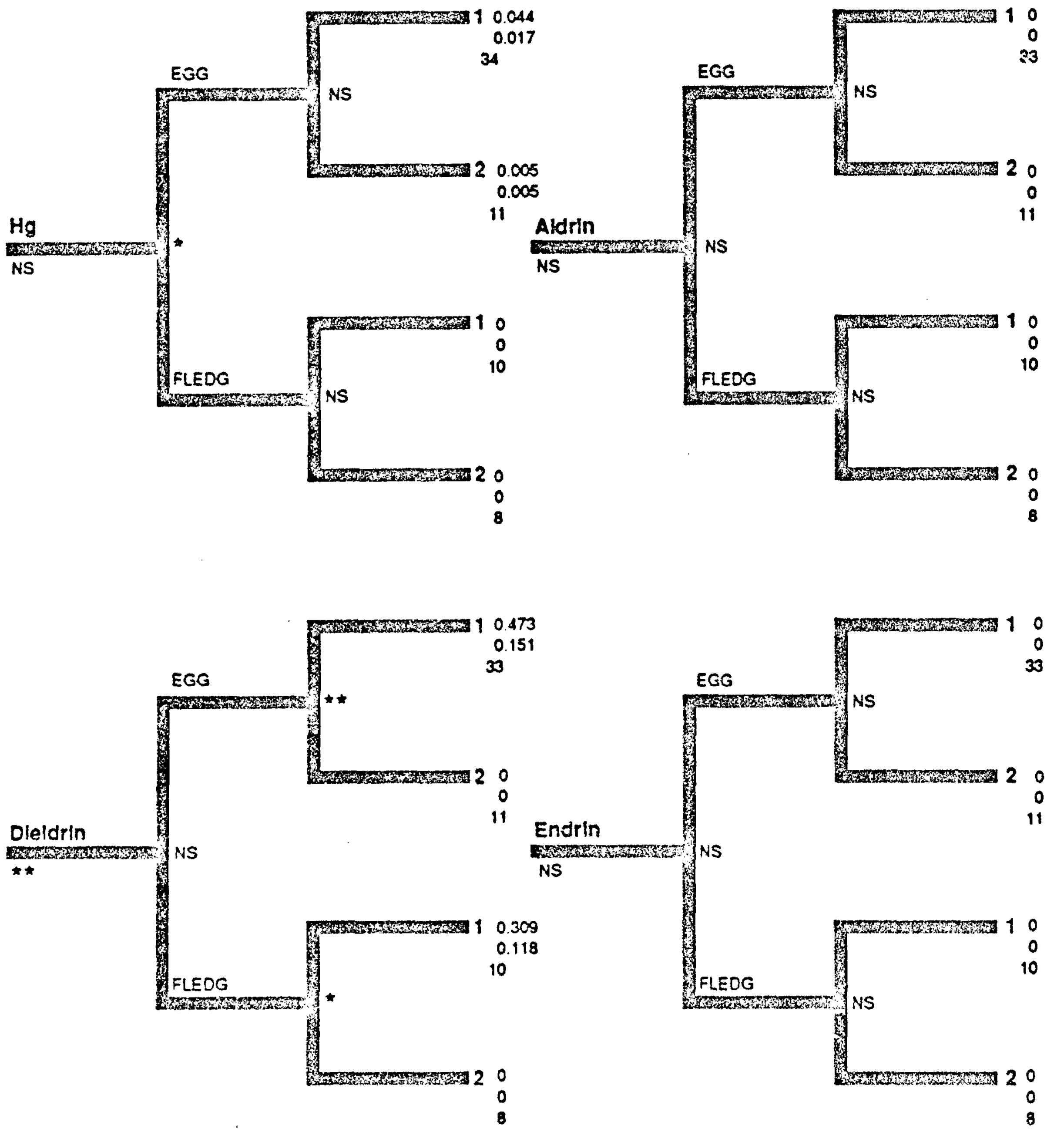
SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

Results

Statistical results are summarized in Figure B.1-7. Data for aldrin, endrin, DDE, and DDT were never detected in any of the analyzed specimens. A significant difference between eggs and fledglings was obtained for mercury, but neither of the control versus contaminated comparisons were significant. For dieldrin, significance from the preliminary comparison of the four groups is partially resolved by the a priori contrasts in which differences between control and contaminated sites were detected for eggs as well as for fledglings.



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$\bar{y}$ = Mean
$S\bar{y}$ = Standard Error of Mean
n = Sample Size

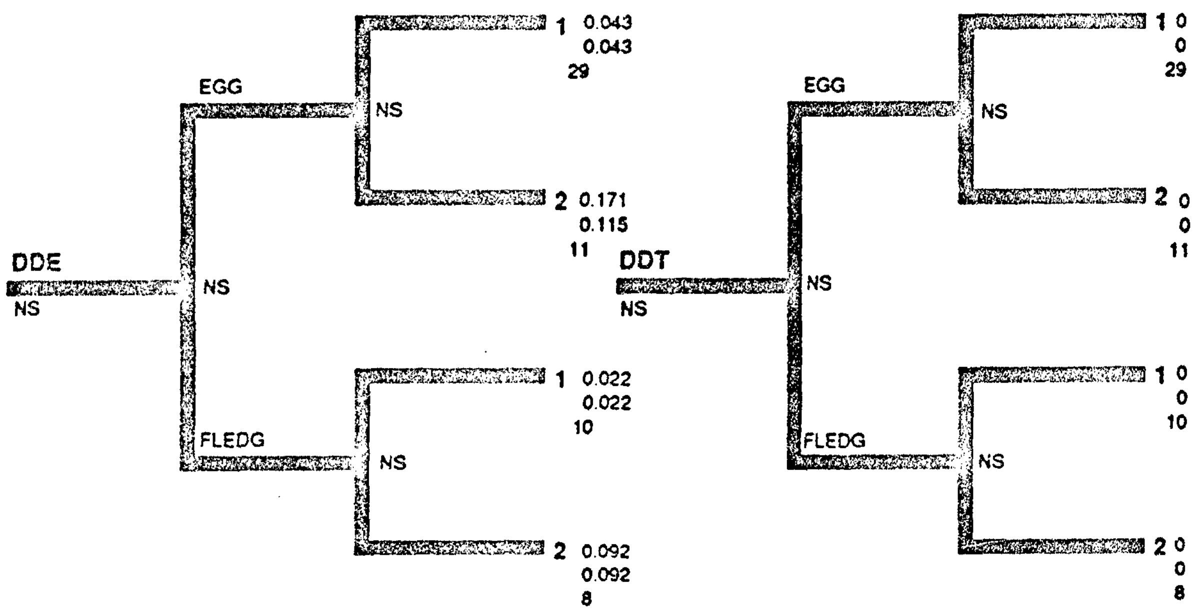
1 = On-site Contaminated (RMA)
2 = On-site Control

Figure B.1-7 (1 of 2)
STATISTICAL ANALYSIS OF CONTAMINANTS IN AMERICAN KESTRELS

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

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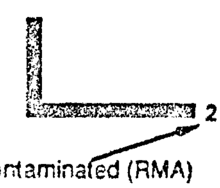

ȳ = Mean
Sȳ = Standard Error of Mean
n = Sample Size

Figure B.1-7 (2 of 2)
STATISTICAL ANALYSIS OF CONTAMINANTS IN AMERICAN KESTRELS

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

2.0 STATISTICAL ANALYSES FOR CONTAMINATION EFFECTS

2.1 INTRODUCTION

This section is designed to briefly explain the results of statistical analyses of the Biota Assessment. Each section of this document corresponds to a particular data set and comprises three parts: (1) introductory remarks explaining the rationale of the analysis, (2) actual statistical results provided in tabular form and appended to the text, and (3) remarks as to the conclusions derived from the statistical analysis.

2.2 SNAILS

Rationale

Although snail densities and total weights were estimated from 7 sites in each of two years (1986 and 1987), the same sites were not evaluated in each year. In particular, Wellington B was unique to 1986 and Wellington C was unique to 1987. This lack of correspondence across years prevents a more powerful two way ANOVA or ANCOVA approach to evaluating the effect of year and contamination level on snail density or snail weight. In lieu of the more powerful factorial approach, a separate one way ANOVA comparing snail density cross sites was calculated for each year. Similarly, a separate one way ANOVA comparing total snail weight across sites was calculated for each year. For each of the two dependent variables, more powerful orthogonal a priori tests were conducted that compared the controls to each other (Wellington A versus B in 1986, and Wellington A versus C in 1987), the five contaminated lakes to each other (Lake Mary versus Gun Club versus Lake Derby versus Ladora versus North Bog in each year), and the controls as a group to the contaminated sites as a group. Again, ANOVA and the orthogonal a priori contrasts are considered to be robust with respect to deviations from homoscedasticity. Nonetheless, the very highly significant heteroscedasticity detected by the Fmax Test is of considerable concern; as such, Kruskal-Wallis one way ANOVA by ranks and associated non-parametric orthogonal a priori contrasts were conducted as a fail safe measures.

In order to control for the possible confounding effects on snails of differences among samples in temperature, pH, and vegetation weight (referred to as covariates hereafter), each of these three factors was used as an independent variable in a multiple regression for snail density in

1986, snail density in 1987, total snail weight in 1986, and total snail weight in 1987. The residuals from each of these four analyses were saved and used as dependent variables in four separate sets of a priori contrasts and ANOVAs.

Results

Tables B.2-1, B.2-2, B.2-3, and B.2-4 report the statistical results of parametric and non-parametric analyses as well as descriptive group statistics for snail density in 1986, snail density in 1987, total snail weight in 1987, and total snail weight in 1987, respectively.

Remarks

Variances were very highly heteroscedastic for all four analyses ($p << 0.001$). Even though the results of the parametric analyses are reported in full, subsequent consideration will only focus on the results from the Kruskal-Wallis one way ANOVA by ranks (for both usual and residual ANOVAs).

- o Density 1986--The significant differences among the seven sites were, in part, affected by differences between controls, differences among the contaminated sites, and differences between controls as a group and contaminated sites as a group (Table B.2-1). Although the covariates significantly affected snail density, similar differences among sites persisted in the ANOVA by ranks on the residuals, with the exception that mean values among the contaminated sites were indistinguishable.

- o Density 1987--The significant differences among the seven sites were, in part, affected by differences between controls, differences among the contaminated sites, and differences between controls as a group and contaminated sites as a group (Table B.2-2). Although the covariates significantly affected snail density, similar differences among sites persisted in the ANOVA by ranks on the residuals, with the exception that mean differences between control sites as a group and contaminated sites as a group did not obtain significance.

Table B.2-1. Statistical Results of Parametric and Non-Parametric Analyses for Snail Density, 1986.

Above--One Way ANOVA and Orthogonal A Priori Comparisons of Snail Density Among the Seven Treatment Groups (NS, Not Significant with P > 0.05). Significance of the Non-parametric Tests was Identical to That of the Parametric Tests Except Where Noted by [1], in Which Case the Non-parametric Test was Significant at p < 0.001.

Below--Descriptive Statistics.

	ANOVA					
Source of Variation	DF	SS	MS	F	KW	Significance
Among	6	2,309,575	384,929	6.905	46.228	0.001 > p
Between Controls	1	818,101	818,101	14.675	7.000	0.001 > p
Among Contaminants	4	442,858	110,715	1.986	28.695	NS[1]
Controls vs. Contam.	1	969,995	969,995	17.399	20.516	0.001 > p
Within	63	3,512,166	55,749			
Total	69	5,821,741	84,373			

F_{max} test of homoscedasticity: F_{max} = 27,996.4; DF = 9,6; P << 0.001.

Treatment	Mean	N	Variance	Standard Error
Controls				
Wellington A	563.100	10	126,725.322	112.584
Wellington B	158.600	10	24,672.711	49.672
Contaminated				
Lake Mary	118.200	10	4,548.622	21.327
Gun Club	258.900	10	224,278.989	149.759
Lake Derby	2.700	10	8.011	0.895
Ladora	9.700	10	83.344	2.887
North Bay	60.100	10	9,896.767	31.459

DF = Degrees of Freedom
SS = Sum of Squares
MS = Mean Square
F = F Value
KW = Test Statistic From a Kruskal-Wallis One Way ANOVA by Ranks
N = Sample Size

Source: ESE, 1988

Table B.2-2. Statistical Results of Parametric and Non-Parametric Analyses for Snail Density, 1987.

Above--One Way ANOVA and Orthogonal A Priori Comparisons of Snail Density Among the Seven Treatment Groups (NS, Not Significant with p . 0.05). Significance of the Non-parametric Tests was Identical to That of the Parametric Test Except Where Noted by [1], in Which Case the Non-parametric Test was Significant at $p < 0.001$.

Below--Descriptive Statistics.

Source of Variation	ANOVA DF	SS	MS	F	KW	Significance
Among	6	1,385,033	230,839	15.440	43.798	0.001 > p
Between Controls	1	767,536	767,536	51.340	13.176	0.001 > p
Among Contaminants	4	31,925	7,981	0.533	21.404	NS[1]
Controls vs. Contam.	1	585,572	585,572	39.169	23.632	0.001 > p
Within	63	941,872	14,950			
Total	69	2,326,875	33,722			

F_{max} test of homoscedasticity: F_{max} = 6,424.6; DF = 9,6; P << 0.000.

Treatment	Mean	N	Variance	Standard Error
Controls				
Wellington A	428.100	10	80,237.211	89.575
Wellington B	36.300	10	434.011	6.588
Contaminated				
Lake Mary	43.000	10	5,417.333	23.275
Gun Club	23.300	10	424.622	6.516
Lake Derby	2.600	10	12.489	1.118
Ladora	71.800	10	17,926.844	42.340
North Bay	8.100	10	199.878	4.471

DF = Degrees of Freedom
SS = Sum of Squares
MS = Mean Square
F = F Value
KW = Test Statistic From a Kruskal-Wallis One Way ANOVA by Ranks
N = Sample Size

Source: ESE, 1988

Table B.2-3. Statistical Results of Parametric and Non-Parametric Analyses for Total Snail Weight, 1986.

Above--One-Way ANOVA and Orthogonal *A Priori* Comparisons of Total Snail Weight Among the Seven Treatment Groups (NS, Not Significant with $p > 0.05$). Significance of the Non-parametric Tests that Differed from that of the ANOVA are Indicated by Numeric Superscripts (^{2}indicates $p < 0.001$; and ^{3} indicates $0.01 > p > 0.001$).

Below--descriptive statistics.

Source of Variation	ANOVA DF	ANOVA SS	ANOVA MS	ANOVA F	KW	Significance
Among	6	106.88	17.813	3.605	49.885	$0.01 > p > 0.001^2$
Between Controls	1	17.47	17.466	3.535	8.698	NS^2
Among Contaminants	4	80.80	20.200	4.088	33.665	$0.01 > p > 0.001^2$
Controls vs. Contam.	1	7.20	7.197	1.457	14.557	NS^3
Within	63	311.29	4.941			
Total	69	418.17	6.060			

F_{max} test of homoscedasticity F_{max} = 58,900.8; DF = 9,6; $P << 0.001$.

Treatment	Mean	N	Variance	Standard Error
Controls				
Wellington A	2.676	10	2.454	0.495
Wellington B	0.807	10	0.729	0.270
Contaminated				
Lake Mary	1.195	10	2.410	0.491
Gun Club	3.356	10	28.903	1.700
Lake Derby	0.012	10	<0.001	0.004
Ladora	0.057	10	0.006	0.025
North Bay	0.205	10	0.084	0.091

DF = Degrees of Freedom
SS = Sum of Squares
MS = Mean Square
F = F Value
KW = Test Statistic From a Kruskal-Wallis One Way ANOVA by Ranks
N = Sample Size

Source: ESE, 1988

Table B.2-4. Statistical Results of Parametric and Non-Parametric Analyses for Total Snail Weight, 1987.

Above--One Way ANOVA and Orthogonal *A Priori* Comparisons of Total Snail Weight Among the Seven Treatment Groups (NS, Not Significant with $p > 0.05$). Significance of Non-parametric Tests, if Different from the ANOVA, are Indicated by Numeric Superscripts (^{2}indicates $0.01 > p > 0.001$).

Below--Descriptive Statistics.

Source of Variation	ANOVA DF	SS	MS	F	KW	Significance
Among	6	31.498	5.250	5.199	38.546	0.001 > p
Between Controls	1	8.844	8.844	15.489	3.727	NS
Among Contaminants	4	1.425	0.356	0.623	14.308	NS^2
Controls vs. Contam.	1	21.228	21.288	37.177	28.585	0.001 > p
Within	63	35.951	0.571			
Total	69	67.499	0.977			

F_{max} test of homoscedasticity F_{max} = 1,100.0; DF = 9,6; P << 0.001.

Treatment	Mean	N	Variance	Standard Error
Controls				
Wellington A	2.160	10	2.200	0.469
Wellington B	0.830	10	0.256	0.160
Contaminated				
Lake Mary	0.130	10	0.013	0.037
Gun Club	0.410	10	0.188	0.137
Lake Derby	0.020	10	0.002	0.013
Ladora	0.400	10	0.472	0.207
North Bay	0.380	10	0.831	0.288

DF = Degrees of Freedom
SS = Sum of Squares
MS = Mean Square
F = F Value
KW = Test Statistics a Kruskal-Wallis One Way ANOVA by Ranks
N = Sample Size

Source: ESE, 1988

- Weight 1986--The significant differences among the seven sites were, in part, affected by differences between controls, differences among the contaminated sites, and differences between controls as a group and contaminated sites as a group (Table B.2-3). Although the covariates significantly affected total snail weight, similar differences among sites persisted in the ANOVA by ranks on the residuals without exception.

- Weight 1987--The significant differences among the seven sites were, in part, affected by differences among the contaminated sites, and differences between controls as a group and contaminated sites as a group (Table B.2-4). Although the covariates significantly affected total snail weight, similar differences among sites persisted in the ANOVA by ranks on the residuals, with the exception that an additional difference between controls was revealed.

2.3 GRASSHOPPER DENSITY

Rationale

Mean grasshopper densities were estimated from counts derived from three groups: onpost controls (N = 10), offpost controls (N = 26), and contaminated sites (N = 21). Although Bartlett's Test indicated significant heterogeneity among group variances using untransformed (X^2 = 77.420; DF = 2; p >> 0.05) or square root transformed data (X^2 = 27.980; DF = 2; p >> 0.05), the ANOVA is robust with respect to heteroscedasticity. A logical sequence of a priori comparisons [comparing onpost and offpost controls, then comparing combined controls (both onpost and offpost) to the contaminated site] were then conducted as well. Because of the high degree of heteroscedasticity, parallel non-parametric analyses were calculated as a fail safe measure. If parametric and non-parametric results agree, then one can be confident of the statistical interpretations, regardless of the inherent assumptions of the two kinds of analyses.

Differences in time of day, temperature, and floral characteristics (height and density) associated with each of the quadrats could have a confounding affect on grasshopper density beyond that directly associated with the statistical treatments described above. The effect of all four of these variables were statistically removed via multiple regression analysis, and the residual variation subjected to analyses that were analogous to those described above.

Results

Table B.2-5 contains the results of parametric and non-parametric ANOVA, a priori tests, and descriptive statistics on the untransformed data; Table B.2-6 contains the results of the multiple regression analysis, as well as the parametric and non-parametric ANOVA and a priori tests on the residuals from the multiple regression analysis.

Remarks

The overall ANOVA, as well as each of the a priori comparisons, were non-significant, indicating a lack of treatment effect on mean grasshopper density for the untransformed data as well as the residuals. The differences in degrees of freedom between analyses of untransformed data and residuals occurs because floral characteristics were not available for all the data, effectively reducing sample sizes for analyses involving the residuals from the multiple regression analysis.

2.4 EARTHWORM DENSITY

Rationale

Estimates of worm density from three sites (Barr Lake Control, N=4; Section 5 Control, N=5; and South Plant Contaminated, N=5) were statistically compared using a hierarchical set of orthogonal comparisons via the ANOVA (and a priori comparisons) as well as via non-parametric Kruskal-Wallis one way ANOVA by ranks. Controls were first compared to each other, then the controls as a group were compared simultaneously. Although the parametric tests are robust with respect to moderate deviations from homoscedasticity, Bartlett's Test indicated heteroscedasticity ($p < 0.05$), and the non-parametric tests were conducted to validate the results of the ANOVA.

Results

Table B.2-7 contains the result of all statistical analyses.

Table B.2-5. Statistical Analysis of Grasshopper Density.

Above--One Way ANOVA and Orthogonal *A Priori* Comparisons of Grasshopper Density Among the Three Treatment Groups. Statistical Results are Identical for Both Parametric and Non-parametric Tests.

Below--Descriptive Statistics.

Source of Variation	ANOVA DF	SS	MS	F	KW	Significance
Among	2	701.4	350.73	3.00	3.168	NS
Between Controls	1	430.7	430.68	3.69	0.844	NS
Controls vs. Contam.	1	270.8	270.78	2.32	1.779	NS
Within	54	6,304.7	116.75			
Total	56	7,006.1	125.11			

Bartlett's test of homoscedasticity: X^2 = 77.420; DF = 2; P > 0.05.

Treatment	Mean	N	Variance	Standard Error
Control	1.524	21	4.262	0.450
Contaminated				
Onpost	8.923	26	247.274	3.084
Offpost	2.800	10	4.178	0.646

KW = Test Statistic From Kruskal-Wallis One Way ANOVA by Ranks
NS = Not Significant with p > 0.05
N = Sample Size
DF = Degrees of Freedom
SS = Sum of Squares
MS = Mean Square
F = F Value

Source: ESE, 1988

Table B.2-6. Multiple Regression Analysis of Grasshopper Density and Analysis of Residuals From the Multiple Regression Analysis.

Above -- Multiple Regression Analysis of Grasshopper Density as a Function of Time, Temperature, Vegetation Height, and Vegetation Density (= Model). Multiple R^2 of the Model was Low (0.128); Simple Correlations with Grasshopper Density by Time, Temperature, Vegetation Height, and Vegetation Weight were 0.007, 0.064, -0.070, -0.343, Respectively.

Below -- One Way ANOVA and Orthogonal A Priori Comparisons of Grasshopper Density Among the Three Treatment Groups. Statistical Results are Identical for Both Parametric and Non-parametric Tests.

Source of Variation	DF	SS	MS	F	Significance
Model	4	766.3	191.58	1.32	NS
Error	36	5228.5	145.24		
Total	40	5994.8	149.87		

Source of Variation	ANOVA DF	SS	MS	F	KW	Significance
Among	2	575.3	287.67	2.35	1.877	NS
Between controls	1	202.0	202.03	1.65	0.314	NS
Controls vs. Contams.	1	373.3	373.31	3.05	1.590	NS
Within	38	4653.2	122.45			
Total	40	5228.5	130.71			

KW = Test Statistic From Kruskal-Wallis One Way ANOVA by Ranks
NS = Not Significant with $p > 0.05$
N = Sample Size
DF = Degrees of Freedom
SS = Sum of Squares
MS = Mean Square
F = F Value

Source: ESE, 1988.

Table B.2-7. Statistical Analysis of Earthworm Density

Above -- One Way ANOVA and Orthogonal *A Priori* Comparisons of Worm Density Among the Three Treatment Groups. Statistical Results of the More Conservative Non-parametric Tests are Reported (Significance of the Parametric Analyses was Consistently Less than 0.001).

Below--Descriptive Statistics.

Source of Variation	ANOVA DF	SS	MS	F	KW	Significance
Among	2	9,181.0	4,590.50	42.14	9.861	0.01 > p > 0.001
Between Controls	1	6,360.6	6,360.56	58.41	6.050	0.01 > p > 0.001
Control vs. Contams.	1	2,820.5	2,830.46	25.90	4.049	0.05 > p > 0.01
Within	11	1198.2	108.93			
Total	13	10379.2	798.40			

Bartlett's Test of Homoscedasticity: $X^2 = 8.691$; DF = 2; $0.01 < p < 0.05$.

Treatment	Mean	N	Variance	Standard Error
Contaminated	2.600	5	33.800	2.600
Control				
Barr	2.500	4	9.000	1.500
Section 5	56.000	5	259.000	7.197

KW = Test Statistics From Kruskal-Wallis One Way ANOVA by Ranks
NS = Not Significant with p > 0.05
N = Sample Size
DF = Degrees of Freedom
SS = Sum of Squares
MS = Mean Square
F = F Value

Source: ESE, 1988.

Remarks

Results of non-parametric and parametric tests were in agreement for all analyses. The overall significant differences among groups were further resolved in that the two controls differed from each other, and that despite this difference, the combined control group was different from the contaminated site.

2.5 ACETYLCHOLINESTERASE (AChE) ACTIVITY

2.5.1 PRAIRIE DOGS

Rationale

Specimens were obtained from four locales (Sections 36, 31, onpost control and offpost control), each of which constitutes a statistical treatment group. Sections 36 and 31 are contaminated sites whereas onpost and offpost controls represent sites without direct evidence of contamination. One way analysis of variance (ANOVA) was conducted to evaluate the existence of mean treatment effects among the four groups. More powerful a priori tests were conducted to compare the two controls to each other, the two contaminated sites to each other, and the combined control sites to the combined contaminated sites. Although the ANOVA and a priori tests were relatively robust with respect to inequality of variances (heteroscedasticity) for the statistical treatment groups, many a posteriori test are quite sensitive to deviations from homoscedasticity. Bartlett's Test (Sokal and Rohlf, 1981), indicated that variances were homoscedastic ($X^2 = 5.168$, DF = 3, $p < 0.05$), hence the SNK test was used to make all possible comparisons among treatment groups. Although less powerful than either ANOVA or a priori tests, the SNK test does facilitate particular pair-wise comparisons that the other two analyses cannot evaluate.

Results

Table B.2-8 contains the descriptive statistics and results of the ANOVA, orthogonal a priori tests, and a posteriori results from the SNK test.

Remarks

The ANOVA clearly detected the existence of at least one group with a mean level of AChE that differed from the others ($p < 0.01$). Moreover, the a priori tests detected significant differences between the two control sites

Table B.2-8. Statistical Analysis of AChE Activity in Prairie Dogs.

Above--One Way ANOVA and Orthogonal A Priori Comparisons of AChE Activity Among Four Treatment Groups.

Below--Descriptive Statistics and Results of A Posteriori Comparisons Using the Student-Neuman-Kuel's Test; Treatment Means with Identical Letter Superscripts are Statistically Indistinguishable at the 0.05 Level of Significance.

