APPENDIX C
(SECTION C.5)

ECOLOGICAL STATUS AND HEALTH

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µg/g	micrograms per gram
AChE	acetylcholinesterase
Army	U.S. Department of the Army
BEMA	Bald Eagle Management Area
BMF	biomagnification factor
BSAs	biota study areas
Buckley	Buckley Air National Guard Base
CRL	certified reporting limit
CMP	Comprehensive Monitoring Program
COC	contaminant of concern
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
EPA	U.S. Environmental Protection Agency
ERC	Ecological Risk Characterization
ESC	estimated soil area concentrations
FDA	U.S. Food and Drug Administration
FR	Federal Register
ft	foot
ft^2	square foot/feet
HI	hazard index
IEA	Integrated Endangerment Assessment
km	kilometer
MATC	maximum allowable tissue concentration
MKE	Morrison-Knudsen Environmental
PCC	Plains Conservation Center
ppm	parts per million
RI	Remedial Investigation
RMA	Rocky Mountain Arsenal
RTIC	Rocky Mountain Arsenal Technical Information Center
Shell	Shell Oil Company
USFWS	U.S. Fish and Wildlife Service

C.5 ECOLOGICAL STATUS AND HEALTH

C.5.1 INTRODUCTION

Information on the ecological status and health of biota populations and communities at Rocky Mountain Arsenal (RMA) was provided to fulfill two general objectives: to provide a general characterization of plant communities, animal habitats, populations and communities at RMA from a regional perspective, and to evaluate the potential for specific ecological effects of RMA contaminants on biota as revealed by defined ecological-effect endpoints. The first objective is consistent with the U.S. Environmental Protection Agency (EPA) guidance on providing site characterization, which provides a context within which to consider risk to receptors of potential contaminants when pathways exist from abiotic media such as soil, sediment, and water. The second objective is consistent with the effects evaluation portion of an ecological risk assessment (EPA 1989a, 1992a) since it identifies the effects of contamination on populations or communities when endpoints appropriate to the contaminants of concern (COCs) have been measured. The studies used for characterizing RMA biota and for the evaluation of effects come from a variety of existing documents that are published and available in the RMA Technical Information Center (RTIC) at RMA, including the Biota Remedial Investigation (RI) (ESE 1989), Biota Comprehensive Monitoring Program (CMP) (RLSA 1990, 1992), and various U.S. Fish and Wildlife (USFWS) studies.

This ecological status and health section is not intended to offset the quantitative characterization of potential ecological risk based on toxicological endpoints. Rather, it is intended to provide context and additional information to guide the interpretation and application of the results of the quantitative characterization of potential ecological risk.

Ecological risk assessment guidance (EPA 1989a) emphasizes and defines effects at the population and community levels. This guidance discusses lethal and sublethal toxicant effects in the context of their impacts at the population level. Updates to current EPA risk assessment guidance acknowledge that while contaminant exposure occurs at the level of an individual organism, populations, communities, and ecosystems are the crucial levels on which to focus

evaluation and management (EPA 1992a, b). In keeping with EPA guidance (1989a) this section incorporates information on the health and status of the population, community, and ecosystem and health at RMA from all available and pertinent sources.

Ecological health must be defined in the context of contaminant effects. For purposes of this risk assessment, ecological health is defined as consisting of the normal range of those ecological characteristics identified by EPA (1989a, pg. 42 to 43) as providing a basis for selecting appropriate assessment endpoints. A population is defined as the individuals of an interbreeding group of organisms of the same species (Hickman et al. 1979). Contamination effects are evaluated in the context of their impacts on populations. Populations are appropriately defined on a species-specific basis. For sedentary species, populations may be definable within the confines of specific contaminated sites. For more mobile species, however, populations cannot be defined and population parameters cannot be measured at anything less than an RMA-wide scale. Such individuals utilize ranges that include contaminated and uncontaminated areas and occasionally include more than one contaminated area. It is these mobile, upper-trophic level species that would be expected to be most sensitive to contaminant effects and that must be assessed in the context of their inclusion in populations that extend beyond the RMA boundaries. These are populations that occupy a particular region characterized by a habitat or habitats that are more or less contiguous and occur within a major biogeographic region (e.g., short grass prairie and associated habitats such as riparian woodland, pasture land, and wetlands).

RMA is unusual among Superfund sites in that it contains extensive areas with low levels of contamination as well as several areas with high levels of contamination. Some other very important attributes of RMA are its large size (27 square miles), proximity to a major urban area, extensive areas of native grassland habitat, and sizable populations of deer, prairie dogs, and raptors. Along the Colorado Front Range—and nationwide—these characteristics make RMA a very unique site for an ecological risk assessment.

C.5.2 ECOLOGICAL CHARACTERIZATION AND STATUS

To provide a context for the consideration of potential risk, ecological data are used to characterize the plant communities, the wildlife habitats these communities provide, and the wildlife species that are present in these communities. This section describes the ecosystems at RMA.

C.5.2.1 Plant Communities and Animal Habitats at Rocky Mountain Arsenal

The structure of RMA plant communities and the wildlife habitats they provide results from interactions between native and introduced species of plants and animals, historical and current land-use practices, and abiotic factors such as climate, geology, and topography. RMA is situated within a temperate grassland region and is part of a broad ecotone (transition zone) between montane and plains habitats. Native vegetation of the region consists primarily of open semiarid grasslands, with some areas of yucca, shrubland, woodland, and riparian habitats. Human societal changes in the region have altered the landscape to a mosaic of agricultural, developed (industrial facilities, residential areas, and successional parcels), and native habitats. At present, 41 percent of the RMA land surface supports early successional vegetation communities; an additional 19 percent of RMA land surface is vegetated by crested wheatgrass, which was used in the 1930s and 1940s to stabilize erodible land (MKE 1989b). The remainder of the vegetated land surface at RMA consists of native grassland (28 percent), and smaller areas with shrubland, patches of yucca, riparian woodlands, cattail marshes and other wetland types, locust and wild plum thickets, upland groves of deciduous trees, and ornamental plantings that collectively comprise the remaining 12 percent of RMA (MKE 1989b; Attachment C.5-2, Rocky Mountain Arsenal Vegetation Classification Map). Each of these varied vegetative groups provides potential wildlife habitat.

The occurrence of native forbs in the grassland areas is variable depending upon substrate and climate (MKE 1989b). Common perennial forbs in addition to those already named include American vetch, prairie clover, silvery lupine, narrowleaf and white penstemon, prairie coneflower, prairie aster, hairy golden-aster, western wallflower, scarlet globemallow, scarlet

butterfly-weed, skeleton-weed, green-thread, evening primrose, sand verbena, and wild buckwheat. Prickly pear cactus and pasture sage may be locally abundant. Annual forbs include woolly plantain, prairie peppergrass, and narrowleaf goosefoot. Six-weeks fescue, an annual grass, is a widespread component of all grasslands.

Riparian woodlands and associated wetland areas occur along water courses. Plains cottonwood and peachleaf willow dominate the overstory, with lesser numbers of box-elder. The understory includes shrubby willows as well as a variety of midgrass and tallgrass species such as yellow Indiangrass, slender wheatgrass, switchgrass, and Canada wildrye. Golden currant, wild rose, chokecherry, and snowberry may also occur in moist areas, and wild plum and hawthorn may form dense thickets in such sites. Cattails and bulrushes may dominate minor drainages. Western wheatgrass and inland saltgrass are conspicuous dominants on bottomlands with finer saline soils.

The occurrence of shrubs and subshrubs is also variable, depending upon substrate and topography. Fringed sage, rubber rabbitbrush, broom snakeweed, and winterfat clusters occur on coarse soils. Sand sagebrush occurs on deep sand soils and yucca on areas where bedrock is near the soil surface. Each of these shrubland types is somewhat limited both at RMA and regionally due to agricultural conversion to cropland and development. Much of the wildlife at RMA depends on the habitat values that shrubland areas provide. There are also many windbreaks and thickets of New Mexico locust (which is a result of landscaping activity by previous landowners) that provide many of the same habitat values as shrublands, but have greater structural diversity.

Non-native weedy forbs and grasses are widespread at RMA as a result of abandoned agricultural fields or other surface disturbances (e.g., tracks and disturbances from vehicular traffic associated with military maneuvers, facility maintenance, and off-road traffic) that removed the existing vegetation but was not followed by revegetation with perennial cover. Further, plant-community development is very slow in the semiarid climate at RMA, especially after exotic, weedy

vegetation is established. Even though dominated by "less desirable" vegetation, weedy habitat receives considerable use by wildlife. In addition, annual and perennial weedy forbs present in other habitats provide forage for a variety of wildlife.

Some minor habitat modification projects have been conducted by USFWS and Shell Oil Company (Shell) to improve habitat for selected wildlife species. While these projects have necessarily involved the alteration of certain habitats through an initial plowing, the total acreage is minimal (i.e., less than 500 acres total), the habitats impacted were of uniformly low wildlife value (e.g., cheatgrass habitats), and the period of low resource availability was restricted to 1 year or less. Although it has not been specifically assessed, the effects of these habitat modification projects on wildlife are expected to have been more beneficial than deleterious.

C.5.2.2 Animals at Rocky Mountain Arsenal

Formal ecological inventories of the biota resources at RMA began in the mid-1970s (RLSA 1988). These inventories have documented a diversity of species that vary in their habitat selectivity. Some species are generally confined to specific habitat types (e.g., Brewer's sparrow requires sagebrush shrublands), while other species inhabit a range of habitat types (e.g., black-billed magpie and coyote can be found in all terrestrial habitats at RMA). For RMA fish communities, management history also plays a particularly important role in determining the species present and their population dynamics.

The species of wildlife, fish, and other terrestrial or aquatic organisms at RMA serve as potential receptors of RMA contaminants present in the soil, sediment, or water of RMA when an exposure pathway is present that allows contaminant uptake. Species that grow in, burrow in, or ingest soil or sediment or that take dust baths in soil may take in contaminants that are present on soil particles. Similarly, species that ingest water or swim in it may take in contaminants that are dissolved in water or adhering to sediment particles suspended in the water. Contaminants that enter RMA food webs in this way are passed from prey to predator species.

C.5.2.2.1 Mammals

Twenty-six species of mammals have been observed at RMA (Attachment C.5-1, Table 2), including all of the common mammals that inhabit the prairie grasslands of the Colorado Front Range (Armstrong 1972; Bissel and Dillon 1982). Desert cottontails, black-tailed jackrabbits, thirteen-lined ground squirrels, black-tailed prairie dogs, kangaroo rats, and numerous other small mammal species make up the major prey base at RMA. Badgers and coyotes are the principle carnivores. Mule deer are abundant in all habitats, and white-tailed deer frequent the riparian woodlands. Areas of musk thistle and cheatgrass can provide cover and green forage for deer in the winter, wetlands occasionally support muskrats and raccoons, and shelter belts provide habitat for fox squirrels, striped skunks, foxes, and other mammals.

C.5.2.2.2 Birds

RMA habitats are primarily open grassland and weedy plains, and a variety of ground-nesting songbirds and other birds preferring such open habitat are common (Attachment C.5-1, Table 1). At least two regionally rare or declining species (Cassin's sparrow and Brewer's sparrow) are relatively common breeding birds at RMA (Webb et al. 1991). Regionally, these two species are restricted to ungrazed sites with dense cover.

Prairie rangelands are often interspersed by woodland, shrubland, or landscaped areas whose trees and shrubs provide potential nesting habitat for raptors, songbirds, and other taxa. Raptor population density and species diversity are comparable to these characteristics of other regional sites (MKE 1989a). Winter raptor populations, particularly of the bald eagle, are a primary attraction for the 20,000 to 30,000 visitors to RMA during this season (USFWS 1992b).

Riparian corridors, woodlands, wetlands, and aquatic habitats also attract particular assemblages of bird species. Areas dominated by an overstory of musk thistle and an understory of cheatgrass support numerous pairs of lark buntings during the summer. In general, the RMA avifauna in these habitats is similar to that in comparable local habitats in the region (MKE 1989a), although the bald eagle winter roost at RMA is one of only five such sites in the region.

One hundred seventy-six species of birds (approximately 40 percent of all bird species recorded in the state of Colorado [Bailey and Niedrach 1965; Chase et al. 1982]) have been observed at RMA (Attachment C.5-1, Table 1). The species richness of RMA avifauna is high relative to that in the region. There is an official Breeding Bird Survey route established on RMA. This route has been assigned to Stratum 36 of the Breeding Bird Survey system on the basis of its natural land use. The breeding bird survey conducted at RMA in 1991 documented 1,456 individuals of 51 species, which was the highest recorded species richness in the region in 1991 (USFWS 1992c). No other route in Stratum 36 has recorded more than 50 species since 1968 (Peterjohn, per. comm.). In 1992 and 1993, RMA recorded 39 and 42 species, respectively (USFWS 1994).

C.5.2.2.3 Reptiles and Amphibians

Although reptiles and amphibians are not common at RMA, several species may be encountered in nearly every habitat type. Incidental observation has recorded 61 percent or 17 of the 28 species of reptiles and amphibians that could potentially occur at RMA (Attachment C.5-1, Table 4). The native grasslands support plains spadefoot toad, short-horned lizard, lesser earless lizard, and prairie rattlesnake. A great number and variety of amphibians and reptiles occur in riparian habitat, including the littoral zone of permanent water and temporary pools. Commonly observed species include tiger salamander, striped chorus frog, leopard frog, painted turtle, and various garter snakes. Other reptiles and amphibians are more or less ubiquitous at RMA. These include plains garter snake, bull snake, eastern yellow-bellied racer, and Woodhouse's toad.

C.5.2.2.4 Aquatic Life

The aquatic resources of RMA include four sizable impoundments (i.e., Upper Derby Lake, Lower Derby Lake, Lake Ladora, and Lake Mary) and one smaller nearby water body (Rod and Gun Club Pond), collectively referred to as the Lower Lakes; three minor water bodies (i.e., North Bog Pond, Havana Pond, and Toxic Storage Yard Pond); and a fairly persistent stream (First Creek). Of these resources, the Lower Lakes occupy the largest volume and support the largest extent of RMA's fisheries, waterfowl, and littoral and limnetic habitats. The Lower Lakes

(except Rod and Gun Club Pond) were also a part of the cooling system for the South Plants manufacturing facilities and so received contaminant input from periodic leaks and spills.

Due to the extensive wildlife, fisheries, and recreational resources they support, as well as to the concurrent issues of contamination, the Lower Lakes have received a good bit of attention from biological investigators since the early 1950s. Waterfowl mortality in the Lower Lakes was one of the first indications of wildlife damages related to operations at RMA. While there had once apparently been a fishery in these lakes, there were no fish present in 1951 (Hyman 1953). Several years later, it was reported that there were no fish or amphibians in the Lower Lakes and that waterfowl die off was estimated to be 2,000 birds per year in late winter and early spring when mud flats were exposed and migrations brought large numbers to the area (Finley 1959). In 1964 and 1965, Upper and Lower Derby Lakes and Lake Ladora were drained and the sediments were removed in an effort to clean the lakes (Rosenlund et al. 1986).

Fisheries were established in the Lower Lakes through stocking in the late 1960s (Bartschi 1968) and population and status trends were monitored on a fairly regular basis through the 1970s (U.S. Army 1973; Bartschi 1975; Rocky Mountain Fisheries Consultants 1977). Species identified in the RMA lakes are listed in Attachment C.5-1, Table 3. While the fisheries have required active management, they have generally been productive with respect to growth and numbers of individuals. In addition to the periodic addition of predatory and/or prey species, the lakes have been managed by adjusting the water levels.

Despite these efforts, contaminants have been reported to occur in the sediments of all four of the large Lower Lakes (Myers et al. 1983; Myers and Greg 1984; Bergersen et al. 1984). Dieldrin and aldrin were the most ubiquitous of contaminants found, with an average dieldrin level in Lower Derby Lake of 0.034 micrograms per gram (µg/g). In Upper and Lower Derby Lakes and Lake Ladora, contaminants reached their highest levels in the upper organic sediments near the inflow points and in the deepest parts of the lakes. In Lake Mary, the contaminants were distributed more evenly through the upper sediments of the lake. Contaminant levels in the

lake water itself were generally below detection limits for all of the bodies of water that were measured. Rosenlund et al. (1986) reported no water samples with contaminant levels above detection limits for any of the four larger lakes. Myers and Greg (1984) reported one water sample from Lake Mary had a dieldrin concentration of 0.02 μg/g.

Contaminants have also been reported to occur in the tissues of the fishes of the Lower Lakes by a number of studies conducted during the 1970s and 1980s (U.S. Army 1975; Thorne 1982; Rosenlund et al. 1986). Rosenlund et al. (1986) reported that, although the principle contaminant sink lies in the sediments, some of the COCs are available to the system via a process of uptake and mobilization by the aquatic vascular plants. They found widespread levels of aldrin and dieldrin that were above detection limits in the biota for these lakes and found a general trend for bioconcentration and bioaccumulation, with the highest levels found in the fatty tissues of the top predator fishes (i.e., largemouth bass and pike). These levels were generally below the U.S. Food and Drug Administration (FDA) action guidelines for commercial fish products (Rosenlund et al. 1986).

MKE (1989c) conducted population-level assessments of the phytoplankton, zooplankton, macroinvertebrate, macrophyte, and fish populations of the Lower Lakes, comparing each of the populations to the rest and to populations in an off-post control lake (McKay Lake, Adams County, Colorado). The control lake was selected because it is similar to the Lower Lakes in size, morphometry, substrate, and fish species composition. The biota communities of the Lower Lakes were generally found to be comparable to the off-post lake and within the expected ranges. The fish communities were "healthy, reproducing and included many large individuals." Differences did occur both between the RMA and control lakes and among RMA lakes themselves. These differences appeared to be predominately attributable to differences in stocking (e.g., predator species introduced) and management regime (e.g., macrophyte density), and not to any trends of contamination. It is imperative that such results of management not be construed as indicative of contaminant effects. For example, in discussing the disappearance of

bullheads from the RMA lakes, USFWS (1993a) states that "bullheads have successfully been eliminated" as a result of stocking of predator species.

USFWS has assessed RMA's fisheries since 1979 through standardized gill net sampling, electrofishing, and an angler satisfaction survey (USFWS 1993a). The focus of this sampling program, as reported, is on the "maintenance of a high quality sport fishery." Data from these samples indicate that populations are within normal parameters of growth rate, weight/length ratio, and numeric distribution for lakes in the region. There are no apparent contaminant effects reported. Angler satisfaction is also very high for the RMA fisheries. There is an active Arsenal Anglers group that considers the RMA lakes the best warm-water fisheries of their type in the state. This is confirmed by a great demand for a limited number of fishing passes that are sold annually. An angler survey conducted by USFWS in 1992 reported that 95 percent of the anglers were satisfied with the number of fish captured, 80 percent were satisfied with the length of fish caught, and 95 percent were satisfied with the overall fishing experience (USFWS 1993a).

Population assessments of the non-avian aquatic resources seem to indicate that, although exposure pathways exist and bioaccumulation and bioconcentration have been demonstrated, there are no apparent effects on wildlife populations from contamination of the lakes. While the confounding effect of the long and extensive history of management of the lakes and their fisheries make it impossible to rule out the possibility that contaminant effects exist, no such effects are specifically indicated. Some concern has been raised, however, concerning the water birds that use the Lower Lakes (see Section C.5.3.2.2). There may also be potential for the levels of contamination found in the fishes to be bioaccumulated by predators such as the bald eagle or the great blue heron. While no discernable effects have been found in the wintering bald eagles, no data are available to assess the population of great blue herons that frequent RMA.

C.5.3 ECOLOGICAL EFFECT INVESTIGATIONS

Contaminant toxicity can produce adverse effects at the individual, population, community, and ecosystem level of organization (EPA 1989a). The ecological effect endpoints that provide pertinent evidence include both assessment endpoints and their associated measurement endpoints, a format appropriate to ecological risk assessments (EPA 1989a).

- Assessment endpoints are formal expressions of the actual environmental values that are to be protected
- The assessment endpoints are environmental characteristics, which, if they were found to be significantly affected, would indicate a need for remediation
- A measurement endpoint is a quantitative expression of an observed or measured effect of the hazard; it is a measurable environmental characteristic that is related to the valued characteristic chosen as an assessment endpoint

Selecting appropriate assessment and measurement endpoints, therefore, depends on the COCs, their toxic effects on individuals and the consequences of these effects at higher levels of ecological organization (EPA 1989a pg. 2-1 to 2-2).

Suter (1989) suggests the use of assessment endpoints to identify the ecological properties and processes that need to be protected or recovered. Given that quantification of assessment endpoints may be too difficult, expensive, or time consuming, surrogate indices or measurement endpoints may be used.

Ecological assessment and measurement endpoints should be reflective of relationships that may exist between contaminant effects and specific sites of contamination, between effects and specific contaminants, or between specific receptors and contaminants. Such endpoints may involve comparison to off-site control areas, comparison to on-site control areas, and/or within-sample correlations to assess these relationships. Suter suggests that indices such as occurrence, abundance, age/size class structure, reproductive performance, yield/production, frequency of gross morbidity, and frequency of mass mortality are valuable measures of population health.

The utility of such indices for the appraisal of ecosystem health and functionality is further supported by an extensive literature that defines the characteristics of disturbed systems (Odum 1985; Schindler 1987; Pratt and Bowens 1992).

EPA (1989a, b) suggests measuring a very similar set of ecological indices (i.e., population abundance, age structure, reproductive potential and fecundity, species diversity, food-web or trophic diversity, nutrient retention or loss, standing crop, and productivity) for use in characterizing the effects of contaminants on populations, communities, and ecosystems. The EPA further recognizes that certain receptors may be particularly important for measurement of endpoints by virtue of special status (e.g., threatened and endangered species), specific susceptibility to chemical contaminants, and/or representative status for specific exposure pathways.

Available data provide important insights into both the general robustness of RMA populations and communities and the extent and severity of potential contamination effects as indicators of ecological health. The investigation of contaminant effects on biota at RMA began with the documentation of waterfowl deaths and fish kills in the 1950s and continued intermittently through the 1970s, leading to the Biota RI studies, Biota CMP, and related USFWS and Shell investigations in the 1980s and 1990s. These studies are summarized in Appendix A. Although many of the ecological investigations used to examine potential contaminant effects were conducted prior to 1989 when EPA issued its initial guidance on conducting ecological risk assessments (EPA 1989a, b), they are consistent with this guidance. For example, although the RMA site encompasses approximately 27 square miles, actual contamination sources within the site are much smaller. Studies of sedentary species (e.g., plants, earthworms, grasshoppers) focused on contaminated areas within RMA to identify potential contaminant effects, while studies of more mobile species (e.g., deer) were conducted throughout RMA to evaluate effects on their RMA-wide populations. Some studies used both on- and off-post controls (e.g., earthworms and grasshoppers), while studies of more mobile species (e.g., waterfowl) used only off-post controls. Ecological effects investigations looked primarily at population-level effects

that could be related to RMA contaminants, such as population abundance and reproductive success. Effects at other levels of organization, including biomarkers in individuals (e.g., acetylcholinesterase [AChE] inhibition, eggshell thinning) and community-level effects (e.g., species richness) were also examined.

The criteria for selecting these effects and for conducting investigations were consistent with the selection of ecological endpoints under current EPA guidance (EPA 1989a). There is substantial information relating to appropriate ecological endpoints. Records on morbidity at RMA, for example, are available for nearly a 40-year time span (Hyman 1953; Sciple 1952; Jensen 1955; Finley 1959). Both qualitative and quantitative floral and faunal observations related to chemical contamination have been conducted intensively for more than a decade (ESE 1989; MKE 1989a, b; RLSA 1990a and 1992). More recently, studies by the USFWS have been conducted that address both contaminant and wildlife management issues. RMA-wide studies of deer, prairie dogs, and burrowing owls, and other species have looked at general population health, reproduction, and other aspects of the population biology of these species that are potential effects of contamination.

While some of these studies were conducted for management purposes, they were designed to investigate potential adverse population effects that could result from RMA contamination and that are pertinent to the ecological risk assessment. These investigations focused on population parameters that are indicative of general population condition. Population density is an appropriate ecological endpoint in most circumstances even when the absence of data on emigration and immigration, important population parameters for some studies, adds uncertainty. If movement of mobile animals is so free that local differences in population density cannot be detected, it is reasonable to assume that the biological population, which ranges across both contaminated and uncontaminated areas, is properly evaluated throughout RMA in the context of its regional abundance. In addition, data on site-specific population parameters not affected by emigration and immigration, such as nesting success and clutch size, were used as more appropriate measurement endpoints whenever they were available.

Identifying appropriate ecological endpoints from among the available RMA data required screening of available information for data pertinent to the endpoints. Many studies were less useful because they were conducted before the extent and pattern of contamination at RMA were known, and their study design thus bears little relationship to these patterns. In addition, contaminants in the RMA environment have varied over time. A review process was conducted across various studies and data sets to screen for bias, power, and relevance. Studies that provide pertinent information on potential contaminant effects are provided in a "weight-of-evidence" approach consistent with EPA guidance. Results are reviewed in conjunction with results of the quantitative exposure assessment to characterize ecological risk.

C.5.3.1 Ecological Effect Endpoints

Ecological effect endpoints were selected that reflect what is occurring within RMA's populations and communities, are sensitive enough to detect effects that may exist, and match with the endpoints being sought in the risk assessment. The numerous ecological studies performed at RMA were evaluated for information pertinent to ecological endpoints at the community and population level as described below. Individual biomarker endpoints were also evaluated. A total of 18 studies conducted by the U.S. Department of the Army (Army) and USFWS provide information on the overall health of biota at RMA and were used in the Integrated Endangerment Assessment (IEA). Of these, six were designed to directly evaluate contaminant effects. While some of the studies have low statistical power due to small sample sizes, the results of the various studies are generally consistent with each other and with the predictions of the quantitative exposure modelling.

C.5.3.1.1 Community-Level Endpoints

The community-level endpoints considered were species richness and trophic diversity. Each of these endpoints provides information on the overall structural diversity of the communities at RMA.

Species Richness

Species richness, the total number of species present, is an appropriate measurement endpoint because contaminants are widely distributed at RMA and could adversely affect populations and, in turn, affect ecosystem organization. In the Biota RI, seven RMA contaminants were considered major COCs based on criteria of toxicity, persistence, and areal distribution in the environment. While specific studies focused on the potential direct effects of major COCs, species richness serves as an appropriate ecological endpoint because it is a broad indicator of community structure and functional completeness.

Species richness was assessed by comparing the number of species present at RMA with the number of species that would be expected (Bailey and Niedrach 1965; Chase et al. 1982; Armstrong 1972; Bissell and Dillon 1982; Hammerson and Langlois 1981) given RMA's location and landscape characteristics. Species richness was also assessed within RMA boundaries by comparing similar habitats in contaminated and uncontaminated sites.

Trophic Diversity

Another effective way of assessing the functional completeness and complexity of biological communities is to evaluate the number and complexity of food chains that describe the successive predator/prey relationships. Food chains are composed of successive trophic (feeding) levels that reflect the number of food energy transfers between prey and predators. Thus, trophic diversity, as reflected in the number of food chains and the number of trophic levels represented in various food chains, serves as a community-level endpoint. Information to assess this aspect of ecosystem health resulted from inventories of species present, observations of their foraging habits, and gut-content analysis of selected species.

C.5.3.1.2 Population-Level Endpoints

Population-level endpoints such as population density may be difficult to interpret for some species because of the mobility of the organisms involved. Selection of the correct measurement endpoints to detect adverse effects must consider complicating factors that could mask an adverse

effect. For example, measuring the population density of migratory raptors or a highly mobile resident species such as deer does not reliably indicate adverse effects because a reduction in the population due to death or reproduction might be masked by factors such as emigration or immigration of individuals from surrounding uncontaminated areas. However, for sedentary species with small home ranges and limited vagility, estimates of population density and reproductive success are appropriate. Additionally, other measurement endpoints at the population level (e.g., nest success, fledgling success) may be appropriate even for migratory species, such as the American kestrel, that produce and raise their young within limited areas of exposure.

Considerable data have been accumulated on the distribution and population densities of several animal species at RMA since the initiation of the RI program in 1985. The endpoints selected for evaluation here are a subset of this information that considers the interpretability of the data in terms of possible contaminant effects. Population-level endpoints considered are relative abundance, reproductive success, and morbidity. Each of these endpoints provides information about the overall robustness of the population.

Relative Abundance

Relative abundance was evaluated by quantitatively comparing the relative numbers of individuals within and among species at RMA to off-post control areas (i.e., Plains Conservation Center [PCC] and Buckley Air National Guard Base [Buckley]) and by comparing contaminated sites to uncontaminated sites at RMA. Randomly selected sampling plots for small birds and small mammals were established in both uncontaminated and relatively contaminated portions of RMA.

Relative abundance or relative density (number of individuals/unit area), is both an assessment and measurement endpoint. Population indices that compare the number of individuals per standard transect/plot at RMA and in control areas are suitable population-level measurement endpoints that provide a basis for comparing RMA with appropriate controls.

Reproductive Success

Reproductive success was evaluated by comparing measures of birth rate, nesting success, recruitment, and/or age class comparisons for several RMA animal species to published values from other studies, as well as by comparing contaminated sites at RMA to uncontaminated sites at RMA and on-post sites to off-post sites. These measurements may reflect direct impacts to reproduction through reduced capacity or indirect impacts through unequal mortality.

The ability of species to reproduce at levels sufficient to maintain healthy populations is an appropriate assessment endpoint at RMA because of the possible direct and indirect effects of RMA contaminants on the various physiological and behavioral mechanisms involved in the reproductive process.

Avian reproductive success was calculated using several measures, including nesting success and fledgling success. Data were collected on mallard, ring-necked pheasant, and American kestrel to represent waterfowl (dabbling ducks), upland game birds, and raptors, respectively. Data were collected in relation to known sites of contamination at RMA and at locations off post. Details of the specific methods, locations, and analyses performed, including statistical analyses, are provided in the Biota RI (ESE 1989).

Morbidity

Morbidity was evaluated from data on the numbers of individuals discovered dead and dying at RMA. Morbidity, supported by analyses of tissues and investigation into cause of death, may be indicative of contamination effects. Care must be taken in evaluating mortality data to consider both the numbers of highly aware observers and the difficulty in finding carcasses in uncultivated habitat. Although the number of dead animals located may be inflated over normal numbers as a result of a large, observant worker population at RMA (particularly in the vicinity of Building 111, the Administration Building), no specific effort has been made to locate and account for all dead animals.

C.5.3.1.3 Individual Endpoints

Selected biomarkers (i.e., AChE inhibition and eggshell thinning) were examined at the individual level. These endpoints are indicative of harmful effects of chemical contamination as reflected in eggshell thinning by dichlorodiphenyltrichloroethane/dichlorodiphenyldichloroethene (DDT/DDE) and AChE reduction by nerve agent. Both of these biomarkers are appropriate for evaluating adverse effects on individuals of threatened or endangered species that by definition have populations reduced to the level where individuals are important, and for detecting effects that might affect populations.

C.5.3.1.4 Evaluation of Bias, Power, and Relevance for Cited Studies

The variety of ecological endpoints selected for evaluation in this risk assessment required the evaluation of data that varied in its appropriateness for risk assessment. As mentioned in the introduction to this section, many of the investigations into the potential adverse effects of RMA contamination were conducted during the Biota RI studies, prior to EPA's issuance of formal guidance for conducting ecological evaluations and ecological risk assessments. Some studies provided data on the general condition of populations of selected species or groups at RMA (e.g., songbird and breeding bird surveys, prairie dog population densities, small mammal abundance studies). However, several investigations were designed specifically to collect biological samples or data in known contaminated areas and control sites and to evaluate effects that are considered to be adverse and that could potentially result from exposure to COCs at RMA (e.g., population densities of earthworms, grasshoppers, and aquatic snails; reproductive success in kestrels, ring-necked pheasants, and mallards; eggshell thinning). Many of the effects data were collected in conjunction with analyses of tissue concentrations in order to strengthen conclusions regarding any observed effects in relation to the presence of contaminants.

Information was obtained from a variety of additional studies that provided useful information on contaminant transport and effects at RMA but that were not appropriate for an experimental-control study design. Data on contaminant concentrations in selected tissues and on the cause of death of hawks and eagles has been collected for individuals found dead at RMA throughout

the Biota RI, Biota CMP, and subsequent USFWS investigations (1986 to the present). Sampling at control sites was deemed inappropriate for this effort because of the adverse effect on raptor populations and because published information exists that establishes relationships between tissue concentrations of major RMA contaminants and adverse effects.

The results of the review of the various RMA studies for their bias, power, and relevance in relation to the endpoints just identified are summarized below. The studies identified in Table C.5-1 were screened from all those available for RMA because they provided data that were relevant to the ecological endpoints. The bias, power, and relevance ratings assigned to the selected studies are provided in Table C.5-2. The criteria used in rating the studies (defined in footnotes to Table C.5-2) should be viewed in an ecological context against a backdrop of natural variability, not viewed in a strictly numerical, statistical context. Because of natural variability, statistical power is not necessarily relevant, and may be misleading. The bias, power, and relevance ratings of the selected studies show that most are of low bias and at least medium power and relevance. For the most part, they meet the rating criteria reasonably. The use of diverse endpoints at different levels of ecological organization is considered a strength of the RMA approach for the Biota RI because it provides a holistic examination of the ecosystem, lending greater confidence to risk estimates (EPA 1993).

When reviewing the selected studies on the following pages, the following considerations are also pertinent:

- RMA is a unique site at which to conduct an ecological risk assessment because of its large size and history. For many of the studies completed at RMA, control sites were selected that were ecologically comparable to RMA with respect to habitat. While not every biotic and abiotic variable in addition to the test variable could be matched exactly, the most appropriate control sites that were available were selected.

- While population factors such as immigration and emigration may influence the measurement of density for mobile species, population density is unlikely to be affected for the less mobile species, especially because the potential for immigration and emigration also occurs at the control sites. In addition, many of the measurement endpoints (e.g., morbidity estimates and reproductive success estimates such as the relative numbers of buck to doe deer, doe to fawn deer, juvenile to adult prairie dogs, and of

American kestrel eggs laid to eggs hatched to juveniles fledged) are unaffected by either immigration of emigration.

- Many of the studies were designed to specifically identify contaminant-related effects at the population level. For example, aquatic snails were collected for population parameters in contaminated and uncontaminated lakes (ESE 1989), and grasshoppers were collected in uncontaminated reference locations, areas of low contamination on post (on-post controls) and areas of high contamination on post (Section 36 and Basin F) (ESE 1989). Population effects in more mobile species of animals were evaluated on a larger scale, such as those population measurements for deer and raptors (ESE 1989; MKE 1989a). In these cases, qualitative comparisons were made relative to impacts on RMA-wide populations. Collectively, the data from these studies support a weight-of-evidence approach to evaluating populational status and health using ecological endpoints.

- Studies such as the analysis of fortuitous animals (mostly raptors) provided valuable data on contaminant concentrations in tissue that could be related to adverse effects. These studies were relevant, but not amenable to power analysis.

C.5.3.2 Investigations of Particular Species or Other Taxonomic Groups

Species-specific studies have been completed for mule deer and white-tailed deer, black-tailed prairie dogs, American kestrels, bald eagles, great horned owls, burrowing owls, ring-necked pheasants, mallards, and mourning doves. In addition, small mammal, cottontail, jackrabbit, raptor, songbird, and invertebrate species groups have been studied. The more wide-ranging of these species were studied throughout RMA and compared to off-post populations. The more sedentary of these species were studied in both contaminated and control areas at RMA and at off-post control areas as well. Ecological endpoints measured in the various sample locations, especially measurements of density, were compared statistically for most of these studies (Table C.5-3). For some of the species, tissue concentrations of contaminants were analyzed from the same locations where density measurements were taken; Table C.5-4 provides the results of the significant statistical comparisons between control and contaminated areas for these species.

C.5.3.2.1 Mammals

Deer

The health and well-being of deer populations at RMA is of great public interest and an important management goal. Mackie et al. (1982), MKE (1989a), and Whittaker (1993) estimated population densities of both mule deer and white-tailed deer at RMA. Whittaker also assessed herd health, productivity, and habitat-use patterns for both species. The USFWS (unpublished data) performed necropsies and collected tissue samples for histopathological analyses from 13 mule deer and 10 white-tailed deer that were collected at RMA in March and April 1991. In all cases, the study area for these investigations was the entire on-post operable unit.

Ecological Endpoints

The above-referenced studies provide data for three assessment endpoints for the deer herds at RMA:

- Relative abundance and distribution
- Reproductive success as indicated by such measurement endpoints as fawning rate, fawn survival, and population growth rate
- General individual health as indicated by such measurement endpoints as muscle mass, fat reserves, physical condition, incidence of disease or parasitism, and incidence of other health-related problems

Study Findings

Mule deer are more common and more widely distributed at RMA than white-tailed deer because most of the on-post habitat is more suitable for mule deer (MKE 1989a; USFWS 1992a). White-tailed deer are essentially limited to the wooded and riparian areas of First Creek and the southern sections. Pellet surveys, which do not differentiate between species, indicate the amount of time spent by deer in different habitats. Significant positive correlations were found for both total vegetation cover and for tall weedy forbs, while significant negative correlations were found for open habitats and habitats dominated by cheatgrass and crested wheatgrass (MKE 1989b).

Weedy forbs provide excellent food sources as well as cover and shelter; open habitats offer little cover. Cheatgrass and crested wheatgrass are poor food resources, except in the spring when shoots are green.

Studies of reproductive potential show abundant populations of both mule deer and white-tailed deer at RMA (MKE 1989a; USFWS 1992a, 1993a). During the past 4 years, the mule deer population has doubled, while the white-tailed deer population has fluctuated around a relatively lower density (Whittaker 1993). Both species produced fawns at rates capable of supporting or increasing their population densities. The primary source of mortality for both species was coyote predation. White-tailed deer fawns, however, had a significantly lower probability of surviving to the age of 30 days because the white-tailed deer fawning season begins first and this species takes the brunt of intense predation (personal communication with D.G. Whittaker, 1993).

Population structure is also a good indicator of productivity and population health. Data from Whittaker (1993) provide indications of the deer populations' structure and relative health. The RMA deer populations are older than most hunted herds. In fact, adults at RMA tend to die of old age. Buck/doe ratios at RMA (1:1.6) are considered excellent in hunting terms compared to populations statewide (1:10), although this comparison must be qualified by the fact that the RMA population is not hunted. The large number of bucks may actually be a detriment as it promotes conflict during the breeding season. In spite of the observed high densities and older age structure, productivity seems to be normal as indicated by fawn/doe ratios (1.5:1) that are normal when compared to ratios for other populations statewide.

The good health of both mule deer and white-tailed deer herds is indicated by the presence of fat reserves at a time of year when such reserves are typically depleted in stressful environments and by generally good physical condition (USFWS 1993b). While fawns generally do not accumulate fat because their energy intake does not exceed that consumed by growth, fat reserves have been documented in fawns born at RMA and indicate their good health. During the winter of 1992-1993, which had above average snowfall along the front range, slightly more winter-

killed deer were observed at RMA than in the previous two winters. This is to be expected since "[o]verwinter...survival is low and condition of survivors is poor after winters of heavy snowfall because deep snow covers much of the of the forage and makes it unavailable" (Connolly 1981). Most of the deer that died were bucks, which is to be expected since bucks expend proportionately more of their fat reserves during the fall rut than does. Necropsies of 18 mule and white-tailed deer collected in March of 1993 revealed that "[T]he overall deer herd health on Rocky Mountain Arsenal appears to be relatively good. In general white-tailed deer are in better physical condition than the mule deer, but no overtly diseased animals of either species were encountered. The physical condition of the mule deer examined indicates that this species is probably near carrying capacity and any substantial population increase could result in a decline in the herd health. White-tailed deer were in good to excellent physical condition. Based on these findings, this species can be maintained near its present level without risks of disease related to mortality.

In qualification of this generally good assessment, however, health-related problems have been observed in a few individuals. These include retention of velvet in four mule deer males, testicular atrophy in four mule deer and one white-tailed deer, presence of an acid-fast bacterium in one male mule deer, and abnormal hoof growth and pelage characteristics potentially related to positive serological virus titers for bluetongue and epizootic hemorrhagic disease.

Study Conclusions and Comparison with Tissue Analyses from Various Studies

Both mule deer and white-tailed deer fawning and survival rates are sufficient to maintain stable populations and the mule deer population has demonstrated a capacity for quite rapid growth. Population growth is benefited by the absence of hunting pressure, but is affected negatively by high predator pressures, primarily from coyotes. Tissue analyses (Attachment C.5-2) indicate that both species are relatively free of contaminant accumulation (ESE 1989; RLSA 1992; USFWS 1993b). The highest level of dieldrin detected in deer was 0.187 parts per million (ppm) in one liver tissue sample, which is just below the whole-body mammal maximum allowable tissue concentration (MATC). The mean concentration of dieldrin in liver tissue samples was about 10

times less than the highest concentration. Note that concentrations in liver tend to be higher than the whole-body concentration for the same individual. Other contaminants detected in deer were as low or lower than dieldrin concentrations relative to their respective whole-body MATC levels (Attachment C.5-2). Given these results, deer species would not be expected to display detrimental effects of contaminant exposure, especially at the population level.

Prairie Dogs

Black-tailed prairie dogs are the major prey for the wintering bald eagle population at RMA as well as for several other raptor species. Thus, this prairie dog species, which lives in close proximity to soil-bound contaminants, provides an important exposure pathway for the bald eagle and other raptors. ESE (1989) and RLSA (1992) studied prairie dog density and distribution at RMA and at off-post locations several miles from RMA. RLSA (1992) documents the population impacts of a campestral plague outbreak at RMA. MKE (1989a) investigated reproductive potential as reflected by the age-class structure of the population (i.e., the proportion of the population made up of juveniles). Data were analyzed statistically on an RMA-wide basis and did not specifically address known sources of contamination. Additional information is provided in the Biota RI (ESE 1989).

Ecological Endpoints

The above-referenced studies provide data for two assessment endpoints for the prairie dog colonies at RMA:

- Relative abundance as measured by abundance indices/density
- Reproductive success as measured by the juvenile-to-adult ratio in the RMA population compared to off-post control areas

Study Findings

In 1988, prairie dogs were found throughout RMA and occupied 4,571 acres at an average density of 49.9 prairie dogs per acre. In the winter of 1988–89, campestral plague infected RMA prairie dogs and almost completely eliminated some colonies. By September 1989, only 247

acres were occupied by prairie dogs; the average density, recorded in October 1990 when the occupied areal extent had increased to 575 acres, was 30.1 prairie dogs per acre (RLSA 1992). Within this time period, there is no pattern evident in the average prairie dog density relative to degree of contamination; the lowest densities were in northeast control plots where the plague may have already begun affecting populations. Since that time, natural reproduction and the relocation of more than 5,800 prairie dogs onto RMA have resulted in a substantial recovery of the prairie dog population (USFWS 1993a). The prairie dog population at RMA achieved a maximum intrinsic rate of increase of 1.05 in the second year following the plague epizootic of 1988-1989. Merriam (1966) demonstrated that under the most favorable conditions the black-tailed prairie dog rate of increase could barely exceed 1.0. It is apparent that prairie dog reproductive potential is reasonably high at RMA (USFWS 1993b).

The percentage of the prairie dog population represented by juveniles at off-post control sites averaged 23 percent higher in 1986 and 20 percent higher in 1987 (i.e., at Buckley and PCC) than at RMA (MKE 1989a). These differences were significant for both years. Recent work (May 1993) completed by USFWS (1993b) found a mean litter size of 4.44 (±1.47, N=27), which is at the high end of the normal range (2.3 to 4.9) found in several other studies (Tileston and Lechleitner 1966; Kerwin 1972; King 1955; and Knowles 1987). Garrett et al. (1982) reported that the ratio of juvenile-to-adult prairie dogs is an indicator of prairie dog reproductive success; that rates of successful pregnancy, litter size, and survival rate in prairie dogs are related to habitat quality; and that mature colonies have a lower number of juveniles. The relatively low juvenile-to-adult ratios for prairie dogs at RMA during 1986 and 1987 may have been related to the maturity of the colonies because habitat analyses during that period indicated that many of the colonies were near carrying capacity.

Retrospective linking of sites where juvenile density was sampled to estimated exposure area soil concentrations of dieldrin (i.e., ESC) indicated that all but one of the prairie dog age-structure observations were made in areas where dieldrin levels were below the detection limit. In these areas, ESC values from exposure ranges centered on the sample sites ranged from 0 to 0.523

ppm. The one sample site (#17) with an ESC value greater than the certified reporting limit (CRL) of 1.195 ppm had 65 percent juvenile prairie dogs in 1986 (which was above the mean of 47 percent) and 62 percent of juvenile prairie dogs in 1987 (which was right at the mean of 62 percent). Sample site #17 was in the northwest quarter of the southwest quarter of Section 31. Sample site #16 (northwest quarter of southwest quarter of Section 24), which had the lowest density recorded (16 percent juvenile prairie dogs in 1986), had 77 percent juvenile prairie dogs in 1987, which was the third highest value recorded. Therefore, any differences in reproductive success among populations at RMA sample sites cannot be legitimately attributed to effects of contamination.

Study Conclusions and Comparison With Tissue Analyses from Various Studies

Average prairie dog population density had no apparent correlation with the general distribution of soil contamination in RMA areas where prairie dogs occur. There were no statistically significant differences ($p>0.05$) in prairie dog densities between the central colony that included portions of Sections 25 and 36, which are possible sources of contamination, and other colonies at RMA. The percentage of juveniles in the population was significantly lower at RMA in 1987 than in the off-post control sites, but about the same in 1993. Tissue concentrations of the COCs were generally below the whole-body MATC levels, except for dieldrin (Attachment C.5-2). All prairie dog samples from Section 36 at RMA had detectable carcass concentrations of dieldrin (mean summer = 2.03 ppm; mean winter = 1.44 ppm) and were as high as 13.4 ppm. These levels are well in excess of the whole-body MATC value for aldrin/dieldrin in medium mammals (0.19 ppm). Prairie dogs from elsewhere at RMA had substantially lower concentrations of dieldrin in carcass samples. However, some of these prairie dog samples contained concentrations of DDE above the whole-body MATC of 0.22 ppm (Attachment C.5-2). Comparison of measured tissue concentrations with whole-body MATC values for prairie dogs indicated that some individuals are likely to be affected by RMA contaminants. However, the effects of campestral plague, which occurs as a well-documented phenomenon in natural populations (RLSA 1992), and the subsequent managed immigration of thousands of prairie dogs,

especially between 1988 and 1990, have obscured any potential population effects of contamination.

Small Mammals

Small mammals provide an important prey base for bird and mammal predators at RMA. Because they reproduce rapidly and are relatively short-lived, their populations respond quickly to environmental factors and contamination. MKE (1989a) characterized the abundance of small mammal populations (i.e., high abundance was indicated by trapping success greater than 10 percent) and quantified their mean abundance (i.e., number captured per 100 trap nights) at RMA relative to reference populations at Buckley. At RMA, small mammal data were collected over 4,635 trap-nights (3,060 in fall 1986; 1,575 in spring 1987) in eight habitats, while at Buckley, data were collected over 540 trap-nights (fall 1986) in three habitats.

Ecological Endpoints

The above-referenced studies provide data for the assessment endpoint of relative abundance as measured by general population abundance and mean abundance.

Study Findings

Populations of small mammals were generally low at RMA during 1986 and capture frequencies were too low to allow statistical analysis of the data. Five sampling locations had moderate to high abundance, and 11 locations had low abundance (MKE 1989a). The trend was somewhat better in 1985 when five locations had low abundance and five locations had moderate to high abundance. The mean abundance of small mammals in certain habitats (native grasslands [RMA—1.2; Buckley—9.4] and crested wheatgrass [RMA—2.8; Buckley—5.6]) was lower at RMA than at Buckley. Mean abundance in cheatgrass habitat was higher at RMA than at Buckley (RMA—8.6; Buckley—3.3).

Overall, small mammal abundance tended to be highest on sites that are characterized as weedy forbs/grasses, followed by sites characterized as wetlands or shrubs/succulents. MKE (1989a)

concluded that these differences in population densities were primarily related to differences in habitat quality and not the result of contaminant effects. This conclusion was based primarily on the qualitative observation that on-post sites located in areas believed to be highly contaminated also supported some of the highest abundances of small mammals. Two of the sites with the highest trapping success, for example, were immediately north of Basin F.

Retrospective linking of sample sites to ESC values for aldrin/dieldrin (calculated using the deer mouse exposure range) indicated that the highest and the eighth highest abundance and trapping success measured in 1986 and 1987 occurred at the two most highly contaminated sites. When the data presented in Table C.5-5 for species count and total individuals trapped were each plotted against the ESC value for their sampling site, no strong trends were apparent for species count. While the site with the highest number of species had an ESC value of zero, the two sites with the highest ESC values were still slightly above the mean number of species per site (1.69), with two species each. The total number of individuals trapped seemed to show a positive correlation with increasing ESC value, particularly if the 24 individuals at the site with the highest ESC value (just east of Basin F) were ignored. While this seeming trend is in part driven in part by low and/or BCRL aldrin/dieldrin concentrations in soil, there is no indication that small mammal abundance was deleteriously affected by aldrin/dieldrin contamination.

Additional perspective is gained by overlaying small mammal sampling sites with areas where the small mammal HI is greater than 1.0 (Figure C.3-25). There are five sites (1, 2, 3, 13, and 27) that fall within the area where HI is greater than 1.0 for at least two of the biomagnification factor (BMF) values used. The average number of small mammals caught at these five sites was 37.8 (trapping success of 20.5 percent) as compared to an average of 13.6 (trapping success 9.8 percent) for all sampling locations outside the area of potential risk. Clearly, factors other than contaminant concentration are having an important influence on small mammal populations.

Study Conclusions and Comparison with Tissue Analyses from Various Studies

Populations of small mammals were generally low at RMA during 1986, with only five sampling locations having moderate to high abundance and 11 locations having low trapping success (MKE 1989a). The trend was somewhat better in 1987 as the populations of five locations were characterized as low and the other five characterized as moderate to high. Comparisons of mean abundance on post to those of the reference populations at Buckley indicated that certain habitats, such as native grasslands (RMA—1.2; Buckley—9.4) and crested wheatgrass (RMA—2.8; Buckley—5.6), produced relatively lower numbers of small mammals on post than off post. Other habitats, such as cheatgrass (RMA—8.6; Buckley—3.3), produced higher mean abundances on post.

Whole-body concentrations of dieldrin in some individual deer mice were quite high—up to 35.0 ppm—which is greatly above the whole-body MATC of 0.19 ppm for small mammals. Detectable levels of aldrin and endrin were also found in whole-body deer mice samples from RMA at concentrations well above the whole-body MATC of 0.19 ppm for aldrin (mammal MATC values were not available for endrin). DDE and DDT concentrations in some whole-body deer mice samples also exceeded the whole-body MATC of 0.22 ppm (Attachment C.5-2). The highest mean abundances of small mammals at RMA were in areas of weedy forbes/grasses north or east of Basin F (MKE 1989a); evaluation of trends between small mammal abundance and ESC values showed no indication that small mammal abundance is deleteriously affected by aldrin/dieldrin contamination.

C.5.3.2.2 Birds

American Kestrel

The American kestrel is a common breeding bird at RMA. Because such birds occupy a high trophic level, they are particularly susceptible to the bioaccumulation and toxicity of organochlorine pesticides. American kestrels make excellent subjects for the study of potential impacts of contamination since they are relatively smaller and have larger brood sizes than many other raptors, and because their populations can be managed because they use nest boxes (Wiemeyer and Lincer 1987). As a result, the several reproductive success and contamination

monitoring studies of RMA kestrels represent the most extensive data set currently available for any species at RMA.

In 1982, a 2-year study was initiated by USFWS to examine the possibility that contaminant residues were having adverse effects upon the reproductive capacity (i.e., clutch size, hatching success, and/or fledgling success) of American kestrels (DeWeese et al. 1982). Concurrent with the measurement of nesting success, egg and nestling samples were collected to test the hypothesis that nesting success/failure could be correlated with contaminant burden. The study was structured around three sampling zones: at RMA, at "near-RMA" control sites (i.e., within 10 miles of RMA), and at "control" control sites (i.e., sites more than 40 miles from RMA). All study sites were in the same general habitat type, but differed somewhat in principal vegetation and habitat characteristics. The near-RMA sites were a combination of mixed deciduous woodlots, riparian woodlands, cultivated fields, and residential/industrial developments. The control sites consisted of one area of shortgrass rangeland, linear woodlots along a permanent river, and shrub-covered foothills.

Kestrel reproductive success at RMA have been repeated in four of the years since 1982–83. In 1986 (ESE 1989), as well as 1988 and 1990 (RLSA 1990, 1992), nest outcome data were combined with egg (not analyzed in 1990) and nestling samples from RMA and off-post control sites for contaminant analyses. In 1991 and 1992, on-post nesting success data were collected (USFWS 1992a; 1993a). Appendix Section C.4 contains a map indicating nest box locations (Figure C.4-6).

Ecological Endpoints

The above-referenced studies provide data for the assessment endpoint of reproductive success as measured at several points in the reproductive cycle (i.e., nesting attempts per available opportunity, clutch size, hatching success, and fledgling success).

Study Findings

DeWeese et al. (1982) reported that, although the average number of eggs in a complete set (i.e., clutch size was similar for the three sampling zones in 1982 (Table C.5-6), relatively fewer nestlings hatched at RMA compared to the other two sampling zones. DeWeese et al. (1982) noted the low average number of young fledged per initiated clutch "near two of the lakes south of the Shell Chemical Plant" and the increase in the average number of young fledged with increasing distance from these lakes. The major cause of poor fledgling numbers was attributed to nestling mortality from predation or other causes such as disturbances due to investigative studies or nest-site competition (DeWeese et al. 1982).

A re-analysis of the 1982 data with 1983 data (DeWeese et al., no date pg. 7-2 and 7-13) resulted in a slight revision of the 1982, but reproductive success was still not statistically different between RMA and the combined results from the two off-post sampling zones. The area of lowest reproductive success and/or nesting attempts for this later analysis was described as a "core area," which includes the area "within the vicinities of Basins A and F and the chemical manufacturing plant." Special note was made by DeWeese et al. (no date pg. 7-2 and 7-13) that the area around Basin F was apparently avoided by breeding kestrels and that all nests located within 1 mile of these three most contaminated areas failed to fledge young.

The field surveys conducted by McEwen and Peterson in 1986 were described in the Biota RI (ESE 1989). The 1986 results indicated that productivity at RMA was "much higher" than in 1982 or 1983 and that on-post productivity was not significantly different from that reported from the control sites. In 1986, the majority of failed nests were concentrated along First Creek in a relatively uncontaminated area.

The 1988 data indicate that a relatively greater number of nests in all study areas failed to produce hatchlings than in previous years (RLSA 1990). Although the differences were not statistically different, percent of nests that were successful and number of young fledged per nesting attempt were slightly higher at the control sites. However, successful nests fledged more nestlings at RMA than at control sites. The pattern of nest-box use in 1988 was also worthy of

note in that the greatest occupancy rate occurred near Basin F, which had not yet been fully remediated and capped. There were, however, no occupied nest boxes in the vicinity of Basin A.

In 1990 (Table C.5-6), the measured reproductive parameters did not differ markedly from those in 1988 either at RMA or in off-post control areas. Exceptions to this generalization were that a lower percentage of attempted nests hatched at RMA in 1990, while a higher percentage of attempted nests hatched in control areas. However, the percentage of hatched nests that fledged young was higher in 1990 at RMA, but lower in control areas.

Monitoring of kestrel reproduction by the USFWS in 1991 indicated similar nesting success in RMA and control areas (USFWS 1992a). Nest box occupancy was poor along the western boundary. Nest failures occurred in Sections 5, 11, 12, 20, and 24, all of which were outside the core area. All of these failed nests were within 1 mile of the RMA boundary.

In six of seven breeding seasons, the number of fledglings per nesting attempt at RMA was lower than that for pooled off-post control areas. Because clutch size and number of nestlings per nest tended to be similar between populations, the qualitative differences in success appear attributable to unequal nestling mortality. In no case, however, were these on-post/off-post differences statistically significant. Despite the fact that the same nest-box locations were monitored at RMA for 7 years, no geographic continuity or pattern is apparent with relation to nest failures among kestrels. While clusters of nest failures have been suggested to occur in specific years (e.g., the core area in 1982 and 1983 and First Creek in 1986), the validity of such a pattern breaks down over the cumulative span of biomonitoring. When all 7 years of data are considered together, no apparent pattern in the geographic location of nest failures at RMA is evident. Sources of variation that significantly contributed to observed differences in reproductive success were the frequency and intensity of interspecific competition for nest boxes and the disturbance of the nest for collection of eggs before the onset of incubation (DeWeese et al., no date).

Separate statistical analyses were performed on three different sets of American kestrel data: 1982 and 1983 data (DeWeese et al. no date); 1986 (ESE 1989); and 1988 and 1990 data (reanalyzed from Enserch in-house Biota CMP records). The information provided in these three studies was not sufficiently comparable for a single analysis to be performed on a composite data set. The 1982/1983 analyses of differences across the 2 years and among three study areas (at RMA, 0.5 to 16 kilometers (km) from RMA, and 68 to 95 km from RMA) in hatching and fledgling success were not statistically significant (2 by 2 chi^2, $p>0.05$). This study also compared, but did not statistically analyze, the occupancy and fledgling success of nests in specific locations within RMA. This comparison found occupancy rates and fledgling success were lower near than far from Basin A, Basin F, and the central area (defined to be more than a mile inside RMA boundaries); areas near South Plants had higher occupancy rates but lower fledgling success than areas far from this site. The 1986 statistical analyses (ANOVA, parametric a priori, Kruskall-Wallis Anova, and nonparametric a priori) compared clutch size, hatchling numbers per nest, fledgling numbers per successful nest and per all nests for control and RMA data using the 1982 and 1983 data as well as the 1986 data. Generally, these comparisons were nonsignificant. Exceptions were that comparisons among years in the number of hatchlings per nest and fledglings per all nests showed significant ($p<0.05$) differences, and that here was a significant difference between RMA and control fledgling numbers for all nests in 1983.

Nest-specific data on reproductive parameters, location at RMA, and tissue-sample concentrations were available only for the 1988 and 1990 studies. American kestrel data on success at each nest from which tissue samples were collected in 1988 and 1990 (i.e., number of eggs, hatchlings, and fledglings per nest) were plotted against kestrel ESC values estimated for the location of the nest site and against contaminant concentrations found in sampled eggs and juveniles using the data found in Table C.5-7. This was done to add information to the Integrated Endangerment Assessment/Risk Characterization (IEA/RC) on potential differences between contaminated and uncontaminated sites at RMA. No trends in nest-success parameters were apparent between years or with changes in kestrel ESC or tissue concentration values. The number of eggs in a clutch did not decrease, nor did the number of hatchlings or fledglings decrease with increasing

concentrations of dieldrin (the most frequently detected analyte) in eggs, juveniles, or soil (as represented by the ESC estimate).

Correlations were investigated statistically for the 1988 and 1990 data, which were combined into one data set, using Pearson's product-moment correlation and Spearmans rank correlation. Correlations of egg concentration, ESC value, and juvenile tissue concentration were investigated relative to each other, and also relative to the number of eggs, number of hatchlings, number of fledglings, number of deaths before hatching, number of nestling deaths, and number of total deaths before fledgling. For dieldrin, no statistically significant Pearson's correlations between the variables were found. The slight negative correlations observed between the ESC values and the three mortality variables are not scientifically reasonable (i.e., mortality should not decrease in response to increasing exposure concentration) and could be spurious, i.e., due entirely to one or a few data points out of 13. Spearman's rank correlations were similar to the Pearson's product-moment correlation and also nonsignificant.

For DDE, a Pearson's correlation of 0.92 occurred between egg concentration and the number of nestling deaths. This correlation was statistically significant at the 0.05 level; however, the high magnitude of this correlation was somewhat spurious, attributed in part to a small sample size (N=5) and the majority of points being concentrated at the origin while the only nonzero number of deaths occurred at the highest egg concentration. The positive correlation of 0.44 between egg concentration and total mortality, while not statistically significant ($p = 0.27$), provided additional, though weak, evidence supporting the hypothesis that mortality is affected by the DDE concentrations in eggs. Spearman's rank correlations were similar to the Pearson's product moment correlations. The Spearman's correlations for egg concentration vs. number of nestling deaths and number of total deaths before fledgling were 0.79 and 0.49, respectively. In the scatter plots for the two sets of variables, both the egg concentrations and the mortality variables indicated that the correlations are not robust; they depend heavily on the location of one out of five data points in the case of egg concentration vs. number of nestling deaths, and two out of eight points in the case of egg concentration vs. number of total deaths before fledgling.

There is no evidence in the data that the dieldrin ESC values, egg concentrations, or juvenile concentrations are positively correlated to either the number of eggs, hatchlings, and fledglings, or the mortality from one stage to another. The slight (nonsignificant) negative correlations between ESC and the mortality variables are not scientifically reasonable and may possibly be explained by the high uncertainty in estimating the exposure concentrations for a given nest location.

The data indicate a possible relationship between egg DDE concentration and mortality, in particular mortality of nestlings. The correlation between these two variables is statistically significant at the 0.05 level, but is based on a total of five data points, with one extreme data point having a very high influence in determining the presence of correlation.

Off-post nest boxes had distinctly lower egg and juvenile tissue dieldrin concentrations than the RMA nest boxes; however, the off-post boxes did not have consistently lower mortalities. Off-post egg and juvenile DDE concentrations were not generally lower than on-post DDE concentrations.

Study Conclusions and Comparison with Tissue Analyses from Various Studies

The trends over time for on-post/off-post comparisons are not consistent. Control areas appear to have larger clutches, a higher percentage of attempted nests that hatched, a higher percentage of hatched nests that fledged, and a greater number of young that fledged per nest attempt. However, the 1986, 1988, and 1990 data show more hatchlings per hatched nest and more young fledged per successful nest at RMA than in the control areas; this trend does not carry into 1991 and 1992 for hatchlings per hatched nest.

The information associated with tissue contaminant data from RMA and off-post control areas (Attachment C.5-2) does not allow identification of possible contributing factors that are related to habitat. However, results of tissue analyses were summarized for each biota study area (BSA) associated with areas of known contamination, the "near-RMA area" (within one-half mile of

BSA boundaries), and the "far-RMA area" (more that one-half mile from BSA boundaries but within RMA). There were no marked differences in the frequency of COC detections between BSA and near-RMA area samples; no samples were collected in the far-RMA area (Attachment C.5-2). Kestrel eggs and nestlings from RMA, but not from control areas, frequently contained levels of dieldrin, which has been implicated in reducing reproductive success of birds (Wiemeyer et al. 1986; Newton et al. 1982). Concentrations of dieldrin in dressed carcasses of some individuals were as high as 3.7 ppm (Attachment C.5-2), which is well above the whole-body MATC of 0.73 ppm for kestrels. The concentrations of dieldrin found in kestrel tissue and the reduced reproductive success in the core area are consistent with exposure pathways and possible adverse effects of contamination and suggest that there was risk associated with dieldrin, particularly in the early 1980s. Dieldrin concentrations in eggs and juveniles tended to be higher on post in 1988 and 1990. However, no trend between nest success and contaminant concentrations were observed in 1988 and 1990 data for dieldrin. The statistically significant correlation between nestling mortality and DDE concentration in eggs may be spurious; it was not generally associated with higher DDE concentrations in eggs or juveniles at RMA.