Source of Variation	DF	SS	MS	F	Significance
Among	3	104.3	34.78	6.48	$0.01 > p > 0.001$
Sites 36 versus 31	1	32.9	32.89	6.12	$0.05 > p > 0.01$
Control Onpost vs. Offpost	1	26.7	26.73	4.98	$0.05 > p > 0.01$
Control vs. Contam.	1	44.7	44.72	8.32	$0.01 > p > 0.001$
Within	35	187.8	5.37		
Total	38	292.2	7.69		

Bartlett's test of homoscedasticity: $X^2 = 5.636$; DF = 3; $P > 0.05$.

Treatment	Mean	N	Variance	Standard Error
Contaminated				
Section 31	10.690^{a}	5	2.304	0.679
Section 36	$13.678^{a,b}$	14	3.870	0.526
Control				
Onpost	$14.090^{a,b}$	12	3.901	0.570
Offpost	16.450^{b}	8	12.200	1.235

N = Sample Size
DF = Degrees of Freedom
SS = Sum of Squares
MS = Mean Square
F = F Value

Source: ESE, 1988

($p < 0.05$), between the two contaminated sections ($p < 0.05$), and between control sites as a group and contaminated sections as a group ($p < 0.01$). The only additional information provided by the results of SNK Test is that prairie dogs from contaminated Section 31 and the offsite control exhibited statistically different levels of AChE as well.

2.5.2 COTTONTAIL RABBITS

Rationale

AChE activity in rabbits was evaluated from four sites. The sample size from Section 35 was too small (N = 1) for statistical analyses and was combined with data from Section 36 (N = 7) to constitute the contaminated group (N = 8). Sample sizes from onpost and offpost control sites were sufficiently large (onpost, N = 11; offpost, N = 8) for statistical purposes, and together with the contaminated site, constituted the three treatment groups. One way ANOVA was conducted to evaluate the existence of mean treatment effects among the three groups. More powerful a priori tests were conducted to compare the two controls to each other, and the combined control sites to the contaminated sites. A posteriori tests were not performed on the data because the more powerful ANOVA failed to detect significant differences among groups.

Results

Table B.2-9 contains the descriptive statistics, the result of Bartlett's Test, and results of the ANOVA and orthogonal a priori tests.

Remarks

Both the ANOVA and a priori comparisons failed to detect any mean differences among treatment groups.

2.5.3 MALLARDS

Rationale

AChE activity in mallards was evaluated from two sites. The samples from all contaminated sites were combined as a single group (N = 9) and compared to those from the offpost control (N = 6) via a one way ANOVA. Neither a priori nor a posteriori tests were conducted because the number of groups equalled two.

Table B.2-9. Statistical Analysis of AChE Activity in Cottontail Rabbits

Above--One Way ANOVA and Orthogonal A Priori Comparisons of AChE Activity Among 3 Treatment Groups.

Below--Descriptive Statistics; SNK Tests were not Conducted Because the Overall Results of the ANOVA were not Significant.

Source of Variation	DF	SS	MS	F	Significance
Among	2	2.48	1.24	1.10	NS
Control Onpost vs Offpost	1	2.48	2.48	1.10	NS
Control vs Contam.	1	0.00	0.00	0.00	NS
Within	19	21.40	1.13		
Total	21	23.88	1.14		

Bartlett's test of homoscedasticity: $X^2 = 1.575$; DF = 2; $P > 0.05$.

Treatment	Mean	N	Variance	Standard Error
Contaminated	11.248	8	0.757	0.308
Control				
Onpost	11.733	6	1.958	0.571
Offpost	10.882	8	0.901	0.336

NS = Not Significant with $p > 0.05$
N = Sample Size
DF = Degrees of Freedom
SS = Sum of Squares
MS = Mean Square
F = F Value

Source: ESE, 1988.

Results

Table B.2-10 contains the result of the ANOVA as well as descriptive statistics.

Remarks

The ANOVA indicated that evidence for mean differences between contaminated and control groups was not present in the data, the low degrees of freedom (V = 1,13) combined with the level of significance (p = 0.149) suggest that with larger samples sizes, true differences might be forthcoming.

2.5.4 PHEASANTS

Rationale

AChE activity in pheasants was evaluated from two sites. The samples from all contaminated sites were combined as a single group (N = 6) and compared to those from the offpost control (n = 7) via a one-way ANOVA. Neither a priori nor a posteriori tests were conducted because the number of groups equalled two.

Results

Table B.2-11 contains the result of Bartlett's Test for homogeneity of variances, the ANOVA, and descriptive statistics.

Remarks

The ANOVA indicated that evidence for a mean difference between contaminated and control groups was not present in the data.

2.6 PRAIRIE DOG DENSITY

Rationale

Counts of prairie dog density form a total of six different treatment groups constitute the data. In general, two independent factors (season--summer and winter: as well as treatment--contaminated and control) describe each treatment group: however, the sections that constituted the contaminated groups were not the same in both seasons. As a result, two-way ANOVA could not be performed. Nonetheless, a one way ANOVA with a priori contrasts, designed to take into account season and contamination status, provided a powerful method of detecting differences among groups. The first level of

Table B.2-10. Statistical Analysis of AChE Activity in Mallards.

Above--One Way ANOVA of AChE Activity Between Two Treatment Groups (control versus contaminated sites).

Below--Descriptive Statistics.

Source of Variation	DF	SS	MS	F	Significance
Among	1	6.37	6.37	1.99	NS
Within	13	41.56	3.20		
Total	14	47.93	3.42		

Bartlett's test of homoscedasticity: $X^2 = 0.480$; DF = 1; P > 0.05.

Treatment	Mean	N	Variance	Standard Error
Contaminated	14.836	9	3.845	0.654
Control	13.505	6	2.160	0.600

NS = Not Significant with p > 0.05
N = Sample Size
DF = Degrees of Freedom
SS = Sum of Squares
MS = Mean Square
F = F Value

Source: ESE, 1988.

Table B.2-11. Statistical Analyses of AChE Activity in Pheasants

Above--One Way ANOVA of AChE Activity Between Two Treatment Groups (control versus contaminated sites).

Below--Descriptive Statistics.

Source of Variation	DF	SS	MS	F	Significance
Among	1	5.32	5.32	0.70	NS
Within	11	84.02	7.64		
Total	12	89.34	4.45		

Bartlett's test of homoscedasticity: $X^2 = 1.914$; DF = 1; $P > 0.05$.

Treatment	Mean	N	Variance	Standard Error
Contaminated	21.765	6	12.340	1.434
Control	23.079	7	3.720	0.729

NS = Not Significant with $p > 0.05$
N = Sample Size
DF = Degrees of Freedom
SS = Sum of Squares
MS = Mean Square
F = F Value

Source: ESE, 1988.

the hierarchical division of groups is between summer and winter census data. Within winter, combined controls (west and east) were compared to central sites (contaminated Plot 21 and 22 plus uncontaminated but adjacent, Plot 24 and 23). Within winter controls, east and west were compared to each other. Within summer, Plots 1, 4, 13, 8, and 9, as a group (Others) were compared to combined controls (east and west). Subsequently, east control and west control sections were compared to each other.

Results

Table B.2-12 contains the results of the ANOVA, orthogonal a priori contrasts, and descriptive statistics.

Remarks

Bartlett's Test indicated that the variances of the treatment groups were homoscedastic. Although the ANOVA suggested no significant differences among the six treatment groups, the more powerful a priori tests were conducted as described in the rationale above. Nonetheless, none of the orthogonal comparisons yielded significant differences, indicating that mean prairie dog densities did not differ among the six sites to any detectable degree beyond chance expectations. A posteriori tests were not conducted because they would be less powerful than the ANOVA (which did not detect any mean group differences).

2.7 AMERICAN KESTREL STUDY

Rationale

American kestrel nesting success was compared between sites (control vs RMA) and among years (1982 vs 1983 vs 1986). Four factors (clutch size, hatchlings per nest, fledgling per successful nest, and fledgling per all nests) were tested. Both parametric and non-parametric statistics were performed.

Results

Table B.2-13 contains the results of the ANOVA, Kruskal-Wallis ANOVA, and a priori contrasts.

Table B.2-12. Statistical Analysis of Prairie Dog Density.

Above--One Way ANOVA and Orthogonal *A Priori* Comparisons of Prairie Dog Density Among Six Treatment Groups

Below--Descriptive Statistics.

Source of Variation	DF	SS	MS	F	Significance
Among	5	745.6	149.11	1.09	NS
Summer vs Winter	2	124.2	124.22	0.91	NS
Summer					
Control E vs W	1	387.4	387.36	2.84	NS
Control vs Others	1	23.8	23.82	0.18	NS
Winter					
Control E vs W	1	50.0	50.00	0.37	NS
Control vs Central	1	160.2	160.17	1.174	NS
Within	25	3,410.3	136.41		
Total	30	4,155.9	138.53		

Bartlett's test of homoscedasticity: $X^2 = 4.354$; DF = 5; $P > 0.05$.

Treatment	Mean	N	Variance	Standard Error
Summer				
Others	17.600	5	197.300	6.282
Control E	16.222	9	65.694	2.702
Control W	27.200	5	123.700	4.974
Winter				
Central	28.750	4	60.917	3.902
Control E	18.500	4	169.667	6.513
Control W	23.500	4	303.000	8.703

NS = Not Significant with $p > 0.05$
N = Sample Size
DF = Degrees of Freedom
SS = Sum of Squares
MS = Mean Square
F = F Value

Source: ESE, 1988.

Table B.2-13. Statistical Analysis of American Kestrel Nesting Success.

Analysis/Kestrel	Clutch Size	Hatchling Per Nest	Fledgling per Success Nest	Fledgling per All Nest
ANOVA:				
Source				
Between Sites (S)	NS	NS	NS	@
Among Gores (Y)	NS	*	NS	**
S x Y	NS	NS	NS	NS
A priori (PARAMETRIC)				
82-Control vs. RMA	NS	NS	NS	NS
83-Control vs. RMA	NS	NS	NS	*
86 Control vs. RMA	NS	NS	NS	NS
82 vs. 83 vs. 86	NS	*	NS	*
K-W ANOVA: Source				
Among site-yr combos	NS	@	NS	*
A priori (NONPARAMETRIC)				
82-Control vs. RMA	NS	NS	NS	NS
83-Control vs. RMA	NS	NS	NS	*
86 Control vs. RMA	NS	NS	NS	NS
82 vs. 83 vs. 86	NS	*	NS	*

NS = Not Significant.

* = $p<0.05$.

** = $p<0.01$

@ = Near Significant ($0.100>p>0.050$)

3.0 STATISTICAL ANALYSES FOR AQUATIC CONTAMINANTS

3.1 RATIONALE

The objectives of the RMA aquatic biota investigations in 1986 were to test for contaminant differences among RMA lakes, among aquatic species, and among tissue types within species. In 1988, objectives were similar except that samples were taken from only one RMA lake, Lower Derby Lake, and compared with samples taken from one offsite lake, McKay Lake. Lower Derby Lake was chosen as representative of RMA lakes based on the findings of the 1986 studies.

Two approaches were used in the statistical analyses of the aquatic data. The first emphasized comparing differences among lakes and among fish species using strictly orthogonal (i.e., non-overlapping) data sets. These tests are referred to in the text as "primary tests." The second approach focused upon exploring for differences among many combinations of lakes, species, and tissue types. To accomplish this, numerous pair-wise comparisons were performed. These tests are referred to in the text as "secondary tests." Problems with the second approach involved smaller sample sizes and a lack of independence among some tests. As an example of the latter, data for fillets and remains of bass in McKay Lake (1988) were used both for comparisons between McKay Lake and Lower Derby Lake, and between fillets and remains within McKay Lake.

A nonparametric approach was used as the principal basis for assessing statistical differences because of the greater generality provided by nonparametric test (compared to parametric tests) and:

- To avoid problems of well-documented heteroscedasticity in the data (including where treatment cells have zero variance because all samples are below the CRL);
- To avoid questions of assignment of numerical values to below CRL situations which could introduce bias in parametric tests but not in nonparametric tests based on ranks (i.e., all below CRL values would be tied at the lowest rank in KW tests); and
- To avoid criticism of treatment cells which appear markedly non-normal.

In the majority of cases (13 of 16 tests) the data were either heteroscedastic ($p < 0.05$) or a treatment cell had zero variance. Homoscedasticity was observed in three cases, but the power was low due to the small sample sizes. Although primary tests comprise both parametric and nonparametric approaches, consistently significant heteroscedasticity, treatment cells with zero variance, and small sample sizes with non-normal appearing distributions argue for reliance on the nonparametric results. The Kruskal-Wallis nonparametric ANOVA has a 95% asymptotic power efficiency compared to the parametric test (when its assumptions are valid), and the levels of significance for both approaches are similar throughout. As a result, "primary tests" hereafter only refer to the nonparametric results.

In addition, both the 90 percent and 95 percent rejection levels were considered when interpreting the results. The 95 percent level ($p < 0.05$) is referred to in this report as being "significant," while the 90 percent level ($0.05 < p < 0.1$) is said to be "approaching significance." F_{max} tests of homoscedasticity were performed for all analyses.

3.2 RESULTS AND DISCUSSION

Descriptive statistics (mean, standard error, and sample size) for all tests rejecting null hypotheses are shown in Table B.3-1. Tables B.3-2 through B.3-8 present primary tests, including significant and nonsignificant results. Tables B.3-9 through B.3-11 present secondary tests, for significant results only. Tables B.3-12 through B.3-14 present additional secondary tests with only nonsignificant results.

Sample sizes of the treatment groups varied from two to six; as a result, statistical power was low. Large group differences are required to produce significant analyses. In many cases, a lack of significance may be an artifact of sample size rather than an indicator of no treatment effect. Inconsistent (or nonparallel) data collection between levels of the possible treatment factors (years, lakes, species, tissues) also prevents many questions concerning the effects of contamination from being answered in a satisfactory manner.

Table B.3-1. Descriptive statistics (mean, standard error, and sample size) for analytes (A, mercury: B, dieldrin; and C, DDE) involved in previous statistical analyses.

LAKE	BLUEGILL			LARGEMOUTH BASS			NORTHERN PIKE		
	WHOLE	REMAIN	FILLET	WHOLE	REMAIN	FILLET	WHOLE	REMAIN	FILLET
A. MERCURY									
DERBY (1986)									
MEAN	0.050			0.054					0.406
S.E.	0.000			0.004					0.064
N	3			3					3
LADORA (1986)									
MEAN	0.084			0.182					0.330
S.E.	0.020			0.049					0.040
N	2			3					3
MARY (1986)									
MEAN	0.074		0.083	0.074		0.075			
S.E.	0.014		0.016	0.015		0.025			
N	6		3	3		2			
DERBY (1988)									
MEAN	0.063				0.250	0.359			
S.E.	0.007				0.025	0.062			
N	6				5	5			
MCKAY (1988)									
MEAN	0.050	0.109	0.188		0.084	0.152			
S.E.	0.000	0.022	0.030		0.011	0.023			
N	2	5	5		5	5			

Table B.3-1 (continued)

LAKE	BLUEGILL			LARGEMOUTH BASS			NORTHERN PIKE		
	WHOLE	REMAIN	FILLET	WHOLE	REMAIN	FILLET	WHOLE	REMAIN	FILLET
B. DIELDRIN									
DERBY (1986)									
MEAN	0.149			0.077					0.031
S.E.	0.006			0.024					0.000
N	3			3					3
LADORA (1986)									
MEAN	0.100			0.032					0.038
S.E.	0.027			0.001					0.007
N	3			3					2
MARY (1986)									
MEAN	0.088		0.034	0.059		0.031			
S.E.	0.019		0.003	0.028		0.000			
N	6		3	3		2			
DERBY (1988)									
MEAN	0.070			0.375	0.486	0.218			
S.E.	0.016			0.097	0.132	0.060			
N	6			5	5	5			
MCKAY (1988)									
MEAN	0.031	0.031	0.031		0.031	0.031			
S.E.	0.000	0.000	0.000		0.000	0.000			
N	2	5	5		5	5			

Table B.3-1 (continued)

LAKE	BLUEGILL			LARGEMOUTH BASS			NORTHERN PIKE		
	WHOLE	REMAIN	FILLET	WHOLE	REMAIN	FILLET	WHOLE	REMAIN	FILLET
C. DDE									
DERBY (1988)									
MEAN	0.094				0.593	0.329			
S.E.	0.000				0.152	0.101			
N	6				5	5			
MCKAY (1988)									
MEAN	0.094	0.094	0.094		0.094	0.094			
S.E.	0.000	0.000	0.000		0.000	0.000			
N	2	5	5		5	5			
D. ALDRIN[2]									
DERBY (1988)									
MEAN	0.020			0.020	0.033	0.005			
S.E.	0.000			-----	0.006	0.005			
N	5			1	5	5			
MCKAY (1988)									
MEAN	0.020	0.020	0.020		0.020	0.020			
S.E.	0.000	0.000	0.000		0.000	0.000			
N	2	5	5		5	5			

[1] Values for whole tissue samples of Mercury in 1988 for Bass in Lake McKay, and Bluegill in Lake McKay were reconstituted samples.

[2] Although data were collected on DDE in 1986. all sample values were the CRL (0.094) except for the single Bullhead from Lower Derby (whole tissue) regardless of lake, species, or tissue type. No statistical tests were performed on these data and descriptive statistic were similarly not reported in tabular form since sample means (0.094) and sample standard errors (0.000) would be equal.

[3] Although data were collected on aldrin in 1986, all sample values were the CRL (0.020) regardless of lake, species, or tissue type. No statistical tests were performed on these data and descriptive statistic were similarly not reported in tabular form since sample means (0.020) and sample standard errors (0.000) would be equal.

Table B.3-2 Results of one-way (Lake Derby versus Ladora) parametric and nonparametric (Kruskal-Wallis one-way analysis of variance by ranks = KW) ANOVA on analytes (A, mercury; and B, dieldrin) for pike fillets in 1986.

SOURCE	DF	MS	F	SIGNIFICANCE	K-W	SIGNIFICANCE
A. MERCURY						
LAKE	1	0.007	0.749	0.451	0.351	0.554
WITHIN	3	0.009				
TOTAL	4					
B. DIELDRIN						
LAKE	1	0.000	1.800	0.259	1.500	0.221
WITHIN	3	0.000				
TOTAL	4					

DF - Degrees of Freedom
MS - Mean Square

Table B.3-3 Results of one-way (bluegill versus largemouth bass) parametric and nonparametric (Kruskal-Wallis one-way analysis of variance by ranks = KW) ANOVA on analytes (A, mercury; and B, dieldrin) for Lake Mary fillets in 1986.

SOURCE	DF	MS	F	SIGNIFICANCE	K-W	SIGNIFICANCE
A. MERCURY						
SPECIES	1	0.000	0.063	0.818	0.093	0.761
WITHIN	3	0.001				
TOTAL	4					
B. DIELDRIN						
SPECIES	1	0.000	0.600	0.495	0.667	0.414
WITHIN	3	0.000				
TOTAL	4					

DF - Degrees of Freedom
MS - Mean Square

Table B.3-4 Results of one-way (remains versus fillets) parametric and nonparametric (Kruskal-Wallis one-way analysis of variance by ranks = KW) ANOVA on analytes (A, mercury; B, dieldrin; and C, DDE) for bluegill from Lake McKay in 1988.

SOURCE	DF	MS	F	SIGNIFICANCE	K-W	SIGNIFICANCE
A. MERCURY						
TISSUE	1	0.016	4.523	0.067	3.153	0.076 @
WITHIN	8	0.003				
TOTAL	9					
B. DIELDRIN						
TISSUE	1	0.000	-----	1.000	0.000	1.000
WITHIN	8	0.000				
TOTAL	9					
C. DDE						
TISSUE	1	0.000	-----	1.000	0.000	1.000
WITHIN	8	0.000				
TOTAL	9					

DF - Degrees of Freedom
MS - Mean Square
@ - Near Significance (0.100 > p > 0.050)

Table B.3-5. Results of two-way (lakes -- Derby versus Ladora versus McKay; species -- largemouth bass versus bluegill) parametric ANOVA (including a priori tests) and hierarchical nonparametric Kruskal-Wallis one-way ANOVA by ranks (KW) on analytes (A, mercury; B, dieldrin) for whole tissue samples in 1986.

SOURCE	DF	MS	F	P	K-W	P
A. MERCURY						
GROUPS	5	0.007	4.318	0.012		
LAKES WITHIN BASS	2	0.014	8.400	0.001		
LAKES WITHIN BLUEGILL	2	0.001	0.600	0.550		
BASS VERSUS BLUEGILL	1	0.006	3.600	0.070		
LAKES (L)	2	0.011	6.552	0.009		
SPECIES (S)	1	0.005	2.961	0.096		
L X S	2	0.005	2.964	0.082		
WITHIN	15	0.002				
GROUPS					9.948	0.077 @
LAKES WITHIN BASS					5.241	0.073 @
LAKES WITHIN FILLETS					4.403	0.132
LARGEMOUTH BASS VERSUS BLUEGILL					1.437	0.487
B. DIELDRIN						
GROUPS	5	0.005	2.927	0.049		
LAKES WITHIN BASS	2	0.002	1.250	0.140		
LAKES WITHIN BLUEGILL	2	0.004	2.500	0.120		
BASS VERSUS BLUEGILL	1	0.013	8.125	0.010		
LAKES (L)	2	0.004	2.233	0.142		
SPECIES (S)	1	0.014	8.918	0.009		
L X S	2	0.001	0.626	0.548		
WITHIN	15	0.002				
GROUPS					8.667	0.123
LAKES WITHIN BASS					0.461	0.794
LAKES WITHIN FILLETS					3.103	0.212
LARGEMOUTH BASS VERSUS BLUEGILL					5.284	0.071 @

DF - Degrees of Freedom
MS - Mean Square
@ - Approaches significance (0.100 > p > 0.050)

Table B.3-6 Results of two-way (lakes -- Derby versus McKay; tissues -- remains versus fillets) parametric ANOVA and hierarchical nonparametric Kruskal-Wallis one-way ANOVA by ranks (KW) on analytes (A, mercury; B, dieldrin; C, DDE; D, aldrin) for largemouth bass in 1988.

SOURCE	DF	MS	F	SIGNIFICANCE	K-W	SIGNIFICANCE
A. MERCURY						
GROUPS	3	0.072	11.143	0.000		
LAKES (L)	1	0.174	27.038	0.000		
TISSUES (T)	1	0.039	6.071	0.026		
L X T	1	0.002	0.322	0.578		
WITHIN	16	0.006				
GROUPS					14.657	0.002 **
BETWEEN LAKES WITHIN REMAINS					6.818	0.009 **
BETWEEN LAKES WITHIN FILLETS					5.741	0.016 *
FILLETS VERSUS REMAINS					2.286	0.131
B. DIELDRIN						
GROUPS	3	0.295	8.321	0.001		
LAKES (L)	1	0.616	17.367	0.001		
TISSUES (T)	1	0.135	3.798	0.072		
L X T	1	0.135	0.135	3.798		
WITHIN	16	0.567				
GROUPS					15.234	0.002 **
BETWEEN LAKES WITHIN REMAINS					7.759	0.005 **
BETWEEN LAKES WITHIN FILLETS					5.538	0.019 *
FILLETS VERSUS REMAINS					0.685	0.408
C. DDE						
GROUPS	3	0.885	8.321	0.001		
LAKES (L)	1	0.674	16.165	0.001		
TISSUES (T)	1	0.087	2.095	0.136		
L X T	1	0.087	2.095	0.136		
WITHIN	16					
GROUPS					14.657	0.002 **
BETWEEN LAKES WITHIN REMAINS					6.818	0.009 **
BETWEEN LAKES WITHIN FILLETS					5.741	0.016 *
FILLETS VERSUS REMAINS					2.286	0.131

Table B.3-6 (continued)

SOURCE	DF	MS	F	SIGNIFICANCE	K-W	SIGNIFICANCE
D. ALDRIN						
GROUPS	3	0.00020	2.728	0.078		
LAKES (L)	1	0.00420	5.666	0.031		
TISSUES (T)	1	0.00009	1.260	0.156		
L X T	1	0.00009	1.260	0.156		
WITHIN	16	0.00007				
GROUPS					10.038	0.018 *
BETWEEN LAKES WITHIN REMAINS					5.538	0.019 *
BETWEEN LAKES WITHIN FILLETS					1.000	0.371
FILLETS VERSUS REMAINS					1.935	0.164

DF - Degrees of Freedom
MS - Mean Square
* - Significant ($p < 0.05$)
** - Highly significant ($p < 0.01$)

Table B.3-7. ABOVE Results of two-way (lakes--Derby versus McKay; species--Largemouth Bass versus Bluegill) parametric ANOVA (including a *priori* tests) and hierarchical nonparametric Kruskal-Wallis one-way ANOVA by ranks (KW) on mercury for whole tissue samples in 1988. BELOW--Results of one-way (Lake Derby versus Lake McKay) parametric and nonparametric (Kruskal-Wallis one-way ANOVA by ranks = KW) ANOVA on dieldrin and DDE for whole tissues in 1988.

SOURCE	DF	MS	F	SIGNIFICANCE	K-W	SIGNIFICANCE
A. MERCURY						
GROUPS		3	0.045	11.250	0.000	
LAKES WITHIN BASS	1	0.074	19.923	0.000		
LAKES WITHIN BLUEGILL	1	0.000	2.243	0.130		
BASS VERSUS BLUEGILL	1	0.053	14.269	0.001		
LAKES (L)	1	0.015	3.981	0.620		
SPECIES (S)	1	0.053	14.236	0.001		
L X S	1	0.068	18.226	0.000		
WITHIN	21	0.004				
GROUPS					14.162	0.003**
LAKES WITHIN BASS					6.587	0.010**
LAKES WITHIN BLUEGILL					2.613	0.106
BASS VERSUS BLUEGILL					6.311	0.102*
B. DIELDRIN						
LAKES	1	0.002	1.801	0.201	2.018	0.155
WITHIN	6	0.001				
TOTAL	7					
C. DDE						
TISSUE	1	0.000	-----	1.000	0.000	1.000
WITHIN	6	0.000				
TOTAL	7					

* DF = Degrees of Freedom
MS = Mean Square
F = one-way ANOVA results
P = significance of F to t-test results
KW = Kruskal-Wallis results
P(KW) = significance of Kruskal-Wallis results

Table B.3-8. Statistical comparisons of species, lakes, and tissues. Tests are two-way ANOVAs and nonparametric Kruskal-Wallis.*

1\.