Bald Eagle

The bald eagle is a federally protected species under the Endangered Species Act (32 Federal Register [FR] 4001; 43 FR 4621) the Migratory Bird Treaty Act, and the Bald Eagle Protection Act (1940), and thus warrants special consideration at the individual level (EPA 1989a). As a predator that feeds high in the food chain, the bald eagle has been shown to be particularly sensitive to the presence and bioaccumulative nature of a number of environmental contaminants (Wiemeyer et al. 1984). Chlorinated hydrocarbons such as DDT, DDE, and polychlorinated biphenyls (PCBs) have been demonstrated to cause reproductive failure in eagles and several other species primarily through eggshell thinning (Grier 1974; Krantz et al. 1970; Newton 1979; Weimeyer et al. 1972).

Information assessing the level of risk posed to bald eagles by RMA contaminants comes from three studies: 1) a study that analyzed food habits, feeding habits, and habitat use of bald eagles

at RMA during the winters of 1986–87 and 1987–88 (ESE 1988b); 2) a regional telemetry study that assessed several aspects of bald eagle ecology including habitat-use patterns, movement patterns, food and feeding habits, and blood and fat deposit levels of a number of contaminants during 1988, 1989, and 1990 (USFWS 1992a, b, 1993a, respectively); and 3) general raptor surveys of RMA that include observations of bald eagles and reflect relative activity patterns and general habitat use during 1991 and 1992 (USFWS 1992a, 1993a).

Ecological Endpoints

Because of the bald eagle's status as a threatened and endangered species, the critical role that each individual plays in the continued viability of its population mandates that risks be considered and expressed in terms of individuals.

Two assessment endpoints are pertinent to individuals in bald eagle populations at RMA:

- Relative abundance as evaluated by surveys and distribution at RMA
- Morbidity as evaluated by potential exposure and general health

While these assessment endpoints have not been directly measured at RMA, the available data are pertinent to these assessment endpoints due to the following:

- Population studies indicate the number of individuals using RMA and establish the maximum annual duration of potential exposure
- Food and feeding habits indicate principal pathways of potential contaminant acquisition (i.e., those prey most frequently fed upon)
- Habitat-use and activity studies reflect the areas frequented by bald eagles and, hence, the areas from which exposure is most appropriately projected
- General health and mortality observations provide very general indications of the extent of gross contamination

Study Results

Bald eagles roost at RMA and its surrounding areas primarily from October through March. The yearly pattern of RMA use can be characterized as follows. Building steadily from a few individuals that arrive in late October, populations peak at as many as 100 individuals, with a 1-night maximum of 38 individuals in late December to mid-January. Usage drops off in late January and slowly declines to no use by mid-March. One pair of eagles nests at nearby Barr Lake, but RMA has not been shown to be a part of this pair's normal home range during the breeding season (USFWS 1992b).

Several factors influence eagle exposure and risk at RMA: total time in residence, food habits, prey distribution, total area-use patterns, and specific habitat-use patterns. The regionally significant concentration of individuals that spend some portion of the winter at RMA move on post and off post at varying times and durations (USFWS 1993a, b). Thus, while a realistic exposure period would be less than 5 months, the possibility exists that individual birds may spend the entire winter period at RMA.

Telemetry data on areas used by bald eagles in 1987 to 1990 (USFWS 1992b) indicate that while individuals frequently move into and out of RMA and the general Denver metropolitan area, RMA is centrally located in the area of use. Thus, while relative exposure is mitigated for more transient individuals, some individuals use RMA intensively. It is not uncommon for individuals to center a majority of their activities at RMA for weeks or months.

Analyses of castings and behavioral observations of bald eagles wintering at RMA indicate that their primary food source is prairie dogs (about 75 percent), with rabbits representing a secondary food source (about 20 percent) (ESE 1988; USFWS 1992b). Thus, exposure is largely confined to those areas of RMA where these prey species exist. Data on the historical and current ranges of prairie dogs at RMA show limited overlap between the areas of prairie dog habitation and the areas of highest contamination either because habitat for prairie dogs is unsuitable or nonexistent

in these areas or because there has been active management to exclude prairie dogs from the areas of highest contamination.

Likewise, the abundance of rabbits is somewhat limited in the highly contaminated zones. Desert cottontails and black-tailed jackrabbits show a distributional relationship to crested wheatgrass, which is limited in contaminated areas, and eastern cottontails are mostly limited to thickets and riparian zones (MKE 1989a).

Bald eagles use wetland/riparian, wetland trees, and dryland trees more frequently than expected on the basis of habitat availability, and use cheatgrass/weedy forb, shrub/succulents, cultivated species, and unclassified areas less frequently than expected. Since the time the bald eagle spent in more contaminated areas is proportionally less, its primary exposure to contamination may come from prey exposed elsewhere.

The majority of bald eagles captured at RMA have been within normal ranges for size, weight, and condition for their age and the time of year they were captured (personal communication, from M. Lockhart of USFWS to Michael Macrander of Shell, 1993). The single bald eagle carcass found at RMA was in the Bald Eagle Management Area (BEMA) at the end of the 1990 wintering season; its condition did not allow determination of the cause of death.

Study Conclusions and Comparison With Tissue Analyses from Various Studies

Bald eagles are present in the vicinity of RMA for only a portion of the year and are on post for some subset of that time. As a result of their habitat-use patterns, bald eagles at RMA use certain habitats and areas disproportionately with respect to their availability. Therefore, they naturally tend to underutilize the more contaminated areas of RMA. The removal of prairie dogs and perch sites from Section 36 (Basin A) further minimized potential exposure. As bald eagles rely on kleptoparasitism (i.e., theft of prey items from other birds of prey, most notably ferruginous hawks) for a significant portion of their diet, it is pertinent that analysis of

ferruginous hawk habitat use reflects a similar habitat-related avoidance of the most highly contaminated areas (USFWS 1993a).

In 90 bald eagle blood samples (70, including eight recaptures, in 1987 to 1989; 20 in 1990 to 1992) and 11 fat samples (1991 to 92) analyzed for trace metals and organochlorine pesticides (USFWS 1992b, 1993a), detectable blood concentrations of arsenic, DDE, and dieldrin were found. No other COCs were detected, although selenium, lead, and PCBs were found. None of the detected concentrations exceeded the lower limits of concern (USFWS 1992b); however, many of the samples were obtained soon after bald eagles arrived at RMA and blood levels of contaminants only provide data on concentrations being transported via the blood at the time of sampling. The current general health of bald eagles at RMA does not reveal any adverse effects of RMA contamination, and bald eagles are unlikely to be significantly exposed to contaminants while wintering at RMA. These two considerations to not suggest that eagles are likely to be adversely affected by contamination at RMA.

Great Horned Owl

The great horned owl, a top predator, is also susceptible to the bioaccumulative characteristics of organochlorine pesticides (Buck 1992). Great horned owls are one of the few raptors with year-round residence and, therefore, high potential exposure at RMA. Accordingly, data that reflect relative survivorship, reproductive potential, exposure, and contaminant burden of great horned owls at RMA are particularly pertinent to the overall assessment of risks.

Three studies include data on great horned owls at RMA. The Biota RI reported results of necropsy and tissue analyses for four great horned owls (ESE 1989). The Biota CMP reported results of analyses of five great horned owl eggs and three adults (RLSA 1992). The USFWS monitored great horned owl nesting locations and reproductive success in 1990, 1991, and 1992 (USFWS 1992a, 1993a). Appendix Section C.4 contains a map indicating nest locations (Figure C.4-5).

Ecological Endpoints

The assessment endpoints pertinent to great horned owl risk at RMA are reproductive potential and mortality. Appropriate measurement endpoints, therefore, include the following:

- Reproductive success as measured and compared among RMA nesting pairs and between RMA populations and published accounts
- Morbidity as measured by cases of potentially injurious contamination

Study Findings

Nesting success of great horned owls has fluctuated during the 3 years for which data have been gathered. In 1990 and 1992, there were 11 breeding attempts in each year, 10 and 11 of which were successful, respectively. In 1991, five of the eight breeding attempts were successful. There was no difference among the 3 years, however, in the number of young fledged per successful nest (range = 1.9 to 2.1).

Data on reproductive success of great horned owls available as number of young observed and number of young branched (i.e., out of the nest but not yet flying) for 29 nests recorded by the USFWS over a period of 3 years (1991, 8 nests; 1992, 11 nests; 1993, 10 nests) were also compared with ESC values for great horned owl exposure areas of 2,660-foot (ft) radius centered on the nest location (Table C.5-8). As can be seen in Table C.5-8, at most of the nests, including the two nests with ESC values greater than 0.5, either two or three young were observed. Not all the observed young survived to leave the nest: one nest in each of four ESC categories (0.01 to 0.02 ppm, 0.02 to 0.03 ppm, 0.05 to 0.06 ppm, and 9.0 to 13.0 ppm) lost a single young; one nest (ESC value of 0.09 to 0.1 ppm) lost both its young, while nests in each of two ESC categories (0.03 to 0.04 ppm and 0.07 to 0.08 ppm) collectively lost seven young, which represents a loss of 30 percent and 70 percent of the young in nests associated with these ESC categories, respectively. This pattern of loss shows no trend associated with exposure concentrations of soil contaminants as expressed by ESC values (Figure C.5-1).

Mortality of great horned owls appears to be an occasional result of contaminant exposure. One great horned owl was observed displaying, and eventually succumbing to, symptoms typical of pesticide poisoning (USFWS 1993b).

Study Conclusions and Comparison With Tissue Analyses from Various Studies

Great horned owls are one of a few species whose individuals may spend their entire lives at RMA. Three years of reproductive data indicate above-average production in 1990 and 1992 (USFWS 1993a).

Because great horned owls are resident species at RMA, it is highly likely that any contaminants in their tissues were acquired on post. Of four great horned owls found dead in 1986, three had detectable levels of dieldrin in both brain and liver tissue samples (Attachment C.5-2). The levels reported for great horned owls were among the highest reported for raptors at RMA. Mercury and DDE were also detected in these samples (ESE 1989). All of the eggs collected in 1990 contained dieldrin, as did all of the muscle and liver samples collected from birds found dead between 1988 and 1990. Endrin, DDT (not in eggs), and especially DDE and mercury, were also found in these samples (RLSA 1992). Maximum concentrations of dieldrin in liver (27.7 ppm, Biota RI; 25.0 ppm, Biota CMP) and DDE (15.5 ppm, Biota RI; 5.40 ppm, Biota CMP) are particularly noteworthy relative to those in other species sampled during the Biota CMP. Maximum brain concentrations of these two chemicals were also quite high (dieldrin, 15.6 ppm; DDE, 10.4 ppm). These concentrations are higher than the whole-body MATC (0.76 ppm) for great horned owls. Thus, results of current studies indicate lethal effects of contaminants in individual great horned owls, although no adverse effects on average production nor population are apparent from the study.

Burrowing Owl

The burrowing owl has been a species of concern over much of its range for more than a decade (Johnsgard 1988) because its populations have been declining over much of its range. This is apparently in response to the expansion of cropland and reduction of burrow-producing colonial

rodents (Butts 1973). Locally, however, the creation of open areas has actually increased local abundance (Wiseman 1986). This raptor, which typically breeds in prairie dog burrows, is unique in that it spends an important portion of its life cycle in direct contact with the soils of RMA.

A study of nest site selection and habitat use of burrowing owls at RMA provided data on habitat requirements, food and feeding habits, and reproductive output (Plumpton 1992). Nests from which at least one individual fledged were recorded as successful. Because burrowing owl nests at RMA were consistently located within active prairie dog colonies, the map for active prairie dog colonies at RMA indicates potential burrowing owl nesting habitat at RMA (RLSA 1992).

Ecological Endpoints

Reproductive success, as measured by nesting success, is the assessment endpoint derived from the data available. Other information, such as habitat-use patterns and food habits, may provide some indication of the relative probability of exposure.

Study Findings

Burrowing owls tended to use sparsely vegetated and roadside habitats, but available data did not allow a quantitative estimate of use proportional to habitat availability. The majority of nest burrows were associated with active prairie dog towns. While invertebrates, small mammals, and passerine birds were all hunted by burrowing owls, small mammals of the genus *Peromyscus* were the key food source.

Table C.5-9 shows that the nesting attempts, number of successful nests, and mean number of young fledged from each nest attempted in 1990 and 1991 were very similar. Detailed information on burrowing owl nest success based on number of live juveniles observed above ground was recorded for the USFWS during 1990 (27 nests), 1991 (40 nests), 1992 (40 nests), and 1993 (43 nests) at RMA. ESC values were calculated from the Ecological Risk Characterization (ERC) database for each of these 150 nest locations using a radius of 2,874 ft for the exposure range (Haug and Oliphant 1990). The number of juveniles ranged from zero

to 9; ESC values ranged from 0.000 to 13.078 ppm. Table C.5-10 shows the relationship of number of burrowing owl juveniles and the ESC values calculated for their nest sites. This comparison of number of juveniles vs. ESC value revealed no trends. Ninety-two percent of the nests (i.e., 138 nests) were associated with ESC values less than 0.125; in fact, 65 percent (i.e., 98 nests) of the nests were associated with ESC values less than 0.05. It can be seen that for the 12 nest sites with ESC values above 0.125 ppm, 58 percent had five or more juveniles. At ESC values at or below 0.125 ppm, 39 percent had five or more juveniles. The only time nine juveniles were found was at two nests in 1990; one of these nests was associated with an ESC value between 0.05 and 0.125 ppm and the other was associated with the highest ESC value calculated for a burrowing owl nest location, 13.08 ppm. These data provide no indication that burrowing owl populations, as reflected in nest success, are adversely affected by mean contaminant levels within their expected exposure range centered on their nest sites.

During 1990, five juvenile burrowing owls were collected and analyzed for aldrin, dieldrin, endrin, DDT, DDE, arsenic, and mercury. Table C.5-11 shows the aldrin/dieldrin tissue concentrations in these juveniles, the aldrin/dieldrin ESC values for the nest location closest to the collection location for the juvenile, and the number of juveniles at this closest nest location. The juvenile with the highest tissue concentration is associated with the nest having the lowest ESC value; the juvenile with the lowest tissue concentration is associated with the next to highest ESC value and the next to lowest number of young. The available data do not show obvious trends in association between reproductive success (based on number of live young observed above ground), ESC, and tissue concentration of burrowing owls.

Study Conclusions and Comparison With Tissue Analyses from Various Studies

The reproductive potential of the burrowing owl may be significant at the individual level, as well as the population level, since it is a species of concern to the public because of declines in its population documented in the 1980s (Johnsgard 1988, Tate and Tate 1982) and at least as far back as the 1960s (Bailey and Niedrach 1965). Burrowing owls at RMA appear to be reproducing at an appreciable rate and offspring produced at RMA are returning and breeding

successfully in the years following the year in which they were banded. The 2-year mean breeding success rate of 4.38 young fledged per nesting pair is higher than for many areas reported in the literature.

Carcasses of burrowing owls collected during the Biota CMP had measurable levels of dieldrin contamination as high as 1.1 ppm, which is just above the whole-body MATC of 0.76 ppm. Thus, while known diet and limited data on tissue levels indicate contaminant exposure for some individuals, population reproductive, fledgling, and breeding return data do not reveal adverse effects on the population at RMA.

All Raptors

Collective studies of all raptor species have been performed at RMA in addition to the species-specific studies of bald eagles, American kestrels, and burrowing owls. The general focus of RMA investigations on raptors is due to their status as upper trophic-level sentinels for the effects of bioaccumulative contamination (Newton 1979) and due to the public interest in raptor populations.

Two types of data are available for investigating ecological effects on raptors at RMA: results from roadside surveys and results from nest monitoring studies. In 1986 and 1987, MKE conducted observational surveys from roadsides at RMA and at two off-post control areas (Adams and Arapaho Counties, Colorado). Population trends and relative abundances of each species were compared between these areas. From August 1991 through May 1992, USFWS conducted weekly or biweekly roadside surveys of raptors along a 24-mile route at RMA (USFWS 1993a). Data collected on raptor abundance were used to monitor population trends, while the data on raptor distribution were used to develop indices of habitat use vs. habitat availability at RMA.

During the springs and summers of 1990 through 1992, USFWS conducted inventories and monitoring studies of RMA raptor nests. Reproductive success was recorded for red-tailed hawks, Swainson's hawks, American kestrels, great horned owls, and long-eared owls.

Ecological Endpoints

Assessment endpoints that may be reflective of contaminant impacts upon raptors are the following:

- Species richness as measured by roadside surveys of species
- Relative abundance as measured by roadside surveys of individual raptors
- Reproductive success as measured by nest success at RMA

Study Findings

Roadside census data (MKE 1989a: Figures 4-14, 4-15, 4-16; Table 5) indicate that RMA supported higher densities of individuals and more species of wintering and breeding raptors than either of two control areas in Adams and Arapahoe Counties (MKE 1989a). While raptors are common at RMA year-round, the abundance of individual species fluctuates in accordance with their individual life cycles and area use patterns. Great horned owls represent the main year-round resident. Burrowing owls, Swainson's hawks, red-tailed hawks, and American kestrels are present primarily as breeding populations. Northern harriers, ferruginous hawks, rough-legged hawks, other owls, and bald eagles are present primarily as wintering populations.

Habitat-use patterns indicate that several species utilize specific RMA habitats in proportions greater than their availability would indicate. Red-tailed hawks tended to utilize wetland habitats to a greater extent than expected, and ferruginous hawks utilized weedy forb habitats to a greater extent than expected.

Study Conclusions and Comparison With Tissue Analyses from Various Studies

As documented from the results of roadside counts (MKE 1989a; USFWS 1993a), total abundance and species richness of raptors at RMA are both quite high. Habitat-use patterns appear to be related to species-specific ecology (e.g., habitat quality, prey abundance, and protection) (USFWS 1993a) rather than attributable to any trends in contamination. These habitat-use patterns affect the potential exposure among species. Bald eagles, red-tailed hawks, and rough-legged hawks, for example, utilize wetland/riparian habitat in proportions greater than occurrence would predict. Because these habitats tend to be less contaminated and/or ecologically impacted, the potential for exposure may be relatively low for these species.

A number of raptor tissues have been analyzed for contaminants in various programs such as American kestrel egg and juvenile samples from early investigations (McEwen 1982), the Biota RI (ESE 1989) and Biota CMP (RLSA 1992) and great horned owl egg samples from the Biota CMP (RLSA 1992). Fortuitous samples were collected from dead and dying individual raptors during the Biota RI (ESE 1989), Biota CMP (RLSA 1992), and ongoing USFWS programs. The reports on these programs contain maps and information on locations of fortuitous samples.

Some of the COCs have been detected in a number of the raptor species collected at RMA including American kestrel, bald eagle, golden eagle, red-tailed hawk, ferruginous hawk, burrowing owl, and great horned owl. The frequency of contaminant detection was higher in kestrels collected on post than those collected off post. Dieldrin is the primary contaminant in the raptor samples that were analyzed and occasionally reached high levels (i.e., as much as 25 to 27.7 ppm in the brain and liver of the great horned owl). Other notable concentrations of dieldrin in fortuitous samples collected at RMA included 9.44 ppm in a red-tailed hawk's brain, 15.6 ppm in a great horned owl's brain, and 9.98 ppm in a ferruginous hawk's brain (Attachment C.5-2). Whole-body MATCs for dieldrin in raptors range from 0.41 (bald eagle) to 0.76 ppm (owl). The brain to whole-body ratio of dieldrin tends to be highly variable, ranging between 0.1 and 2 based on a survey of the general literature.

The high concentrations detected in brain and liver tissue of individuals of some species found dead at RMA are consistent with known exposure pathways and contaminant sources. The levels and frequency of dieldrin and DDE contamination in some raptors at RMA (i.e., American kestrel, ferruginous hawk, and great horned owl) indicate some level of risk for these species. Brain levels of the organochlorine pesticides found in some individuals are within ranges associated with reduced reproductive success or death, and are above the whole-body MATCs (Attachment C.5-2) for organochlorine pesticides in these raptors. While studies of raptor reproduction, abundance, and diversity were not specifically designed to assess potential impacts of contamination, they have not revealed adverse effects to these parameters (USFWS 1993a).

Water Birds

Water birds (i.e., waterfowl and coots) are susceptible to deleterious effects of chemical contamination. By virtue of their close association with environmental media such as water and sediment and the tendencies of these media to act as contaminant sinks, water birds are very likely to be exposed to contaminants at RMA.

In the biota RI, the water bird species present at RMA were compared to those in off-post lakes during the breeding season of 1986 (ESE 1989). Reproductive success was also recorded during this study. In addition, the USFWS has conducted year-round observations of water birds at RMA's lakes and wetlands to identify important habitats and temporal-use patterns.

Ecological Endpoints

Reproductive success, as measured by nest success at RMA, is an assessment endpoint that may be reflective of contaminant impacts upon water birds.

Study Findings

In 1984 and 1986, fewer water bird nests and broods were observed at RMA than would be indicated by habitat availability. No successful mallard broods were observed in 1986, while off-post control areas exhibited normal success (ESE 1989). However, in 1988 through 1990,

pre-flight juveniles of blue-winged teal, mallards, and American coots were collected at RMA and analyzed for contaminant burden. Thus, their presence proves some level of reproduction was occurring for those years. Relative abundance of individual species differed between the lakes of RMA and off-post control areas (MKE 1989a). Likewise, individual RMA lakes have been shown to support differing water bird communities.

Study Conclusions and Comparison With Tissue Analyses from Various Studies

Reproductive success/failure has been documented for water birds, although limited quantitative information exists even for the mallard. Poor water bird reproduction may be the result of such factors as contaminant effects, nest interference by fishermen, high levels of predation, or management-related fluctuating water levels. Among these factors, contamination is of particular concern in closed aquatic systems, which may receive contaminant inflow from widespread surrounding uplands.

In two samples of addled mallard eggs reported in the Biota RI (ESE 1989), dieldrin was the most commonly detected contaminant at levels of 4.89 and 3.0 ppm. The eggs also had DDE levels ranging from 0.606 to 0.919 ppm. The organochlorine pesticide levels were within the range of literature values indicative of adverse reproductive effects and substantially above the whole-body MATC for water birds. Concentrations in eggs tend to be lower than whole-body concentrations from the same individual for DDT/DDE. Aldrin/dieldrin concentrations are not typically measured in eggs.

Upland Game Birds

Important upland game birds such as mourning dove and pheasant are present at RMA. Several studies of upland game birds have been performed to determine potential ecological impacts of contaminants. Data on reproductive potential of pheasants are available on an RMA-wide basis only.

Ecological Endpoints

The assessment endpoints for upland game birds, as available data allow, are the following:

- Reproductive success as measured by brood size and number of broods for pheasants
- Relative abundance as measured by roadside call counts of pheasants and mourning doves at RMA relative to control areas

Study Findings

Abundance of ring-necked pheasants and mourning doves expressed as the number of vocalizations occurring during timed stays at listening stations was compared between RMA and an off-post control area (Weld County, Colorado) (MKE 1989a). Pheasant abundance was significantly higher at RMA (mean number of vocalizations at RMA = 552, Weld County = 108). Conversely, mourning doves had higher population levels at the off-post location (mean number of vocalizations at RMA = 32, Weld County = 110). Generally, mourning doves were not abundant at RMA during the breeding season.

Ring-necked pheasant brood sizes surveyed in 1984 and 1986 at RMA and off-post control areas were smaller at RMA (RMA mean = 1.8; control area mean = 3.2) (MKE 1989a).

Study Conclusions and Comparison With Tissue Analyses from Various Studies

The results of pheasant reproductive surveys are qualitative, but indicate high breeding activity and a low number of successful broods. The low number of successful broods could be the result of contaminants, poor-quality habitat, or high predation pressure. Dieldrin contamination in pheasants and mourning doves was detected at levels ranging up to 5.95 ppm (dressed carcass tissue). Some individuals had concentrations that were substantially above the whole-body MATC for small birds, suggesting that contamination may be partially responsible for the observed poor reproductive success.

<u>Songbirds</u>

Many species of songbirds are present at RMA. Several studies of songbirds have been performed to determine potential ecological impacts of contaminants. Data on reproductive potential of selected species of songbirds are available on an RMA-wide basis only. Information on relative abundance and species richness has also been collected for many of the songbird species.

Ecological Endpoints

Relative abundance, as measured by censuses and breeding bird surveys of on-post vs. off-post songbird species, is the assessment endpoint for songbirds at RMA.

Study Findings

Small bird populations were censused at RMA, Buckley, and PCC. The predominant species were horned larks and western meadowlarks (MKE 1989a). Horned larks were significantly more abundant at PCC, and meadowlarks were more abundant at Buckley. These differences in species abundance were assumed to result from differences in habitat at RMA and the reference locations because no within-site variation was attributable to trends in contamination (MKE 1989a).

The quantitative breeding bird survey results (Table C.5-12) indicate that "grassland songbirds nested at higher densities off site" (MKE 1989a). For all four species evaluated, western meadowlark, horned lark, grasshopper sparrow, and vesper sparrow, densities were highest off post for both crested wheatgrass and native grassland habitats. The results of multiple correlation and principle components analyses attributed the differences in breeding density of these four species to differences in habitat quality, which was evaluated on the basis of 16 independent habitat variables that were grouped as descriptors of habitat complexity, openness, and denseness (MKE 1989a).

Study Conclusions and Comparison With Tissue Analyses from Various Studies

The lower abundance and density of songbirds at RMA relative to control areas have been attributed to differences in habitat (MKE 1989a). Chemical analyses of vesper sparrows, western meadowlarks, mourning doves, and of several species sampled fortuitously revealed no consistent patterns of concentration and spatial distribution, although tissue concentrations of aldrin, dieldrin, and endrin in mourning doves were substantially above the whole-body MATCs for small birds (Attachment C.5-2). Most of the fortuitous samples were collected dead from the lawn in front of Building 111. A Brewer's blackbird was exhibiting muscular tremors when collected in front of a warehouse just east of South Plants; chemical analysis revealed 8.0 ppm dieldrin, which is well above the whole-body MATC of 0.15 ppm. Thus, there is evidence that individual songbirds are being adversely affected by contaminants at RMA.

C.5.3.2.3 Invertebrates

Invertebrates were studied because of their importance in the structure and function of regional ecosystems, because some species are known to bioaccumulate contaminants, and because they can serve as sensitive indicators of contaminant effects (ESE 1989). Each group was sampled at the population level at sites of known contamination and in off-post control areas.

Grasshopper abundance was estimated using standard ocular techniques. Ten 1-ft-square (ft^2) plots were established at 33-ft intervals along five 328-ft transects located in on-post sites of contamination (i.e., the Basins A, C, and F) and similar habitats in off-post control sites at Wellington State Wildlife Area (Larimer County, Colorado) and in Aurora Environmental Park (Adams County, Colorado). Information on exact sampling locations, detailed methods, and statistical analyses is provided in the Biota RI (ESE 1989).

Earthworm population density was estimated by excavating known soil volumes and plots (11 ft^2 in size and dug to a depth of approximately 0.5 ft) and hand sorting the soil to remove earthworms. Sample sites were selected in South Plants, at an on-post control site in Section 5, and an off-post control site at Barr Lake State Park (Weld County, Colorado). Samples at each

location were from the same soil type. Other potential locations in sites of contamination (e.g., Basin A) were not sampled due to a variety of reasons including soil compaction, absence of vegetation, or soil types not suitable to sustain earthworm populations. Data were analyzed by nonparametric methods. Analyses are described in Appendix B of the Biota RI (ESE 1989).

Ecological Endpoints

The assessment endpoint investigated to evaluate whether RMA contaminants adversely affected invertebrate populations was population abundance of selected invertebrate groups: grasshoppers, earthworms, and aquatic snails. The measurement endpoints were the following:

- Grasshoppers—Population density
- Earthworms—Population density
- Aquatic snails—Population density and biomass

Study Findings

For grasshoppers, the analyses showed a nonsignificant ($p>0.05$) statistical difference between controls (on post n=10; off post n=26) and between controls and contaminated samples (n=21) using both parametric and nonparametric tests. This was true even when variation resulting from differences in time of day, temperature, and floral characteristics were removed via multiple regression analysis and the residual variation analyzed among the control and contaminated sites.

For earthworms, results indicated that the on- and off-post control sites were significantly different, and that both control sites were significantly different from the contaminated site. Differences in population density were not consistent with patterns of contamination (e.g., the on-post control site had the highest population density).

For aquatic snails, statistical differences in population density in both 1986 and 1987 were found between RMA lakes and off-post control sites. Statistical differences were also detected between controls for 1986 and 1987 and among RMA lakes for 1986, but not for 1987. Results indicated

a high degree of variability between sites and years. Additional statistical analyses indicated that covariates of aquatic vegetation, snail weight, water temperature, and water pH affected results.

Study Conclusions and Comparison With Tissue Analyses from Various Studies

The above-referenced data indicate no obvious contaminant effects on population density of grasshoppers, earthworms, or aquatic snails.

In grasshopper samples from the population survey areas, none of the organochlorine pesticide COCs, arsenic, mercury were detected in the on- or off-post control sites. Arsenic, dieldrin, endrin, and mercury were found in earthworms from the on-post control and South Plant sites (Attachment C.5-2). Earthworm population and tissue contaminant levels were reported as not indicative of adverse contaminant effects (ESE 1989).

C.5.3.2.4 Terrestrial Vegetation

Terrestrial vegetation is the basis of terrestrial ecosystems, and its biomass is as much as 10 times greater than the biomass of terrestrial animals. Much of the biomass of most plant species is below the ground and in contact with soils and the chemicals in soils. The distribution of vegetation at RMA is documented by good aerial photo coverage of the RMA area dating to 1937 and by a remote sensing program conducted in 1978–79 (Strahler et al. 1979). MKE (1989b) performed extensive sampling of ecological parameters for vegetation both on post and off post. Data for plant species cover, production, phenology, density, as well as plant community floristics, were collected.

Ecological Endpoints

Assessment endpoints for vegetation are species richness, relative abundance, and morbidity of plant communities. Soil contamination may affect these assessment endpoints directly by influencing the presence or growth of particular plant species, as well as indirectly via plant symbiont or decomposition microorganisms that make nutrients available for plant use. Measurement endpoints for these assessment endpoints are the following:

- Structure and species composition at the population and community level, respectively
- Growth and phenology at the population and individual level

Study Findings

Portions of RMA are contaminated with materials that are toxic to plants and that continue to affect vegetation. The Lime Settling Basins in Section 36 are, for example, devoid of vegetation, a condition that is attributable to the toxic chemicals concentrated at these locations. At this time, areas such as this are localized and do not cover a large portion of RMA. Between 1976 and 1978, larger expanses of bare ground were present adjacent to Basin F and other waste basins where surficial deposition of contamination occurred through evaporation of contaminated material. This retrogression most likely occurred when severe drought added stress to plant communities already impacted by contaminant deposition (Strahler et al. 1978). With average precipitation, weedy and early successional species have naturally revegetated these areas, and native grasses that have been seeded at these locations have grown normally.

Aside from these relatively limited areas of high contamination, it is very difficult to discern contaminant effects on vegetation at RMA. The RMA landscape is, generally, a highly modified mosaic with local vegetation being primarily a function of past land uses. Although Strahler et al. (1979) suggested a correlation between contaminated surface water and groundwater flow and plant community successional status, MKE (1986) found that no specific vegetation type is reflective of contamination. Although weedy vegetation is associated with contaminated areas, weedy species are just as likely to dominate in uncontaminated portions of RMA. Weediness is a result of land disturbance, whether the disturbance is the result of facility construction, contaminated waste disposal, or abandonment of agricultural activity. Conversely, native grasslands occur in undisturbed surface areas with surficial contamination, as well as in undisturbed areas remote from contamination. Section 36, one of the most severely contaminated areas of RMA, contains about 25 acres of undisturbed native grassland.

Variables such as total vegetation cover, total productivity, species richness, and phenology are similar between weedy and native vegetation sites within moderately contaminated and noncontaminated sites at RMA as well as at off-post locations (MKE 1989b). The MKE terrestrial plant study investigated 658 locations at three different sites (RMA, 424 locations; Buckley, 121 locations; and Prairie Conservation Center, 113 locations) as to their cover, height, density and production. Statistical comparisons of cover, production, density, and diversity were performed for the major vegetation types (native grassland—RMA, 73 transects; mixed grass prairie—Buckley, 51 transects; mixed grass prairie—PCC, 51 transects; short grass prairie—PCC, 52 transects; crested wheatgrass—RMA, 48 transects; and crested wheatgrass, 49 transects) using one-way ANOVA. In crested wheatgrass, cover and species per transect were significantly lower ($p=0.05$) at RMA than at Buckley, but production and density were not. Other types were not strictly analogous. The total number of species in native grassland at RMA was greater than in any of the other vegetation types at any site. The occurrence of diverse management practices, human activities, and environmental variables at RMA and at the control sites precludes identification of the basis for quantitative differences in vegetation between these sites. In general, habitats at RMA are comprised of healthy plant communities that are proceeding through normal successional processes for semiarid environments.

Study Conclusions and Comparison With Tissue Analyses from Various Studies

The distribution of plants at RMA is affected by localized, high contaminant concentrations as well as by various other factors. A number of plant samples analyzed under the Biota RI and Biota CMP contained low levels of arsenic and OCPs. Arsenic was detected at 4.5 ppm in sunflower leaves collected in Basin A. No phytotoxic effects were exhibited by the plants and it was suggested that the detections of arsenic may have been due to dust deposited on the leaves (ESE 1989). Levels reported during the Biota RI (ESE 1989) for RMA vegetation (Attachment C.5-2) do not suggest direct adverse effects. Similar low levels of contaminants were reported from the Biota CMP, so terrestrial plants proved to be relatively ineffective indicators of the COCs in 1988 through 1990 (RLSA 1992).

C.5.3.3 Investigations of Biomarkers

Biomarkers such as the inhibition of AChE in brain tissue and eggshell thinning are specific possible effects of some of the contaminants found at RMA. Data on these parameters were collected as part of the Biota RI to evaluate whether these adverse effects were occurring at RMA on or near sites of known contamination (ESE 1989). To evaluate AChE inhibition, analyses were performed on brain tissues from mallard, ring-necked pheasant, black-tailed prairie dog, and desert cottontail from sites of contamination at RMA and from control sites more than 40 miles from RMA. Fortuitous samples (three red-tailed hawks, two golden eagles, and one mourning dove) from RMA were also analyzed. Eggshell thinning can be produced by some of the RMA COCs and could result in lower reproductive success for some bird species. Shell thickness and other measurements were made on the eggs of mallards, pheasants, and kestrels that were collected as part of the Biota RI.

Biomarker Endpoints

AChE inhibition and eggshell thinning are not considered ecological endpoints as these measurements are not used to assess parameters of population or community-level status. Rather, these measurements were made because they are known to be indicative of harmful levels of chemical contamination. While eggshell thinning is known to be caused by exposure to harmful levels of DDT/DDE in the diet, AChE inhibition is used as a measure of adverse exposure to organophosphates and chemical compounds with similar activities.

Study Findings

The only significant ($p<0.01$) AChE inhibition (> 20 percent reduction) was found in prairie dogs living in or near the Toxic Storage Yard. The decrease could not be related to known contaminants found in that area, but appeared to result from the naturally occurring concentrations of arsenic and metals compounds associated with the soil type found at that location (ESE 1989). Eggshell thickness did not differ significantly between RMA sites and the off-post control sites (ESE 1989) for mallards, ring-necked pheasants, and American kestrels.

Study Conclusions and Comparison With Tissue Analyses from Various Studies

Results of AChE and eggshell-thinning studies did not indicate that either adverse effect was present at RMA as a result of contamination. Sample sizes for mallard, pheasant, kestrel, prairie dog, and cottontail were sufficient for nonparametric statistical analyses. Incidental data on other species, though inconclusive, were consistent with these results. Details of the statistical analyses are presented in Appendix B of the Biota RI (ESE 1989).

C.5.3.4 Incidences of Mortality

Direct mortality of wildlife as a result of exposure to chemical contamination is a well-documented phenomenon (Connel and Miller 1984). Several RMA COCs are lethal at relatively low doses. Data that provide indications of wildlife mortality at RMA include historic accounts, current observations, and interpretations of mortality events documented by USFWS. Historical reports of significant levels of wildlife mortality at RMA began in the early 1950s (Hyman 1953). At least three studies were conducted in the 1950s specifically to document and investigate the causes of wildlife mortality (Sciple 1952; Jensen 1955; Finley 1959). Fortuitous samples were collected during 1988, 1989, and 1990 (RLSA 1992). Since that time, the USFWS has continued to collect fortuitous samples at RMA.

Ecological Endpoints

In spite of the fact that past occurrences of wildlife mortalities at RMA are not pertinent to the current risk of mortality, documentation of such occurrences provide clear evidence that RMA contaminants have caused mortality. The measurement endpoint that is pertinent to assessing the risk of mortality is the observation of dead, dying, or seriously impaired individual animals.

Study Findings

Caustic releases into the lakes have been thought to cause declines in the fish populations since the late 1940s. Finley (1959) estimated a minimum mortality of 20,000 water birds during a 10-year period. McEwen (1981) recorded the death of numerous ducks with high levels of dieldrin in their tissues in 1955. Hundreds of individuals, including waterfowl, amphibians,

raptors, songbirds, fish, and shorebird species, have been found dead or dying in every decade since 1950 (ESE 1989). Most hawks and owls found dead at RMA and analyzed for contaminants in brain and liver tissues were found to contain dieldrin. Lethal dieldrin brain levels are reported to range between 4 and 20 ppm (Robinson and Crabtree 1967; Coon et al. 1968; Belisle et al. 1972; Mulhern et al. 1970). The brain-tissue concentrations of dieldrin in most raptors (excluding eagles) found dead due to unknown causes at RMA and analyzed fell within this range. During the Biota RI program, numerous dead birds were noticed on the mowed lawns around Building 111 at RMA. Deaths in this area were specifically recorded during the Biota CMP through pedestrian surveys of the Building 111 grounds that continued each spring until specimens were no longer consistently found. The surveys resulted in the collection of mostly American robins and European starlings. In addition to specimens from this area, numerous specimens were collected during the Biota CMP field work at RMA (1988–90). Table C.5-13 provides descriptive information from field notes written between 1988 and 1990 during the Biota CMP about animals exhibiting behavioral abnormalities or animals found dead and showing abnormalities from autopsy reports or necropsies.

Study Conclusions and Comparison With Tissue Analyses from Various Studies

Incidents of extensive wildlife mortality have occurred in the past at RMA. The extent and implications of current mortality are not well documented and poorly understood, but it is substantially less than that documented in the 1950s and 1960s (see Appendix A).

The extensive analytical data reported in the Biota RI (1989) and the subsequent Biota CMP (1988–90) shows variable concentrations of organochlorine pesticides in individuals of all taxa sampled. Dieldrin levels were as high as the 56 ppm reported in a mourning dove carcass found on the lawn of Building 111. Thus, potentially lethal concentrations of organochlorine pesticides, chiefly dieldrin, occur in the tissues of some individuals of certain mammal and bird species (Attachment C.5-2). Dieldrin is the contaminant most likely to be detected at injurious levels and occurs in a variety of trophic levels and species.

Despite the contaminant levels detected, current contamination-related mortality is not believed to be causing deleterious effects on the overall abundance or richness of wildlife populations at RMA. Wildlife resources are generally quite abundant at RMA and the species composition is quite diverse for the Rocky Mountain/plains grassland ecotone of eastern Colorado.

C.5.4 ECOLOGICAL ENDPOINT SUMMARY

This section summarizes the information from the ecological effects investigations into a hierarchy of ecological endpoints consistent with current EPA guidance (EPA 1989a, b). EPA guidance provides for the selection of endpoints at various levels of ecological organization. The selection of endpoints at the individual level, such as endocrine disruption and immunological effects, could conceivably produce adverse effects at the population level, but would be difficult or impossible to evaluate from such an ecological perspective. Consequently, effects at the community and population level were deemed to be more appropriate ecological endpoints.

Several animal species at RMA belong to populations that may range beyond RMA boundaries (e.g., deer, coyote), so population density for these species is a better measure of habitat quality than of adverse effects of contamination. For highly mobile species, it would be appropriate to collect data on immigration and emigration in order to evaluate contaminant effects on population density. This consideration was recognized in selecting endpoints for population density estimates. Only species of small animals with limited mobility were selected for overall population density studies (e.g., aquatic snails, earthworms, prairie dogs). For highly mobile species, endpoints were selected that took into account the mobility, exposure pathways, and potential effects of RMA contaminants. Reproductive success studies on waterfowl and kestrels fall into this category.

C.5.4.1 Community-Level Endpoints

C.5.4.1.1 Species Richness

Data on species richness are provided by studies of plant community structure and species composition by roadside species surveys of raptor diversity. A variety of field tasks, such as the collection of grasshoppers, also provided information on species richness.

Species richness of vegetation as a measure of habitat diversity within RMA ecosystems was difficult to assess because of the anthropogenic disturbance of many areas of contamination. Elevated concentrations of arsenic in soil, sufficient to limit the presence of some plant species, are present at RMA. Other contaminants, including salts and metals, may also adversely affect plants, reducing local species richness of plants and, indirectly, animals by modifying the habitat. However, soil compaction, application of herbicides for weed control, burning, and other activities made it impossible in most areas to distinguish between physical and chemical contaminant effects with any degree of certainty.

The extensive inventories of species conducted at RMA during the last decade by the Army, Shell, USFWS, and the Denver Museum of Natural History have produced data showing that the vertebrate species (i.e., birds, mammals, reptiles, amphibians, and fish) in terrestrial and aquatic ecosystems are typical of similar habitats throughout the region. In fact, RMA ecosystems contain sizable populations of key species including burrowing owls, wintering bald eagles, and coyotes. While the large numbers of individuals within these populations are largely attributable to agriculture and the lack of hunting and consumptive fishing within RMA boundaries, the presence of diverse species (i.e., species richness) and sustained populations is a good indication of general ecosystem health. Specific comparisons of contaminated sites within RMA are difficult to assess because of the absence of specific quantitative ecological data correlated with contaminant concentrations and the extensive noncontaminant-related disturbances associated with these sites. EPA (1989a) states that in such instances interpretation of results must be done with a great deal of caution.

When grasshopper samples were collected, only one species (*Melanoplus sanguinipes*) was represented in samples from contaminated sites at RMA, which compares to the four to six

species found in on- and off-post control samples. However, this difference in species richness between control and contaminated sites was attributed to the reduced vegetation diversity at contaminated sites rather than to a direct effect of chemical contamination on grasshoppers (MKE 1989a).

C.5.4.1.2 Trophic Diversity

Trophic diversity was not studied directly. Rather, data from pellet analysis of raptors, analysis of the contents of guts of various prey species, and numerous direct-foraging observations served as general measurement endpoints. When this information was evaluated together with data on observed species richness at RMA and food-web pathways studies, there was no indication of adverse effects by chemical contamination on the trophic diversity at RMA.

C.5.4.2 Population-Level Endpoints

C.5.4.2.1 Abundance

Data on abundance are provided by studies of (1) deer through surveys of their distribution; (2) prairie dogs through average density surveys; (3) small mammals through documentation of general population abundance and mean abundance during trapping; (4) bald eagles through surveys of individuals and their distribution; (5) raptors through roadside surveys; (6) upland game through roadside call counts at RMA and in control areas; (7) songbirds through censuses and breeding bird surveys; (8) invertebrates through aquatic snail population density and biomass measurement, earthworm population density records, and grasshopper population density indices; and (9) vegetation through a survey of species distribution.

The mule deer population is increasing. Additional data on individual effects and contaminant concentrations support the general conclusion that RMA contamination is not adversely affecting deer populations. Studies of prairie dogs, small mammals, bald eagles and other raptors, upland game birds, songbirds, and invertebrates at RMA either indicated no significant reduction in populations at RMA or reported ambiguous results that were difficult to interpret. Some species, including horned larks and mourning doves, were significantly more abundant at the off-post

control sites than at RMA. While contamination effects are possible, additional analyses indicate that the differences in habitat quality and diversity account for most of the differences observed (MKE 1989a).

C.5.4.2.2 Reproductive Success

Data on reproductive success are provided by studies of (1) deer (based on fawning rate, fawn survival, and population growth rate); (2) prairie dog (based on juvenile-to-adult ratios); (3) American kestrel (based on nesting attempts per available opportunity, clutch size, hatching success, and fledgling success); (4) great horned owl (based on nesting success at various locations at RMA and relative to published data); (5) burrowing owl (based on nesting success); (6) raptors (based on nesting success); (7) water bird (based on nesting success at RMA); and (8) upland game birds (based on brood size and number).

Information on the reproductive success of deer indicates healthy populations. Both mule deer and white-tailed deer are reproducing well, although health-related problems in some individuals have been noted. While prairie dog reproductive success was lower on post than off post, the differences were strongly confounded by the impacts of campestral plague and colony maturity. The trends for small mammal reproductive success were ambiguous and appeared to be related to habitat quality.

Results from the various measurement endpoints evaluated for birds at RMA indicated a possibility of contaminant-related reproductive effects for some species. American kestrel studies documented potentially harmful levels of contamination in some individuals, but significant population effects were not documented. While a greater percentage of nests appeared successful off post, in recent years the nests that were successful on post tended to produce more eggs and more fledged young. Causes of nest failure were not studied. While this higher production per successful nest does not offset the overall greater success rates observed off post, it does indicate that high productivity is possible within contaminated areas. It may also suggest that other unexamined factors, such as predation, human disturbance, and nest site competition, may

contribute to on-post nest failure. Reproductive success of both owl species and of other raptors breeding at RMA appears comparable to or better than data from off-post control areas and to data from related studies conducted in other areas. In mallards studied in 1986, reproductive success was reduced in RMA lakes compared to off-post control sites, and contaminant levels in the two tissue samples taken were elevated, both of which suggest contaminant effects consistent with the modeled exposure routes to this trophic box.

C.5.4.2.3 Morbidity

Data on morbidity are provided by studies of (1) deer mortality and general health (e.g., muscle mass, fat reserves, physical condition, the incidence of disease or parasitism, and the incidence of health-related problems in individuals); (2) bald eagle general health and potential exposure; (3) great horned owl individuals exhibiting symptoms of contamination; (4) fortuitous observations and necropsy of dead and dying raptors as well as accompanying tissue analyses; and (5) vegetation presence, growth, and phenology at the species and individual level.

Most individual deer appear healthy and are free of contaminants. The few instances of health-related problems continue to be evaluated.

The bald eagle winter roost at RMA is one of only five in the region. It has been used consistently since 1986, providing not only a protected roosting site but a dense prey population of prairie dogs nearby. While contaminant levels measured in the blood of captured bald eagles were not above the lower limits of concern, most of the birds were captured soon after their arrival at RMA. The bald eagles' potential exposure to contaminants via the food-web pathway during their stay at RMA (about 5 months) continues to be of concern, and prairie dogs are being kept out of the most contaminated areas of RMA to eliminate potential exposure of eagles from this prey source until these areas have been remediated.

Although a number of great horned owls have been found dead, due allegedly to RMA contaminants, the reproduction rate for the population remains above average.

The numerous factors affecting the presence and distribution of vegetation confound the consideration of plant morbidity.

C.5.4.3 Individual Endpoints

Data on individual endpoints are provided by studies of (1) eggshell thinning (mallards, pheasants, kestrels) and (2) AChE inhibition (pheasant, mallard, prairie dog, desert cottontail, and fortuitous samples of individuals of miscellaneous other species).

AChE and eggshell-thinning studies did not reveal contaminant-related adverse effects in the individuals studied. The results for AChE were statistically supported for species with sufficient sample sizes (mallard, pheasant, kestrel, prairie dog, and cottontail).

C.5.4.4 General Conclusions

Adverse effects of contamination at RMA were severe in the past, as is indicated by the documentation of water bird die offs and fish kills associated with contaminant releases to the lakes. Investigations on the effects of contamination at RMA during the past decade indicate that while some effects may still be present in biota at RMA, the wildlife communities and populations are viable and appear healthy. The ecological effects of the contaminants that have been documented are consistent with the exposure pathways and endpoints developed in the pathways-modeling portion of the risk assessment (e.g., raptor mortality may be a consequence of biomagnification through the food web).

Observations of reduced reproductive success in mallards in RMA lakes and of dead and dying raptors indicate that some adverse effects of contamination may still be occurring. This conclusion is supported by tissue-concentration results and by the exposure pathways model. Likely effects of RMA contamination on individual animals have been observed (e.g., tissue concentrations above MATC values associated with toxicological endpoints in individuals that appeared healthy when collected as intentional specimens; behavioral symptoms and necropsy results indicating contaminants caused or contributed to the death of raptors and carnivores).

From the ecological endpoints that have been measured, these effects are not apparent at the population level at RMA.

C.5.5 UNCERTAINTY AND LIMITATIONS

Sources of uncertainty in the characterization of the status and health of RMA fish and wildlife populations include variability in study methodologies and reporting formats as well as normal biological variability among measured populations. The many ecological studies of RMA varied considerably in their study designs (e.g., sample size, location of control areas, and experimental treatment) and presentation of data. Data on wildlife population trends are not continuous through time and frequently have been derived using different methodologies, which makes them difficult to interpret, particularly given the many sources of natural variability. Natural populations routinely fluctuate on both an annual and a seasonal basis. Some species may only spend a few days or weeks at RMA. Timing of reproduction, relative reproductive success, intensity of predation, level of parasitism, quality and abundance of food sources, and climate all are variables that can positively or negatively affect population levels at any given point in time. Recent data from USFWS breeding bird surveys indicate that some species fluctuate up and down with a periodicity of 10 years or more. Further discussion of the uncertainties associated with the characterization of the status and health of RMA biota can be found in Appendix Section E.12.

The potential for wildlife exposure to contaminants at RMA has also been variable. In spite of the fact that environmental persistence of the chemical contaminants at RMA is long term, a number of intermediate remediation responses have been carried out in the last two decades with the specific purpose of reducing exposure (e.g., draining and dredging of the Lower Lakes, draining and removing sediment from Basin F, installing vegetative and physical barriers at Basin A). Thus, contaminants should currently be less available to biota than they were when some of the biota tissue samples were collected. Although a time lag would be expected between reduction of exposure and a subsequent reduction in tissue concentration, the positive effects of

exposure intervention programs should result in the declining availability and effects of contamination.

Because of variability in the design of past studies, the variability of wildlife exposure, and anticipated resultant reduction in tissue concentrations, data from the long-term monitoring of population trends are needed. A consistent long-term study design would enable separation of contaminant effects on populations from natural long-term population cycles and animal mobility. Such a study could minimize the number of variables that might obscure detection of any correlation between population trends or other ecological effects and contamination. The study could also provide data useful for risk management, facility/refuge management, and regulatory oversight. The biomonitoring program currently being conducted by USFWS is addressing these goals.

C.5.6 REFERENCES

Armstrong, D. 1972. Distribution of Mammals in Colorado. Museum of Natural History, Univ. of Kansas, Lawrence.

Bailey, A.M., and R.J. Niedrach. 1965. Birds of Colorado. Denver Museum of Natural History, Denver, CO. 895 p.

Bartschi, D.K. 1968. Visitation report: fishery management program at Rocky Mountain Arsenal. U.S. Fish and Wildlife Service, Vernal, UT.

Bartschi, D.K. 1975. Special project report: fishery management program. U.S. Fish and Wildlife Service, Vernal, UT.

Belisle, A.A., W.L. Reichel, L.N. Locke, T.G. Lamont, B.M. Mulhern, R.M. Prouty, R.B. DeWolf, and E. Cromartie. 1972. Residues of organochlorine pesticides, polychlorinated biphenyls, and mercury and autopsy data for bald eagles, 1969 and 1970. Pestic. Monit. J . 6(3) pp. 133-8.

Bergersen, E.P., P. Hiross, and A. Martinez. 1984. Sediment investigations in Lower Derby and Ladora Lakes, Rocky Mountain Arsenal. Colorado Cooperative Fishery Research Unit, Ft. Collins, CO.

Bissel, S.J., and M.B. Dillon. 1982. Colorado mammal distribution latilong study. Colorado Division of Wildlife, Denver, CO.

Buck, J.A. 1992. Monitoring great horned owls for exposure to organophosphorus pesticides in agricultural areas in Iowa. Thesis, Clemson University. Clemson, SC.

Butts, K.O. 1973. Life history and habitat requirements of burrowing owls in western Oklahoma. M.S. Thesis, Oklahoma State Univ. Stillwater, OK. 188 pg.

Chase, C.A., III, S.J. Bissel, H.E. Kingery, W.D. Graul, and M.M. Dillon. 1982. Colorado bird distribution latilong study. Denver Museum of Natural History, Denver, CO.

Connel, D.W., and G.J. Miller. 1984. Chemistry and ecotoxicology of pollution. John Wiley & Sons, New York. 444 pg.

Connoly, G.E. 1981. Limiting factors and population regulation. Pages 245-287. In: Wallmo, O.C. (ed.). Mule deer and black-tailed deer of North America.

DeWeese et al. Not published, no date. Organochlorine contamination and reproductive success in American kestrels(Falco sparverius on the Colorado Rocky Mountain Arsenal) p. 7-2 and p. 7-13.

DeWeese, L., L. McEwen, and B. Petersen. 1982. Chemical contaminant residues and effects on kestrels and other wildlife of the Colorado Rocky Mountain Arsenal. Progress report, parts 1 and 2. U.S. Fish and Wildlife Service. RIC #87091R01. In: RLSA (1990a).

RTIC 91309R06V.2
EPA (U.S. Environmental Protection Agency). 1989a. Risk Assessment guidance for Superfund. Volume II. Environmental Evaluation Manual. EPA/540/1-89/001.

EPA. 1989b. Ecological assessment of hazardous waste sites: a field and laboratory reference. EPA/600/3-89/013.

EPA. 1992a. Peer review workshop report on a framework for ecological risk assessment. EPA/625/3-91/022.

EPA. 1992b. Report on the ecological risk assessment guidelines strategic planning workshop. EPA/630/R-92/002.

EPA. 1993. A review of Ecological Assessment Case Studies from a Risk Assessment Perspective. Risk Assessment Forum. EPA/630/R-92/005.

RTIC 88293R09
ESE. 1988. Bald eagle study: Winters 1986-1987, 1987-1988. Final Report. Commerce City, CO.

RTIC 89173R02
ESE. 1989. Biota Remedial Investigation, Rocky Mountain Arsenal. Final Report (version 3.2). Prepared for U.S. Army.

Finley, R.B. 1959. Investigations of waterfowl mortality at the Rocky Mountain Arsenal. Internal U.S. Fish and Wildlife Service Report, Denver Wildlife Research Center, CO.

Garrett, M.G., J.L. Hoogland, and W.L. Franklin. 1982. Demographic differences between an old and a new colony of black-tailed prairie dogs. Amer. Midl. Nat. 108:51-59.

Grier, J.W. 1974. Reproduction, organochlorines, and mercury in northwestern Ontario bald eagles. Can. Field Nat. 88:469-475

Hammerson, G.A., and D. Langlois 1981. Colorado reptile and amphibian distribution latilong study. Colorado Division of Wildlife, Denver, CO.

Haug, E.A., and L.W. Oliphant. 1990. Movements,activity patterns, and habitat use of burrowing owls in Saskatchewan. J. Wildl. Manage. 54:27-35.

Hickman, C.P. Sr., C.P. Hickman Jr., F.M. Hickman, and L.S. Roberts. 1979. Integral Principles of Zoology. C.V. Mosby Co., St. Louis, MO. p. 7.

Hyman, J. 1953. Report of analysis of toxicants in duck fat, lake water, and surface foam. RLA 006 1131-1133.

Jensen, W.I. 1955. Waterfowl mortality, Rocky Mountain Arsenal. Summary Report. Denver, CO.

Johnsgard, P.A. 1988. North American Owls. Smithsonian Press, Washington, D.C.

Kerwin, C. 1972. Population size and productivity of the black-tailed prairie dog in Saskatchewan. Blue Jay 29(1):35-37.

King, J.A. 1955. Social behavior, social organization, and population dynamics in a black-tailed prairie dog town in the Black Hills of South Dakota. Contrib. Lab. Vert. Biol., No. 67, University of Michigan, Ann Arbor. 123 pg.

Knowles, C.J. 1987. Reproductive ecology of black-tailed prairie dogs in Montana. Great Basin Nat. 47(2):202-206.

Krantz, W.C., B.M. Mulhern, G.E. Bagley, A. Sprunt IV, F.J. Ligas, and W.B. Robertson Jr. 1970. Organochlorine and heavy metal residues in bald eagle eggs. Pestic. Monit. J. 4:136-140.

Lockhart, M. (USFWS). 1993. Personal Communication to Michael Macrander (Shell). Re: Bald Eagles.

Mackie, R.J., K.L. Hamlin, and D.F. Pac. 1982. Mule deer. In: J.A. Chapman and G.A. Feldhamer (eds.). Wild mammals of North America. The Johns Hopkins University Press, Baltimore, MD.

McEwen, L.C. 1981. Collection of Articles and Letters from Fish and Wildlife Service. Microfilm RSH 855, Frame 1544F.

McEwen. 1982. Mendenhall, V.M., E.E. Klaas, and M.A.R. McLane. 1983. Breeding success of barn owls (*Tyto alba*) fed low levels of DDE and dieldrin. Archives of Environmental Contamination and Toxicology 12:235-240.

Merriam, H.G. 1966. Reproductive potential of prairie dogs. Texas J. Science. 18:417-419.

Miesner, J. 1994. Personal telephone communication with D. Jean Tate, Enserch Environmental.

MKE (Morrison-Knudsen Environmental). 1989a. Wildlife resources of Rocky Mountain Arsenal. Morrison-Knudsen Environmental Services, Inc.

MKE. 1989b. Vegetation resources of Rocky Mountain Arsenal, Adams County, Colorado. Morrison-Knudsen Environmental Services, Inc.

MKE. 1989c. Aquatic Resources of Rocky Mountain Arsenal, Adams County, Colorado.

Mulhern, B.M., W.L. Reichel, L.N. Locke, T.G. Lamont, A. Belisle, and R.M. Prouty. 1970. Organochlorine residues and autopsy data from bald eagles 1966-68. Pestic. Monitor. J. 4(3) pp. 136-40.

Myers, T.E. and R.E. Greg. 1984. Lake Mary and Lake Ladora sediment investigation, Rocky Mountain Arsenal. U.S. Army Corps of Engineers, Waterways Experiment Station and Technical Operations, Vicksburg, MS.

Myers, T.E., P.A. Spain, and R.E. Gregg. 1983. Upper and Lower Derby Lakes and Gun Club Pond sediment investigation. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Newton I. 1979. Population ecology of raptors. Buteo Books, Vermillion, SD. 399 pg.

Newton, I., A.A. Bell, and I. Wyllie. 1982. Mortality of sparrow hawks and kestrels. Brit. Birds 75:195-204.

Odum, E.P. 1985. Trends expected in stressed ecosystems. BioScience 37:419-422.

Peterjohn, B. 1993. Personal telephone communication with Jane Griess, USFWS.

Plumpton, D.L. 1992. Aspects of nest site selection and habitat use by burrowing owls at the Rocky Mountain Arsenal, Colorado. Thesis, Texas Tech Univ., Lubbock, TX.

Pratt, J.R. and N.J. Bowens 1992. Variability of community metrics: detecting changes in structure and function. Environ. Tox. and Chem.

RLSA (R.L. Stollar & Associates, Inc.). 1988. Comprehensive Monitoring Program, Draft Final Technical Plan. Prepared for U.S. Army Program Manager's Office, Rocky Mountain Arsenal Contamination Cleanup. Prepared by R.L. Stollar & Associates, Inc., Harding Lawson Associates, Ebasco Services Incorporated, Datachem, Inc., Enseco-Cal Lab, and Midwest Research Institute. June.

RTIC 90220R01
RLSA. 1990. Comprehensive Monitoring Program, Final Biota Annual Report for 1988, Version 2.1. Prepared for U.S. Army Program Manager, Rocky Mountain Arsenal. Prepared by RLSA, Harding Lawson Associates, Ebasco Services, Inc., DataChem, Inc., and Midwest Research Institute. May.

RTIC 92287R03
RLSA. 1992. Comprehensive Monitoring Program, Biota Annual Report for 1990 and Summary Report for 1988 to 1990. Prepared by R.L. Stollar & Associates, Inc., Harding Lawson Associates, Ebasco Services, Inc., DataChem, Inc., and Midwest Research Institute. May.

Robinson, J. and A.N. Crabtree. 1969. The effect of dieldrin on homing pigeons (*Columbia livia var.*). Med. Rijks. Landb. Wetenschappen. Gent. 34:413-427.

Rocky Mountain Fisheries Consultants, Inc. 1977. Preliminary aquatic survey, Rocky Mountain Arsenal, Commerce City, CO.

Rosenlund, B., S.D. Jenning, B. Karey, T. Jackson, and E. Bergersen. 1986. Contaminants in aquatic systems at the Rocky Mountain Arsenal-1984. U.S. Fish and Wildlife Service Final Report.

Schindler, D.W. 1987. Detecting ecosystem responses to anthropogenic stress. Can. J. Fish. Aquat. Sci. 44:6-25.

Sciple, G.W. 1952. Study of avian mortality of three lakes at the Rocky Mountain Arsenal, Denver, Colorado. Wildlife Research Laboratory, Denver, CO. Special report. May 28, 1952. RIC #84269R01. In: RLSA 1990.

Strahler, A.H., J. Blakely, and W. Hallada. 1978. Vegetation Map of Rocky Mountain Arsenal, Commerce City, CO. Final Report of Army Contract DAAA05-78-M-0853.

Strahler, A.H., S. Krieg, E. Rosenkrantz, J. Blakely, and J. Baggett. 1979. Vegetation Study of the Rocky Mountain Arsenal, Commerce City, CO. Final Report of Army Contract ARMY-79-N-2223.

Suter, G.W. II. 1989. Ecological Endpoints. In: EPA 1989b.

Tate, J., Jr. and D.J. Tate. 1982. The Blue List for 1982. American Birds 36(2):126-135.

Thorne, D.S. 1982. Contaminants in fish and game animals on Rocky Mountain Arsenal 1977 - 1982. Rocky Mountain Arsenal Information Center, Commerce City, CO.

Tileston, J.V. and R.R. Lechleitner. 1966. Some comparisons of the black-tailed and white-tailed prairie dogs in north-central Colorado. Amer. Midl. Nat. 75(2):292-316.

U.S. Army. 1973. Baseline ecology surveys of Rocky Mountain Arsenal/Tooele Army Depot. Life Sciences Laboratory Division, U.S. Army Dugway Proving Ground, Dugway, UT.

USFWS (U.S. Fish and Wildlife Service). 1992a. U.S. Fish and Wildlife Service, Rocky Mountain Arsenal Field Office, Fiscal Year 1991, Annual Progress Report. U.S. Fish and Wildlife Service, Commerce City, CO.

1992b. Minutes from Natural Resource Conservation Committee meeting, 14 July 1992.

1992c. Results of breeding bird survey. Patuxent, MD.

1993a. U.S. Fish and Wildlife Service Rocky Mountain Arsenal National Wildlife Area, Fiscal Year 1992, Annual Progress Report. U.S. Fish and Wildlife Service, Rocky Mountain Arsenal National Wildlife Area, Building 111, Rocky Mountain Arsenal, Commerce City, CO.

1993b. Minutes from Natural Resource Conservation Committee meeting, 13 July 1993.

1994. FY93 Annual Progress Report, Rocky Mountain Arsenal National Wildlife Area. Commerce City, Colorado.

Webb, E.A., B. Bennett, and C.R. Preston. 1991. Documentation and interpretation of selected wildlife habitat relationships at Rocky Mountain Arsenal. Task Two: Small Birds. 1991 Annual Progress Report. Denver Museum of Natural History, Denver, CO.

Whittaker, D.G. 1993. Patterns of coexistence for sympatric mule and white-tailed deer on the Rocky Mountain Arsenal, Colorado. In: USFWS 1992.

Wiemeyer, S.N., and J.L. Lincer. 1987. The use of kestrels in toxicology. In: D.M. Bird and R. Bowman (eds.). The ancestral kestrel. Raptor Research Foundation, Inc. and Macdonald Raptor Research Center of McGill University, Ste. Anne de Bellevue, Quebec, Canada.