SOURCE Mercury 1986 Whole-Body:	DF	MS	F	P	P(KW)
Ladora, Mary	1	0.012	5.011	0.071	0.213
Bass, Bluegill	1	0.009	3.639	0.069	0.271
Lake by Species	1	0.006	2.391	0.121	0.340
Within	8	0.002			

2\.

SOURCE Mercury 1988 McKay:	DF	MS	F	P	P(KW)
Fillets, Remains	1	0.027	10.681	0.005	0.006
Bass, Bluegill	1	0.005	1.814	0.197	0.293
Tissue by Species	1	0.000	0.062	0.807	0.859
Within	16	0.003			

3\.

SOURCE Dieldrin 1986 Whole-Body:	DF	MS	F	P	P(KW)
Derby, Ladora, Mary	2	0.004	3.258	0.052	0.138
Bass, Bluegill	1	0.012	9.245	0.009	0.013
Lake by Species	2	0.001	1.103	0.269	0.609
Within	12				

* DF = degrees of freedom
MS = mean square
F = one-way ANOVA results
P = significance of F
P(KW) = significance of Kruskal-Wallis results

04/11/89

Table B.3-9. Statistical comparisons among lakes. Tests are parametric ANOVA, t-tests, and nonparametric Kruskal-Wallis.*

1. Lakes: Ladora versus Derby versus Mary
Means and sample sizes: 0.182(3) 0.054(3) 0.074(3)

SOURCE	DF	MS	F	P	KW	P(KW)
Mercury 1986						
Bass, Whole-body	2	0.014	5.355	0.046	5.241	0.073
Within	6	0.003				

2. Lakes: Derby versus McKay
Means and sample sizes: 0.359(5) 0.152(5)

SOURCE	t	P	KW	P(KW)
Mercury 1988				
Bass, Fillets	3.122	0.014	5.771	0.016

3. Lakes: Derby versus McKay
Means and sample sizes: 0.250(5) 0.084(5)

SOURCE	t	P	KW	P(KW)
Mercury 1988				
Bass, Remains	6.040	0.000	6.818	0.009

Source: MKE, 1988.

* DF = degrees of freedom
MS = mean square
F = one-way ANOVA results
t = t-test results
P = significance of F or t-test results
KW = Kruskal-Wallis results
P(KW) = significance of Kruskal-Wallis results

Table B.3-10. Statistical comparisons among species. Tests are parametric t-tests and nonparametric Kruskal-Wallis.*

1. Species: Bass versus Bluegill**
   Means and sample sizes: 0.294(5) 0.063(6)

SOURCE	t	P	KW	P(KW)
Mercury 1988				
Whole-body, Derby	7.304	0.000	7.639	0.006
Within				

2. Species: Bass versus Bluegill
   Means and sample sizes: 0.375(5) 0.070(6)

SOURCE	t	P	KW	P(KW)
Dieldrin 1988				
Whole-body, Derby	3.425	0.008	4.822	0.028
Within				

3. Species: Bass versus Bluegill
   Means and sample sizes: 0.032(3) 0.100(3)

SOURCE	t	P	KW	P(KW)
Dieldrin 1986				
Whole-body, Ladora	2.509	0.066	3.857	0.050
Within				

Source: MKE, 1988.

* DF = degrees of freedom
MS = mean square
F = one-way ANOVA results
t = t-test results
P = significance of F or t-test results
KW = Kruskal-Wallis results
P(KW) = significance of Kruskal-Wallis results

** In test No. 1, bass data are from five reconstructed whole-body samples.

Table B.3-11. Statistical comparisons among tissue types. Tests are parametric t-tests and nonparametric Kruskal-Wallis.*

1. Tissues: Fillets versus Remains
   Means and sample sizes: 0.152(5) 0.084(5)

SOURCE	t	P	KW	P(KW)
Mercury 1988				
Bass, McKay	2.684	0.028	5.771	0.016
Within				

2. Tissues: Fillets versus Whole-Bodies
   Means and sample sizes: 0.034(3) 0.088(6)

SOURCE	t	P	KW	P(KW)
Dieldrin 1986				
Bluegill, Mary	1.886	0.101	2.483	0.115
Within				

3. Tissues: Fillets versus Remains
   Means and sample sizes: 0.218(5) 0.486(5)

SOURCE	t	P	KW	P(KW)
Dieldrin 1988				
Bass, Derby	1.849	0.102	2.455	0.117
Within				

4. Tissues: Fillets versus Remains
   Means and sample sizes: 0.188(5) 0.109(5)

SOURCE	t	P	KW	P(KW)
Mercury 1988				
Bluegill, McKay	2.137	0.065	3.153	0.076
Within				
Total				

Source: MKE, 1988.

* DF = degrees of freedom
MS = mean square
F = one-way ANOVA results
t = t-test results
P = significance of F or t-test results
KW = Kruskal-Wallis results
P(KW) = significance of Kruskal-Wallis results

04/11/89

Table B.3-12. Nonsignificant comparisons among RMA lakes. Tests are parametric ANOVA.[1]

Tissue Type[2]	Analyte	Lower Derby	Lake Ladora	Lake Mary	
Bluegill (w) 1986	Dieldrin	.149 (.161)	.100 (.153)	.088 (.107)	P = 0.17
Bluegill (w) 1986	Mercury		.084 (.124)	.074 (.137)	P > 0.50
Largemouth Bass (w) 1986	Dieldrin	.077 (.112)	.032 (.034)	.059 (.115)	P > 0.10
Northern Pike (f) 1986	Mercury	.406 (.470)	.330 (.370)		P ~ 0.50

1 Data are mean tissue concentrations in ug/g; maximum values are shown in parentheses.

2 w = whole body; f = fillet; r = remains (whole body minus fillets).

Source: MKE, 1988.

04/12/89

Table 5.3-13. Nonsignificant comparisons among species. Tests are parametric ANOVA.[1]

Tissue Type[2]	Lake	Contaminant	Black Bullhead	Bluegill[3]	Largemouth Bass[3]	
1986 whole body	Lower Darby	Dieldrin	.144 (.209)	.149 (.161)	.077 (.112)	P = 0.16
whole body	Lower Darby	Mercury	.051 (.051)		.054 (.063)	P > 0.50
whole body	Lake Ladora	Mercury		.084 (.124)	.182 (.235)	P > 0.10
whole body	Lake Mary	Dieldrin		.088 (.156)	.059 (.115)	P > 0.20
whole body	Lake Mary	Mercury		.074 (.137)	.072 (.101)	P > 0.50
1988 whole body	McKay	Mercury		[.141] (.178)	[.109] (.157)	P > 0.50
fillet	McKay	Mercury		.188 (.255)	.152 (.236)	P > 0.50
remains	McKay	Mercury		.109 (.171)	.084 (.119)	P > 0.20

1 Data are mean tissue concentrations in ppm; the maximum value is shown in parenthesis.
2 Pair-wise comparisons of fillets for 1986 and whole bodies for 1988 were not possible because of non-analogous data sets.
3 Values in brackets indicate whole-body data obtained by re-combining fillet and remains data on a biomass-weighted basis.

Source: MKE, 1988.

Table 8.3-11. Nonsignificant comparisons among tissue types. Tests are parametric ANOVA.[1]

Species, year	Lake	Contaminant	(w)[2]	(f)[2]	(r)[2]	
Bluegill, 1986	Lake Mary	Mercury	.074 (.137)	.083 (.099)		$P > 0.50$
Largemouth Bass, 1986	Lake Mary	Mercury	.074 (.101)	.076 (.101)		$P > 0.50$
Largemouth Bass, 1988	Lower Derby	Aldrin		.025 (.044)	.033 (.653)	P ~ 0.25
Largemouth Bass, 1988	Lower Derby	DDE		.329 (.684)	.593 (.838)	$P > 0.10$
Largemouth Bass, 1988	Lower Derby	Mercury		.359 (.550)	.250 (.319)	$P > 0.10$

1 Data are mean tissue concentrations in ppm; the maximum value is shown in parenthesis.

2 w = whole body; f = fillet; r = remains (whole body minus fillets).

Source: NKE, 1988.

04/13/88

3.2.1 DATA FROM 1986 AQUATIC STUDIES

Three separate analyses were performed on analyte data. Each analysis was conducted separately for mercury and dieldrin. The results of each analysis appear in Tables B.3-2, B.3-3, and B.3-5, while the discussion of each table follows and is based upon the nonparametric results. No significant differences were found between onpost and control lakes or between species in the lakes for any of the contaminants which were analyzed.

3.2.2 DATA FROM 1988 AQUATIC STUDIES

Three separate analyses were performed on analyte data. Each analysis was conducted separately for mercury, dieldrin, aldrin, and DDE. The results of each analysis appear in Tables B.3-4, B.3-6, and B.3-7, while the discussion of each table follows and is based upon the nonparametric results.

Table B.3-6 presents the differences among combinations of lakes (Derby versus McKay) and tissues (remains versus fillets), holding species (bass) and year (1988) constant.

Mercury. The significant differences among the four treatment groups in the preliminary KW is primarily caused by consistent significant differences between Derby and McKay lakes regardless of tissue type. No significant difference between tissue types was detected when the lakes samples were pooled.

Dieldrin. The significant differences among treatment groups in the preliminary KW is primarily caused by consistent significant differences between Derby and McKay lakes regardless of tissue type. No significant difference between tissue types was detected when the lakes samples were pooled.

DDE

The significant difference among treatment groups in the preliminary KW is primarily caused by consistent significant differences between Derby and McKay lakes regardless of tissue type. No significant difference between tissue types was detected when the lakes samples were pooled.

Aldrin

The significant difference among treatment groups in the preliminary KW is primarily caused by a significant difference between Derby and McKay lakes in samples of remains. No significant differences occurred between lakes in samples of fillets or between tissue types when lake samples were pooled.

Table B.3-7 presents the differences between lakes (Derby versus McKay) holding specie' (bluegill), tissue (whole) and year (1988) constant. No significant difference between lakes was detected for mercury, dieldrin, or DDE.

Table B.3-4 presents the differences between tissues (remains versus fillets) holding lake (McKay), species (bluegill), and year (1988) constant.

Mercury

Significance was approached for differences between tissues.

Dieldrin

No difference was detected between tissues: all samples for both tissue types were at the CRL.

DDE and Aldrin

No difference was detected between tissues: all samples for both tissue types were at the CRL.

3.3 CONCLUSIONS

The most important and informative comparisons from the point-of-view of the effects of contamination at RMA on the biota are those that involve comparisons of sites in which at least one contaminated and one control lake exist. MKE do not provide these data for 1986. Two of the statistical analyses (Tables B.3-6 and B.3-7) for 1988 do permit evaluation of the question as to whether biota in a contaminated lake (Derby) exhibit analyte concentrations that are distinguishable from those in a control lake.

Nonetheless, sample sizes in both cases are small and real differences may be missed because of low power. Moreover, comparisons that involved a single control lake and a single onsite lake may represent false replication in that "all other features of the lakes are not equal," making interpretation of significance or nonsignificance difficult. Each of the four (mercury, dieldrin, DDE, aldrin) contaminants exhibited highly significant differences between RMA and control lakes for bass despite small sample sizes. None of the analytes exhibited significant differences between control (N = 2) and RMA (N = 6) lakes for bluegill (whole tissue), at least in part because of small samples. Additional comment on tests or comparisons that do not directly involve control and contaminated lakes are not made herein.

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LITERATURE REVIEW
THE USE OF PESTICIDES AND HERBICIDES
BY THE ARMY FOR THE CONTROL OF PESTS
AND VEGETATION AT ROCKY MOUNTAIN ARSENAL

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OCTOBER 1988

EXECUTIVE SUMMARY

This report presents the results of an in-depth survey of all available extant literature on the use by the Army of chemical pesticides and herbicides for pest and vegetation control at Rocky Mountain Arsenal between 1943 and 1987. The literature on this subject while voluminous is fragmentary and/or non-existent in strategic areas. This situation effectively precludes a reconstruction of Army pest and vegetation control operations on a site-specific basis. Meaningful quantification of historical herbicide and pesticide usage is similarly impossible. In consequence, this report takes the form of an Arsenal-wide narrative, chronicling to the extent possible the Army experience in this area. The report covers only Army activities. The requisite documents and records, necessary to a reconstruction of the record of Shell Chemical Co. and its predecessor, the Julius Hyman Co., in the area of pest and vegetation control have as yet not been released. Bibliographies of the extant literature on pest and vegetation control activities and herbicide and pesticide usage are presented on pages 38 to 66 and Appendix D.

Use of Pesticides and Herbicides for the Control of Pests and Vegetation at Rocky Mountain Arsenal

Since 1943, the Army has conducted a series of ongoing programs for the control of pests and vegetation at Rocky Mountain Arsenal. Over the years, programmatic efforts have concentrated on the removal of weeds and vegetation from railroad tracks, canals and creeks, the control of aquatic vegetation and mosquitoes in the process water storage lakes and the eradication of various pests inhabiting the general area of sites occupied by administrative and living quarters, and production and storage facilities (Deputy, 1985; Donnelly, 1985; Green, 1985; Heim, 1985; Lynes, 1985; Wright, 1985; Donnelly, 1986; Mitchell, 1986, pp. 554-554). Integral to the implementation of these programs for pest and vegetation control has been the extensive utilization of a wide variety of chemical herbicides and pesticides. Available information suggests that herbicides and pesticides were transported to the Arsenal in bulk and mixed on-site to use-proportions in so-called "herbicide and pesticide shops" (Mitchell, 1986, pp. 562-564). The usual practice was to transfer bulk concentrate from a drum to a sprayer tank. The desired solution was then attained by adding either water or kerosine (Lynes, 1985, pp. 79-81). At various times during the active period of the Arsenal's history, Buildings 616, 627B and 643 were used for bulk storage of herbicides and pesticides (USAEHA, 1979; Grodt, 1988; Donnelly, 1986; Mitchell, 1986, p. 628). The first "herbicide and pesticide shop," Building 646, was a temporary structure relocated from GB Plants Area in 1952 (RMA, 1952a; RMA, 1952c, p. 2; RMA, 1953a; Donaghe, 1980). By the mid-1950s, Building 646 had been replaced by a permanent facility, Building 544, constructed in 1953 (DOA, 1953; Parsons, 1957; COE, 1984; Mitchell, 1986, pp. 562-563). Building 544 was operated as the designated "herbicide and pesticide shop" at the Arsenal until supplanted in the early 1980's by Building 742 (Mitchell, 1986, pp. 562-564). Apparently, little, if any relationship existed between the Army's pest and vegetation control programs, and the herbicide and pesticide manufacturing operations conducted by various lessees of the Army between 1947 and 1982. The individual compounds were, for the most part, different, and as well as can be determined, the Army purchased its bulk herbicide and pesticide stocks from sources off-site (Deputy, 1985; Donnelly, 1985; Green, 1985; Heim, 1985; Lynes, 1985; Wright, 1985; Donnelly, 1986; Mitchell, 1986). Regarding the pest and vegetation control activities conducted by the various lessees, most notably, Julius Hyman & Co. and Shell Chemical Co., in their respective leasehold areas, virtually nothing is known.

In August 1943, the Army began treating the South Lakes with crystalline copper sulfate (Blue Vitriol) to control the growth of algae. Row boats were used to spread the chemical near the surface of the water. The average dosage was between 2.5 and 3.0 pounds of copper sulfate per million gallons of water. On September 30, 1943, three hundred pounds of copper sulfate were mixed in Building 374 and allowed to flow through the baffle flume into Lake Ladora. This method proved ineffective, and subsequent applications of copper sulfate in August 1944 and July 1945 followed the surface treatment method described above (CWS, 1945).

On May 22, 1944, the Arsenal's industrial hygiene and sanitation committee recommended spraying either Paris Green[1] or oil on the seepage pond near Sixth Avenue south of Derby Lake and on the stagnant water holes on "E" Street between Sixth and Seventh Avenues to prevent mosquitoes from breeding (Shaw et al., 1944). In late November 1944, the Army began using rat poison and traps

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[1] A poisonous, bright green powder, $(CuO)_3As_2O_3.Cu(C_2H_3O_2)_2$, used as an insecticide.

to exterminate field mice and rats on the Arsenal (Holaday et al., 1944).

As of April 20, 1945, for the purpose of eradicating flies, mosquitoes and other insects, DDT had been sprayed in various parts of the Arsenal including the pyrotechnic incendiary branch, the service branch, and the Building T-157 barracks. At this time, the industrial hygiene committee of the Arsenal also recommended that the post engineer responsible for the insecticide program apply DDT in all barracks, cafeterias, dispensaries, and mess halls to control bedbugs, cockroaches, and flies (Mnookin et al., 1945).

During May 1946, a large number of gnats and mosquitoes were adversely affecting Army personnel working in the Toxic Storage Yard in Section 6. In response, the industrial hygiene committee recommended spraying DDT insecticide in the South Lakes area to control mosquito and gnat breeding. In previous years, the breeding of these insects had been sufficiently controlled by the variation of water levels in the South Lakes (McLaughlin et al., 1946a). By July 17, 1946, the Army had completed the spraying of DDT on the screens of all the cafeterias, mess halls, and staff houses on the Arsenal (McLaughlin et al., 1946b).

In late March 1947, the industrial hygiene committee recommended that the post engineer spread oil all stagnant ponds, particularly the seepage area west of Ladora Lake, to control flies and mosquitoes (McLaughlin, 1947). On May 6, 1948, the post surgeon directed the spraying of DDT insecticide on apartment and house screens to decrease flies. The surgeon also indicated that the land around these apartments would be sprayed with DDT to control fleas (Harbaugh, 1948).

Army usage of DDT at the Arsenal continued throughout the decade of the 1950s and extended into the 1960s. Available records suggest that on the average three 55-gallon drums of DDT were purchased by the Army annually. During the mosquito season, DDT was sprayed around the South Lakes, connecting water and ditch ways, and picnic areas approximately twice a week. A motor-driven fogger mounted on a two-wheel trailer was used to widen the area of application, facilitating the spraying operation (Lynes, 1985, p. 62; Mitchell, 1986, pp. 555-558).

In 1948, Julius Hyman and Company leased Buildings 633 and 633A located in the southeastern quarter of Section 4 of the Arsenal. Hyman used these structures along with Building 633B, a Hyman-owned building, as a laboratory designed to test insecticides on flies and other insects (Silber, 1948; Goodall, 1953; Atchley and Kent, 1954; Silber, 1954). In 1952, with the acquisition of Hyman's lease, Shell Chemical Company assumed occupancy of these buildings. Between 1953 and 1957, Shell Development Company, an affiliated Shell company, used these buildings, also known as the "bug lab," for agricultural research and bioassay purposes (Goodall, 1953; Shadle, 1953; Silber, 1955; Silber, 1957; Parsons, 1957; Mitchell, 1986, pp. 644-645). The extent of laboratory operations in these facilities is unknown.

In January 1949, the post engineer prepared a land management plan to serve as a guide for the utilization and maintenance of all lands at Rocky Mountain Arsenal. For the purposes of land management, the Arsenal was divided into three distinct areas. In one of these areas, the plan specified the application of "weed control chemicals" to control weeds on bluegrass lawns.[2] Herbi-

[2] The selected area covered 913 acres and was considered an intensive use area. It contained the administration and manufacturing areas, shops and warehouses, officers' quarters, and the sewage treatment plant (Unauthored, 1949).

cides and soil sterilizing chemicals were to be used to control vegetation along the Arsenal's railroad tracks (Unauthored, 1949).

During the spring of 1950, the Army announced its intention to use 2,4-D (2,4-dichlorophenoxyacetic acid) to control weeds at the Arsenal. Pests were to be controlled with Chlordane[3] insecticide (Chemical Corps, 1950).

In July 1951, Julius Hyman and Company began treating Lake Ladora to control the growth of algae. Hyman performed routine maintenance work on the Arsenal's water system as part of its lease obligations (Silber, 1953a). On August 18, 1953, Hyman informed the Army that "chemical eradication" would be required to control the heavy weed growth in Lake Ladora (Silber, 1953b). Several years later, in July 1958, Shell Chemical Corporation notified the Army that it had "recently completed treatment of the lower lake" to control weeds and algae (Hughes, 1958). Shell continued to treat and control aquatic vegetation in Lake Ladora until at least 1969 (Williams, 1964; Howard, 1969). Unfortunately, the types and quantities of vegetation control of chemicals used by Hyman and Shell during this period are unknown.

In 1952, the Army conducted an insecticide-filling program for the United States Forest Service. Two insecticides, ethylenedibromide and orthodichlorobenzene, were transported to the Arsenal and stored temporarily. The insecticides were mixed with fuel oil and an emulsifier, and placed in containers. By December 31, 1952, the Army had shipped approximately 197,000 pounds of ethylenedibromide and 183,000 pounds of orthodichlorobenzene off the Arsenal (RMA, 1952a; Smith, 1952; RMA, 1952b; RMA, 1952c, p. 33).

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[3] A highly chlorinated liquid insecticide, $C_{10}H_6Cl_8$

During the summer of 1954, the Army sprayed 750 acres of the Arsenal with isopropyl ester of 2,4-D to control the growth of Russian thistle, <u>Salsola</u> <u>pertifer</u>. Russian Thistle was a prickly weed that grew along railroads, roadways, and fields throughout the Arsenal (RMA, 1954; Shogren, 1977, p. 31).

In mid-1955, the Arsenal's maintenance division sprayed approximately 500 acres with isopropyl ester of 2,4-D to control Russian thistle and other noxious weeds. Later in the year, 200 acres were sprayed with isopropyl ester of 2,4-D,and 320 acres of land were treated with sodium fluoracetate to reduce the prairie dog population (RMA, 1955a; RMA, 1955b).

Between July and September 1956, the maintenance division chemically treated 400 acres of land to control broad-leaf weeds. Approximately 2,000 pounds of Ureabor was spread around various Arsenal buildings to control vegetation. Ureabor, a nonselective soil sterilant, was a combination of sodium borates, 3-p-chlorophenyl, and 1,1 dimethylurea. By the year's end, an additional 5,300 pounds of Ureabor had been spread in the North Plants area and other sections of the Arsenal (RMA, 1956a; RMA, 1956b; Shogren, 1977, p. 34).

Early in 1957, the maintenance division applied 10,700 pounds of Ureabor to various areas of the Arsenal for the purpose of controlling vegetation. That spring, the railroad maintenance branch spread 22,000 pounds of Ureabor along the Arsenal railroad tracks. During the same period, the insect and rodent control branch fumigated one building with hydrogen cyanide (HCN), sprayed trees and shrubbery, and spread 1,000 pounds of Ureabor Soil Sterilant for vegetation control (RMA, 1957a; RMA, 1957b). Throughout the summer and fall of 1957, the Army sprayed all trees, lawns, and shrubbery on the Arsenal to control insects and rodents.

Three acres of land were treated with Ureabor Soil Sterilant to control vegetation (RMA, 1957c; RMA, 1957d). During this period, the Army used various insecticides and rodenticides, including Warfarin,[4] thallium sulfate, sodium fluoroacetate, Chlordane, Dieldrin, DDT, lead arsenate, Bordeaux mixture,[5] Malathion,[6] and nicotine sulfate (USAEHL, 1957).

In 1958, the maintenance division sprayed lawns and trees on the Arsenal to control insects, rodents, and predators. Ureabor Soil Sterilant was applied to the storage pads in Section 31 and forty-five additional acres of Arsenal land to control weed and vegetation growth (RMA, 1958a; RMA, 1958b; RMA, 1958c; RMA, 1958d).

During 1959, the Army treated the "Open Storage Area" with 2,500 pounds of Ureabor Soil Sterilant. An unknown quantity of Ureabor was applied to all active railroad trackage and areas adjacent to the Arsenal's perimeter fence (RMA, 1959a; RMA, 1959b; RMA, 1959c). Insecticides in use at this time included Chlordane, Lindane (1,2,3,4,5,6-hexachlorobenzene), Malathion, and DDT (Ledwell, 1959).

In early 1960, Army personnel spread 4,000 pounds of Ureabor Soil Sterilant around sign posts, utility poles, and warehouses. Ureabor was also placed on standby railroad trackage. During the spring, another 4,000 pounds of Ureabor were spread throughout the installation (RMA, 1960a; RMA, 1960b). On July 11, 1960, Shell's industrial hygienist contacted the Army about the possibility of having the Shell leased area sprayed for mosquitoes. Four days

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[4] A colorless crystalline compound, $C_{19}H_{16}O_4$, used to kill rodents

[5] A mixture of copper sulfate, lime, and water, used as a fungicide and insecticide

[6] Trademark for an organic compound, $C_{10}H_{19}O_6PS_2$, used as an insecticide

later, an Army representative toured Shell's leased facilities to determine which areas needed to be sprayed. By July 20, 1960, the Arsenal's insect and rodent control branch had sprayed the Shell plant area, part of Lake Ladora, and the north sides of Upper and Lower Derby Lakes (McGilvray, 1956-1972).

In the spring of 1961, the maintenance division sprayed for insects and spread 10,000 pounds of Ureabor Soil Sterilant on vegetation (RMA, 1961a). On June 30, 1961, Shell requested the Army to spray the Shell-leased area for mosquitoes under terms of a contract between Shell and the Army. Within three days, Arsenal personnel had sprayed the acetylene area and other parts of Shell's leased facilities. The picnic area north of Lake Mary possibly was sprayed in mid-July (Brisbane, 1961; McGilvray, 1956-1972; RMA, 1961b). Pesticides used by the Army in 1961 included Lindane, Chlordane, Malathion, and DDT (Vining, 1961). During the last three months of the year, the Army spread approximately 600 pounds of Ureabor Soil Sterilant around various Arsenal buildings (RMA, 1961c).

In early 1962, the maintenance division spread approximately 20,000 pounds of Ureabor Soil Sterilant around fences, sign posts, and buildings in the South Plants. Another 12,000 pounds of Ureabor were applied to active railroad trackage. The Army also treated the western end of Lake Mary with sodium arsenite to control aquatic vegetation (RMA, 1962a; RMA, 1962b). On June 22, 1962, Shell requested the Army to spray specific areas of Shell's leased facilities for mosquitoes under terms of a contract between Shell and the Army. As of July 10, 1962, Arsenal personnel had sprayed the acetylene unit, the mustard area, and the open area north of the bicycloheptadiene production unit (Brisbane, 1962; McGilvray, 1956-1972). During the summer and fall, the Army treated the eastern end of Lake Mary with sodium arsenite and spread 20,000 pounds of Ureabor Soil Sterilant (RMA, 1962c; RMA, 1962d). The Arsenal grounds were treated with an additional 20,000 pounds of Ureabor Soil Sterilant during the first half of 1963 (RMA, 1963).