Wiemeyer S.N., B.M. Mulhern, F.J. Ligas, R.J. Hensel, J.E. Mathisen, F.C. Robards, and S. Postupalsky. 1972. Residues of organochlorine pesticides, polychlorinated biphenyls, and mercury in bald eagle eggs and changes in shell thickness-1969 and 1970. Pestic. Monit. J. 6:50-55.

Wiemeyer, S.M., R.D. Porter, G.L. Hensler, and J.R. Mastrelli. 1984. Organochlorine pesticide, polychlorobiphenyl and mercury residues in bald eagle eggs 1969-1979 and their relationships to shell thinning and reproduction. U.S. Fish and Wildlife Service Technical Report 6. 33 pg.

Wiemeyer, S.M., T.G. Lamont, C.M. Bunck, C.R. Sindelar, F.J. Gramlich et al. 1986. DDE, DDT, and Dieldrin: Residues in American Kestrels (*Falco sparverius*) and relations to reproduction. Arch. Environ. Contam. Toxicol. 13:529-549.

Wiseman, T. 1986. Factors influencing the distribution and abundance of burrowing owls (*Athene cunicularia*) in Cape Coral, Florida. M.S. Thesis, Appalachian State Univ., Boone, NC.

Table C.5-1 Studies Relevant to Ecological Endpoints

Assessment Endpoint	Measurement Endpoint	Relevant Studies (Source)
Reproductive Success	Nesting Success	Water birds (ESE 1989) Raptors (see specific species) Burrowing Owl (Plumpton 1992) Great Horned Owl (USFWS 1992a, 1993a) Kestrel (DeWeese et al., 1982 and undated.; ESE 1989; RLSA 1990, 1992, 1993; USFWS 1992a, 1993a) Pheasant (MKE 1989a) Upland game birds (MKE 1989a)
	Juvenile/Adult ratio Litter size Fawn rate, survival	Prairie Dog (MKE 1989a) Prairie Dog (USFWS 1993b) Mule Deer (MKE 1989a, USFWS 1992a, USFWS 1993a; Whittaker 1993)
Morbidity	Surviability as indicated by potentially toxic contaminant concentrations in tissue	Great Horned Owl (USFWS 1993b; ESE 1989; RLSA 1992) Bald Eagle (USFWS 1992b, 1993a) Raptors (ESE 1989) Kestrel (ESE 1989, RLSA 1992)
	Morbidity as indicated by potential exposure	Bald Eagle (USFWS 1992b)
	Morbidity/health as indicated by muscle mass, fat reserves, physical condition, incidence of disease or parasitism	Mule Deer (USFWS 1993b)
Abundance	Relative abundance	Bald Eagle (USFWS 1992b) Small Mammals (MKE 1989a) Prairie Dog (ESE 1989; USFWS 1993a; MKE 1989a; RLSA 1992) Mule Deer (MKE 1989a, USFWS 1992a; Whittaker 1993) Pheasant (ESE 1989; MKE 1989a) Raptors (ESE 1989; MKE 1989a) Upland game (MKE 1989a) Songbirds (MKE 1989a)
Species Richness and Trophic Diversity	Density	Grasshoppers (ESE 1989) Earthworms (ESE 1989) Aquatic Snails (ESE 1989)
	Numbers of Species Identified	Raptors (ESE 1989; MKE 1989a; USFWS 1993a) Plants (MKE 1989b)

Table C.5-1 Studies Relevant to Ecological Endpoints

Assessment Endpoint	Measurement Endpoint	Relevant Studies (Source)
Vegetation		
Species Richness	Structure and Species Composition	Plants (Strahler et al. 1978; MKE 1986, 1989b)
Relative Abundance	Structure and Species Composition	Plants (Strahler et al. 1978; MKE 1986, 1989b)
Survivability	Growth and Phenology	Plants (Strahler et al. 1978; MKE 1986, 1989b)

Table C.5-2 Bias, Power, and Relevance Ratings of RMA Studies Selected to Evaluate Ecological Endpoints Relevant to Risk Characterization

Study	Bias[1]	Power[2]	Relevance[3]
Aquatic snail population density and biomass	Low	High	Medium
Grasshopper abundance	Low	Medium	High
Earthworm population density	Low	Medium	High
AChE inhibition in mammals and birds	Low	Medium	Low
Eggshell thinning	Low	Medium	High
Prairie dog population density and age ratios	Medium	Medium	Medium
Avian reproductive success (kestrels, pheasants, ducks)	Low	Medium	High
Deer and raptor population density indices	Medium	Medium	Medium
Fortuitous Observations	Medium	NA	High
Other Abundance Studies small mammals, bald eagle, mourning dove, songbird, breeding bird	Medium	Medium	Medium
Other Reproductive Success Studies	Medium	Medium	Medium
Morbidity Studies[4] Deer, great horned owl, bald eagle, vegetation	Medium	Low	Medium

1 Bias is the magnitude and direction of the tendency to measure something other than was intended; measurement bias is a consistent under- or overestimation of the true value in population units. Bias was minimized when: samples were representative of sites of contamination and appropriate control (reference) sites were selected and used.

High: None of the above
Medium: Evaluation of magnitude of potential bias
Low: Samples representative; controls were used and were appropriate

2 Power is the probability of rejecting the null hypothesis when in fact it is false and the alternative hypothesis is correct. Power was maximized when: the study was designed to test contaminant-related effects; appropriate statistical tests were used and site data were compared to appropriate reference area data or regional background values.

High: All of the above
Medium: Some combination of the above (professional judgment)
Low: No statistical design was used
Data were collected RMA-wide

3 Relevance is pertinence to the matter at hand. Relevance was maximized when: endpoint(s) selected were consistent with potential contaminant effects; study was designed to measure the appropriate effect; study focused on sites of contamination; appropriate receptors were identified and investigated and measurement endpoint = assessment endpoint; Note that some studies may be relevant to only some COCs (e.g., eggshell thinning is relevant as an endpoint only for DDE).

High: All or most of the above
Medium: Some combination of the above (professional judgment)
Low: Study not designed to evaluate specific endpoint (effect measurement incidental to purpose of the study)
Study RMA-wide (did not focus on contaminated sites)

4 Study design not appropriate to power analysis

Table C.5-3 Significance of Statistical Comparisons of Selected Ecological Endpoints Between Control and Contaminated Areas

Species, Statistical Test and (Type)	N	Sample Location	$\bar{x}$	Significance	Source
Measurement Endpoint: Density					
Earthworm (No./M^2)					
	4	Off-post Control	2.5	0.01> p >0.001	ESE 1989
ANOVA (P)	5	On-post Control	56	0.05> p >0.01	
Kruskal-Wallis (NP)	5	On-post Treated	2.6		
Grasshopper (No./M^2)					
ANOVA (P)	26	Off-post Control		NS	ESE 1989
Kruskal-Wallis (NP)	10	On-post Control		NS	
Multiple Regression (P)	21	On-post Treated			
Aquatic Snails (No./M^2)					
One-way ANOVA (P)	10	Off-post Control A	563.1	0.001> p (1986, 1987)	ESE 1989
Kruskal-Wallis One-way	10	Off-post Control B	158.6	0.001> p (1986, 1987)	
ANOVA (NP)		On-post Treated			
	10	Lake Mary	118.2	0.001> p (1986, 1987)	
Multiple Regression (P)	10	Gun Club	258.9		
	10	Lake Derby	2.7		
	10	Lake Ladora	9.7		
	10	North Bog	60.1		
Prairie Dogs (No./ha)		Summer			
ANOVA (P)	5	Control W	27.2	NS	ESE 1989
Orthogonal Contrasts	9	Control E	16.22	NS	
	5	On-post Treated	17.6		
		Winter			
	5	Control W	23.5	NS	
	9	Control E	18.5	NS	
	5	On-post Treated	28.75		
Mule Deer (No./sq.mi)					
NA (NA)	5	RMA-wide	8	Total census;	MKE 1989a
	NA	Off-post Control[1]	5	conducted 5 times	
Cottontails (No./mi)					
T-test (P)	4	RMA-wide	0.52	NS	MKE 1989a
	4	Off-post Control	0.49		

P = parametric
NP = nonparametric
p = probability
$\bar{x}$ = mean

NA = not significant
N = # of samples
NA = not applicable
M^2 = square meter

WF = weedy forb
CWF = cheatgrass with weedy forbs
PCA = principal component analysis

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Table C.5-3 Significance of Statistical Comparisons of Selected Ecological Endpoints Between Control and Contaminated Areas

Species, Statistical Test and (Type)	N	Sample Location	$\bar{x}$	Significance	Source
Measurement Endpoint: Density					
Jackrabbits (No./mi)					
T-test (P)	4	RMA-wide	0.35	$p < 0.02$	MKE 1989a
	4	Off-post Control	1.23		
MKE Pheasants					
T-test (P)	20	RMA-wide	552	$p < 0.001$	MKE 1989a
	20	Off-post Control	108		
Measurement Endpoint: Nesting Success					
American Kestral-					
ANOVA (P)		Control	NA	Control vs. RMA:	ESE 1989
Kruskal-Wallis (NP)		RMA-wide		Clutch Size - NS	
		1982		Hatchlings/nest - NS	
		1983		Fledgling/Successful Nest - NS	
		1986		Fledgling/All nests - $p < 0.05$	
Meadowlark (No./plot)					
None for contamination	12	WF RMA	0.6	NA	MKE 1989a
PCA for habitat analysis	61	CWF RMA	0.8		
	6	WF RMA-Sec. 36	1		
	2	CWF RMA-Sec. 36	1		

P = parametric
NP = nonparametric
p = probability
$\bar{x}$ = mean

NA = not significant
N = # of samples
NA = not applicable
M^2 = square meter

WF = weedy forb
CWF = cheatgrass with weedy forbs
PCA = principal component analysis

Table C.5-4 Significant Statistical Comparisons of Tissue Concentrations Between Control and Contaminated Areas Where Ecological Endpoints Were Also Measured For Selected Species*

Species, Chemical-Tissue	Control vs. Contaminated	Onsite Control vs. Offsite Control	Contaminated Site 1 vs. Contaminated Site 2
Earthworms			
Arsenic	S	S	
Grasshoppers			
Aldrin			S
Dieldrin	HS		S
Endrin			S
Arsenic			S
Mallards (arsenic data not available)			
Dieldrin—eggs	VHS		
Dieldrin—fledglings	S		
Mercury—fledglings	S		
Pheasants			
Dieldrin—eggs	VHS		
Cottontails (DDT-DDE data not available)			
Dieldrin	S		
Prairie dogs (DDT-DDE data not available)			
Dieldrin**	VHS	VHS	VHS
American kestrel			
Dieldrin—egg	HS		
Dieldrin—fledgling	S		
Mercury***			

* Comparisons were made for aldrin, dieldrin, endrin, DDT, DDE, arsenic and mercury; only significant comparisons are listed.
S = significant ($0.05 \geq p > 0.01$)
HS = highly significant ($0.01 \geq p > 0.001$)
VHS = very highly significant ($0.001 \geq p$)

** Summer/winter differences were also significant in control (S) and contaminated areas (VHS)

*** Significant differences were found between eggs and fledglings irrespective of location (S)

Source: ESE 1989, Appendix B

Table C.5-5 Small Mammal Trapping Data from Fall 1986 and Spring 1987 on RMA and ESC Values for Trapping Locations

Site #	Species									Totals	Species Count	Trapping Success (percent)	Habitat Type	Aldrin/ Dieldrin ESC in ppm
	Vole		Deer	Mouse					Rat					
				Harvest		Northern Grass-hopper	Pocket		Ord's Kanga-roo					
	Prairie	Meadow		Plains	Western		Hispid	Silkey						
1	1		23							24	2	13	wf/g	1.250
2			88	8						96	2	53	wf/g	0.615
3			2							2	1	1	wf/g*	0.053
4			1							1	1	<1	npg	0
5	1									1	1	<1	wf/g*	0.008
6										0	0	0	wf/g	0.02
7			10							10	1	6	wf/g	–
8			3	3						6	2	3	wf/g	–
9			12			5				17	2	9	np	–
10						1				1	1	<1	npg	0
11			6							6	1	3	wf/g*	0.026
12			28							28	1	16	wf/g	0.121
13			7							7	1	4	wf/g	0.105
14			1							1	1	<1	wf/g*	0
15										0	0	0	wf/g	0.035
16		7	1	1						9	3	5	w	0.019
17			14							14	1	8	wf/g	0

wf/g = weedy forb/grasses
wf/g* = weedy forb/grasses/with crested wheatgrass
w = wetland
ut = upland tree
s/s = shrub succulent
npg = native perennial grasslands

Site #	Species									Totals	Species Count	Trapping Success (percent)	Habitat Type	Aldrin/ Dieldrin ESC in ppm
	Vole		Deer	Mouse					Rat					
				Harvest		Northern Grass-hopper	Pocket		Ord's Kanga-roo					
	Prairie	Meadow		Plains	Western		Hispid	Silkey						
18			25			6			2	33	3	18	s/s	–
19					4					4	1	2	s/s	0
20	1		1		2					4	3	3	w	0
21	19	41	8							68	3	34	w	0.019
22	5				2					7	2	5	ut	0.027
23	8		4		10		4	1		27	5	14	s/s	0
24		2	45		1				40	48	4	24	s/s	0.004
25			6		3					9	2	12	s/s	0.013
26		2	2		3					7	3	4	w	0.018
27			60							60	1	30	wf/g	0.283
28											0	0	s/s	0
29			1							1	1	1	w	–

wf/g = weedy forb/grasses
wf/g* = weedy forb/grasses/with crested wheatgrass
w = wetland
ut = upland tree
s/s = shrub succulent
npg = native perennial grasslands

Table C.5-6 Summary of American Kestrel Reproductive Results 1982–92[1]

		1982	1983	1986	1988	1990	1991	1992
Nest Attempts	RMA	17	24	21	17	21	26	24
	Off-site-N	21	14	9	5	9	12	5
	Off-site-F	14	8					
Clutch Size	RMA	4.59	4.75	4.81	5.00	4.56	5.00	4.54
	Off-site-N	4.67	4.93	4.78	5.00	4.89	4.91	5.00
	Off-site-F	4.71	4.75					
Percent of Nests Hatched	RMA	65	54	81	59	52	85	58
	Off-site-N	70	57	89	60	78	100	80
	Off-site-F	58	88					
Hatchlings/Nest	RMA	3.09	2.85	3.65	3.14	4.18	3.58	3.86
	Off-site-N	2.93	3.25	3.25	2.33	3.57	3.92	4.75
	Off-site-F	3.29	3.00					
Percent of Nests Fledged	RMA	38	50	71	70	73	81	58
	Off-site-N	60	50	89	100	86	92	60
	Off-site-F	38	86					
# Fledged Per Successful Nest	RMA	2.83	2.67	3.13	4.00	4.00	3.90	3.40
	Off-site-N	2.83	3.57	3.12	2.00	3.17	3.90	3.33
	Off-site-F	3.40	3.00					
# Fledged Per Nest Attempt	RMA	1.06	1.33	2.24	1.14	1.52	3.31	2.1
	Off-site-N	1.70	1.79	2.78	1.20	2.11	3.58	2.0
	Off-site-F	1.31	2.57					

Off-site-N = Sampling sites within 10 miles of RMA
Off-site-F = Sampling sites more than 40 milesfrom RMA

[1] Pre-1988 data from ESE 1989 and DeWeese, no date; 1988 and 1990 data from Stollar & Associates, 1992 (RLSA, 1992); 1991 data from USFWS 1992c; 1992 data from USFWS, no date.

Table C.5-7 Kestrel Reproductive Success Versus Contaminant Concentrations of Dieldrin and DDE

Nest Box Number	Dieldrin Egg Conc. in ppm		Dieldrin Juvenile Conc. in ppm		Dieldrin ESC in ppm	Clutch Size		Hatchlings per Nest		Fledglings per Nest	
	88	90	88	90	as of 3/93	88	90	88	90	88	90
RMA - Basin F Area											
113	ND	ND	1.6	ND	0.068	5	ND	5	ND	5	ND
114	1.3	ND	ND	ND	0.068	5	3	0	3	0	3
116	0.403	ND	1.8	ND	0.122	5	ND	5	ND	5	ND
RMA - Basin A Area											
123	ND	ND	ND	0.0336	0.113	ND	5	ND	5	ND	5
RMA - Lower Lakes Area											
136	ND	ND	ND	0.106	0.035	ND	4	ND	4	ND	4
138	ND	ND	ND	0.0328	0.025	5	4	5	4	5	4
RMA - Other Areas											
119	(Lt) 0.084	ND	0.51	ND	0.078	5	ND	5	ND	5	ND
122	ND	ND	ND	0.0748	0.14	ND	5	ND	5	ND	5
129	1.7	ND	1.3	0.072	0.097	5	4	4	4	4	4
134	0.788	ND	0.349	ND	0.018	5	ND	2	ND	0	ND
Off-post Control Areas											
081	(Lt) 0.084	ND	ND	(Lt) 0.018	NA	5	5	0	5	0	5
082	ND	ND	ND	(Lt) 0.018	NA	ND	5	ND	4	ND	4
096	(Lt) 0.084	ND	ND	ND	NA	5	ND	0	ND	0	ND
097	ND	ND	(Lt) 0.084	ND	NA	5	5	3	4	3	4
097	0.0859	ND	(Lt) 0.084	0.0226	NA	-	-	-	-	-	-
100	ND	ND	ND	(Lt) 0.018	NA	ND	5	ND	4	ND	4
102	(Lt) 0.084	ND	ND	ND	NA	ND	5	ND	5	ND	5
102A	ND	ND	0.115	0.0175	NA	5	5	4	5	4	5
103	(Lt) 0.084	ND	(Lt) 0.084	ND	NA	4	5	4	0	4	0

ESC = estimated soil concentrations
ND = no data
NA = not applicable

Table C.5-7 Kestrel Reproductive Success Versus Contaminant Concentrations of Dieldrin and DDE

Nest Box Number	DDE Egg Conc. 88	DDE Egg Conc. 90	DDE Juvenile Conc. 88	DDE Juvenile Conc. 90	DDE ESC in ppm as of 3/93	Clutch Size 88	Clutch Size 90	Hatchlings per Nest 88	Hatchlings per Nest 90	Fledglings per Nest 88	Fledglings per Nest 90
RMA - Basin F Area											
113	ND	ND	0.322	ND	0.01	5	ND	5	ND	5	ND
114	(Lt) 0.1	ND	ND	ND	0.01	5	3	0	3	0	3
116	(Lt) 0.1	ND	(Lt) 0.1	ND	0.007	5	ND	5	ND	5	ND
RMA - Basin A Area											
123	ND	ND	ND	(Lt) 0.063	0.006	ND	5	ND	5	ND	5
RMA - Lower Lakes Area											
136	ND	ND	ND	0.811	0.011	ND	4	ND	4	ND	4
138	ND	ND	ND	(Lt) 0.063	0.008	5	4	5	4	5	4
RMA - Other Areas											
119	(Lt) 0.1	ND	(Lt) 0.1	ND	0.043	5	ND	5	ND	5	ND
122	ND	ND	ND	(Lt) 0.063	0.01	ND	5	ND	5	ND	5
129	0.203	ND	0.275	0.0806	0.02	5	4	4	4	4	4
134	0.352	ND	(Lt) 0.1	ND	0.008	5	ND	2	ND	0	ND
Off-post Control Areas											
081	0.232	ND	ND	(Lt) 0.063	NA	5	5	0	5	0	5
082	ND	ND	ND	(Lt) 0.063	NA	ND	5	ND	4	ND	4
096	(Lt) 0.1	ND	ND	ND	NA	5	ND	0	ND	0	ND
097	ND	ND	0.227	ND	NA	5	5	3	4	3	4
097	0.117	ND	0.244	0.768	NA	ND	ND	ND	ND	ND	ND
100	ND	ND	ND	0.345	NA	ND	5	ND	4	ND	4
102	(Lt) 0.1	ND	ND	ND	NA	ND	5	ND	5	ND	5
102A	ND	ND	(Lt) 0.1	0.184	NA	5	5	4	5	4	5
103	(Lt) 0.1	ND	(Lt) 0.1	ND	NA	4	5	4	0	4	0

ESC = estimated soil concentrations
ND = no data
NA = not applicable

* 09-Feb-94 trr created on 10/05/93

Table C.5-8 ESC Values, Number of Young Observed, and Number of Young Branched from Great Horned Owl Nests Observed in 1991, 1992, and 1993

Nest Number	ESC in ppm	Number of Young	
		Observed	Branched
1991-1	0.032	3	2
-2	0.071	3	–
-3	0.058	3	2
-4	0.021	3	2
-5	0.035	2	–
-6	0.022	2	2
-7	8.678	3	3
-8	0.037	3	–
1992-1	0.011	2	2
-2	0.033	4	4
-3	0.096	2	0
-4	0.076	3	1
-5	0.055	3	3
-6	0.046	2	2
-7	0.045	3	3
-8	0.071	2	0
-9	0.035	3	3
-10	0.016	2	1
-11	0.033	3	2
1993-1	0.126	1	1
-2	0.005	0	0
-3	0.033	3	3
-4	0.035	2	2
-5	12.183	2	1
-6	0.081	2	2
-7	0.001	2	2
-8	0.024	2	2
-9	0.071	2	2
-10	0.151	3	3

Reproductive Parameters	1990	1991
Nest Attempts	23	33
Percent of Attempted Nests Fledged	87	100
Number Fledged/Nest Attempts	4.54	4.29

Table C.5-10 Number of Juvenile Burrowing Owls Associated with ESC Values at their 1990, 1991, 1992, and 1993 Nest Locations*

ESC in ppm	Number of Juveniles at Each Nest										Total Juveniles in ESC Category
	0	1	2	3	4	5	6	7	8	9	
> 0.05	21	1	9	9	18	17	13	6	4		98
0.05 < ≤ 0.125	12		3	7	4	3	5	4	1	1	40
0.125 < ≤ 0.5	2					1					3
0.5 < ≤ 1.0		1									1
1.0 < ≤ 5.0					1		1				2
5.0 < ≤ 7.0					1						1
7.0 < ≤ 12.0									1		1
12.0 < ≤ 14.0						1	1	1		1	4
Overall Total											150

*ESC based on a radius of 2874 feet

Table C.5-11 1990 Juvenile Burrowing Owl Aldrin/Dieldrin Tissue Concentrations versus Data from Closest Nest Location

Juvenile Burrowing Owl	Data from Closest Nest Location		
Sample Tag Number	Aldrin/Dieldrin Tissue Concentration	Aldrin/Dieldrin ESC Value	Number of Juveniles
B1367	0.0514	12.277	7
B1372**	0.2185	13.078	9
B1385**	0.1085	13.078	9
B1490	0.457	4.786	4
B1491	1.107	0.095	8

Breeding Bird Density	Rocky Mountain Arsenal		Buckley Air Force Base		Plains Conservation Center
	Crested Wheatgrass	Native Grassland	Crested Wheatgrass	Native Grassland	Native Grassland
Western Meadowlark	1.1	1.0	1.9	1.6	1.6
Horned Lark	0.2	0.7	0.4	0.9	0.9
Grasshopper Sparrow	1.1	0.3	1.6	1.0	1.8
Vesper Sparrow	0.1	0.0	0.4	0.6	0.9

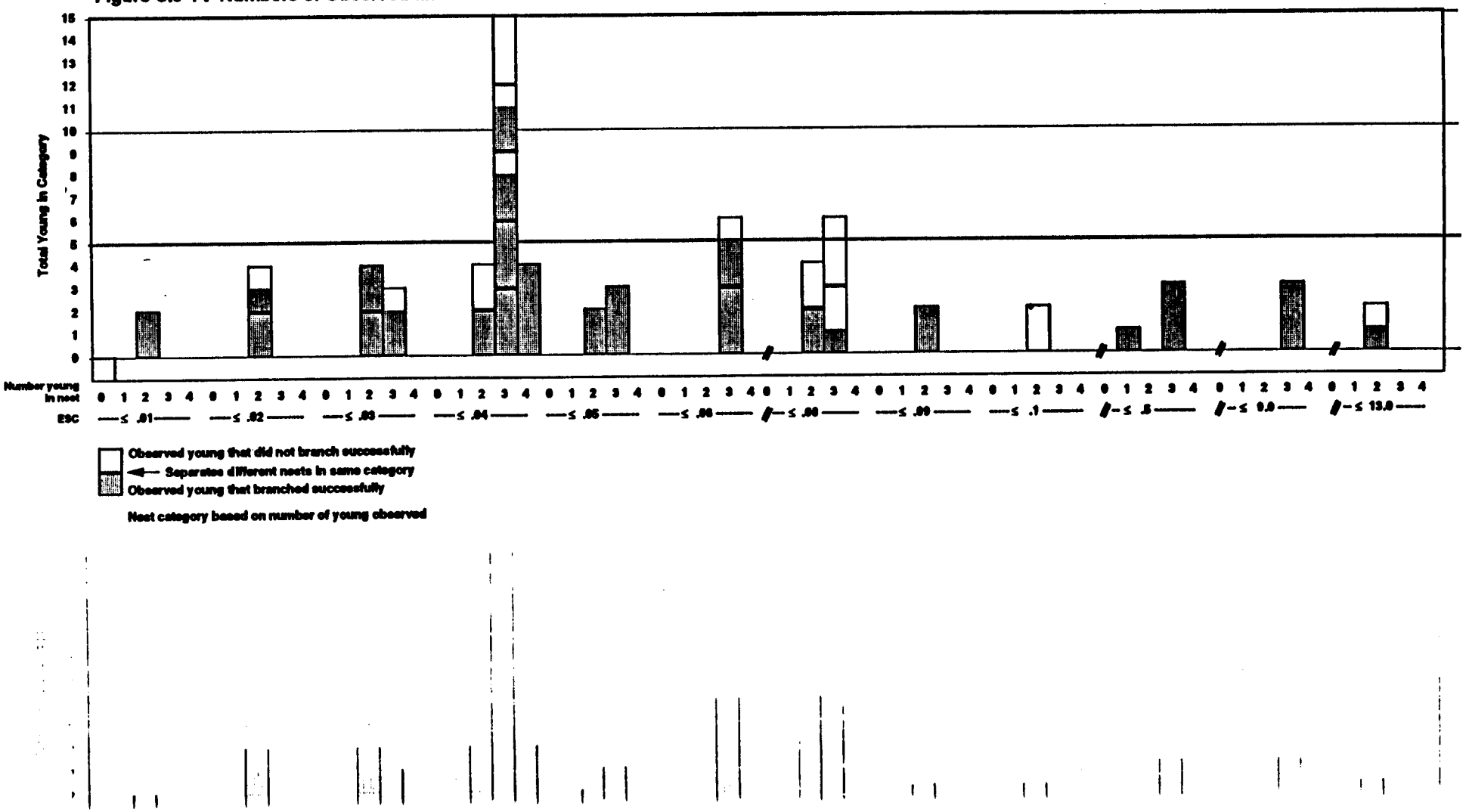
Table C.5-13 Descriptive Information Associated with Animal Mortality on RMA

Species	Comment
American Robin	Right testes discolored.
Meadowlark	Could not fly, emaciated, enlarged gut.
American Kestrel	Found dead in nest box #134 (sample ID #BU1288)
Red-tailed Hawk	Unable to fly, Bldg. 111, captured and caged; died within 5 hrs. of capture, see autopsy report; clenched feet, rested forward on breast while in cage. No apparent gross cause of death.
American Kestrel	Alive, unable to fly, being dive-bombed by other birds; taken into custody, died 1 day later, skull fractures; may have been incapacitated by something (not apparent at autopsy) other than sustained fracture.
Swainson's Hawk (juvenile fledgling)	Found dead after having been observed repeatedly along December 7th Avenue. Probable road kill. No food in crop/gizzard. No apparent aberrations.
Red-tailed Hawk	Found alive; euthanized by Boulder City Birds of Prey Foundation.
Great Horned Owl	Found dead near Bldg. 732.
Badger	Found dead near Section 36 decontamination pad, various tissue samples taken.
Brewer's Blackbird	In convulsions near a South Plants warehouse.
Ferruginous Hawk (adult)	Found dead in Section 25 NE, small amount of blood from nasal passages.
Great Horned Owl (adult)	Found dead in Section 1 NW at base of roost tree with several sticks clutched in talons; eyes gone; no wounds or obvious signs of ill health.
Ferruginous Hawk (adult)	Flew, crashed into a tree and was injured.
American Robin (adult)	Signs of neurological damage (unable to fly or control legs.
Red-tailed Hawk	Very small, no obvious wounds; tail and wings broken, emaciated; taken to Raptor Rehabilitation Center, died 12 hours later.
Rabbit (cottontail?)	Collected in Section 6 near warehouse; alive but weak, died 2 hours later.
Mourning Dove	Found alive but unable to fly, Road C at Bldg. 618.

Table C.5-13 Descriptive Information Associated with Animal Mortality on RMA

Species	Comment
Northern Pike (adult)	Collected by USFWS personnel; spinal deformity and large tumors at base of dorsal fin.
Bull Snake	Found dead one-half mile east of EBASCO base trailer on railroad tracks on December 7th Avenue; later analyzed.
Bldg. 111/112 Dead Bird Patrol	Interview with Dale Moore, Bldg. Groundskeeper: "Past 4 years regularly find dead birds under the trees, especially the clump north of Bldg. 112 parking lot."
Red-tailed Hawk	Found an adult at west side of Upper Derby Lake inlet; unable to fly and panting behavior observed; died later in the day; autopsy performed in Broomfield.
Mourning Dove	Collected an adult in Section 36; had two tumors, one next to beak and other on top of head.
Badger	Found resting, with shallow breathing, went into violent convulsions: twisting, jerking, heaving into air, gasping for breath, teeth gnashing and snarling. Convulsions subsided, followed by labored breathing and wide-eyed, glassy stare; animal attempted to stand, but fell over several times; eventually stood, but lacked complete balance, and charged observer.
Ring-necked Pheasant	Observed flying at full speed into Basin F liquid holding tank; died from impact, turned in for analysis.

Figure C.5-1 . Numbers of Observed and Branched Juvenile Great Horned Owls in Individual Nests and Collectively — by ESC Category



ATTACHMENT C.5-1

SPECIES OBSERVED OR POTENTIALLY PRESENT ON RMA

LIST OF TABLES

Species[1]	Season of Occurrence[2]	Relative Abundance[3]	Habitat Preference[4]
Podicopedidae			
Pied-billed grebe *Podilymbus podiceps*	R	C	LP
Eared grebe *Podiceps nigricollis*	M	U	LP
Western grebe *Aechmophorus occidentalis*	M	U	LP
Pelecanidae			
American white pelican *Pelecanus erythrorhynchos*	S	U	LP
Phalacrocoracidae			
Double-crested cormorant *Phalacrocorax auritus*	S	U	LP
Ardeidae			
American bittern *Botaurus lentiginosus*	S	U	CT, LP
Great blue heron *Ardea herodias*	R	U	LP
Snowy egret *Egretta thula*	M	U	LP
Little blue heron *Egretta caerulea*	M	U	LP
Black-crowned night-heron *Nycticorax nycticorax*	S	U	CT, LP
Threskiornithidae			
White-faced ibis *Plegadis chihi*	M	U	LP
Anatidae			
Canada goose *Branta canadensis*	R	A	LP
Green-winged teal *Anas crecca*	S	C	LP

Species[1]	Season of Occurrence[2]	Relative Abundance[3]	Habitat Preference[4]
Mallard *Anas platyrhynchos*	R	A	LP
Northern pintail *Anas acuta*	S	C	LP
Blue-winged teal *Anas discors*	S	C	LP
Cinnamon teal *Anas cyanoptera*	S	U	LP
Northern shoveler *Anas clypeata*	S	C	LP
Gadwall *Anas strepera*	R	A	LP
American wigeon *Anas americana*	R	C	LP
Canvasback *Aythya valisineria*	M	U	LP
Redhead *Aythya americana*	R	C	LP
Ring-necked duck *Aythya collaris*	M	C	LP
Lesser scaup *Aythya affinis*	M	C	LP
Common goldeneye *Bucephala clangula*	M	U	CT, LP
Bufflehead *Bucephala albeola*	M	U	LP
Hooded merganser *Lophodytes cucullatus*	M	U	LP
Common merganser *Mergus merganser*	M	U	LP
Ruddy duck *Oxyura jamaicensis*	M	U	LP

Species[1]	Season of Occurrence[2]	Relative Abundance[3]	Habitat Preference[4]
Cathartidea			
Turkey vulture *Cathartes aura*	S	U	Ubiquitous
Accipitridae			
Osprey *Pandion haliaetus*	M	U	LP
Bald eagle *Haliaeetus leucocephalus*	W	C	RW, GL, WF
Northern harrier *Circus cyaneus*	R	U	GL
Sharp-shinned hawk *Accipiter striatus*	R	U	RW, UG
Cooper's hawk *Accipiter cooperii*	R	U	RW, UG
Swainson's hawk *Buteo swainsoni*	S	C	GL, UG, RW
Red-tailed hawk *Buteo jamaicensis*	S	U	RW, UG
Ferruginous hawk *Buteo regalis*	R	C	GL, WF
Rough-legged hawk *Buteo lagopus*	W	C	GL, WF
Golden eagle *Aquila chrysaetos*	W	U	GL, WF
American kestrel *Falco sparverius*	S	C	GL, WF, UG, RW
Prairie falcon *Falco mexicanus*	S	U	GL, WF
Phaseanadea			
Ring-necked pheasant *Phasianus colchicus*	R	A	WF, CT, RW
Rallidae			
Virginia rail *Rallus limicola*	S	U	CT

Species[1]	Season of Occurrence[2]	Relative Abundance[3]	Habitat Preference[4]
Sora *Porzana carolina*	S	U	CT
American coot *Fulica americana*	R	A	LP
Charadriidae			
Killdeer *Charadrius vociferus*	S	C	LP, GL
Recurvirostridae			
American avocet *Recurvirostra americana*	M	C	LP
Scolopacidae			
Greater yellowlegs *Tringa melanoleuca*	M	U	LP
Lesser yellowlegs *Tringa flavipes*	M	C	LP
Herring gull *Larus argentatus*	R	C	LP
Columbidae			
Rock dove *Columba livia*	R	U	AB
Mourning dove *Zenaida macroura*	R	C	Ubiquitous
Cuculidae			
Yellow-billed cuckoo *Coccyzus americanus*	S	U	RW
Strigidae			
Eastern screech-owl *Otus asio*	R	U	RW, UG
Great horned owl *Bubo virginianus*	R	C	RW, UG
Burrowing owl *Athene cunicularia*	S	A	GL, WF
Long-eared owl *Asio otus*	R	U	RW, UG

Species[1]	Season of Occurrence[2]	Relative Abundance[3]	Habitat Preference[4]
Short-eared owl *Asio flammeus*	W	U	GL, UG, ST
Caprimulgidae			
Common nighthawk *Chordeiles minor*	S	C	Ubiquitous
Apodidae			
Chimney swift *Chaetura pelagica*	S	U	AB
Alcedinidae			
Belted kingfisher *Ceryle alcyon*	S	U	LP
Picidae			
Red-headed woodpecker *Melanerpes erythrocephalus*	S	U	RW, UG
Yellow-bellied sapsucker *Sphyrapicus varius*	M	U	RW, UG
Downy woodpecker *Picoides pubescens*	R	C	RW, UG
Hairy woodpecker *Picoides villosus*	W	U	RW, UG
Northern flicker *Colaptes auratus*	R	C	RW, UG
Tyrannidae			
Western wood-pewee *Contopus sordidulus*	S	U	RW
Willow flycatcher *Empidonax traillii*	M	U	RW
Dusky flycatcher *Empidonax oberholseri*	M	U	RW, UG
Cordilleran flycatcher *Empidonax occidentalis*	S	U	RW
Say's phoebe *Sayornis saya*	S	U	GL, AB

Species[1]	Season of Occurrence[2]	Relative Abundance[3]	Habitat Preference[4]
Western kingbird *Tyrannus verticalis*	S	A	GL, UG
Eastern kingbird *Tyrannus tyrannus*	S	C	GL, UG
Alaudidae			
Horned lark *Eremophila alpestris*	R	A	GL, WF
Hirundinidae			
Tree swallow *Tachycineta bicolor*	M	U	RW
Violet-green swallow *Tachycineta thalassina*	S	U	RW
Northern rough-winged swallow *Stelgidopteryx serripennis*	S	U	RW, GL
Cliff swallow *Hirundo pyrrhonota*	S	U	RW, LP
Barn swallow *Hirundo rustica*	S	C	RW, LP, AB
Corvidae			
Blue jay *Cyanocitta cristata*	R	U	RW, UG
Black-billed magpie *Pica pica*	R	C	RW, UG
American crow *Corvus brachyrhynchos*	R	U	Ubiquitous
Paridae			
Black-capped chickadee *Parus atricapillus*	R	U	RW, UG
Sittidae			
Red-breasted nuthatch *Sitta canadensis*	W	U	RW, UG
White-breasted nuthatch *Sitta carolinensis*	W	U	RW, UG
Certhiidae			

Species[1]	Season of Occurrence[2]	Relative Abundance[3]	Habitat Preference[4]
Brown creeper *Certhia americana*	W	U	RW, UG
Troglodytidae			
House wren *Troglodytes aedon*	S	C	RW,UG
Marsh wren *Cistothorus palustris*	M	U	RW, GT
Muscicapidae			
(Sylviinae)			
Golden-crowned kinglet *Regulus satrapa*	W	U	RW, UG
Ruby-crowned kinglet *Regulus calendula*	M	U	RW, UG
(Turdinae)			
Mountain bluebird *Sialia currucoides*	M	U	GL, UG
Townsend's solitaire *Myadestes townsendi*	W	C	RW, UG
Swainson's thrush *Catharus ustulata*	M	U	RW
Hermit thrush *Catharus guttatus*	M	U	RW
American robin *Turdus migratorius*	R	C	UG, RW
Mimidae			
Gray catbird *dumetella carolinensis*	S	U	RW
Northern mockingbird *Mimus polyglottos*	R	U	UG, ST
Brown thrasher *Toxostoma rufum*	S	U	RW
Motacillidae			
American pipit *Anthus rafescens*	W	C	GL

Species[1]	Season of Occurrence[2]	Relative Abundance[3]	Habitat Preference[4]
Bombycillidae			
Cedar waxwing *Bombycilla cedrorum*	W	U	UG, RW
Laniidae			
Northern shrike *Lanius excubitor*	W	U	UG, GL
Loggerhead shrike *Lanius ludovicianus*	S	U	UG, GL
Sturnidae			
European starling *Sturnus vulgaris*	R	C	AB, RW, UG
Vireonidae			
Solitary vireo *Vireo solitarius*	M	U	RW, UG
Warbling vireo *Vireo gilvus*	S	C	RW
Red-eyed vireo *Vireo olivaceus*	S	U	RW
Emberizidae			
(Parulinae)			
Tennessee warbler *Vermivora peregrina*	M	U	RW, UG
Orange-crowned warbler *Vermivora celata*	M	C	RW, UG
Nashville warbler *Vermivora ruficapilla*	M	U	RW
Northern parula *Parula americana*	M	U	RW
Yellow warbler *Dendroica petechia*	S	C	RW, UG
Chestnut-sided warbler *Dendroica pensylvanica*	M	U	RW
Yellow-rumped warbler *Dendroica coronata*	M	C	RW, UG

Species[1]	Season of Occurrence[2]	Relative Abundance[3]	Habitat Preference[4]
Blackburnian warbler *Dendroica fusca*	M	U	RW
Blackpoll warbler *Dendroica fusca*	M	U	RW, UG
Black-and-white warbler *Mniotilta striata*	M	U	RW
American redstart *Setophaga ruticilla*	M	U	RW
Ovenbird *Seiurus aurocapillus*	M	U	RW
Northern waterthrush *Seiurus noveboracensis*	M	U	RW
MacGillivray's warbler *Oporornis tolmiei*	M	U	RW
Common yellowthroat *Geothlypis trichas*	S	U	CT, RW
Hooded warbler *Wilsonia citrina*	M	U	RW
Wilson's warbler *Wilsonia pusilla*	M	U	RW
Yellow-breasted chat *Icteria virens*	M	U	RW
Rose-breasted grosbeak *Pheucticus ludovicianus*	M	U	RW, UG
Black-headed grosbeak *Pheucticus melanacephalus*	S	U	RW
Blue grosbeak *Guiraca caerulea*	S	U	UG, GL
Lazuli bunting *Passerina amoena*	S	U	RW
Indigo bunting *Passerina cyanea*	S	C	RW
Dickcissel *Spiza americana*	M	U	GL

Species[1]	Season of Occurrence[2]	Relative Abundance[3]	Habitat Preference[4]
Rufous-sided towhee *Pipilo erythrophthalmus*	S	U	RW
Cassin's sparrow *Aimophila cassinii*	M	U	GL, ST
American tree sparrow *Spizella arborea*	W	A	RW, GL, WF
Chipping sparrow *Spizella passerina*	S	U	UG
Clay-colored sparrow *Spizella pallida*	M	U	WF
Bewer's sparrow *Spizella breweri*	M	U	ST
Vesper sparrow *Pooecetes gramineus*	S	C	GL, ST
Lark sparrow *Chondestes grammacus*	S	U	GL, ST, UG
Lark bunting *Calamospiza melanocorys*	S	U	GL
Savannah sparrow *Passerculus sandwichensis*	M	U	GL
Grasshopper sparrow *Ammodramus savannarum*	S	A	GL
Fox sparrow *Passerella iliaca*	M	U	RW
Song sparrow *Melospiza melodia*	R	C	RW, CT
Lincoln's sparrow *Melospiza lincolnii*	M	U	RW, CT
White-throated sparrow *Zonotrichia albicollis*	W	U	UG, WF
White-crowned sparrow *Zonotrichia leucophrys*	W	C	RW, UG, WF
Harris' sparrow *Zonotrichia querula*	W	U	UG, WF

Species[1]	Season of Occurrence[2]	Relative Abundance[3]	Habitat Preference[4]
Dark-eyed junco *Junco hyemalis*	W	A	RW, UG, WF
McCown's longspur *Calcarius mccownii*	M	U	GL
Chestnut-collared longspur *Calcarius ornatus*	M	U	GL
(Icterinae)			
Bobolink *Dolichonyx oryzivorus*	M	U	GL, CT
Red-winged blackbird *Agelaius phoeniceus*	S	C	CT, RW
Western meadowlark *Sturnella neglecta*	R	A	GL
Yellow-headed blackbird *Xanthocephalus xanthocephalus*	S	U	CT
Brewer's blackbird *Euphagus cyanocephalus*	R	C	RW, UG, WF
Common grackle *Quiscalus quiscula*	S	C	RW, UG
Brown-headed cowbird *Molothrus ater*	S	C	RW, UG
Northern oriole *Icterus galbula*	S	C	RW, UG
Fringillidae			
House finch *Carpodacus mexicanus*	R	C	RW, UG, AB
Pine siskin *Carduelis pinus*	W	C	RW, UG
Lesser goldfinch *Carduelis psaltria*	S	C	UG, WF
American goldfinch *Carduelis tristis*	S	U	UG, WF

Species[1]	Season of Occurrence[2]	Relative Abundance[3]	Habitat Preference[4]
Passeridae			
House sparrow *Passer domesticus*	R	C	AB, UG

[1] Nomenclature follows AOU (1983, and supplements)

[2]
- R Resident
- M Migrant
- W Winter
- S Summer

[3]
- A Abundant, regularly present in large numbers
- C Common, regularly present in moderate numbers
- U Unconmmon, regularly present in small numbers, or irregularly present

[4]
- RW Riparian woodland
- UG Upland groves or ornamentals
- LP Lakes and ponds
- CT Cattails or wet meadows
- GL Grasslands
- WF Weedy forbs
- ST Shrublands or thickets
- YU Yucca
- AB Abandoned buildings

Table 2 Mammals Observed or Potentially Present on RMA

Species[1]	Status[2]	Abundance[3]	Habitat[4]
Soricidae			
Masked shrew *Sorex cinereus*	ptl		
Least shrew *Cryptotis parva*	ptl		
Vespertilionidae			
Small-footed myotis *Myotis leibii*	ptl		
Silver-haired bat *Lasionycteris noctivagans*	ptl		
Big brown bat *Eptesicus fuscus*	ptl		
Hoary bat *Lasiurus cinereus*	ptl		
Leporidae			
Eastern cottontail *Sylvilagus floridanus*	obs	C	RW, WF
Desert cottontail *Sylvilagus auduboni*	obs	A	GL, YU, ST
Black-tailed jackrabbit *Lepus californicus*	obs	C	GL, YU, ST
White-tailed jackrabbit *Lepus townsendi*	obs	U	GL
Sciuridae			
Thirteen-lined ground squirrel *Spermophilus tridecemlineatus*	obs	U	GL, WF
Spotted ground squirrel *Spermophilus spilosoma*	obs	U	GL
Black-tailed prairie dog *Cynomys ludovicianus*	obs	A	GL, WF
Fox squirrel *Sciurus niger*	obs	C	RW
Geomyidae			

Species[1]	Status[2]	Abundance[3]	Habitat[4]
Northern pocket gopher *Thomomys talpoides*	ptl		
Plains pocket gopher *Geomys bursarius*	obs	A	GL, ST, WF
Heteromyidae			
Silky pocket mouse *Perognathus flavus*	obs	U	ST, GL
Olive-backed pocket mouse *Perognathus fasciatus*	ptl		
Hispid pocket mouse *Perognathus hispidus*	obs	U	ST, GL
Plains pocket mouse *Perognathus flavescens*	ptl		
Ord kangaroo rat *Dipodomys ordii*	obs	C	YU
Cricetidae			
Plains harvest mouse *Reithrodontomys montanus*	obs	C	WF, GL
Western harvest mouse *Reithrodontomys megalotis*	obs	C	ST
Deer mouse *Peromyscus maniculatus*	obs	A	Ubiquitous
Northern grasshopper mouse *Onychomys leucogaster*	obs	C	GL
Meadow vole *Microtus pennsylvanicus*	obs	C	CT, RW, GL
Prairie vole *Microtus ochrogaster*	obs	C	GL, RW, CT
Muskrat *Ondatra zibethica*	obs	C	LP
Zapodidae			
Meadow jumping mouse *Zapus hudsonius*	ptl		
Erethzontidae			

Species[1]	Status[2]	Abundance[3]	Habitat[4]
Porcupine *Erethizon dorsatum*	ptl		
Castoridae			
Beaver *Castor canadensis*	ptl		
Muridae			
Norway rat *Rattus norvegicus*	ptl		
House mouse *Mus musculus*	ptl		
Canidae			
Coyote *Canis latrans*	obs	C	Ubiquitous
Red fox *Vulpes fulva*	obs	U	Ubiquitous
Swift fox *Vulpes velox* (ESE 1989)		U	
Gray fox *Urocyon cinereoargenteus* (tracks)		U	
Procyonidae			
Raccoon *Procyon lotor*	obs	U	RW, CT
Mustelidae			
Short-tailed weasel *Mustela erminea*	ptl		
Long-tailed weasel *Mustela frenata*	ptl		
Mink *Mustela vison*	ptl		
Badger *Taxidea taxus*	obs	C	GL
Striped skunk *Mephitis mephitis*	obs	U	Ubiquitous
Cervidae			

Species[1]	Status[2]	Abundance[3]	Habitat[4]
Mule deer *Odocoileus hemionus*	obs	A	WR, RW, UG, ST
White-tailed deer *Odocoileus virginianus*	obs	C	RW, ST
Antilocapridae			
Pronghorn *Antilocapra americana*	ptl		

1 Nomenclature follows Armstrong (1972)

2
- obs Observed on the RMA
- ptl Potentially present on the RMA (Armstrong 1972)

3
- A Abundant, regularly present in large numbers
- C Common, regularly present in moderate numbers
- U Uncommon, regularly present in small numbers, or irregularly present

4
- RW Riparian woodland
- LP Lakes and ponds
- UG Upland groves or ornamentals
- CT Cattails or wet meadows
- GL Grasslands
- WF Weedy forbs
- ST Shrublands or thickets
- YU Yucca
- AB Abandoned buildings

Table 3 Fish Species Identified from the Study Area Lakes, 1987 [a]

Species	Lower Derby	Ladora	Mary	McKay[b]
Salmonidae				
Rainbow trout *Salmo gairdneri*				X
Cyprinidae				
Fathead minnow *Pimephales promelas*	X			
Bluntnose minnow *P. notatus*	X			
Common carp *Cyprinus carpio*	X	X	X	X
Catostomidae				
White sucker *Catostomus commersoni*				X
Ictaluridae				
Black bullhead *Ictalurus melas*	X	X		X
Channel catfish *I. punctatus*			X	X
Centrarchidae				
Bluegill *Lepomis macrochirus*	X	X	X	X
Green sunfish *L. cyanellus*	X	X		
Pumpkinseed *L. gibbosus*		X		X
Black crappie *Pomoxis nigromaculatus*			X	X
White crappie *P. annularis*				X
Largemouth bass *Micropterus salmoides*	X	X	X	X
Percidae				
Yellow perch *Perca flavescens*		X		X

Table 3 Fish Species Identified from the Study Area Lakes, 1987 [a]

Species	Lower Derby	Ladora	Mary	McKay[b]
Esocidae				
Northern pike *Esox lucius*	X	X		

Note:

[a] Samples were obtained by electrofishing
[b] Off–post reference lake, Adams County, Colorado

Table 4 Reptiles and Amphibians Observed or Potentially Present on RMA

Species[1]	Status[2]	Abundance[3]	Habitat[4]
Snakes			
Colubridae			
Plains garter snake *Thamnophis radix*	obs	U	Ubiquitous
Common garter snake *Thamnophis sirtalis*	obs	U	Moist areas
Western terrestrial garter snake *Thamnophis elegans*	obs	U	Moist areas
Lined snake *Tropidoclonion lineatum*	ptl		
Northern water snake *Nerodia sipedon*	ptl		
Western hognose snake *Heterodon nasicus*	obs	U	Sandy areas
Milk snake *Lampropeltis triangulum*	ptl		
Bullsnake *Pituophis melanoleucus*	obs	C	Ubiquitous
Smooth green snake *Opheodrys vernalis*	ptl		
Racer *Coluber constrictor*	obs	U	Ubiquitous
Coachwhip *Masticophis flagellum*	ptl		
Viperidae			
Western rattlesnake *Crotalus viridis*	obs	U	Uplands
Lizards			
Scincidae			
Many-lined skink *Eumeces multivirgatus*	obs	U	Wooded areas
Teiidae			
Six-lined racerunner *Cnemidophorus sexlineatus*	ptl		

Species[1]	Status[2]	Abundance[3]	Habitat[4]
Iguanidae			
Eastern fence lizard *Sceloporus undulatus*	ptl		
Short-horned lizard *Phrynosoma douglassi*	obs	U	Sandy areas
Lesser earless lizard *Holbrookia maculata*	obs	U	Sandy areas
FROGS			
Hylidae			
Northern chorus frog *Pseudacris triseriata*	obs	A	Wet areas
Ranidae			
Bullfrog *Rana catesbeiana*	obs	C	Lakes and ponds
Northern leopard frog *Rana pipiens*	obs	C	Wet areas
Toads			
Pelobatidae			
Plains spadefoot *Spea bombifrons*	obs	U	Wet areas
Bufonidae			
Woodhouse's toad *Bufo woodhousei*	obs	C	Wet areas
Great Plains toad *Bufo cognatus*	obs	U	Wet areas
Salamanders			
Ambystomatidae			
Tiger salamander *Ambystoma tigrinum*	obs	U	Lakes and ponds
Turtles			
Trionychidae			
Spiny softshell *Trionyx spiniferus*	ptl		

Table 4 Reptiles and Amphibians Observed or Potentially Present on RMA

Species[1]	Status[2]	Abundance[3]	Habitat[4]
Chelydridae			
Common snapping turtle *Chelydra serpentina*	ptl		
Emydidae			
Western box turtle *Terrapene ornata*	ptl		
Painted turtle *Chrysemys picta*	ptl		

1 Nomenclature follows Smith (1978), and Smith and Brodie (1982)

2 obs Observed on the RMA
ptl Potentially present on the RMA (Hammerson 1986)

3 A Abundant, regularly present in large numbers
C Common, regularly present in moderate numbers
U Uncommon, regularly present in small numbers, or irregularly present

ATTACHMENT C.5-2

CONTAMINANT LEVELS DETECTED IN INTENTIONAL SAMPLES, ON-POST CONTROL SAMPLES, AND OFF-POST CONTROL SAMPLES

LIST OF TABLES

LIST OF FIGURES

Note: These figures have been reproduced directly from the MKE (1989) report entitled Wildlife Resources of the Rocky Mountain Arsenal, Adams County, Colorado

Note: These figures have been produced independently or have been extracted from informally published documents

Table 4.3-1. Contaminant Levels in Terrestrial Ecosystems - Terrestrial Program Samples (Page 1 of 2).

Species	Tissue	Location (Section)	Contaminant Level in parts per million (mg/kg wet weight basis)(Range/mean*)						
			Arsenic (n/nt)	Mercury (n/nt)	Aldrin (n/nt)	Dieldrin (n/nt)	Endrin (n/nt)	p,p-DDE (n/nt)	p,p-DDT (n/nt)
TERRESTRIAL PLANTS									
Morning Glory	Whole Plant	RMA, (26, 36)	<0.250-5.35 (1/5)	BDL (5)	BDL (5)	<0.046-0.084 (2/5)	BDL (5)	NRQ	NRQ
	Whole Plant	RMA Control (20)	BDL (1)	BDL (1)	BDL (1)	BDL (1)	BDL (1)	NRQ	NRQ
Sunflower	Flowers	RMA, Basin A	BDL (6)	BDL (6)	BDL (6)	BDL (6)	BDL (6)	NRQ	NRQ
	Flowers	RMA Control (19)	BDL (1)	BDL (1)	BDL (1)	BDL (1)	BDL (1)	NRQ	NRQ
	Leaves								
		RMA Basin A	<0.250-4.51 (4/5), 1.37	BDL (5)	BDL (5)	BDL (5)	BDL (5)	NRQ	NRQ
		RMA Basin C	BDL (1)	BDL (1)	BDL (1)	>0.300 (1)	0.188 (1)	NRQ	NRQ
	Leaves	RMA (19)	BDL (1)	BDL (1)	BDL (1)	BDL (1)	BDL (1)	NRQ	NRQ
INVERTEBRATES									
Earthworms	Whole	RMA, South Plants	BDL (1)	<0.050->2.35 (1/2)	BDL (1)	1.93 (1)	BDL (1)	BDL (1)	BDL (1)
	Whole	RMA Control (5)	0.618-1.53 (8/8) 1.03	<0.050-0.265 (2/8)	BDL (7)	<0.062-5.30 (1/7)	<0.080-0.914 (1/7)	BDL (8)	BDL (8)
	Whole	Offpost Control	BDL (2)	BDL (2)	BDL (1)	BDL (1)	BDL (1)	BDL (1)	BDL (1)
Grasshoppers	Whole	RMA Section 26	BDL (4)	BDL (4)	0.046-5.8 (4/4) 1.59	0.496-7.2 (4/4) 2.53	<0.064-1.65 (3/4) 0.528	BDL (4)	BDL (4)
		RMA Section 36	0.905-6.60 (4/4) 3.17	<0.050-0.108 (2/4) 0.058	BDL (4)	0.271-0.446 (4/4) 0.381	BDL (4)	BDL (4)	BDL (4)
		RMA Control (7, 8)	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)
		Offpost Control	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)
VERTEBRATES									
Mallard	Juvenile Carcass	RMA***	NRQ	<0.050-0.066 (2/3) 0.051	BDL (3)	<0.031-0.522 (2/3) 0.201	BDL (3)	<0.094-0.507 (1/3)	BDL (3)
	Adult Carcass	RMA	NRQ	BDL (8)	BDL (8)	<0.031-4.53 (3/8)	BDL (8)	BDL-0.360 (4/8) 0.239	BDL (8)
	Juvenile Carcass	Offpost Control	NRQ	BDL (6)	BDL (6)	BDL (6)	BDL (6)	BDL (6)	BDL (6)
	Adult Carcass	Offpost Control	NRQ	<0.050-0.061 (1/8)	BDL (8)	BDL (8)	BDL (8)	<0.094-1.02 (2/8)	BDL (8)
	Egg	RMA (1)	NRQ	0.173-0.185 (2/2) 0.179	BDL (2)	3.0-4.89 (2/2) 3.94	BDL (2)	0.606-0.919 (2/2) 0.762	BDL (2)
	Egg	Offpost Control	NRQ	<0.050-0.186 (5/10) 0.068	BDL (10)	BDL (10)	BDL (10)	<0.094-1.35 (6/10) 0.302	BDL (2)
Ring-necked pheasant	Juvenile Carcass	RMA	<0.250-1.82 (3/11)	BDL (11)	BDL (12)	<0.031-1.33 (5/12)	BDL (12)	BDL (11)	BDL (11)
	Adult Carcass	RMA	BDL (4)	BDL (4)	BDL (4)	<0.031-2.92 (3/4) 0.767	BDL (4)	BDL (3)	BDL (3)
	Juvenile Carcass	Offpost Control	<0.250-1.40 (2/11)	BDL (11)	BDL (14)	<0.031-18.6 (1/14)	BDL (14)	<0.094-1.34 (1/12)	BDL (12)
	Adult Carcass	Offpost Control	BDL (2)	BDL (2)	BDL (3)	BDL (3)	BDL (3)	BDL (2)	BDL (2)
	Egg	RMA	BDL (10)	BDL (11)	BDL (11)	<0.031-5.38 (9/11) 1.12	<0.40-0.143 (1/11)	BDL (10)	BDL (10)
	Muscle**	RMA	<0.250-4.07 (2/20)	BDL (20)	BDL (20)	<0.018-0.063 (2/20)	BDL (20)	BDL (20)	BDL (20)
		Offpost Control	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)

Table 4.3-1. Contaminant Levels in Terrestrial Ecosystems - Terrestrial Program Samples (Continued, Page 2 of 2).

Species	Tissue	Location (Section)	Contaminant Level in parts per million (mg/kg wet weight basis)(Range/Mean*)						
			Arsenic (n/nt)	Mercury (n/nt)	Aldrin (n/nt)	Dieldrin (n/nt)	Endrin (n/nt)	p,p-DDE (n/nt)	p,p-DDT (n/nt)
Ring-necked pheasant	Liver**	RMA	NRQ	NRQ	BDL (6)	<0.018-2.3 (4/6) 0.655	BDL-0.091 (1/6)	BDL-0.44 (1/6)	BDL
		Offpost Control	NRQ	NRQ	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL
	Egg	Offpost Control	BDL (10)	BDL (11)	BDL (11)	BDL (11)	BDL (11)	BDL (10)	BDL (10)
American Kestrel	Juvenile Carcass	RMA	NRQ	BDL (10)	BDL (10)	<0.031-1.01 (6/10) 0.316	BDL (10)	<0.094-0.219 (1/10)	BDL (10)
	Juvenile Carcass	Offpost Control	NRQ	BDL (8)	BDL (8)	BDL (8)	BDL (8)	<0.094-0.733 (1/8)	BDL (8)
	Egg	RMA	NRQ	<0.050-0.405 (8/34)	BDL (33)	<0.031-3.63 (17/33) >0.512	BDL (33)	<0.094-1.25 (1/29)	BDL (29)
	Egg	Offpost Control	NRQ	<0.050-0.057 (1/11)	BDL (11)	BDL (11)	BDL (11)	<0.094-1.04 (2/11)	BDL (11)
Prairie Dog	Carcass	RMA (36) Summer	<0.250-0.741 (2/9)	BDL (9)	BDL (9)	0.233-13.4 (9/9) 2.03	BDL (9)	NRQ	NRQ
	Carcass	RMA (36) Winter	BDL (5)	BDL (5)	BDL (5)	0.119-6.18 (5/5) 1.44	BDL (5)	NRQ	NRQ
	Carcass	RMA, TSF	<0.250-4.22 (1/5)	BDL (5)	BDL (5)	0.064-0.155 (5/5) 0.114	BDL (5)	NRQ	NRQ
	Carcass	RMA Control Summer (19, 20)	BDL (9)	BDL (9)	BDL (9)	<0.031-0.346 (2/9)	BDL (9)	NRQ	NRQ
	Carcass	RMA Control Winter (20)	BDL (5)	BDL (5)	BDL (5)	<0.031-0.096 (1/5)	BDL (5)	NRQ	NRQ
	Carcass	Offpost Control Summer	BDL (9)	BDL (9)	BDL (8)	BDL (8)	BDL (8)	NRQ	NRQ
	Kidneys	RMA, (36) Winter	BDL (5)	<0.10-0.356 (3/5) 0.178	BDL (5)	<0.248-1.54 (2/5)	BDL (5)	NRQ	NRQ
Cottontail	Muscle	RMA, (36)	BDL (7)	BDL (7)	BDL (7)	<0.031-0.092 (3/7)	BDL (7)	NRQ	NRQ
	Muscle	RMA Control (19, 20)	BDL (7)	BDL (7)	BDL (7)	BDL (7)	BDL (7)	NRQ	NRQ
	Muscle	Offpost Control	BDL (7)	BDL (7)	BDL (7)	BDL (7)	BDL (7)	NRQ	NRQ
Mule Deer	Liver	RMA	BDL (14)	BDL (14)	BDL (14)	<0.031-0.187 (1/14)	BDL (14)	NRQ	NRQ
	Liver	Offpost Control	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	NRQ	NRQ
	Muscle	RMA	BDL (14)	BDL (14)	BDL (14)	BDL (14)	BDL (14)	NRQ	NRQ
	Muscle	Offpost Control	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	NRQ	NRQ

* Mean is calculated when 50 percent or more of samples have detectable contaminant levels. If less than 50 percent of samples have detectable contaminant levels, only the range of values are presented. When calculating the mean, values of ½ the detection limit are substituted for samples that are below detection limit.

BDL Below Detection Limit.

n = Number of samples analyzed that contain detectable contaminant levels, nt = total number of samples.

NRQ Not Requested.

** MKE Sample

*** For highly mobile species (mallard, pheasant, kestrel, mule deer) samples were widespread and RMA was evaluated as a whole entity.

Source: ESE, 1988

Table 4.3-4 Contaminant Levels in Terrestrial Ecosystems - Miscellaneous Samples: Samples ... nance and USFWS Supplemental Samples.

Species	Tissue	Location (Section)	Contaminant Level in parts per million (mg/kg wet weight basis)(Range/Mean*)						
			Arsenic (n/nt)	Mercury (n/nt)	Aldrin (n/nt)	Dieldrin (n/nt)	Endrin (n/nt)	p,p-DDE (n/nt)	p,p-DDT (n/nt)
Blue-winged teal	Liver	RMA Upper Derby	BDL (3)	0.371-1.64 (3/3) 1.07	BDL (3)	0.183-0.281 (3/3) 0.239	BDL (3)	BDL (3)	BDL (3)
	Muscle	RMA Upper Derby	BDL (3)	0.259-0.559 (3/3) 0.391	BDL (3)	0.090-0.164 (3/3) 0.127	BDL (3)	BDL (3)	BDL (3)
Redhead	Liver	RMA Upper Derby	BDL (5)	0.080-0.368 (5/5) 0.211	<0.030-0.088 (1/5)	0.307-0.747 (5/5) 0.458	<0.064-0.074(1/5)	<0.094-0.156(1/5)	BDL (5)
	Muscle	RMA Upper Derby	BDL (5)	<0.050-0.073 (2/5)	BDL (5)	0.117-0.320 (5/5) 0.203	BDL (5)	BDL (5)	BDL (5)
American Coot	Liver	RMA Upper Derby	BDL (9)	0.300-1.77 (9/9) 1.08	BDL (9)	<0.124-0.693 (8/9) 0.291	BDL (9)	BDL (9)	BDL (9)
	Muscle	RMA Upper Derby	BDL (9)	<0.050-0.339 (8/9) 0.179	BDL (9)	<0.062-1.77 (8/9) 0.53	BDL (9)	<0.940-0.313 (2/9)	BDL (9)
Mourning Dove	Carcass	RMA (35)	BDL (2)	BDL (2)	<0.633-1.83 (2/2) 1.23	5.57-56.3 (2/2) 30.9	<0.800-3.44 (1/2) 2.0	BDL (2)	BDL (2)
	Liver	RMA (1)	BDL (1)	BDL (1)	BDL (1)	7.37 (1)	3.74 (1)	BDL (1)	BDL (1)
Bald Eagle	Egg	Barr Lake	BDL	0.099	BDL (1)	0.808 (1)	BDL (1)	6.93 (1)	BDL (1)
Golden Eagle	Liver	RMA**	BDL (1)	<0.050-0.216 (1/2) 0.120	BDL (2)	<0.031-0.221 (1/2) 0.118	BDL (2)	BDL (2)	BDL (2)
	Brain	RMA	BDL (2)	<.098-.257 (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)
Ferruginous Hawk	Liver	RMA	BDL (5)	<0.050-0.293 (1/5)	BDL (5)	0.263-4.79 (5/5) 2.66	BDL (5)	BDL (5)	BDL (5)
	Brain	RMA	BDL (5)	<0.050-0.152 (1/5)	BDL (5)	<0.238-9.98 (4/5) 5.07	BDL (5)	BDL (5)	BDL (5)
Red-tailed Hawk	Liver	RMA	BDL (3)	<0.050-0.345 (1/3)	BDL (3)	0.520-6.59 (3/3) 4.10	BDL (3)	<0.313-0.799 (2/3) 0.482	BDL (3)
	Brain	RMA	BDL (3)	<0.050-0.093 (1/3)	BDL (3)	<0.751-9.44 (2/3) 6.34	BDL (3)	BDL (3)	BDL (3)
Great-horned Owl	Liver	RMA	BDL (4)	<0.050-0.086 (2/4) 0.047	BDL (4)	0.143-27.7 (4/4) 11.88	BDL (4)	<0.094-15.5 (3/4) 5.88	BDL (4)
	Brain	RMA	BDL (4)	BDL (4)	BDL (4)	<0.175-15.6 (3/4) 8.80	BDL (4)	<0.529-10.3 (3/4) 3.32	BDL (4)
Northern Harrier	Egg	RMA	BDL (2)	BDL (2)	BDL (2)	0.303-0.676 (2) 0.49	BDL (2)	BDL (2)	BDL (2)
Coyote	Liver	RMA (25)	BDL (1)	BDL (1)	BDL (1)	7.60 (1)	BDL (1)	BDL (1)	BDL (1)
Badger	Liver	RMA (25)	BDL (1)	BDL (1)	BDL (1)	1.64 (1)	BDL (1)	NRQ	NRQ
	Kidneys	RMA (25)	NRQ	NRQ	BDL (1)	0.801 (1)	BDL (1)	NRQ	NRQ

* Mean is calculated when 50 percent or more of samples have detectable contaminant levels. If less than 50 percent of samples have detectable contaminant levels, only the range of values are presented. When calculating the mean, values of ½ the detection limit are substituted for samples that are below detection limit.

BDL Below Detection Limit.

n = Number of samples analyzed that contain detectable contaminant levels, nt = total number of samples.

NRQ Not Requested.

** For highly mobile species (mallard, pheasant, kestrel, mule deer) samples were widespread and RMA was evaluated as a whole entity.

Source: ESE, 1988

Table 4.3-3. Certified Reporting Limits for Biota Analysis Methods

USATHAMA Method Code	Matrix Type	Analyte	Certified Reporting Limit (ug/g)
B-6	Animals and Plants	Arsenic	0.250
C-6	Animals and Plants	Mercury	0.050
D-6	Plants	Aldrin	0.022
		Dieldrin	0.044
		Endrin	0.040
E-6A	Animals	Aldrin	0.020
		Dieldrin	0.031
		Endrin	0.040
F-6A	Animals	p,p'-DDE	0.094
		p,p'-DDT	0.289

Source: ESE, 1988a.

Table 4.3-4. Contaminant Levels in Black-Tailed Prairie Dogs Collected by MKE.

Tissue	Location (Section)	Contaminant Level in parts per million (mg/kg wet weight basis)(Range/Mean*)						
		Arsenic (n/nt)	Mercury (n/nt)	Aldrin (n/nt)	Dieldrin (n/nt)	Endrin (n/nt)	p,p-DDE (n/nt)	p,p-DDT (n/nt)
Muscle and Viscera	RMA (26)	BDL (2)	BDL (2)	BDL (2)	0.33-0.66 (2/2) 0.495	BDL (2)	BDL (2)	BDL (2)
	RMA (36)	BDL (4)	BDL (4)	BDL (4)	0.150-0.800 (4/4) 0.315	BDL (4)	BDL (4)	BDL (4)
	RMA (30)	BDL (4)	BDL (4)	BDL (4)	0.021-0.086 (4/4) 0.045	BDL (4)	BDL (4)	BDL (4)
	RMA (27)	BDL (2)	BDL (2)	BDL (2)	0.027-0.040 (2/2) 0.034	BDL (2)	BDL (2)	BDL (2)
	RMA (9)	BDL (4)	BDL (4)	BDL (4)	BDL (4)	BDL (4)	BDL (4)	BDL (4)
	Buckley	BDL (4)	BDL (4)	BDL (4)	BDL (4)	BDL (4)	BDL (4)	BDL (4)

* Mean is calculated when 50 percent or more of samples have detectable contaminant levels. If less than 50 percent of samples have detectable contaminant levels, only the range of values are presented. When calculating the mean, values of ½ the detection limit are substituted for samples that are below detection limit.

BDL Below Detection Limit.

n = Number of samples analyzed that contain detectable contaminant levels, nt = total number of samples.

Source: MKE, 1988.

Table 4.3-5. Contaminant Levels in Aquatic Ecosystems (page 1 of 2).

C-RMA-09D/MKEAQUA2.WK1
4/12/89

SPECIES	Tissue	Location	Contaminant Level in parts per million (mg/kg wet weight basis) (Range/mean*)						
			Arsenic (n/nt)	Mercury (n/nt)	Aldrin (n/nt)	Dieldrin (n/nt)	Endrin (n/nt)	DDE (n/nt)	p,p'-DDT (n)
AQUATIC PLANTS AND PLANKTON									
Plankton	Composite	RMA Lake Mary, 1986	<0.250-0.432 (1/3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)
	Composite	RMA Lake Ladora, 1986	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)
	Composite	RMA Lower Derby, 1986	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)
	Composite	RMA North Bog, 1986	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)
Aquatic Macrophytes	Whole	RMA Lake Mary, 1986	0.465-0.782 (2/2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)
	Whole	RMA Lake Ladora, 1986	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)
	Whole	RMA Lower Derby, 1986	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)
FISH									
Largemouth Bass	Fillet	Offpost Control 1988	BDL (5)	0.111-0.236 0.152 (5/5)	BDL (5)	BDL (5)	BDL (5)	BDL (5)	BDL (5)
	Remainder	Offpost Control 1988	BDL (5)	0.058-0.120 0.084 (5/5)	BDL (5)	BDL (5)	BDL (5)	BDL (5)	BDL (5)
	Compos. Whole	Offpost Control 1988	BDL (1)	0.084 (1)	BDL (1)	BDL (1)	BDL (1)	BDL (1)	BDL (1)
	Whole(Reconst.)	Offpost Control 1988	BDL (5)	0.086-0.157 0.375 (5/5)	BDL (5)	BDL (5)	BDL (5)	BDL (5)	BDL (5)
Largemouth Bass	Fillet	RMA Lower Derby 1988	BDL (5)	0.176-0.550 0.369 (5/5)	<0.020-0.044 (1/5)	<0.031-0.370 0.212 (4/5)	BDL (5)	<0.094-0.684 0.319 (4/5)	BDL (5)
	Remainder	RMA Lower Derby 1988	BDL (5)	0.190-0.319 0.250 (5/5)	<0.020-0.053 0.031 (4/5)	0.100-0.860 0.486 (5/5)	BDL (5)	0.101-0.839 0.593 (5/5)	BDL (5)
	Compos. Whole	RMA Lower Derby 1988	BDL (1)	0.098 (1)	BDL (1)	BDL (1)	BDL (1)	BDL (1)	BDL (1)
	Whole(Reconst.)	RMA Lower Derby 1988	BDL (5)	0.183-0.394 0.294 (5/5)	BDL (5)	0.067-0.644 0.375 (5/5)	BDL (5)	BDL (5)	BDL (5)
Largemouth Bass	Whole	RMA Lake Mary, 1986	BDL (3)	<0.050-0.101 0.066 (2/3)	BDL (3)	<0.031-0.115 (1/3)	BDL (3)	BDL (3)	BDL (3)
	Fillet	RMA Lake Mary, 1986	BDL (2)	<0.050-0.101 (1/2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)
	Whole	RMA Lake Ladora, 1986	BDL (3)	0.084-0.235 0.182 (3/3)	BDL (3)	<0.031-0.034 0.027 (2/3)	BDL (3)	BDL (3)	BDL (3)
Largemouth Bass	Whole	RMA Lower Derby, 1986	BDL (3)	<0.050-0.063 (1/3)	BDL (3)	<0.031-0.112 0.072 (2/3)	BDL (3)	BDL (3)	BDL (3)

Table 4.3-5. Contaminant Levels in Aquatic Ecosystems (page 2 of 2).

SPECIES	Tissue	Location	Contaminant Level in parts per million (mg/kg wet weight basis) (Range/mean*)						
			Arsenic (n/nt)	Mercury (n/nt)	Aldrin (n/nt)	Dieldrin (n/nt)	Endrin (n/nt)	DDE (n/nt)	p,p'-DDT (n)
Bluegill	Fillet	RMA Lake Mary, 1986	BDL (3)	<0.050-0.099 0.074 (2/3)	BDL (3)	<0.031-0.041 (1/3)	BDL (3)	BDL (3)	BDL (3)
	Whole	RMA Lake Mary, 1986	BDL (6)	<0.050-0.137 0.061 (3/6)	BDL (6)	<0.031-0.158 0.085 (5/6)	BDL (6)	BDL (6)	BDL (6)
Bluegill	Whole	RMA Lower Derby, 1988	BDL (6)	<0.050-0.091 0.056 (3/6)	BDL (6)	<0.031-0.129 0.074 (4/6)	BDL (6)	BDL (6)	BDL (6)
	Whole	RMA Lower Derby, 1986	BDL (3)	BDL (3)	BDL (3)	0.142-0.161 0.149 (3/3)	BDL (3)	BDL (3)	BDL (3)
Bluegill	Whole	RMA Lake Ladora, 1986	BDL (3)	0.059-0.124 0.084 (3/3)	BDL (3)	0.065-0.153 0.100 (3/3)	BDL (3)	BDL (3)	BDL (3)
Bluegill	Fillet	Offpost Control, 1988	BDL (5)	0.081-0.256 0.188 (5/5)	BDL (5)	BDL (5)	BDL (5)	BDL (5)	BDL (5)
	Remainder	Offpost Control, 1988	BDL (5)	<0.050-0.171 0.104 (4/5)	BDL (5)	BDL (5)	BDL (5)	BDL (5)	BDL (5)
	Compos.(Whole)	Offpost Control, 1988	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)	BDL (2)
	Whole(Reconst.)	Offpost Control, 1988	BDL (5)	0.088-0.178 0.141 (5/5)	BDL (5)	BDL (5)	BDL (5)	BDL (5)	BDL (5)
Northern Pike	Fillet	RMA Lower Derby, 1986	BDL (3)	0.278-0.470 0.405 (3/3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)	BDL (3)
	Fillet	RMA Lake Ladora, 1986	BDL (2)	0.289-0.366 (2/2)	BDL (2)	<0.031-0.044 (1/2)	BDL (2)	BDL (2)	BDL (2)
Fathead Minnows	Composite	RMA North Bog, 1986	BDL (1)	BDL (1)	BDL (1)	BDL (1)	BDL (1)	BDL (1)	BDL (1)
Black Bullhead	Whole	RMA Lower Derby, 1986	BDL (3)	<0.050-0.052 (1/3)	BDL (3)	0.085-0.209 0.144 (3/3)	BDL (3)	<0.094-0.098 (1/3)	BDL (3)

* Mean is calculated when 50 percent or more of samples (n > 2) have detectable contaminant levels. If less than 50 percent of samples have detectable contaminant levels, only the range of values are presented. When calculating the mean, values of 1/2 the detection limit are substituted for 'BDL'.

BDL = Below Detection Limit (Below Certified Reporting Limit).

n = Number of samples analyzed that contain detectable contaminants, nt = total number of samples.

Compos. (Whole) = A number of small fish in a composite sample.

Whole (Reconst.) = A sample comprised of a portion of the fillet and remainder samples reconstituted into a 'whole' sample.

Source: MKE, 1988 and ESE, 1988.

Table 5.1-3 Aldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ACRI - grasshopper							
CMP-BSA 1	0	16	BCRL	BCRL	NA	NA	NA
2	0	15	BCRL	BCRL	NA	NA	NA
3	0	10	BCRL	BCRL	NA	NA	NA
4	0	10	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	66	BCRL	BCRL	NA	NA	NA
Control	0	12	BCRL	BCRL	NA	NA	NA
AQCH - golden eagle (FORTUITOUS)							
Muscle	0	1	BCRL	BCRL	NA	NA	NA
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
Liver	0	1	BCRL	BCRL	NA	NA	NA
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
Brain	0	1	BCRL	BCRL	NA	NA	NA
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
All Samples	0	3	BCRL	BCRL	NA	NA	NA
Off RMA							
ATCU - burrowing owl							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	7	BCRL	BCRL	NA	NA	NA
BRTE - cheatgrass							
CMP-BSA 1	0	12	BCRL	BCRL	NA	NA	NA
2	1	13	0.0754	0.0754	NC	NC	NC
3	0	10	BCRL	BCRL	NA	NA	NA
4	0	7	BCRL	BCRL	NA	NA	NA
5	0	13	BCRL	BCRL	NA	NA	NA
11	0	6	BCRL	BCRL	NA	NA	NA
12	1	4	0.254	0.254	NC	NC	NC
All RMA CMP-BSAs	2	65	0.0754	0.254	NC	NC	NC
Control	0	16	BCRL	BCRL	NA	NA	NA
BUJA - red-tailed hawk (FORTUITOUS)							
Muscle							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
13	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-3 Aldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
BURE - ferruginous hawk (FORTUITOUS)							
Muscle							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA NEAR	0	2	BCRL	BCRL	NA	NA	NA
BUSW - Swainson's hawk (FORTUITOUS)							
Muscle							
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
BUVI - great horned owl (FORTUITOUS)							
Muscle							
CMP-BSA 4	0	1	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 4	0	1	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
Brain							
CMP-BSA 4	0	1	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 4	0	3	BCRL	BCRL	NA	NA	NA
5	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	8	BCRL	BCRL	NA	NA	NA
COLE - ground beetles							
CMP-BSA 1	3	5	0.0151	0.330	0.0239	14.4	5.12
2	2	4	0.0160	0.0569	0.0140	2.87	2.79
5	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	5	10	0.0151	0.330	0.0170	5.59	3.71
Control	0	4	BCRL	BCRL	NA	NA	NA
CYLU - prairie dog							
CMP-BSA 1	0	44	BCRL	BCRL	NA	NA	NA
2	0	21	BCRL	BCRL	NA	NA	NA
3	0	19	BCRL	BCRL	NA	NA	NA
11	0	1	BCRL	BCRL	NA	NA	NA
12	0	5	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	95	BCRL	BCRL	NA	NA	NA
Control	0	20	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

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NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-3 Aldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
EUCY - Brewer's blackbird (FORTUITOUS)							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
FASP - kestrel							
Dressed carcass							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
5	0	2	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	10	BCRL	BCRL	NA	NA	NA
Control	0	9	BCRL	BCRL	NA	NA	NA
Egg							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	5	BCRL	BCRL	NA	NA	NA
Control	0	7	BCRL	BCRL	NA	NA	NA
All Samples	0	5	BCRL	BCRL	NA	NA	NA
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
5	0	3	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	11	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	17	BCRL	BCRL	NA	NA	NA
Control	0	14	BCRL	BCRL	NA	NA	NA
FASP - kestrel (FORTUITOUS)							
Dressed carcass							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
HALE - bald eagle (FORTUITOUS)							
Muscle							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
Brain							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
HEAN - sunflower							
CMP-BSA 1	2	12	0.0238	0.226	NC	NC	NC
2	1	13	0.105	0.105	NC	NC	NC
3	0	10	BCRL	BCRL	NA	NA	NA
4	0	10	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	3	60	0.0238	0.226	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA

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NA = Not applicable.

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Table 5.1-3 Aldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
KOIR - kochia							
CMP-BSA 1	1	5	0.0970	0.0970	NC	NC	NC
2	0	7	BCRL	BCRL	NA	NA	NA
3	0	4	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	31	0.0970	0.0970	NC	NC	NC
Control	0	10	BCRL	BCRL	NA	NA	NA
LASE - wild lettuce							
CMP-BSA 1	0	7	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
4	0	3	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	14	BCRL	BCRL	NA	NA	NA
Control	0	3	BCRL	BCRL	NA	NA	NA
ODHE - mule deer							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
4	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	8	BCRL	BCRL	NA	NA	NA
Control	0	2	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-3 Aldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ODVI - white-tail deer							
Muscle							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 5	0	4	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	12	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
OLIG - earthworm							
CMP-BSA 1	0	6	BCRL	BCRL	NA	NA	NA
2	2	7	0.110	0.290	NC	NC	NC
3	0	7	BCRL	BCRL	NA	NA	NA
4	1	5	0.447	0.447	NC	NC	NC
5	0	13	BCRL	BCRL	NA	NA	NA
11	0	4	BCRL	BCRL	NA	NA	NA
12	0	3	BCRL	BCRL	NA	NA	NA
13	0	7	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	3	52	0.110	0.447	NC	NC	NC
Control	0	12	BCRL	BCRL	NA	NA	NA
PEMA - deer mouse							
CMP-BSA 1	1	15	0.700	0.700	NC	NC	NC
2	0	14	BCRL	BCRL	NA	NA	NA
3	3	11	0.119	0.337	NC	NC	NC
4	1	10	2.20	2.20	NC	NC	NC
5	1	15	0.410	0.410	NC	NC	NC
11	0	6	BCRL	BCRL	NA	NA	NA
12	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	6	75	0.119	2.20	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-3 Aldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
PHCO - pheasant							
Dressed carcass							
CMP-BSA 2	0	10	BCRL	BCRL	NA	NA	NA
3	0	5	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
RMA FAR	0	12	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	47	BCRL	BCRL	NA	NA	NA
Control	0	13	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 2	0	3	BCRL	BCRL	NA	NA	NA
3	0	5	BCRL	BCRL	NA	NA	NA
5	0	8	BCRL	BCRL	NA	NA	NA
11	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	12	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	33	BCRL	BCRL	NA	NA	NA
Control	0	9	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 2	0	13	BCRL	BCRL	NA	NA	NA
3	0	10	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
5	0	18	BCRL	BCRL	NA	NA	NA
11	0	4	BCRL	BCRL	NA	NA	NA
RMA FAR	0	24	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	80	BCRL	BCRL	NA	NA	NA
Control	0	22	BCRL	BCRL	NA	NA	NA
PIME - bullsnake (FORTUITOUS)							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
PIPI - black-billed magpie (FORTUITOUS)							
CMP-BSA 13	0	1	BCRL	BCRL	NA	NA	NA
SPTR - thirteen-lined groundsquirrel							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
STNE - western meadowlark							
CMP-BSA 2	0	8	BCRL	BCRL	NA	NA	NA
5	0	2	BCRL	BCRL	NA	NA	NA
12	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	5	BCRL	BCRL	NA	NA	NA
Control							
STNE - western meadowlark (FORTUITOUS)							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA

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NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-3 Aldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
STVU - starling							
CMP-BSA 13	0	1	BCRL	BCRL	NA	NA	NA
SYAU - desert cottontail							
Dressed carcass							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
5	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	11	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
Muscle							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	9	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
5	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	17	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
SYAU - desert cottontail (FORTUITOUS)							
Muscle	0	1	BCRL	BCRL	NA	NA	NA
CMP-BSA 1							
TATA - badger (FORTUITOUS)							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Brain							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Fat							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Solid stomach contents							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liquid stomach contents							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	6	BCRL	BCRL	NA	NA	NA

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Table 5.1-3 Aldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
TUMI - American robin (FORTUITOUS)							
CMP-BSA 13	0	6	BCRL	BCRL	NA	NA	NA
ZEMA - mourning dove							
CMP-BSA 1	0	11	BCRL	BCRL	NA	NA	NA
2	1	13	0.0227	0.0227	NC	NC	NC
3	0	11	BCRL	BCRL	NA	NA	NA
4	0	16	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	1	BCRL	BCRL	NA	NA	NA
12	0	3	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	68	0.0227	0.0227	NC	NC	NC
Control	0	10	BCRL	BCRL	NA	NA	NA
ZEMA - mourning dove (FORTUITOUS)							
CMP-BSA 13	1	4	1.30	1.30	NC	NC	NC

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Table 5.1-4 Dieldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ACRI - grasshopper							
CMP-BSA 1	12	16	0.0568	1.20	0.171	4.19	3.31
2	13	15	0.0360	0.730	0.145	2.54	2.63
3	9	10	0.0466	2.60	0.353	8.89	4.39
4	6	10	0.172	3.10	0.125	32.7	6.47
5	1	10	0.0389	0.0389	NC	NC	NC
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	41	66	0.0360	3.10	0.106	11.8	4.81
Control	0	12	BCRL	BCRL	NA	NA	NA
AQCH - golden eagle (FORTUITOUS)							
Muscle							
Off RMA	1	1	0.271	0.271	0.271	NA	NA
Liver							
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
Brain							
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
Control	1	3	0.271	0.271	NC	NC	NC
ATCU - burrowing owl							
CMP-BSA 2	1	1	0.102	0.102	0.102	NA	NA
3	1	1	0.130	0.130	0.130	NA	NA
12	1	1	0.0449	0.0449	0.0449	NA	NA
RMA NEAR	4	4	0.114	1.10	0.331	2.60	2.66
All RMA CMP-BSAs	7	7	0.0449	1.10	0.184	3.06	2.88
BRTE - cheatgrass							
CMP-BSA 1	8	12	0.0331	0.223	0.0593	2.78	2.75
2	8	13	0.0299	0.628	0.0559	3.77	3.16
3	6	9	0.0551	0.540	0.0734	5.97	3.81
4	4	7	0.0553	0.156	0.0458	2.87	2.79
5	2	13	0.145	0.145	NC	NC	NC
11	0	6	BCRL	BCRL	NA	NA	NA
12	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	28	64	0.0299	0.628	NC	NC	NC
Control	0	16	BCRL	BCRL	NA	NA	NA
BUJA - red-tailed hawk (FORTUITOUS)							
Muscle							
CMP-BSA 5	1	1	0.454	0.454	0.454	NA	NA
13	1	1	3.10	3.10	3.10	NA	NA
All RMA CMP-BSAs	2	2	0.454	3.10	1.19	6.33	3.89
Liver							
CMP-BSA 13	1	1	7.20	7.20	7.20	NA	NA
All Samples							
CMP-BSA 5	1	1	0.454	0.454	0.454	NA	NA
13	2	2	3.10	7.20	4.72	1.43	1.81
All RMA CMP-BSAs	3	3	0.454	7.20	2.16	7.44	4.12

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Table 5.1-4 Dieldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
BURE - ferruginous hawk (FORTUITOUS)							
Muscle							
RMA NEAR	1	1	11.0	11.0	11.0	NA	NA
Liver							
RMA NEAR	1	1	13.0	13.0	13.0	NA	NA
All Samples							
RMA NEAR	2	2	11.0	13.0	12.0	1.01	1.13
BUSW - Swainson's hawk (FORTUITOUS)							
Muscle							
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
BUVI - great horned owl							
Egg							
CMP-BSA 5	1	1	7.00	7.00	7.00	NA	NA
RMA FAR	1	1	0.236	0.236	0.236	NA	NA
RMA NEAR	3	3	0.590	3.30	1.67	2.31	2.50
All RMA CMP-BSAs	5	5	0.236	7.00	1.50	6.53	3.93
BUVI - great horned owl (FORTUITOUS)							
Muscle							
CMP-BSA 4	1	1	0.178	0.178	0.178	NA	NA
5	1	1	2.60	2.60	2.60	NA	NA
12	1	1	8.10	8.10	8.10	NA	NA
All RMA CMP-BSAs	3	3	0.178	8.10	1.55	46.7	7.10
Liver							
CMP-BSA 5	1	1	25.0	25.0	25.0	NA	NA
All Samples							
CMP-BSA 4	1	1	0.178	0.178	0.178	NA	NA
5	2	2	2.60	25.0	8.06	13.0	4.96
12	1	1	8.10	8.10	8.10	NA	NA
All RMA CMP-BSAs	4	4	0.178	25.0	3.11	89.3	8.33
COLE - ground beetles							
CMP-BSA 1	5	5	0.132	8.00	1.24	18.6	5.52
2	4	4	0.217	2.19	1.01	2.96	2.83
5	1	1	0.215	0.215	0.215	NA	NA
All RMA CMP-BSAs	10	10	0.132	8.00	0.957	6.99	4.03
Control	2	4	0.0343	0.0368	0.0179	1.88	2.21
CYLU - prairie dog							
CMP-BSA 1	38	44	0.0425	4.00	0.167	5.19	3.61
2	17	20	0.0200	0.204	0.0589	1.95	2.27
3	15	18	0.0177	0.219	0.0438	2.43	2.57
11	0	1	BCRL	BCRL	NA	NA	NA
12	4	5	0.0296	0.125	0.0395	2.73	2.72
RMA NEAR	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	74	93	0.0177	4.00	0.0789	6.07	3.83
Control	0	20	BCRL	BCRL	NA	NA	NA

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Table 5.1-4 Dieldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
EUCY - Brewer's blackbird (FORTUITOUS)							
CMP-BSA 5	1	1	8.00	8.00	8.00	NA	NA
FASP - kestrel							
Dressed carcass							
CMP-BSA 1	1	1	0.0336	0.0336	0.0336	NA	NA
2	1	1	1.80	1.80	1.80	NA	NA
5	2	2	0.0328	0.106	0.0590	1.99	2.29
RMA NEAR	6	6	0.0720	1.60	0.355	6.12	3.84
All RMA CMP-BSAs	10	10	0.0328	1.80	0.230	12.2	4.86
Control	3	9	0.0175	0.115	NC	NC	NC
Egg							
CMP-BSA 2	1	1	0.403	0.403	0.403	NA	NA
5	3	4	0.788	1.70	0.520	18.5	5.52
RMA NEAR	4	5	0.403	1.70	0.494	9.02	4.41
All RMA CMP-BSAs	1	5	0.0859	0.0859	NC	NC	NC
Control							
All Samples							
CMP-BSA 1	1	1	0.0336	0.0336	0.0336	NA	NA
2	2	2	0.403	1.80	0.852	3.06	2.88
5	2	2	0.0328	0.106	0.0590	1.99	2.29
RMA NEAR	9	10	0.0720	1.70	0.413	7.51	4.14
All RMA CMP-BSAs	14	15	0.0328	1.80	0.297	10.8	4.67
Control	4	14	0.0175	0.115	NC	NC	NC
FASP - kestrel (FORTUITOUS)							
Dressed carcass							
CMP-BSA 5	1	1	3.70	3.70	3.70	NA	NA
13	1	1	1.70	1.70	1.70	NA	NA
RMA NEAR	1	1	0.461	0.461	0.461	1.05	1.26
All RMA CMP-BSAs	3	3	0.461	3.70	1.43	3.03	2.86
HALE - bald eagle (FORTUITOUS)							
Muscle							
RMA NEAR	1	1	0.276	0.276	0.276	NA	NA
						NA	NA
Liver							
RMA NEAR	1	1	0.109	0.109	0.109	NA	NA
						NA	NA
Brain							
RMA NEAR	1	1	0.112	0.112	0.112	NA	NA
All Samples							
RMA NEAR	3	3	0.109	0.276	0.150	1.32	1.70
HEAN - sunflower							
CMP-BSA 1	5	12	0.0443	0.670	NC	NC	NC
2	5	13	0.0321	0.355	NC	NC	NC
3	3	10	0.0417	0.194	NC	NC	NC
4	8	10	0.0425	0.159	0.0584	2.32	2.50
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	21	60	0.0321	0.670	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA

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Table 5.1-4 Dieldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
KOIR - kochia							
CMP-BSA 1	1	5	0.0853	0.0853	NC	NC	NC
2	1	7	0.110	0.110	NC	NC	NC
3	1	4	0.294	0.294	NC	NC	NC
5	1	10	0.0931	0.0931	NC	NC	NC
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	4	31	0.0853	0.294	NC	NC	NC
Control	0	10	BCRL	BCRL	NA	NA	NA
LASE - wild lettuce							
CMP-BSA 1	3	7	0.0560	0.0860	NC	NC	NC
2	0	1	BCRL	BCRL	NA	NA	NA
3	2	2	0.120	0.336	0.201	1.70	2.07
4	2	3	0.0706	0.0743	0.0537	1.31	1.68
5	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	7	14	0.0560	0.336	0.0526	1.71	2.08
Control	0	3	BCRL	BCRL	NA	NA	NA
ODHE - mule deer							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	1	1	0.101	0.101	0.101	NA	NA
3	1	1	0.172	0.172	0.172	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	2	4	0.101	0.172	0.0744	1.62	2.00
Control	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	1	2	0.101	0.101	0.0651	1.47	1.86
3	1	2	0.172	0.172	0.0850	2.70	2.71
4	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	2	8	0.101	0.172	NC	NC	NC
Control	0	2	BCRL	BCRL	NA	NA	NA

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Table 5.1-4 Dieldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ODVI - white-tail deer							
Muscle							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	2	3	0.0282	0.0895	0.0283	3.74	3.15
All RMA CMP-BSAs	2	6	0.0282	0.0895	NC	NC	NC
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 5	0	4	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
RMA NEAR	2	6	0.0282	0.0895	NC	NC	NC
All RMA CMP-BSAs	2	12	0.0282	0.0895	NC	NC	NC
Control	0	10	BCRL	BCRL	NA	NA	NA
OLIG - earthworm							
CMP-BSA 1	6	6	0.280	2.90	0.539	2.18	2.42
2	7	7	0.188	3.80	1.40	3.10	2.90
3	6	7	0.0583	0.950	0.203	4.52	3.42
4	5	5	0.175	3.20	0.952	3.76	3.16
5	11	13	0.0435	2.70	0.325	9.37	4.46
11	3	4	0.0240	0.111	0.0381	3.96	3.23
12	3	3	0.191	0.655	0.407	1.55	1.94
13	4	7	0.0275	0.250	0.0680	1.94	2.26
All RMA CMP-BSAs	45	52	0.0240	3.80	0.304	10.5	4.64
Control	0	12	BCRL	BCRL	NA	NA	NA
PEMA - deer mouse							
CMP-BSA 1	13	13	0.122	13.0	2.20	8.66	4.35
2	13	13	0.172	5.90	0.804	4.07	3.27
3	11	11	0.104	13.0	2.47	14.3	5.11
4	9	9	0.239	35.0	3.43	9.05	4.41
5	12	15	0.0304	6.60	0.349	21.0	5.73
11	1	6	0.0335	0.0335	NC	NC	NC
12	2	4	0.0208	0.113	0.0307	3.16	2.92
All RMA CMP-BSAs	61	71	0.0208	35.0	0.717	81.3	8.14
Control	2	15	0.0262	0.111	NC	NC	NC

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-4 Dieldrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
PHCO - pheasant							
Dressed carcass							
CMP-BSA 2	9	10	0.0885	5.90	0.275	7.22	4.08
3	4	5	0.0544	0.190	0.0907	1.48	1.87
4	1	1	1.40	1.40	1.40	NA	NA
5	6	10	0.158	4.76	0.180	589	12.5
11	0	3	BCRL	BCRL	NA	NA	NA
RMA FAR	1	12	2.70	2.70	NC	NC	NC
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	21	47	0.0544	5.90	NC	NC	NC
Control	0	13	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 2	2	3	0.867	2.20	0.431	72.5	7.92
3	5	5	0.0282	0.646	0.277	5.25	3.62
5	6	8	0.165	5.95	0.326	82.2	8.16
11	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	2	12	0.151	0.180	NC	NC	NC
RMA NEAR	1	4	0.0247	0.0247	NC	NC	NC
All RMA CMP-BSAs	16	33	0.0247	5.95	NC	NC	NC
Control	0	9	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 2	11	13	0.0885	5.90	0.305	9.35	4.46
3	9	10	0.0282	0.646	0.159	3.52	3.07
4	1	1	1.40	1.40	1.40	NA	NA
5	12	18	0.158	5.95	0.234	197	9.97
11	0	4	BCRL	BCRL	NA	NA	NA
RMA FAR	3	24	0.151	2.70	NC	NC	NC
RMA NEAR	1	10	0.0247	0.0247	NC	NC	NC
All RMA CMP-BSAs	37	80	0.0247	5.95	NC	NC	NC
Control	0	22	BCRL	BCRL	NA	NA	NA
PIME - bullsnake (FORTUITOUS)							
RMA NEAR	1	1	0.457	0.457	0.457	NA	NA
PIPI - black-billed magpie (FORTUITOUS)							
CMP-BSA 13	1	1	5.10	5.10	5.10	NA	NA
SPTR - thirteen-lined ground squirrel							
CMP-BSA 1	2	2	0.545	1.10	0.774	1.28	1.64
2	1	1	0.758	0.758	0.758	NA	NA
All RMA CMP-BSAs	3	3	0.545	1.10	0.769	1.13	1.42
STNE - western meadowlark							
CMP-BSA 2	8	8	0.0370	2.10	0.203	12.9	4.94
5	1	2	0.0618	0.0618	0.0236	6.40	3.91
All RMA CMP-BSAs	9	10	0.0370	2.10	0.132	20.4	5.68
Control	0	5	BCRL	BCRL	NA	NA	NA
STNE - western meadowlark (FORTUITOUS)							
CMP-BSA 2	1	1	4.40	4.40	4.40	NA	NA
12	1	1	6.50	6.50	6.50	NA	NA
All RMA CMP-BSAs	2	2	4.40	6.50	5.35	1.08	1.32
STVU - starling (FORTUITOUS)							
CMP-BSA 13	1	1	5.90	5.90	5.90	NA	NA

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**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
SYAU - desert cottontail							
Dressed carcass							
CMP-BSA 1	2	3	0.374	0.525	0.202	6.55	3.94
2	2	2	2.70	6.00	4.02	1.38	1.76
3	2	2	0.273	1.50	0.640	4.27	3.34
5	2	4	0.0899	0.101	0.0633	1.25	1.61
All RMA CMP-BSAs	8	11	0.0899	6.00	0.281	22.1	5.81
Control	0	4	BCRL	BCRL	NA	NA	NA
Muscle							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	3	3	0.562	2.20	1.28	1.69	2.06
All Samples							
CMP-BSA 1	5	9	0.374	2.20	0.222	16.4	5.32
2	2	2	2.70	6.00	4.02	1.38	1.76
3	2	2	0.273	1.50	0.640	4.27	3.34
5	2	4	0.0899	0.101	0.0633	1.25	1.61
All RMA CMP-BSAs	11	17	0.0899	6.00	0.263	22.3	5.82
Control	0	4	BCRL	BCRL	NA	NA	NA
SYAU - desert cottontail (FORTUITOUS)							
Liver							
CMP-BSA 1	1	1	0.890	0.890	0.890	NA	NA
TATA - badger (FORTUITOUS)							
Muscle							
CMP-BSA 1	1	1	1.20	1.20	1.20	NA	NA
Liver							
CMP-BSA 1	1	1	9.90	9.90	9.90	NA	NA
Brain							
CMP-BSA 1	1	1	0.321	0.321	0.321	NA	NA
Fat							
CMP-BSA 1	1	1	29.0	29.0	29.0	NA	NA
Solid stomach contents							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liquid stomach contents							
CMP-BSA 1	1	1	0.295	0.295	0.295	NA	NA
All Samples							
CMP-BSA 1	5	6	0.295	29.0	1.05	361	11.3
TUMI - American robin (FORTUITOUS)							
Dressed carcass							
CMP-BSA 13	6	6	1.20	19.0	8.02	2.94	2.83
ZEMA - mourning dove							
CMP-BSA 1	9	11	0.0179	8.00	0.0934	159	9.50
2	12	13	0.0271	3.81	0.267	37.3	6.70
3	8	11	0.127	2.00	0.142	39.6	6.81
4	11	16	0.0178	1.71	0.0676	54.6	7.39
5	3	10	0.0221	0.0667	NC	NC	NC
11	0	1	BCRL	BCRL	NA	NA	NA
12	2	3	0.0497	1.52	0.0879	917	13.6
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	45	68	0.0178	8.00	0.0739	68.3	7.81
Control	0	10	BCRL	BCRL	NA	NA	NA
ZEMA - mourning dove (FORTUITOUS)							
CMP-BSA 13	4	4	7.80	32.0	14.3	1.42	1.81

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NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-5 Endrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ACRI - grasshopper							
CMP-BSA 1	2	16	0.0423	0.155	NC	NC	NC
2	0	15	BCRL	BCRL	NA	NA	NA
3	0	10	BCRL	BCRL	NA	NA	NA
4	1	10	0.233	0.233	NC	NC	NC
5	1	10	0.0981	0.0981	NC	NC	NC
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	4	66	0.0423	0.233	NC	NC	NC
Control	0	12	BCRL	BCRL	NA	NA	NA
AQCH - golden eagle (FORTUITOUS)							
Muscle							
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
Liver							
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
Brain							
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
Off RMA	0	3	BCRL	BCRL	NA	NA	NA
ATCU - burrowing owl							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	1	4	0.0585	0.0585	NC	NC	NC
All RMA CMP-BSAs	1	7	0.0585	0.0585	NC	NC	NC
BRTE - cheatgrass							
CMP-BSA 1	0	12	BCRL	BCRL	NA	NA	NA
2	1	13	0.116	0.116	NC	NC	NC
3	0	10	BCRL	BCRL	NA	NA	NA
4	0	7	BCRL	BCRL	NA	NA	NA
5	1	13	0.0963	0.0963	NC	NC	NC
11	0	6	BCRL	BCRL	NA	NA	NA
12	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	2	65	0.0963	0.116	NC	NC	NC
Control	0	16	BCRL	BCRL	NA	NA	NA
BUJA - red-tailed hawk (FORTUITOUS)							
Muscle							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	1	1	0.125	0.125	0.125	NA	NA
All RMA CMP-BSAs	1	2	0.125	0.125	0.0680	2.10	2.37
All Samples							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
13	1	2	0.125	0.125	0.0680	2.10	2.37
All RMA CMP-BSAs	1	4	0.125	0.125	NC	NC	NC

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NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-5 Endrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
BURE - ferruginous hawk (FORTUITOUS)							
Muscle							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA NEAR	1	1	0.233	0.233	0.233	NA	NA
All Samples							
RMA NEAR	1	2	0.233	0.233	0.0928	5.44	3.67
BUSW - Swainson's hawk (FORTUITOUS)							
Muscle							
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
BUVI - great horned owl							
Egg							
CMP-BSA 5	1	1	0.181	0.181	0.181	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	1	3	0.103	0.103	NC	NC	NC
All RMA CMP-BSAs	2	5	0.103	0.181	NC	NC	NC
BUVI - great horned owl (FORTUITOUS)							
Muscle							
CMP-BSA 4	0	1	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 5	1	1	0.386	0.386	0.386	NA	NA
Brain							
CMP-BSA 4	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 4	0	2	BCRL	BCRL	NA	NA	NA
5	1	2	0.386	0.386	0.120	15.6	5.25
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	6	0.386	0.386	0.0547	2.50	2.60
COLE - ground beetles							
CMP-BSA 1	3	5	0.0702	0.350	0.0716	6.97	4.03
2	3	4	0.0646	0.0975	0.0535	1.75	2.11
5	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	6	10	0.0646	0.350	0.0555	3.41	3.03
Control	0	4	BCRL	BCRL	NA	NA	NA

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NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-5 Endrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
CYLU - prairie dog							
CMP-BSA 1	2	44	0.177	0.190	NC	NC	NC
2	0	21	BCRL	BCRL	NA	NA	NA
3	0	19	BCRL	BCRL	NA	NA	NA
11	0	1	BCRL	BCRL	NA	NA	NA
12	0	5	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	2	95	0.177	0.190	NC	NC	NC
Control	0	20	BCRL	BCRL	NA	NA	NA
EUCY - Brewer's blackbird (FORTUITOUS)							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
FASP - kestrel							
Dressed carcass							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
5	0	2	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	10	BCRL	BCRL	NA	NA	NA
Control	0	9	BCRL	BCRL	NA	NA	NA
Egg							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	7	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
5	0	3	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	11	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	17	BCRL	BCRL	NA	NA	NA
Control	0	14	BCRL	BCRL	NA	NA	NA
FASP - kestrel (FORTUITOUS)							
Dressed carcass							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
HALE - bald eagle (FORTUITOUS)							
Muscle							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
Brain							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA

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NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-5 Endrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
HEAN - sunflower							
CMP-BSA 1	1	12	0.550	0.550	NC	NC	NC
2	1	13	0.114	0.114	NC	NC	NC
3	0	10	BCRL	BCRL	NA	NA	NA
4	0	10	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	2	60	0.114	0.550	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA
KOIR - kochia							
CMP-BSA 1	1	5	0.0583	0.0583	NC	NC	NC
2	0	7	BCRL	BCRL	NA	NA	NA
3	0	4	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	31	0.0583	0.0583	NC	NC	NC
Control	0	10	BCRL	BCRL	NA	NA	NA
LASE - wild lettuce							
CMP-BSA 1	0	7	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
4	0	3	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	14	BCRL	BCRL	NA	NA	NA
Control	0	3	BCRL	BCRL	NA	NA	NA
ODHE - mule deer							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
4	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	8	BCRL	BCRL	NA	NA	NA
Control	0	2	BCRL	BCRL	NA	NA	NA

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Table 5.1-5 Endrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ODVI - white-tail deer							
Muscle							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 5	0	4	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	12	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
OLIG - earthworm							
CMP-BSA 1	3	6	0.0603	0.120	0.0555	1.28	1.64
2	4	6	0.111	0.561	0.142	3.98	3.24
3	1	7	0.100	0.100	NC	NC	NC
4	1	5	0.107	0.107	NC	NC	NC
5	1	12	0.479	0.479	NC	NC	NC
11	0	4	BCRL	BCRL	NA	NA	NA
12	1	1	0.0485	0.0485	0.0485	1.55	1.94
13	0	7	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	11	48	0.0485	0.561	NC	NC	NC
Control	0	12	BCRL	BCRL	NA	NA	NA
PEMA - deer mouse							
CMP-BSA 1	2	15	0.0934	0.910	NC	NC	NC
2	0	14	BCRL	BCRL	NA	NA	NA
3	0	11	BCRL	BCRL	NA	NA	NA
4	0	10	BCRL	BCRL	NA	NA	NA
5	0	15	BCRL	BCRL	NA	NA	NA
11	0	6	BCRL	BCRL	NA	NA	NA
12	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	2	75	0.0934	0.910	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA

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**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-5 Endrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
PHCO - pheasant							
Dressed carcass							
CMP-BSA 2	0	10	BCRL	BCRL	NA	NA	NA
3	0	5	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
RMA FAR	0	12	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	47	BCRL	BCRL	NA	NA	NA
Control	0	13	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 2	0	3	BCRL	BCRL	NA	NA	NA
3	0	5	BCRL	BCRL	NA	NA	NA
5	0	8	BCRL	BCRL	NA	NA	NA
11	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	12	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	33	BCRL	BCRL	NA	NA	NA
Control	0	9	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 2	0	13	BCRL	BCRL	NA	NA	NA
3	0	10	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
5	0	18	BCRL	BCRL	NA	NA	NA
11	0	4	BCRL	BCRL	NA	NA	NA
RMA FAR	0	24	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	80	BCRL	BCRL	NA	NA	NA
Control	0	22	BCRL	BCRL	NA	NA	NA
PIME - bullsnake (FORTUITOUS)							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
PIPI - black-billed magpie (FORTUITOUS)							
CMP-BSA 13	0	1	BCRL	BCRL	NA	NA	NA
SPTR - thirteen-lined ground squirrel							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
STNE - western meadowlark							
CMP-BSA 2	1	8	0.0584	0.0584	NC	NC	NC
5	0	2	BCRL	BCRL	NA	NA	NA
12	1	10	0.0584	0.0584	NC	NC	NC
All RMA CMP-BSAs	0	5	BCRL	BCRL	NA	NA	NA
Control							
STNE - western meadowlark (FORTUITOUS)							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
12	1	1	0.130	0.130	0.130	NA	NA
All RMA CMP-BSAs	1	2	0.130	0.130	0.0694	2.20	2.43

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-5 Endrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
STVU - starling (FORTUITOUS)							
CMP-BSA 13	1	1	0.394	0.394	0.394	NA	NA
SYAU - desert cottontail							
Dressed carcass							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
5	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	11	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
Muscle							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	9	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
5	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	17	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
SYAU - desert cottontail (FORTUITOUS)							
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
TATA - badger (FORTUITOUS)							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Brain							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Fat							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Solid stomach contents							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liquid stomach contents							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	6	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

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BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-5 Endrin Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
TUMI - American robin (FORTUITOUS)							
Dressed carcass							
CMP-BSA 13	3	6	0.100	0.980	0.103	5.94	3.80
ZEMA - mourning dove							
CMP-BSA 1	2	11	0.0651	0.218	NC	NC	NC
2	6	13	0.0732	0.338	NC	NC	NC
3	2	11	0.0529	0.102	NC	NC	NC
4	1	16	0.253	0.253	NC	NC	NC
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	1	BCRL	BCRL	NA	NA	NA
12	1	3	0.0779	0.0779	NC	NC	NC
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	12	68	0.0529	0.338	NC	NC	NC
Control	0	10	BCRL	BCRL	NA	NA	NA
ZEMA - mourning dove (FORTUITOUS)							
CMP-BSA 13	2	4	0.316	1.30	0.154	21.0	5.73

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**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-6 DDT Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ACRI - grasshopper							
CMP-BSA 1	0	16	BCRL	BCRL	NA	NA	NA
2	1	15	0.143	0.143	NC	NC	NC
3	0	10	BCRL	BCRL	NA	NA	NA
4	1	10	0.182	0.182	NC	NC	NC
5	0	10	BCRL	BCRL	NA	NA	NA
11	1	3	0.134	0.134	NC	NC	NC
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	3	66	0.134	0.182	NC	NC	NC
Control	0	12	BCRL	BCRL	NA	NA	NA
AQCH - golden eagle (FORTUITOUS)							
Muscle							
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
Liver							
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
Brain							
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
Off RMA	0	3	BCRL	BCRL	NA	NA	NA
ATCU - burrowing owl							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	7	BCRL	BCRL	NA	NA	NA
BRTE - cheatgrass							
CMP-BSA 1	0	12	BCRL	BCRL	NA	NA	NA
2	0	13	BCRL	BCRL	NA	NA	NA
3	0	10	BCRL	BCRL	NA	NA	NA
4	0	7	BCRL	BCRL	NA	NA	NA
5	1	13	0.117	0.117	NC	NC	NC
11	0	6	BCRL	BCRL	NA	NA	NA
12	1	4	0.118	0.118	NC	NC	NC
All RMA CMP-BSAs	2	65	0.117	0.118	NC	NC	NC
Control	0	16	BCRL	BCRL	NA	NA	NA
BUJA - red-tailed hawk (FORTUITOUS)							
Muscle							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
13	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

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NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-6 DDT Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
BURE - ferruginous hawk (FORTUITOUS)							
Muscle							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA NEAR	0	2	BCRL	BCRL	NA	NA	NA
BUSW - Swainson's hawk (FORTUITOUS)							
Muscle							
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
BUVI - great horned owl							
Egg							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	5	BCRL	BCRL	NA	NA	NA
BUVI - great horned owl (FORTUITOUS)							
Muscle							
CMP-BSA 4	0	1	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 5	1	1	0.243	0.243	0.243	NA	NA
All Samples							
CMP-BSA 4	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
COLE - ground beetles							
CMP-BSA 1	0	5	BCRL	BCRL	NA	NA	NA
2	0	4	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	10	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
CYLU - prairie dog							
CMP-BSA 1	0	44	BCRL	BCRL	NA	NA	NA
2	0	21	BCRL	BCRL	NA	NA	NA
3	1	19	0.159	0.159	NC	NC	NC
11	0	1	BCRL	BCRL	NA	NA	NA
12	0	5	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	95	0.159	0.159	NC	NC	NC
Control	0	20	BCRL	BCRL	NA	NA	NA
EUCY - Brewer's blackbird (FORTUITOUS)							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA

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NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-6 DDT Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
FASP - kestrel							
Dressed carcass							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
5	0	2	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	10	BCRL	BCRL	NA	NA	NA
Control	1	9	0.141	0.141	NC	NC	NC
Egg							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	7	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
5	0	3	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	11	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	17	BCRL	BCRL	NA	NA	NA
Control	1	14	0.141	0.141	NC	NC	NC
FASP - kestrel (FORTUITOUS)							
Dressed carcass							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
HALE - bald eagle (FORTUITOUS)							
Muscle							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
Brain							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
HEAN - sunflower							
CMP-BSA 1	1	12	0.146	0.146	NC	NC	NC
2	0	13	BCRL	BCRL	NA	NA	NA
3	0	10	BCRL	BCRL	NA	NA	NA
4	0	10	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	60	0.146	0.146	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

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NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-6 DDT Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
KOIR - kochia							
CMP-BSA 1	0	5	BCRL	BCRL	NA	NA	NA
2	1	7	0.0908	0.0908	NC	NC	NC
3	0	4	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	31	0.0908	0.0908	NC	NC	NC
Control	0	10	BCRL	BCRL	NA	NA	NA
LASE - wild lettuce							
CMP-BSA 1	0	7	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
4	0	3	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	14	BCRL	BCRL	NA	NA	NA
Control	0	3	BCRL	BCRL	NA	NA	NA
ODHE - mule deer							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
4	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	8	BCRL	BCRL	NA	NA	NA
Control	0	2	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-6 DDT Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ODVI - white-tail deer							
Muscle							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 5	0	4	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	12	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
OLIG - earthworm							
CMP-BSA 1	1	6	0.259	0.259	NC	NC	NC
2	0	7	BCRL	BCRL	NA	NA	NA
3	0	7	BCRL	BCRL	NA	NA	NA
4	0	5	BCRL	BCRL	NA	NA	NA
5	2	13	0.155	0.177	NC	NC	NC
11	0	4	BCRL	BCRL	NA	NA	NA
12	0	3	BCRL	BCRL	NA	NA	NA
13	4	7	0.127	1.49	0.154	4.07	3.27
All RMA CMP-BSAs	7	52	0.127	1.49	NC	NC	NC
Control	1	12	0.148	0.148	NC	NC	NC
PEMA - deer mouse							
CMP-BSA 1	3	15	0.154	0.362	NC	NC	NC
2	0	14	BCRL	BCRL	NA	NA	NA
3	0	11	BCRL	BCRL	NA	NA	NA
4	0	10	BCRL	BCRL	NA	NA	NA
5	0	15	BCRL	BCRL	NA	NA	NA
11	0	6	BCRL	BCRL	NA	NA	NA
12	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	3	75	0.154	0.362	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

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BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-6 DDT Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
PHCO - pheasant							
Dressed carcass							
CMP-BSA 2	0	10	BCRL	BCRL	NA	NA	NA
3	0	5	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
RMA FAR	0	12	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	47	BCRL	BCRL	NA	NA	NA
Control	0	13	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 2	0	3	BCRL	BCRL	NA	NA	NA
3	0	5	BCRL	BCRL	NA	NA	NA
5	0	8	BCRL	BCRL	NA	NA	NA
11	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	12	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	33	BCRL	BCRL	NA	NA	NA
Control	0	9	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 2	0	13	BCRL	BCRL	NA	NA	NA
3	0	10	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
5	0	18	BCRL	BCRL	NA	NA	NA
11	0	4	BCRL	BCRL	NA	NA	NA
RMA FAR	0	24	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	80	BCRL	BCRL	NA	NA	NA
Control	0	22	BCRL	BCRL	NA	NA	NA
PIME - bullsnake (FORTUITOUS)							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
PIPI - black-billed magpie (FORTUITOUS)							
CMP-BSA 13	1	1	0.207	0.207	0.207	NA	NA
SPTR - thirteen-lined ground squirrel							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
STNE - western meadowlark							
CMP-BSA 2	0	8	BCRL	BCRL	NA	NA	NA
5	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	10	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
STNE - western meadowlark (FORTUITOUS)							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

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NA = Not applicable.

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Table 5.1-6 DDT Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
STVU - starling (FORTUITOUS)							
CMP-BSA 13	0	1	BCRL	BCRL	NA	NA	NA
SYAU - desert cottontail							
Dressed carcass							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
5	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	11	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
Muscle							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	9	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
5	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	17	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
SYAU - desert cottontail (FORTUITOUS)							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
TATA - badger (FORTUITOUS)							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Brain							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Fat							
CMP-BSA 1	1	1	0.539	0.539	0.539	NA	NA
Solid stomach contents							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liquid stomach contents							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	1	6	0.539	0.539	NC	NC	NC

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BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-6 DDT Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
TUMI - American robin (FORTUITOUS)							
Dressed carcass							
CMP-BSA 13	2	6	0.339	0.950	NC	NC	NC
ZEMA - mourning dove							
CMP-BSA 1	0	11	BCRL	BCRL	NA	NA	NA
2	0	13	BCRL	BCRL	NA	NA	NA
3	0	11	BCRL	BCRL	NA	NA	NA
4	0	16	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	1	BCRL	BCRL	NA	NA	NA
12	0	3	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	68	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
ZEMA - mourning dove (FORTUITOUS)							
CMP-BSA 13	1	4	0.308	0.308	NC	NC	NC

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Table 5.1-7 DDE Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ACRI - grasshopper							
CMP-BSA 1	0	16	BCRL	BCRL	NA	NA	NA
2	0	15	BCRL	BCRL	NA	NA	NA
3	0	10	BCRL	BCRL	NA	NA	NA
4	0	10	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	66	BCRL	BCRL	NA	NA	NA
Control	0	12	BCRL	BCRL	NA	NA	NA
AQCH - golden eagle (FORTUITOUS)							
Muscle							
Off RMA	1	1	0.639	0.639	0.639	NA	NA
Liver							
Off RMA	1	1	0.124	0.124	0.124	NA	NA
Brain							
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
Off RMA	2	3	0.124	0.639	0.158	5.30	3.64
ATCU - burrowing owl							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
3	1	1	0.0764	0.0764	0.0764	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	1	4	0.197	0.197	NC	NC	NC
All RMA CMP-BSAs	2	7	0.0764	0.197	NC	NC	NC
BRTE - cheatgrass							
CMP-BSA 1	0	12	BCRL	BCRL	NA	NA	NA
2	0	13	BCRL	BCRL	NA	NA	NA
3	0	10	BCRL	BCRL	NA	NA	NA
4	0	7	BCRL	BCRL	NA	NA	NA
5	1	13	0.0692	0.0692	NC	NC	NC
11	0	6	BCRL	BCRL	NA	NA	NA
12	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	65	0.0692	0.0692	NC	NC	NC
Control	0	16	BCRL	BCRL	NA	NA	NA
BUJA - red-tailed hawk (FORTUITOUS)							
Muscle							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 13	1	1	0.145	0.145	0.145	NA	NA
All Samples							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	1	2	0.145	0.145	0.0851	1.76	2.12
All RMA CMP-BSAs	1	3	0.145	0.145	NC	NC	NC

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NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
BURB - ferruginous hawk (FORTUITOUS)							
Muscle							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA NEAR	0	2	BCRL	BCRL	NA	NA	NA
BUSW - Swainson's hawk (FORTUITOUS)							
Muscle							
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
BUVI - great horned owl							
Egg							
CMP-BSA 5	1	1	1.01	1.01	1.01	NA	NA
RMA FAR	1	1	0.285	0.285	0.285	NA	NA
RMA NEAR	3	3	0.587	0.729	0.659	1.01	1.12
All RMA CMP-BSAs	5	5	0.285	1.01	0.607	1.24	1.60
BUVI - great horned owl (FORTUITOUS)							
Muscle							
CMP-BSA 4	0	1	BCRL	BCRL	NA	NA	NA
5	1	1	0.501	0.501	0.501	NA	NA
12	1	1	0.667	0.667	0.667	NA	NA
All RMA CMP-BSAs	2	3	0.501	0.667	0.256	7.52	4.14
Liver							
CMP-BSA 5	1	1	5.40	5.40	5.40	NA	NA
All Samples							
CMP-BSA 4	0	1	BCRL	BCRL	NA	NA	NA
5	2	2	0.501	5.40	1.64	16.9	5.37
12	1	1	0.667	0.667	0.667	NA	NA
All RMA CMP-BSAs	3	4	0.501	5.40	0.548	39.3	6.79
COLE - ground beetles							
CMP-BSA 1	1	5	0.0688	0.0688	NC	NC	NC
2	0	4	BCRL	BCRL	NA	NA	NA
5	1	1	0.355	0.355	0.355	NA	NA
All RMA CMP-BSAs	2	10	0.0688	0.355	NC	NC	NC
Control	0	4	BCRL	BCRL	NA	NA	NA
CYLU - prairie dog							
CMP-BSA 1	1	44	0.301	0.301	NC	NC	NC
2	0	21	BCRL	BCRL	NA	NA	NA
3	1	19	0.204	0.204	NC	NC	NC
11	0	1	BCRL	BCRL	NA	NA	NA
12	0	5	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	2	95	0.204	0.301	NC	NC	NC
Control	0	20	BCRL	BCRL	NA	NA	NA

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NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-7 DDE Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
BUCY - Brewer's blackbird (FORTUITOUS)							
CMP-BSA 5	1	1	1.10	1.10	1.10	NA	NA
FASP - kestrel							
Dressed carcass							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
5	1	2	0.811	0.811	0.160	196	9.94
RMA NEAR	3	6	0.0806	0.322	0.0908	2.55	2.63
All RMA CMP-BSAs	4	10	0.0806	0.811	NC	NC	NC
Control	5	9	0.184	0.768	0.124	3.84	3.19
Egg							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	2	5	0.203	0.352	NC	NC	NC
All RMA CMP-BSAs	2	7	0.203	0.352	NC	NC	NC
Control	2	5	0.117	0.232	NC	NC	NC
All Samples							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
5	1	3	0.811	0.811	NC	NC	NC
RMA NEAR	5	11	0.0806	0.352	NC	NC	NC
All RMA CMP-BSAs	6	17	0.0806	0.811	NC	NC	NC
Control	7	14	0.117	0.768	0.106	2.78	2.75
FASP - kestrel (FORTUITOUS)							
Dressed carcass							
CMP-BSA 5	1	1	0.401	0.401	0.401	NA	NA
13	1	1	0.122	0.122	0.122	NA	NA
RMA NEAR	1	1	0.114	0.114	0.114	NA	NA
All RMA CMP-BSAs	3	3	0.114	0.401	0.177	1.65	2.03
HALE - bald eagle (FORTUITOUS)							
Muscle							
RMA NEAR	1	1	1.70	1.70	1.70	NA	NA
Liver							
RMA NEAR	1	1	0.404	0.404	0.404	NA	NA
Brain							
RMA NEAR	1	1	0.400	0.400	0.400	NA	NA
All Samples							
RMA NEAR	3	3	0.400	1.70	0.650	2.00	2.30
HEAN - sunflower							
CMP-BSA 1	0	12	BCRL	BCRL	NA	NA	NA
2	0	13	BCRL	BCRL	NA	NA	NA
3	0	10	BCRL	BCRL	NA	NA	NA
4	0	10	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	60	BCRL	BCRL	NA	NA	NA
Control	2	15	0.0483	0.0499	NC	NC	NC

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Table 5.1-7 DDE Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
KOIR - kochia							
CMP-BSA 1	0	5	BCRL	BCRL	NA	NA	NA
2	0	7	BCRL	BCRL	NA	NA	NA
3	0	4	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	31	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
LASE - wild lettuce							
CMP-BSA 1	0	7	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
4	0	3	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	14	BCRL	BCRL	NA	NA	NA
Control	0	3	BCRL	BCRL	NA	NA	NA
ODHE - mule deer							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
4	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	8	BCRL	BCRL	NA	NA	NA
Control	0	2	BCRL	BCRL	NA	NA	NA

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	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ODVI - white-tail deer							
Muscle							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 5	0	4	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	12	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
OLIG - earthworm							
CMP-BSA 1	0	6	BCRL	BCRL	NA	NA	NA
2	2	7	0.169	0.170	NC	NC	NC
3	1	7	0.120	0.120	NC	NC	NC
4	1	5	0.675	0.675	NC	NC	NC
5	3	13	0.110	1.30	NC	NC	NC
11	0	4	BCRL	BCRL	NA	NA	NA
12	0	3	BCRL	BCRL	NA	NA	NA
13	5	7	0.432	1.40	0.296	7.80	4.19
All RMA CMP-BSAs	12	52	0.110	1.40	NC	NC	NC
Control	0	12	BCRL	BCRL	NA	NA	NA
PEMA - deer mouse							
CMP-BSA 1	1	15	0.877	0.877	NC	NC	NC
2	0	14	BCRL	BCRL	NA	NA	NA
3	2	11	0.120	0.151	NC	NC	NC
4	2	10	0.478	1.90	NC	NC	NC
5	0	15	BCRL	BCRL	NA	NA	NA
11	0	6	BCRL	BCRL	NA	NA	NA
12	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	5	75	0.120	1.90	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-7 DDE Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
PHCO - pheasant							
Dressed carcass							
CMP-BSA 2	0	10	BCRL	BCRL	NA	NA	NA
3	1	5	0.214	0.214	NC	NC	NC
4	1	1	0.430	0.430	0.430	NA	NA
5	3	10	0.0701	0.172	NC	NC	NC
11	0	3	BCRL	BCRL	NA	NA	NA
RMA FAR	1	12	0.319	0.319	NC	NC	NC
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	6	47	0.0701	0.430	NC	NC	NC
Control	0	13	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 2	0	3	BCRL	BCRL	NA	NA	NA
3	2	4	0.109	0.129	0.0611	1.80	2.16
5	5	8	0.144	0.810	0.146	4.88	3.52
11	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	12	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	7	32	0.109	0.810	NC	NC	NC
Control	0	9	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 2	0	13	BCRL	BCRL	NA	NA	NA
3	3	9	0.109	0.214	NC	NC	NC
4	1	1	0.430	0.430	0.430	NA	NA
5	8	18	0.0701	0.810	NC	NC	NC
11	0	4	BCRL	BCRL	NA	NA	NA
RMA FAR	1	24	0.319	0.319	NC	NC	NC
RMA NEAR	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	13	79	0.0701	0.810	NC	NC	NC
Control	0	22	BCRL	BCRL	NA	NA	NA
PIME - bullsnake (FORTUITOUS)							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
PIPI - black-billed magpie (FORTUITOUS)							
CMP-BSA 13	1	1	2.20	2.20	2.20	NA	NA
SPTR - thirteen-lined ground squirrel							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
STNE - western meadowlark							
CMP-BSA 2	0	8	BCRL	BCRL	NA	NA	NA
5	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	10	BCRL	BCRL	NA	NA	NA
Control	1	5	0.123	0.123	NC	NC	NC
STNE - western meadowlark (FORTUITOUS)							
CMP-BSA 2	1	1	0.149	0.149	0.149	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	2	0.149	0.149	0.0863	1.82	2.16
STVU - starling (FORTUITOUS)							
CMP-BSA 13	1	1	4.30	4.30	4.30	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-7 DDE Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
SYAU - desert cottontail							
Dressed carcass							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
5	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	11	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
Muscle							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	9	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
5	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	17	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
SYAU - desert cottontail (FORTUITOUS)							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
TATA - badger (FORTUITOUS)							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Brain							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Fat							
CMP-BSA 1	1	1	0.506	0.506	0.506	NA	NA
Solid stomach contents							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liquid stomach contents							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	1	6	0.506	0.506	NC	NC	NC

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.
**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.
BCRL = Below certified reporting limit. This value varied for different labs and in different years.
NA = Not applicable.
NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-7 DDE Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
TUMI - American robin (FORTUITOUS)							
Dressed carcass							
CMP-BSA 13	5	6	1.40	8.30	2.39	56.4	7.45
ZEMA - mourning dove							
CMP-BSA 1	0	11	BCRL	BCRL	NA	NA	NA
2	0	13	BCRL	BCRL	NA	NA	NA
3	0	11	BCRL	BCRL	NA	NA	NA
4	1	16	0.0766	0.0766	NC	NC	NC
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	1	BCRL	BCRL	NA	NA	NA
12	1	3	0.942	0.942	NC	NC	NC
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	2	68	0.0766	0.942	NC	NC	NC
Control	0	10	BCRL	BCRL	NA	NA	NA
ZEMA - mourning dove (FORTUITOUS)							
CMP-BSA 13	1	4	0.455	0.455	NC	NC	NC

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Table 5.1-8 Arsenic Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ACRI - grasshopper							
CMP-BSA 1	3	16	0.521	0.992	NC	NC	NC
2	0	15	BCRL	BCRL	NA	NA	NA
3	0	10	BCRL	BCRL	NA	NA	NA
4	1	10	1.01	1.01	NC	NC	NC
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	4	66	0.521	1.01	NC	NC	NC
Control	0	12	BCRL	BCRL	NA	NA	NA
AQCH - golden eagle (FORTUITOUS)							
Muscle	0	1	BCRL	BCRL	NA	NA	NA
Off RMA							
Liver							
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
Brain							
Off RMA	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
Control	0	3	BCRL	BCRL	NA	NA	NA
ATCU - burrowing owl							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	7	BCRL	BCRL	NA	NA	NA
BRTE - cheatgrass							
CMP-BSA 1	0	12	BCRL	BCRL	NA	NA	NA
2	1	13	0.481	0.481	NC	NC	NC
3	0	10	BCRL	BCRL	NA	NA	NA
4	1	7	0.600	0.600	NC	NC	NC
5	0	13	BCRL	BCRL	NA	NA	NA
11	0	6	BCRL	BCRL	NA	NA	NA
12	4	4	0.880	1.11	0.993	1.01	1.10
All RMA CMP-BSAs	6	65	0.481	1.11	NC	NC	NC
Control	0	16	BCRL	BCRL	NA	NA	NA
BUJA - red-tailed hawk (FORTUITOUS)							
Liver							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
BURB - ferruginous hawk (FORTUITOUS)							
Liver							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
BUSW - Swainson's hawk (FORTUITOUS)							
Liver	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR							

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NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-8 Arsenic Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
BUVI - great horned owl							
Egg							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	5	BCRL	BCRL	NA	NA	NA
BUVI - great horned owl (FORTUITOUS)							
Liver							
CMP-BSA 4	0	1	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
Brain							
CMP-BSA 4	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 4	0	2	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	5	BCRL	BCRL	NA	NA	NA
COLE - ground beetles							
CMP-BSA 1	5	5	0.623	3.42	1.51	1.62	2.00
2	2	5	1.14	1.35	NC	NC	NC
5	1	2	0.468	0.468	0.242	2.39	2.54
All RMA CMP-BSAs	8	12	0.468	3.42	0.578	4.75	3.48
Control	0	3	BCRL	BCRL	NA	NA	NA
CYLU - prairie dog							
CMP-BSA 1	11	26	0.430	2.67	NC	NC	NC
2	1	21	0.435	0.435	NC	NC	NC
3	3	19	0.468	0.528	NC	NC	NC
11	0	1	BCRL	BCRL	NA	NA	NA
12	0	5	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	15	77	0.430	2.67	NC	NC	NC
Control	2	20	0.502	0.517	NC	NC	NC
EUCY - Brewer's blackbird (FORTUITOUS)							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA

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BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

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Table 5.1-8 Arsenic Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
FASP - kestrel							
Dressed carcass							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
5	0	2	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	10	BCRL	BCRL	NA	NA	NA
Control	0	9	BCRL	BCRL	NA	NA	NA
Egg							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	7	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
5	0	3	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	11	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	17	BCRL	BCRL	NA	NA	NA
Control	0	13	BCRL	BCRL	NA	NA	NA
FASP - kestrel (FORTUITOUS)							
Dressed carcass							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
HALE - bald eagle (FORTUITOUS)							
Liver							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
Brain							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA NEAR	0	2	BCRL	BCRL	NA	NA	NA
HEAN - sunflower							
CMP-BSA 1	2	12	0.374	2.26	NC	NC	NC
2	1	13	0.456	0.456	NC	NC	NC
3	0	10	BCRL	BCRL	NA	NA	NA
4	2	10	0.482	0.877	NC	NC	NC
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	1	2	0.563	0.563	0.265	3.10	2.90
All RMA CMP-BSAs	6	60	0.374	2.26	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

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BCRL = Below certified reporting limit. This value varied for different labs and in different years.