On April 2, 1962, the Army established a special projects division at the Arsenal to produce and store the biological agent TX[7] (McNary, 1962; Whitledge, 1962). In early 1963, the special projects division initiated TX field production operations. During May and early June, approximately 650 acres of wheat were planted in fields located in Sections 23, 24, 25, ' d 26 (Bogan, 1963; Unauthored, 1970).

The Army used various herbicides and pesticides during each TX production season. Between May and August, 1964, the TX fields were sprayed with approximately 450 pounds of 2,4-D to control grasses and two types of weeds, broad-leaf and bindweed. One wheat field in Section 24 was treated with approximately 30 pints of Malathion to control the aphid and leaf mite population (Asai, 1964; Flucke, 1964).

During the 1965 production season, Arsenal personnel sprayed approximately 525 pounds of 2,4-D on the TX wheat fields to control grasses, bindweed, broad-leaf weeds, and knapweed. Additional quantities of 2,4,5-T (2,4,5-trichlorophenoxy acetic acid), Dowpon, and 2,4-D were sprayed on the ditches and perimeter of the production site (Clevenger, 1965). In the summer of 1966, the Army used a self-propelled sprayer to treat TX fields and 400 surrounding acres. At least 250 pounds of 2,4-D, and 500 pounds of

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[7] TX was the military code name for the urediospores of _Puccinia graminis_ var. tritici, the causal agent of wheat stem rust (RMA, 1973).

Malathion were sprayed on the TX fields that season to control weeds and insects (Krenzer and Morkovsky, 1966).

The special projects division continued to use herbicides and insecticides during the 1967 and 1968 TX production seasons. In 1968, approximately 370 pounds of 2,4-D were sprayed on 17 TX fields to control the growth of broad-leaf weeds. An additional 51 gallons of Malathion were used to control a light infestation of grasshoppers and aphids throughout the TX production site (Ammon, 1967; Young, 1967).

During the summer of 1968, the Army used chemical retardants to control the growth of vegetation in Lake Mary. The lake may have been treated twice with Diquat[8] to control aquatic weeds. Approximately one-half to three pounds of Karmex (Diuron)[9] were used per surface acre to control filamentous algae growth. The use of these herbicides helped release nutrients for the production of plankton, which improved fishing conditions in Lake Mary (Bartschi, 1968; Unauthored, 1968).

During the summer months of 1970, the Army sprayed insecticides throughout the Arsenal to control rodents and insects. The specific types and quantities of insecticides used that summer are unknown (Gaon, 1970a; Gaon, 1970b; Gaon, 1970c).

On December 7, 1970, the Arsenal's director of facilities requested command authorization to purchase and use approximately five gallons of R-55[10] Rodent Repellent. The repellant was needed

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[8] A powerful nonpersistent herbicide, $C_{12}H_{12}Br_2N_2$, used to control water weeds.

[9] A persistent herbicide, $C_9H_{10}Cl_2N_2O$, used to control annual weeds.

[10] Phillips Petroleum Company's trademark name for tertiary-butylsulfenyl dimethyldithiocarbamate (Donnelly, 1970b).

to protect underground control cables which linked a network of air monitoring stations on the Arsenal's perimeter from being destroyed by gophers. On December 14, 1970, the Army gave the Arsenal permission to purchase and use the R-55 Rodent Repellent. No information was found on the actual use of this material at Rocky Mountain Arsenal (Donnelly, 1970a; Donnelly, 1970b; Grosskopf, 1970).

Between 1964 and 1969, the population of bullheads and bluegills increased significantly in Lake Mary. To eliminate an over-abundance of these warm water fish which were inhibiting the survival and growth of stocked trout, the lake was chemically treated in 1970. The water level was lowered five to six feet,[11] and a mixture of five gallons of 5 percent emulsifiable Rotenone and 50 pounds of 20 percent Rotenone were applied to the remaining water and sump areas on August 25, 1970. The treatment rid the lake of hordes of bluegill, a large number of black bullheads, approximately 200 rainbow trout, and a few largemouth bass. Subsequent sampling revealed a complete extermination of the undesired fish species (Donnelly, 1974; Mullan, 1975a; Mullan, 1975b; Mullan, 1975c).

Green sunfish, which were present in the canal water that was used to fill Lake Mary, entered the lake during refilling in 1970. The green sunfish population quickly matched the over-abundant populations of the undesired fish species which had existed prior to the treatment of the lake and presented similar undesirable conditions for the survival and growth of stocked fish. This

[11] In period documents, Lake Mary was listed as a surface lake consisting of a main body of water approximately 100 feet wide by 600 feet long; and three fingers, each about 150 feet wide by 100 feet long. The deepest portion of the lake, located at the west end, covered an area nearly 100 feet wide by 200 feet long, averaging 6.5 feet deep, with the deepest point being 9.5 feet. The depth of the remainder of the lake averaged about four feet (Donnelly, 1974; Mullan, 1975c). During 1974-1975, the lake was slightly enlarged and deepened to an average depth of 15 feet (Mullan, 1975b; Mullan, 1975c).

undesirable expansion of green sunfish densities was exacerbated by uncontrolled vegetation and weeds in the lake. To improve these conditions, the lake was drained in late August and early in September of 1974. On September 12, 1974, an unspecified amount of 5 percent emulsifiable Rotenone was applied to 38 acre-feet of mud and water in the lake. Hordes of green sunfish, a few largemouth, and approximately 200 channel catfish were killed. The lake was later refilled (Donnelly, 1974; Mullan, 1975a; Mullan, 1975b; Mullan, 1975c).

While herbicide and pesticide usage by the Army at the Arsenal continued in the 1970s and 1980s, the use of a number of herbicides and pesticides was either eliminated or sharply curtailed. Army Regulation 420-76, enacted on February 1, 1972, governed the use and handling of pesticides and defined specific responsibilities. This regulation required, inter alia, continued training and appropriate certification of personnel to prevent contamination of the environment. The regulation classified Aldrin, benzene hexachloride, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Lindane, and Toxaphene as persistent pesticides and restricted their use to essential purposes for which no reasonable substitutes existed. All pesticide spills were required to be reported. Pending establishment of federal guidelines, up to 50 gallons of obsolete or deteriorated pesticides were allowed to be destroyed by burning in a landfill which met state requirements. The reporting of all pest control operations was also required (DOA, 1971).[12] During the same year, the United States Environmental Protection Agency banned almost all uses of DDT because of its persistence and its possible health hazards to people and ill effect on wildlife (LBA, 1981).

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[12] For Rocky Mountain Arsenal, meticulous record has been found only for the period 1979 through 1985. The data obtained from this record are presented in Appendix A.

In January 1973, the Army began a pesticide monitoring program at 20 different Army installations in the United States to determine the extent of pesticide occurrence in the installation environment and to evaluate the hazards created, if any (Kelly, 1973). Under this program, a number of soil and water samples were taken in 1973 and 1974 from different areas of Rocky Mountain Arsenal, including Section 25, First Creek, Lake Mary, and the sewage oxidation pond. Although complete records are not available, at least seven samples contained detectable quantities of pesticide residues and heavy metals. However, the residual levels were determined to be within expected values, consistent with residue levels resulting from "normal" pest control activities, and within permissible levels allowed by the United States Environmental Protection Agency for public water supplies. Another four samples showed residual levels of pesticides higher than those expected as a result of "normal" pest control activities. These higher levels were considered reasonable in view of pesticide-manufacturing operations at the Arsenal by lessees of the Army (Cordo, 1973; Cordo, 1974; Johnston, 1974; Larsen, 1974a; Larsen, 1974b; Larsen, 1974c; Larsen, 1974d; Larsen, 1974e). Table I in Appendix C summarizes the available data relating to the pesticide monitoring program.

By October 1975, the Army was expediting its efforts to ensure the effectiveness and efficiency of the pest management program at the Arsenal. A number of pest management program surveys were conducted in the succeeding years. The overall purpose of these surveys was to provide technical guidance and to evaluate the pest management program from a variety of perspectives, including the medical and economic aspects of pest control, requirements for pollution abatement, available resources, and the adequacy and goals of the program. The use of herbicides was also monitored during these surveys (Hastriter and McLaurin, 1976; confer Farlow, 1984).

The initial pest management program survey was conducted between October 6 and October 9, 1975. The ensuing report of survey results noted that the areal expanse of that portion of the Arsenal where pest control services were applied totalled 17,500 acres, including 1,536,000 square feet of building space. Cockroach control in food service areas was accomplished using Baygon 1.5 Emulsifiable Insecticide applied as a 1.1 percent emulsion on a monthly basis in warehouses (Buildings 331 and 332), clubs (Buildings 151 and 383), and a dining facility (Building 166). Cockroach control in nonfood areas of these facilities was accomplished using a 47.5 percent solution of Diazinon applied as a 0.5 percent emulsion on a monthly basis. Control in all other areas of the Arsenal was handled on an as-needed basis upon request. Mosquito control consisted of the application of a solution of two ounces of 57 percent Malathion emulsifiable concentrate per gallon of water twice weekly during the breeding season. Moth control had been attempted using Baygon and Malathion. Mice control was effected by placing brown paper bags, at intervals of eight to 12 feet, containing four ounces of ready-mix bait each. Also under the control of pest control personnel, herbicide operations required only two herbicides, Bromacil-borate Mixture and 2,4-D. A vegetation space sprayer was used for 2,4-D applications, whereas a granular spreader mounted on a railroad car was used for dispensing the Bromacil along railroad right-of-ways (Hastriter and McLaurin, 1976). Table I of Appendix B lists herbicides and pesticides being stored at the Arsenal at the time of the survey.

The October 1975 survey report cited a number of deficiencies in pest control operations and practice. Bulk pesticides were stored in an outdoor storage shed which also housed tractors, dispersal equipment, and mowing machinery. Adjacent to and part of the Building 544 herbicide- and pesticide-mixing shop, this storage shed was provided with a dirt floor enclosed on all sides. The dirt floor appeared to be saturated with pesticides. Empty pesticide containers were punched and disposed of in the sanitary landfill.[13] Pesticides were being used without honoring labeling instructions (Hastriter and McLaurin, 1976).

In October 1975, pest control equipment on hand at the Arsenal included a two-gallon hand sprayer, a 100-gallon-capacity turbine, an insecticide applicator, a chemical dispersal unit, and a "towed-type" vegetation space sprayer. The equipment required periodic replenishments of pesticide solutions. Normally, water was added to the unused, excess, or residue solution, and the resulting diluted solution, or "rinse water," was disposed of by spraying or pouring it onto the ground at or near the application site. The possibility of environmental contamination as a result of these operations was considered minimal, since the quantity of pesticide remaining in the rinse water was less than the concentration which was originally sprayed (Hastriter and McLaurin, 1976; Mack, 1985b). No wastewater was generated during the pesticide-mixing process at the Building 544 herbicide and pesticide shop (Lynes, 1985, pp. 79-81). The 1975 survey report recommended contacting the United States Environmental Protection Agency for the approval of this and other suggested methods of disposal (Hastriter and McLaurin, 1976).

In addition, the report emphasized the need for changes that the Arsenal's pest management program in pesticide practices

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[13] The Arsenal's sanitary landfill is located in south-central Section 30, designated as Site 30-4 (Ebasco, 1987).

storage and mixing operations (Hastriter and McLaurin, 1976). Subsequent follow-up pest management program surveys were to follow the 1975 pest management program survey.

Between 1975 and 1978, the Army implemented a consolidated pesticide sampling program as part of a scheduled seven-year monitoring study of the presence of pesticides at a number of Army installations. Soil and sediment samples were collected from unspecified Army installations[14] and analyzed for Chlordane and associated compounds, including Technical Chlordane, oxychlordane, cis-Chlordane, trans-Chlordane, heptachlor, heptachlor expoxide; DDT and its derivative compounds, o,p'-DDT, p-p'-DDT, o,p'-DDE, and p-p'-DDE; the cyclodiene group, including Aldrin, Dieldrin, and Endrin; the organophosphate group, including Malathion, Chlorpyrifos, Diazinon, Parathion, and Ronnel; and benzene hexachloride (BHC) and Lindane (McDermott, 1981).

This pesticide monitoring study concluded that the highest concentrations of pesticides at Army installations using pesticides normally were found in pesticide shop and storage areas, followed by sewage treatment, landfill, and residential areas. Sediment samples had the lowest concentrations of pesticides in the same context. By offering a comparison of one-time installation sampling with the interinstallation, multi-year sampling which revealed "normal" concentration levels, this study also provided a basis for the identification of potential "problem" areas. The mean transformed totals, by land use area for 1975-1978, determined by the study were as follows: sediment, less than 0.13 part per million; residential areas, between 0.25 and 0.5 part per million;

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[14] Rocky Mountain Arsenal may have participated in the sampling, since during the subject period at least two pesticide monitoring surveys were conducted at the Arsenal by the United States Environmental Hygiene Agency, the overseer of the four-year sampling program. The first monitoring survey took place between July 14 and 18, 1975, and the second between March 29 and April 2, 1976. The results were apparently not reported independently of the multi-year study (Johnston, 1975; Johnston, 1976a; Johnston, 1976b).

shop and storage areas, between 2.5 and 3.5 parts per million; and other selected areas, between 0.75 and 0.53 part per million (McDermott, 1981). Table II of Appendix C summarizes the "normal" pesticide and herbicide concentration levels in soil and sediment samples taken from selected Army installations where herbicides and pesticides are known to have been used for pest and vegetation control.

Between 1975 and 1978, the Army conducted a study to evaluate the distribution of pesticides in the soil and biota of the environment of Rocky Mountain Arsenal, on the basis of a comparative analysis of samples collected from the Arsenal and 33 other installations in 1975. Table III in Appendix C gives the number of pesticides, means, and concentrations for all pesticides detected in the Arsenal's substrates in the course of this study. The study indicated that under "good" pest practices, pesticide concentrations in various environmental media rarely would exceed the following levels: 5.0 parts per million (ppm) in soil, 0.1 ppm in sediment, and 1.0 ppm in fish and birds. Using these criteria, the study concluded that the Arsenal's pesticide shop and pesticide storage areas, sewage disposal plant, recreational areas, and impoundments had excessive levels of pesticide concentrations. In general, environmental contamination by pesticides appeared to be in excess of that which would be expected to result from recognized pest management practices. However, the study made no effort to identify other potential sources of pesticide contamination, i.e., pesticide production activities conducted by lessees of the Army (Olds et al., 1978). Table IV in Appendix C summarizes the pertinent findings and conclusions of the study.

In July of 1976, the Center for Disease Control of the U.S. Department of Health, Education and Welfare at Fort Collins, Colorado identified the plague bacillus (Yersina pestis) in fleas collected from the burrows of black-tailed prairie dogs in a colony at Rocky Mountain Arsenal. Based on the increased incidence of plague in Colorado, both the Center for Disease Control and the Colorado Department of Health recommended that flea control measures be instituted immediately in prairie dog towns adjacent to areas frequented by humans at Rocky Mountain Arsenal (Phillips, 1976). As a further precautionary measure, the Army decided in August 1976 to eliminate all potentially infected prarie dogs in these areas (Johnston, 1976).

Approximately 1,000 acres of land infested with prairie dogs were identified and quarantined pending the implementation of control measures to reduce flea indices to less than 0.3 per burrow (Phillips, 1976). To achieve the necessary objective, the affected acreage in Sections 2, 3, 9, 22, 25, 26, 28, 31, 33, 35 and 36 was first dusted with approximately 2,100 pounds of flea control registered 10 percent Sevin (Carbaryl) and 1,100 pounds of non-flea control Sevin (Carbaryl)(Phillips, 1976; Fairbanks and Pelle, 1976; Johnston, 1976c; Byrne, 1976). Subsequently, an estimated 200 pounds of 2 percent zinc phosphide bait was applied at a lethal dose rate of 4 grams per burrow. The control measures implemented resulted in the elimination of approximately 6,000 prairie dogs (Johnston, 1976c; Turner, 1976).

In 1977, the Army revised the land management plan for Rocky Mountain Arsenal. Overall, the revised plan aimed to effect an updated coordination of all land use and grounds maintenance activities at the Arsenal. Subsection program provisions detailed approved methods for the control of insects and weed growth and the maintenance of shrubs and trees (Shogren, 1977).

Soil sterilants were used to keep ammunition storage magazines free from all plant growth. Additional control measures were directed at the Russian thistle, which dominated at the edges of cultivated fields, along railroad tracks and roadways, and in unused fields. A solution of 2,4-D was used to keep this weed in check. The areas around storage tanks, security fence lines, and railroad rights of way were all treated with Ureabor, a granular, nonselective soil sterilant. Power poles and substations were treated in the same manner (Shogren, 1977). Trees, shrubs, and evergreens surrounding the administration quarters were sprayed with organic phosphates to control chewing insects. Malathion was used to control sucking insects in this area, and spraying occurred on a weekly basis, or when necessary. According to the maintenance plan, one quart of 57 percent Malathion emulsifying concentrate was mixed with 100 gallons of water and sprayed as a wet spray. A 3-percent Malathion emulsion was used for residual applications (Shogren, 1977).

In late 1977, the Army was storing approximately two tons of DDT for the Colorado Department of Health in Building 643 on the Arsenal. On April 4, 1978, the Army transferred the supply of DDT off the Arsenal to Buckley Air National Guard Base (Emerson, 1978a; Emerson, 1978b; Rodger, 1977b).

In 1979, the Army conducted an installation pest management program review at the Arsenal. The resulting report disclosed the following information. A 14-gallon metal drum containing 85 percent Naled was stored in the shed adjacent to Building 544. In addition, 10 gallons of an unidentified pesticide remained stored in a 55-gallon metal drum in the storage shed. No disposition of this substance was possible until it had been accurately identified. Four 5-gallon drums of Ded-Weed[15] remained stored at the

[15] Ded-Weed is a herbicide consisting of a mixture of 2,4,5,-T and 2,4-D. It was manufactured by the Thompson Hayward Chemical Company.

Arsenal, pending plans for final disposition following the Environmental Protection Agency's suspension of the use of 2,4,5-T in February 1979. Finally, the report noted that bulk quantities of pesticides were stored in Buildings 616 and 618. These buildings were the supply division warehouses, and contained in excess 500 gallons of unidentified pesticides (Grodt, 1979).

The 1979 installation pest management program report contained a discussion of pest control programs that were currently in operation. Action was being taken to control the rodent population. Anticoagulant poison was used to bait rodent feeding stations along interior walls in Building 362. This same control method was used in Building 383 (Grodt, 1979). Mosquito surveillance had begun on August 1, 1978. The old barracks area and Building 383 were targets of this investigation. Adult mosquitoes were sprayed with 3- and 5- percent concentrations of Malathion, 57 percent EC. Mosquito larvae were also treated with Malathion at a rate of approximately 13 fluid ounces per acre (Grodt, 1979).

Following the pest management program review, the Arsenal adopted a number of the recommendations contained in the report. The drum of Naled was to be repackaged for storage in accordance with the appropriate regulations. Malathion was to be applied in accordance with label directions and Environmental Protection Agency regulations. Pending the construction of a new pest control shop, pesticide rinse water was to be disposed by spraying over a large outdoor area (Mack, 1979).

Another pest management program review was conducted in early 1980. By this time, the construction of a new pest control shop replacing Building 544 had been completed in Building 742. The program review report noted the following: 1) Pesticides stored prior to disposal by the supply division in Buildings 616 and 643 for the most part contained 2,4-D and 2,4-D - 2,4,5-T; 2) The 14-gallon drum containing 85 percent Naled in need of repackaging was being stored in Building 742; and 3) 12 four-pound containers of Wilco Ground Squirrel Bait, use of which was not permitted in Colorado, were being stored in Building 643. It was hoped that the substance could be returned to the manufacturer or transferred to California, where its use was permitted (Grodt, 1980).

During 1980, a new mosquito control program was implemented at the Arsenal. This program was run jointly by Rocky Mountain Arsenal and the City of Denver, Department of Public Health. As a result of this program, adult mosquitoes in areas of vegetation were controlled with a mixture of 2-percent solution of Malathion and 0.12 percent Carbaryl. A 2-percent solution of Malathion was applied to standing water to control larval mosquito development (Grodt, 1980).

In 1981, a further pest management program review was conducted at the Arsenal. The metal drum containing Naled mentioned in the previous review was still present and was being stored in Building 643 (Grodt, 1981). The program review noted the additional problem presented by twenty-two 55-gallon drums containing DDT. These drums were stored in Building 616 pending final disposition by the Army's defense property disposal office. It was recommended that these drums be transferred to Building 643 and stored in accordance with Environmental Protection Agency regulations (Grodt, 1981). In September 1981, the defense property disposal office received all records relating to the stored DDT. On September 18, it reported that the DDT had been sold and that the defense property disposal office was awaiting Environmental Protection Agency clearance to remove the DDT from storage in Building 616 (Heim, 1981).

The mosquito control program, run jointly by the Arsenal and the City of Denver Department of Health, continued in 1981. A mixture of 2 percent Malathion and 0.12 percent Carbaryl was sprayed on vegetation to eliminate adult mosquitoes. A 2-percent solution of Malathion was applied to standing water for larval mosquito control (Grodt, 1981).

The use of herbicides and pesticides was reported by Arsenal personnel on a monthly basis in compliance with Army requirements derived from the 1972 regulation governing the use of herbicides and pesticides. Unfortunately, available records enable the reconstruction of a comprehensive record only for the period 1979 through 1985. During March 1979, Diazinon was used as a residual treatment in residential and warehouse areas to control cockroaches and spiders. Anticoagulants were used to control rodents in some industrial areas. Pyrethrum was used in some warehouse areas to control food pests, and Bromacil-borate Mixture was used in open areas with underbrush for all vegetation (Marlow, 1979a).

In April 1979, Diazinon and Bromacil-borate Mixture were used in the pest control program. Diazinon was used in residual treatments of cockroaches for 2,000 square feet of warehouse space. Bromacil-borate Mixture was used as a sterilant for vegetation on four acres of open field (Marlow, 1979b). During May, mosquitoes were treated with Malathion, and food pests were controlled with Pyrethrum. Diazinon was used in the warehouse areas for other insects (Sutherland, 1979). In June, mosquitoes in various parts of the Arsenal were treated with Carbaryl or Malathion. Bromacil-borate Mixture, Dursban, Timec, and Pyrethrum were also used during this month (Marlow, 1979c).

Carbaryl, Malathion, and Pyrethrum were used during July 1979. These substances were used to control mosquitoes and ants in open, grassy fields and in the warehouse area (Marlow, 1979d). In August, Carbaryl was used at food handling buildings to control ants (Marlow, 1979e).

In September 1979, anticoagulants were used on mice in over 57,000 square feet of warehouse space, 230,000 square feet of industrial space, and 6,000 square feet of office areas and/or food handling areas. In addition, 610,000 cubic feet of warehouse space were treated with Pyrethrum and 9,000 square feet were treated with Diazinon (Marlow, 1979f).

In October 1979, another 610,000 cubic feet of warehouse space were treated with Pyrethrum. Diazinon was used in 11,000 square feet of warehouse space as well. Anticoagulants were spread over 33,000 square feet of office and industrial space. Finally, Bromacil-borate Mixture was used on eight acres of open, grassy fields to control all vegetation (Marlow, 1979g).

Anticoagulants were used in November and December 1979, to control mice in 27,000 square feet of industrial space and 3,000 square feet of office space. Bromacil-borate Mixture was spread over 12 acres of grassy, open field to control all vegetation (Marlow, 1979h; Marlow, 1980a).

From January through April 1980, anticoagulants to control mice were used on 90,000 square feet of warehouse space and 12,000 square feet of industrial area. Diazinon was used on 8,000 square feet of warehouse area and 1,000 square feet of food-handling space. In addition, Bromacil-borate Mixture was used to control all vegetation on an acre of open, grassy field during January, February, and March. During March 1980, 2,000 square feet of office space were treated with Carbaryl, and 610,000 cubic feet of warehouse area were treated with Pyrethrum to control food pests (Marlow, 1980b; Marlow, 1980c; Marlow, 1980d; Marlow, 1980e).

In June 1980, anticoagulants were used to control mice in 37,000 square feet of warehouse space and 12,000 square feet of industrial area. Carbaryl was spread over 15 acres of open, grassy field to control mosquitoes and five acres of the same terrain to eliminate leaf-chewing insects. Warehouse areas totaling 4,000 square feet were sprayed with Diazinon as were 2,000 square feet of residential area. In addition, Diquat was sprayed, by hand, over eight acres of a surface impoundment to control aquatic weeds. Malathion was spread over open, grassy fields totaling 125 acres to control mosquitoes and culicoids. Finally, four acres of surface impoundment were treated for mosquitoes with Naled, and zinc phosphite was used on four acres of open, grassy field to control prairie dogs (Marlow, 1980f).

During July 1980, mice were controlled by placing anticoagulants in bait covering 18,000 square feet of warehouse space. Also, Carbaryl was used to combat leaf-chewing insects on two acres of open, grassy field, and Diazinon was used to treat 2,000 square feet of warehouse space and 2,000 square feet of residential area. Malathion was used to control culicoids on 177 acres of open, grassy field. The herbicide Borate-2,4-D was used on five acres of similar terrain (Marlow, 1980g).

In August 1980, anticoagulants again were used to combat mice in 48,000 square feet of industrial area and 3,000 square feet of office space. Herbaceous, broad-leaf weeds were controlled on three acres of open, grassy field through the use of Borate-2,4-D. Malathion was spread over thirty-five acres of the same terrain to eliminate culicoids, and Bromacil-borate Mixture was spread over one acre to control all vegetation (Sutherland, 1980).

During September 1980, Diquat was employed to control aquatic weeds in a ten-acre area of A warehouse area totaling 2,000 square feet was treated with Diazinon to eliminate food pests. Finally, 54,000 square feet of warehouse area and 45,000 square feet of industrial area were treated with anticoagulants used in bait for mice (Marlow, 1980h).

In October 1980, warehouse areas totaling 1,280,000 cubic feet were fumigated with Pyrethrum to eliminate food pests. Cockroaches were controlled with Diazinon in 2,000 square feet of both industrial and warehouse areas. Bromacil-borate Mixture was sprayed over seven acres of open, grassy field to control all vegetation. Finally, Borate-2,4-D was sprayed over 34 acres of similar terrain to eliminate herbaceous, broad-leaf weeds, and Diquat was used against aquatic weeds (Marlow, 1980i).

In November 1980, anticoagulants in mice bait were used in 102,000 square feet of industrial space, 99,000 square feet of warehouse area, and 3,000 square feet of both office and food-handling areas. In December, 45,000 square feet of industrial areas and 12,000 square feet of warehouse areas were treated. In addition, vegetation was controlled in open, grassy fields with Bromacil-borate Mixture. During each month, three acres were treated. Finally, Diazinon was used to eliminate spiders in 7,000 square feet of warehouse space (Marlow, 1980j; Marlow, 1981a).

In February 1981, anticoagulants were used on 84,000 square feet of warehouse space and 42,000 square feet of industrial area. Vegetation on one acre of open, grassy field was controlled with Bromacil-borate Mixture, and Diazinon was used to treat 9,000 square feet of warehouse space and 1,000 square feet of industrial area (Marlow, 1981b). No activity was reported during March, and there were only limited projects during April. In this month, vegetation on eight acres of open, grassy fields was controlled with Bromacil-borate Mixture, and grassy weeds were controlled on three acres of the same terrain using DCPA (2,3,5,6-tetrachloroterephthalic acid). Finally, 6,000 square feet of warehouse space were treated with Diazinon (Marlow, 1981c).

During May 1981, twelve acres of open, grassy terrain were treated with Carbaryl and Malathion to eliminate mosquitoes. Diazinon was used on 1,000 square feet of residential area, 8,000 square feet of warehouse area, 3,000 square feet of industrial area, and one acre of open, grassy field. Anticoagulants in mice bait were placed on 3,000 square feet of residential space, and 610,000 cubic feet of warehouse space were sprayed with Pryethrum. Finally, Borate-2,4-D was spread over one acre of open, grassy field to control broad-leaf weeds (Marlow, 1981d).

During June 1981, anticoagulants were used again in mice bait. Warehouse areas totaling 105,000 square feet were treated in this manner. Also, Carbaryl and Malathion were used on 48 acres of open, grassy field to control leaf-chewing insects and culicoids. Diazinon was used on 2,000 square feet of office space, and warehouse space totaling 5,000 square feet. Finally, 640,000 cubic feet of office space were sprayed with Pyrethrum to control moths, and Borate-2,4-D was used to control broad-leaf weeds on seven acres of open, grassy field (Marlow, 1981e).

In July 1981, 15,000 square feet were treated for mice with anticoagulants. Carbaryl, to combat leaf-chewing insects, and Malathion, to get rid of culicoids, were spread over 36 acres of open, grassy field. The herbicide Borate-2,4-D was spread on three acres of similar terrain, and Diazinon was used on 12,000 square feet of warehouse space. Finally, Diquat was used to combat aquatic weeds on the surface impoundment, and 1,240,000 cubic feet of warehouse area were treated with Pyrethrum to control food pests (Marlow, 1981f).

Pest control activities during August and September were similar. During these two months, mice were controlled with anticoagulants in 79,000 square feet of industrial space and 9,000 square feet of office space. Diazinon was used against ants, cockroaches, and spiders in 7,000 square feet of warehouse area, 2,000 square feet of office area, and 2,000 square feet of industrial space. Finally, in September, Pyrethrum was used on 640,000 cubic feet of warehouse space to control food pests (Marlow, 1981g; Marlow, 1981h).

During October 1981, anticoagulants were used to eliminate mice in 21,000 square feet of industrial area and 90,000 square feet of warehouse space. Calcium cyanide was spread over 25 acres of open, grassy field to control prairie dogs. Three acres of similar terrain were treated with 2,4-D to control broad-leaf weeds. Also, Carbaryl and Malathion were applied to an additional four acres to combat culicoids. Finally, Diazinon was used on warehouse space totaling 8,000 square feet and 1,000 square feet of residential area (Marlow, 1981i).

In November 1981, 120,000 square feet of industrial area and 45,000 square feet of warehouse space were treated with anticoagulants. Mice were controlled on 31,000 square feet of open, grassy field, 21,000 square feet of warehouse space, and 15,000 square feet of industrial space with the same substance in the following month. Bromacil-borate Mixture was used on four acres of open, grassy field to control all vegetation. Calcium cyanide was used on 33 acres of the same terrain to combat prairie dogs. Finally, Diazinon was used to control spiders in warehouse areas totaling 24,000 square feet (Marlow, 1981j; Marlow, 1981k).

Between January and May 1982, pest control activities were directed primarily at mice and spiders. Anticoagulants were used to control mice on 225,000 square feet of warehouse space, 51,000 square feet of industrial area, 9,000 square feet in food-handling buildings, and 30 acres of open, grassy fields. Spiders were controlled with Diazinon in 48,000 square feet of warehouse space, 2,000 square feet of food handling space, and 2,000 square feet of residential area. In addition to these projects, Bromacil-borate Mixture was spread over nine acres of open, grassy field to control all vegetation. Also, Diazinon, was used to combat ants on 2,000 square feet of both industrial and food-handling areas (Marlow, 1982a; Marlow, 1982b; Marlow, 1982c; Marlow, 1982d).

During June 1982, food pests were sprayed with Pyrethrum in a warehouse area encompassing 90,000 cubic feet. Various insects were treated with Diazinon in 19,000 square feet of warehouse space, 3,000 square feet of industrial space, and 2,000 square feet in food-handling buildings, residential areas, and office space. Malathion and Carbaryl were used on 11 acres of open, grassy fields to combat culicoids and on one acre to combat mice. Malathion was also used on 10 acres of surface impoundment against mosquitoes. Finally, calcium cyanide was used to control prairie dogs on four acres of open, grassy field (Marlow, 1982e).

During July 1982, Roundup, an uncombined herbicide, was spread over three acres and 12,000 square feet of open, grassy field to combat grassy weeds. Anticoagulants were used on 6,000 square feet of both industrial and residential areas. Two acres of open, grassy fields were treated with Malathion and Carbaryl to eliminate culicoids. One acre of similar terrain was sprayed with Bromacil-borate Mixture to control all vegetation. Also, aquatic weeds in eight acres of the surface impoundment were treated with Diquat. Finally, Pyrethrum was used on 132,000 cubic feet of warehouse space, and Diazinon was used on 4,000 square feet of warehouse space (Marlow, 1982f).

No pest control reports have been located for August through November 1982. However, a command health report for November states that pest control activities during that month emphasized weed control, mice baiting, and spider and cockroach control through the use of Diazinon (Lewis, 1982). In December, anticoagulants were used to control mice in 9,000 square feet of industrial areas and 12,000 square feet of warehouse space. Also, Diazinon was used on 17,000 square feet of warehouse space to eliminate spiders (Marlow, 1983a).

During January 1983, 18,000 square feet of warehouse space were treated with anticoagulants, and Diazinon was used on 5,000 square feet of warehouse space to control spiders and termites (Marlow, 1983b; Smith, 1983). During the next two months, more pesticide use was reported. In February, 148,000 square feet of industrial space and 33,000 square feet of warehouse space were treated with anticoagulants. Diazinon was used on 14,000 square feet of warehouse area and 1,000 square feet in food-handling buildings. Vegetation on two acres of open, grassy fields was treated with Bromacil-borate Mixture, and zinc phosphide was used on three acres to control prairie dogs (Unauthored, 1983). During March, Diazinon was used on 3,000 square feet of warehouse space. Mice were controlled with anticoagulants spread throughout 42,000 square feet of industrial space and 3,000 square feet of warehouse area. Strychnine was also used to eradicate mice over a four-acre plot of open, grassy field (Marlow, 1983c).

In April 1983, strychnine and anticoagulants again were used to control mice. Strychnine was applied to three acres, and anticoagulants were applied to 15 acres of open, grassy fields.

Anticoagulants were also applied to 15,000 square feet of industrial space and 66,000 square feet of warehouse space. Diazinon was used to control ants within 1,000 square feet of industrial areas. Finally, five acres of land were treated with zinc phosphide to control prairie dogs, and Bromacil-borate Mixture was used to control all vegetation on one acre of open, grassy field (Marlow, 1983d).

During May 1983, two plus acres of open field were treated with Diquat to reduce grassy weeds. Herbicide 2,4-D was applied to 39 acres of similar terrain to eliminate broad-leafed weeds. Malathion and Phostoxin[16] were spread on four acres of land to control culicoids and prairie dogs, respectively. Diazinon use during this period included treatment of 16,000 square feet of warehouse space and 1,000 square feet each in industrial areas and food-handling areas. Finally, Pyrethrum was used in warehouse areas, and anticoagulants were used in 3,000 square feet of industrial space to control mice (Marlow, 1983e).

In June 1983, anticoagulants were used to eliminate mice in 6,000 square feet of residential areas and 8,000 square feet of warehouse space. Diazinon was used in 15,000 square feet of warehouse space, 1,000 square feet of food-handling areas, and 14 acres of open, grassy fields. In addition, one acre of land was treated with aluminum phosphide to control prairie dogs, Bromacil-borate Mixture was used on three acres to control all vegetation, Malathion was used on seven acres, and Diquat was spread over five acres to control grassy weeds. Finally, 30 acres of similar terrain were treated with 2,4-D to eradicate broad-leaf weeds (Marlow, 1983f).

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[16] A rodenticide, produced by Degesch America Incorporated, Weyers Cave, Virginia, consisting of 55 percent aluminum phosphide and inert substances for the remainder (Mack, 1985a; Polchow, 1982). Approval to use Phostoxin was issued on August 8, 1983 (Marten, 1983).

During July, the Army emphasized the treatment of open grassy fields on the Arsenal. Ten acres were treated with Malathion, 24 acres were treated with Borate-2,4-D, and six acres were treated with Diquat. In addition, Carbaryl was used on 20 acres to control leaf-chewing insects, Phostoxin was used on five acres for prairie dogs, and Bromacil-borate Mixture was sprayed on two acres to control vegetation. Other pest control activities included the application of Diazinon in warehouse areas totaling 13,000 square feet. Another 63,000 square feet were treated with anticoagulants, and 230,000 cubic feet of warehouse space were treated with Pyrethrum to control food pests (Marlow, 1983g).

In August 1983, mice were eradicated by using anticoagulants in warehouse areas encompassing 33,000 square feet. Pyrethrum was used to kill cockroaches in 435,000 cubic feet of warehouse space. Diazinon was used in 11,000 square feet of warehouse space, 2,000 square feet of food handling areas, and 1,000 square feet of residential space. In addition, 11 acres of open, grassy fields were treated for leaf-chewing insects with Carbaryl, 18 acres were treated with Borate-2,4-D for broad-leaf weeds, and two acres were treated with Diquat. Finally, six acres of the same terrain were treated with Phostoxin to eliminate prairie dogs. Malathion was used on five acres (Marlow, 1983h).

During the final four months of 1983, aluminum phosphide was used to control prairie dogs on 18 acres of open, grassy field. Diazinon was used on 25,000 square feet of warehouse space, 2,000 square feet of industrial space, 1,000 square feet of food-handling areas, and 2,000 square feet of hospital or laboratory areas to eliminate cockroaches. In addition, Pyrethrum was used on 64,000 square feet of both warehouse and food-handling areas. Anticoagulants were used to control mice on 120,000 square feet of warehouse space, 54,000 square feet of industrial areas, 18,000 square feet of food-handling areas, and 3,000 square feet of both office and hospital or laboratory areas. Finally, anticoagulants were used on 16 acres of open, grassy fields. Borate-2,4-D was used on eight acres, and Phostoxin was used on four acres of the same terrain (Marlow, 1983i; Marlow, 1983j; Marlow, 1983k; Marlow, 1984a).

In the winter and early spring of 1984, anticoagulants once again were used to control mice throughout various parts of the Arsenal. Approximately 183,000 feet of warehouse space were treated, as were 66,000 square feet of industrial areas, 15,000 square feet of food-handling areas, and 42 acres of open, grassy fields. Diazinon was used on 39,000 square feet of warehouse areas and 3,000 square feet of food-handling areas. Finally, vegetation on four acres of land was treated with the herbicide Hyvarx, and an additional two acres were treated with Bromacil-borate Mixture (Marlow, 1984b; Unauthored, 1984a; Unauthored, 1984b; Unauthored, 1984c).

During May 1984, the focus of activity was the treatment of open, grassy fields. Malathion was sprayed on 18 acres, Diazinon was applied to seven acres, and Phostoxin was used to combat prairie dogs on four acres. All vegetation on a four-acre plot was treated with Bromacil-borate Mixture. In addition, Diquat was used on six acres to control aquatic weeds, Borate - 2,4-D was used on broad-leaf weeds covering 114 acres, and 2,4-D - 2,4,5-T was used on 70 acres. Finally, Trifluralin was applied to 13 acres, 2,4-D was used on 40 acres, and the combined herbicide, Diquat - 2,4-D, was used to treat an additional 12,000 square feet of the same terrain. Other pest control activities during the month included the use of Diazinon on 3,000 square feet of warehouse space. Pyrethrum was used on 120,000 cubic feet of warehouse space and 120,000 cubic feet of food-handling area (Unauthored, 1984d).

No pest control activity was reported for June and July 1984. Control programs resumed in August. During this month, anticoagulants were used to control mice in 15,000 square feet of warehouse space. Diazinon was applied to 1,000 square feet of food-handling areas, 4,000 square feet of warehouse space, and 1,000 square feet of office space. Pyrethrum was used on 135,000 cubic feet of warehouse space. Eight acres of open, grassy fields were treated with Malathion and Carbaryl for leaf-chewing insects and culicoids. Bromacil-borate Mixture was used on five and a half acres and 2,4-D was used on 24 acres to control culicoids. Chlordane, to control ants, was applied to an additional 800,000 square feet of the same terrain, and anticoagulants were applied to 15,000 square feet (Unauthored, 1984e).

During the last four months of 1984, anticoagulants were used on 126,000 square feet of warehouse space, 15,000 square feet of office space, 84,000 square feet of industrial areas, 6,000 square feet of food-handling areas, and five acres and 30,000 square feet of open, grassy terrain. In addition, food pests were treated with Pyrethrum in 120,000 cubic feet of warehouse space. Diazinon was used on 31,000 square feet of warehouse space and 1,000 square feet of food-handling areas. Finally, Phostoxin was sprayed over three acres of open, grassy fields to control prairie dogs (Unauthored, 1984f; Unauthored, 1984g; Unauthored, 1984h; Unauthored, 1984i).

Between February 22, 1984, and February 29, 1984, the Army conducted a pest management program review to evaluate the installation management program and to provide recommendations for improving program effectiveness and correcting any attendant health and environmental problems. The program review report noted that as of the date of the program review, pesticides were being stored at three locations on Rocky Mountain Arsenal: Building 742 (pest control shop), Building 643 (supply storage), and Shed 1 of Plot

3 of the Toxic Storage Yard. The herbicides and pesticides kept in Building 743 were housed in separate rooms which were dry, secure, fire resistive, curbed, and ventilated. The pest control shop was used for mixing purposes in addition to storage. Building 643 was used to store excess pesticides and was dry, secure, and fire resistive, but not suitable for pesticide storage due to a lack of ventilation. Shed 1 of Plot 3 of the Toxic Storage Yard was used for excess inventory storage. Pesticide inventories taken during the 1984 program review may be found in Tables VIII and IX of Appendix B which follows this report (Farlow, 1984).

During the first three months of 1985, anticoagulants were used on 12,000 square feet of warehouse space, 6,000 square feet of industrial area, and 23 acres of open, grassy fields to eradicate mice. In addition, approximately 15 acres of land were treated with Phostoxin to control prairie dogs. Four acres were treated with Trifluralin to eliminate grassy and broad-leaf weeds. Finally, Diazinon was used on 12,000 square feet of warehouse area to control spiders (Unauthored, 1985a; Unauthored, 1985b; Unauthored, 1985c).

In April 1985, trifluralin was used on six acres of open, grassy fields, and Bromacil was used on 48 acres to control all vegetation. Broad-leaf weeds on 151 acres were sprayed with Dicamba and Borate-2,4-D. Bromacil-borate was used on three and a half acres for vegetation, and prairie dogs were controlled on 120 acres with Phostoxin. Finally, Diazinon was used on 4,000 square feet of warehouse space, and anticoagulants were used to control mice on 30,000 square feet of warehouse space (Unauthored, 1985d).

In May of 1985, Banvel- 2,4-D was applied to 129 open, grassy acres to control the growth of broad-leaf weeds, while five acres were treated with Diquat to suppress the growth of mixed grassy and broad-leaf weeds. Additionally, Dalapon was used on five acres of open land for grassy weeds and Dicamba - 2,4-D was sprayed manually over 380 acres to herbaceous broad-leaf weeds. Phostoxin was also used in May of 1985 to combat the prairie dog population on 75 open, grassy acres of Rocky Mountain Arsenal (Unauthored, 1985e).

During June of 1985, Dicamba - 2,4-D was sprayed with power equipment over 233 open, grassy acres in an effort to control weeds. Phostoxin was applied to 60 acres of open, grassy land to combat prairie dogs at the Arsenal (Unauthored, 1985f).

The month of July 1985 saw continued use of Dicamba - 2,4-D for weed control over 60 open, grassy acres. Anticoagulant and Pyrethrum were used to control mice and other food pests within 40,000 square feet and 64,000 cubic feet of warehouse space, respectively. Mosquitoes were treated with Malathion over ten open, grassy acres (Unauthored, 1985g).

In August of 1985, Diazinon was sprayed in 7,000 square feet of industrial space, anticoagulants were utilized to control mice in 5,000 square feet of industrial space, and Pyrethrum was applied to 12,000 square feet of industrial space to wipe out roaches. Finally, 30 open, grassy acres at Rocky Mountain Arsenal received Phostoxin to help eliminate prairie dogs (Unauthored, 1985h).

In September of 1985, Diazinon was used for wasp and bee eradication in 1,000 square feet of warehouse space, as well as spider control over 21,000 square feet of open, grassy land. Anticoagulants were employed for mice control in 216,000 square feet of warehouse space, while Phostoxin was sprayed over 30 open, grassy acres to combat prairie dogs (Unauthored, 1985i).

During October 1985, anticoagulants were used as bait in 103,000 square feet of warehouse space to control mice. Diazinon was applied to 2,000 square feet of warehouse space for ant and spider prevention, and also to 26,000 square yards of warehouse space to handle wasps and bees (Unauthored, 1985j).

In November 1985, 63,000 square feet of warehouse area were treated with Pyrethrum to control miscellaneous food pests. In addition, Diazinon was used as a residual treatment over 2,000 square feet of warehouse space for spider control. Lastly, 247,000 square feet of warehouse space were baited with anticoagulant to eradicate mice (Unauthored, 1985k).

In January 1986, an inventory of herbicides, rodenticides, and pesticides stored in the Building 742 pest control shop was conducted. The results of the inventory can be found in Table X of Appendix B which follows this report (Marlow, 1986).

In April 1987, the administrators at Rocky Mountain Arsenal were contemplating the implementation of another prairie dog control program to begin in August or September of 1987, and an additional program providing for the spraying of mosquitoes starting in May of 1987 and continuing throughout the summer. As planned, the prairie dog control program was to focus on the following areas:

1) Old barracks area and fire station;
2) The club and swimming pool area, and the western south plants area;
3) The logistics area;
4) The rifle range, reserve center, and picnic area;

5) The air force building and construction area;

6) Three-quarters of a mile from the north and western boundaries;

7) Fifty feet along Seventh Avenue on both sides from Quebec to "D" Street; and

8) Sixty feet on both sides of "B" Street, "C" Street, and "D" Street from Seventh Avenue to the north boundary.

The mosquito control program would concentrate on the South Lakes area, Section 20 and certain other unidentified areas of the Arsenal (Demarest and Lovell, 1987; Heim, 1987).

Documents and records necessary to a reconstruction of Army pest and vegetation control operations and herbicide and pesticide usage after 1987 were not available to the authors of this study. During the periods covered by this report, the Army used numerous substances in a variety of ways to control vegetation growth, reduce the presence of insects adn rodents and to control the fish and prairie dog populations at the Arsenal. In retrospect, the application of these substances appears to have fallen squarely within the parameters of normal usage during the periods covered.

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APPENDICES

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APPENDIX A

TABLE I

Documented Quantities of Herbicides, Pesticides, and Insecticides Used at Rocky Mountain Arsenal[1]

SUBSTANCE	YEAR	QUANTITY	REFERENCES
2,4-D	1964	450 pounds	(Asai, 1964; Flucke, 1964)
	1966	250 pounds	(Krenzer and Morkovsky, 1966)
	1968	370 pounds	(Ammon, 1967-1968)
	1983	4,325 gallons	(Marlow, 1983e; Marlow, 1983f)
	1984	2,950 gallons	(Unauthored, 1984d; Unauthored, 1984e)
2,4-D-2,4,5-T	1984	1,900 gallons	(Unauthored, 1984d)
Aluminum phosphide	1983	16 pounds	(Marlow, 1983f; Marlow, 1983i)
Anticoagulant	1979	91 pounds	(Marlow, 1979a; Marlow, 1979f; Marlow, 1979g; Marlow, 1979h; Marlow, 1980a)
	1980	193 pounds	(Marlow, 1980b; Marlow, 1980c; Marlow, 1980f-j; Marlow, 1981a; Sutherland, 1980)
	1981	233 pounds	(Marlow, 1981b; Marlow, 1981d; Marlow, 1981e-k)

[1]The above-furnished quantities represent actual substances used at Rocky Mountain Arsenal as quantified in the historical database.

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SUBSTANCE	YEAR	QUANTITY	REFERENCES
	1982	114 pounds	(Marlow, 1982a-d; Marlow, 1982f; Marlow, 1983a)
	1983	253 pounds	(Marlow, 1983b-k)
	1984	209 pounds	(Marlow, 1984a-b; Unauthored, 1984a-h)
	1985	105 pounds	(Unauthored, 1985a-d; Unauthored, 1985g-k)
Banvel-2,4-D	1985	2,200 gallons	(Unauthored, 1985e)
Borate-2,4-D	1980	1,350 gallons	(Marlow, 1980g; Marlow, 1980i; Sutherland, 1980)
	1981	528 gallons	(Marlow, 1981d-f; Marlow, 1981i)
	1983	5,150 gallons	(Marlow, 1983g-k)
	1984	4,000 gallons	(Unauthored, 1984d)
	1985	2,300 gallons	(Unauthored, 1985d)
Bromacil	1985	854 gallons	(Unauthored, 1985d)
Bromacil-borate	1979	2,800 pounds	(Marlow, 1979a-c; Marlow, 1979g; Marlow, 1979h; Marlow, 1980a)
	1980	1,726 pounds	(Marlow, 1980b-d; Marlow, 1980i; Marlow, 1980j; Marlow, 1981a; Sutherland, 1980)
	1981	1,300 pounds	(Marlow, 1981b; Marlow, 1981c; Marlow, 1981j)
	1982	1,000 pounds	(Marlow, 1982a-d; Marlow, 1982f)

SUBSTANCE	YEAR	QUANTITY	REFERENCES
	1983	4,900 pounds	(Unauthored, 1983; Marlow, 1983d; Marlow, 1983f; Marlow, 1983g; Marlow, 1983i; Marlow, 1983j)
	1984	424 gallons	(Unauthored, 1984c; Unauthored, 1984f; Unauthored, 1984g)
		1,850 pounds	(Unauthored, 1984d; Unauthored, 1984e)
	1985	150 pounds	(Unauthored, 1985d)
Calcium cyanide	1981	68 pounds	(Marlow, 1981i; Marlow, 1981j)
	1982	20 pounds	(Marlow, 1982e)
Carbaryl	1976	3,200 pounds	(RMA, 1976)
	1979	3,940 gallons	(Marlow, 1979c-e)
	1980	352 gallons	(Marlow, 1980d-g)
	1981	2,500 gallons	(Marlow, 1981d-f; Marlow, 1981i)
	1982	450 gallons	(Marlow, 1982e; Marlow, 1982f)
	1983	2,450 gallons	(Marlow, 1983g; Marlow, 1983h)
	1984	200 gallons	(Unauthored, 1984e)
Chlordane	1984	11 gallons	(Unauthored, 1984e)
Copper sulfate	1943	300 pounds	(CWS, 1945)
DCPA	1981	80 pounds	(Marlow, 1981c)
Dalapon	1985	100 gallons	(Unauthored, 1985e)

SUBSTANCE	YEAR	QUANTITY	REFERENCES
Diazinon	1979	35 gallons	(Marlow, 1979a; Marlow, 1979b; Marlow, 1979f; Marlow, 1979g; RMA, 1952c; Sutherland, 1979)
	1980	34 gallons	(Marlow, 1980b-j)
	1981	105 gallons	(Marlow, 1981b-d; Marlow, 1981f-k)
	1982	105 gallons	(Marlow, 1982a-f; Marlow, 1983a)
	1983	1,468 gallons	(Marlow, 1983b-k; Marlow, 1984a)
	1984	783 gallons	(Marlow, 1984b; Unauthored, 1984a; Unauthored, 1984c-f; Unauthored, 1984h)
	1985	45 gallons	(Unauthored, 1985a-d; Unauthored, 1985h-k)
Dicamba	1985	2,300 gallons	(Unauthored, 1985d)
Dicamba-2,4-D	1985	10,200 gallons	(Unauthored, 1985e-g)
Diquat-2,4-D	1980	120 gallons	(Marlow, 1980f; Marlow, 1980h; Marlow, 1980i)
	1981	35 gallons	(Marlow, 1981f)
	1982	750 gallons	(Marlow, 1982f)
	1983	1,418 gallons	(Marlow, 1983e-g)
	1984	600 gallons	(Unauthored, 1984d)
	1985	100 gallons	(Unauthored, 1985e)
Dursban	1979	250 pounds	(Marlow, 1979c)
Hyvarx	1984	630 gallons	(Unauthored, 1984c)
Malathion	1964	30 pints	(Asai, 1964; Flucke, 1964)

SUBSTANCE	YEAR	QUANTITY	REFERENCES
	1966	500 pounds	(Krenzer and Morkovsky, 1966)
	1979	3,940 gallons	(Marlow, 1979c; Marlow, 1979d; Sutherland, 1979)
	1980	4,700 gallons	(Marlow, 1980f; Marlow, 1980g; Sutherland, 1980)
	1981	2,500 gallons	(Marlow, 1981d-f; Marlow, 1981i)
	1982	925 gallons	(Marlow, 1982e; Marlow, 1982f)
	1983	2,300 gallons	(Marlow, 1983e-g)
	1984	2,250 gallons	(Unauthored, 1984d; Unauthored, 1984e)
	1985	350 gallons	(Unauthored, 1985g)
Naled	1980	200 gallons	(Marlow, 1980f)
Phostoxin	1983	35 pounds	(Marlow, 1983e; Marlow, 1983g; Marlow, 1983j)
	1984	28 pounds	(Unauthored, 1984d; Unauthored, 1984e; Unauthored, 1984g)
	1985	831 pounds	(Unauthored, 1985a-f; Unauthored, 1985h-k)
Pyrethrum	1979	6 gallons	(Marlow, 1979a; Marlow, 1979c; Marlow, 1979d; Marlow, 1979f; Marlow, 1979g; RMA, 1952c; Sutherland, 1979)
	1980	2 gallons	(Marlow, 1980b-e; Marlow, 1980i)
	1981	4 gallons	(Marlow, 1981d-f; Marlow, 1981h)
	1982	2 gallons	(Marlow, 1982e; Marlow, 1982f)