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Table 5.1-8 Arsenic Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
KOIR - kochia							
CMP-BSA 1	3	5	0.353	1.17	0.306	2.41	2.56
2	0	7	BCRL	BCRL	NA	NA	NA
3	0	4	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	1	2	0.334	0.334	0.204	1.62	2.00
All RMA CMP-BSAs	4	31	0.334	1.17	NC	NC	NC
Control	0	10	BCRL	BCRL	NA	NA	NA
LASE - wild lettuce							
CMP-BSA 1	0	7	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
4	1	3	0.965	0.965	NC	NC	NC
5	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	14	0.965	0.965	NC	NC	NC
Control	0	3	BCRL	BCRL	NA	NA	NA
ODHE - mule deer							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
4	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	8	BCRL	BCRL	NA	NA	NA
Control	0	2	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

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BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-8 Arsenic Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ODVI - white-tail deer							
Muscle							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 5	0	4	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	12	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
OLIG - earthworm							
CMP-BSA 1	6	6	1.06	2.22	1.36	1.11	1.39
2	7	7	1.41	3.23	1.75	1.09	1.33
3	6	6	0.708	1.38	0.923	1.07	1.29
4	5	5	0.682	3.45	1.36	1.47	1.86
5	13	13	0.621	2.18	1.06	1.12	1.41
11	4	4	1.31	2.05	1.65	1.03	1.20
12	1	1	110	110	110	NA	NA
13	7	7	1.15	2.19	1.36	1.05	1.25
All RMA CMP-BSAs	49	49	0.621	110	1.40	1.73	2.09
Control	11	12	0.636	1.27	0.776	1.21	1.55
PEMA - deer mouse							
CMP-BSA 1	2	15	0.547	1.06	NC	NC	NC
2	0	14	BCRL	BCRL	NA	NA	NA
3	0	11	BCRL	BCRL	NA	NA	NA
4	0	10	BCRL	BCRL	NA	NA	NA
5	0	15	BCRL	BCRL	NA	NA	NA
11	0	6	BCRL	BCRL	NA	NA	NA
12	2	4	1.16	2.50	0.531	7.12	4.06
All RMA CMP-BSAs	4	75	0.547	2.50	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-8 Arsenic Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
PHCO - pheasant							
Dressed carcass							
CMP-BSA 2	0	10	BCRL	BCRL	NA	NA	NA
3	0	4	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
5	0	8	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
RMA FAR	0	6	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	33	BCRL	BCRL	NA	NA	NA
Control	0	8	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 2	0	6	BCRL	BCRL	NA	NA	NA
3	0	4	BCRL	BCRL	NA	NA	NA
5	0	7	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
RMA FAR	0	6	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	27	BCRL	BCRL	NA	NA	NA
Control	0	8	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 2	0	16	BCRL	BCRL	NA	NA	NA
3	0	8	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
5	0	15	BCRL	BCRL	NA	NA	NA
11	0	6	BCRL	BCRL	NA	NA	NA
RMA FAR	0	12	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	60	BCRL	BCRL	NA	NA	NA
Control	0	16	BCRL	BCRL	NA	NA	NA
PIME - bullsnake (FORTUITOUS)							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
PIPI - black-billed magpie (FORTUITOUS)							
CMP-BSA 13	0	1	BCRL	BCRL	NA	NA	NA
SPTR - thirteen-lined ground squirrel							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
STNE - western meadowlark							
CMP-BSA 2	0	8	BCRL	BCRL	NA	NA	NA
5	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	10	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
STNE - western meadowlark (FORTUITOUS)							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
STVU - starling (FORTUITOUS)							
CMP-BSA 13	0	1	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
SYAU - desert cottontail							
Dressed carcass							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
5	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	11	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	6	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
5	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	14	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
SYAU - desert cottontail (FORTUITOUS)							
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
TATA - badger (FORTUITOUS)							
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Brain							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Fat							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Solid stomach contents							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liquid stomach contents							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	5	BCRL	BCRL	NA	NA	NA
TUMI - American robin (FORTUITOUS)							
Dressed carcass							
CMP-BSA 13	0	6	BCRL	BCRL	NA	NA	NA
ZEMA - mourning dove							
CMP-BSA 1	0	11	BCRL	BCRL	NA	NA	NA
2	1	13	2.63	2.63	NC	NC	NC
3	0	11	BCRL	BCRL	NA	NA	NA
4	0	16	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	1	BCRL	BCRL	NA	NA	NA
12	0	3	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	68	2.63	2.63	NC	NC	NC
Control	0	10	BCRL	BCRL	NA	NA	NA
ZEMA - mourning dove (FORTUITOUS)							
CMP-BSA 13	0	4	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-9 Mercury Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ACRI - grasshopper							
CMP-BSA 1	0	11	BCRL	BCRL	NA	NA	NA
2	0	10	BCRL	BCRL	NA	NA	NA
3	0	6	BCRL	BCRL	NA	NA	NA
4	0	6	BCRL	BCRL	NA	NA	NA
5	0	5	BCRL	BCRL	NA	NA	NA
11	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	39	BCRL	BCRL	NA	NA	NA
Control	0	7	BCRL	BCRL	NA	NA	NA
AQCH - golden eagle (FORTUITOUS)							
Muscle							
Off RMA	1	1	0.140	0.140	0.140	NA	NA
Liver							
Off RMA	1	1	0.304	0.304	0.304	NA	NA
Brain							
Off RMA	1	1	0.0969	0.0969	0.0969	NA	NA
All Samples							
Off RMA	3	3	0.0969	0.304	0.160	1.41	1.79
ATCU - burrowing owl							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	7	BCRL	BCRL	NA	NA	NA
BRTE - cheatgrass							
CMP-BSA 1	0	8	BCRL	BCRL	NA	NA	NA
2	0	8	BCRL	BCRL	NA	NA	NA
3	0	6	BCRL	BCRL	NA	NA	NA
4	0	4	BCRL	BCRL	NA	NA	NA
5	0	8	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	39	BCRL	BCRL	NA	NA	NA
Control	0	11	BCRL	BCRL	NA	NA	NA
BUJA - red-tailed hawk (FORTUITOUS)							
Muscle							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 5	1	1	0.0489	0.0489	0.0489	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	2	0.0489	0.0489	0.0336	1.32	1.70
All Samples							
CMP-BSA 5	1	2	0.0489	0.0489	0.0336	1.32	1.70
13	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	4	0.0489	0.0489	NC	NC	NC

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
BURE - ferruginous hawk (FORTUITOUS)							
Muscle							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA NEAR	1	1	0.0760	0.0760	0.0760	NA	NA
All Samples							
RMA NEAR	1	2	0.0760	0.0760	0.0419	2.03	2.32
BUSW - Swainson's hawk (FORTUITOUS)							
Muscle							
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
Liver							
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
BUVI - great horned owl							
Egg							
CMP-BSA 5	1	1	0.106	0.106	0.106	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	5	0.106	0.106	NC	NC	NC
BUVI - great horned owl (FORTUITOUS)							
Muscle							
CMP-BSA 4	0	1	BCRL	BCRL	NA	NA	NA
5	1	1	0.0643	0.0643	0.0643	NA	NA
12	1	1	0.0664	0.0664	0.0664	NA	NA
All RMA CMP-BSAs	2	3	0.0643	0.0664	0.0462	1.43	1.82
Liver							
CMP-BSA 4	0	1	BCRL	BCRL	NA	NA	NA
5	1	1	0.131	0.131	0.131	NA	NA
12	1	1	0.0581	0.0581	0.0581	NA	NA
All RMA CMP-BSAs	2	3	0.0581	0.131	0.0561	2.12	2.38
All Samples							
CMP-BSA 4	0	2	BCRL	BCRL	NA	NA	NA
5	2	2	0.0643	0.131	0.0918	1.29	1.65
12	2	2	0.0581	0.0664	0.0621	1.01	1.10
All RMA CMP-BSAs	4	6	0.0581	0.131	0.0509	1.58	1.96
COLE - ground beetles							
CMP-BSA 1	0	5	BCRL	BCRL	NA	NA	NA
2	1	5	0.0589	0.0589	NC	NC	NC
5	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	12	0.0589	0.0589	NC	NC	NC
Control	0	3	BCRL	BCRL	NA	NA	NA
CYLU - prairie dog							
CMP-BSA 1	0	26	BCRL	BCRL	NA	NA	NA
2	0	21	BCRL	BCRL	NA	NA	NA
3	1	19	0.0472	0.0472	NC	NC	NC
11	0	1	BCRL	BCRL	NA	NA	NA
12	0	5	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	77	0.0472	0.0472	NC	NC	NC
Control	0	20	BCRL	BCRL	NA	NA	NA

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BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-9 Mercury Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
BUCY - Brewer's blackbird (FORTUITOUS)							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
FASP - kestrel							
Dressed carcass							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
5	0	2	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	10	BCRL	BCRL	NA	NA	NA
Control	0	9	BCRL	BCRL	NA	NA	NA
Egg							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	7	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
5	0	3	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	11	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	17	BCRL	BCRL	NA	NA	NA
Control	0	13	BCRL	BCRL	NA	NA	NA
FASP - kestrel (FORTUITOUS)							
Dressed carcass							
CMP-BSA 5	0	1	BCRL	BCRL	NA	NA	NA
13	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	3	BCRL	BCRL	NA	NA	NA
HALE - bald eagle (FORTUITOUS)							
Muscle							
RMA NEAR	1	1	0.0542	0.0542	0.0542	NA	NA
Liver							
RMA NEAR	1	1	0.153	0.153	0.153	NA	NA
Brain							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
RMA NEAR	2	3	0.0542	0.153	0.0577	2.45	2.57
HEAN - sunflower							
CMP-BSA 1	0	7	BCRL	BCRL	NA	NA	NA
2	0	8	BCRL	BCRL	NA	NA	NA
3	0	6	BCRL	BCRL	NA	NA	NA
4	0	6	BCRL	BCRL	NA	NA	NA
5	0	7	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	36	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.
**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.
BCRL = Below certified reporting limit. This value varied for different labs and in different years.
NA = Not applicable.
NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-9 Mercury Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
KOIR - kochia							
CMP-BSA 1	0	5	BCRL	BCRL	NA	NA	NA
2	0	7	BCRL	BCRL	NA	NA	NA
3	0	4	BCRL	BCRL	NA	NA	NA
5	0	8	BCRL	BCRL	NA	NA	NA
11	0	1	BCRL	BCRL	NA	NA	NA
12	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	27	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
LASE - wild lettuce							
CMP-BSA 1	0	7	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
4	0	3	BCRL	BCRL	NA	NA	NA
5	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	14	BCRL	BCRL	NA	NA	NA
Control	0	3	BCRL	BCRL	NA	NA	NA
ODHE - mule deer							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
3	0	1	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
4	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	8	BCRL	BCRL	NA	NA	NA
Control	0	2	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-9 Mercury Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ODVI - white-tail deer							
Muscle							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 5	0	2	BCRL	BCRL	NA	NA	NA
RMA FAR	0	1	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 5	0	4	BCRL	BCRL	NA	NA	NA
RMA FAR	0	2	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	12	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
OLIG - earthworm							
CMP-BSA 1	6	6	0.0586	0.141	0.0906	1.15	1.45
2	5	7	0.0550	0.103	0.0528	1.45	1.84
3	3	7	0.0474	0.0688	NC	NC	NC
4	3	5	0.0621	0.132	0.0493	1.76	2.12
5	8	13	0.0534	0.169	0.0487	1.57	1.95
11	1	4	0.0519	0.0519	NC	NC	NC
12	3	3	0.0596	0.144	0.0996	1.23	1.58
13	4	6	0.0534	0.0971	0.0493	1.43	1.82
All RMA CMP-BSAs	33	51	0.0474	0.169	0.0508	1.50	1.89
Control	2	12	0.0561	0.0595	NC	NC	NC
PEMA - deer mouse							
CMP-BSA 1	2	15	0.123	0.807	NC	NC	NC
2	1	14	0.0579	0.0579	NC	NC	NC
3	0	11	BCRL	BCRL	NA	NA	NA
4	0	10	BCRL	BCRL	NA	NA	NA
5	1	15	0.107	0.107	NC	NC	NC
11	0	6	BCRL	BCRL	NA	NA	NA
12	1	4	0.338	0.338	NC	NC	NC
All RMA CMP-BSAs	5	75	0.0579	0.807	NC	NC	NC
Control	2	15	0.0563	0.0641	NC	NC	NC

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-9 Mercury Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
PHCO - pheasant							
Dressed carcass							
CMP-BSA 2	2	10	0.106	0.122	NC	NC	NC
3	0	5	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
RMA FAR	0	6	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	2	41	0.106	0.122	NC	NC	NC
Control	0	13	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 2	0	4	BCRL	BCRL	NA	NA	NA
3	0	4	BCRL	BCRL	NA	NA	NA
5	0	7	BCRL	BCRL	NA	NA	NA
RMA FAR	0	6	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	23	BCRL	BCRL	NA	NA	NA
Control	0	9	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 2	2	14	0.106	0.122	NC	NC	NC
3	0	9	BCRL	BCRL	NA	NA	NA
4	0	1	BCRL	BCRL	NA	NA	NA
5	0	17	BCRL	BCRL	NA	NA	NA
11	0	3	BCRL	BCRL	NA	NA	NA
RMA FAR	0	12	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	8	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	2	64	0.106	0.122	NC	NC	NC
Control	0	22	BCRL	BCRL	NA	NA	NA
PIME - bullsnake (FORTUITOUS)							
RMA NEAR	0	1	BCRL	BCRL	NA	NA	NA
PIPI - black-billed magpie (FORTUITOUS)							
CMP-BSA 13	0	1	BCRL	BCRL	NA	NA	NA
SPTR - thirteen-lined ground squirrel							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
2	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
STNE - western meadowlark							
CMP-BSA 2	0	8	BCRL	BCRL	NA	NA	NA
5	0	2	BCRL	BCRL	NA	NA	NA
12	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	5	BCRL	BCRL	NA	NA	NA
Control							
STNE - western meadowlark (FORTUITOUS)							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
12	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	2	BCRL	BCRL	NA	NA	NA
STVU - starling (FORTUITOUS)							
CMP-BSA 13	1	1	0.0477	0.0477	0.0477	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-9 Mercury Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
SYAU - desert cottontail							
Dressed carcass							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
5	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	11	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
Muscle							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	3	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	8	BCRL	BCRL	NA	NA	NA
2	0	2	BCRL	BCRL	NA	NA	NA
3	0	2	BCRL	BCRL	NA	NA	NA
5	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	16	BCRL	BCRL	NA	NA	NA
Control	0	4	BCRL	BCRL	NA	NA	NA
SYAU - desert cottontail (FORTUITOUS)							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	2	BCRL	BCRL	NA	NA	NA
TATA - badger (FORTUITOUS)							
Muscle							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Brain							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Fat							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Solid stomach contents							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
Liquid stomach contents							
CMP-BSA 1	0	1	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 1	0	6	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-9 Mercury Statistical Results for Terrestrial Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
TUMI - American robin (FORTUITOUS)							
Dressed carcass							
CMP-BSA 13	1	6	0.0623	0.0623	NC	NC	NC
ZEMA - mourning dove							
CMP-BSA 1	0	11	BCRL	BCRL	NA	NA	NA
2	0	13	BCRL	BCRL	NA	NA	NA
3	0	11	BCRL	BCRL	NA	NA	NA
4	0	16	BCRL	BCRL	NA	NA	NA
5	0	10	BCRL	BCRL	NA	NA	NA
11	0	1	BCRL	BCRL	NA	NA	NA
12	0	3	BCRL	BCRL	NA	NA	NA
RMA NEAR	0	3	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	68	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
ZEMA - mourning dove (FORTUITOUS)							
CMP-BSA 13	1	4	0.400	0.400	NC	NC	NC

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Pages TABLE 5.1-10 through TABLE 5.1-17 are missing from the original.

Table 5.1-18 Aldrin Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
AMBY - salamander (FORTUITOUS)							
CMP-BSA 2	2	2	0.208	0.413	0.293	1.27	1.62
ANDI - blue-winged teal							
Dressed Carcass							
CMP-BSA 10	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
ANPL - mallard							
Dressed Carcass							
CMP-BSA 10	1	13	0.0934	0.0934	NC	NC	NC
All RMA CMP-BSAs	1	13	0.0934	0.0934	NC	NC	NC
Control	0	11	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 10	0	9	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	9	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 10	1	22	0.0934	0.0934	NC	NC	NC
All RMA CMP-BSAs	1	22	0.0934	0.0934	NC	NC	NC
Control	0	16	BCRL	BCRL	NA	NA	NA
CEDE - eoontail							
CMP-BSA 6	0	7	BCRL	BCRL	NA	NA	NA
7	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	13	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
CHVO - killdeer							
CMP-BSA 5	0	5	BCRL	BCRL	NA	NA	NA
6	0	3	BCRL	BCRL	NA	NA	NA
8	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	10	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
ESLU - northern pike							
CMP-BSA 7	0	3	BCRL	BCRL	NA	NA	NA
8	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	7	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
FUAM - American coot							
CMP-BSA 6	0	4	BCRL	BCRL	NA	NA	NA
7	1	8	0.0658	0.0658	NC	NC	NC
9	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	13	0.0658	0.0658	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-18 Aldrin Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ICNB and ICMB - bullhead							
Whole body							
CMP-BSA 6	0	1	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	11	BCRL	BCRL	NA	NA	NA
Control	0	9	BCRL	BCRL	NA	NA	NA
Composite							
CMP-BSA 10	3	5	0.0196	0.0673	0.0173	2.73	2.72
All RMA CMP-BSAs	3	5	0.0196	0.0673	0.0173	2.73	2.72
Control	0	2	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 6	0	1	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
10	3	5	0.0196	0.0673	0.0173	2.73	2.72
All RMA CMP-BSAs	3	16	0.0196	0.0673	NC	NC	NC
Control	0	11	BCRL	BCRL	NA	NA	NA
ICPU - channel catfish							
CMP-BSA 6	0	12	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	12	BCRL	BCRL	NA	NA	NA
Control	0	15	BCRL	BCRL	NA	NA	NA
LEMA - bluegill							
Whole body							
CMP-BSA 6	0	10	BCRL	BCRL	NA	NA	NA
7	0	14	BCRL	BCRL	NA	NA	NA
8	0	15	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	39	BCRL	BCRL	NA	NA	NA
Control	0	14	BCRL	BCRL	NA	NA	NA
Composite							
CMP-BSA 6	0	5	BCRL	BCRL	NA	NA	NA
7	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 6	0	15	BCRL	BCRL	NA	NA	NA
7	0	15	BCRL	BCRL	NA	NA	NA
8	0	15	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	45	BCRL	BCRL	NA	NA	NA
Control	0	14	BCRL	BCRL	NA	NA	NA
MISA - largemouth bass							
CMP-BSA 6	0	14	BCRL	BCRL	NA	NA	NA
7	0	15	BCRL	BCRL	NA	NA	NA
8	0	15	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	44	BCRL	BCRL	NA	NA	NA
Control	0	15	BCRL	BCRL	NA	NA	NA
PLAN - plankton							
CMP-BSA 6	0	10	BCRL	BCRL	NA	NA	NA
7	0	10	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	30	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

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NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-18 Aldrin Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
POND - American pondweed							
CMP-BSA 6	0	8	BCRL	BCRL	NA	NA	NA
7	0	8	BCRL	BCRL	NA	NA	NA
8	0	8	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	24	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
POPE - sago pondweed							
CMP-BSA 6	0	6	BCRL	BCRL	NA	NA	NA
7	0	6	BCRL	BCRL	NA	NA	NA
8	0	6	BCRL	BCRL	NA	NA	NA
9	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	22	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-19 Dieldrin Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
AMBY - salamander (FORTUITOUS)							
CMP-BSA 2	2	2	2.50	4.00	3.16	1.12	1.39
ANDI - blue-winged teal							
Dressed Carcass							
CMP-BSA 10	4	4	0.204	0.571	0.349	1.24	1.59
All RMA CMP-BSAs	4	4	0.204	0.571	0.349	1.24	1.59
Control	0	5	BCRL	BCRL	NA	NA	NA
ANPL - mallard							
Dressed Carcass							
CMP-BSA 10	15	15	0.0697	4.20	0.398	4.59	3.44
All RMA CMP-BSAs	15	15	0.0697	4.20	0.398	4.59	3.44
Control	0	11	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 10	10	10	0.179	1.50	0.516	1.53	1.92
All RMA CMP-BSAs	10	10	0.179	1.50	0.516	1.53	1.92
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 10	25	25	0.0697	4.20	0.441	2.90	2.81
All RMA CMP-BSAs	25	25	0.0697	4.20	0.441	2.90	2.81
Control	0	16	BCRL	BCRL	NA	NA	NA
CEDE - eastern cottontail							
CMP-BSA 6	0	7	BCRL	BCRL	NA	NA	NA
7	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	13	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
CHVO - killdeer							
CMP-BSA 5	5	5	0.920	6.80	2.34	1.81	2.16
6	3	3	0.895	1.37	1.07	1.05	1.25
8	2	2	0.154	1.14	0.419	7.42	4.12
All RMA CMP-BSAs	10	10	0.154	6.80	1.31	2.68	2.70
Control	0	5	BCRL	BCRL	NA	NA	NA
ESLU - northern pike							
CMP-BSA 7	2	3	0.242	0.283	0.142	3.07	2.88
8	4	4	0.202	0.273	0.226	1.02	1.14
All RMA CMP-BSAs	6	7	0.202	0.283	0.185	1.56	1.95
Control	0	10	BCRL	BCRL	NA	NA	NA
FUAM - American coot							
CMP-BSA 6	5	5	0.0202	0.301	0.102	2.70	2.71
7	11	11	0.0735	0.207	0.128	1.12	1.41
9	0	1	BCRL	BCRL	NA	NA	NA
10	1	1	0.110	0.110	0.110	NA	NA
All RMA CMP-BSAs	17	18	0.0202	0.301	0.112	1.45	1.84
Control	0	15	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-19 Dieldrin Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ICNB and ICMB - bullhead							
Whole body							
CMP-BSA 6	1	1	0.155	0.155	0.155	NA	NA
8	3	10	0.0350	0.285	NC	NC	NC
All RMA CMP-BSAs	4	11	0.0350	0.285	NC	NC	NC
Control	0	9	BCRL	BCRL	NA	NA	NA
Composite							
CMP-BSA 10	5	5	0.105	0.240	0.155	1.09	1.34
All RMA CMP-BSAs	5	5	0.105	0.240	0.155	1.09	1.34
Control	0	2	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 6	1	1	0.155	0.155	0.155	NA	NA
8	3	10	0.0350	0.285	NC	NC	NC
10	5	5	0.105	0.240	0.155	1.09	1.34
All RMA CMP-BSAs	9	16	0.0350	0.285	0.0571	3.77	3.17
Control	0	11	BCRL	BCRL	NA	NA	NA
ICPU - channel catfish							
CMP-BSA 6	9	12	0.0301	0.618	0.0682	10.4	4.62
All RMA CMP-BSAs	9	12	0.0301	0.618	0.0682	10.4	4.62
Control	0	15	BCRL	BCRL	NA	NA	NA
LEMA - bluegill							
Whole body							
CMP-BSA 6	2	10	0.0194	0.0258	NC	NC	NC
7	14	14	0.0203	0.515	0.109	2.84	2.78
8	12	15	0.0348	0.444	0.0802	7.77	4.19
All RMA CMP-BSAs	28	39	0.0194	0.515	0.0653	5.07	3.58
Control	0	14	BCRL	BCRL	NA	NA	NA
Composite							
CMP-BSA 6	0	5	BCRL	BCRL	NA	NA	NA
7	1	1	0.0209	0.0209	0.0209	NA	NA
All RMA CMP-BSAs	1	6	0.0209	0.0209	NC	NC	NC
All Samples							
CMP-BSA 6	2	15	0.0194	0.0258	NC	NC	NC
7	15	15	0.0203	0.515	0.0978	3.16	2.92
8	12	15	0.0348	0.444	0.0802	7.77	4.19
All RMA CMP-BSAs	29	45	0.0194	0.515	0.0511	6.15	3.85
Control	0	14	BCRL	BCRL	NA	NA	NA
MISA - largemouth bass							
CMP-BSA 6	9	14	0.0199	0.222	0.0308	2.33	2.51
7	13	15	0.0428	0.778	0.108	3.50	3.06
8	14	14	0.0216	0.384	0.102	2.00	2.30
All RMA CMP-BSAs	36	43	0.0199	0.778	0.0704	3.43	3.03
Control	0	15	BCRL	BCRL	NA	NA	NA
PLAN - plankton							
CMP-BSA 6	0	10	BCRL	BCRL	NA	NA	NA
7	0	10	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	30	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-19 Dieldrin Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
POND - American pondweed							
CMP-BSA 6	0	8	BCRL	BCRL	NA	NA	NA
7	0	8	BCRL	BCRL	NA	NA	NA
8	0	8	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	24	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
POPE - sago pondweed							
CMP-BSA 6	0	6	BCRL	BCRL	NA	NA	NA
7	0	6	BCRL	BCRL	NA	NA	NA
8	0	6	BCRL	BCRL	NA	NA	NA
9	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	22	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.
**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.
BCRL = Below certified reporting limit. This value varied for different labs and in different years.
NA = Not applicable.
NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-20 Endrin Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
AMBY - salamander (FORTUITOUS)							
CMP-BSA 2	2	2	0.540	1.00	0.735	1.21	1.55
ANDI - blue-winged teal							
Dressed Carcass							
CMP-BSA 10	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
ANPL - mallard							
Dressed Carcass							
CMP-BSA 10	1	15	0.104	0.104	NC	NC	NC
All RMA CMP-BSAs	1	15	0.104	0.104	NC	NC	NC
Control	0	11	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 10	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	10	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 10	1	25	0.104	0.104	NC	NC	NC
All RMA CMP-BSAs	1	25	0.104	0.104	NC	NC	NC
Control	0	16	BCRL	BCRL	NA	NA	NA
CEDE - eastern cottontail							
CMP-BSA 6	0	7	BCRL	BCRL	NA	NA	NA
7	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	13	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
CHVO - killdeer							
CMP-BSA 5	2	5	0.0861	0.101	NC	NC	NC
6	3	3	0.0714	0.195	0.111	1.30	1.67
8	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	5	10	0.0714	0.195	0.0543	2.71	2.71
Control	0	5	BCRL	BCRL	NA	NA	NA
ESLU - northern pike							
CMP-BSA 7	0	3	BCRL	BCRL	NA	NA	NA
8	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	7	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
FUAM - American coot							
CMP-BSA 6	0	5	BCRL	BCRL	NA	NA	NA
7	1	11	0.135	0.135	NC	NC	NC
9	0	1	BCRL	BCRL	NA	NA	NA
10	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	18	0.135	0.135	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-20 Endrin Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ICNE and ICME - bullhead							
Whole body							
CMP-BSA 6	0	1	BCRL	BCRL	NA	NA	NA
8	1	10	0.0791	0.0791	NC	NC	NC
All RMA CMP-BSAs	1	11	0.0791	0.0791	NC	NC	NC
Control	0	9	BCRL	BCRL	NA	NA	NA
Composite							
CMP-BSA 10	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	5	BCRL	BCRL	NA	NA	NA
Control	0	2	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 6	0	1	BCRL	BCRL	NA	NA	NA
8	1	10	0.0791	0.0791	NC	NC	NC
10	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	16	0.0791	0.0791	NC	NC	NC
Control	0	11	BCRL	BCRL	NA	NA	NA
ICPU - channel catfish							
CMP-BSA 6	1	12	0.101	0.101	NC	NC	NC
All RMA CMP-BSAs	1	12	0.101	0.101	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA
LEMA - bluegill							
Whole body							
CMP-BSA 6	0	10	BCRL	BCRL	NA	NA	NA
7	0	14	BCRL	BCRL	NA	NA	NA
8	1	15	0.0976	0.0976	NC	NC	NC
All RMA CMP-BSAs	1	39	0.0976	0.0976	NC	NC	NC
Control	0	14	BCRL	BCRL	NA	NA	NA
Composite							
CMP-BSA 6	0	5	BCRL	BCRL	NA	NA	NA
7	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 6	0	15	BCRL	BCRL	NA	NA	NA
7	0	15	BCRL	BCRL	NA	NA	NA
8	1	15	0.0976	0.0976	NC	NC	NC
All RMA CMP-BSAs	1	45	0.0976	0.0976	NC	NC	NC
Control	0	14	BCRL	BCRL	NA	NA	NA
MISA - largemouth bass							
CMP-BSA 6	1	14	0.0518	0.0518	NC	NC	NC
7	1	15	0.0478	0.0478	NC	NC	NC
8	0	15	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	2	44	0.0478	0.0518	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA
PLAN - plankton							
CMP-BSA 6	0	10	BCRL	BCRL	NA	NA	NA
7	0	10	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	30	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-20 Endrin Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
POND - American pondweed							
CMP-BSA 6	0	8	BCRL	BCRL	NA	NA	NA
7	0	8	BCRL	BCRL	NA	NA	NA
8	0	8	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	24	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
POPE - sago pondweed							
CMP-BSA 6	0	6	BCRL	BCRL	NA	NA	NA
7	0	6	BCRL	BCRL	NA	NA	NA
8	0	6	BCRL	BCRL	NA	NA	NA
9	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	22	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-21 DDT Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
AMBY - salamander (FORTUITOUS)							
CMP-BSA 2	1	2	0.124	0.124	0.0855	1.32	1.69
ANDI - blue-winged teal							
Dressed Carcass							
CMP-BSA 10	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
ANPL - mallard							
Dressed Carcass							
CMP-BSA 10	0	15	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	15	BCRL	BCRL	NA	NA	NA
Control	0	11	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 10	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	10	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 10	0	25	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	25	BCRL	BCRL	NA	NA	NA
Control	0	16	BCRL	BCRL	NA	NA	NA
CEDE - eastern cottontail							
CMP-BSA 6	0	7	BCRL	BCRL	NA	NA	NA
7	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	13	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
CHVO - killdeer							
CMP-BSA 5	3	5	0.171	1.03	0.355	3.87	3.20
6	2	3	0.955	1.22	0.425	13.7	5.04
8	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	5	10	0.171	1.22	0.268	5.66	3.73
Control	0	5	BCRL	BCRL	NA	NA	NA
ESLU - northern pike							
CMP-BSA 7	0	3	BCRL	BCRL	NA	NA	NA
8	1	4	0.134	0.134	NC	NC	NC
All RMA CMP-BSAs	1	7	0.134	0.134	NC	NC	NC
Control	0	10	BCRL	BCRL	NA	NA	NA
FUAM - American coot							
CMP-BSA 6	0	5	BCRL	BCRL	NA	NA	NA
7	1	11	0.569	0.569	NC	NC	NC
9	0	1	BCRL	BCRL	NA	NA	NA
10	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	18	0.569	0.569	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.
**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.
BCRL = Below certified reporting limit. This value varied for different labs and in different years.
NA = Not applicable.
NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-21 DDT Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ICNE and ICMB - bullhead							
Whole body							
CMP-BSA 6	0	1	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	11	BCRL	BCRL	NA	NA	NA
Control	0	9	BCRL	BCRL	NA	NA	NA
Composite							
CMP-BSA 10	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	5	BCRL	BCRL	NA	NA	NA
Control	0	2	BCRL	BCRL	NA	NA	NA
Whole body							
CMP-BSA 6	0	1	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
10	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	16	BCRL	BCRL	NA	NA	NA
Control	0	11	BCRL	BCRL	NA	NA	NA
ICPU - channel catfish							
CMP-BSA 6	0	12	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	12	BCRL	BCRL	NA	NA	NA
Control	0	15	BCRL	BCRL	NA	NA	NA
LEMA - bluegill							
Whole body							
CMP-BSA 6	0	10	BCRL	BCRL	NA	NA	NA
7	0	14	BCRL	BCRL	NA	NA	NA
8	0	15	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	39	BCRL	BCRL	NA	NA	NA
Control	0	14	BCRL	BCRL	NA	NA	NA
Composite							
CMP-BSA 6	0	5	BCRL	BCRL	NA	NA	NA
7	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 6	0	15	BCRL	BCRL	NA	NA	NA
7	0	15	BCRL	BCRL	NA	NA	NA
8	0	15	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	45	BCRL	BCRL	NA	NA	NA
Control	0	14	BCRL	BCRL	NA	NA	NA
MISA - largemouth bass							
CMP-BSA 6	1	14	0.267	0.267	NC	NC	NC
7	1	15	0.299	0.299	NC	NC	NC
8	1	15	0.144	0.144	NC	NC	NC
All RMA CMP-BSAs	3	44	0.144	0.299	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA
PLAN - plankton							
CMP-BSA 6	0	10	BCRL	BCRL	NA	NA	NA
7	0	10	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	30	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-21 DDT Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
POND - American pondweed							
CMP-BSA 6	0	8	BCRL	BCRL	NA	NA	NA
7	0	8	BCRL	BCRL	NA	NA	NA
8	0	8	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	24	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
POPE - sago pondweed							
CMP-BSA 6	0	6	BCRL	BCRL	NA	NA	NA
7	0	6	BCRL	BCRL	NA	NA	NA
8	0	6	BCRL	BCRL	NA	NA	NA
9	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	22	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-22 DDE Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
AMBY - salamander (FORTUITOUS)							
CMP-BSA 2	0	2	BCRL	BCRL	NA	NA	NA
ANDI - blue-winged teal							
Dressed Carcass							
CMP-BSA 10	2	4	0.105	0.127	0.0603	1.77	2.13
All RMA CMP-BSAs	2	4	0.105	0.127	0.0603	1.77	2.13
Control	0	5	BCRL	BCRL	NA	NA	NA
ANPL - mallard							
Dressed Carcass							
CMP-BSA 10	7	15	0.101	0.408	NC	NC	NC
All RMA CMP-BSAs	7	15	0.101	0.408	NC	NC	NC
Control	6	11	0.0668	0.146	0.0677	1.15	1.46
Liver							
CMP-BSA 10	1	10	0.638	0.638	NC	NC	NC
All RMA CMP-BSAs	1	10	0.638	0.638	NC	NC	NC
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 10	8	25	0.101	0.638	NC	NC	NC
All RMA CMP-BSAs	8	25	0.101	0.638	NC	NC	NC
Control	6	16	0.0668	0.146	NC	NC	NC
CEDE - cocktail							
CMP-BSA 6	0	7	BCRL	BCRL	NA	NA	NA
7	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	13	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
CHVO - killdeer							
CMP-BSA 5	5	5	0.883	7.20	3.31	2.03	2.32
6	3	3	2.56	28.8	7.02	4.88	3.52
8	2	2	0.283	3.70	1.02	27.2	6.16
All RMA CMP-BSAs	10	10	0.283	28.8	3.28	4.61	3.44
Control	5	5	0.169	0.561	0.250	1.28	1.64
ESLU - northern pike							
CMP-BSA 7	2	3	0.118	0.430	0.136	3.23	2.95
8	4	4	0.312	0.602	0.407	1.08	1.32
All RMA CMP-BSAs	6	7	0.118	0.602	0.255	2.16	2.41
Control	0	10	BCRL	BCRL	NA	NA	NA
FUAM - American coot							
CMP-BSA 6	4	5	0.166	0.241	0.146	2.13	2.39
7	2	11	0.209	0.359	NC	NC	NC
9	0	1	BCRL	BCRL	NA	NA	NA
10	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	6	18	0.166	0.359	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-22 DDE Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ICNE and ICME - bullhead							
Whole body							
CMP-BSA 6	1	1	0.425	0.425	0.425	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	11	0.425	0.425	NC	NC	NC
Control	0	9	BCRL	BCRL	NA	NA	NA
Composite							
CMP-BSA 10	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	5	BCRL	BCRL	NA	NA	NA
Control	0	2	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 6	1	1	0.425	0.425	0.425	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
10	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	1	16	0.425	0.425	NC	NC	NC
Control	0	11	BCRL	BCRL	NA	NA	NA
ICPU - channel catfish							
CMP-BSA 6	8	12	0.0661	0.376	0.110	2.62	2.67
All RMA CMP-BSAs	8	12	0.0661	0.376	0.110	2.62	2.67
Control	1	15	0.178	0.178	NC	NC	NC
LEMA - bluegill							
Whole body							
CMP-BSA 6	0	10	BCRL	BCRL	NA	NA	NA
7	0	14	BCRL	BCRL	NA	NA	NA
8	0	15	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	39	BCRL	BCRL	NA	NA	NA
Control	0	14	BCRL	BCRL	NA	NA	NA
Composite							
CMP-BSA 6	0	5	BCRL	BCRL	NA	NA	NA
7	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 6	0	15	BCRL	BCRL	NA	NA	NA
7	0	15	BCRL	BCRL	NA	NA	NA
8	0	15	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	45	BCRL	BCRL	NA	NA	NA
Control	0	14	BCRL	BCRL	NA	NA	NA
MISA - largemouth bass							
CMP-BSA 6	10	14	0.0741	0.247	0.0915	1.51	1.90
7	6	15	0.112	0.164	NC	NC	NC
8	10	15	0.0718	0.613	0.0887	2.11	2.37
All RMA CMP-BSAs	26	44	0.0718	0.613	0.0806	1.73	2.10
Control	0	15	BCRL	BCRL	NA	NA	NA
PLAN - plankton							
CMP-BSA 6	0	10	BCRL	BCRL	NA	NA	NA
7	0	10	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	30	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-22 DDE Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
POND - American pondweed							
CMP-BSA 6	0	8	BCRL	BCRL	NA	NA	NA
7	0	8	BCRL	BCRL	NA	NA	NA
8	0	8	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	24	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
POPE - sago pondweed							
CMP-BSA 6	0	6	BCRL	BCRL	NA	NA	NA
7	0	6	BCRL	BCRL	NA	NA	NA
8	0	6	BCRL	BCRL	NA	NA	NA
9	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	22	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.
**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.
BCRL = Below certified reporting limit. This value varied for different labs and in different years.
NA = Not applicable.
NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-23 Arsenic Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
AMBY - salamander (FORTUITOUS)							
CMP-BSA 2	0	1	BCRL	BCRL	NA	NA	NA
ANDI - blue-winged teal							
Dressed Carcass							
CMP-BSA 10	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	4	BCRL	BCRL	NA	NA	NA
ANPL - mallard							
Dressed Carcass							
CMP-BSA 10	0	9	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	9	BCRL	BCRL	NA	NA	NA
Control	0	12	BCRL	BCRL	NA	NA	NA
Liver							
CMP-BSA 10	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	6	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 10	0	15	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	15	BCRL	BCRL	NA	NA	NA
Control	0	17	BCRL	BCRL	NA	NA	NA
CEDE - eocntail							
CMP-BSA 6	4	6	0.357	0.656	0.294	1.62	2.00
7	0	6	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	4	12	0.357	0.656	NC	NC	NC
Control	5	5	0.521	0.761	0.632	1.02	1.16
CHVO - killdeer							
CMP-BSA 5	0	5	BCRL	BCRL	NA	NA	NA
6	0	3	BCRL	BCRL	NA	NA	NA
8	0	2	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	10	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
ESLU - northern pike							
CMP-BSA 7	0	3	BCRL	BCRL	NA	NA	NA
8	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	7	BCRL	BCRL	NA	NA	NA
Control	1	10	0.407	0.407	NC	NC	NC
FUAM - American coot							
CMP-BSA 6	0	4	BCRL	BCRL	NA	NA	NA
7	0	7	BCRL	BCRL	NA	NA	NA
9	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	12	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-23 Arsenic Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ICNB and ICME - bullhead							
Whole body							
CMP-BSA 6	0	1	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	11	BCRL	BCRL	NA	NA	NA
Control	0	9	BCRL	BCRL	NA	NA	NA
Composite							
CMP-BSA 10	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	5	BCRL	BCRL	NA	NA	NA
Control	0	2	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 6	0	1	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
10	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	16	BCRL	BCRL	NA	NA	NA
Control	0	11	BCRL	BCRL	NA	NA	NA
ICPU - channel catfish							
CMP-BSA 6	0	12	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	12	BCRL	BCRL	NA	NA	NA
Control	1	15	2.42	2.42	NC	NC	NC
LEMA - bluegill							
Whole body							
CMP-BSA 6	0	10	BCRL	BCRL	NA	NA	NA
7	0	10	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	30	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
MISA - largemouth bass							
CMP-BSA 6	0	9	BCRL	BCRL	NA	NA	NA
7	0	10	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	29	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA
PLAN - plankton							
CMP-BSA 6	15	15	0.459	1.33	0.635	1.10	1.36
7	4	15	0.329	0.495	NC	NC	NC
8	7	15	0.371	0.723	NC	NC	NC
10	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	26	50	0.329	1.33	0.274	1.88	2.21
Control	15	15	0.358	1.09	0.577	1.11	1.39

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-23 Arsenic Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
POND - American pondweed							
CMP-BSA 6	3	13	0.356	0.446	NC	NC	NC
7	1	13	0.373	0.373	NC	NC	NC
8	4	8	0.397	0.685	0.257	1.85	2.19
10	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	8	39	0.356	0.685	NC	NC	NC
Control	14	15	0.378	3.40	0.784	1.95	2.26
POPE - sago pondweed							
CMP-BSA 6	4	6	0.326	0.805	0.325	1.88	2.21
7	1	6	0.338	0.338	NC	NC	NC
8	6	6	0.462	2.90	0.861	1.56	1.95
9	4	4	0.283	1.35	0.589	1.84	2.18
All RMA CMP-BSAs	15	22	0.283	2.90	0.381	2.40	2.55
Control	4	9	1.97	4.17	NC	NC	NC

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-24 Mercury Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
AMBY - salamander (FORTUITOUS)							
CMP-BSA 2	2	2	0.0747	0.0758	0.0752	1.00	1.01
ANDI - blue-winged teal							
Dressed Carcass							
CMP-BSA 10	4	4	0.0816	0.338	0.167	1.57	1.96
All RMA CMP-BSAs	4	4	0.0816	0.338	0.167	1.57	1.96
Control	5	5	0.0529	0.216	0.104	1.44	1.83
ANPL - mallard							
Dressed Carcass							
CMP-BSA 10	8	15	0.0558	0.242	0.0498	1.76	2.12
All RMA CMP-BSAs	8	15	0.0558	0.242	0.0498	1.76	2.12
Control	10	12	0.0528	0.143	0.0592	1.30	1.67
Liver							
CMP-BSA 10	9	9	0.0585	0.353	0.158	1.56	1.95
All RMA CMP-BSAs	9	9	0.0585	0.353	0.158	1.56	1.95
Control	4	5	0.101	0.679	0.121	4.22	3.32
All Samples							
CMP-BSA 10	17	24	0.0558	0.353	0.0769	2.28	2.48
All RMA CMP-BSAs	17	24	0.0558	0.353	0.0769	2.28	2.48
Control	14	17	0.0528	0.679	0.0731	1.92	2.24
CEDE - cocktail							
CMP-BSA 6	0	6	BCRL	BCRL	NA	NA	NA
7	0	5	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	11	BCRL	BCRL	NA	NA	NA
Control	0	5	BCRL	BCRL	NA	NA	NA
CHVO - killdeer							
CMP-BSA 5	5	5	0.0518	0.117	0.0818	1.10	1.36
6	3	3	0.0832	0.105	0.0965	1.02	1.14
8	1	2	0.109	0.109	0.0522	2.96	2.83
All RMA CMP-BSAs	9	10	0.0518	0.117	0.0786	1.25	1.60
Control	3	5	0.0639	0.305	0.0702	3.30	2.98
ESLU - northern pike							
CMP-BSA 7	3	3	0.375	0.448	0.413	1.01	1.09
8	4	4	0.200	0.347	0.249	1.07	1.29
All RMA CMP-BSAs	7	7	0.200	0.448	0.309	1.11	1.39
Control	7	10	0.0803	0.186	0.0756	1.92	2.24
FUAM - American coot							
CMP-BSA 6	2	5	0.0571	0.0834	NC	NC	NC
7	3	11	0.0538	0.0596	NC	NC	NC
9	0	1	BCRL	BCRL	NA	NA	NA
10	0	1	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	5	18	0.0538	0.0834	NC	NC	NC
Control	6	15	0.0674	0.180	NC	NC	NC

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-24 Mercury Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
ICNB and ICMB - bullhead							
Whole body							
CMP-BSA 6	1	1	0.264	0.264	0.264	NA	NA
8	7	10	0.0504	0.0863	0.0479	1.32	1.69
All RMA CMP-BSAs	8	11	0.0504	0.264	0.0559	1.67	2.05
Control	0	9	BCRL	BCRL	NA	NA	NA
Composite							
CMP-BSA 10	5	5	0.0787	0.138	0.0999	1.06	1.27
All RMA CMP-BSAs	5	5	0.0787	0.138	0.0999	1.06	1.27
Control	0	2	BCRL	BCRL	NA	NA	NA
All Samples							
CMP-BSA 6	1	1	0.264	0.264	0.264	NA	NA
8	7	10	0.0504	0.0863	0.0479	1.31	1.69
10	5	5	0.0787	0.138	0.0999	1.06	1.27
All RMA CMP-BSAs	13	16	0.0504	0.264	0.0670	1.54	1.93
Control	0	11	BCRL	BCRL	NA	NA	NA
ICPU - channel catfish							
CMP-BSA 6	8	12	0.0465	0.0938	0.0453	1.31	1.68
All RMA CMP-BSAs	8	12	0.0465	0.0938	0.0453	1.31	1.68
Control	9	15	0.0583	0.430	0.0660	2.66	2.69
LEMA - bluegill							
Whole body							
CMP-BSA 6	10	10	0.0572	0.138	0.0825	1.08	1.31
7	9	14	0.0610	0.202	0.0563	1.70	2.07
8	14	15	0.0603	0.205	0.0987	1.35	1.73
All RMA CMP-BSAs	33	39	0.0572	0.205	0.0771	1.45	1.84
Control	12	14	0.0529	0.275	0.0925	1.81	2.16
Composite							
CMP-BSA 6	5	5	0.0534	0.119	0.0922	1.11	1.39
7	1	1	0.189	0.189	0.189	NA	NA
All RMA CMP-BSAs	6	6	0.0534	0.189	0.104	1.19	1.51
All Samples							
CMP-BSA 6	15	15	0.0534	0.138	0.0856	1.08	1.33
7	10	15	0.0610	0.202	0.0610	1.81	2.16
8	14	15	0.0603	0.205	0.0987	1.35	1.73
All RMA CMP-BSAs	39	45	0.0534	0.205	0.0802	1.42	1.81
Control	12	14	0.0529	0.275	0.0925	1.81	2.16
MISA - largemouth bass							
CMP-BSA 6	14	14	0.0917	0.303	0.227	1.11	1.37
7	15	15	0.0615	0.610	0.248	1.57	1.96
8	14	15	0.0599	0.626	0.128	1.89	2.22
All RMA CMP-BSAs	43	44	0.0599	0.626	0.192	1.61	1.99
Control	12	15	0.0529	0.198	0.0757	1.52	1.91
PLAN - plankton							
CMP-BSA 6	0	10	BCRL	BCRL	NA	NA	NA
7	0	10	BCRL	BCRL	NA	NA	NA
8	0	10	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	30	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

Table 5.1-24 Mercury Statistical Results for Aquatic Species Sampled for CMP, 1988 to 1990*

	Total # of Hits	Total # of Samples	Minimum Detected Conc (µg/g)	Maximum Detected Conc (µg/g)	USFWS Geometric Mean**	USFWS Geometric Variance**	USFWS Geometric Std Dev**
POND - American pondweed							
CMP-BSA 6	0	13	BCRL	BCRL	NA	NA	NA
7	0	13	BCRL	BCRL	NA	NA	NA
8	1	8	0.0514	0.0514	NC	NC	NC
10	1	5	0.0543	0.0543	NC	NC	NC
All RMA CMP-BSAs	2	39	0.0514	0.0543	NC	NC	NC
Control	0	15	BCRL	BCRL	NA	NA	NA
POPE - sago pondweed							
CMP-BSA 6	0	6	BCRL	BCRL	NA	NA	NA
7	0	6	BCRL	BCRL	NA	NA	NA
8	0	6	BCRL	BCRL	NA	NA	NA
9	0	4	BCRL	BCRL	NA	NA	NA
All RMA CMP-BSAs	0	22	BCRL	BCRL	NA	NA	NA
Control	0	10	BCRL	BCRL	NA	NA	NA

*This table incorporates all available data for all samples (intentional and fortuitous) analyzed under the Biota CMP.

**The USFWS geometric mean includes nonhits and assigns them a value equal to one-half of the lower CRL; descriptive statistics are calculated only when 50% or more of the samples are hits.

BCRL = Below certified reporting limit. This value varied for different labs and in different years.

NA = Not applicable.

NC = Number of detections was less than 50% of the sample size and a mean was not calculated.

TABLE 4-2

RELATIVE ABUNDANCE OF SMALL MAMMALS AT RMA, FALL 1986[1]

Species	Tall Weedy Forbs	Short Weedy Forbs	Cheatgrass	Crested Wheatgrass	Native Grass	[2]Shrubs/ Yucca	Cottonwoods
Deer Mouse	31.9	15.6	8.3	2.5	0.3	13.9	1.1
Plains Harvest Mouse	2.2	--	--	--	--	--	1.1
Western Harvest Mouse	--	--	--	--	--	2.2	--
Northern Grasshopper Mouse	--	--	--	--	0.6	3.3	--
Meadow Vole	--	--	--	--	--	--	7.8
Prairie Vole	0.3	--	0.3	0.3	0.3	--	--
Ord's Kangaroo Rat	--	--	--	--	--	1.1	--
Total	34.4	15.6	8.6	2.8	1.2	20.5	10.0
Locations[3]	2,12	17	1,6,13,15	3,5,11,14	4,10	18,19	16

1 Relative abundance = number caught per 100 trap-nights.
2 Shrubs include sand sagebrush and rubber rabbitbrush.
3 Locations shown on Figure 3-8.

TABLE 4-3

RELATIVE ABUNDANCE OF SMALL MAMMALS AT RMA, SPRING 1987[1]

Species	Weedy Forbs	[2]Shrubs/ Yucca	[3]Thickets	Cattails/ Rushes	Streamside Meadows	Cottonwoods
Deer Mouse	30.0	9.8	2.7	2.6	1.0	1.0
Western Harvest Mouse	--	2.2	2.2	3.1	1.5	--
Meadow Vole	--	0.4	--	11.7	1.0	--
Prairie Vole	--	1.6	2.2	5.7	--	--
Silky Pocket Mouse	--	0.2	--	--	--	--
Hispid Pocket Mouse	--	0.8	--	--	--	--
Ord's Kangaroo Rat	--	2.5	--	--	--	--
Total	30.0	17.5	7.1	23.1	3.5	1.0
Locations[4]	27	23,24,28	22,25	20,21	26	29

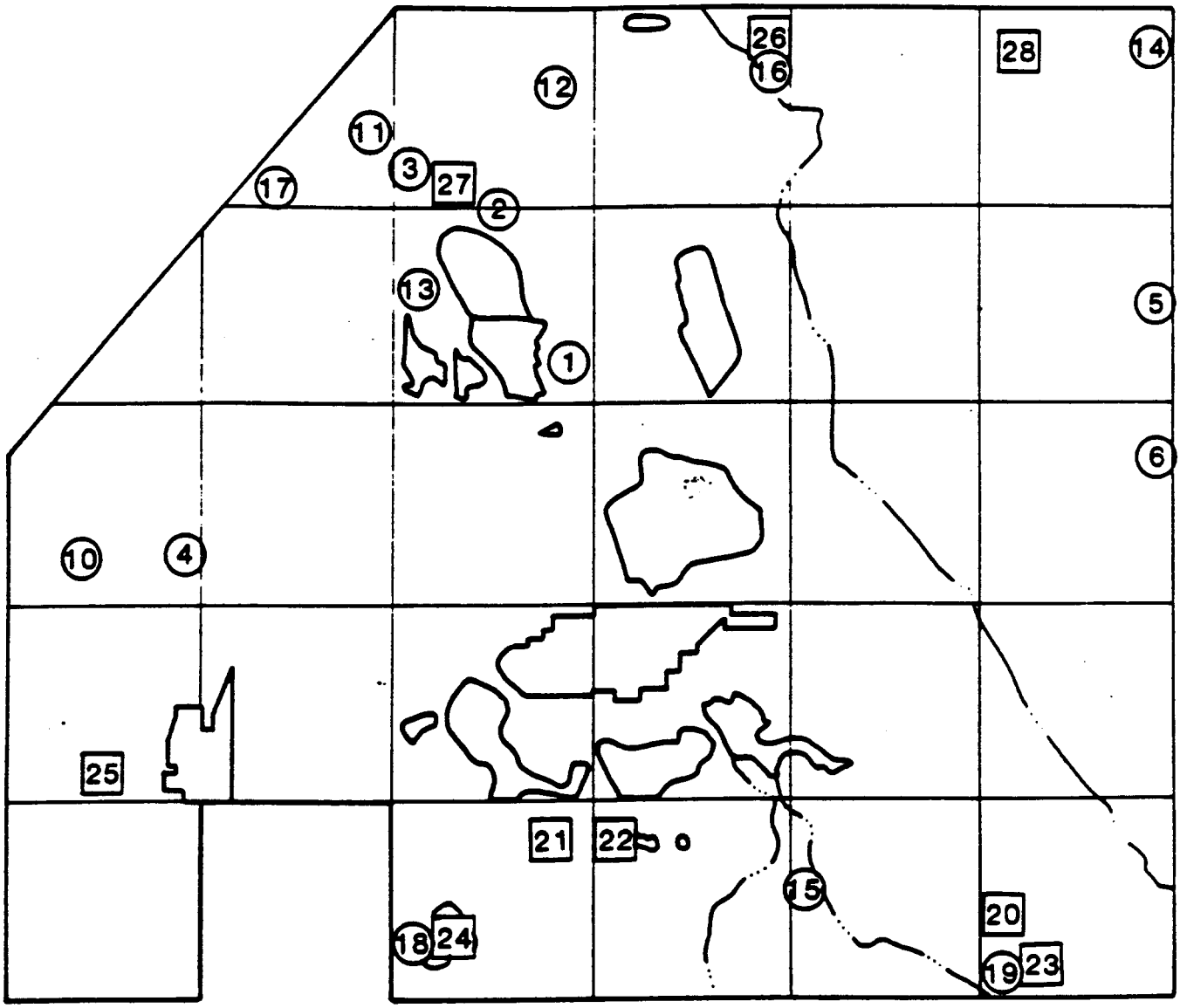
1 Relative abundance = number caught per 100 trap-nights.
2 Shrubs include sand sagebrush and rubber rabbitbrush.
3 Thickets include New Mexico locust and American plum.
4 Locations shown on Figure 3-8.

Table 5. Raptors observed along the Arsenal road survey during the winter period and the entire survey period of 1991-92.

	1991-92 (Oct-Mar)				1991-92 (Aug-May)			
Species	N	AVG	%	RANGE	N	AVG	%	RANGE
Red-tailed hawk	96	(5.1)	24.2	(1-17)	154	(4.8)	23.5	(0-17)
Rough-legged hawk	68	(3.6)	17.1	(0-9)	68	(3.6)	10.4	(0-9)
Ferruginous hawk	119	(6.3)	30.0	(0-16)	126	(3.9)	19.2	(0-16)
Bald eagle	53	(2.8)	13.4	(0-7)	53	(2.8)	8.1	(0-7)
Golden eagle	14	(0.7)	3.5	(0-2)	14	(0.7)	2.4	(0-2)
American kestrel	24	(1.3)	6.0	(0-13)	93	(2.9)	14.2	(0-13)
Unknown buteo	11	(0.6)	2.8	(0-2)	16	(0.5)	2.4	(0-2)
Northern harrier	5	(0.3)	1.3	(0-2)	5	(0.3)	0.7	(0-2)
Merlin	3	(0.2)	0.8	(0-1)	3	(0.2)	0.5	(0-1)
Prairie falcon	4	(0.2)	1.0	(0-1)	4	(0.2)	0.6	(0-1)
Swainson's hawk	--	(----)	----	----	22	(0.7)	3.4	(0-5)
Burrowing owl	--	(----)	----	----	90	(2.8)	13.7	(0-17)
Total raptors	397	(20.9)	----	(15-32)	648	(20.3)	----	(9-32)

N = number observed
AVG = average
% = percent of total

Pg 32-34 from MKE 1989



LEGEND

(2) 1986 sampling location

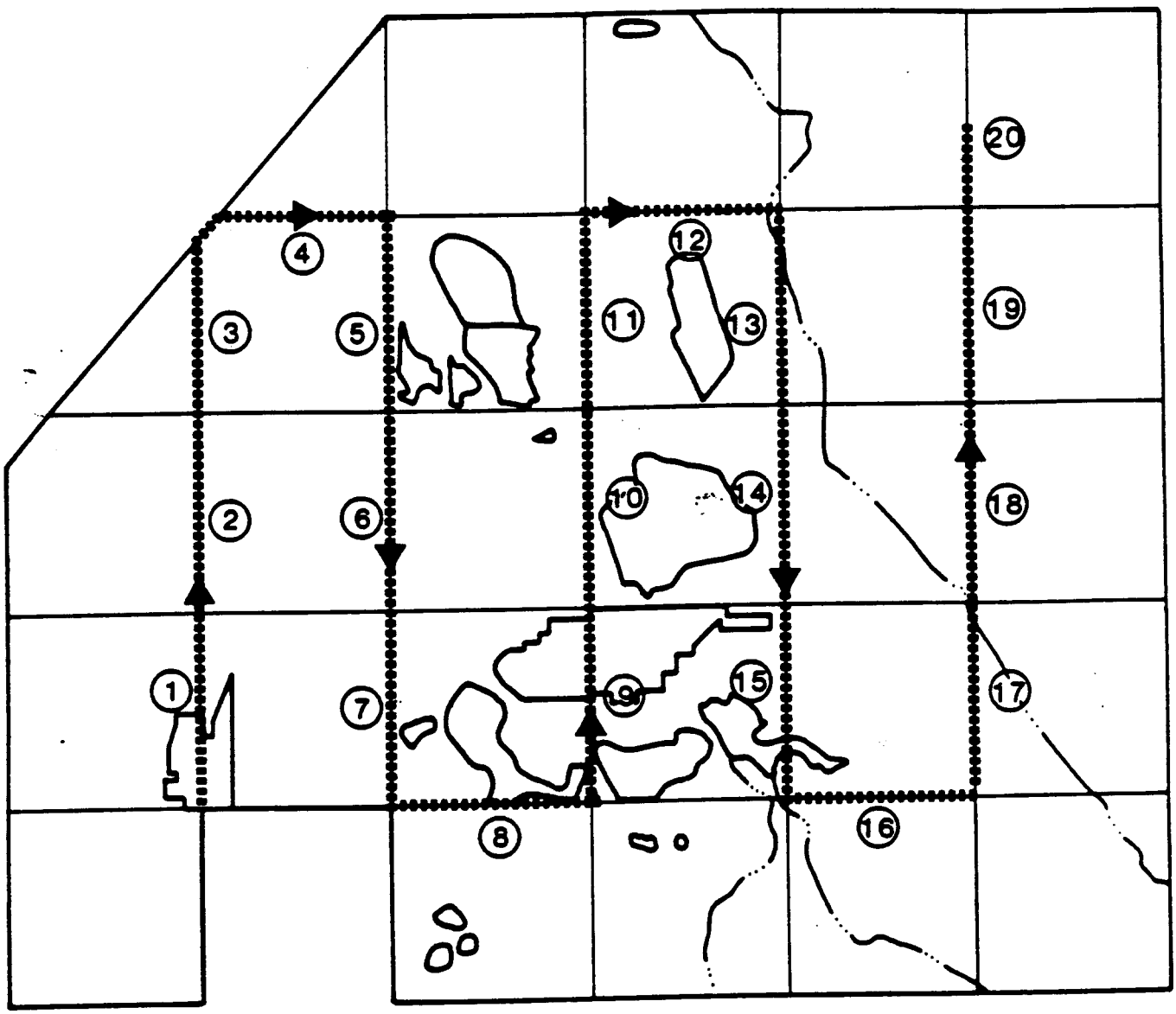
[20] 1987 sampling location

Rocky Mountain Arsenal

Figure 3-6.

Small Mammal Trapping Locations

MORRISON-KNUDSEN ENGINEERS, INC.



Note: Circled numbers represent listening stations.

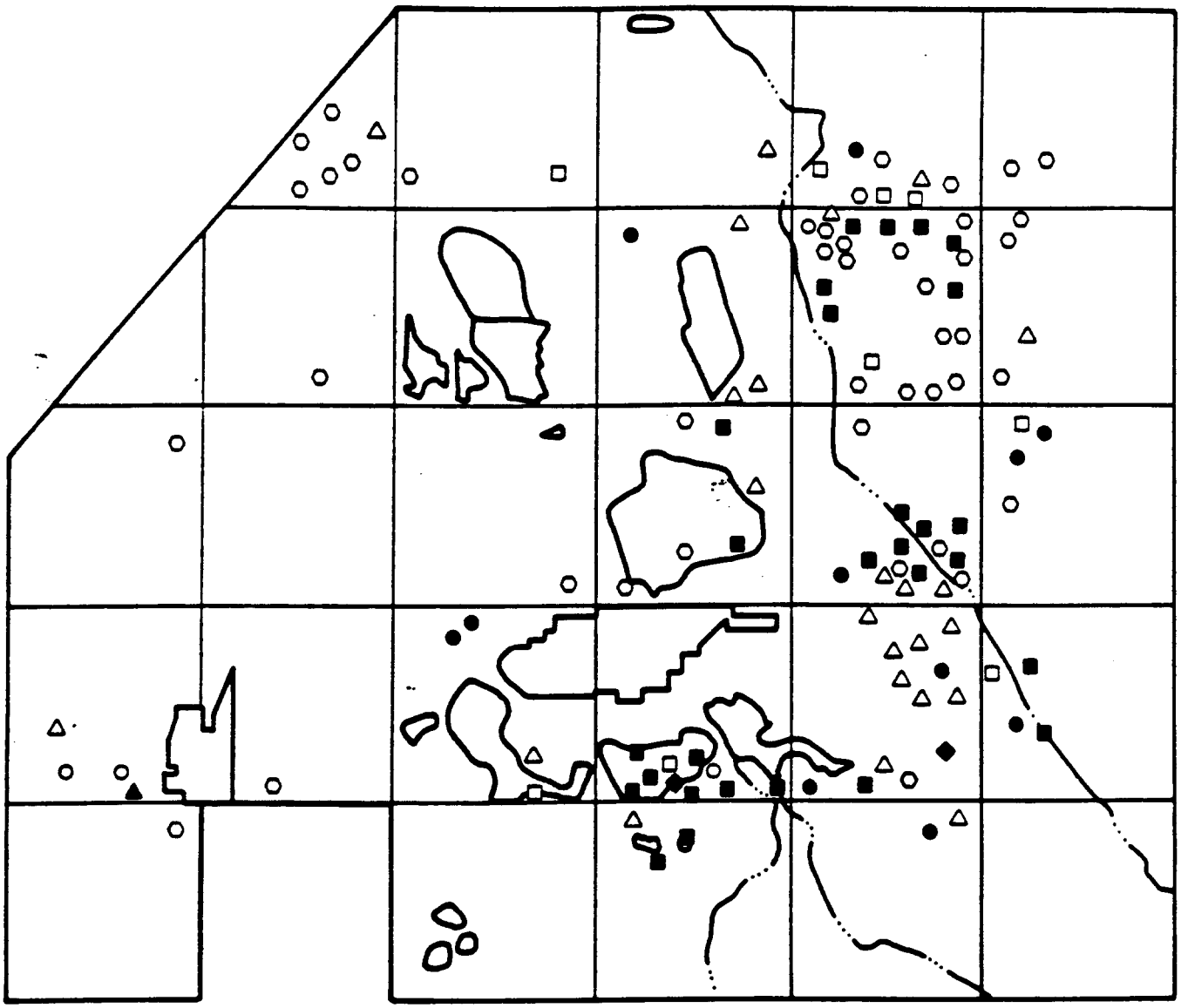
Rocky Mountain Arsenal

Figure 3-12.

Pheasant and Dove Survey Route

MORRISON-KNUDSEN ENGINEERS, INC.

Pg 37 From MKE-1989



Note: Symbols represent sightings from seven counts.

LEGEND

- □ Northern harrier
- ○ Red-tailed hawk
- ○ Ferruginous hawk
- △ Rough-legged hawk
- ■ Bald eagle
- ● Golden eagle
- ● Prairie falcon
- ▲ Great horned owl

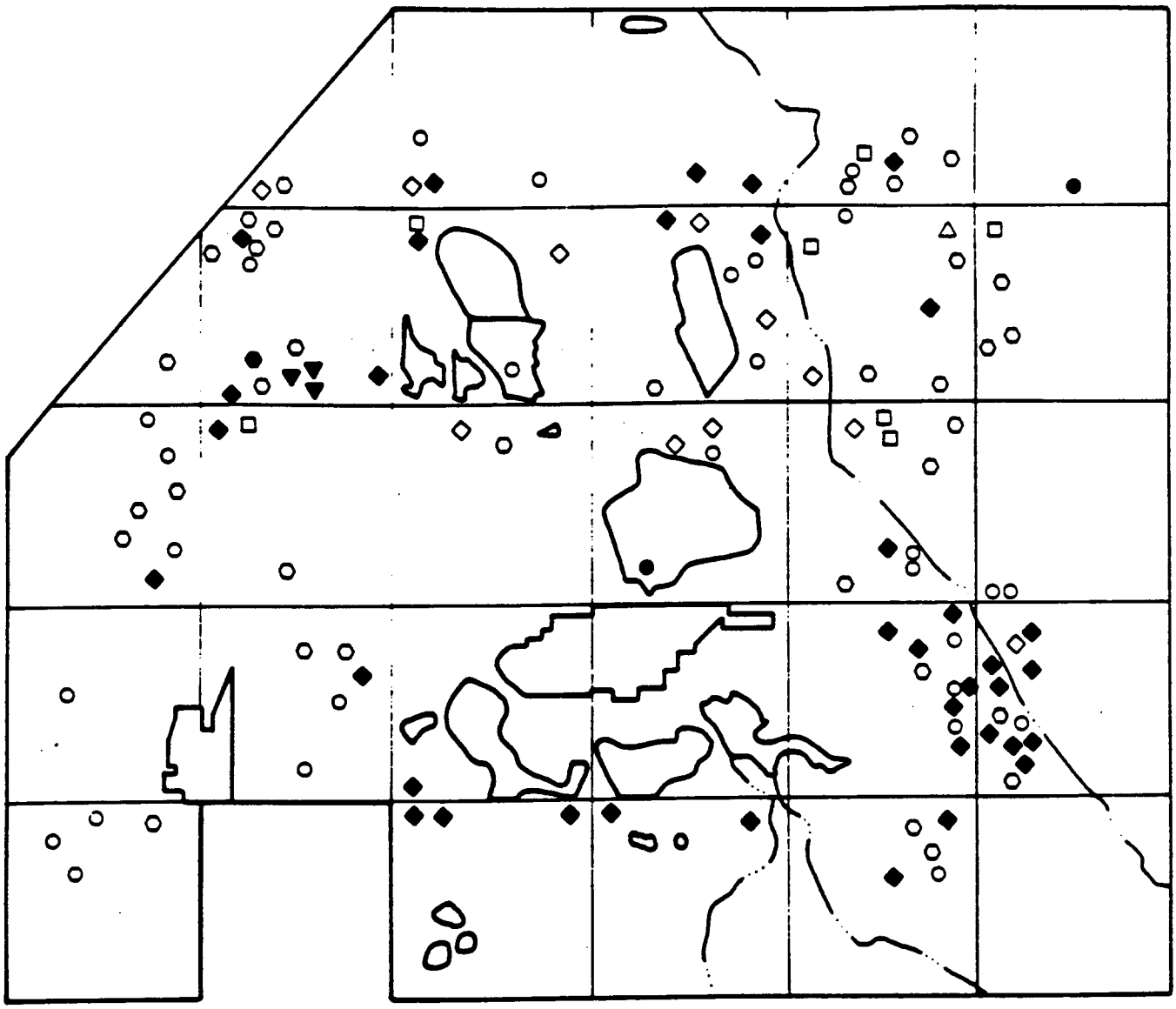
Rocky Mountain Arsenal

Figure 4-14.

Raptor Roadside Counts,
Winter 1985-86

MORRISON-KNUDSEN ENGINEERS, INC.

Pg 32-34 from MKE-1989



Note: Symbols represent sightings from six counts.

LEGEND

- □ Northern harrier
- ○ Red-tailed hawk
- ◇ Swainson's hawk
- ○ Ferruginous hawk
- ● Golden eagle
- ◆ American kestrel
- ● Prairie falcon
- ▼ Burrowing owl

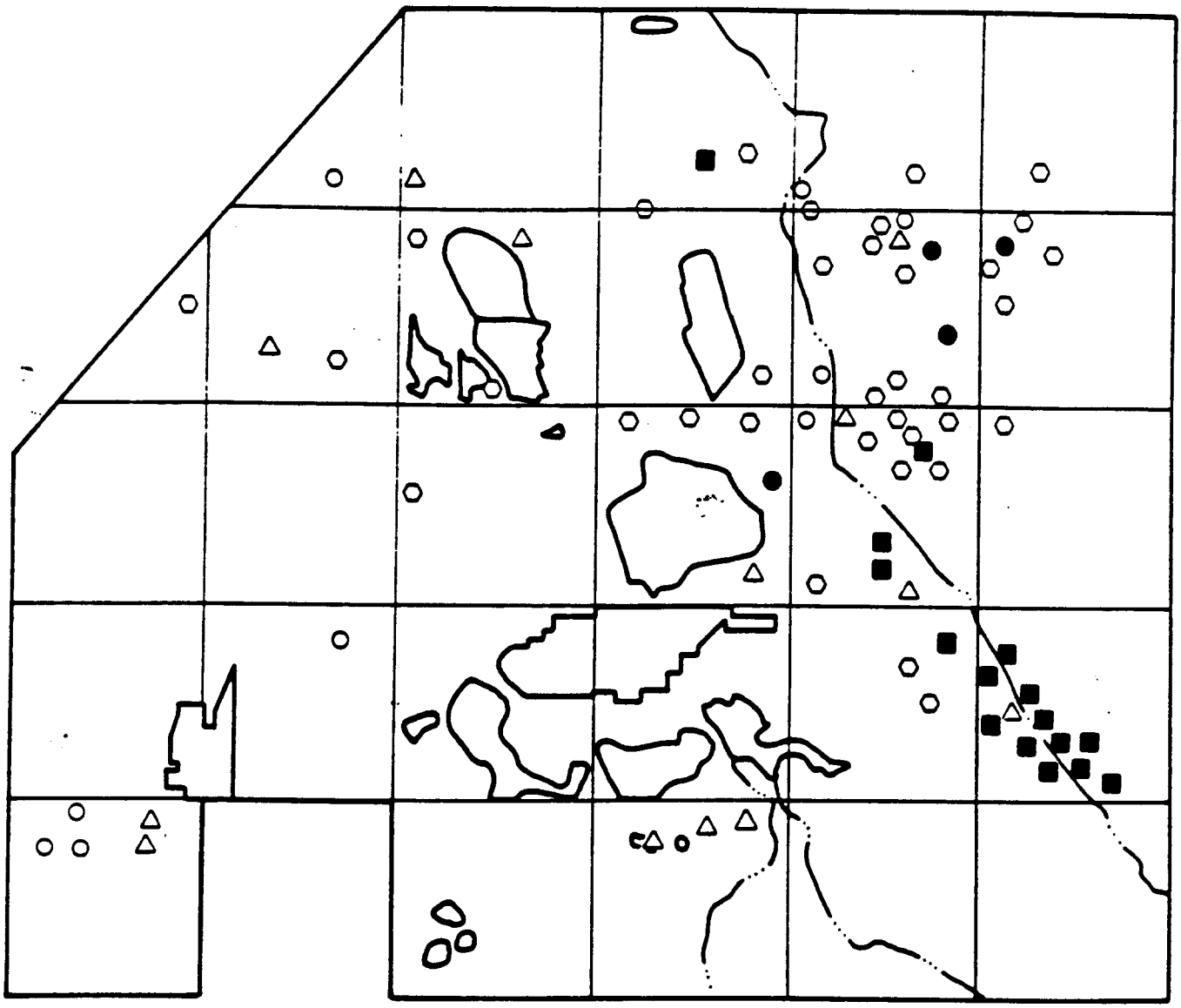
Rocky Mountain Arsenal

Figure 4-15.

Raptor Roadside Counts,
Spring 1986

MORRISON-KNUDSEN ENGINEERS, INC

Pg 32-34 from MKE-1989



Note: Symbols represent sightings from three counts.

LEGEND

- ○ Red-tailed hawk
- ○ Ferruginous hawk
- △ Rough-legged hawk
- ■ Bald eagle
- ● Golden eagle
- ● Prairie falcon

Rocky Mountain Arsenal

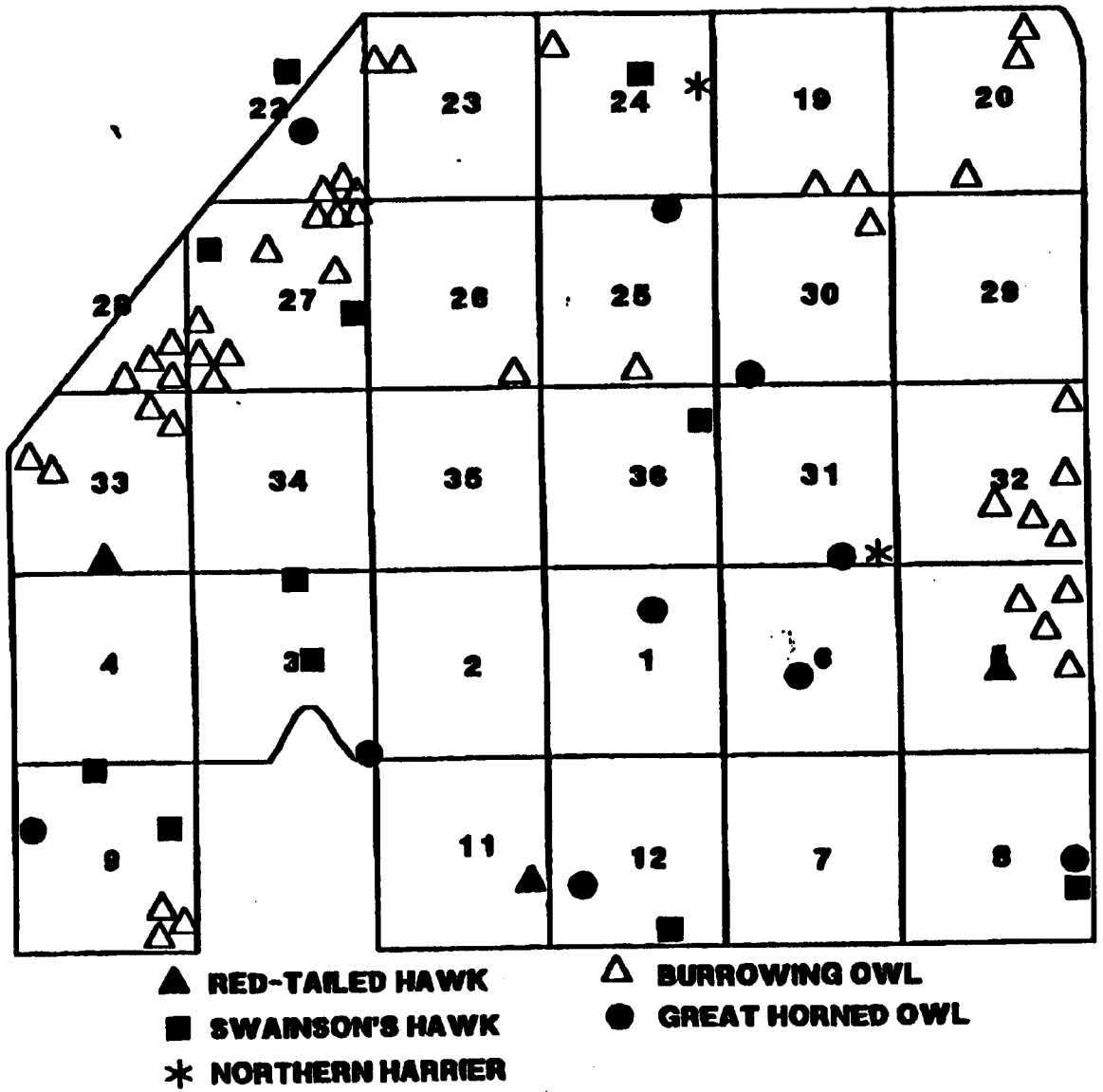
Figure 4-16.

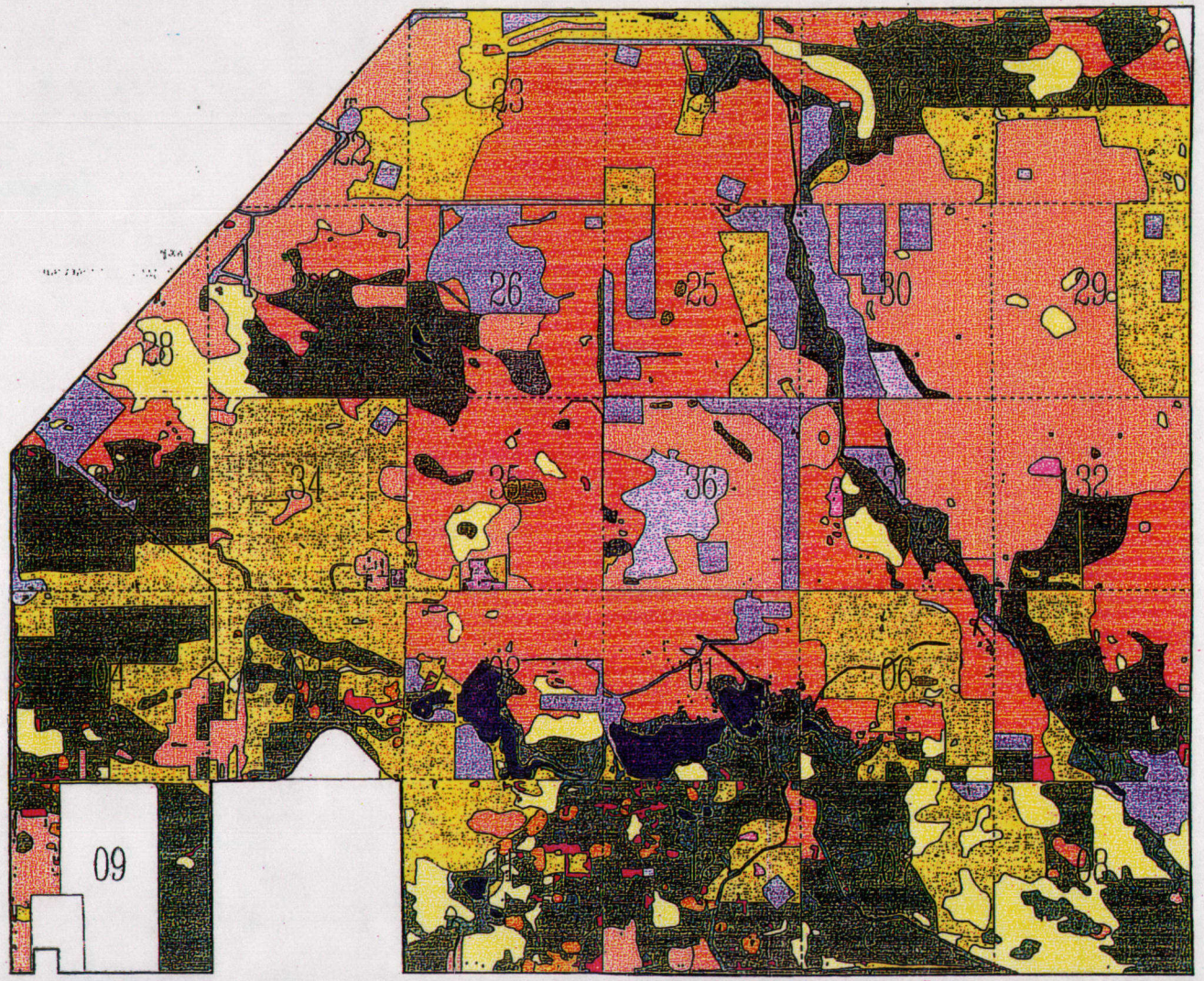
Raptor Roadside Counts,
Winter 1986-87

MORRISON-KNUDSEN ENGINEERS, INC.

Pg 32-34 from MKE - 1989

Breeding pairs of raptors monitored during 1993.





ROCKY MOUNTAIN ARSENAL VEGETATION CLASSIFICATION

LEGEND

- Weedy forbs
- Cheatgrass/weedy forbs
- Native perennial grassland
- Crested wheatgrass stand
- Shrubland/succulents
- Locust thicket
- Wetland
- Tree grove
- Lawn
- Seeded area
- Cereal rye
- Cobble soil vegetation
- Alfalfa/sweetclover
- Water
- Bare ground
- Research area
- Unclassified

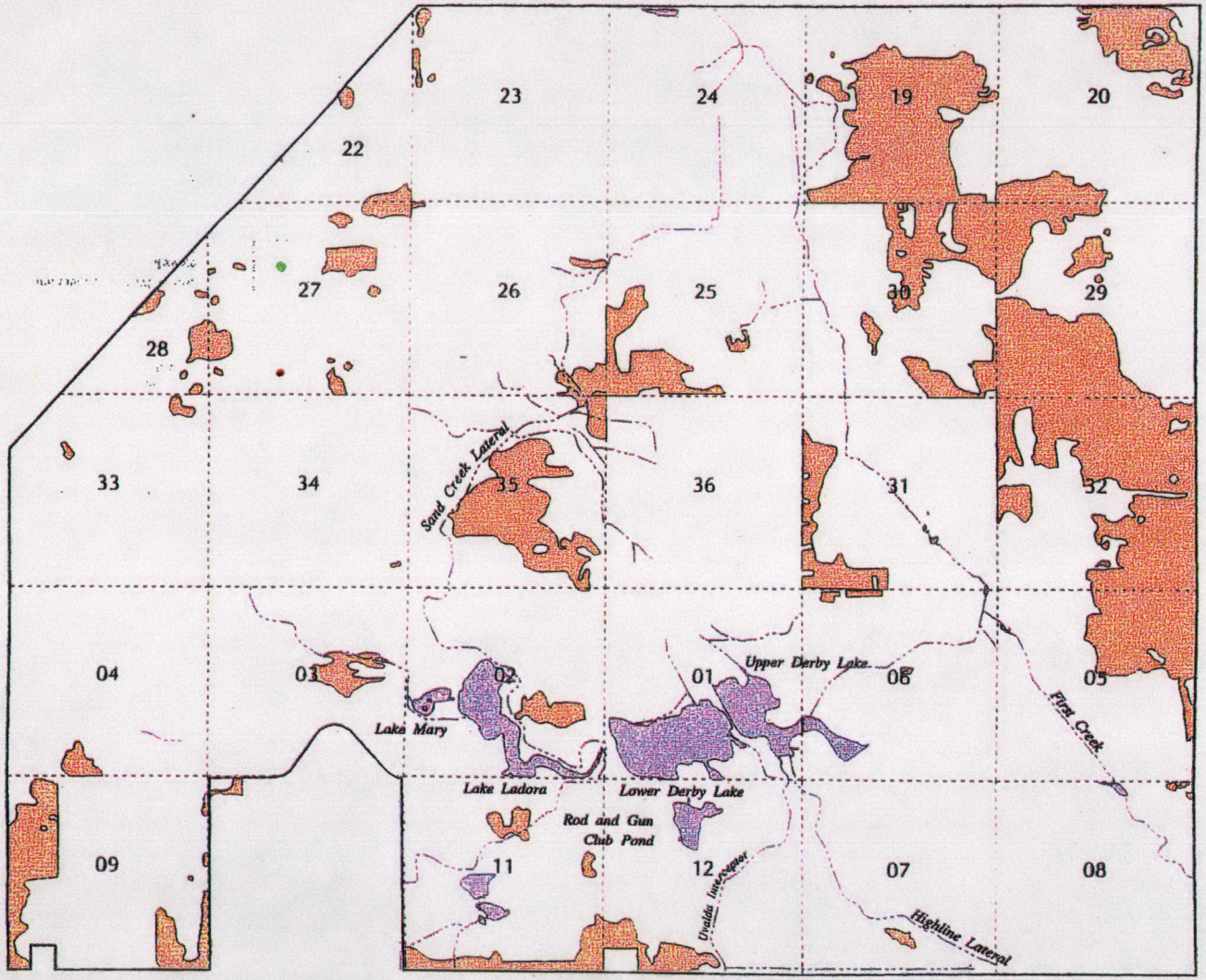
MORRISON KNUDSEN CORPORATION
Environmental Services Division

N

SCALE 1 : 38,000

1 .5 0 MILE

December 1992



ROCKY MOUNTAIN ARSENAL PRAIRIE DOG TOWNS July 1993

LEGEND

Hydrography

- Stream
- Water

Boundaries

- RMA Boundary
- Section Line

- Prairie Dog Town

MORRISON KNUDSEN CORPORATION
Environmental Services Division

-N-

SCALE 1 : 36,000

1 .5 0 MILE

August 11, 1993

ATTACHMENT C.5-3

INFORMATION ON FORTUITOUS SAMPLES COLLECTED BY THE U.S. FISH AND WILDLIFE SERVICE BETWEEN 1990 AND 1993

This attachment contains information on fortuitous samples collected by the U.S. Fish and Wildlife Service between 1990 and 1993. Three types of information are included: (1) a list of biota samples that have been submitted for chemical analysis but for which analytical data have not been received; (2) a list of biota samples for which chemical analyses have been completed, together with their analytical results; and (3) a tabular summary of necropsy results for biota samples that have been thus examined.

It should be noted that fortuitous samples by definition represent specimens of sick or dead individuals. As in all prior biota sampling programs on RMA, professional judgement was used in selecting sick or dead organisms to be evaluated. For example, top carnivore mammals and birds (including primarily raptors) were always collected unless there was some contraindication such as extreme decay. Road killed prairie dogs were not collected, because their cause of death was obvious and because numerous samples have already been analyzed under the Biota RI and Biota CMP.

It should also be noted that the samples that were analyzed do not necessarily reflect only exposure to RMA contaminants or situations. Carnivores, especially the raptors, range widely for food. Except for the great horned owl, the raptors on RMA also migrate to other locales in some seasons, spending only the winter or summer on RMA or simply passing through during migration. Therefore, although the following data on fortuitous samples (and that elsewhere in the IEA/RC) provides information pertinent to the status and health of biota on RMA, it may also reflect exposure to areas outside RMA and can only be used in a qualitative sense.

Table C.5-3.1 U.S. Fish and Wildlife Service, Rocky Mountain Arsenal National Wildlife Area, Sample Log (Purchase Order #DAAA05-94-A-0001)

Sample #	Species	Tissue	Location	Date Collected
11088-001	Barn Owl	Brain	North Plants	10/14/92
11088-002	Barn Owl	Brain	North Plants	10/14/92
923-05002	Badger	Liver	7th by fire st.	9/22*
923-05002	Badger	Brain	7th by fire st.	9/92
11298-001	Great Horned Owl	Liver	South Plants	7/30/92
11298-001	Great Horned Owl	Brain	South Plants	7/30/92
10943-001	Great Horned Owl	Brain	South Plants	7/30/92
11410-001	Bald Eagle	Liver	From Buckley	2/27/93
11410-001	Bald Eagle	Brain	From Buckley	2/27/93
AR-19	American Robin	Whole Body	Bldg. 111	6/17/93
HF-21	House Finch	Whole Body	Bldg. 111	6/14/93
HF-24	House Finch	Whole Body	Bldg. 111	6/17/93
02	Sharp-shinned Hawk	Whole Body	Bldg. 111	4/27/93
03	Western Kingbird	Whole Body	Bldg. 111	6/7/93
04	American Robin	Whole Body	Bldg. 111	6/22/93
05	American Robin	Whole Body	Bldg. 111	6/20/93
09	House Finch	Whole Body	Bldg. 111	6/14/93

* These samples constitute a reanalysis of this badger specimen to verify earlier analytical results on this specimen were not subject to adequate QA/QC.

Note: An additional 285 samples were submitted to a laboratry for residue analysis but the data reported from these samples may have been improperly reported and are under investigation; no samples aliquots were retained that could be subjected to verifying analyses.

Table C.5-3.2 Analytical Data Received on Fortuitous Samples Collected and Submitted for Analysis by U.S. Fish and Wildlife Service

Species Analyzed	Analytical Results	Comments
Badger 923-5002	Liver: 13 ppm dieldrin Subcutaneous fat: 75 ppm dieldrin	Analyzed by University of California Veterinary Diagnostic Laboratory; methods used differ from the USATHAMA protocols, particularly regarding quality control procedures

Table C.5-3.3 Synopsis of Necropsy Data on Fortuitous Samples Collected and Submitted for Fish and Wildlife Service

Species Necropsied	Comments	Diagnosis
Swainson's Hawk Specimen 10802-001	(10802-001) Little fat; unremarkable observations on bacteria, viruses, brain cholinesterase, liver lead, and histopathology	(10802-001) Cause of death undetermined
Starling Specimen 2336	(2336) Unremarkable cholinesterase observations	(2336) None
Great Horned Owl Specimen 10943	(10943) No obvious subcutaneous, pericardial, or peritoneal fat; emaciated from no apparent cause; unremarkable observations on liver lead, bacteria, viruses, cholinesterase, and histopathology; minor inflammation of heart tissues; talons of both feet tightly clenched	(10943) Emaciation
Specimen 11298	(11298) Talons tightly clenched; abundant subcutaneous, pericardial and peritoneal fat; found under power line with burn mark on wing; scant intestinal contents; severe fungal dermatitis; observations unremarkable of organ histopathology, cholinesterase	(11298) Electrocution, severe fungal dermatitis

Table C.5-3.3 Synopsis of Necropsy Data on Fortuitous Samples Collected and Submitted for Fish and Wildlife Service

Species Necropsied	Comments	Diagnosis
Badger Specimen 923-5002	(923-5002) Alive when collected; fair to poor body condition; hind limb paralysis; generally unremarkable histopathology, cholinesterase, and parasite infestations; no apparent cause of paralysis from examination of spinal column or evidence of tick paralysis	(923-5002) Cause of paralysis undetermined by necropsy; results of chemical analysis of liver, kidney, brain, and subcutaneous fat for organophosphates and organochlorines reported in Table C.5-2.2
Barn Owl Specimen 11088-001	(11088-001) No subcutaneous, pericardial, or peritoneal fat; cause of severe emaciation not evident; unremarkable observations regarding cholinesterase levels, bacteria, viruses, infectious disease, and organ histopathology; marked autolysis of specimen	(11088-001) Emaciation
Specimen 11088-002	(11088-002) Alive when collected, but died shortly; observations generally same as for 11088-001	(11088-002) Emaciation

ATTACHMENT C.5-4

EPA'S POSITION ON HEALTH AND DIVERSITY

EPA'S POSITION

APPENDIX C.5, ECOLOGICAL STATUS AND HEALTH OF BIOTA POPULATIONS AT ROCKY MOUNTAIN ARSENAL

EPA invoked dispute on this issue on September 20, 1993. A series of intensive technical meetings failed to achieve a text on which the parties of RMA (Army, Shell, USFWS, EPA, and State of Colorado) could reach consensus. Therefore, the RMA Council resolved that, in order to finalize the IEA/RC, the parties' dissenting opinions would be presented in this document. This submittal is EPA's opinion.

Throughout the main text of the IEA/RC, numerous references are made to "ecological measurement endpoint" studies which are said to indicate that "the overall ecosystems and animal communities have retained their integrity and most wildlife populations appear healthy." It is further stated that "the available data on ecological measurement endpoints do not reveal adverse effects of chemical contamination on trophic diversity at RMA." Similar statements are also made regarding adverse effects of chemical contamination on other "ecological measurement endpoints" such as reproductive success, abundance, survivability, structural diversity of the ecosystem, population robustness, morbidity, species richness, and other endpoints.

While all of these characteristics may be valid, **the extent to which biological studies at RMA were designed to measure these characteristics as measurement or assessment endpoints relative to exposure to a stressor was very limited.** Regarding exposure analysis, EPA's Framework for Ecological Risk Assessment (EPA/630/R-92/001, February, 1992) states at Section 3.1.3 "The next step is to combine the spatial and temporal distributions of both the ecological component and the stressor to evaluate exposure." and "The most common approach to exposure analysis is to measure concentrations or amounts of a stressor and combine them with assumptions about co-occurrence, contact, or uptake." It is also stated (Section 3.2.1), "Controlled ... field tests ... can provide strong causal evidence linking a stressor with a response and can also help discriminate between multiple stressors."

Although the ecological assessment endpoint studies summarized in Appendix C.5 did provide some ecological measurements for selected locations at RMA, **they did not measure endpoints relative to exposure to a stressor.** They were not controlled field tests designed to provide evidence as to whether or not there was a link between stressors (contaminant concentrations in soil) and responses (endpoints such as those described above). In addition,

o Very few of the studies referenced in Appendix C.5 were conceived or designed as part of the ecological risk assessment (ERA) for RMA,

o Very few, if any, of the studies were quantitatively or spatially linked to stressors, i.e., contaminant concentrations, and

o Although some studies claimed to compare "contaminated" versus "uncontaminated" areas, no measurements of soil contamination were part of these studies and very few, if any, of the studies drew any conclusions regarding the potential ecological impacts of soil contamination at specific locations.

o Most of the studies were conducted mainly in the less contaminated areas of RMA, with few or no observations in the more contaminated areas.

The studies summarized in Appendix C.5 are appropriate to discuss in Section 5.2 (Uncertainties Associated with the Ecological Risk Characterization) and in Appendix E, but reference to these studies should be deleted from the rest of the main text because **they did not measure endpoints relative to exposure to stressors and, therefore, are not directly comparable to the quantitative results of the ERC. These studies should also not be interpreted as a "reality check" on the results of the ERC.**

EPA has reviewed Appendix C.5, as presented by the Army in the March 3, 1994 version of the IEA/RC,and also key studies cited by the Army in Appendix C.5. The results of this review are presented as EPA's opinion regarding the Ecological Status and Health of RMA biota (Attachment 3). In general, each of the studies reviewed had several aspects in common:

o The precise location of biota tissue sample collections or ecological outcomes was not identified or co-located relative to specific locations of soil contamination.

o A few of the studies compared observations at locations within or near the core contaminated areas with peripheral locations, assuming, without verification, that the former were highly contaminated, but the latter were not. This is an unwarranted assumption due to the heterogeneity of soil contamination at RMA.

o With one exception (songbirds), very few observations were made in the core-contaminated areas.

The results of these studies appear to support general conclusions regarding the status of wildlife species on RMA as a whole, but do not provide information regarding the actual

status, health or ecological effects on biota at specific locations relative to soil contamination. As a result, most of the studies cited actually have high potential for bias and low power; many also have low relevance as explained below. EPA's overall conclusion concerning Appendix C.5, Ecological Status and Health, is that, generally, the field studies were not adequately designed to assess the potential effects of contaminants on RMA biota at the individual, population, or community level. Hence, they are of little or no value in testing hypotheses about the potential ecological effects of soil contaminants at RMA. Some animals collected at RMA have tissue levels of contaminants that exceed the MATC, and at least a few appear to have been lethally poisoned. Several species do occur and even breed successfully close to core contaminated areas. Except for a few American kestrels, however, the actual exposure of these animals has not been characterized. Hence, the available information on RMA biota neither confirms nor refutes the predictions of the ERC. Implications otherwise are misleading.

EPA believes that the text of the following sections should be modified as follows:

C.5.4.4.1 Status and Diversity

The status and diversity of the biota at RMA are reasonably well characterized as a result of extensive studies conducted in recent years. RMA is situated within a temperate grassland region and is part of a broad transition zone between montane and plains habitats. Native vegetation of the region consists primarily of open semiarid grasslands, with some areas of yucca, shrubland, woodland, and riparian habitats. The terrestrial vegetation has been modified by past agricultural activities and more recent industrial activities, including localized effects of contamination, remediation, and vegetation management (Sections C.5.2.1, and C.5.3.2.4). Probably as a result of these activities, the terrestrial vegetation is somewhat impoverished (lower structural complexity) compared to that at selected offsite control areas (MKE 1989a). RMA also includes four manmade lakes which are subject to management for angling. Three of these lakes were heavily contaminated in the past and were drained for sediment removal in 1964-65 (Section 5.2.2.4).

RMA supports a wide variety of animal species, including 26 species of mammals, 176 species of birds, 17 species of reptiles and amphibians, and a number of fish species (Section C.5.2.2). RMA has noteworthy populations of several species, including mule deer, white-tailed deer, black-tailed prairie dogs, burrowing owls, and wintering raptors, including a significant winter roost of bald eagles. These and other species (e.g., American badger, coyote, ring-necked pheasant) appear to benefit from the restrictions on human access, lack of hunting, and management activities at RMA, whereas predatory fish (largemouth bass, pike)

benefit from active management for sport fishing (catch and release).

Population sizes (total numbers of individuals within RMA boundaries) have been determined or estimated for a number of species, including mule deer, white-tailed deer, black-tailed prairie dog, great horned owl, burrowing owl, American kestrel, and other breeding raptors. The winter roost of bald eagles is counted on a weekly basis. Information on population density or other indices of population (e.g., trapping frequency, transect counts) is available for other species, including terrestrial invertebrates (grasshoppers, earthworms) and aquatic organisms. Reproductive success has been measured for mule deer, great horned owls, burrowing owls, mallards, and American kestrels, and indices of reproductive success are available for several other species. However, population dynamics have not been studied and there is no information on survival, dispersal, immigration, or emigration. In addition, ecosystem-level studies (e.g., trophic diversity, nutrient cycling, or primary productivity) have not been conducted on RMA. Although the diets of several predatory species have been reported, there is no systemic information on the structure or complexity of food webs. Such a study would include a quantitative evaluation of the diet in prey consumed by the predator species.

The available information on the biota of RMA is useful in characterizing the resources at risk, specifically in documenting which species occur in or near the more contaminated parts of RMA. In particular, there is useful information on the status, numbers, and distribution of some species that are likely to be most highly exposed to bioaccumulative contaminants (e.g., burrowing mammals, predatory fish, and predatory birds). However, little information is available to date on predatory mammals.

C.5.4.4.2 Ecological Health

Except for a study of deer (Section C.5.3.2.1), no studies of the health of individual animals have been conducted at RMA. USFWS has necropsied many birds but analysts did not speculate on the cause of death. The data on these birds (see Table C.51), however, includes conditions such as lack of fat and no food in the gut, as well as behavioral signs in some individuals, that are consistent with pesticide poisoning.

Major incidents of wildlife mortality attributable to poisoning have been reported at RMA in the past, particularly in the 1950s. These incidents primarily involved waterfowl and other aquatic organisms. Overt mortality of these species appears to have been reduced by the dredging of the lakes (1964-65) and Basin F (1988-1989). More recently, individuals of several terrestrial bird species (great horned owl, red-tailed hawk, ferruginous hawk,

mourning dove) have been found dead at RMA with tissue concentrations of dieldrin within the lethal range (Sections C.5.3.2.2, C.5.3.4). In recent years, numerous dead birds (mostly American robins and starlings) have been found dead at RMA, especially on the lawns surrounding Building 111 (Section C.5.3.4).

No information is available on the population dynamics or metapopulation structure of animal species at RMA. Specifically, there is no information on survival rates or rates of dispersal of animals among subpopulations within RMA (e.g., movements between more contaminated and less contaminated parts of the site). Lacking such information, it is difficult to draw conclusions about the viability or self-sustainability of populations or subpopulations at any spatial scale within RMA. Numbers of black-tailed prairie dogs increased rapidly following an epizootic plague in 1988-89, the increase being much larger than the number of animals released in the reintroduction program (USFWS 1993a, 1993b). For species with little or no potential for immigration (e.g., deer, fish), the continued presence of significant numbers at RMA indicates that the total populations must be self-sustaining. For species with small dispersal ranges (e.g., earthworms), self-sustaining local subpopulations clearly exist within RMA, but the spatial distribution of these species within RMA has not been characterized.

The only species for which population densities have been compared to those at well-characterized offpost control sites are four species of songbirds (MKE 1989a). For these species, frequencies of encounter in summer (an index of breeding density) were lower on RMA than at the control sites; this difference was statistically associated with more homogeneous and less complex habitats at RMA. Although offpost control sites have been used in several other studies, these sites were either inadequately characterized or were substantially different in habitat from the RMA study-sites, precluding rigorous comparisons.

EPA considers the concept of ecological "health" to be inadequately defined and not useful for application to communities and ecosystems.

C.5.4.4.3 Effects of Contamination on Biota

RMA is unusual among Superfund sites in that it contains large areas with little or no contamination levels, as well as substantial areas with high contamination levels. Hence, studies of population characteristics that are conducted on an RMA-wide scale are subject to confounding by mixing animals that are relatively unexposed with animals that are exposed to varying degrees. The appropriate spatial scale for study and analysis of potential effects of contamination, therefore, should be determined on a species-by-species basis, taking into

consideration the scale of change in contamination levels and the scale over which individual animals of each species use the habitat.

The outcome of the risk assessment conducted under the IEA/RC is a set of predictions that animals are at high risk of adverse effects in central areas of RMA and at low risk in peripheral areas. The central ("core contaminated") areas are those in which the average levels of soil contamination are high, but the actual distribution of contaminants within these areas is very patchy and many locations have low or undetectable levels. Likewise, the peripheral areas have low average levels of soil contamination, but include locations where low to moderate levels of contaminants have been detected. The location of the boundary between areas of high risk and low risk is very uncertain (because of uncertainties in the process of risk assessment and disputes about risk assessment procedures) and varies from species to species (because of differences in factors controlling exposure, spatial averaging over home ranges, and differences in sensitivity to toxic effects).

If the predictions of the risk assessment are correct, one would expect gradients of effects within RMA from the contaminated core areas to the less contaminated peripheral areas. Field investigations within RMA, if properly conducted, might serve to confirm or to refute these predictions. If the effects are confirmed, field investigations might serve further to define the areas over which the effects take place, and their consequences for populations and communities on larger scales.

The major effects predicted by the risk assessment include lack of occupation (e.g., because of reductions in prey populations or other habitat impairments), increased mortality, and/or reduced reproductive success. Each of these effects could be measured directly with appropriately designed studies. Increased mortality or reduced reproductive success may be detected indirectly by observations of gradients in population density. However, such observations need to be interpreted carefully in relation to the population dynamics of these species under study. Effects of increased mortality or reduced reproductive success may be offset partially or fully by net immigration from surrounding areas where effects are smaller or absent. Hence, although the observation that numbers of animals are present in or near the core contaminated areas provides useful information on abundance and density in these areas, the comparison of this information to results of the ERC is ambiguous unless survival rates or reproductive rates are measured, or unless rates of immigration and emigration are measured or taken into account through modelling.

Studies of several species (e.g., black-tailed prairie dogs, small mammals, songbirds, American kestrels, wintering raptors),

have characterized the distribution, density, and/or reproductive success of animals at various locations within RMA (Section C.5.3.2). These and other species have been recorded in numbers close to and even within the core contaminated areas of RMA (e.g., RMA Section 26), indicating locally high potential for exposure. With three exceptions, however, none of these studies included characterization of actual exposure or even measurement of soil contamination levels at the study sites, and the locations of the study sites were not recorded precisely enough for the post hoc estimation of potential exposure. Retrospective investigation of the relationship between endpoints observed in some of these studies and exposure to contaminants (as attempted by the Army in Sections C.5.3.2.1 and C.5.3.2.2) is not possible because of the imprecise location of study sites, inconsistent and unreliable measures of exposure, focusing of studies in uncontaminated areas, and other problems.

The three exceptions mentioned in the last paragraph are the studies of invertebrates (Section C.5.3.2.3) and American kestrels (Section C.5.3.2.2). Each of these studies included measurements of tissue concentrations of contaminants in individual organisms that were studied. The invertebrate study (ESE 1989) involved collection of earthworms at one contaminated site and grasshoppers at two contaminated sites, as well as onpost and offpost controls. For earthworms, only one study sample was analyzed for organochlorine contaminants, so this study does not provide sufficient information on potential effects. For grasshoppers, contaminants were detected in the study sample and not in controls, but the sampling methods were not sufficiently standardized to draw conclusions about potential differences in population density.

The only studies conducted at RMA to date that are useful in testing hypotheses about potential effects of contaminants are those of American kestrels (Section C.5.3.2.2). Although these studies included offpost control sites, these were poorly matched for habitat and other characteristics and the most informative comparisons are those that can be made within RMA. The earliest studies (DeWeese et al. unpublished) suggested a strong within-RMA gradient in nest occupancy and productivity, both being low within 1 mile of the core contaminated areas, intermediate in areas between 1 and 2 miles from them, and high in areas more than 2 miles from them. These gradients have not been clearly indicated in subsequent studies (ESE 1989, RLSA 1992, USFWS 1992a, 1993), but data on occupancy have not been reported and only a few nest boxes have been placed near the core contaminated areas. Moreover, concentrations in eggs and fledglings were very variable, even within clutches and broods, and were not closely related to distance from the core contaminated areas (ESE 1989). Retrospective analysis of the relationship between various measures of reproductive success and various measures of contamination (Section C.5.3.2.2) yielded inconclusive results,

in part because of inadequate study design, but primarily because very few of the study pairs were significantly exposed to contaminants. The key variable of nest box occupation was not examined in this analysis.

Overall, therefore, the results of the kestrel studies are inconclusive in assessing potential ecological effects caused by RMA contaminants. However, they do show that a few pairs of kestrels nest close to the core contaminated areas and that some of these pairs raise young to fledgling. A more systematic study would be needed to define effects on the kestrel population.

C.5.4.4.4 Conclusions

The field studies of biota conducted at RMA are useful in describing the status of many plant and animal species, including in some cases information on population sizes or density and/or distribution within RMA. They are thus useful in defining the resources at risk. However, little information is available on the "health", exposure, or contamination effects of individual animals or populations.

EPA's overall conclusion concerning Appendix C.5, Ecological Status and Health, is that, generally, the field studies were not adequately designed to assess the potential effects of contaminants on RMA biota at the individual, population, or community level. Hence, they are of little or no value in testing the hypotheses about effects that can be derived from the risk characterization. Some animals collected at RMA have tissue levels of contaminants that exceed the MATC, and at least a few appear to have been lethally poisoned. Several species occur and even breed successfully close to core contaminated areas. Except for a few American kestrels, however, the actual exposure of these animals has not been characterized. Hence, the available information on RMA biota neither confirms nor refutes the predictions of the risk characterization. Implications otherwise are misleading.

Summary of Attachments

The EPA position stated herein includes four Attachments as follows:

Attachment 1: EPA's definitions and categorization of bias, power, and relevance.

Attachment 2: EPA's statement concerning the appropriate scale for investigation of population impairments.

Attachment 3: A detailed analysis of the studies used to support the Army's conclusions regarding the status and health of invertebrates, small mammals, prairie dogs,

songbirds, American kestrel, burrowing owl, and bald eagle, as well as biomarkers and fortuitous samples.

Attachment 4: Retrospective linking of data on measurement endpoints to soil concentrations.

ATTACHMENT 1

EPA's Definitions and Categorization of Bias, Power, and Relevance

General Introduction

A number of different investigations of the biota of the Rocky Mountain Arsenal (RMA) have been carried out. In Appendix C.5 of the IEA/RC, the Army reviews these investigations and draws inferences about the "status" and "health" of the biota and ecosystems of RMA. Although the inferential process is not stated formally, three different types of questions are addressed:

1. What is the "status" of the biological populations and communities at RMA?
2. How "healthy" are the organisms, populations, and ecosystems at RMA?
3. To what extent have the "status" and "health" of the biota at RMA been impaired by the contamination there?

Status

"Status" is not defined in the IEA/RC, but the term appears to be used more or less synonymously with "diversity." Diversity includes both species richness and trophic diversity (Section C.5.3.1.1). However, there is no formal information on trophic diversity ("the number of food chains and the number of trophic levels represented in various food chains", p. C.5-15) at RMA, so most information on the "status" of the biota at RMA consists of estimates of species richness, with some information on absolute and relative abundances. Species richness ("the total number of species present", p. C.5-14) is estimated by selecting a group of taxa to be evaluated (e.g., small birds), selecting an area, selecting survey methods, and enumerating the species encountered. Although the concept and procedure are straightforward, each of the four steps listed in the preceding sentence affect and determine the reliability and relevance of the results.

In principle, information on status can be used in two ways: (a) to define the resources at risk: (b) to identify elements of the biota as being of "high" status or "low" status. The latter would be necessary to identify impairment of status attributable to contamination (see below). Ranking the status of the biota in this way implies a scale against which the status can be measured, which usually requires a comparison with an unimpaired or "normal" system (see below).

Health

"Ecological health" is defined on p. C.5-2 as "consisting of the

normal range of those ecological characteristics identified by EPA (1989a, pg. 42 to 43) as providing a basis for selecting appropriate assessment endpoints." EPA has objected to this definition on the grounds that it is so vague as to be meaningless and unintelligible. Moreover, the Army states that for mobile, upper-trophic level species, contaminant effects must be assessed in the context of their inclusion in populations that extend beyond the RMA boundaries. "These are populations that occupy a particular region characterized by a habitat or habitats that are more or less contiguous and occur within a major biogeographic region", p. (C.5-2). However, none of the mobile, upper trophic level species was actually assessed in this context, so the Army's definition is not useful or meaningful for the IEA/RC.

"Ecological health" is not a well defined term or concept in ecology, and EPA considers that the concept is not appropriate or useful in the IEA/RC. As used by the Army in the IEA/RC, the term appears to include four components:

1. "Health" of individuals: presence or absence of anatomical, physiological, or pathological conditions that would indicate ill-health.

2. "Health" of populations: presence or absence of population characteristics (e.g., numbers, distribution, reproductive rate, mortality rate, recruitment rate, net immigration rate, age structure) that would indicate impairment or lack of viability.

3. "Health" of communities: presence or absence of community characteristics (e.g., species richness, trophic diversity) that would indicate impoverishment.

4. "Health" of ecosystem: presence or absence of structural or functional ecosystem characteristics (e.g., productivity, stability) that would indicate impairment or dysfunction.

Each of these components is defined in terms of presence or absence of impairment, i.e., "good health" is defined as the lack of signs of ill-health. This feature probably corresponds to the word "normal" in the Army's definition, quoted above. To define "health" in this way implies a comparison with an unimpaired or "normal" system (see next section).

Evidence for ecological effects related to contamination

The general question posed is: To what extent have the biota at RMA experienced ecological effects due to contamination? This question can be addressed by comparisons at several levels:

1. Comparison of characteristics of the RMA biota with "normal"

characteristics for the species, community, or ecosystem.

2. Comparison of characteristics of the RMA biota with data on regional populations, communities, or ecosystems.
3. Comparison of characteristics of the RMA biota with data on populations, communities, or ecosystems in selected control sites.
4. Comparison of characteristics of the biota in areas of RMA close to contaminated zones with those of biota in areas farther from contaminated zones.
5. Comparison of characteristics of the biota in areas of RMA known to be highly contaminated with those of the biota in areas of RMA known to be less highly contaminated.
6. Correlation of characteristics of the biota with levels of contaminants in different areas.
7. Correlation of characteristics of the biota with specific measures of exposure (e.g., tissue concentrations).

These comparisons are arranged in increasing order of specificity, i.e., the later comparisons provide more specific evidence for relationships between contaminants and differences in the measured characteristics than do the earlier comparisons. At all levels of comparison, however, the results have to be evaluated for bias, power, and relevance.

Bias

General Definition. The magnitude and direction of the tendency to measure something other than what was intended (Table C.5-2, footnote 1, in the IEA/RC, and Table 3-1, footnote 1, in EPA's Attachment 3 to these comments).

Application to Investigations of Biota at RMA and Inferences about Status and Health. In ecology, bias is rarely measured directly because this requires knowledge of the "true" value of the characteristic being measured for comparison with the measured value. Bias can occasionally be estimated by theoretical analysis of the measurement process, or by repeated measurements over a range of the factors thought likely to introduce bias. However, these methods of estimating bias have not been used at RMA. What is at issue, therefore, is potential bias. The question to be addressed is whether the observations were designed and executed in such a way as to minimize bias. Specific questions include the following:

1. Were the observations representative of the individuals, population, or community which was the intended object of study? For example, if the intended object of study is the small mammal population of the entire RMA, were the samples or observations appropriately randomized with respect to location, habitat, and other factors that might introduce bias?
2. If an off-site control area is used, was it appropriately

matched to the study site in terms of all factors likely to affect the characteristic being measured? Is it justifiable to assume that the off-site control area was uncontaminated?

3. If an on-site control area is used, was it appropriately matched to the study area in terms of all factors likely to affect the characteristic being measured except level of contamination? Was the level of contamination at both the study and control areas measured?
4. If within-site comparisons are made among study areas, were the areas appropriately matched in terms of all factors likely to affect the characteristic being measured except levels of contamination? Were the levels of contamination measured in comparable ways in all study areas? If not, is there a reliable basis for the assumption that some areas were more contaminated than others?
5. If endpoints are compared to tissue concentrations or other measures of the exposure of individual animals, were these individual animals appropriately matched in terms of all factors likely to affect the characteristic being measured except levels of exposure? Were the levels of exposure measured in comparable ways in all the organisms?

Unless all the relevant questions can be answered in the affirmative, the potential for bias cannot be categorized as "low".

Typically, ecological systems are very variable in time and space and are influenced by many uncontrolled factors. Without very careful attention to design of sampling and matching of control and study areas, the potential for bias is usually very large.

Criteria for categorizing potential bias

LOW: 1. Study design fully documented and sufficient to make samples or observations representative of intended object of study; and

2a. control areas fully described and characterized, and matched to study areas in terms of all factors likely to affect the characteristic being measured except levels of exposure; or (in case comparisons are made among samples with different levels of contamination)

2b. samples matched in terms of all factors likely to affect the characteristic being measured except levels of exposure; levels of exposure measured in comparable ways among samples.

HIGH: One or other of the above criteria not met (e.g., samples not representative, control areas not described or characterized, areas not appropriately matched, or

samples not appropriately matched).

MEDIUM: One or other of the above criteria not fully met (e.g., control areas inadequately characterized, or areas or samples incompletely matched).

In all three cases, professional judgment is required to interpret and apply the terms "sufficient," "representative," "fully," "matched," etc.

Power

General Definition. The probability of rejecting the null hypothesis when in fact it is false and the alternative hypothesis is correct (Table C.5-2, footnote 2, in the IEA/RC, and Table 3-1, footnote 2 of EPA's Attachment 3 in these comments).

Application to Investigations of Biota at RMA and Inferences about Health and Diversity. The term "power" has a precise meaning and definition in statistics, where null and alternative hypotheses also can be framed in precise terms. In ecology, the term "power" has a much broader meaning, and it is often difficult to frame null and alternative hypotheses precisely. In the context of RMA, null hypotheses can be framed in terms like the following:

-the average abundance of species X on RMA is not lower than that in similar habitats in the western United States;

-characteristic A of species X is not lower on RMA than in matched control site C;

-characteristic A of species X is not lower in contaminated areas of RMA than in less contaminated areas of RMA;

-characteristic A of species X is not correlated with exposure to contaminant Q among selected sites within RMA.

Although some of these ecological null hypotheses can be translated into precise statistical hypotheses about measurement endpoints, this translation is sometimes uncertain or incomplete, because the measurement endpoints are not precisely related to the biological characteristics that are the subject of the ecological hypotheses. For example, characteristic "A" might be reproductive success; statistical tests conducted on components of reproductive success, such as clutch-size or number of chicks fledged, may not cover all the components that are affected by the contaminant. Thus, although the concept of ecological power includes the statistical power of the statistical test that is conducted, it also includes other elements. In general, ecological systems (populations, communities, and ecosystems) are very "noisy" and are influenced by a wide variety of uncontrolled variables. Unless this "noise" is taken into account, the power of comparisons can easily be overestimated.

Criteria for categorizing power.

HIGH: 1. Close correspondence between the quantities that are measured and the biological characteristics that are under investigation; and

2. ability of the study design to capture the major sources of variance in the quantities that are measured; and

3. (statistical power) ability of the study design to detect an ecologically meaningful difference in the quantities that are measured if such a difference in fact exists and is related to levels of contamination.

LOW: One or more of the above three criteria not met.

MEDIUM: Uncertainty about one or more of the above criteria.

In all three cases, professional judgment is needed to interpret and apply these criteria, including the words "close", "major", and "ecologically meaningful."

Relevance

General Definition. Pertinent to the matter at hand (Table C.5-2 of the IEA/RC, footnote 3, and Table 3-1 , footnote 3, of EPA's Attachment 3 in these comments)

Application to Investigations of Biota at RMA and Inferences about Status and Health. The "matter at hand" is the extent to which the "status" and "health" of the biota at RMA have been impaired by the contamination there. Hence, a study is "relevant" if it provides unambiguous evidence that some characteristic of the biota that falls within the definitions of "status" or "health" has or has not been impaired by the contamination there. To do so, the study must be related to an *a priori* hypothesis about the effects of specific contaminants on RMA biota, and this hypothesis must be consistent with or be suggested by the results of the risk assessment. For example, a study comparing specific reproductive elements of reproductive success (eggshell thinning and chick survival) in individual pairs of American kestrels with residue levels of OCPs in their diets, tissues, or eggs would have high relevance. However, a study comparing the total numbers or average density of American kestrels on RMA with those at a comparable site elsewhere would have low relevance, because the risk assessment indicates that the survival and/or reproductive success of kestrels may be affected in certain parts of the site but not in others; this does not yield a prediction of a change in total numbers or average density without population modelling.

Criteria for categorizing relevance

HIGH: 1. The study involves a measurement endpoint related to an a priori hypothesis that the endpoint would be affected by one of the contaminants present at RMA; and
2. the measurement endpoint reflects some aspect of "status" or "health" as outlined above; and
3. the a priori hypothesis is consistent with the predictions of the ecological risk characterization; and
4. the study is carried out on a scale appropriate to this prediction.

LOW: One or more of the above criteria is not met.

MEDIUM: Uncertainty about one or more of the above criteria.

In all three cases, professional judgment is needed to interpret and apply these criteria, including the words "related," "consistent," and "appropriate."

ATTACHMENT 2

Appropriate Scale for Investigation of Population Impairments

One of the general issues raised by EPA in its comments on the IEA/RC is the issue of spatial scale. RMA is unusual among Superfund sites in that it contains large areas with low or zero contamination levels, as well as substantial areas with high contamination levels. Hence, studies of population characteristics that are conducted on an RMA-wide scale are subject to confounding by mixing animals that are unexposed with animals that are exposed to varying degrees. EPA believes that the appropriate spatial scale for study and analysis of potential effects of contamination should be determined on a species-by-species basis, taking into consideration the scale of gradients in contamination and the scale over which individual animals of each species use the habitat.

The outcome of the risk assessment conducted under the IEA/RC is a set of predictions that animals are at high risk of adverse effects in central areas of RMA and at low risk in peripheral areas. The location of the boundary between areas of high risk and low risk is very uncertain (because of uncertainties in the process of risk assessment and disputes about procedure) and varies from species to species (because of differences in factors controlling exposure, spatial averaging over home ranges, and differences in sensitivity to toxic effects).

If the predictions of the risk assessment are correct, one would expect gradients of effects within RMA from the contaminated core areas to the uncontaminated peripheral areas. Field investigations within RMA, if properly conducted, might serve to confirm or to refute these predictions. If the effects are confirmed, field investigations might serve further to define the areas over which the effects take place, and their consequences for populations and communities on larger scales.

The major effects predicted by the risk assessment include lack of occupation (e.g., because of reductions in prey populations or other habitat impairments), increased mortality, and/or reduced reproductive success. Each of these effects could be measured directly with appropriately designed studies. Increased mortality or reduced reproductive success may be detected indirectly by observations of gradients in population density. However, such observations need to be interpreted carefully in relation to the population dynamics of the species under study. Effects of increased mortality or reduced reproductive success may be offset partially or fully by net immigration from surrounding areas where effects are smaller or absent. Hence, the observation that numbers of animals are present in the more contaminated areas is ambiguous unless survival rates or reproductive rates are measured, or unless rates of immigration

and emigration are measured or taken into account through modelling.

EPA believes, therefore, that investigation of potential effects of contamination of the biota of RMA requires: (i) studies conducted on a scale smaller than the site; and (ii) explicit consideration of population dynamics of the species studies, including rates of dispersal. Several field studies at RMA have in fact been conducted on scales smaller than the site, and the Army has attempted to interpret them by comparing measurement endpoints between putatively contaminated and uncontaminated areas. EPA believes that none of these studies provides strong evidence either for or against the predictions of the risk assessment (in part because of objectives that were unrelated to the ERC, or errors of interpretation, as documented in this report, and in part because none of the studies has been interpreted in terms of dispersal or other elements of population dynamics). However, EPA agrees with the general assumption underlying the Army's interpretation of these studies: comparisons between contaminated and uncontaminated areas, if correctly designed, executed, and interpreted, could provide useful information about the existence, magnitude, and spatial scale of adverse effects of RMA contamination at the individual, population, or community level.

Nevertheless, the Army appears to believe that the results of the field investigations can only be interpreted at the scale of the entire site, and evidence of impairment in one part of the site would not be significant unless effects could be demonstrated on the entire RMA population.

In the text of Appendix C.5, the Army generally uses the term "population" as though it applied to the entire population of a species within the RMA boundary. EPA disagrees with the Army's positions on the appropriate scale for population assessment, for the following reasons:

1. The Army's positions are internally inconsistent. Although the Army states that "populations cannot be defined and population parameters cannot be measured at anything less than an RMA-wide scale," the Army cites and conducts a number of analyses comparing population parameters between "contaminated" and "uncontaminated" areas within RMA. The Army's retrospective analyses comparing measurements of ecological endpoints among sites within RMA with values of ESC are examples of these analyses, and are applied to some of the most wide-ranging and mobile species (e.g., American kestrel, burrowing owl, great horned owl).