SUBSTANCE	YEAR	QUANTITY	REFERENCES
	1983	10 gallons	(Marlow, 1983e; Marlow, 1983f-k)
	1984	4 gallons	(Marlow, 1983i; Marlow, 1983k; Unauthored, 1984d-f)
	1985	3 gallons	(Unauthored, 1985g; Unauthored, 1985h; Unauthored, 1985k)
Rotenone	1970	50 pounds	(Mullan, 1975c)
Roundup	1982	287 gallons	(Marlow, 1982f)
Strychnine	1983	35 pounds	(Marlow, 1983c; Marlow, 1983d)
Tirec	1979	4 gallons	(Marlow, 1979c)
Trifluralin	1984	1,100 pounds	(Unauthored, 1984d)
	1985	460 pounds	(Unauthored, 1985d)
Ureabor	1956	7,300 pounds	(RMA, 1956a; RMA, 1956b)
	1957	33,700 pounds	(RMA, 1957a; RMA, 1957b)
	1960	8,000 pounds	(RMA, 1960a; RMA, 1960b)
	1961	10,000 pounds	(RMA, 1961)
	1962	72,000 pounds	(RMA, 1962a; RMA, 1962c)
	1976	200 pounds	(Johnston, 1976; Phillips, 1976)
Zinc phosphide	1980	7 pounds	(Marlow, 1980f)
	1983	50 pounds	(Marlow, 1983d; Unauthored, 1983)

TABLE II

Herbicides and Pesticides Used at Rocky Mountain Arsenal in Unknown Quantities

SUBSTANCE	YEAR	REFERENCES
2,4-D	1950	(Chemical Corps, 1950)
	1954	(RMA, 1954; Shogren, 1977, p. 31)
	1965	(Clevenger, 1965)
2,4,5-T	1965	(Clevenger, 1965)
Bordeaux mixture	1957	(USAEHL, 1957)
Chlordane	1950	(Chemical Corps, 1950)
	1957	(USAEHL, 1957)
	1959	(Ledwell, 1959)
	1961	(Vining, 1961)
Crystalline copper sulfate (Blue Vitriol)	1944	(CWS, 1945)
	1945	(CWS, 1945)
DDT	1945	(Mnookin et al., 1945)
	1946	(McLaughlin et al., 1946)
	1948	(Harbaugh, 1948)
	1957	(USAEHL, 1957)
	1959	(Ledwell, 1959)
	1961	(Vining, 1961)
	1950s and 1960s	(Mitchell, 1986)
Dieldrin	1957	(USAEHL, 1957)

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SUBSTANCE	YEAR	REFERENCES
Dowpon	1965	(Clevenger, 1965)
Hydrogen cyanide	1957	(RMA, 1957a-b)
Isopropyl ester of 2,4-D	1955	(RMA, 1955a; RMA, 1955b)
Karmex (Diuron)	1968	(Bartschi, 1968; Unauthored, 1968)
Lead arsenate	1957	(USAEHL, 1957)
Lindane	1959	(Ledwell, 1959)
	1961	(Vining, 1961)
Malathion	1957	(USAEHL, 1957)
	1959	(Ledwell, 1959)
	1961	(Vining, 1961)
	1978	(Grodt, 1979)
Nicotine sulfate	1957	(USAEHL, 1957)
"Oil"	1944	(Shaw *et al*., 1944)
	1947	(McLaughlin, 1947)
Organic phosphates	1977	(Shogren, 1977)
Paris Green	1944	(Shaw *et al*., 1944)
"Rat poison"	1944	(Holaday *et al*., 1944)
Rotenone	1974	(Donnelly, 1974; Mullan, 1975a-c)
Sodium arsenite	1962	(RMA, 1962a-b)
Sodium fluoracetate	1955	(RMA, 1955a-b)
	1957	(USAEHL, 1957)
Thallium sulfate	1957	(USAEHL, 1957)
Ureabor	1958	(RMA, 1958a-d)
	1959	(RMA, 1959a-c)
Warfarin	1957	(USAEHL, 1957)

TABLE III

Pesticides and Herbicides Used at Rocky Mountain Arsenal: Consolidated Data[1]

SUBSTANCE	YEAR	REFERENCES
2,4-D	1950	(Chemical Corps, 1950)
	1954	(RMA, 1954; Shogren, 1977, p. 31)
	1964	(Asai, 1964; Flucke, 1964)
	1965	(Clevenger, 1965)
	1966	(Krenzer and Morkovsky, 1966)
	1968	(Ammon, 1967-1968)
	1983	(Marlow, 1983e; Marlow, 1983f)
	1984	(Unauthored, 1984d; Unauthored, 1984e)
2,4-D - 2,4,5-T	1984	(Unauthored, 1984d)
2,4,5-T	1965	(Clevenger, 1965)
Aluminum phosphide	1983	(Marlow, 1983f; Marlow, 1983i)
Anticoagulant	1979	(Marlow, 1979a; Marlow, 1979f; Marlow, 1979g; Marlow, 1979h; Marlow, 1980a)
	1980	(Marlow, 1980b; Marlow, 1980c; Marlow, 1980f-j; Marlow, 1981a; Sutherland, 1980)

[1]This table lists all pesticides and herbicides identified in Tables I and II of Appendix A.

SUBSTANCE	YEAR	REFERENCES
	1981	(Marlow, 1981b; Marlow, 1981d; Marlow, 1981e-k)
	1982	(Marlow, 1982a-d; Marlow, 1982f; Marlow, 1983a)
	1983	(Marlow, 1983b-k)
	1984	(Marlow, 1984a-b; Unauthored, 1984a-h)
	1985	(Unauthored, 1985a-d; Unauthored, 1985g-k)
Banvel-2,4-D	1985	(Unauthored, 1985e)
Borate-2,4-D	1980	(Marlow, 1980g; Marlow, 1980i; Sutherland, 1980)
	1981	(Marlow, 1981d-f; Marlow, 1981i)
	1983	(Marlow, 1983g-k)
	1984	(Unauthored, 1984d)
	1985	(Unauthored, 1985d)
Bordeaux mixture	1957	(USAEHL, 1957)
Bromacil	1985	(Unauthored, 1985d)
Bromacil-borate	1979	(Marlow, 1979a-c; Marlow, 1979g; Marlow, 1979h; Marlow, 1980a)
	1980	(Marlow, 1980b-d; Marlow, 1980i; Marlow, 1980j; Marlow, 1981a; Sutherland, 1980)
	1981	(Marlow, 1981b; Marlow, 1981c; Marlow, 1981j)
	1982	(Marlow, 1982a-d; Marlow, 1982[illegible])

SUBSTANCE	YEAR	REFERENCES
	1983	(Unauthored, 1983; Marlow, 1983d; Marlow, 1983f; Marlow, 1983g; Marlow, 1983i; Marlow, 1983k)
	1984	(Unauthored, 1984c; Unauthored, 1984f; Unauthored, 1984g)
		(Unauthored, 1984d; Unauthored, 1984e)
	1985	(Unauthored, 1985d)
Calcium cyanide	1981	(Marlow, 1981i; Marlow, 1981j)
	1982	(Marlow, 1982e)
Carbaryl	1976	(RMA, 1976)
	1979	(Marlow, 1979c-e)
	1980	(Marlow, 1980d-g)
	1981	(Marlow, 1981d-f; Marlow, 1981i)
	1982	(Marlow, 1982e; Marlow, 1982f)
	1983	(Marlow, 1983g; Marlow, 1983h)
	1984	(Unauthored, 1984e)
Chlordane	1950	(Chemical Corps, 1950)
	1957	(USAEHL, 1957)
	1959	(Ledwell, 1959)
	1961	(Vining, 1961)
	1984	(Unauthored, 1984e)
Copper sulfate	1943	(CWS, 1945)

SUBSTANCE	YEAR	REFERENCES
Crystalline copper sulfate (Blue Vitriol)	1944	(CWS, 1945)
	1945	(CWS, 1945)
DCPA	1981	(Marlow, 1981c)
DDT	1945	(Mnookin *et al.*, 1945)
	1946	(McLaughlin *et al.*, 1946)
	1948	(Harbaugh, 1948)
	1957	(USAEHL, 1957)
	1959	(Ledwell, 1959)
	1961	(Vining, 1961)
	1950s and 1960s	(Mitchell, 1986)
Dalapon	1985	(Unauthored, 1985e)
Diazinon	1979	(Marlow, 1979a; Marlow, 1979b; Marlow, 1979f; Marlow, 1979g; RMA, 1952c; Sutherland, 1979)
	1980	(Marlow, 1980b-j)
	1981	(Marlow, 1981b-d; Marlow, 1981f-k)
	1982	(Marlow, 1982a-g)
	1983	(Marlow, 1983b-k; Marlow, 1984a)
	1984	(Marlow, 1984b; Unauthored, 1984a; Unauthored, 1984c-f; Unauthored, 1984h)
	1985	(Unauthored, 1985a-d; Unauthored, 1985h-k)
Dicamba	1985	(Unauthored, 1985d)
Dicamba-2,4-D	1985	(Unauthored, 1985e-g)
Dieldrin	1957	(USAEHL, 1957)

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SUBSTANCE	YEAR	REFERENCES
Diquat-2,4-D	1980	(Marlow, 1980f; Marlow, 1980h; Marlow, 1980i)
	1981	(Marlow, 1981f)
	1982	(Marlow, 1982f)
	1983	(Marlow, 1983e-g)
	1984	(Unauthored, 1984d)
	1985	(Unauthored, 1985e)
Dowpon	1965	(Clevenger, 1965)
Dursban	1979	(Marlow, 1979c)
Hydrogen cyanide	1957	(RMA, 1957a-b)
Hyvarx	1984	(Unauthored, 1984c)
Isopropyl ester of 2,4-D	1955	(RMA, 1955a; RMA, 1955b)
Karmex (Diuron)	1968	(Bartschi, 1968; Unauthored, 1968)
Lead arsenate	1957	(USAEHL, 1957)
Lindane	1959	(Ledwell, 1959)
	1961	(Vining, 1961)
Malathion	1957	(USAEHL, 1957)
	1959	(Ledwell, 1959)
	1961	(Vining, 1961)
	1964	(Asai, 1964; Flucke, 1964)
	1966	(Krenzer and Morkovsky, 1966)
	1977	(Shogren, 1977)
	1978	(Grodt, 1978)
	1979	(Marlow, 1979c; Marlow, 1979d; Sutherland, 1979)

SUBSTANCE	YEAR	REFERENCES
	1980	(Marlow, 1980f; Marlow, 1980g; Sutherland, 1980)
	1981	(Marlow, 1981d-f; Marlow, 1981i)
	1982	(Marlow, 1982e; Marlow, 1982f)
	1983	(Marlow, 1983d-f)
	1984	(Unauthored, 1984d; Unauthored, 1984e)
	1985	(Unauthored, 1985g)
Naled	1980	(Marlow, 1980f)
Nicotine sulfate	1957	(USAEHL, 1957)
"Oil"	1944	(Shaw et al., 1944)
	1947	(McLaughlin, 1947)
Organic phosphates	1977	(Shogren, 1977)
Paris Green	1944	(Shaw et al., 1944)
Phostoxin	1983	(Marlow, 1983e; Marlow, 1983g; Marlow, 1983k)
	1984	(Unauthored, 1984d; Unauthored, 1984e; Unauthored, 1984g)
	1985	(Unauthored, 1985a-f; Unauthored, 1985h-k)
Pyrethrum	1979	(Marlow, 1979a; Marlow, 1979c; Marlow, 1979d; Marlow, 1979f; Marlow, 1979g; RMA, 1952c; Sutherland, 1979)
	1980	(Marlow, 1980b-e; Marlow, 1980i)
	1981	(Marlow, 1981d-f; Marlow, 1981h)

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SUBSTANCE	YEAR	REFERENCES
	1982	(Marlow, 1982e; Marlow, 1982f)
	1983	(Marlow, 1983d; Marlow, 1983f-k)
	1984	(Marlow, 1983i; Marlow, 1983k; Unauthored, 1984d-f)
	1985	(Unauthored, 1985g; Unauthored, 1985h; Unauthored, 1985k)
"Rat poison"	1944	(Holaday *et al*., 1944)
Rotenone	1970	(Mullan, 1975c)
	1974	(Donnelly, 1974; Mullan, 1975a-c)
Roundup	1982	(Marlow, 1982f)
Sodium arsenite	1962	(RMA, 1962a-b)
Sodium fluoracetate	1955	(RMA, 1955a-b)
	1957	(USAEHL, 1957)
Strychnine	1983	(Marlow, 1983c; Marlow, 1983d)
Thallium sulfate	1957	(USAEHL, 1957)
Timec	1979	(Marlow, 1979c)
Trifluralin	1984	(Unauthored, 1984d)
	1985	(Unauthored, 1985d)
Ureabor	1956	(RMA, 1956a; RMA, 1956b)
	1957	(RMA, 1957a; RMA, 1957b)
	1958	(RMA, 1958a-d)
	1959	(RMA, 1959a-c)
	1960	(RMA, 1960a; RMA, 1960b)
	1961	(RMA, 1961)

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SUBSTANCE	YEAR	REFERENCES
	1962	(RMA, 1962a; RMA, 1962c)
Warfarin	1957	(USAEHL, 1957)
	1976	(Johnston, 1976; Phillips, 1976)
Zinc phosphide	1980	(Marlow, 1980f)
	1983	(Marlow, 1983d; Unauthored, 1983)

TABLE IV

Aggregate Yearly Quantities of Herbicides, Pesticides, and Insecticides Used at Rocky Mountain Arsenal[1]

Year	Gallons[2]	Pounds[2]
1943		300
1944-1955		No amounts reported
1956		7,300
1957		33,700
1958		No amounts reported
1959		2,500
1960		8,000
1961		10,000
1962		52,000
1963		20,000
1964	3	450
1965		525
1966		750
1967		No amounts reported
1968		370
1969		No amounts reported
1970		50
1971-1975		No amounts reported
1976		3,200
1977-1978		No amounts reported
1979	7,925	3,141

[1]Source: Appendix A, Table I.

[2]The above-furnished quantities represent actual substances used at Rocky Mountain Arsenal as quantified in the historical database. The quantities reported in pounds (gallons) are independent of those reported in gallons (pounds).

Year	Gallons[2]	Pounds[2]
1980	6,758	1,926
1981	5,672	1,681
1982	2,519	1,134
1983	17,121	5,289
1984	13,764	3,187
1985	18,452	1,546
1986-		No amounts reported
TOTAL	72,214	157,000

APPENDIX B

TABLE I

1975 Pesticide Inventory, Building 544 Area[1]

PESTICIDE	QUANTITY[2]
2,4-D	272 gallons
2,4,5-T	25 gallons
2,4-D and 2,4,5-T	209 gallons
Anticoagulant Dusting Powder	5 pounds
Baygon Propoxur	5 pounds
Borate-Bromacil Mixture	597 pounds
Bordeaux Mixture	52 pounds
Boric Acid	10 pounds
Calcium Cyanide	5 pounds
Carbaryl	100 pounds
Chlordane	9 gallons
Copper acetoarsenite	5 pounds
DDT Powder	50 pounds
Diazinon	229 gallons
Dieldrin granules	2 pounds
Diquat	17 gallons
Diuron	5 gallons
Diuron	50 pounds
Lidnane	10 gallons
Malathion	124 gallons
Naled	22 gallons
Poison Grain	25 pounds
Propoxur	1 gallon
Pyrethrum Roach Powder	5 pounds
Simazine	20 pounds
Sodium 2,2-dichloropropionate	30 pounds
Strychnine Grain	38 pounds
Thiram	2 pounds
Vapona	140 strips
Warfarin	128 pounds

[1]Source: Hastriter and McLaurin, 1976

[2]Quantities shown in the above chart reflect actual amounts stored but do not necessarily represent pure quantities of that substance. Many named substances were substantially diluted with water or some other chemical prior to application.

TABLE II

1979 Pesticide Inventory, Building 544 and Storage Shed[1]

PESTICIDE	AMOUNT[2]	LOCATION
797-A Powdered Insecticide, pyrethrine 1 percent, silica gel 40 percent	84 ounces	Building 544
Aldrin	110 gallons	Outside Storage Shed
Arasan[R] 75 thiram 75 percent	2 pounds	Building 544
Arsenate of Lead	2 pounds	Building 544
Baygon [R] Roach Bait propoxur 2 percent	2.5 pounds	Building 544
Cyanogas-A[R] Calcium Cyanide 42 percent	1 pound	Building 544
De-Pester[R] Ded-Weed[R] 2,4-D 2,4,5-T	55 gallons	Outside Storage Shed
Diquat Water Weed Killer diquat dibromide 35.3 percent	20 gallons	Outside Storage Shed
Experimental Anticoagulant Dusting Powder calcium salt of 2-substituted 1,3 indandione 2.174 percent	4.5 gallons	Building 544
Herbicide Dimethyl Tetrachloroterephalate Dachthal[R] W-75 DCPA 75 percent	108 pounds	Building 544

[1]Source: Grodt, 1979

[2]Quantities shown in the above chart reflect actual amounts stored but do not necessarily represent pure quantities of that substance. Many named substances were substantially diluted with water or some other chemical prior to application.

7-55cr

PESTICIDE	AMOUNT	LOCATION
Herbicide 2,4-D Thompson Weedicide Concentrate, dimethyl salt 2,4-D acid 50 percent equivalent 2,4-D acid 41.5 percent	55 gallons	Outside Storage Shed
House Mouse, Meadow Mouse, and Pocket Gopher Bait Strychnine alkaloid 0.5 percent	40 pounds	Building 544
Insecticide Chlordane EC, 73.6 percent	2 gallons	Outside Storage Shed
Insecticide Diazinon EC, 47.5 percent	5.5 gallons	Building 544
Insecticide Diazinon EC, 48.2 percent, D-Tox 4E	1 gallon	Building 544
Insecticide Diazinon Liquid Residual, 0.5 percent	2 gallons	Building 544
Insecticide Naled, 85 percent	14 gallons	Outside Storage Shed
Insecticide Powder Roach sodium fluoride 47.5 percent pyrethrins 0.2 percent	5 pounds	Building 544
Insecticide Pyrethrin, 0.6 percent	324 ounces	Building 544
Insecticide Strip dichlorovos	140 strips	Outside Storage Shed
Malathion, 57 percent	190 gallons	Outside Storage Shed
Paris Green, Copper aceto arsenite 85.4 percent	5 pounds	Building 544
Radapon[R] dalapon 82 percent	5 pounds	Building 544
Rid-A-Bird[R] endrin 9.75 percent	1 pint	Building 544
Rodenticidal Bait Anticoagulant warfarin 0.025 percent	150 pounds	Building 544
Sevin[R] Sprayable Carbaryl 80 percent	220 pounds	Building 544
Simazine 80W, 80 percent	17 pounds	Building 544

PESTICIDE	AMOUNT	LOCATION
ULD[R] BP-300 Insecticide	10.5 gallons	Building 544
Unknown	10 gallons	OutsideStorage Shed
Zinc Phosphide on Steam Rolled Oats, 2 percent	250 pounds	Outside Storage Shed

TABLE III
1979 Pesticide Inventory, Building 616[1]

Pesticide	Amount[2] Container
Insecticide, DDT, 20 percent	990 gallons (55- gallon drums)
Insecticide, DDT, 20 percent	220 gallons (55-gallon drums)

[1]Source: Grodt, 1979

[2]Quantities shown in the above chart reflect actual amounts stored but do not necessarily represent pure quantities of that substance. Many named substances were substantially diluted with water or some other chemical prior to application.

TABLE IV
1979 Pesticide Inventory, Building 618[1]

Pesticide	Amount[2] (Container)
Bordeaux Mixture copper 12.75 percent	48 pounds (4-pound bags)
Boric Acid	10 pounds (1-pound bottles)
Caw Caw Rope (bird repellant)	240 feet (48-foot bundles)
DED-Weed[R] 2,4-D 2,4,5-T	165 gallons (55-gallon drums)
Dowpon[R] dalapon 85 percent	25 pounds (5-pound boxes)
Herbicide 2,4-D, 50 percent	165 gallons (55-gallon drums)
Insecticide, Diazinon 2 percent Dust	225 gallons (25-gallon drums)
Insecticide, Lindane 1-pound/gallon	10 gallons (5-gallon cans)
Insecticide, Naled Concentrate	25 gallons (25-gallon drums)
Poison Grain strychnine 0.5 percent	50 gallons (50-gallon drums)
Tordon [R] 101 Mixture picloram 39 percent	5 gallons (5-gallon cans)
Wilco Ground Squirrel Bait chlorophacinone 0.5 percent	48 pounds (4-pound cans)

---

[1]Source: Grodt, 1979

[2]Quantities shown in the above chart reflect actual amounts stored but do not necessarily represent pure quantities of that substance. Many named substances were substantially diluted with water or some other chemical prior to application.

TABLE V
1979 Pesticide Inventory, Building 785[1]

Pesticide	Amount[2] (Container)
Oxy[R] Borocil IV sodium metaborate tetrahydrate 94 percent bromacil 4 percent	5,200 pounds (50-pound bags)

[1]Source: Grodt, 1979

[2]Quantities shown in the above chart reflect actual amounts stored but do not necessarily represent pure quantities of that substance. Many named substances were substantially diluted with water or some other chemical prior to application.

TABLE VI
1981 Pesticide Inventory, Building 616[1]

Pesticide	Amount[2] (Container)
Insecticide, DDT, 20 percent	990 gallons (55-gallon drums)
Insecticide, DDT, 20 percent	220 gallons (55-gallon drums)

---

[1]Source: Grodt, 1981

[2]Quantities shown in the above chart reflect actual amounts stored but do not necessarily represent pure quantities of that substance. Many named substances were substantially diluted with water or some other chemical prior to application.

TABLE VII
1981 Pesticide Inventory, Building 643[1]

Pesticide	Amount[2] (Container)
Bordeaux Mixture copper 12.75 percent	48 pounds (4-pound bags)
DED-Weed 2,4-D 2,4,5-T	165 gallons (55-gallon drums)
Herbicide 2,4-D, 50 percent	165 gallons (55-gallon drums,
Insecticide, aldrin (unserviceable)	110 gallons (55-gallon drums)
Insecticide, Diazinon 2 percent Dust	225 gallons (25-gallon drums)
Insecticide, Naled Concentrate	25 gallons (25-gallon drum)
Tordon 101 Mixture picloram 39 percent	5 gallons (5-gallon can)

[1] Source: Grodt, 1981

[2] Quantities shown in the above chart reflect actual amounts stored but do not necessarily represent pure quantitites of that substance. Many named substances were substantially diluted with water or some other chemical prior to application.

TABLE VIII
1984 Pesticide Inventory, Building 643[1]

Pesticide	Amount[2] (Container)
Bordeaux Mixture copper 12.7 percent	48 pounds (4-pound bags)
DED-Weed 2,4-D 2,4,5-T	166 gallons (55-gallon drums)
Herbicide 2,4-D, 50 percent	100 gallons (55-gallon drums)
Insecticide, Aldrin (unserviceable)	110 gallons (55-gallon drums)
Insecticide, Diazinon 2 percent Dust	225 pounds (25-gallon drums)
Insecticide, Naled Concentrate	25 gallons (25-gallon drums)

---

[1]Source: Farlow, 1984

[2]Quantities shown in the above chart reflect actual amounts stored but do not necessarily represent pure quantities of that substance. Many named substances were substantially diluted with water or some other chemical prior to application.

TABLE IX
1984 Pesticide Inventory, Toxic Storage Yard[1]

Pesticide	Amount[2] (Container)
Insecticide, Heptachlor	165 gallons (55-gallon drums)

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[1]Source: Farlow, 1984

[2]Quantities shown in the above chart reflect actual amounts stored but do not necessarily represent pure quantities of that substance. Many named substances were substantially diluted with water or some other chemical prior to application.

TABLE X
1986 Herbicide, Rodenticide, and Pesticide Inventory, Building 742[1]

Herbicide	Quantity[2]
2,4-d 50 percent	3 Bags/5 poundseach
Banvel 48.2 percent	30 Each/1-gallon cans
Borocil Soil Sterilant	1 Bag/50 pounds
Dacthal W-75 WWP	4 Bags/24 pounds each
Diquat	17 Each/5-gallon cans
Embark Plant Growth Regulator, 28 percent	8 Each/1-gallon cans
Fertilome Lawn Fertilizer	48 Each/10-pound bags
LWK No. 2 Weed Killer	1 Quart bottle
Ortho X-77 Spreader	29 Each/1-gallon cans
Simazine 80W WWP	3 Bags/5-pounds each
Tordon 101 Mixture	1 Each/5-gallon can
Rodenticide	
Anticoagulant 0.3 percent	299 Each/1-pound cans
Baygon Roach Bait 0.2 percent	1/4 Pound
Fumitoxin 55 percent	48 Flasks/2-pounds 3.28 ounces each
Phostoxin 55 percent	120 Flasks/3.3-pounds each
Zinc Phosphide	4 Bags/50-pounds each
Pesticide	
797-A-Powder Insecticide (Pyrethrin) 1.0 percent	8 Bulbs/30 ounces each
Diazinon 0.5 percent solution	1-1/4 Gallon
Diazinon 4e 47.5 percent	14 Gallons
Diazinon Concentrate 47.5 percent E.C.	12 Gallons
Dibrom 14 (Naled)	Approximately 2 Gallons
Insect Repellant (Personal Application)	17 Each dispenser/2 ounces each
Malathion 57 percent	1 Each/55-gallon drum
Naled 85 percent	3-Gallon jar
Paris Green 85.4 percent	1 Each/5 pound can
Pyrethrum Roach Powder .2 percent	
Sevin Carbaryl WWP 80 percent	15 Bags/10 pounds each
ULD 20 Smoke Odor Counteract	1 Gallon
ULD BP 300 3.0 percent Solution	1-1/4 Gallon
ULD CS 85 Micro Generator Cleaning Solvent	1 Gallon

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[1]Source: Marlow, 1986

[2]Quantities shown in the above chart reflect actual amounts stored but do not necessarily represent pure quantities of that substance. Many named substances were substantially diluted with water or some other chemical prior to application.

8:45pm

3 May, 1993

APPENDIX C

TABLE I

Results of Pesticide Residue Analyses and Heavy Metal Analyses of Soil, Sediment, and Water Samples: Rocky Mountain Arsenal Pesticide Monitoring Program, 1973-1974

Type of Sample	Place of Collection	Results Name Concentration	Date Result(s) Reported	Reference
Water	First Creek, near "E" Street	Dieldrin Trace	December 21, 1973	(Cordo, 1973)
Water	Unknown	Dieldrin 0.011 parts per million (ppm)[1] Endrin 0.0021 ppm[1]	December 21, 1973	(Cordo, 1973)
Water	First Creek on "F" Street, between Eighth and Ninth Avenues	Mercury 0.0004 parts per million (ppm)	April 8, 1974	(Larsen, 1974a)
Water	Unknown	Mercury Detectable	April 8, 1974	(Larsen, 1974a)
Water	Sewage oxidation pond	Aldrin and Dieldrin "Higher than expected values"	April 15, 1974	(Larsen, 1974b)

Soil	Between "F" and "G" Streets, near Eighth Avenue	Negative for any pesticide residues	April 15, 1974	(Larsen, 1974b)
Water	Sewage oxidation pond	Mercury 0.0002 ppm Lead 0.008 ppm	April 23, 1974	(Cordo, 1974)
Sediment	Sewage oxidation pond	p,p-DDD 0.15 ppm Aldrin <u>circa</u> 1.94 ppm[1,2] Chlordane Trace Dieldrin circa 0.19 ppm[2]	April 23, 1974	(Cordo 1974)
Water	Unknown	Aldrin "Higher than expected values"	May 15, 1974	(Larsen, 1974c)
Water	Sewage oxidation pond	Arsenic Detectable	May 22, 1974	(Larsen, 1974d)
Soil	Section 25	Unknown Detectable	August 22, 1974	(Larsen, 1974e)
Water	Lake Mary	Cadmium 0.009 ppm	December 19, 1974	(Johnston, 1974)

[1] The concentration level was considered to be higher than expected from routine pest control activities.

[2] The second digit of the figure is not clearly legible in the documents.

TABLE II

"Normal" Pesticide and Herbicide Concentration Levels in Soil and Sediment Samples Taken from Selected Army Installations Using Pesticides and Herbicides, 1975 Through 1978[1]

Compound/ Category	Area(s) Represented	Yearly Mean Concentrations 1975 - 1978 (parts per million)[2]
Chlordane	Sediment	Less than 0.06
	Residential	Between 0.1 and 0.4
	Pesticide shop and storage	Between 2.3 and 3.3
	Other selected areas	Between 0.25 and 0.5
Total DDT including DDD and DDE	Sediment	Between 0.06 and 0.25
	Residential	Between 0.50 and 0.75
	Pesticide shop and storage	About 2.0
	Other selected areas	About 1.0
Cyclodienes like Aldrin, Dieldrin, and Endrin	Sediment	Less than 0.06
	Residential	Between 0.2 and 0.4
	Pesticide shop and storage	Between 2.2 and 3.3
	Other selected areas	Between 0.2 and 0.5
Organophosphates like Malathion, Chlorpyrifor Diazinon, Parathion, and Ronnel	Sediment	0.0
	Residential	0.0
	Pesticide shop and storage	Between 0.5 and 1.5
	Other selected areas	Less than 0.05
"BHC" including Lindane	Sediment	0.0
	Residential	0.0
	Pesticide shop and storage	Less than 0.21
	Other selected areas	Less than 0.051

[1]Source: McDermott, 1981

[2]No units are specified in the pages reporting these data. A review of the remainder of the document and of other relevant documents indicates that all concentrations are in parts per million.

3:23pm
[illegible]

3 May 1985

TABLE III

Evaluation of Pesticide Distribution in Selected Components of the Environment of Rocky Mountain Arsenal, 1975: Pesticide Profile[1]

Substrate	Number of Samples	Number of Pesticides	Concentration Range (parts per million)	Mean
Soil	18	14	BDL[2]-294.33	18.99
Sediment	7	4	BDL[2]-0.13	0.05
Fish	4	8	0.12-3.53	1.57

---

[1]Source: Olds *et al.*, 1978

[2]Below detection limits--no pesticides were detected at the levels of detectability.

Table IV

Evaluation of Pesticide Distribution in Selected Components of the Environment of Rocky Mountain Arsenal, 1975: Overall Concentrations of Pesticides[1]

Environmental Concentration(s) Component	Not Excessive[2]	Excessive	Major Pesticide(s): Reported (parts per million)
Soil			
Pesticide Shop		X	Aldrin 34.400 Chlordane 131.83 DDT group[3] 93.53 Dieldrin 33.240
Pesticide Storage		X	Aldrin 0.55 Dieldrin 4.44
Landfill	X		
Residential	X		
Cantonment	X		

[1]Source: Olds et al., 1978

[2]The following levels were considered excessive: soil above 5.0 ppm, sediment above 0.1 ppm, and fish above 1.0 ppm.

[3]This group includes DDT, DDE, and DDD.

Environmental Component	Not Excessive[2]	Excessive	Major Pesticide(s): Reported Concentration(s) (parts per million)
Recreation		X	DDT group[3] 11.69
Sediment Stream/originating		X	Chlordane 0.13
Impounded water	X		
Fish Impounded		X	Dieldrin 1.120

APPENDIX D

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APPENDIX D
CHEMISTRY DATA

ESE#	SPECIES	TISSUE	SEX	AGE	SAMPDATE	STATION ID	SITE DESCRIPTION	ARSENIC	MERCURY	ALDRIN	DIELDRIN	ENDRIN	DDE	DDT	COMMENTS
								CHEMICAL CONCENTRATIONS (UG/G)							
609	Ana dis	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	1.21	BDL	0.281	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
611	Ana dis	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	1.64	BDL	0.181	BDL	CDL	BDL	1984 - 1985 USFWS SAMPLES
627	Ana dis	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.171	BDL	0.252	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
608	Ana dis	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.154	BDL	0.164	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
610	Ana dis	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.559	BDL	0.127	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
626	Ana dis	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.259	BDL	0.09	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
101	Ana pla	carcass	F	JUV	860729	12M	RMA	NRQ	0.066	BDL	0.522	BDL	BDL	BDL	
111	Ana pla	carcass	M	JUV	860815	SPGNDS	SOUTH PONDS, SEC. 11	NRQ	BDL	BDL	0.065	BDL	BDL	BDL	
112	Ana pla	carcass	M	JUV	860815	NBOG	NORTH BOG	NRQ	0.061	BDL	BDL	BDL	0.507	BDL	
124	Ana pla	carcass	M	ADULT	860828	SPGNDS	SOUTH PONDS, SEC. 11	NRQ	BDL	BDL	BDL	BDL	0.097	BDL	
125	Ana pla	carcass	F	ADULT	860828	1SM	LAKE DERBY, SEC. 1	NRQ	BDL	BDL	BDL	BDL	0.36	BDL	
126	Ana pla	carcass	M	ADULT	860828	1SM	LAKE DERBY, SEC. 1	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
161	Ana pla	carcass	M	JUV	860910	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
162	Ana pla	carcass	F	JUV	860910	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
163	Ana pla	carcass	M	JUV	860912	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
164	Ana pla	carcass	F	JUV	860912	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
165	Ana pla	carcass	M	JUV	860912	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
166	Ana pla	carcass	F	JUV	860912	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
213	Ana pla	carcass	M	ADULT	860912	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
215	Ana pla	carcass	M	ADULT	860912	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
217	Ana pla	carcass	M	ADULT	860912	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	0.061	BDL	BDL	BDL	BDL	BDL	
219	Ana pla	carcass	M	ADULT	860912	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
222	Ana pla	carcass	M	ADULT	860912	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	BDL	BDL	BDL	BDL	0.484	BDL	
224	Ana pla	carcass	F	ADULT	860912	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
249	Ana pla	carcass	F	ADULT	860912	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
251	Ana pla	carcass	M	ADULT	860912	LARIMERRM	LAR.CO.N.OF WELLNGTN	NRQ	BDL	BDL	BDL	BDL	1.02	BDL	
253	Ana pla	carcass	M	ADULT	860926	CIRCLUB	RMA	NRQ	BDL	BDL	BDL	BDL	0.152	BDL	
255	Ana pla	carcass	M	ADULT	860926	CURCLUB	RMA	NRQ	BDL	BDL	0.067	BDL	0.222	BDL	
257	Ana pla	carcass	M	ADULT	860926	CURCLUB	RMA	NRQ	BDL	BDL	4.51	BDL	BDL	BDL	
284	Ana pla	carcass	F	ADULT	861001	SPGNDS	RMA, SEC. 11	NRQ	BDL	BDL	0.088	BDL	BDL	BDL	
286	Ana pla	carcass	M	ADULT	861001	25M	RMA LK. LADORA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
52	Ana pla	egg			860519	GRANBYN	NEAR GRNBY ON COLO R	NRQ	0.058	BDL	BDL	BDL	BDL	BDL	
53	Ana pla	egg			860605	WELLING	WLNGTN-STAT.WILD AREA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
54	Ana pla	egg			860609	1SM	RMA	NRQ	0.185	BDL	4.89	BDL	0.919	BDL	
55	Ana pla	egg			860612	LKDERBY	RMA	NRQ	0.171	BDL	1	BDL	0.606	BDL	2 DAYS OLD ON YOLK SAC
56	Ana pla	egg			850604	MVISTANWR	MONTEVISTA NAT.WILD.	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
57	Ana pla	egg			860604	MVISTANWR	MONTEVISTA NAT.WILD.	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
58	Ana pla	egg			860604	MVISTANWR	MONTEVISTA NAT.WILD.	NRQ	BDL	BDL	BDL	BDL	1.35	BDL	
59	Ana pla	egg			860604	MVISTANWR	MONTEVISTA NAT.WILD.	NRQ	BDL	BDL	BDL	BDL	0.133	BDL	
60	Ana pla	egg			860604	MVISTANWR	MONTEVISTA NAT.WILD.	NRQ	0.111	BDL	BDL	BDL	0.215	BDL	
61	Ana pla	egg			860617	MVISTANWR	MONTEVISTA NAT.WILD.	NRQ	0.186	BDL	BDL	BDL	0.135	BDL	
62	Ana pla	egg			860617	MVISTANWR	MONTEVISTA NAT.WILD.	NRQ	0.13	BDL	BDL	BDL	0.158	BDL	
63	Ana pla	egg			860617	MVISTANWR	MONTEVISTA NAT.WILD.	NRQ	0.066	BDL	BDL	BDL	0.227	BDL	
77	Aqu chr	brain	UNK	UNK	860703	NBASINF	RMA NORTH OF BASIN F	BDL	0.257	BDL	BDL	BDL	BDL	BDL	
30	Aqu chr	liver	UNK	UNK	860703	NBASINF	RMA NORTH OF BASIN F	NRQ	0.216	BDL	0.221	BDL	BDL	BDL	
448	Aqu chr	wholebird	F	IMMAT	870202	32S16	SEC. 32, ON "G" ST.								
477	Aqu chr	brain	F	IMMAT	870124	32S16	SEC. 32, ON "G" ST.	BDL	BDL	BDL	BDL	BDL	BDL	BDL	FROM ESE 446
478	Aqu chr	liver	F	IMMAT	870124	32S16	SEC. 32, ON "G" ST.	BDL	BDL	BDL	BDL	BDL	BDL	BDL	FROM ESE 446

CHEMICAL CONCENTRATIONS (UG/G)

ESE#	SPECIES	TISSUE	SEX	AGE	SAMPDATE	STATION ID	SITE DESCRIPTION	ARSENIC	MERCURY	ALDRIN	DIELDRIN	ENDRIN	DDE	DDT	COMMENTS
184	AquaPlnts	pondweed			861008	LKMARY	RMA	NRQ	BDL	BDL	BDL	BDL	NRQ	NRQ	
185	AquaPlnts	Elodea			861017	LKLADORA	RMA	NRQ	BDL	BDL	BDL	BDL	NRQ	NRQ	
186	AquaPlnts	Plant A			861020	LKDERBY	RMA	NRQ	BDL	BDL	BDL	BDL	NRQ	NRQ	
187	AquaPlnts	Plant B			861020	LKLADORA	RMA	NRQ	BDL	BDL	BDL	BDL	NRQ	NRQ	
189	AquaPlnts	coontail			861022	WELLINGN	WELLINGN NORTH LKS.	NRQ	BDL	BDL	BDL	BDL	NRQ	NRQ	
351	AquaPlnts				861028	WELLINGN	WELLINGTN NORTH LAKES	NRQ	BDL	BDL	BDL	BDL	NRQ	NRQ	
352	AquaPlnts				861028	WELLINGN	WELLINGTN NORTH LAKES	NRQ	BDL	BDL	BDL	BDL	NRQ	NRQ	
353	AquaPlnts				861028	WELLINGN	WELLINGTN NORTH LAKES	NRQ	BDL	BDL	BDL	BDL	NRQ	NRQ	
354	AquaPlnts				861028	WELLINGN	WELLINGTN NORTH LAKES	NRQ	BDL	BDL	BDL	BDL	NRQ	NRQ	
355	AquaPlnts				861028	WELLINGN	WELLINGTN NORTH LAKES	NRQ	BDL	BDL	BDL	BDL	NRQ	NRQ	
629	Age pho	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.08	0.088	0.66	BDL	0.156	BDL	1984 - 1985 USFWS SAMPLES
631	Age pho	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.119	BDL	0.211	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
633	Age pho	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.285	BDL	0.747	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
635	Age pho	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.168	BDL	0.364	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
637	Age pho	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.184	BDL	0.307	0.074	BDL	BDL	1984 - 1985 USFWS SAMPLES
628	Age pho	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	BDL	BDL	0.142	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
630	Age pho	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	BDL	BDL	0.702	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
632	Age pho	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.073	BDL	0.12	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
634	Age pho	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.055	BDL	0.117	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
636	Age pho	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	BDL	BDL	0.236	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
436	Bub vir	brain	UNK	ADULT	870122	11SE	RMA, UNKNOWN	BDL	BDL	BDL	15.6	BDL	10.3	BDL	FROM ESE 371
510	Bub vir	brain	M	ADULT	871001	31NW	RMA	BDL	BDL	BDL	10.2	BDL	2.24	BDL	
575	Bub vir	brain	UNK	ADULT	871211	BLDG213	S PLANTS, BUIL. 213	BDL	BDL	BDL	BDL	BDL	BDL	BDSL	FROM ESE 182
538	Bub vir	brain	UNK	ADULT	871211	SPLANTS	RMA	BDL	BDL	BDL	9.12	BDL	0.475	BDL	FROM ESE 172
437	Bub vir	liver	UNK	ADULT	870122	11SE	RMA, UNKNOWN	BDL	0.086	BDL	10.8	BDL	15.5	BDL	FROM ESE 371
508	Bub vir	liver	M	ADULT	871001	31NW	RMA	BDL	0.051	BDL	8.89	BDL	5.49	BDL	
579	Bub vir	liver	UNK	ADULT	871211	BLDG213	S PLANTS, BUIL. 213	BDL	BDL	BDL	0.141	BDL	BDL	BDL	FROM ESE 182
539	Bub vir	liver	UNK	ADULT	871211	SPLANTS	RMA	BDL	BDL	BDL	27.7	BDL	2.47	BDL	FROM ESE 122
420	But jam	brain	UNK	ADULT	870122	11D	SEC. 11, ON D ST.	BDL	0.093	BDL	9.2	BDL	BDL	BDL	FROM ESE 369
522	But jam	brain	UNK	IMM	871211	11SE	ESE TRAILER PARK	BDL	BDL	BDL	BDL	BDL	BDL	BDL	FROM ESE 127
601	But jam	brain	F	IMM	880413	1NE	RMA	BDL	BDL	BDL	9.44	BDL	BDL	I	
438	But jam	liver	UNK	ADULT	870122	11D	SEC. 11, ON D ST.	BDL	0.145	BDL	6.59	BDL	0.759	BDL	FROM ESE 369
518	But jam	liver	UNK	IMM	871211	11SE	ESE TRAILER PARK	BDL	BDL	BDL	0.52	BDL	BDL	BDL	FROM ESE 127
601	But jam	liver	F	IMM	880413	1NE	RMA	BDL	BDL	BDL	5.19	BDL	0.579	BDL	
433	But reg	brain	UNK	ADULT	870122	BLDG111	RMA, SEC. 35, BUILD. 111	BDL	0.152	BDL	7.73	BDL	BDL	BDL	FROM ESE 372
444	But reg	brain	UNK	ADULT	870122	27ST8	SEC. 27, ON 8TH ST.	BDL	BDL	BDL	0.678	BDL	BDL	BDL	FROM ESE 370
512	But reg	brain	F	IMM	871211	MONTBELLO	JUST SOUTH OF RMA	BDL	BDL	BDL	9.98	BDL	BDL	BDL	FROM ESE 121
591	But reg	brain	F	ADULT	880129	24NW	RMA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
596	But reg	brain	F	IMM	880407	35SW	RMA	BDL	BDL	BDL	6.85	BDL	BDL	BDL	
430	But reg	liver	UNK	ADULT	870122	BLDG111	RMA, SEC. 35, BUILD. 111	BDL	0.293	BDL	4.79	BDL	BDL	BDL	FROM ESE 372
442	But reg	liver	UNK	ADULT	870122	27ST8	SEC. 27, ON 8TH ST.	BDL	BDL	BDL	0.527	BDL	BDL	BDL	FROM ESE 370
513	But reg	liver	F	IMM	871211	MONTBELLO	JUST SOUTH OF RMA	BDL	BDL	BDL	1.45	BDL	BDL	BDL	FROM ESE 121
593	But reg	liver	F	ADULT	880129	24NW	RMA	BDL	BDL	BDL	0.261	BDL	BDL	BDL	
598	But reg	liver	F	IMM	880407	35SW	RMA	BDL	BDL	BDL	4.26	BDL	BDL	BDL	
424	Can lat	liver	M	ADULT	860320	25E9	RMA	BDL	BDL	BDL	7.6	BDL	BDL	BDL	
641	Cir cya	eggs			840626	RMA	RMA	BDL	BDL	BDL	0.303	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
640	Cir cya	eggs			840626	RMA	RMA	BDL	BDL	BDL	0.676	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
444	Con arv	plant			870812	EBASINA	E. OF BASIN A, SEC. 36	0.535	BDL	BDL	BDL	BDL	NRQ	NRQ	

Appendix D. Analysis of RMA Biota Samples for Major Contaminants of Concern (Page 1 of 8). BIORIAPD.WK1 30-Dec-88

ESE#	SPECIES	TISSUE	SEX	AGE	SAMPDATE	STATION ID	SITE DESCRIPTION	CHEMICAL CONCENTRATIONS (UG/G) ARSENIC	MERCURY	ALDRIN	DIELDRIN	ENDRIN	DDE	DDT	COMMENTS
485	Cen arv	plant			870312	EBASINA	E OF BASIN A, SEC. 36	BDL	BDL	BDL	0.084	BDL	NRQ	NRQ	
485	Cen arv	plant			870312	EBASINA	E OF BASIN A, SEC. 36	BDL	BDL	BDL	0.081	BDL	NRQ	NRQ	
497	Cen arv	plant			870804	RHAVEG44	BAS. A VEG TRANSECT	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
498	Cen arv	plant			870804	RHAVEG45	BAS. A VEG TRANSECT	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
507	Cen arv	plant			870804	20S	SOUTH HALF SEC. 20	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
54	Cyn lud	carcass	M	ADULT	861001	16NE (?)	RMA	BDL	BDL	BDL	0.237	BDL	NRQ	NRQ	
55	Cyn lud	carcass	M	ADULT	861001	36NE (?)	RMA	BDL	BDL	BDL	0.233	BDL	NRQ	NRQ	
120	Cyn lud	carcass	M	ADULT	861001	36NE (?)	RMA	BDL	BDL	BDL	0.422	BDL	NRQ	NRQ	
153	Cyn lud	carcass	M	ADULT	861001	16NE (?)	RMA	0.478	BDL	BDL	2.46	BDL	NRQ	NRQ	
154	Cyn lud	carcass	M	ADULT	861001	16NE (?)	RMA	0.741	BDL	BDL	0.441	BDL	NRQ	NRQ	
155	Cyn lud	carcass	M	ADULT	861001	16NE (?)	RMA	BDL	BDL	BDL	0.148	BDL	NRQ	NRQ	
156	Cyn lud	carcass	M	ADULT	861008	16NE (?)	RMA	BDL	BDL	BDL	0.284	BDL	NRQ	NRQ	
157	Cyn lud	carcass	M	ADULT	861008	36NE (?)	RMA	BDL	BDL	BDL	13.4	BDL	NRQ	NRQ	
158	Cyn lud	carcass	M	ADULT	861008	36NE (?)	RMA	BDL	BDL	BDL	0.434	BDL	NRQ	NRQ	
159	Cyn lud	carcass	M	ADULT	861107	PAWNEENG	PAWNEE NATL GRASS.	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
160	Cyn lud	carcass	M	ADULT	861107	PAWNEENG	PAWNEE NATL GRASS.	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
172	Cyn lud	carcass	M	ADULT	861107	PAWNEENG	PAWNEE NATL. GRASS.	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
173	Cyn lud	carcass	F	ADULT	861107	PAWNEENG	PAWNEE NATL. GRASS.	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
231	Cyn lud	carcass	M	ADULT	860923	19NW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
232	Cyn lud	carcass	M	ADULT	860923	19NW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
242	Cyn lud	carcass	M	ADULT	860923	20NW	RMA	BDL	BDL	BDL	0.346	BDL	NRQ	NRQ	
243	Cyn lud	carcass	M	ADULT	860923	20NW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
244	Cyn lud	carcass	F	ADULT	860923	20NW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
248	Cyn lud	carcass	M	ADULT	860923	19PR	RMA PISTOL RANGE	NRQ	NRQ	NRQ	NRQ	NRQ	NRQ	NRQ	
259	Cyn lud	carcass	M	ADULT	860926	19NW	RMA	BDL	BDL	BDL	0.064	BDL	NRQ	NRQ	
260	Cyn lud	carcass	M	ADULT	860926	20NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
261	Cyn lud	carcass	M	ADULT	860926	20NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
381	Cyn lud	carcass	M	ADULT	861228	LARIMERP.D	LAR.CO.N.OF WELLNGTN	BDL	BDL	NRQ	NRQ	NRQ	NRQ	NRQ	
382	Cyn lud	carcass	M	ADULT	861202	LARIMERP.D	LAR.CO.N.OF WELLNGTN	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
383	Cyn lud	carcass	M	ADULT	861216	LARIMERP.D	LAR.CO.N.OF WELLNGTN	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
384	Cyn lud	carcass	M	ADULT	861126	LARIMERP.D	LAR.CO.N.OF WELLNGTN	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
385	Cyn lud	carcass	M	ADULT	861202	LARIMERP.D	LAR.CO.N.OF WELLNGTN	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
399	Cyn lud	carcass	M	ADULT	861001	19NW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	brain to ese681
400	Cyn lud	carcass	F	ADULT	870212	20NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	brain to ese580
401	Cyn lud	carcass	M	ADULT	870212	20NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	brain to ese682
402	Cyn lud	carcass	M	ADULT	870212	20NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	brain to ese683
403	Cyn lud	carcass	F	ADULT	870212	20NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	no brain
404	Cyn lud	carcass	M	ADULT	870212	20NE	RMA	BDL	BDL	BDL	0.096	BDL	NRQ	NRQ	brain to ese685
405	Cyn lud	carcass	M	ADULT	870212	31NE	RMA	BDL	BDL	BDL	0.113	BDL	NRQ	NRQ	brain to ese686
406	Cyn lud	carcass	M	ADULT	870212	31NE	RMA	BDL	BDL	BDL	0.064	BDL	NRQ	NRQ	brain to ese687
407	Cyn lud	carcass	F	ADULT	870212	31NE	RMA	4.22	BDL	BDL	0.155	BDL	NRQ	NRQ	brain to ese688
408	Cyn lud	carcass	F	ADULT	870212	31NE	RMA	BDL	BDL	BDL	0.079	BDL	NRQ	NRQ	brain to ese689
409	Cyn lud	carcass	M	ADULT	870212	31NW	RMA	BDL	BDL	BDL	0.137	BDL	NRQ	NRQ	brain to ese690
410	Cyn lud	carcass	M	ADULT	870212	36NE	RMA	BDL	BDL	BDL	0.427	BDL	NRQ	NRQ	brain to ese691
411	Cyn lud	carcass	F	ADULT	870212	36NE	RMA	BDL	BDL	BDL	0.268	BDL	NRQ	NRQ	brain to ese692
412	Cyn lud	carcass	M	ADULT	870212	36NE	RMA	BDL	BDL	BDL	0.199	BDL	NRQ	NRQ	brain to ese693
413	Cyn lud	carcass	M	ADULT	870212	36NE	RMA	BDL	BDL	BDL	0.119	BDL	NRQ	NRQ	brain to ese694
414	Cyn lud	carcass	F	ADULT	870212	36NE	RMA	BDL	BDL	BDL	6.18	BDL	NRQ	NRQ	brain to ese695