2. The boundary of RMA is not a natural ecological boundary and populations within the boundary are not isolated from those outside it.

3. Although the Army states that the "mobile, upper-trophic level species...must be assessed in the context of their inclusion in populations that extend outside the RMA boundaries", Appendix C.5 does not in fact assess any species in this context.

4. At least in the breeding season, most of the "mobile, upper trophic level species" are, in fact, limited to territories or discrete home ranges that are much smaller than the entire site. It is therefore meaningful and legitimate to analyze data on these species by individual territory or subpopulation (as the Army does in several cases). As an example, one of the species considered by the Army for which individuals range over the entire site (or larger areas) during the period for which they are assessed is the bald eagle. Although individual bald eagles may focus their feeding (and hence, their exposure) within limited parts of the site, EPA agrees that population assessment of bald eagles should be based on the entire group using the site as a roost.

5. For example, there is nothing in the ecological literature to indicate that populations can only be defined and studied on a scale on which they are isolated from neighboring populations. Recent ecological textbooks make it clear that populations can be defined and studied at any scale: "arbitrarily at the convenience of the investigator" (Ricklefs 1990); "boundaries are determined by an investigator's purpose or convenience" (Begon et al. 1990).

EPA believes that the appropriate spatial scale for study is the scale of the predictions which the studies are designed to test. Depending on the species, this scale may be that between the core area with high average contaminant levels and the peripheral areas with low average contaminant levels, or on a smaller scale of local contamination gradients within the core area.

At RMA, the appropriate spatial scale for study is the scale of the predictions which the studies are designed to test. Depending on species, this scale may be that between the core area with high average contamination levels and the peripheral areas with low average contamination levels, or on a smaller scale of local contamination gradients within the core area.

ATTACHMENT 3

EPA's Review of Key Documents pertaining to RMA Ecological Status and Health

This attachment summarizes EPA's review of many of the documents cited by the Army in Appendix C.5, Ecological Status and Health. Our review of each study included the following types of information: who conducted the study and the dates of study, the purpose of the study, summary and results, a comparison of the Army's and EPA's conclusions, the differences between the Army's and EPA's conclusions, the relation of the study to issues raised by EPA in its September 20, 1993 comments on Appendix C.5, and EPA's characterization of bias, power, and relevance. EPA's characterization of bias, power, and relevance for each study is summarized in Table 3-1 of this attachment.

Aquatic Snail Population Density and Biomass.

Study conducted by: Environmental Science and Engineering, Inc.(ESE, 1989); pages B-27 through B-33; pages 5-311, 5-316, and 3-18.

Purpose of study: "...invertebrate groups were selected for population studies as a means of evaluating potential effects on their populations (pages 3-18, 5-316).

Dates of study: 1986, 1987

Summary of study:

Aquatic snails were surveyed to provide information on total body weights and snail densities. Snail densities and total weights were estimated from seven sites in each of two years (1986 and 1987), although the same sites were not evaluated in each year (page B-27).

Aquatic snails from RMA lakes, including Lake Mary, Rod and Gun Club Lake, Lake Derby (Upper or Lower not specified), and Lake Ladora sampled compared with three control sites labeled as Wellington A,B, and C., The statistical tables associated with this report also repeatedly refer to an RMA lake identified as "North Bay" (pages B-29, B-30, B-31, and B-32). It is presumed that the authors intended to indicate the RMA waterbody known as North Bog.

As previously noted, the study incorporated five RMA lakes, regarded as "contaminated sites", and three offpost controls. However, only seven sites were sampled and compared in each of two different years (1986 and 1987). Thus, the same sites were not evaluated in each year (page B-29). For example, the five RMA lakes were compared against Wellington A and Wellington B in 1986, and with Wellington A and Wellington C in 1987 (page B-27). Analyses for contaminant burdens were not made.

Summary of results:

Snail densities and snail total weights were compared statistically between RMA lakes and the control sties. The lack of correspondence in sampling and analytical sites prevented the use of either the two-way ANOVA or ANOVA methods for evaluating the effect of either year or "contamination level" on snail density or snail weight (page B-27). Instead, separate one way ANOVA analyses comparing snail densities and total weights across sites was performed for each year. Statistically significant relationships were established, although substantially different statistical variances were observed. In fact, the authors state:

> ...[t]he very highly significant heteroscedasticity detected by the Fmax Test is of considerable concern...(page B-27).

The authors report their findings in a section labeled "Remarks" (pages B-28-B-33). Their comments were as follows:

"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).

- 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 B2-1). 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.

- 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 B2-2). 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.

- 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 B2-3). 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 B2-4). 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."

The authors summarized their finding in a conclusory section of the document. Their conclusions are as follows (page 5-311):

> The results of statistical analyses indicated that a very high degree of variability exists among sites and between years. Multiple regression analyses of snail results with the covariates of vegetation (substrate) weights, temperature, and pH indicated that these factors affected results.

> Interpretation of these analyses suggests that differences between on-post (contaminated) sites and off-post (control) areas are attributable to a number of environmental factors, some of which vary with time (e.g., temperature, amount of substrate, etc.) The lack of contaminant analyses for aquatic snails and the lack of pattern in variability do not allow any conclusions with respect to the possible effects of RMA contaminants on aquatic snail populations of RMA.

EPA's conclusion:

This study does not provide useful information for assessing aquatic snail population densities or total weights because the multiple regression analyses of snail results with the covariates of substrate, weight, temperature, and pH indicated these factors affected the results of the study. As a consequence, the authors note that differences between onpost and offpost sites are attributable to a number of environmental factors, some of which vary with time, notably temperature, and substrate (page 5-311). The large differences in statistical variances ("highly significant heteroscedasticity") ranging from F_{max} = 6,424.6 to F_{max} = 27,996.4 for aquatic snail density and F_{max} = 1,100.0 to F_{max} = 58,900.8 for total snail weight caused the authors "considerable concern" (page B-27).

The statistical variation and the interference of the covariates with variables of interest do not allow the data to be used to draw inferences or conclusions. EPA agrees with the authors who state (page 5-311):

> The lack of contaminant analyses for aquatic snails and the lack of pattern in variability do not allow any conclusions with respect to the possible effects of RMA contaminants on aquatic snail populations at RMA.

Army's conclusions:

The above-referenced data indicate no obvious contaminant effects on population density of grasshoppers, earthworms, or aquatic snails (page C.5-53).

Differences between EPA's and Army's conclusions:

EPA believes the Army's conclusion with respect to aquatic snails is unwarranted. The Army summarizes the study by suggesting that there are "...no obvious effects on population density of ...aquatic snails." What is not stated is that the data themselves do not allow effects on either population densities or total weights to be assessed. The authors of the study specifically summarize their findings by indicating that the data, "...do not allow **any conclusions** with respect to possible effects of RMA contaminants on aquatic snail populations at RMA" [emphasis added]. EPA concurs with this conclusion.

Bias, power, and relevance:

Aquatic snail population density and biomass was included in the Army's table of bias, power and relevance (Table C5-2). The Army has categorized bias, power, and relevance for aquatic snail studies as low, high, and medium, respectively. EPA's categorization of bias, power, and relevance is as follows:

Categorization		Comments
Aquatic Snail Population Density and Biomass		
Bias	HIGH	Variables of interest could not be reliably measured because of confounding covariates including substrate, weight, temperature, and pH. Time variable environmental factors were a particular problem.
Power	LOW	The null hypothesis could not be rejected because of confounding covariates. The lack of contaminant analyses and the lack of a pattern in variability obviated conclusions drawn from the data.
Relevance	LOW	No a priori hypothesis is presented. If the study had appropriately and consistently used control sites throughout the study, had accounted for environmental variation, and had used measurements of contaminants in substrate and snail tissue, it could have yielded useful information regarding population density and total weight in relation to contaminant levels. However, there is no a priori basis for predicting that aquatic snails would be affected at the contaminant concentrations occurring at RMA.

Invertebrates

Study conducted by: Environmental Science and Engineering, Inc., (ESE, 1989), Pages 3-18 through 19, 4-32 through 4-36.

Purpose of Study:

> ...invertebrate groups were selected for population studies as a means of evaluating potential contaminant effects on their populations (pages 3-18, 5-316).

Dates of Study: Earthworms: Spring, 1987
Grasshoppers: Summer, 1986, 1987

Summary of Study: Invertebrates were surveyed to provide information on occurrence, distribution, and relative abundance (page 3-15). Following the survey, earthworms and grasshoppers were also collected for contaminant analysis (arsenic, aldrin, dieldrin, endrin, mercury, DDT, and DDE) (page 4-32).

Earthworms were sampled at one onpost "control" site (in Section 5), one offpost control site (Barr Lake), and one onpost "contaminated" site (South Plants). Plots (1 m square, dug to a depth of approximately 15 cm) were randomly selected at each location, except for South Plants, where sampling was limited to areas of suitable substrate (page 5-319). Four such plots were located at the offpost control site, five plots were located at the onpost control site, and five plots were located in South Plants. Information was neither provided nor referenced regarding soil contamination, and the precise locations of study areas were not reported. Descriptions of the Barr Lake control site (page 3-7) were too general to ascertain whether the control site was adequately selected or not. The onpost "control" site may have been inadequately selected.

Grasshopper abundance was estimated at two onpost "contaminated" sites (Sections 26 and 36), at two onpost control sites (Sections 7 and 8), and at two offpost control sites. Grasshoppers were counted within 0.1m^2 plots at 10-m intervals along five 100-m transects located in each onpost and offpost area. As for earthworms, information regarding soil contamination and precise locations of study areas were not reported. Following the population surveys, grasshoppers were collected for contaminant analysis along the population transects. Descriptions of the offpost control sites (page 3-9) were too general to determine adequacy of control site selection. In addition, it appears that numerous variables, such as time of day, temperature, and floral characteristics were not comparable for sampling at the different sites (page B-33).

Summary of Results:

Population Studies: For earthworms, results of population comparisons indicated that onpost and offpost controls were significantly different, and that controls as a group were significantly different from the South Plants site (page 5-319).

For grasshoppers, the sample results were highly variable, and statistical analyses indicated no significant differences among sites (page 5-317). However, "[d]ifferences in time of day, temperature, and floral characteristics (height and density) associated with each of the quadrats could have a confounding effect on grasshopper density beyond that directly associated with the statistical treatments described..." (page B-33).

Contaminant Analysis: Contaminant levels in RMA invertebrates are presented on Figure 4.3-2, and discussed in the text of Section 4.3.2.2. For earthworms, only two samples (only one analyzed for OCPs) were collected from the onpost "contaminated" site (location not specified, and no soil measurements taken) in South Plants, eight were collected from the onpost control site, and two were collected from the offpost control site at Barr Lake. For the offpost control earthworm samples, no COCs were detected. For the onpost samples, arsenic was observed in all eight samples from the onpost control site, but not in the South Plants ("contaminated site") sample, dieldrin was detected in the South Plants sample and in one of seven onpost control samples, endrin was detected only in one of the onpost control samples, and mercury was detected in two samples (second earthworm sample from "contaminated site" analyzed for mercury only) from South Plants, and in two of eight samples from the onpost control site.

Results indicated significant differences among the three sites. When the two control sites were pooled and compared to the "contaminated" site, only comparisons for arsenic yielded significant differences. However, the Army stated that ..."Due to low sample sizes, differences between onpost control and contaminated sites may have remained undetected" (page 4-35). EPA agrees. Since the sample sizes are so small, the statistical power of such a study to draw any conclusions regarding statistical differences in contaminant concentrations among sites is virtually non-existent. In addition, since no information is provided regarding soil contamination levels, comparison is meaningless in terms of assessing impairment.

For grasshoppers, neither DDE nor DDT was detected in any of the samples. Arsenic and mercury were detected at only one of the "contaminated" sites (Section 36), aldrin and endrin were detected at only one of the "contaminated" sites (Section 26), and dieldrin was detected in both Section 26 and 36 samples. All analytes were below detection in onpost and offpost control samples. Results varied among the COCs regarding significant or non-significant differences between contaminated, pooled contaminated, control, and pooled control sites. No conclusions were drawn regarding statistical analysis of contaminant levels in grasshoppers (page 4-36).

EPA's Conclusions:

Status: This study did not provide useful information regarding the status of earthworms or grasshoppers Arsenal-wide because the sample locations were too few, and it is unclear how onpost "contaminated" versus onpost "control" sites were selected. In addition, for grasshoppers, variations in time of day, temperature, and floral characteristics were not controlled among the sites. If this study were designed using larger sample sizes and selection of "contaminated" versus "uncontaminated" sites on the basis of actual soil contamination values, this study might have provided useful population data for comparison among sites. This information could have been useful in the "weight-of-evidence" approach used by the Army. The current data, however, cannot be used for that purpose.

Health: The study provided no information on the "health" of earthworms or grasshoppers at RMA at the individual, population, or community level.

Impairment: The study did not provide information on the possible impairment of invertebrates at RMA, in that there was no attempt to measure or estimate contaminant exposure and resultant toxic effects. In addition, the high dieldrin detection in earthworms in the onpost "control" area indicates that this area should have been considered part of the "contaminated" site, and not used as a "control" site. Had sites been selected on the basis of actual soil contamination values, and soil and biota samples co-located, and a larger sample size used, this study might have provided quantitative information regarding contamination levels in earthworms and grasshoppers in contaminated versus uncontaminated sites. As it stands, no information regarding the impairment of earthworm or grasshopper populations can be ascertained from the Biota RI.

Army's Conclusions:
For earthworm densities, results indicated that the on- and offpost control sites were significantly different, and that both control sites were significantly different from the contaminated site... (page C.5-52).

The ... data indicate no obvious contaminant effects on population density of grasshoppers or earthworms. Earthworm population and tissue contaminant levels were reported as not indicative of adverse contaminant effects (ESE 1989) (page C.5-53).

Differences in population density for earthworms were not consistent with patterns of contamination (e.g., the onpost control site had the highest population density) (page C.5-52).

Differences between EPA's and Army's Conclusions: EPA believes the Army's conclusions are unjustified, for several reasons:

Earthworms

1. For earthworms, the study reports that significant

differences between the control sites and the contaminated site were significant only for arsenic, and that ..."Due to low sample sizes, differences between onpost control and contaminated sites may have remained undetected."

2. Comparisons of Figure 4.3-2 and Table B.2-7 in the earthworm study show that five sample plots were located in South plants, resulting in a mean density of 2.6 worms, and two composite samples for analysis; five sample plots were located in the Section 5 onpost control area, resulting in a mean density of 56 worms, and eight composite samples for analysis; and four sample plots were located at Barr Lake, resulting in a mean density of 2.5 worms, and two composite samples for analysis. Of the eight samples analyzed from Section 5, one had a dieldrin hit much higher than the detection in the sample from South Plants.

Since it is not apparent that either the onpost "contaminated" or "control" sites or location of sample plots were selected on the basis of actual soil contamination levels, it is likely that one of the earthworm sample plots located in Section 5 may have intersected an unanticipated "hot spot". The onpost control site may have therefore been inappropriately selected, and the resulting comparisons are meaningless. In fact, it may have been more appropriate to pool the date from the onpost "contaminated" site with the onpost "control" site, and compare results to the offpost control site. It is therefore inappropriate to draw conclusions that "earthworm densities were not consistent with patterns of contamination".

3. The sample sizes used in this study are insufficient to draw any conclusions regarding the comparative densities of earthworm populations. Based on the mean density and variance values reported on Table B.2-7, the small sample sizes render these data unusable for drawing any statistical comparisons of field observations. For example, for the South Plants site, to obtain a mean of 2.6 with a variance of 33.8, at 80 percent confidence and 20 percent precision (80 percent confidence and 20 percent precision are typically the minimally acceptable parameters to allow inferences about populations), a minimum of 297 sample plots would be required. The Army sampled from 5 sample plots. The resulting mean and variance are associated with 25 percent confidence and 50 percent precision. As a result, conclusions regarding earthworm populations from these data are virtually meaningless.

4. The lack of evaluation of actual exposure to soil contamination negates any attempt to draw conclusions regarding effect of contaminants on earthworm or grasshopper populations at the Arsenal.

5. The statement that differences in population density were not consistent with patterns of contamination may be attributable to the process of site selection, rather than any contamination effects (see issue 2, above).

6. No statement was found in the study reporting that earthworm population and tissue contaminant levels were not indicative of adverse contaminant effects.

Grasshoppers

1. Population characteristics cannot be compared among "contaminated" and onpost or offpost "control" sites, since there was no effort made to collect sample data under similar environmental and vegetative conditions.

2. Grasshopper tissue samples were not co-located with any soil data, nor was information presented that actual soil concentrations in the vicinity of grasshopper samples was known. Therefore, no inferences can be made regarding contaminant effects on population densities of grasshoppers.

3. The sample sizes used in this study are also insufficient to draw any conclusions regarding abundance of grasshopper populations. Based on the mean density and variance values reported on Table B.2-5, the small sample sizes render these data unusable for drawing any statistical comparisons of field observations. For example, for the contaminated site, to obtain a mean of 8.92 with a variance of 247.27, at 80 percent confidence and 20 percent precision, a minimum of 185 sample plots would be required. The Army sampled from 26 sample plots. As a result, conclusions regarding grasshopper populations from these data are virtually meaningless.

Relation of This Study to Issues Raised by EPA:

1. Definition of Ecological "Health". The Biota RI provided no information on the "health" of earthworm or grasshopper populations at RMA.

2. Appropriateness of Offpost Control Areas. For earthworms, not only was the offpost control area inadequately described in comparison to the "contaminated" site, but the onpost control site appears to have been erroneously selected as a control site. For grasshoppers, the offpost control sites were described too generally to ascertain their appropriateness as control sites.

3. Spatial Scale and Within-RMA Comparisons. The spatial scale for these relatively sedentary species seemed appropriate. The within-RMA comparisons, however, are inconclusive, since no attempt was made to determine actual soil contamination levels at either "contaminated" or "control" sites. Conclusions regarding contaminant effects on population densities of invertebrates are, therefore, inappropriate and misleading.

4. Relationship of Ecological Characteristics to Contamination Levels. No information was collected,

presented, or used regarding soil contamination levels in the areas where population densities were studied.

5. Population Characteristics. Sample sizes of four and five are insufficient to draw conclusions regarding population characteristics of earthworms. For grasshoppers, sample sizes appear adequate to make inferences about relative numbers, but no other population characteristics were studied.

6. Treatment of Uncertainty. No discussion of uncertainty was presented either in the study report, or in the Army's summary of it.

Bias, power, and relevance:

Both grasshopper abundance and earthworm population density were included in the Army's table of bias, power, and relevance ratings (Table C.5-2). The Army categorized bias, power, and relevance for both grasshopper abundance and earthworm abundance as low, medium, and high, respectively. EPA's categorization of bias, power, and relevance are as follows:

	Categorization	Comments
Earthworms		
Bias	HIGH	Only two sites were evaluated on RMA using very small sample sizes. The study sites were not selected to be representative of contaminated and uncontaminated areas, and the study site locations were not matched for other factors that would affect earthworm density.
Power	LOW	Sample sizes were much too low to detect differences between control and contaminated sites.
Relevance	LOW	Whereas the Army cites studies of bioaccumulation in earthworms by Korschgen and Beyer and Gish, there was no a priori hypothesis presented that contaminants at the levels found might affect earthworm abundance.
Grasshoppers:		
Bias	HIGH	Study and control sites were not matched for environmental characteristics.
Power	MEDIUM	Sample sizes were adequate to assess differences between a contaminated and an uncontaminated site, had the study been designed for this purpose. However, to extrapolate Arsenal-wide, a larger number of sample locations would have

		been required.
Relevance	MEDIUM	If the study had included enough samples to yield adequate power (including actual measurements of soil contaminants), it could have yielded useful information regarding population density of grasshoppers in relation to contaminant levels.

Biomarker Endpoints

The Army has cited the use of two biomarker endpoints used as indices of "harmful levels of chemical contamination" (page C.5-55-56). These biomarkers included acetylcholinesterase (AChE) inhibition in brain tissue and eggshell thinning. The Army asserts (page C.5-55) that these biomarkers, "... are specific possible effects of some of the contaminants at RMA." The application of these parameters is considered below.

Study conducted by: Data on these parameters were collected as part of the Biota RI (ESE 1989).

Purpose of study: "... to evaluate whether these adverse effects of (AChE inhibition and eggshell thinning) were occurring at RMA on or near sites of known contamination" (IEA/RC, p. C.5-56). However, the Biota RI did not state this or any other purpose of the studies.

Summary of studies:

AChE analyses were performed on brain tissues of several species including mallard, ring-necked pheasant, black-tailed prairie dog and desert cottontail within the RMA boundaries and from control sites more than 40 miles from RMA (page C.5-56). Additionally, six fortuitous specimens from the RMA were examined, i.e., three red-tailed hawks, two golden eagles, and one mourning dove.

Eggshell thinning was investigated in the eggs of mallards, pheasants, and kestrels. These samples were collected as part of the Biota RI (page C.5-56).

Summary of results:

AChE inhibition was found only in prairie dogs living in or near the Toxic Storage Yard. The reductions were greater than 20 percent and were statistically significant ($p < 0.01$). The decrease could not be directly related to any observed contaminant in the area, but appeared to be associated with concentrations of arsenic and other metallic substances at the site (ESE 1989, p. 5-321).

Eggshell thinning was not observed in samples of ring-necked pheasant or American kestrel eggs on the RMA as compared with off-post control sites. The data for mallards were inconclusive because only one egg was collected onpost (ESE 1989, Table 5.3-7).

EPA's conclusions:

AChE inhibition is classically a function of exposure to organophosphorus-based compounds. Given the Army's continued reassurances regarding the lack of Agent on the grounds of RMA, and the fact that the COCs at RMA are primarily organochlorine-based substances, AChE testing is not appropriate for assessing the adverse effects of RMA compounds of concern. This contention is supported by the USFWS data on fortuitous samples. Of the several dozen AChE analyses performed at necropsy on animals

suffering frank and apparent symptoms of unknown origin, AChE inhibition studies have been uniformly negative. AChE analyses are inappropriate for evaluating the adverse effects on individuals and populations at the RMA because these analyses do not address the major contaminating substances, i.e., organochlorine compounds, at RMA.

Eggshell-thinning studies have the potential for identifying effects of exposure to DDE. However, ring-necked pheasants are known to be insensitive to this effect of DDE, so the inclusion of this species in the studies was inappropriate. Only one mallard egg was collected onpost, so the study had zero power to detect an effect in this species. In addition, the Risk Characterization indicates that the potential for exposure of mallards was very low (HQ of 0.05 for DDE/DDT, Figure D.1-20). For American kestrels, likewise, there is no evidence for significant exposure to DDE at any of the sample sites (Table C.5-7). Thus, there is no a priori hypothesis that eggshell thinning would have occurred in any of the samples, so the studies have low relevance.

Army's conclusions:

> Results of AChE and eggshell thinning studies did not indicate that either adverse effect was present at RMA as a result of contamination. Sample sizes for mallard, pheasant, kestrel, prairie dog, and cottontail were sufficient for nonparametric statistical analysis. Incidental data on other species, though inconclusive, were consistent with these results (pages C.5-56-57).

Differences between EPA's and Army's Conclusions:

EPA does not believe AChE inhibition is an appropriate biomarker for evaluation of adverse effects of the contaminants of concern on individuals or populations at the RMA. AChE testing is useful for determining the effects of Agent or organophosphorus compounds. However, since the COCs at the RMA are primarily organochlorine substances, the application of AChE testing would produce no useful information regarding the impacts of the principal COCs. EPA believes that inclusion of this parameter and the conclusions drawn relative to it are inappropriate.

EPA regards the eggshell thinning studies as irrelevant for the reasons stated. Hence, the Army's claim that this effect was not present at RMA is inappropriate. It is unclear how the Army can regard a sample size of 1 (mallard, onpost) as sufficient for nonparametric statistical analysis.

Bias, power and relevance:

Both AChE inhibition and eggshell thinning are included in the Army's table of bias, power and relevance (Table C.5-2). The Army has categorized bias, power and relevance for AChE inhibition as low, medium, and low, and eggshell thinning as low, medium and high. EPA's categorization of bias, power and relevance are as follows:

	Categorization	Comments
AChE Inhibition		
Bias	HIGH	Control areas uncharacterized..
Power	LOW	Small sample sizes (1 to 9 per species).
Relevance	LOW	AChE testing would be appropriate for organophosphates, but not for the COCs at RMA. In addition to the lack of relevance to COCs at RMA, no a priori hypothesis was presented, as this investigation was a part of the Biota RI.
Eggshell Thinning		
Bias	HIGH	Control areas uncharacterized.
Power	LOW-MEDIUM	Sample sizes of 1 for mallard, 7 for pheasants, 22 for kestrel.
Relevance	LOW	No evidence of significant exposure to DDE at any of the study locations for any of the species; pheasant known to be insensitive to this effect.

Prairie Dogs

The Army cited three major studies (MKE 1989a, ESE 1989, RLSA 1992) in its assessment of the status and health of black-tailed prairie dogs at RMA. These three studies will be evaluated sequentially in this section. The Army also cited background information from several published studies and information on the current status of prairie dogs from USFWS (1993a, 1993b); this information will be considered only in evaluating and comparing conclusions.

STUDY I (MKE 1989a)

Study conducted by: Morrison-Knudsen Environmental Services, Inc. (MKE, 1989a) Pages 1, 18-20, 53-57.

Purpose of Study.

> "...to (1) document the distribution and relative abundance of [prairie dogs] across the RMA, (2) evaluate [prairie dogs] use at RMA in relation to habitat types and contamination sources, and (3) compare [prairie dogs] use at RMA with selected offsite areas" (p. 1).

Dates of Study. June 1986 and May 1987 (p. 18).

Summary of Study. Prairie dogs were observed at 20 locations in 1986 and at the same 20 locations in 1987. The locations were selected by driving along roads and choosing observation points when at least 30 animals could be seen from a vehicle. Most locations were in peripheral parts of RMA; only two were near contaminated areas (p. 19). Six control sites were located at Buckley Air National Guard Base or Plains Conservation Center in 1986 and 20 in 1987. Neither RMA nor control sites were described. The only observations recorded at both RMA and control sites were the relative numbers of adult and juvenile animals.

Summary of Results. Results were presented in Table 4-1 (p. 55). The proportion of juvenile animals at RMA was significantly lower than that at the control sites in both years. The report attributes these differences to "normal ecological factors," citing superior habitat at the control sites and higher predation rates at RMA. The report concluded that contamination could not be causally involved, because the average proportion of juveniles at the four locations closest to contamination areas was higher in each year than that at the more distant locations (p. 57). No information on contamination was either reported or referenced, however.

STUDY II (ESE 1989)

Study conducted by: Environmental Science and Engineering, Inc. (ESE, 1989). Pages 1-1, 3-16 to 3-17, 4-51 to 4-56, 5-322 to 5-331.

Purpose of Study.

Part of the Biota Remedial Investigation (Biota RI), whose overall purpose was to present an overall environmental contamination assessment of biota within the RMA Study Area. (p. 1-1). Specific objectives of the Biota RI included evaluation of data on contamination, provision of specific information on the migration and accumulation of contaminants in regional food webs, and assessment of environmental effects of RMA contamination (pp. 1-8, 1-12). Objectives of the prairie dog study were to estimate minimum population densities and overall distribution of prairie dogs on RMA, to determine the relationship of this distribution to major sites of contamination, and to estimate the number of prairie dogs available as prey for bald eagles and other raptors (p. 3-16).

Dates of Study. Summer 1987 and January 1988.

Summary of Study. Visual counts were conducted at 20 locations on RMA in 1987 and at 12 locations on RMA in 1988; the latter included two locations in Section 36 and two in Section 25 near to contaminated areas. The method for selecting count locations was not specified, but appears to have been similar to that used in Study I (above). Sampling design for contaminant analysis specified the collection of 39 carcass samples (18 from two contaminated areas onpost, 13 from a control site onpost, and 8 from a control site offpost). Precise collection locations were not reported and the extent of soil contamination at the collection locations apparently was not assessed; the offpost control site was not identified. Counts of juvenile/adult ratios were reported also by MKE (1989a) and are discussed under Study I (above).

Summary of Results. Contaminant concentrations were reported in Table 4.3-1. High concentrations of dieldrin were measured in most samples from contaminated areas (Section 36 and the Toxic Storage Yard; range 0.064-13.4 ppm, N=19), lower concentrations in a few samples from onpost control areas (BDL-0.346 ppm, N=14); all samples from offpost control areas were BDL (N=18). Population estimates averaged about 20 animals/ha and did not differ significantly between winter and summer, or between contaminated and control areas in winter (Tables 5.3-1 to 5.3-3). However, only one of the four count locations was within the part of Section 36 where prairie dogs were sampled for contamination (Figures 4.3-12 and 5.3-1).

STUDY III (RLSA 1992)

Study conducted by: R.L. Stollar & Associates, Inc. (RLSA 1992), Vol. IV, pp. 1-11.

Purpose of Study.

"[t]o estimate the relative abundance and distribution of prairie dogs on RMA" (p. 1). The studies were undertaken because of the importance of prairie dogs as prey for highly mobile species and their role in contaminant transport (p. 1).

Dates of Study. Fall 1990; results compared with earlier surveys in 1987-1989 (p. 1).

Summary of Study. The extent and distribution of prairie dog colonies was determined by mapping, using aerial photographs and field verification. Relative abundances were determined by visual counts. Two plots were located in "potentially contaminated" areas and four control plots in areas with no known contamination (p. 4); the Figure cited mapped areas of active prairie dog towns but did not indicate the locations of the study plots.

Summary of Results. The area of active prairie dog towns on RMA declined from 1,851 ha in Oct. 1988 to 98 ha in Oct. 1989 as a result of an outbreak of campestral plague. By the time of the 1990 survey it had increased to 230 ha, in part because of reintroduction efforts. Relative abundances (animals counted/ha within towns) also declined between 1988 and 1990. The report stated that "In 1988 and 1990 the relative densities of prairie dogs in uncontaminated and potentially contaminated areas appeared to be similar" (p. 7). However, no statistical analysis was presented and no information on contamination was reported or referenced.

OTHER INFORMATION CITED

The Army also cited information from an annual report (USFWS 1993a) and minutes from a meeting (USFWS 1993b). These reports document the recovery of prairie dog populations following the plague epizootic of 1988-89. The US Fish and Wildlife Service relocated 5,229 prairie dogs to RMA between 1989 and 1991. By 1993, the area occupied by prairie dog towns had increased to 741 ha, with an estimated total population of 29,393 animals. A survey of 27 litters (locations unstated) yielded a mean of 4.44 pups per litter. The Army stated that this value was at the high end of the normal range found in several other studies, citing four published studies (only one in Colorado).

The Army also cited information on tissue concentrations in prairie dogs at RMA, including a number of specimens with concentrations of aldrin/dieldrin or DDE above the MATCs.

EPA's Conclusions:

Status: The studies and reports cited provided good information on the distribution of prairie dogs at RMA and on the effects of the plague epizootic, the reintroduction program, and natural recovery. Although not measures of absolute abundance, the data from visual counts provided useful quantitative information on relative abundance.

Health: The studies cited provided useful information on litter size and the juvenile/adult ratios at several points in time; the value of this information is limited by the small number and unsystematic selection of sample locations for juvenile/adult ratios, and by the lack of location information for the measurements of litter size. The studies document the effect of the epizootic but do not provide any information on possible interactions between contamination and plague.

Impairment: The surveys cited provided no usable information on the possible impairment of the status or health of prairie dogs, because of the lack of information on soil contamination or exposure at the survey locations. The data on tissue concentrations indicate risks to prairie dogs in some areas and risks to their predators over wider areas.

Army's Conclusions:

"Average prairie dog density had no apparent correlation with the general distribution of soil contamination in RMA where prairie dogs occur. There were no statistically significant differences ($p>0.05$) in prairie dog densities between the central colony that included portions of Sections 25 and 36, which are possible sources of contamination, and other colonies at RMA. The percentage of juveniles in the population was significantly lower at RMA in 1987 than in the offpost reference sites, but about the same in 1993. ... Comparison of measured tissue concentrations with whole-body MATC values for prairie dogs indicated that some individuals are likely to be affected by RMA contaminants. However, the effects of campestral plague, which occurs as a well-documented phenomenon in natural populations (RLSA 1992), and the subsequent managed immigration of thousands of prairie dogs, especially between 1988 and 1990, have obscured any potential effects of contamination" (p. C.5-20).

Differences between EPA's and Army's Conclusions. The first conclusion appears to be wrong because contamination levels were not reported, and no analysis of the relation between density and "general distribution of contamination" was reported, either by the original authors or by the Army. The Army's retrospective analysis is unjustified for reasons stated in EPA's comments (see comments on Retrospective Linking, Attachment 4). All the sites at which prairie dog density was measured had soil contamination levels close to or below the CRLs. The Army's second conclusion is unjustified for the same reasons. The Army's third conclusion appears to be incorrect because no information was cited for control sites in 1993.

Relation of this Study to Issues Raised by EPA.

1. Definition of Ecological "Health". This study was not conducted on a regional scale and provides no information on ecological "health" as defined by the Army.
2. Appropriateness of Off-Post Control Areas. Off-post control areas were used in all three studies, but were not described and were stated to have differed in important ecological characteristics from the on-post study-areas.

3. Spatial Scale and Within-RMA Comparisons. Although the Army's conclusions were purportedly based on comparisons among locations within RMA, underlying data were not reported in Study III. For all three studies, the comparisons were informal at best.

4. Relationship of Ecological Characteristics to Contamination Levels. No information was collected, presented, or used on soil contamination levels. Only one study plot (in Study II) was located within an area where contamination levels were measured; even in this case, there is no information on the contamination levels at or near the observation point. The claim that average prairie dog density had no apparent correlation with the "general distribution" of soil contamination was unsupported and conjectural. The Army's retrospective analysis is invalid for reasons stated elsewhere in these comments (Attachment 4).

5. Population characteristics. The studies cited provided useful information on distribution, semi-quantitative information on abundance and total RMA population, and useful information on litter size and juvenile/adult ratios.

6. Treatment of uncertainty. No discussion of uncertainty was presented either in the study reports or in the Army's summary of them, except for the Army's statement that the effects of the epizootic obscured any potential effects of contamination.

Bias, power, and relevance

The Army categorized the information on prairie dogs as "Medium" for each of the factors bias, power, and relevance (Table C.5-2). EPA's categorizations of bias, power, and relevance are as follows:

Categorization		Comments
Bias	HIGH	All studies: Off-post control areas were not described and were stated to have differed ecologically from on-post study-areas. Effects of plague and subsequent recovery may have confounded attempts to identify effects of contamination. I: Study locations were selected because

		they had large numbers of animals. II: Selection of study locations not specified, but apparently similar to that for Study I. III: Locations of study plots not indicated.
Power	MEDIUM (I)	20 study plots and 20 controls in 1987.
	LOW (II)	Only 4 study plots near contaminated areas; only one within sampled area.
	LOW (III)	Only 2 study-plots and 4 controls in 1992.
Relevance	HIGH	The studies could have provided relevant information on effects of contamination on reproduction, distribution and abundance if the problems of design had been overcome and if levels of contamination had been measured at locations of observations.

American Kestrel

The Army cited four successive studies (DeWeese et al. 1982 and unpublished, ESE 1989, RLSA 1990 and 1992, and USFWS 1992a and 1993) in its assessment of the status and health of American kestrels at RMA. These studies will be evaluated sequentially in this section.

STUDY I (DeWeese et al., 1982 and unpublished)

Study conducted by: DeWeese et al. (unpublished, ca. 1983; the report was not paginated, but page numbers have been added starting with the first page of the Abstract). The report by DeWeese et al. (1982) is not available to EPA at the time of this review, but the unpublished report appears to include the results from both years of the study.

Purpose of study:

..."to determine the magnitude of organochlorine pesticide contamination in the terrestrial system on the RMA" (p.3).

Dates of study: Spring-summer, 1982 and 1983.

Summary of study. The RMA study-area included all the land within the RMA boundary; two control study-areas were established 0.5-16 km and 68-95 km away from RMA; each study-area included several zones at different distances and directions from RMA. Habitats differed considerably both among and within RMA and control study-areas. Fifty-three nest boxes were placed in the RMA study-area and 38 in the control study-areas; locations of nest boxes were not described or mapped and spacing between boxes varied widely. Boxes were visited at 10- to 14-day intervals. Methods and criteria for determining clutch size, hatching success, and fledging success were not described. One egg was removed for contaminant analysis from each clutch laid on RMA and from "a portion" of the clutches in the control study-areas.

Summary of Results. Pooling data from the two years, 41 nest attempts were recorded at RMA, 35 in the near-RMA control area and 22 in the distant control area. Hatching success and fledging success were lower on RMA than in the control areas, but the differences were not statistically significant. However, the difference in the proportion of nestlings that died or disappeared (27% at RMA, 14% in controls) approached statistical significance ($P = 0.06$). When nests were stratified according to distance (<1.6 km, 1.6-3.2 km, and > 3.2 km) from contaminated zones (Basin A, Basin F and the chemical manufacturing plant), both nest-box utilization and nest success varied strongly with distance (Table 4). Dieldrin was detected in 25/41 eggs collected on RMA but in only 2/24 eggs from control areas. The authors stated: "When dieldrin concentrations in sample eggs were plotted against the success of nests sampled, no strong negative correlation was detected" (p.9). However, the data supporting this statement were not given, and no formal analysis was presented.

STUDY II (ESE 1989)

Study conducted by: Environment Science and Engineering, Inc. (ESE, 1989). Pages 1-1, 3-21 to 3-24, 4-37 to 4-40, 5-341 to 5-348.

Purpose of study: Part of the Biota Remedial Investigation (Biota RI), whose overall purpose was to present an overall environmental contamination assessment of biota within the RMA Study Area (p. 1-1). Specific objectives of the Biota RI included evaluation of data on contamination, provision of specific information on the migration and accumulation of contaminants in regional food webs, and assessment of environmental effects of RMA contamination (pp. 1-8, 1-12). Objectives of the kestrel study were to determine organochlorine concentrations in and nesting success of American kestrels and to compare current findings with the 1982 and 1983 results and with data on concurrent controls as an indication of trends in terrestrial contamination at RMA (p. 3-20).

Dates of study. Spring-summer, 1986.

Summary of study. "About" forty-five nest boxes were placed on RMA and on each of two control areas north of RMA, a near-zone within 10 miles and a control zone more than 40 miles away. Control areas were not described. The basis for selecting nest box locations was not stated; the distribution of boxes on RMA appears to have been haphazard, with only 7 or 8 boxes located near the more contaminated areas (Figure 3.2-3). Methods and criteria for determining clutch size, hatching success and fledging success were not described. One egg was removed for contaminant analysis from each active nest box in each of the three study-areas in each year. A "representative sample" of young kestrels was also collected prior to fledging from each area (p. 3-21).

Summary of Results. Contaminant concentrations were reported in Figures 4.3-3 and 4.3-4. Dieldrin was detected in 17/33 eggs collected on RMA, compared to 0/11 from control areas. High concentrations of dieldrin (1.01-3.63 ppm) were reported in eggs and/or nestlings from five nest boxes on RMA, including 4/8 boxes near the more contaminated areas and one in a remote area near the RMA boundary. Productivity of kestrels on RMA in 1986 was 2.24 fledged/nest attempt, higher than on RMA in 1982 and 1983, but still lower than in control areas in 1986 (2.78 fledged/nest attempt) (Table 5.3-6). Most nest failures were in boxes along First Creek; 2/5 of the failures in this area and 1/4 elsewhere were associated with high dieldrin levels. However, the report did not analyze the relationship between reproductive success and contamination levels.

STUDY III (RLSA 1992)

Study conducted by: R.L. Stollar & Associates, Inc. (RLSA 1992), Vol. IV, pp. 13-15. The Army also cited RLSA (1990), but the 1992 report appears to include all the information on American kestrels for both survey years except the contamination data for 1988.

Purpose of Study. Not stated (p. 14).

Dates of Study. May-July 1988 and 1990; results compared with earlier surveys in 1982-1986 (p. 14).

Summary of Study. Fifty nest boxes were observed at RMA in each year, including the 45 used in Study II plus five new boxes installed in 1988; 23 off-site boxes (locations unstated) were observed in each year. "Eggs and nestlings were selected from among the occupied boxes most correlated with the RMA BSAs and appropriate control areas. Data on nest occupancy and success were collected incidentally to this sampling program." Methods and criteria for determining clutch size, hatching success and fledging success were not described.

Summary of Results. Results are presented in Table 6.3-1. On RMA, 17/50 nest boxes were occupied in 1988 and 21/50 in 1990; off-site, 5/23 were occupied in 1988 and 7/23 in 1990. Locations of occupied boxes were not described or mapped. Mean productivity was lower on RMA than in the off-site nests in each year (1.14 vs 1.20 in 1988, 1.52 vs 2.11 in 1990), but the differences were not statistically significant (p. 15). Contaminant concentrations are reported in Table 4.1-2 and 5.1-4. Dieldrin was detected in most kestrel samples from RMA and in few samples from off-site locations. Locations of collection sites were not described or mapped. No analysis was presented of the relationship between reproductive data and contaminant concentrations.

STUDY IV (USFWS 1992a, 1993)

Study conducted by: U.S. Fish and Wildlife Service (USFWS, 1992a) Pages D-7 to D-14. The Army also cited USFWS (1993) in its introductory paragraph, but did not summarize the data in the text.

Purpose of Study. Not stated.

Dates of Study. May-July 1991 (p. D-7); 1992 (pp. 27-28).

Summary of Study. This study was a continuation of Studies I-III (see above). In 1991, 46 nest boxes were monitored at RMA and 19 at four off-post control sties. In 1992, 24 breeding pairs were monitored at RMA and 11 at two off-post control sites, but only five of the off-post pairs laid eggs. No contaminant analyses were conducted in either year.

Summary of Results. In 1991, the proportion of occupied boxes was 27/46 at RMA and 12/19 at control sites. The average productivity was 3.31 fledglings/nest attempt at RMA and 3.58 at control sites. Although the occupied boxes at RMA were mapped (Figure 2) and productivity data were listed by box (Table 1), the data were not analyzed in relation to location. In 1992, the average productivity was 2.1 fledglings/pair at RMA (N=24) and 2.0 at control sites (N=5).

EPA's Conclusions:

Status: The studies provided good information on the numbers and trends of American kestrels nesting at RMA during a 10-year period, and moderately good (incomplete) information on the pattern of occupation of next boxes.

Health: The studies provided useful information on several components of reproductive success in American kestrels at RMA, and on the temporal trends in these components since 1982. Although methods and criteria for measuring these parameters were not stated in any of the studies, this information is probably reasonably reliable.

Impairment: None of the cited studies listed investigation of possible impairment among the stated objectives. Nevertheless, the studies provided some information on the possible impairment of the status and health of American kestrels at RMA. The data suggest reduced productivity on RMA relative to offsite controls, and lower occupancy and productivity in core areas of RMA versus peripheral areas, especially in 1982 and 1983. These findings are inconclusive, however, for the following reasons: poorly matched off-site controls; unsystematic placement of nest boxes; small number of nest boxes in contaminated areas, and low occupancy of these boxes; limited analysis of the relationship of reproductive success to location; inadequate information and lack of analysis of the relationship of reproductive success to contaminant levels.

Army's Conclusions: "The trends over time for on-post/off-post comparisons are not consistent. ... The information associated with tissue contaminant data from RMA and off-post control areas (Attachment C.5-2) does not allow identification of possible contributing factors that are related to habitat .... The concentrations of dieldrin found in kestrel tissue and the reduced reproductive success in the core area are consistent with exposure pathways and possible adverse effects of contamination and suggest that there was risk associated with dieldrin, particularly in the early 1980s. However, no trend between nest success and contaminant concentrations were observed in 1988 and 1990 data for dieldrin. The statistically significant correlation between nestling mortality and DDE concentration in eggs may be spurious; it was not generally associated with higher DDE concentrations in eggs or juveniles at RMA (p. C.5-35).

Differences between EPA's and Army's Conclusions: The Army's first sentence is questionable. The most important measure of reproductive success, number of chicks fledged per nesting attempt, was lower at RMA than in the off-post areas in six of the seven years of study. The Army's claim that trends were "inconsistent" appears to be based on results for other reproductive endpoints. The Army's last two sentences are based on its retrospective analysis, which is invalid for reasons stated elsewhere in EPA's comments (see comments on Retrospective Linking, Attachment 4).

Relation of these Studies to Issues Raised by EPA:

1. Definition of Ecological "Health". This study was not conducted on a regional scale and provides no information on ecological "health" as defined by the Army.

2. Appropriateness of Off-Post Control Areas. Off-post control areas were used in each study, but the locations of the areas and the placement of nest boxes were not described precisely in any report. Habitats and other ecological information for the control areas were not reported in any study except Study I, which indicated substantial differences in habitat within and among control areas and between the control areas and RMA.

3. Spatial Scale and Within-RMA Comparisons. Study I reported a comparison of reproductive success among three zones based on increasing distance from areas thought to be highly contaminated. Study II reported an informal interpretation of the geographical pattern of nest failures. Studies III and IV did not make any within-RMA comparisons.

4. Relationship of Ecological Characteristics to Contamination Levels. Although information on contamination of eggs and fledglings was collected in Studies I, II and III, the results were not analyzed in relation to reproductive success in the original reports. The Army's retrospective analysis of this relationship is invalid for reasons stated elsewhere in these comments (see Attachment 4). The assumption in Studies I and II (and in the Army's assessment) that location within RMA is a reliable index of exposure in questionable, because Study II reported low contaminant levels in several samples collected near the core areas and a high level in one sample collected near the RMA boundary.

5. Population characteristics. The studies provided good information on the total breeding population of RMA and on reproductive success over a 10-year period. Although lethal poisoning is a known effect of dieldrin in American kestrels, no information was collected on survival of adult kestrels at RMA, either within or between breeding seasons. Although lack of occupation of nest boxes might reflect mortality, occupancy was considered as a dependent variable only in Study I.

6. Treatment of uncertainty. No discussion of uncertainty was presented either in the study reports or in the Army's summary of them, except in the Army's statement about the unknown role of habitat differences between RMA and control areas.

Bias, power and relevance. The Army categorized the information on American kestrels as "Low" for bias, "Medium" for power, and "High" for relevance (Table C.5-2). EPA's categorizations of bias, power, and relevance are as follows:

	Categorization	Comments
Bias	HIGH	Off-post control areas were not described in Studies II-IV and were stated in Study I to have differed in habitat from on-post study-areas. Nest boxes were not systematically placed and very few were placed near core areas. Variable occupancy of nest boxes was not analyzed as a dependent variable except in Study I, where large differences were reported related to location. Contaminant levels were not closely correlated with location; contaminant levels in eggs and juveniles were not correlated with ESC.
Power	MEDIUM	For RMA-offpost comparisons, offpost samples were rather small; a two-fold difference in chick loss in Study I was not statistically significant.
	LOW	For within-RMA comparisons, very few nest boxes were placed near core areas and few of these were occupied.
Relevance	HIGH	The studies could have yielded useful information on the relationship between reproductive success and contamination levels if the problems of design had been overcome and if the relationship had been analyzed in a systematic way. The results would have been more relevant if survival of adults had been measured as well as reproductive success.

Burrowing Owls

Study Conducted by: David L. Plumpton, December 10, 1991, in USFWS FY 91 Annual Progress Report.

Purpose of Study.

.....[t]o (1) determine burrowing owl abundance on the RMA, (2) locate areas on the RMA used by burrowing owls, and to quantify habitat variables in selected and non-occupied habitats, (3) determine the behaviors, productivity, morphology, and food habits of burrowing owls breeding on the RMA, (4) determine differences in behavior, productivity and density between owl populations subjected to various management treatments.

Dates of Study: 1990, 1991.

Summary of Study: Abundance was determined by vehicular and foot surveys. Physical and vegetative attributes were measured at equal numbers of nesting burrows and "control" burrows (control burrows were burrows within prairie dog towns that were not selected for nesting). Behavior, productivity, morphology, and food habit data were collected from mated pairs.

Summary of Results : A summary of results is presented on Tables 2.1, 2.2, and 3.1 through 3.9 and discussed in the text. Forty seven nesting burrows and 47 unused burrows were studied. Each year, one nest was located in a "contaminated area" (location not specified, and no soil measurements taken), but no study measurements were taken at these sites (reason not given). In both years, two burrows were in areas that were mowed. Results indicated that burrowing owls select burrows with greater nearest-perch distances than control burrows (P=0.004), as well as burrows with shorter mean grass height than controls (P=0.02). For both years combined, mean productivity was 4.38 chicks per nesting territory (range = 2 to 10).

EPA 's Conclusions:

Status: The study provided useful quantitative information on burrowing owl abundance and productivity at RMA, as well as on physical and vegetative variables associated with nest site selection.

Health: The study did not provide information on the relative "health" of burrowing owls at RMA at the individual, population, or community level, in that no offsite control sites containing nesting burrowing owls were part of the study.

Impairment: The study did not provide usable information on the possible impairment of the status or health of burrowing owls at RMA, in that there was no attempt to measure or estimate potential contaminant exposure to the burrowing owls in this study.

Army's Conclusions:

"Thus, while known diet and limited data on tissue levels

indicate contaminant exposure for some individuals, population reproductive, fledgling, and breeding return data do not reveal adverse effects on the population at RMA".

Differences between EPA's and Army's Conclusions: The Army's conclusion is inappropriate with regard to the central issue of whether contaminants at RMA are affecting individual burrowing owls or burrowing owl populations at RMA. This is because the Army considers the "population" of burrowing owls to be that occupying the entire site. See comments on appropriate scale for investigation of population impairments (Attachment 2). As pointed out in EPA's comments on retrospective linking (Attachment 4), almost all of the burrowing owls included in the Army's retrospective analysis were in uncontaminated areas. The Army's analysis, therefore, gives no information on whether burrowing owls are prevented from occupying more contaminated areas, whether those that attempt to do so are impaired, and whether the total population is reduced because of these local effects. In addition, EPA's review of the paper entitled "Movements, Activity Patterns, and Habitat Use of Burrowing Owls in Saskatchewan", by Haug and Oliphant (J. Wildl. Manage 54(1):27-35) indicates that the appropriate exposure range for burrowing owls has a radius of 600 m (approximately 1968 ft), not 2874 feet. The Army's retrospective analysis is invalid for these, as well as for other reasons (see Attachment 4).

Relation of this Study to Issues Raised by EPA:

1. Definition of Ecological "Health". This study was not conducted on a regional scale and provides no information on ecological "health" as defined by the Army.
2. Appropriateness of Offpost Control Areas. There were no offpost control areas in the burrowing owl study.
3. Spatial Scale and Within-RMA Comparisons. The primary comparison in this study was between used and unused burrows within RMA prairie dog towns. Although one nest each year was located within the "contaminated" area, no measurements of contamination were taken, and no study variables were measured at these nests. Second, nesting birds were compared for various behavior, productivity, morphology, and food habit variables, but these comparisons were all within RMA, and unrelated to contamination.
4. Relationship of Ecological Characteristics to Contamination Levels. No information was collected, presented, or used in the original study regarding soil contamination levels. The Army's retrospective analysis is invalid for reasons stated elsewhere (see Attachment 4)
5. Population Characteristics. Repeated searches conducted throughout the summer suggest that most of the burrowing owls on RMA were identified and included in this study. This gives an accurate representation of population abundance of burrowing owl on the Arsenal.
6. Treatment of Uncertainty. No discussion of uncertainty was presented either in the study report, or in the Army's summary of it.

Bias, power, and relevance:

The Army apparently included this study in the group of Avian reproductive success studies, which it categorized as low, medium, and high for the factors bias, power, and relevance, respectively (Table C.5-2). EPA's categorizations of bias, power, and relevance are as follows:

	Categorization	Comments
Bias	LOW	The original study has low bias, in that adequate data were collected to measure abundance and productivity of burrowing owls on RMA; within-RMA comparisons can be made with low potential for bias.
Power	HIGH	Because most of the population of burrowing owls at RMA were identified and included in the study, the power of the study to accomplish the stated objectives is high.
Relevance	LOW	Because most or all of the burrowing owl nests were in areas with low soil contamination, there is no a priori hypothesis that reproduction would have been impaired. The study would have been more relevant if owls had been nesting in more contaminated areas (but in that case the power to detect effects would have been low).

Fortuitous Observations, Incidences of Mortality, and Morbidity Studies.

Studies conducted by: ESE 1989; USFWS; and others.

Purpose of study: Not stated.

Dates of studies: 1989 to present

Summary of studies:

The present IEA/RC (March, 1994) uses information from the fortuitous sample collection program in two sections and one attachment: (1) Section C.5.3.4 (pages C.5-57 and 58) entitled, "Incidences of Mortality," (2) Section C.5.4.2.3 (pages C.5-63 and 64), entitled "Morbidity," and Attachment C.5-3, entitled "Information on Fortuitous Samples Collected by the U.S. Fish and Wildlife Service between 1990 and 1993."

A discussion of animal mortality is provided in Section C.5.3.4 (pages C.5-57 and 58). A number of historic studies of animal mortalities are presented, linking animal deaths to contaminants. The information presented for 1989 and later is primarily derived from periodic reports of necropsy studies of animals found dead or dying on the Arsenal. The data are, at least in part, summarized in Table C.5-13. This chart contains 24 entries consisting of 23 moribund or dead animals (18 birds, three mammals, one fish, and one reptile) and one report of an interview with the "Building 111/112 Dead Bird Patrol". While not so specified in this section, this listing represents a selected grouping of the dead and dying animals found on RMA. Table C.5-3.1 indicates that samples from an additional 10 animals have been sent for analysis but no results are yet available. This table also indicates that an additional 285 samples were submitted for analysis "but the data reported from these samples may have been improperly reported and are under investigation."

Over the past five years, there have been over 240 recorded instances of wildlife mortality at RMA, recorded in a document entitled the Special Purpose Salvage Log (SPSL). This describes animal mortalities and incidents related to morbidity and trauma. The dead or moribund animals are referred to as "fortuitous samples."

Review of the fortuitous samples collected on RMA between 1989 and 1993 indicates that some 190 birds and 50 mammals were found during this period. Table C.5-3.2 indicates that results are available for one mammal, a badger collected in 9/92 and reported to have dieldrin in concentrations of 13 ppm in liver and 75 ppm in fat. These results are qualified, and have been submitted for reanalysis (see Table C.5-3.1).

Summary of results:

The Army has summarized the results of the several studies considered in the Incidences of Mortality section as follows

(page C.5-58):

> Incidents of extensive wildlife mortality have occurred in the past at RMA. The extent and implications of current mortality are not well documented and poorly understood, but it is substantially less than that documented in the 1950s and 1960s (see Appendix A).
>
> The extensive analytical data reported in the Biota RI (1989) and the subsequent Biota CMP (1988-90) shows variable concentrations of organochlorine pesticides in individuals of all taxa sampled. Dieldrin levels were as high as the 56 ppm reported in a mourning dove carcass found on the lawn of Building 111. Thus, potentially lethal concentrations of organochlorine pesticides, chiefly dieldrin, occur in the tissues of some individuals of certain mammal and bird species (Attachment C.5-2). Dieldrin is the contaminant most likely to be detected at injurious levels and occurs in a variety of trophic levels and species.

EPA's conclusions:

For the 1990-1993 period only one analysis result is reported. EPA believes that there are no consistent data to support conclusory statements related to current morbidity or mortality among RMA animal populations based upon the fortuitous sample collection program.

If mortalities were currently being produced in individuals or resident populations as a result of exposure to organochlorine compounds, a wide variety of sub-lethal effects would also be expected.

Army's conclusions:

Despite the contaminant levels detected, current contamination-related mortality is not believed to be causing deleterious effects on the overall abundance or richness of wildlife populations at RMA. Wildlife resources are generally quite abundant at RMA and the species composition is quite diverse for the Rocky Mountain/plains grassland ecotone of eastern Colorado (page C.5-58).

Differences between EPA's and Army's conclusions:

The Army's conclusion regarding the "current contamination-related mortality" has no apparent basis, given that analysis results are available for only one specimen in the recent (1990-93) period.

Bias, power, and relevance:

The Army has categorized the bias, power, and relevance of the fortuitous observations as medium, N.A., and high, and the

morbidity studies as medium, low, and medium. EPA's categorizations of bias, power, and relevance are as follows:

Categorization		Comments
Fortuitous Observations		
Bias	HIGH	The data can neither define nor measure the problem or question being addressed.
Power	NA	The null hypothesis cannot be addressed by these data.
Relevance	LOW	As previously noted, the data were never intended to measure the effects about which the Army draws conclusions.

Morbidity studies:

The morbidity studies categorized by the Army under this section (C.5.4.2.3) are a collection of studies previously discussed in detail elsewhere in both the IEA and reviewed in this document. These studies included deer mortality and general health, bald eagles general health and potential exposure, great horned owl individuals exhibiting symptoms of contamination, fortuitous observations and necropsy reports, and vegetation presence and growth.

Categorization		Comments
Bias	MEDIUM	No clear study design or question addressed. Controls or reference ranges not defined.
Power	LOW	In some cases the null hypothesis cannot be addressed by the information available, in other cases it cannot be rejected with reasonable probability.
Relevance	LOW	The studies used in this section were not designed to address the question as posed by the Army. In no case was there an a priori hypothesis present for the study in question.

Songbirds

Study conducted by: Morrison-Knudsen Environmental Services, Inc, (MKE, 1989a) Pages 1, 25-32, 66-83.

Purpose of Study.

... [t]o (1) document the distribution and relative abundance of [small birds] across the RMA, (2) evaluate [small bird] use at RMA in relation to habitat types and contamination sources, and (3) compare [small bird] use at RMA with selected offsite areas. (p. 1)

Dates of Study. February-March 1986; May-June 1986.

Summary of Study. Winter surveys were conducted along 26 transects on RMA and along 5 transects at each of two control sites. Each transect was 500m long. Only two transects were within core contaminated areas (pp. 26-27).

Breeding birds were counted (spot counts of singing males) in 111 plots on RMA and in 27 plots at each of two control sites. Each plot was 100 x 100 m (1ha). Plots were positioned at regular intervals along roads; although not randomized, they covered all parts of RMA including core contaminated areas. Habitat variables were measured on each plot. Control sites were mapped and were assessed through the habitat variables.

Summary of Results. Results were presented in Tables 4-4 (winter surveys), 4-5 and 4-6 (breeding bird surveys). Only two species (horned lark and western meadowlark) were widespread in open country in winter. Frequencies of encounter varied widely among habitats and among sites. Horned larks were more abundant at one control site than at RMA and meadowlarks were more abundant at the other control site than at RMA; no statistical analyses were presented.

Only four breeding species (horned lark, western meadowlark, grasshopper sparrow, and vesper sparrow) were sufficiently numerous and widespread for statistical analyses. Because of the small size of the sample plots, numbers of birds per plot ranged only from 0 to 3, with means of less than 1 for each species (Tables 4-5 and 4-6). All four species were significantly more frequent at the control sites than at RMA, the differences holding across major habitat divisions. Multivariate analysis of the habitat variables suggested that much of these differences was attributable to habitat differences, specifically to greater structural complexity of the vegetation at the control sites. Within RMA, comparisons within habitat categories showed no significant differences between plots located within Section 36 (presumed to be contaminated) and plots far from presumptively contaminated areas. However, the significance of this finding is limited: (i) sample sizes were very small (e.g., nine birds of two species in eight plots in two habitat types in Section 36); (ii) the comparison was not controlled for the habitat variables found to be important in the between-site comparisons; (iii) all plots were beside roads, so the assumption that those in Section

36 were all contaminated is questionable; (iv) levels of soil contamination were not measured or referenced.

Descriptive information on the occurrence, diversity, and distribution of songbirds on RMA was also presented (pp. 82-83).

EPA's Conclusions:

Status: The study provided useful qualitative information on the occurrence and distribution of songbirds at RMA and extensive quantitative information on their relative abundance and use of different habitats.

Health: The study did not provide information on the "health" of songbirds at RMA at the individual, population, or community level.

Impairment: The study did not provide information on the possible impairment of the status or health of songbirds, except for documenting the presence of a few singing males of two species beside roads within the core contaminated areas.

Army's Conclusions:

"The lower abundance and density of songbirds at RMA relative to control areas have been attributed to differences in habitat" (MKE 1989a) (p. C.5-50). The Army also cited contaminant levels in fortuitously collected samples of songbirds (Attachment C.5-2) and concluded: "there is evidence that individual songbirds are being adversely affected by contaminants at RMA" (p. C.5-51).

Differences between EPA's and Army's Conclusions: Although there is no major difference between the conclusions of EPA and Army about songbirds, the Army's conclusion did not address the within-RMA comparisons that were discussed in the text. The Army quoted without qualification MKE's (1989a) conclusion that "no within-site variation was attributable to trends in contamination" (p. C.5-50).

Relation of this Study to Issues Raised by EPA:

1. Definition of Ecological "Health". This study was not conducted on a regional scale and does not provide information on ecological "health" as defined by the Army.

2. Appropriateness of Off-Post Control Areas. Off-post control areas were used in this study and (in contrast to other studies cited in this report) were thoroughly characterized for habitat variables. The results of this characterization showed major differences in habitat characteristics between the control areas and RMA. Although in this case the multivariate analysis permitted control for these differences, this result illustrates the importance of proper selection and characterization of control areas.

3. Spatial Scale and Within-RMA Comparisons. Although the

conclusions of this study were based on statistical comparisons among zones within RMA, the sample plots were all located beside roads and the assumption that they were representative of contamination zones is questionable.

4. Relationship of Ecological Characteristics to Contamination Levels. No information was collected, presented, or used on contamination levels. The inference that comparison among plots within zones was equivalent to comparison among levels of contamination was unsupported and is questionable in view of the non-random location of the plots.

5. Population characteristics. No information was collected on population characteristics. The spot counts of singing males are crude indices of relative abundance, but the numbers of birds counted per plot were very small and evidence that the birds were breeding successfully was not presented.

6. Treatment of uncertainty. No discussion of uncertainty was presented either in the study report or in the Army's summary of it.

Bias, power, and relevance: The Army categorized the information on songbirds as "Medium" for each of the factors bias, power, and relevance (Table C.5-2). EPA's categorizations of bias, power, and relevance are as follows:

	Categorization	Comments
Bias	HIGH	Although the breeding bird study measured and controlled for differences in habitat variables, the location of plots beside roads meant that the plots were not representative of the zones they were used to characterize. The winter surveys were not controlled for the differences between sites that were measured in the summer survey.
Power	LOW	Winter survey had very small numbers of transects within habitat types and large variance counts. Breeding-bird survey had very small plots (mean count less than 1 bird per species per plot).
Relevance	MEDIUM	Within-RMA comparisons could provide data relevant to an *a priori* hypothesis of population effects of contaminants if original

data could be found and compared with matched data on soil contamination for the same locations.

Small Mammals

Study conducted by: Morrison-Knudsen Environmental Services, Inc. (MKE, 1989a) Pages 1, 21-24, 58-62.

Purpose of Study.

.... [t]o (1) document the distribution and relative abundance of [small mammals] across the RMA, (2) evaluate [small mammal] use at RMA in relation to habitat types and contamination sources, and (3) compare [small mammal] use at RMA with selected offsite areas. (p. 1)

Dates of Study. November 1986 and June 1987 (p. 21).

Summary of Study. Mice, voles and shrews were surveyed by live-trapping. Sixteen locations on RMA were sampled in 1986 and 11 in 1987. Most of the locations were in peripheral areas of RMA with about six locations (1, 2, 13, 21, 22, 27) near to contaminated areas (p. 22). However, information was neither collected nor referenced on contamination and the precise locations of study-areas were not reported. Each location was an area 50m x 300m, positioned well within a distinct habitat type. Eight habitat types were sampled in 1986 and ten in 1987 (only one in both years). Numbers of trap-nights per habitat type ranged from 75 to 720.