ESE#	SPECIES	TISSUE	SEX	AGE	SAMPDATE	STATION ID	SITE DESCRIPTION	ARSENIC	MERCURY	ALDRIN	DIELDRIN	ENDRIN	DDE	DDT	COMMENTS
								CHEMICAL CONCENTRATIONS (UG/G)							
581	Cyn lud	kidneys	M	ADULT	870212	36NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	FROM ESE 410
582	Cyn lud	kidneys	F	ADULT	870212	36NE	RMA	BDL	0.188	BDL	BDL	BDL	NRQ	NRQ	FROM ESE 411
583	Cyn lud	kidneys	M	ADULT	870212	36NE	RMA	BDL	0.356	BDL	0.421	BDL	NRQ	NRQ	FROM ESE 412
584	Cyn lud	kidneys	M	ADULT	870212	36NE	RMA	BDL	0.245	BDL	BDL	BDL	NRQ	NRQ	FROM ESE 413
585	Cyn lud	kidneys	F	ADULT	870212	36NE	RMA	BDL	BDL	BDL	1.54	BDL	NRQ	NRQ	FROM ESE 414
138	Earthworms				851020	BLDG315	SEC.1,S.OF BLDG315	NRQ	BDL	NRQ	NRQ	NRQ	NRQ	NRQ	
357	Earthworms				861105	BLDG115	SEC.1,S.OF BLDG115	BDL	>2.35	BDL	1.93	BDL	BDL	BDL	
358	Earthworms				861105	SE	NE 1/4 OF SE SEC.5	1.3	BDL	BDL	BDL	BDL	BDL	BDL	
501	Earthworms				870828	SE	NE 1/4 OF SE SEC.5	1.38	0.245	NRQ	NRQ	NRQ	BDL	BDL	
502	Earthworms				870828	SE	NE 1/4 OF SE SEC.5	1.51	0.216	BDL	5.3	0.914	BDL	BDL	
542	Earthworms				870610	BARRLAKE E	S. OF BARRLAKE PLOTS	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
543	Earthworms				870610	SE	NE 1/4 OF SE SEC. 5	0.997	BDL	BDL	BDL	BDL	BDL	BDL	
544	Earthworms				870610	SE	NE 1/4 OF SE SEC. 5	0.846	BDL	BDL	BDL	BDL	BDL	BDL	
545	Earthworms				870610	SE	NE 1/4 OF SE SEC. 5	0.846	BDL	BDL	BDL	BDL	BDL	BDL	
546	Earthworms				870610	SE	NE 1/4 OF SE SEC. 5	0.619	BDL	BDL	BDL	BDL	BDL	BDL	
566	Earthworms				870610	BARRLAKE E	BARRLAKE EWORM PLOT	BDL	BDL	NRQ	NRQ	NRQ	NRQ	NRQ	ASSIGNED ESE# ON 2/23/88
567	Earthworms				870610	SE	NE 1/4 OF SE SEC. 5	0.722	BDL	BDL	BDL	BDL	BDL	BDL	ASSIGNED ESE# ON 2/23/88
81	Fal spa	carcass	M	JUV	860701	KB4	LAR CO.BRIGGS QUAD#4	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
82	Fal spa	carcass	M	JUV	860612	12NW	RMA, BOX 135	NRQ	BDL	BDL	0.406	BDL	BDL	BDL	
83	Fal spa	carcass	F	JUV	860523	LARIMERBF	LAR.CO BIRD FARM #59	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
84	Fal spa	carcass	M	JUV	860623	7NW	RMA, BOX 147	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
85	Fal spa	carcass	F	JUV	860623	25W	RMA, BOX 108	NRQ	BDL	BDL	1.01	BDL	BDL	BDL	
86	Fal spa	carcass	F	JUV	860623	35W	RMA, BOX 129	NRQ	BDL	BDL	0.188	BDL	0.219	BDL	
87	Fal spa	carcass	F	JUV	860708	24NE	RMA, BOX 1	NRQ	BDL	BDL	0.002	BDL	BDL	BDL	
88	Fal spa	carcass	F	JUV	860611	KB74	POUDRE R. KES BOX 74	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
89	Fal spa	carcass	F	JUV	860619	BIGTHOM	BIGTHOM R NEAR NARWS	NRQ	BDL	BDL	BDL	BDL	0.733	BDL	
90	Fal spa	carcass	F	JUV	860623	32SW	RMA, BOX 142	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
91	Fal spa	carcass	M	JUV	860623	9NW	RMA, BOX 125	NRQ	BDL	BDL	0.729	BDL	BDL	BDL	
92	Fal spa	carcass	F	JUV	860612	22SE	RMA, BOX 114	NRQ	BDL	BDL	0.679	BDL	BDL	BDL	
93	Fal spa	carcass	M	JUV	860701	BARRLAKE65	BARR LAKE BOX 65	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
94	Fal spa	carcass	M	JUV	860722	CHAMBY11	SO.OF HOT SULF.SPRGS	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
95	Fal spa	carcass	F	JUV	860718	FTCOLLC1	FT.COLLINS BOX C-1	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
96	Fal spa	carcass	M	JUV	860724	KB51	POUDRE R BOX #53	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
97	Fal spa	carcass	UNK	JUV	860623	5SW	RMA, BOX 144	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	FOUND DECOMPSNG IN BOX,SEX UNK
98	Fal spa	carcass	UNK	JUV	860623	5SW	RMA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	FOUND DECOMPSNG IN BOX,SEX UNK
1	Fal spa	egg			860508	23NW	RMA	NRQ	0.235	BDL	0.054	BDL	BDL	BDL	
2	Fal spa	egg			860508	4SW	RMA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
3	Fal spa	egg			860508	3SE	RMA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
4	Fal spa	egg			860508	32SW	RMA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
5	Fal spa	egg			860508	9SW	RMA	NRQ	BDL	BDL	BDL	BDL	GONE	GONE	
6	Fal spa	egg			860508	9SW	RMA	NRQ	BDL	BDL	BDL	BDL	GONE	GONE	
7	Fal spa	egg			860508	9NE	RMA	NRQ	BDL	BDL	0.165	BDL	GONE	GONE	
8	Fal spa	egg			860508	9SW	RMA	NRQ	BDL	BDL	BDL	BDL	GONE	GONE	
9	Fal spa	egg			860508	22SE	RMA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
10	Fal spa	egg			860514	KB74	POUDRE R. KES BOX.74	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
11	Fal spa	egg			860514	LARIMERDP	LAR CO DEER PEN #4	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
12	Fal spa	egg			860514	LARIMERBF	LAR.CO.BIRD FARM #59	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
13	Fal spa	egg			860520	2SE	RMA	NRQ	BDL	BDL	1.3	BDL	BDL	BDL	

Appendix D. Analysis of RMA Biota Samples for Major Contaminants of Concern (Page 5 of 8). BIORIAPD.WK1 30-Dec-88

ESE#	SPECIES	TISSUE	SEX	AGE	SAMPDATE	STATION ID	SITE DESCRIPTION	ARSENIC	MERCURY	ALDRIN	DIELDRIN	ENDRIN	DDE	DDT	COMMENTS
								CHEMICAL CONCENTRATIONS (UG/G)							
14	Fal spa	egg			860520	7NW	RMA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
15	Fal spa	egg			860520	5SE	RMA	NRQ	BDL	BDL	1.3	BDL	BDL	BDL	
16	Fal spa	egg			860520	5SW	RMA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
17	Fal spa	egg			860520	6SW	RMA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
18	Fal spa	egg			860520	24ST	RMA SEWG.TRT PLANT	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
19	Fal spa	egg			860520	8NE	RMA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
20	Fal spa	egg			860520	12NE	RMA	NRQ	BDL	BDL	1.18	BDL	BDL	BDL	
21	Fal spa	egg			860521	35SE	RMA	NRQ	BDL	BDL	2.87	BDL	BDL	BDL	
22	Fal spa	egg			860521	27SE	RMA	NRQ	BDL	BDL	0.199	BDL	BDL	BDL	
23	Fal spa	egg			860521	30SW	RMA	NRQ	BDL	BDL	0.054	BDL	BDL	BDL	
24	Fal spa	egg			860521	FTCOLLGM	GARY MILLER FT.COLL	NRQ	BDL	BDL	BDL	BDL	0.837	BDL	
25	Fal spa	egg			860522	BIGTHOM	BIGTHOM R NEAR DRAKE	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
26	Fal spa	egg			860522	FTCOLLMP	FTCOLL MARTINAS PARK	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
27	Fal spa	egg			860603	FTCOLLC1	FT COLLINS BOX C 1	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
28	Fal spa	egg			860603	BARRLAKE65	BARR LAKE BOX 65	NRQ	BDL	BDL	BDL	BDL	1.04	BDL	
29	Fal spa	egg			860608	25NE	RMA	NRQ	BDL	GONE	GONE	GONE	GONE	GONE	
30	Fal spa	egg			860612	CRAWBTTT	SO OF HOT SULF SPRGS	NRQ	0.057	BDL	BDL	BDL	BDL	BDL	
31	Fal spa	egg			860619	KB75	POUDRE R. BOX 75	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
118	Fal spa	egg			860729	23SW	RMA BOX 121	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
131	Fal spa	egg			860619	BIGTHOM	BIGTHOM R NEAR MARMS	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
132	Fal spa	egg			860623	15SE	RMA	NRQ	BDL	BDL	3.63	BDL	BDL	BDL	
133	Fal spa	egg			860624	9NE	RMA	NRQ	BDL	BDL	0.332	BDL	1.25	BDL	
134	Fal spa	egg			860624	9SW	RMA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
135	Fal spa	egg			860708	29NW	RMA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
136	Fal spa	egg			860708	29NW	RMA	NRQ	BDL	BDL	BDL	BDL	BDL	BDL	
137	Fal spa	egg			860708	27SE	RMA	NRQ	0.065	BDL	>0.300	BDL	BDL	BDL	
138	Fal spa	egg			860708	27SE	RMA	NRQ	0.088	BDL	1.74	BDL	BDL	BDL	
139	Fal spa	egg			860708	27SE	RMA	NRQ	0.087	BDL	1.38	BDL	BDL	BDL	
140	Fal spa	egg			860708	27SE	RMA	NRQ	0.067	BDL	>.300	BDL	BDL	BDL	
141	Fal spa	egg			860708	2NW	RMA	NRQ	0.259	BDL	>.300	BDL	BDL	BDL	
142	Fal spa	egg			860708	2NE	RMA	NRQ	0.299	BDL	>.300	BDL	BDL	BDL	
143	Fal spa	egg			860708	2NW	RMA	NRQ	0.405	BDL	0.428	BDL	BDL	BDL	
605	Ful ame	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	1.32	BDL	0.289	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
607	Ful ame	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.3	BDL	BDL	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
613	Ful ame	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	1.45	BDL	0.195	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
615	Ful ame	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.741	BDL	0.24	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
617	Ful ame	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.971	BDL	0.106	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
619	Ful ame	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	1.19	BDL	0.198	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
621	Ful ame	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	1.08	BDL	0.449	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
623	Ful ame	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	1.77	BDL	0.384	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
625	Ful ame	liver	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.883	BDL	0.693	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
604	Ful ame	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.219	BDL	0.392	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
606	Ful ame	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
612	Ful ame	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.162	BDL	1.77	BDL	0.113	BDL	1984 - 1985 USFWS SAMPLES
614	Ful ame	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.102	BDL	0.405	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
616	Ful ame	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.161	BDL	0.486	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
618	Ful ame	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.178	BDL	0.383	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
620	Ful ame	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.178	BDL	0.352	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES

ESE#	SPECIES	TISSUE	SEX	AGE	SAMPDATE	STATION ID	SITE DESCRIPTION	ARSENIC	MERCURY	ALDRIN	DIELDRIN	ENDRIN	DDE	DDT	COMMENTS
								CHEMICAL CONCENTRATIONS (UG/G)							
622	Ful ame	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.339	BDL	0.587	BDL	0.146	BDL	1984 - 1985 USFWS SAMPLES
624	Ful ame	muscle	UNK	ADULT	850912	UPPDERBY	RMA	BDL	0.25	BDL	0.376	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES
129	Grasshppr				860917	BASINA	RMA	6.6	0.108	BDL	0.422	BDL	BDL	BDL	
418	Grasshpprs				870812	BASINA	RMA	0.987	BDL	BDL	0.271	BDL	BDL	BDL	
419	Grasshpprs				870812	BASINA	RMA	0.905	BDL	BDL	0.386	BDL	BDL	BDL	
483	Grasshpprs				870812	BASINA	RMA, BASIN A	4.2	0.072	BDL	0.446	BDL	BDL	BDL	
487	Grasshpprs				870814	NWSNE7	NW SEC 8, NE SEC.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
488	Grasshpprs				870814	BASINC	NORTH PART OF BAS.C.	BDL	BDL	0.161	1.19	0.145	BDL	BDL	
489	Grasshpprs				870819	EBASINF	EAST OF BAS.F.SEC.26	BDL	BDL	0.153	1.23	0.283	BDL	BDL	
490	Grasshpprs				870819	EBASINF	EAST OF BAS.F.SEC 26	BDL	BDL	5.8	7.2	1.65	BDL	BDL	
491	Grasshpprs				870819	BASINC	NORTH PART OF BAS.C.	BDL	BDL	0.046	0.496	BDL	BDL	BDL	
492	Grasshpprs				870827	AEP	AURORA ENVIRON PARK	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
493	Grasshpprs				870831	NWSNE7	NW SEC 8, NE SEC.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
494	Grasshpprs				870902	NWSNE7	NW SEC 8, NE SEC.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
495	Grasshpprs				870914	AEP	AURORA ENVIRON PARK	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
482	Hal leu	egg/embryo			870505	BARRLAKEBE	BALD EAGL NEST, B.L.	BDL	0.099	BDL	0.808	BDL	6.93	BDL	
420	Hel spp.	flowers			870812	BASINA	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
496	Hel spp.	flowers			870804	BASINA	RMA, BASIN A	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
500	Hel spp.	flowers			870812	BASINA	RMA, BASIN A	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
504	Hel spp.	flowers			870804	19E	EAST HALF SEC.19	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
505	Hel spp.	flowers			870804	BASINC	NORTH PART OF BAS.C.	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
576	Hel spp.	flowers			870804	BASINA	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	FROM ESE 416UP
577	Hel spp.	flowers			870804	BASINA	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	FROM ESE 417DC
415	Hel spp.	leaves			870804	BASINA	RMA	0.419	BDL	BDL	BDL	BDL	NRQ	NRQ	
416	Hel spp.	leaves			870804	BASINA	RMA	1.01	BDL	BDL	BDL	BDL	NRQ	NRQ	
417	Hel spp.	leaves			870812	BASINA	RMA	0.784	BDL	BDL	BDL	BDL	NRQ	NRQ	
501	Hel spp.	leaves			870804	19E	EAST HALF SEC 19	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
506	Hel spp.	leaves			870804	BASINC	NORTH PART OF BAS.C.	BDL	BDL	BDL	>0.300	0.188	NRQ	NRQ	
578	Hel spp.	leaves			870804	BASINA	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	FROM ESE 420DC
579	Hel spp.	leaves			870804	BASINA	RMA	4.51	BDL	BDL	BDL	BDL	NRQ	NRQ	FROM ESE 500DC
67	Odo hem	liver	F	ADULT	860620	1NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
176	Odo hem	liver	M	ADULT	861208	PAWNEELG	PAW.NAT.GRS.LOGAN CO	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	FROM ESE 175
191	Odo hem	liver	M	ADULT	861010	26S	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	FROM ESE 190
195	Odo hem	liver	M	ADULT	861005	1NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
345	Odo hem	liver	M	ADULT	861009	BASINF	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
346	Odo hem	liver	M	ADULT	861006	11SW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
367	Odo hem	liver	M	ADULT	861115	WELLING	WLNGTNSTAT.WILD.AREA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
453	Odo hem	liver	M	ADULT	861006	RNW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
456	Odo hem	liver	M	ADULT	861007	35NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
461	Odo hem	liver	M	ADULT	861007	31SW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
466	Odo hem	liver	M	ADULT	861008	1SE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
467	Odo hem	liver	M	ADULT	861015	27SE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
474	Odo hem	liver	M	ADULT	861015	1NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
548	Odo hem	liver	M	ADULT	871210	1D7	SEC 1 AT D AND 7TH	BDL	BDL	BDL	0.187	BDL	NRQ	NRQ	
557	Odo hem	liver	M	ADULT	880106	24NW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
561	Odo hem	liver	M	ADULT	880106	36NW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
69	Odo hem	muscle	F	ADULT	860620	1NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
177	Odo hem	muscle	M	ADULT	861208	PAWNEELG	PAW.NAT.GRS.LOGAN CO	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	FROM ESE 175

ESE#	SPECIES	TISSUE	SEX	AGE	SAMPDATE	STATION ID	SITE DESCRIPTION	ARSENIC	MERCURY	ALDRIN	DIELDRIN	ENDRIN	DDE	DDT	COMMENTS
								CHEMICAL CONCENTRATIONS (UG/G)							
194	Odo hem	muscle	M	ADULT	861010	26S	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	FROM ESE 190
199	Odo hem	muscle	M	ADULT	861006	7NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	FROM ESE 195
348	Odo hem	muscle	M	ADULT	861019	BASINF	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
347	Odo hem	muscle	M	ADULT	861006	31SW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
394	Odo hem	muscle	M	ADULT	861115	WELLING	WLNGTNSTAT.WILD.AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
458	Odo hem	muscle	M	ADULT	861006	6NW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
455	Odo hem	muscle	M	ADULT	861007	1SNE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
457	Odo hem	muscle	M	ADULT	861007	31SW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
464	Odo hem	muscle	M	ADULT	861008	1SE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
471	Odo hem	muscle	M	ADULT	861015	23SE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
473	Odo hem	muscle	M	ADULT	861015	1NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
551	Odo hem	muscle	M	ADULT	871210	107	SEC 1 AT D AND 7TH	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
554	Odo hem	muscle	M	ADULT	880106	24NW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
553	Odo hem	muscle	M	ADULT	880106	NW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
99	Pha col	carcass	UNK	JUV	860807	LARIMERP.D	LAR.CO. NO.OF WLNGTN	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
100	Pha col	carcass	M	JUV	860811	LARIMERP.D	LAR CO. NO OF WLNGTN	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
102	Pha col	carcass	M	JUV	860812	2N	RMA EAST SIDE SEC. 2?	1.82	BDL	BDL	BDL	BDL	BDL	BDL	
103	Pha col	carcass	M	JUV	860812	25W	RMA	0.887	BDL	BDL	BDL	BDL	BDL	BDL	
104	Pha col	carcass	M	JUV	860812	25W	RMA	BDL	BDL	BDL	0.214	BDL	BDL	BDL	
105	Pha col	carcass	M	JUV	860813	WELLING	WLNGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
106	Pha col	carcass	M	JUV	860813	WELLING	WLNGTNSTAT.WILD AREA	0.72	BDL	BDL	BDL	BDL	BDL	BDL	
107	Pha col	carcass	M	JUV	860814	WELLING	WLNGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
108	Pha col	carcass	F	JUV	860815	15WS	RMA SW SURF. IN SEC. 1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
109	Pha col	carcass	M	JUV	860815	15WS	RMA SW SURF. IN SEC 1	0.491	BDL	BDL	BDL	BDL	BDL	BDL	
110	Pha col	carcass	F	JUV	860815	NBASINF	RMA NORTH OF BASIN F	BDL	BDL	BDL	1.13	BDL	BDL	BDL	
113	Pha col	carcass	F	JUV	860818	BASINF	BASIN F	BDL	BDL	BDL	0.35	BDL	BDL	BDL	
114	Pha col	carcass	F	JUV	860818	6NE	RMA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
115	Pha col	carcass	F	JUV	860820	WELLING	WLNGTNSTAT.WILD.AREA	1.4	BDL	BDL	BDL	BDL	BDL	BDL	
116	Pha col	carcass	M	JUV	860821	WELLING	WLNGTNSTAT WILD.AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
117	Pha col	carcass	UNK	JUV	860822	WELLING	WLNGTNSTAT.WILD.AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
201	Pha col	carcass	F	ADULT	860808	15WS	RMA SW SURF. IN SEC. 1	BDL	BDL	BDL	2.92	BDL	BDL	BDL	
204	Pha col	carcass	F	ADULT	860811	24E9	RMA AT E AND 9TH	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
207	Pha col	carcass	F	ADULT	860814	WELLING	WLNGTNSTAT.WILD.AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
210	Pha col	carcass	F	ADULT	860920	WELLING	WLNGTNSTAT.WILD.AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
225	Pha col	carcass	M	JUV	860923	26NW	RMA	BDL	BDL	BDL	0.242	BDL	BDL	BDL	
228	Pha col	carcass	M	JUV	860923	26NW	RMA	BDL	BDL	BDL	0.682	BDL	BDL	BDL	
236	Pha col	carcass	M	JUV	860923	24ST	RMA SEWG.TRT.PLANT	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
239	Pha col	carcass	M	ADULT	860923	30SW	RMA	BDL	BDL	BDL	0.047	BDL	BDL	BDL	
245	Pha col	carcass	M	ADULT	860921	2NW	RMA	BDL	BDL	BDL	0.085	BDL	NRQ	NRQ	
280	Pha col	carcass	M	JUV	861001	15WS	RMA LK. DERBY AREA	HELD	HELD	BDL	BDL	BDL	NRQ	NRQ	
330	Pha col	carcass	M	JUV	861115	WELLING	WLNGTNSTAT.WILD AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
333	Pha col	carcass	M	JUV	861120	WAVERLY	5MILES S OF WELLNGTN	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
336	Pha col	carcass	M	JUV	861120	WAVERLY	5MILES S.OF WELLNGTN	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
359	Pha col	carcass	M	JUV	860910	LARIMERP D	LAR CO. COUNT CLUB	NRQ	NRQ	BDL	18.6	BDL	1.14	BDL	
32	Pha col	egg			860529	25E	RMA	BDL	BDL	BDL	0.144	BDL	BDL	BDL	
33	Pha col	egg			860530	25E	RMA	BDL	BDL	BDL	0.106	BDL	BDL	BDL	
34	Pha col	egg			860530	31NW	RMA	BDL	BDL	BDL	0.17	BDL	BDL	BDL	
35	Pha col	egg			860530	31SW	RMA	BDL	BDL	BDL	0.205	BDL	BDL	BDL	

ESE#	SPECIES	TISSUE	SEX	AGE	SAMPDATE	STATION ID	SITE DESCRIPTION	ARSENIC	MERCURY	ALDRIN	DIELDRIN	ENDRIN	DDE	DDT	COMMENTS
								CHEMICAL CONCENTRATIONS (UG/G)							
36	Pha col	egg			860604	25NE	RMA	BDL	BDL	BDL	0.128	BDL	BDL	BDL	
37	Pha col	egg			860604	24NE	RMA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
38	Pha col	egg			860604	24NE	RMA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
39	Pha col	egg			860609	SPLANTS	RMA	BDL	BDL	BDL	5.38	BDL	BDL	BDL	
40	Pha col	egg			860611	WELLING	W NGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
41	Pha col	egg			860611	WELLING	W NGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
42	Pha col	egg			860615	WELLING	W NGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
43	Pha col	egg			860618	WELLING	W NGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
44	Pha col	egg			860618	WELLING	W NGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
45	Pha col	egg			860618	WELLING	W NGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
46	Pha col	egg			860620	WELLING	W NGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
47	Pha col	egg			860606	1SE	RMA	BDL	BDL	BDL	2.93	BDL	BDL	BDL	
48	Pha col	egg			860608	2NE	RMA EAST SIDE SEC.2?	BDL	BDL	BDL	2.05	0.143	BDL	BDL	
49	Pha col	egg			860630	WELLING	W NGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
50	Pha col	egg			860701	WELLING	W NGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
51	Pha col	egg			860703	WELLING	W NGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
144	Pha col	egg			860604	25E	RMA	BDL	BDL	BDL	0.689	BDL	NRQ	NRQ	
123	Syl aud	muscle	M	ADULT	860910	26NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
233	Syl aud	muscle	M	ADULT	860921	19NW	RMA PISTOL RANGE	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	brain to ese713
262	Syl aud	muscle	M	ADULT	860926	19NW	RMA PISTOL RANGE	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	brain to ese714
265	Syl aud	muscle	M	ADULT	861007	19NW	RMA PISTOL RANGE	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	brain to ese710
268	Syl aud	muscle	M	ADULT	861007	19NW	RMA PISTOL RANGE	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	brain to ese711
271	Syl aud	muscle	M	ADULT	861008	26NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	brain to ese715
274	Syl aud	muscle	M	ADULT	861010	36SW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	brain to ese712
277	Syl aud	muscle	M	ADULT	861010	36SW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	brain to ese730
283	Syl aud	muscle	M	ADULT	861015	36SW	RMA	BDL	BDL	BDL	0.033	BDL	NRQ	NRQ	
291	Syl aud	muscle	M	ADULT	861015	36SW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
294	Syl aud	muscle	M	ADULT	861015	36SW	RMA	BDL	BDL	BDL	0.048	BDL	NRQ	NRQ	
297	Syl aud	muscle	M	ADULT	861015	36SW	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
300	Syl aud	muscle	F	ADULT	861015	36SW	RMA	BDL	BDL	BDL	0.092	BDL	NRQ	NRQ	
301	Syl aud	muscle	F	ADULT	861015	26NE	RMA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
305	Syl aud	muscle	M	ADULT	861124	WELLING	W NGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
309	Syl aud	[illegible]	M	ADULT	861118	LARIMERDC	NEAR HORSETOOTH RES.	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
312	Syl aud	muscle	M	ADULT	861119	LARIMERDC	NEAR HORSETOOTH RES.	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
315	Syl aud	muscle	M	ADULT	861120	WELLING	W NGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
318	Syl aud	muscle	M	ADULT	861117	LARIMERDC	NEAR HORSETOOTH RES.	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
321	Syl aud	muscle	F	ADULT	861128	WELLING	W NGTNSTAT WILD AREA	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
324	Syl aud	muscle	M	ADULT	861117	LARIMERDC	NEAR HORSETOOTH RES.	BDL	BDL	BDL	BDL	BDL	NRQ	NRQ	
327	Syl aud	muscle	M	ADULT	861202	WELLING	W NGTNSTAT WILD AREA								
565	Syl aud	muscle	F	ADULT	880222	BLDG111	RMA SEC.35,BUILD.111								
428	Tax tax	kidneys	M	ADULT	860320	25E	RMA	NRQ	NRQ	BDL	0.801	BDL	NRQ	NRQ	
427	Tax tax	liver	M	ADULT	860320	25E	RMA	BDL	BDL	BDL	1.64	BDL	NRQ	NRQ	
530	Zen mac	liver	UNK	ADULT	871211	11SE	ESE TRAILER PARK	BDL	BDL	BDL	7.17	3.74	BDL	BDL	FROM ESE 123
638	Zen mac	carcass	UNK	ADULT	860606	35SE	[illegible]	BDL	BDL	1.81	56.3	3.44	BDL	BDL	1984 - 1985 USFWS SAMPLES
639	Zen mac	carcass	UNK	ADULT	860605	35SE	RMA	BDL	BDL	0.613	5.57	BDL	BDL	BDL	1984 - 1985 USFWS SAMPLES

Note: With Site Descriptions of "RMA", sample location is generally the 1/4 or quarter section described by the Site ID. The "Species" column contains the first three letters of the Genus/Species name (beside the obvious exceptions). Complete species names may be found in Appendix A.