"Emphasis was placed on documenting species occurrence and comparing use among different habitat types." "Random, statistically independent samples were not necessary because the objective was species identification, not a quantitative comparison." (pp. 21-24)

Three control sites were located at Buckley Air National Guard Base in November 1986 only. The sites were not described except to "habitat type." Trapping effort was 180 trap-nights at each site.

Summary of Results. Results for RMA were presented in Tables 4-2 and 4-3 (pp. 59-60), results for Buckley were given in summary form in the text. Seven species of small mammals were trapped; trapping frequencies varied by species and habitat from zero to 31.9 animals per 100 trap-nights. "Statistical tests of differences in abundance among locations were not practicable because of the low capture frequencies" (P. 58). Pooling all species and comparing mean capture frequencies (animals/100 trap-nights) indicated that mean abundances were higher at Buckley than RMA in native grasslands (9.4 vs 1.2) and crested wheatgrass (5.6 vs. 2.8), but higher at RMA in cheatgrass (8.6 vs 3.3). "These differences were apparently related to differences in habitat, rather than to contamination per se, because the highest abundances at RMA were in weedy areas near the disposal basins and manufacturing areas" (p. 58). The basis for the last statement is not given in the report, since data are averaged by habitat. The Tables give individual data for only five locations; one of these was not mapped, three were peripheral; only one (no. 27) was near a disposal basin, and none was near a

manufacturing site. No basis was given for the suggestion that habitats differed between Buckley and RMA.

EPA's Conclusions:

Status. The study provided useful qualitative information on the species of small mammals at RMA and semi-quantitative information on their relative abundance and use of different habitats.

Health. The study did not provide information on the "health" of small mammals at RMA at the individual, population, or community level.

Impairment. The study did not provide useful information on the possible impairment of the status or health of small mammals.

Army's Conclusions:

"The highest mean abundances of small mammals at RMA were in areas of weedy forbs/grasses north or east of Basin F (MKE, 1989a); evaluation of trends between small mammal abundance and ESC values showed no indication that small mammal abundance is deleteriously affected by aldrin/dieldrin contamination")p. C.5-28).

Differences Between EPA's and Army's Conclusions: The first part of the Army's conslusory sentence is correct but irrelevant, since there is no specific information on contamination or exposure in the areas referenced. The second part of the conclusion is unjustified for reasons stated in EPA's comments on Retrospective Linking, Attachment 4.

Relation of this Study to Issues Raised by EPA:

1. Definition of Ecological "Health". This study was not conducted on a regional scale and provides no information on ecological "health" as defined by the Army.

2. Appropriateness of Off-Post Control Areas. Off-post control areas were used for only three of the 18 habitat types and for only one of the two years (seasons) of the study. Off-post control areas were not described in any way except by statement of habitat type. The study report invoked assumed differences in habitat between the on-post study-areas and the off-post control areas as an explanation for the differences found. Hence, the control areas, as described, were not suitable for rigorous comparisons.

3. Spatial Scale and Within-RMA Comparisons. Although the conclusions of this study were purportedly based on comparisons among locations within RMA, the comparisons were informal at best and underlying data were not presented.

4. Relationship of Ecological Characteristics to Contamination Levels. No information was collected,

presented, or used on contamination levels at the locations where mammals were trapped. The Army's retrospective attempt to relate abundances to ESC values is invalid for reasons stated elsewhere in these comments (see Attachment 4).

5. Population characteristics. No information was collected on population characteristics. Data on trapping frequencies were used to make inferences about "abundances", although the objective of the study was not to make quantitative comparisons and the data are unsuitable for this purpose.

6. Treatment of uncertainty. No discussion of uncertainty was presented either in the study report or in the Army's summary of it.

Bias, power, and relevance

The Army categorized bias, power, and relevance for this study as medium, medium, and medium, respectively (Table C.5-2). EPA's categorizations of bias, power, and relevance are as follows:

Categorization		Comments
Bias	HIGH	Study design not intended for quantitative comparisons; control areas not described and stated to differ in habitat; within-RMA comparisons not matched for species or habitat
Power	LOW	Study design not intended for quantitative comparisons; statistical tests not practicable
Relevance	MEDIUM	Within-RMA comparisons might have provided some data relevant to an *a priori* hypothesis of population effects of contaminants if co-located data on soil contamination had been collected.

Bald Eagle

The bald eagle differs from other species considered in this report in two important respects. First, it is a winter visitor to RMA, and individual birds range over wide areas. Hence, the composition of the "population" at RMA changes from year to year and even from day to day. In consequence, much of the information on bald eagles at RMA is in the nature of descriptive surveys rather than systematic or controlled studies of sample areas or representative individuals. Second, the bald eagle is an endangered species, so that assessments of risk and potential impairment need to be made on an individual as well as a population basis.

The information available on bald eagles at RMA includes a series of detailed surveys of the ecology and behavior of the wintering birds, and a number of measurements of contaminant concentrations in birds trapped at RMA. Studies through 1990 were described in two major study reports (ESE 1988b, USFWS Final Report on Bald Eagle Study, December 1992, not cited in the IEA/RC); continued studies in 1991 and 1992 were reported in annual reports of the U.S. Fish and Wildlife Service (USFWS 1992a, 1993a). The Army also made conclusory statements about potential exposure to eagles at RMA, but did not cite most of the information on contaminant concentrations in prey, in other raptors that feed on the same prey, and in a bald eagle that was found dead at RMA. This section of EPA's review, therefore, briefly reviews the available information without following the sequence of topics and studies cited by the Army.

NUMBERS, FEEDING HABITS, AND BEHAVIOR

Detailed information on numbers, feeding habits, and behavior of bald eagles at RMA is presented in the four reports cited above (ESE 1988b, USFWS Final Report 1992a, 1993a). Bald eagles occur at RMA from late October to March, with peak numbers in late December or January. Peak one-night counts at the roost increased steadily to 38 in 1990-91, but declined to 30 in 1991 to 1992. The proportion of subadult birds declined from 78% in 1986-1987 to between 50% and 60% in recent years. Individual birds studies by telemetry regularly moved on and off the site. The primary food items on RMA are prairie dogs (70-80% by frequency) and rabbits (15-25% by frequency). Eagles commonly obtain prey by stealing from other raptors, especially ferruginous hawks.

CONDITION AND TISSUE LEVELS OF CONTAMINANTS

The Army stated: "The majority of bald eagles captured at RMA have been within normal ranges for size, weight, and condition for their age and the time of year when they were captured (personal communication from M. Lockhart to Michael Macrander of Shell, 1993)." The information on which this statement is based, including reference ranges, apparently is not available for review.

Between 1987 and 1990, blood was taken from 90 bald eagles captured at RMA and was analyzed for organochlorine contaminants and certain metals. Dieldrin was found above detection limits in 20 samples (22%), ranging up to 70 ppb. DDE was found above detection limits in 34 samples (38%), ranging up to 280 ppb. PCBs were found above detection limits in 9 samples (10%), ranging up to 710 ppb. Mercury, lead, selenium, and arsenic were also found in many blood samples (USFWS 1992b, 1993a). The Army, citing USFWS (1992b), stated that none of the detected concentrations exceeds the lower limits of concern (p. C.5-39). The basis for this statement is unclear. Additionally, most of the birds were trapped relatively early in the winter seasons, before they would have had time to accumulate organochlorine contaminants in their tissues to steady state levels that would reflect their average exposure at RMA.

Fat samples were taken by biopsy from 11 eagles trapped in the winters of 1991-92 and 1991-92 and were analyzed for organochlorine contaminants. All the samples contained a variety of organochlorine compounds; for example, dieldrin ranged from 0.13 to 1.6 ppm, DDE from 0.58 to 20 ppm, and PCBs from 1.2 to 28 ppm; the highest concentrations of these and other analytes were found in the same individual. Endrin was detected in one sample at 0.18 ppm. The Army, again citing USFWS (1992b), stated that none of the detected concentrations exceeds the lower limits of concern (p. C.5-39). The basis for this statement is unclear, however: assuming that fat would comprise 20% of the total body mass, the individual with the highest concentration would have had a whole-body concentrations of DDE higher than the MATC, and a whole-body concentration of dieldrin approaching the MATC.

One eagle found dead on RMA and analyzed for COCs contained 0.276 ppm dieldrin and 1.70 ppm DDE in its muscle tissue, with corresponding concentrations in liver (0.11 ppm dieldrin, 0.40 ppm DDE) and brain (0.11 ppm dieldrin, 0.40 ppm DDE) (Attachment C.5-2, Tables 5.1-4 and 5.1-7). Based on the expected partitioning of these chemicals between muscle, liver, and whole body, this eagle may well have exceeded the MATCs for both dieldrin and DDE.

CONTAMINANT CONCENTRATIONS IN PREY AND IN OTHER RAPTORS

Attachment C.5.2 to Appendix C.5 of the IEA/RC lists high concentrations of dieldrin in many samples of prairie dogs and cottontails from several Sections of RMA (not limited to Section 36). Page C.5-46 and Attachment C.5.2 list high concentrations of dieldrin in several birds of prey, including lethal concentrations in the brains of single great horned owls, red-tailed hawks, and ferruginous hawks. Attachment C.5.2 (Figures 4-14 to 4-16) shows numerous sightings of raptors, including red-tailed hawks, rough-legged hawks, ferruginous hawks, and bald eagles, around and even within the more contaminated areas of RMA. Based on the known diets of bald eagles at RMA and their habit of stealing food from ferruginous hawks and other raptors, this information indicates that bald eagles at RMA are at risk of exposure to prey containing high concentrations of dieldrin.

EPA's Conclusions:

Status: The surveys cited provide good information on the numbers of bald eagles at RMA since the roost was discovered in 1986, and on their roosting behavior, foraging behavior, flight range, and diets.

Health: The information reviewed does not provide significant information on the "health" of individual eagles or that of the "population" of eagles using RMA.

Impairment: The information reviewed does not provide information on actual impairment of survival, reproduction, or other functions of eagles at RMA. Based on the contaminant levels found in eagles, their prey, and other consumers of eagle prey, bald eagles at RMA are potentially exposed to hazardous concentrations of contaminants in their prey.

Army's Conclusions:

"The current general health of bald eagles at RMA does not reveal any adverse effects of RMA contamination, and bald eagles are unlikely to be significantly exposed to contaminants while wintering at RMA. These two considerations do not suggest that eagles are likely to be adversely affected by contamination at RMA." (p. C.5-39).

Differences between EPA's and Army's Conclusions: EPA considers the Army's conclusions to be unwarranted.

1. There is no information on the "general health" of bald eagles at RMA. The Army cited a personal communication that the "majority" of bald eagles captured at RMA have been within "normal ranges" for size, weight and condition for their age and the time of year when they were captured. However, size, weight, and condition convey little useful information about potential toxic effects of RMA contaminants because these contaminants generally do not affect size, weight, or condition, except in the terminal phase of lethal poisoning by dieldrin and endrin.

2. The Army's claim that bald eagles are "unlikely to be significantly ...exposed to contaminants while wintering at RMA" is inconsistent with the information cited above on the concentrations of dieldrin in their prey, the sightings of bald eagles and other raptors in contaminated areas, and the deaths of other raptors (including a ferruginous hawk) with lethal concentrations of dieldrin in their tissues.

3. The Army's conclusions do not reflect consideration of the data on concentrations of organochlorines in the fat of eagles captured at RMA, and in the tissues of the eagle found dead at RMA.

4. "Likelihood" of exposure and blood chemistry data from captured birds, even if correctly cited and interpreted, would provide information only about potential adverse effects of contamination. It is

inappropriate to argue from this information that adverse effects are not revealed.

Relation of Bald Eagle Studies to Issues Raised by EPA: In its comments dated September 20, 1993, EPA presented eight specific issues raised by the Army's draft of Appendix C.5. One of these eight issues was specific to the bald eagle, and is addressed in detail in this section of the report.

Bias, power, and relevance: The Army categorized the information on abundance of bald eagles as "medium" on each of the factors, bias, power, and relevance. The Army categorized the information from "Morbidity Studies" (sic) of bald eagles as Medium, Low, and Medium, respectively, on these factors (Table C.5-2). EPA considers it difficult to categorize these surveys according to "bias" and "power", because they were generally in the nature of descriptive surveys rather than systematic studies testing specific hypotheses about status, health, or impairment. EPA would rank most of the information as of "High" relevance -- including the information on numbers, trends, behavior, foraging habits, diet, contaminant levels in prey, and contaminant levels in other raptors that feed on the same prey. However, the information on contaminants in blood and fat of captured eagles is of "low" relevance, because most of the eagles were captured early in the season and reference ranges are not available. The information on size, weight, and condition of captured eagles would be of "Low" relevance to assess contaminant effects, because the RMA contaminants generally do not affect size, weight, or condition except in the terminal phase of poisoning by dieldrin and endrin.

Table C.3-1 EPA's Characterization of Bias, Power, and Relevance Ratings of RMA Studies Selected to Evaluate Ecological Endpoints Relevant to Risk Characterization

Study	Bias[1]	Power[2]	Relevance[3]
Aquatic snail population density and biomass	High	Low	Low
Grasshopper abundance	High	Medium	Medium
Earthworm population density	High	Low	Low
AChE inhibition in mammals and birds	High	Low	Low
Eggshell thinning	High	Low to Med	Low
Prairie dog population density and age ratios			
I. distribution/abundance/ habitat use	High	Medium	High
II. contamination assessment	High	Low	High
III. distribution/abundance/use	High	Low	High
Avian reproductive success			
American kestrel			
(RMA-offpost comparison)	High	Medium	High
(Within RMA Comparison)	High	Low	High
Burrowing owl	Low	High	Low
Fortuitous observations and incidences of mortality	High	NA	Low
Other abundance studies			
songbird distribution/ abundance/use	High	Low	Medium
Small mammal distribution/ abundance/use	High	Low	Medium
Morbidity studies	Medium	Low	Low
Bald Eagle			
ecology/behavior	NA	NA	High
contamination	NA	NA	Low
size, weight, condition	NA	NA	Low

[1] Bias is the magnitude and direction of the tendency to measure something other than what was intended. Criteria for evaluation are:

1. Study design fully documented and sufficient such that samples or observations are representative of intended object of study; and

2a. Control areas fully described and characterized, and matched to study areas in terms of all factors likely to affect the characteristic being measured except levels of exposure; or (in case comparisons are made among samples with different levels of contamination)

2b. Samples matched in terms of all factors likely to affect the characteristic being measured except levels of exposure; levels of exposure measured in comparable ways among samples.

High: One or other of the criteria are not met (e.g., samples not representative, control areas not described or characterized, areas not appropriately matched, or samples no appropriately matched).

Medium: One or other of the criteria not fully met (e.g., control areas inadequately characterized, or areas or samples incompletely matched).

Low: All of the criteria are met.

[2] Power is the probability of rejecting the null hypothesis when in fact it is false and the alternative hypothesis is correct. Criteria for evaluating power are:

1. Close correspondence between the quantities that are measured and the biological characteristics that are under investigation; and

2. ability of the study design to capture the major sources of variance in the quantities that are measured; and

3. (statistical power) ability of the study design to detect an ecologically meaningful difference in the biological characteristics that are measured if such a difference in fact exists and is related to levels of contamination.

High: All of the criteria are met.

Medium: Uncertainty about one or more of the above criteria.

Low: One or more of the above three criteria are not met.

[3] Relevance is pertinence to the matter at hand. Criteria for evaluating relevance are:

1. The study involves a measurement endpoint related to an a priori hypothesis that the endpoint would be affected by one of the contaminants present at RMA; and

2. the measurement endpoint reflects some aspect of "status" or "health" as outlined above; and

3. the a priori hypothesis is consistent with the predictions of the ecological risk characterization; and

4. the study is carried out on a scale appropriate to this prediction.

High: All of the criteria are met.

Medium: Uncertainty about one or more of the above criteria.

Low: One or more of the above criteria is not met.

In all cases, professional judgement is needed to interpret and apply these criteria, including the words "related", "consistent", and "appropriate".

ATTACHMENT 4

Retrospective linking of data on measurement endpoints to soil concentrations.

In this version of the IEA/RC, the Army has added five sections in which data on measurement endpoints are linked to estimates of exposure soil concentrations (ESC). These sections appear on p. C5-25 (prairie dog), C.5-27 to C5.28 (small mammals), C.5-32 to C.5-34 (American Kestrel), C.5-40 to C.5-41 (great horned owl) and C.5-43 (burrowing owl). EPA cannot support the material presented in these new sections and the conclusions drawn therein, for the following reasons:

1. In none of the five cases was the analysis of the endpoint in relation to exposure soil concentration part of the original study design or even the original study objectives. The analyses are retrospective attempts to relate the endpoints measured in the original field studies with values of ESC that were derived later for different purposes. It is inappropriate to present these retrospective analyses under the headings "study findings," as is done in these new sections. The analyses should be presented, if at all, under a separate heading making clear the retrospective nature of the investigations and discussing the limitation of this approach.

2. None of the original studies included a precise map or other precise information on the location of study plots. Only in the case of the American kestrel could the locations of the study sites (nest boxes) be determined retrospectively with any precision; however, the text of Appendix C.5 is silent about methods used to determine nest box location and their precision. It is unclear that the locations of study plots vaguely described or vaguely mapped in old reports can be determined retrospectively with sufficient precision for the purposes for which they are now used. In the section on prairie dogs (p. C5-25), for example, one sample site is located as "in the northwest quarter of the southwest quarter of Section 31" -- i.e., somewhere within a square 400 m x 400 m. After pursuing the maps in this report (MKE 1989a), EPA believes that this is about the maximum precision that can be achieved.

3. In earlier comments, EPA has objected to the derivation of ESC and to the use of ESC as a measure of exposure. EPA reiterates its previous opinion that ESC is not an acceptable measure of exposure for any species. In particular, values of ESC are not correlated with values of TC, the concentrations of contaminants measured in the tissues of prey species sampled at RMA. This finding is reinforced by a lack of correlation between ESC and tissue concentrations in the predatory species for which data are presented in the current draft of the IEA/RC (Tables C.5-7 and C.5-11). Accordingly, EPA considers that ESC is not an acceptable measure of the exposure of the species for which these retrospective analyses are conducted. In general, therefore, analysis of the relationship between measurement endpoints and ESC is not an acceptable way to investigate potential effects of contamination.

4. With one exception (American kestrel), the analyses of the relationship between measurement endpoints and ESC are informal and not rigorous.

In addition to these general objections to the retrospective analyses, EPA has the following comments on specific cases:

Prairie Dogs (p.C5-25). Although not clearly stated, the data appear to be derived from the study by MKE (1989a). As stated (p.C5-25), nineteen of the twenty study sites were located in areas where dieldrin levels were below the "detection limit" (presumably meaning the CRL). [This reflects and illustrates EPA's general comments, that most biota studies cited in Appendix C.5 were focused on areas of low contamination.] The twentieth site was located "in the northwest quarter of the southwest quarter of Section 31." In this area of 400 m x 400 m, only five soil samples were analyzed for aldrin and dieldrin; four of these samples were BCRL for both analytes, and the combined concentration was 0.30 ppm in the fifth. It is not clear how the Army's procedures yielded on ESC value of 1.195 ppm for this location. This illustrates EPA's contention that ESC is not a valid measure of exposure. Comparison between the percentage of juvenile prairie dogs and ESC values is meaningless and no conclusions about effects of contamination can be drawn.

Small mammals (pp. C.5-27 to C.5-28). The data are derived from the study by MKE (1989a). The "analysis" presented on p. C.5-27 is informal and makes no attempt to analyze data on individual species or to control for habitat differences. As stated on p. C.5-27, most of the ESC values were driven by BCRL replacement values [another illustration of EPA's general comment that most biota studies cited in Appendix C.5 were focused on areas of low contamination]. The analysis ignores key qualifying statements in the original report by MKE: "Random, statistically independent samples were not necessary because the objective was species identification, not a quantitative comparison" (p. 24). "Statistical tests of differences in abundance among locations were not practicable because of the low capture frequencies" (p. 58). In light of these comments, the Army's retrospective analysis of these data is unjustified.

American kestrel (pp. C.5-32 to C.5-34). The data set for the retrospective comparison is presented in Table C.5-7. Both the data set and the methods of analysis present many problems:

(i) The Army pooled both RMA and offpost data. As pointed out in EPA's comments, offpost ("control") locations in this study were not identified or described, but in the 1982 study (DeWeese et al. no date) the "control" sites differed considerably in habitat, both among themselves and from the RMA study sites.

(ii) No soil concentrations or ESC values were available for the offpost sites. The dieldrin concentrations in eggs and juveniles at the offpost sites were all below or close to the CRLs, as were the DDE values in 6/9 nests.

(iii) For DDE, 3/5 egg concentrations and 5/10 of the

juvenile tissue concentrations were BCRLs; none of the positive values approached the concentrations at which adverse effects of DDE have been reported in wild or captive birds.

(iv) The ESC values for dieldrin at the onpost sites all fell within a narrow range (0.018 to 0.14 ppm) and apparently were driven largely by BCRL replacements. The ESC values for DDE all fell within a narrow range (0.006 to 0.043 ppm) and apparently were determined entirely by BCRL replacements. [This reflects and illustrates EPA's general comments, that most biota studies cited in Appendix C.5 were focused on areas of low contamination.]

(v) Within the small onpost samples, there was no correlation between ESC and either the egg or juvenile tissue concentrations, for either dieldrin or DDE. This further demonstrates the invalidity of using ESC as a measure of exposure.

(vi) The Army pooled 1988 and 1990 data, without testing for inhomogeneity or independence. In fact, 3/10 on-post nests and 4/8 off-post nests were studied in both years. In one of the on-post nests and two of the off-post nests, there were major divergences in the success variables between years. Egg concentrations were measured only in 1988, whereas concentrations in juveniles were measured in both years. For unexplained reasons, concentrations in juveniles were 1-2 orders of magnitude lower in 1990 than in 1988, including data from one nest box from which juveniles were sampled in both years.

(vii) The Army did not consider occupation of nest boxes as a dependent variable, despite the fact that DeWeese et al. (no date) reported that occupation was significantly related to distance from the core contaminated area, and despite the fact that lethal poisoning is a documented effect of dieldrin in American kestrels.

For these reasons, the data set is unsuitable for statistical analysis. The concentrations of dieldrin and DDE in all soil samples and in most tissue samples were so low that no measurable effects would have been predicted (a consequence of experimental design), so that no analysis could be justified. In consequence, the analysis performed by the Army is inappropriate.

Great horned owl (pp. C.5-40 to C.5-41). The data are presented in Table C.5-8. This table pools data from three successive years, although it is likely that some of the same birds or pairs were included in different years. Only data on ESC were available. From the "sample size" of 29 nests, ESC values were below 0.16 ppm in 27 locations; presumably these values were driven largely or entirely by BCRL replacements. [This illustrates EPA's general comment that most biota studies cited in Appendix C.5 were focused on areas of low contamination.] The informal "analysis" of the data that is presented is not appropriate.

Burrowing owl (p. C.5-43). No consensus value is available for the home range of this species.. EPA cannot support the home

range radius of 2,874 feet (home range area of 300 ha) used by the Army in calculating ESC values for this species. In spite of this inflated value used for home range radius, 92% of the nests were at locations where the computed values of ESC were less than 0.125 ppm; presumably, these values were driven largely or entirely by BCRL values. [This illustrates EPA's general comment, that most biota studies cited in Appendix C.5 were focused on areas of low contamination.] Table C.5-11 shows that at 4 of the 8 locations where ESC exceeded 1.0 ppm, the concentrations of aldrin/dieldrin in juvenile burrowing owls were low (below the MATC for great horned owl); at the only location where the concentrations of aldrin/dieldrin in a juvenile burrowing owl was above the MATC for great horned owl, the value of ESC was very low. In view of these facts, analysis of breeding success in relation to ESC would yield meaningless results; the informal "analysis" of the data that is presented is not appropriate.

Based on the foregoing facts, EPA concludes that the retrospective analyses presented in this version of the IEA/RC are unjustified. EPA requests that all these analyses be deleted and replaced by a clear statement that available data are insufficient to analyze the ecological data on any species in relation to contamination levels.

ATTACHMENT C.5-5

U.S. FISH AND WILDLIFE SERVICE'S POSITION
ON HEALTH AND DIVERSITY

As directed by the RMA Council the U.S. Fish and Wildlife Service (Service) is providing this response to the "Ecological Status and Health" Appendix (Appendix C.5) of the Integrated Endangerment Assessment/Risk Characterization for the Rocky Mountain Arsenal On-Post Operable Unit. The Service has been involved with both the implementation of several of the studies cited in the Appendix and the development of the Appendix itself. Results of the studies conducted or sponsored by the Service may be found in our Annual Progress Reports to the Army (1989-1993) and in various Master's Theses available at the Rocky Mountain Arsenal Technical Information Center. The Service has previously commented (February 2, 1994) that the findings of the Appendix accurately reflect the body of knowledge developed at the Arsenal and are scientifically defensible. Nevertheless, critiques of this Appendix have attempted to discredit the findings of these studies through misinterpretation of the biological design of the studies and the meaning of the results. These critiques use three basic arguments to misrepresent the facts:

1) The studies were not designed to address the potential effects of contaminants to individuals, populations, or communities of biota at the Arsenal.

2) The studies were not designed to measure biological endpoints relative to contaminant exposures at the Arsenal.

3) The studies were not designed as a part of the Ecological Risk Assessment for the Arsenal.

First, the argument that the studies did not address potential effects of contaminants to various levels of biological organization is not true. The referenced studies were designed to address the known effects to wildlife caused by Arsenal contaminants. These effects include changes in abundance, reproductive success, survivability, morbidity, species richness, age and sex ratios, and other biological endpoints appropriate for evaluating the actual, not theoretical, effects of Arsenal contaminants on Arsenal biota. The Service has documented over 225 birds species, 34 mammal species, 19 reptile and amphibian species and 14 fish species using the Arsenal during at least part of the year. From all of these studies of biota at the Arsenal, the Service has not been able to identify a single population of animals that is declining in number, which would be the ultimate indication of adverse effects caused by Arsenal contaminants. In fact, all animal populations at the Arsenal that have been evaluated are either self-sustaining, at a minimum, or growing rapidly. The Service has demonstrated that raptors, prairie dogs, and deer at the site reproduce at or above values cited in the literature. The Service has documented longevity in deer, coyotes, prairie dogs, burrowing owls, eagles, red-tailed and Swainson's hawks. The Service agrees and points out that an occasional individual animal may succumb from exposure to contaminants in the "core area" of the Arsenal, but this minor level of mortality has not had an effect on overall wildlife populations across the area. The answer to this problem is not continued study or manipulation of existing data, but to clean up the obvious areas of contamination and start alleviating the problem.

Second the argument that the studies did not compare results between areas of high contamination and low contamination would suggest that contaminant concentration and distribution is so heterogeneous that none of the populations studied (including those studied in the core area) can be assumed to be exposed to chemical stressors. This argument ignores a large and detailed data base developed specifically to characterize contaminant distribution across the Arsenal. This argument also ignores three simple biological facts:

A) all animals do not exist everywhere in the environment for the simple reason that appropriate habitats may not be available in all areas so this comparison cannot always be made and must be interpreted carefully,

B) the Service specifically manages some species (i.e. prairie dogs) out of some areas (i.e. Basin A) for very obvious reasons, again this comparison cannot be made for some species in some areas, and

C) most animals range over areas greater than the distribution of contaminants at the Arsenal making the comparison difficult to interpret.

Again, the Service is evaluating the effects of contaminants at the end result, effects to populations. The Service has not identified a population that is in decline at the Arsenal.

Third the argument that the studies were not designed as a part of an Ecological Risk Assessment assumes that Ecological Risk Assessment methodologies are the only appropriate way to evaluate wildlife at Superfund sites, is incorrect. The referenced studies were designed, implemented, evaluated and reported by professional, on-site fishery and wildlife biologists using standard, up-to-date techniques to establish the status and monitor trends in fish and wildlife populations no matter where they exist. Ecological Risk Assessment methodologies are undergoing intense scrutiny in the scientific community to determine if they are capable of producing the desired results or not.

Finally, it has been concluded that, since the referenced studies supposedly did not measure up to the intense "re-interpretation" leveled on them by the Risk Assessment process, that they are of little or no value to the Risk Assessment and should not be used in concert with the predictions of the Risk Assessment. The Service believes that the quantitative risk assessment is highly theoretical, uses unrealistic biological assumptions as a substitute for a lack of knowledge, and is unproven in its ability to predict biota tissue concentrations or risk to wildlife from contaminants. The Service and Appendix C.5 has approached the topic of evaluating wildlife health from a simple biological tenant; if you want to know what is happening with wildlife, instead of asking a statistician or computer to predict a result, evaluate wildlife at the population, community or ecosystem level. If an adverse effect cannot be identified at these levels of organization, any significant adverse effect does not likely exist.

ATTACHMENT C.5-6

ARMY COMMENT ON EPA'S ECOLOGICAL
STATUS AND HEALTH POSITION

ARMY COMMENT
ON
EPA's ECOLOGICAL STATUS AND HEALTH POSITION
Included in the IEA/RC

The preceeding pages of EPA position on Ecological Status and Health at RMA do not represent the scientific judgement of the other three signatories to the Federal Facilities Agreement, which is presented in Appendix C.5 of this document. EPA Region VIII's position is included in resolution of EPA Region VIII's dispute of the presence and content of Appendix C.5. The Army strongly disagrees with the opinions presented in EPA Region VIII's position because they:

- are inconsistent with EPA's own national guidance,
- are inconsistent with the opinion of an expert panel convened by EPA in a Risk Assessment Forum, which considered data from RMA and other sites,
- contradict EPA Region VIII's own previous statement regarding biota at RMA,
- criticize the appendix but do not provide alternative interpretations or evidence,
- ignore and then dispute the considerable text changes that have been made in good faith response to EPA Region VIII's prior comments.
- minimize the importance and relevance that 9 years of substantial biological information on the potential effects of contamination at RMA provide,
- present misstatements, distortions, and quotes out of context from Appendix C.5,
- fail to consider professional opinions and conclusions of numerous field biologists who have spent considerable time studying RMA biota. and

- do not appear to focus on environmental protection of RMA biota.

EPA Region VIII's position document ignores current and past EPA national guidance on what types of data should be collected and how results should be evaluated in an assessment of the effects of site contamination on biota. Note the following EPA guidance statements:

> "Risk characterization uses the results of the exposure and ecological effects analyses to evaluate the likelihood of adverse ecological effects associated with exposure to a (chemical) stressor." (EPA 1992).
>
> "It is important to recognize that environmental evaluations are not research projects: they are not intended to provide absolute proof of damage..." (EPA 1989).
>
> "The purpose of this document is to provide a scientific framework for designing studies, at the appropriate level of effort, that will evaluate pertinent ecological aspects of a site for the Remedial and Removal processes." (EPA 1989).
>
> "Ecological assessment seeks to determine the nature, magnitude, and transience or permanence of observed or expected effects." (EPA 1989).
>
> "Observational field studies provide environmental realism that laboratory studies lack." (EPA 1992).

EPA guidance, therefore, encourages the use of field studies for the characterization of risk and ecological effects analysis. The studies presented in the Ecological Status and Health section of the IEA/RC do this with the appropriate qualifying statements. EPA Region VIII repeatedly ignores this guidance in their position statement.

Similarly, the standard espoused by EPA Region VIII requires that absolute proof of the lack of damage be provided before such evidence can be considered relevant. Absolute proof of a negative is unlikely and continued speculative seeking of effects is neither in the interest of the public nor of the environment. For example, if there is no indication of exposure at any American kestrel nest boxes, which vary in their location relative to areas of contamination, and there is no evidence of eggshell

thinning, these two pieces of information are mutually corroborative; the first doesn't make the second irrelevant. Further, if no population impairment has been identified, it is not reasonable to require identification of a cause for population impairment or to determine its implications.

In the February 9, 1994 meeting of the EA Technical Subcommittee, EPA Region VIII stated that their concern with the Ecological Status and Health section was that it would counterbalance the exposure modeling portion of the ecological endangerment assessment, which EPA Region VIII also has in dispute. Yet the inclusion of information from both exposure modeling and effects measurements in the characterization of risk is explicitly recommended in current EPA guidance. Explicit language has been added in the IEA/RC stating that neither exposure modeling or effects measurement data is meant to discount the other, but both types of information are provided for consideration during decisions on remediation of RMA.

In their review of the ecological risk assessment approach used at RMA, an expert panel selected by EPA to participate in a Risk Assessment Forum was favorably impressed with the RMA studies. They stated:

> "A diversity of endpoints is used at a number of ecological levels, including tissue concentrations, biomarkers, and population surveys. This wide diversity of endpoints provides a holistic examination of the ecosystem, lending greater confidence in risk estimates." (EPA 1993).

Thus, EPA's own expert panel recognizes the appropriateness and utility of the RMA studies. EPA Region VIII has pointedly ignored this statement and continues to attack the RMA studies and their use.

It should also be noted that considerable additional work has been done, primarily by the U.S. Fish and Wildlife Service, since the studies reviewed and published by the Risk Assessment Forum.

EPA Region VIII has recently contradicted their own past statement on ecological considerations at RMA. For example, throughout the Biota RI process, EPA Region VIII deferred to the U.S. Fish and Wildlife Service for expertise on ecological effects. The U.S. Fish and Wildlife Service played an active role in designing and implementing ecological assessment studies at RMA (e.g., the kestrel studies), selecting and/or approving off-

post control sites (e.g., waterfowl, upland game birds, and others), and in analysis of study results. Formal documentation of EPA Region VIII's deferral is contained in their letter of comment on the Biota RI dated March 13, 1989 in which EPA Region VIII states:

> "As in the past, in regard to matters specific to the RMA biota, we defer to the concerns of the USFWS."

EPA Region VIII has provided no justification for its change in position with respect to the U.S. Fish and Wildlife Service.

The EPA Region VIII position statement criticizes the appendix but does not provide alternative evidence or interpretations of data from Biota RI and U.S. Fish and Wildlife studies they helped to design. For example, since Appendix C.5 addresses ecological health, it is logical that a definition be presented in the document. EPA Region VIII disagreed with the definition presented and accepted the opportunity to provide their own. They failed to provide a definition and continued to criticize the Army definition in written comments provided in early February 1994, Further, EPA Region VIII's written statements totally fail to acknowledge the verbal discussions and agreements that had been made and not honored.

EPA Region VIII has in the past made numerous comments and suggestions for revisions that have been addressed in Appendix C.5. For example, at the 24 June 1993 EA Technical Subcommittee meeting, EPA Region VIII suggested that explicit rankings of bias, power and relevance be added, that perspective on the scale addressed be provided, that ecological health be defined early in the appendix, and that conclusory language be added. Each of these and other requested items was added to Appendix C.5. The Army has been responsive to comments at every step along the way, yet met with increasing resistance from EPA Region VIII.

Substantial information has been collected on biota at RMA since 1985, yet EPA Region VIII states:

> "EPA requests that all these analyses be deleted and replaced by a clear statement that available data are insufficient to analyze the ecological data on any species in relation to contamination levels."

Many of the studies do interpret effects in relation to contamination levels.

EPA Region VIII acknowledges this earlier in their position document (e.g., grasshoppers, earthworms). Studies presented by the Army in the IEA/RC are consistent with the "weight of evidence approach" recommended in EPA guidance, which encourages the use of field studies for the characterization of risk and ecological effects analysis. Please note Tables C.5-1 through C.5-4 in Appendix C.5. EPA Region VIII's insistence on rejecting all studies not performed specifically for the assessment of contaminant risks is counter to EPA's general position on data usability and rational scientific approaches to assessing ecological risk.

Endpoint selection and experimental design are major issues in EPA Region VIII's attack on the ecological health section of the IEA/RC. However, U.S. Fish and Wildlife Service and Colorado Division of Wildlife personnel were closely involved in control site selection and study design, and the appropriate trustee concerns were, therefore, appropriately addressed.

The EPA Region VIII position misstates the experimental design and distorts the interpretation of studies that have been conducted to address contaminant effects. It sets up new definitions for what is said in Appendix C.5 and then states that Appendix C.5 doesn't meet the new definitions. For example, EPA Region VIII established artificial and unrealistic standards for defining bias, power, and relevance and then arbitrarily state: "As a result, most of the studies cited actually have high potential for bias and low power; many also have low relevance as explained below." Designation of levels of bias, power, and relevance were made on the basis of guidance from EPA Region VIII and other involved parties' experts. Differences with specific definitions appear to be the result of EPA Region VIII's treating these studies as academic investigations rather than appropriate studies as part of a "weight of evidence approach suggested by EPA guidance (EPA 1992). Further, EPA Region VIII continues to use words like conclusively...yet their guidance says absolute proof of damage not intended.

EPA Region VIII has established standards of information relevance, data quality, and burden of proof that are unrealistic (given the intricacies of the RMA system) and suggest a remediation strategy that is potentially detrimental to the environment because it would delay cleanup actions and use conservative standards that would result in physical destruction of extensive habitats and individuals. By suggesting the need for explicit studies of dispersal, immigration, emigration, trophic diversity, nutrient

cycling, primary productivity, and further quantitative evaluation of the diet in prey consumed by the predator species, EPA Region VIII is insisting upon an investigative program that is not necessary at a superfund site. The appropriate question is: "Do the available studies indicate unacceptable risk?", not "Is this the best and most detailed approach that could be achieved with unlimited time and money". EPA Region VIII has declined to include any information regarding how long it might take to collect the type of data they desire and has ignored the fact that the studies were designed well and with their participation.

EPA Region VIII's position fails to consider professional opinions and conclusions of numerous field biologists who have spent considerable time studying RMA biota. Yet EPA Region VIII has chosen to reject the investigative findings and professional judgement of dozens of biologists who have spent extensive time assessing the health and diversity of the biota at RMA. Fish and Wildlife personnel alone have collectively spent more than 85 biologist staff years studying biota on RMA. Appendix C.5, as presented, has been developed as a joint effort of all of the parties that have contributed to these investigations. As such, the appendix represents a consensus opinion of these parties. EPA Region VIII, on the other hand, has no record of field participation in the RMA studies. For example, the degree of EPA Region VIII's focus on human rather than ecological perspectives was evidenced by their misunderstanding of the way in which the term "population" was being used in Appendix C.5.

EPA Region VIII's position does not appear to focus on protection of RMA biota. All EPA Region VIII actions should be directed toward the remediation of RMA in a manner that is timely, cost effective, and protective of RMA biota. By arbitrarily rejecting the evidence represented by the current status and health appendix, which is consistent with the results of the quantitative risk assessment, EPA Region VIII is, in effect, delaying timely remediation of RMA. This poses a potential risk to the resources that EPA claims to protect. If indeed population-level effects exist, they would be expected to be greatest within the area already delineated for remediation by concurrence of all parties. Likewise, the rejection of relevant information and insistence upon unwarranted remediation potentially would result in the unnecessary destruction of environmental resources by disturbing areas and species not shown to be affected. This would also result in significant unwarranted costs to the responsible parties and, ultimately, the public.

References Cited

EPA (U.S. Environmental Protection Agency), Risk Assessment Forum. 1992. Framework for Ecological Risk Assessment. EPA/630/R-92/001.

EPA 1989. Risk Assessment Guidance for Superfund II, Environmental Evaluation Manual. Interim Final. EPA/540/1-89/001.

EPA, Risk Assessment Forum. 1993. A Review of Ecological Assessment Case Studies from a Risk Assessment Perspective. EPA/630/R-92/005.

APPENDIX C.6.1

ARMY/EPA JOINT STATEMENT ON DIFFERENCES BETWEEN THE EPA AND ARMY APPROACHES

Section C.1.5 describes three approaches for estimating biomagnification factors (BMFs) for application in risk characterization. The three approaches are referred to as the "Army approach", the "Shell approach" and the "EPA approach". EPA has provided additional description of analyses it has performed in developing its BMF approach, and as well other steps it would like to follow in estimating BMFs by the EPA approach; this is included in the IEA/RC as Appendix C.6.2. Differences among the analytical methods used in the Army, EPA, and Shell approaches are described and discussed in Sections C.1.5 and E.12. This section further describes and discusses the differences between the Army and EPA approaches. This section has been prepared jointly by the Army and EPA and represents a consensus between the two parties on the differences between the two approaches.

1. EPA has prepared an Appendix to the IEA/RC that documents several steps that it would like to follow in estimating BMFs from existing data. These additional steps are collectively referred to as the "full EPA approach." They go beyond the "EPA approach" as implemented in the IEA/RC, although the "EPA approach" was the approach selected by EPA for use under the constraints imposed in the IEA/RC: specifically, the decision to use estimated ESC, as defined in Section C.1.4.1 of the IEA/RC, with which EPA disagrees.

2. Both the Army and EPA would implement BMF estimation differently if more or different data were available.

3. The Army believes that existing data are sufficient to meet the objectives of the IEA/RC; EPA believes that new data should be collected.

4. The Army and EPA agree that the cost of acquiring new data should be balanced against the expected value of those data in improving risk estimates, and against the time that would elapse before improved risk estimates would be developed and risk management actions taken.

5. EPA defines BMF as "the multiplicative factor by which the concentration of a contaminant in the tissues of an organism (TC) exceeds the average concentration (SC) of the contaminant

in the soil to which the organism is exposed (directly or indirectly)."

The Army defines BMF as "an empirical coefficient, calculated by the Army, EPA, or Shell approach, to be used in the model:

$$TC_{pred} = BMF*ESC, \quad (1)$$

where:

TC_{pred} is the predicted population mean tissue concentration at a specific RMA location;

ESC (specifically defined in Appendix C.1.4.1 of the IEA/RC) is the estimated exposure area soil concentration for the location where the population mean tissue concentration is being predicted; and

BMF is an empirical coefficient."

6. EPA and the Army agree that the available data are inadequate as the basis for estimation of BMF, as defined by EPA. EPA and the Army disagree about the adequacy of the data for estimating BMF, as defined by the Army. EPA believes that the limitations of the data for estimating BMF as a biological parameter (as defined by EPA) apply equally to estimating BMF as an empirical modeling coefficient (as defined by the Army). The Army believes that limitations of the data for estimating BMF as a biological parameter are largely inapplicable for estimating BMF as an empirical modeling coefficient.

7. Because EPA regards the empirical values of BMF_{obs} as estimates of biological parameters (concentration ratios in actual organisms), EPA is concerned with obtaining the best possible estimates of the biological parameter consistent with the available data. The Army regards BMF as an empirical coefficient for predicting the population mean tissue concentration from ESC. Therefore, the Army is concerned with obtaining the BMF that, when multiplied by ESCs from across RMA, gives the best possible predictions of the population mean tissue concentrations.

8. The Army and EPA differ in their opinions about the importance of errors in interpolating and averaging the soil contaminant data to obtain estimates of exposure soil concentration. EPA believes that using a different method of interpolating and averaging the IEA/RC soil contaminant data, including taking account of spatial autocorrelation, could significantly reduce systematic error in exposure soil concentration estimates. The Army does not believe that reducing interpolation and averaging errors will significantly improve exposure soil concentration estimates, because other sources of error are large relative to interpolation and averaging errors. These other sources of error include location error (error associated with the assumption that tissue samples were taken at the center of the individual's home range), home range estimation error (error associated with the assumption of uniform utilization of a circular exposure area), and error in the assumption of uniform exposure to contaminants in the 0-1 foot soil profile.

9. EPA is concerned with what it considers to be arbitrary assumptions about the mathematical form of the collocated TC and ESC distributions used by the Army to calculate $BMF_{obs,}$ and about the correlation of the TC and ESC distributions. The Army believes that the quality of the tissue concentration predictions made using its BMFs supports its statistical assumptions.

10. The Army and EPA agree that the IEA/RC tissue concentration predictions are not independent of the tissue concentration observations to which they are compared, because the observations were used to define the BMFs. The Army considers the comparison of dependent tissue concentration predictions and observations to be an appropriate and necessary exercise for both calibrating and evaluating the adequacy of its empirical BMFs. EPA believes that as a calibration exercise, the comparison of dependent tissue concentration predictions and observations is subject to severe data limitations.

11. EPA believes that screening the TC and ESC data from RMA is necessary and that weighting the data is desirable to take account of the widely variable reliability of the data pairs. The Army believes that this problem is reduced by the collocated distributions approach.

12. The Army and EPA agree that linearity, if it does occur, in the relationship between

population mean tissue concentration and the true average exposure soil concentration is only likely to occur over a limited range of soil concentrations. For example, there may be a low dose threshold due to assimilative capacity. In addition, there are statistical problems in precisely estimating average exposure soil concentration and tissue concentration in the low dose region of the dose response curve, which may mask linearity. In the high dose region, non-linearity would be expected to occur because at high values of the true exposure soil concentration, animals could not survive long enough to reach steady-state tissue concentrations. A pharmacokinetics saturation effect could also be responsible for non-linearity in the high dose region of the dose response curve.

EPA believes that the relationship between TC and the estimated exposure soil concentration would be expected to be non-linear because of high and low dose effects such as those described above. EPA believes that non-linearity in this relationship would lead to underestimation of BMFs (using its biological parameter definition of BMF).

The Army believes, on the basis of comparison of mean tissue concentration predictions to individual tissue concentration observations from across RMA, that the empirical model described in equation (1) above, in which TC_{pred} is linearly related to ESC, is adequate for characterizing risks to biota. In other words, the Army believes that equation (1) is an adequate model of the relationship between population mean tissue concentration and ESC, whether or not the underlying relationship is truly linear over the range of exposure soil concentrations present at RMA.

13. The Army and EPA disagree about the relevance of BMF values derived from the literature. EPA believes that there are literature data that allow direct estimation of BMF for biota exposed to relatively uniform concentrations of soil contaminants, and also literature data on bioaccumulation that allow indirect calculation of BMFs. The Army believes that the only estimates that should be used in predicting tissue concentrations through equation (1) are estimates that were derived from or compatible with the existing set of values of ESC, and that there are no such studies reported in the literature.

EPA believes that literature data are relevant and useful for estimating BMFs for at least some combinations of species and contaminants. EPA believes that any biases or other deficiencies in ESC should be addressed by recalculating ESC, rather than by excluding what EPA considers to be relevant (literature) information on BMF. The Army does not consider bias to be a deficiency in ESC, because it is much more cost effective to correct for ESC bias through the use of an empirical BMF than to accurately estimate true exposure soil concentrations.

14. In the "full EPA approach," risk characterization would be effected by multiplying the values of BMF selected by EPA (often literature values) with recalculated estimates of exposure soil concentration:

$$TC_{pred} = BMF^{*}\langle SC\rangle \qquad (2)$$

The Army believes that the resulting tissue concentration predictions would be invalid if the estimate of BMF used in equation (2) is not derived from or compatible with the existing set of values of <SC>.

15. The Army and EPA agree that the relationship between tissue concentration and ESC may be changed by remediating RMA soil contamination, even if the relationship between mean tissue and exposure soil concentration is invariant. The Army and EPA agree that pre-remediation BMFs, when multiplied by post-remediation ESCs, might not accurately predict post-remediation mean biota tissue concentrations. EPA considers this to be a problem that should be solved by improved or additional risk assessment techniques. EPA considers that the "full EPA approach" would yield risk estimates less subject to this problem, and that most steps in the "full EPA approach" (other than the gathering of new data) could be implemented quickly and cost effectively. The Army considers this to be a risk management problem that would be most effectively addressed through biomonitoring before, during, and after site remediation. EPA does not endorse the position that deficiencies in risk assessment can be addressed by biomonitoring. The Army and EPA agree that a risk assessment model designed to predict population mean tissue concentrations under pre-remediation conditions might provide less accurate forecasts of

post-remediation population mean tissue concentrations. The Army does not consider this to be an indication that the risk assessment model is "deficient," because the model is not designed to forecast post-remediation conditions. The Army believes that the pre-remediation data gathering and modeling required to obtain adequate predictions of mean tissue concentrations associated with post-remediation soil concentrations would, at a minimum, take several more years, and would not be a cost effective way to achieve risk management objectives.

APPENDIX C.6.2

EPA'S APPROACH TO ESTIMATING BMFs

Introduction

EPA invoked dispute on this matter in June, 1993. A series of intensive meetings failed to achieve a resolution satisfactory to the RMA parties (Army, Shell, USFWS, EPA, and the State of Colorado). Therefore, the RMA Council resolved that the methodologies for calculating BMF proposed by Army, Shell, and EPA would be presented in the IEA, and that a supplemental field study would be conducted. The purpose of the supplemental study is to determine if biota are exposed to unacceptable levels of contaminants in the areas where the three methods result in different estimates of potential risk. If it is determined that biota are exposed to unacceptable levels of contaminants in these areas, a specific study to improve information on site-specific BMFs would be conducted. The results of these field studies may resolve differences in current risk estimates, but will not address deficiencies of the current data.

This version of the Integrated Endangerment Assessment/Risk Characterization (IEA/RC) presents three alternative methods for calculation of empirical BMFs (BMF_{obs}) derived from RMA field data (TCs and ESCs). The three methods are referred to in Appendix C.1.5.1.2 as the "Army approach", the "Shell approach," and the "EPA approach." The three approaches were developed by the respective parties because of disagreements about the appropriate ways to estimate site-specific BMFs for use in risk assessment, using the IEA/RC food web model. One source of disagreement is the fact that the RMA sampling programs were not originally designed for estimation of BMFs or for calibration of the food web model. The soil sampling program was designed to determine the nature and extent of soil contamination, and focused on areas of known contamination. The tissue sampling program was designed to determine if site-related contaminants are present in biota tissues, and generally focused on areas peripheral to sites of primary contamination. Although these separate sampling programs provide important information regarding their stated goals, they were not designed to be used together to estimate BMF. Because soil sample locations were not specifically co-located with tissue sample locations (different sampling programs at different times), deriving estimates of exposure soil concentrations (ESCs) requires the extrapolation and averaging of soil concentrations measured at various distances from the location of each tissue sample. The parties disagree about the appropriate procedures for deriving ESCs, for deriving estimates of BMF_{obs} from the sets of data

on tissue concentration and ESCs, and for "calibrating" the values of BMF (see Appendix C.6.1).

All three methods for calculating empirical BMFs from field data utilize the same data sets: a set of tissue concentrations (TCs) and a corresponding set of "estimated exposure area soil concentrations" (ESCs). ESCs were calculated in the IEA/RC from estimated soil concentrations for each contaminant in an area surrounding the location where each biota sample was collected. The approaches differ, however, in the manner in which ESC and TC values are used to calculate BMFs. These approaches are described in Appendix C, Section C.1.5.1.2. The three approaches yield different BMFs and, therefore, differing estimates of the spatial extent of risk for ecological receptors.

This Appendix further describes EPA's approach to estimating BMFs for use in risk assessment at RMA. It includes a description of the "EPA approach" or "modified paired data approach" as carried out in the IEA/RC (Appendix C.1.5.1.2), as well as an outline of additional steps that EPA would like to follow in estimating BMFs from existing data. These additional steps are collectively referred to as the "full EPA approach." This Appendix presents the results of implementing one of these additional steps (screening and weighting the field data), carried out by EPA outside the IEA/RC. A separate Appendix (Appendix C.6.1) summarizes differences between the "Army approach" to estimating BMFs and the "full EPA approach", and states differences of opinion between the Army and EPA about these approaches and underlying concepts. Some of these differences of opinion derive from conceptual and definition differences between the Army and EPA, as stated in Appendix C.6.1.

<u>The "full EPA approach"</u>.

The "full EPA approach" to estimating BMFs would include the following steps, each of which is recommended by EPA:

1. Improving statistical methodology for estimating site-specific BMFs (BMF_{obs}) from existing RMA data:
   a. Recalculating values of ESC to take account of spatial structure in the soil

contamination data, e.g., to develop appropriate interpolation distances for calculating ESC;

b. Developing uncertainty estimates for ESC and incorporating these estimates into analysis of uncertainties in estimates of BMF_{obs};

c. Screening and weighting the data to place highest weight on those data pairs (TC/ESC) that yield the most reliable estimates of BMF_{obs}, and to exclude those pairs that yield highly uncertain estimates of BMF_{obs};

d. Developing point estimates of BMF_{obs} from paired values of TC and ESC.

2. Incorporating appropriate literature estimates into the procedure for estimating BMFs:

a. In some cases, estimates of BMF can be derived from literature data directly ($BMF_{liv/dir}$), by dividing tissue concentrations reported in the literature by the corresponding soil concentrations;

b. In other cases, estimates of BMF can be derived through modelling ($BMF_{liv/calc}$), by combining data on bioaccumulation factors at successive trophic levels;

c. Estimates of BMF derived from the literature (where available) should be compared with those derived from field data (where available), and the most appropriate values should be selected based on consideration of the reliability, limitations, and applicability of each.

3. Obtaining new field data to support improved estimates of BMFs.

The rationale for these recommendations may be summarized as follows:

1a. As stated in Appendix C.6.1 (paragraph 8), EPA believes that estimates of BMF could be significantly improved by recalculation of ESCs. EPA has recommended using a different geostatistical technique (e.g., kriging) to take fuller account of spatial autocorrelation in the soil concentration data.

1b. EPA believes that the formal development of uncertainty estimates for ESC would assist in the screening and weighting of the ESC data (see next paragraph) and would lead to improved assessment of uncertainty in estimates of BMF_{obs} (see item 2).

1c. EPA believes that individual values of TC and ESC (and hence pairs of values) differ greatly in reliability because of variability in sampling design and data characteristics. Factors that contribute to this variability include: (a) spatial variability in soil concentrations; (b) variability in sampling density; (c) variable occurrence of BCRL values; (d) variable degree of co-location between tissue and soil samples; and (e) potential non-linearity in the relationship between TC and ESC. As stated in Appendix C.6.1 (paragraph 11), EPA believes that screening the TC and ESC data from RMA is necessary and that weighting the data is desirable to take account of the widely variable reliability of the data pairs. Screening the data would eliminate the least reliable data pairs; weighting the remaining data would place higher weight on the more reliable data pairs.

1d. EPA believes that analyzing paired data (pairing values of TC with values of ESC from the same locations, rather than dissociating the data as in the collocated distributions approaches) would make the best use of the spatial information available in the TC:ESC data set.

2. As stated in Appendix C.6.1 (paragraph 13), EPA believes that literature data are relevant and useful for estimating BMFs for at least some combinations of species and contaminants. EPA believes that there are literature data that allow direct estimation of BMF for biota exposed to relatively uniform concentrations of soil contaminants (item 2b), and also literature data on bioaccumulation that allow indirect calculation of BMFs (item 2c). Literature data on bioaccumulation could also be used as a "reality check" on the ratio between estimates of BMF at successive trophic levels. As stated in Appendix C.6.1 (paragraph 7), EPA regards

the empirical values of BMF_{obs} as estimates of biological parameters (concentration ratios in actual organisms), and hence is concerned with obtaining the best possible estimates of the biological parameter consistent with the available data. Consequently, EPA believes that literature data as well as site-specific data should be used in selecting the values of BMF to be used in risk assessment at RMA (item 2d).

3. For reasons stated later in this Appendix, EPA believes that the field data presently available from RMA are inadequate to derive estimates of BMF_{obs} for many combinations of species and contaminants. Although literature data are available for many of these combinations, EPA believes that better estimates of BMF (and, consequently, better risk estimates) would be obtained if field and literature estimates could be compared (step 2d). For this reason, EPA recommends that additional field data should be collected using a sampling program specifically designed for estimating BMF. EPA believes that such a program could be designed and implemented within one year. In fact, additional field data may be collected in Phase II of the supplemental field study, if this is implemented.

Implementation of the "EPA approach" in the IEA/RC.

Because of time and resource constraints, only part of the "full EPA approach" is implemented in the IEA/RC. The steps that are implemented are steps 1d (analyzing paired data) and part of step 1c (screening the data to exclude areas with low and high average values of ESC). These steps are referred to in the IEA/RC as the "EPA approach." As stated in Appendix C.6.1 (paragraph 1), the "EPA approach" was selected by EPA for use under the constraints imposed in the IEA/RC; specifically, the decision to use the estimated ESC, with which EPA disagrees. EPA regards the values of BMF_{obs} derived using the "EPA approach" as comparable with the values of BMF_{obs} derived using the "Army approach" and the "Shell approach" from the same data sets. However, EPA regards the values of BMF_{obs} derived using the "EPA approach" as interim values only, until other steps in the "full EPA approach" can be implemented.

Procedures used by EPA to further screen and weight biota and soil data.

The remainder of this Appendix describes procedures used by EPA (outside the IEA/RC) to further screen and weight the biota and soil data. This represents an attempt to implement step 1c in the "full EPA approach." EPA reviewed the data pairs individually, examining the original soil contamination data and their spatial variability as well as the values of ESC calculated in the IEA/RC. The objective of the exercise was to identify a subset of the data that could be used for estimating BMF_{obs}, in spite of the limitations imposed by the lack of co-location and other data deficiencies identified earlier in this Appendix.

EPA's three step procedure for screening and weighting the data is described below:

Step 1: Screening of samples with BCRL tissue concentrations.

The first step in screening and weighting the TC/ESC data sets is to address the problems posed by the high prevalence of BCRL values in both data sets. EPA notes initially that each TC/ESC pair consists of a pair of values, a single measured tissue concentration (TC) and an average soil concentration constructed by a process of spatial interpolation (onto a rectangular grid) and spatial averaging (over a circular area surrounding the point of collection and intended to simulate the exposure range of the organism that is sampled). Thus, TC is a single value, whereas ESC is a weighted average of many measured soil concentrations. This structure of the data reflects the biological reality that a single organism is exposed to contaminants at many locations and that the concentration accumulated in tissues integrates its exposure over these locations. Because of this structure, an average soil concentration can be calculated meaningfully even if many of the individual soil concentrations are BCRL. The Army's procedure for calculating ESC assigns numerical values to BCRL samples by a process of weighted averaging over surrounding non-BCRL values. The larger the proportion of replaced values in the set that contributes to the average, the greater the uncertainty in the value of ESC. Accordingly, EPA uses this proportion as a component in the process of weighting described in the next section.

For the tissue concentration, however, a BCRL value is much more problematical. In an

approach that pairs tissue and soil concentrations, a replacement value for a BCRL is largely meaningless, because the point estimate of BMF would be the replacement value for a BCRL tissue concentration divided by ESC (which itself often incorporates replacement values for BCRL soil concentrations). The tissue replacement value may be wrong by orders of magnitude in individual cases. Accordingly, EPA assigns zero weight to all data pairs in which the tissue value is BCRL. Likewise, zero weight is assigned to data pairs in which the ESC is based largely or entirely on BCRL values. EPA assigns variable weight to data pairs in which the tissue value is above the CRL but the ESC is based in part on BCRL values.

The first step in screening the data, therefore, is to identify the data pairs for which the tissue value is BCRL. To effect this screening step, EPA reviewed the complete files of data on tissue concentrations at RMA (files ALDDLDPR.XLS, DDEDDTPR.XLS, ENDRNPR.XLS, and MERCPR.XLS), as provided by the Army. The numbers of positive findings (tissue concentration > CRL) were then compiled for each analyte in each species. Table 1 lists these positive findings. Samples that were not analyzed (concentration listed as 9999.99) or for which data were incomplete (samples with 2- or 3- digit tag identification numbers) are included in the total number of samples but not in the numbers of positive findings.

Combining all species, the total number of biota samples in each file was 752. For dieldrin, the proportion of positive findings was 50% overall, and exceeded 50% in all animal species except for the cottontail (SYAU). Although the proportion of positive findings for aldrin in animals was only 3% (17/516), this is expected because aldrin is metabolized to dieldrin in most animal species. Hence, dieldrin is expected to predominate in most or all animal samples, and the Army's procedures for replacing BCRL values for aldrin will introduce only small uncertainties into the estimates of the combined concentrations (aldrin + dieldrin). For this reason, EPA regards the frequency of positive findings for (aldrin + dieldrin) in animals as numerically sufficient to attempt estimation of BMFs. [Considerations other than numerical sufficiency will be discussed in the next section.]

For plants, the proportion of positive findings was only 25% (60/236) for dieldrin and 2.5%

96/236) for aldrin (Table 1). Because plants accumulate aldrin as well as dieldrin, there is no similar presumption that the true aldrin concentrations in plants would be small compared to the true dieldrin concentrations. Hence, the Army's procedures for replacing BCRL values for aldrin in plants introduce larger uncertainties into the estimates of the combined concentrations (aldrin + dieldrin). For this reason, EPA regards the frequency of positive findings for (aldrin + dieldrin) in plants as too low for reliable estimation of BMFs.

For the other analytes (DDT, DDE, endrin, and mercury), Table 1 shows that the proportions of samples with positive findings ranged from 3% (DDT) to 7% (mercury). Excluding earthworms, the proportions of samples with positive findings ranged only from 2.4% (DDT) to 4.7% (endrin). EPA concludes that these data are inadequate to make any estimates of BMF using RMA field data for DDT+DDE, endrin, or mercury for any species. When the proportions of BCRL values are in the range 93-97%, as they are for these analytes at RMA, estimating replacement values yields results that have very high uncertainty.

Step 2: Further screening and weighting of data for aldrin + dieldrin

In step 2, the paired TC/ESC data are screened and weighted in order to place higher weights on the data pairs which yield more reliable estimates of BMF, and lower or zero weights on the data pairs which yield less reliable estimates of BMF. The weights were assigned to take account of the following factors:

(1) detectability of tissue concentrations (whether one or both analytes were above CRL);

(2) co-location of tissue and soil samples;

(3) measurability of soil concentrations (proportion of soil samples above CRL);

(4) magnitude of average soil concentration (screening out of data pairs with high values of ESC).

These four factors were all utilized in the weighting scheme presented below. EPA originally intended also to take account of the local variability of soil concentrations (placing lower weight on data pairs for which the soil local concentrations were more variable), but was unable to do so, for reasons explained below.

The data were screened using soil concentration maps prepared for this purpose by the Army. The maps were on a scale of 1 inch:300 feet. The collection location for each tissue sample was marked with a colored dot and a list of tissue samples showing the trophic group and Tag ID number for each sample. The Tag ID number was used for sample identification. Reference to the file ALDDLDPR.XLS yielded the trophic group and species, the measurements, if any, of aldrin and dieldrin in the tissue sample, and the estimated value of ESC for the location of collection. The maps also showed the location of each soil sample and the estimated value of ESC. Each soil sample was marked with a symbol showing the number of "hits" (i.e., the number of measurements above CRL for aldrin and/or dieldrin). Triangles indicated 2 "hits", circles indicated one "hit" (plus one BCRL estimation or one not analyzed or NA); squares indicated no "hits" (both BCRL estimations or one BCRL and one NA). Soil sampling locations for which no soil concentration value was posted on the maps (i.e., both values NA) were ignored in all analyses.

For each species, the "home range equivalent radius" (HRER) is defined as the radius of a circle with area equal to the consensus value for the area of the home range. Transparent overlays were prepared with ruled circles of radius equal to the HRER for the various species. Using these overlays, the number of soil samples within the HRER and within half the HRER was determined for each tissue sample. The distance to the nearest soil sample was estimated to the nearest 10 feet. Because of the small scale of the maps, errors of up to 10 feet or more are possible in this measurement, but such errors are smaller than the uncertainty in surveying of the tissue collection locations.

The information collected and used in the analysis is presented on a spreadsheet (Table 2). The spreadsheet is sorted hierarchically in the following order:

Trophic group (alphabetically)

Species (alphabetically)

Tag ID number (alphanumeric, ascending)

The columns in the spreadsheet give the following information:

Column 1: Location number. Location numbers were assigned arbitrarily in order of processing. This was generally in the order of the maps provided, progressing from northwest to southeast within each map. The total number of collection locations was 164.

Columns 2-4: Sample identity. These columns present the Tag ID number, species (4-character code), and trophic group (5-character code), respectively.

Columns 5-7: Co-location. Columns 5 and 6 give the number of soil samples mapped within the HRER and half the HRER, respectively. Column 7 gives the estimated distance (in feet) to the nearest soil collection location.

Columns 8-11: BCRLs in soil. Column 8 gives the proportion of BCRLs among the analyses for soil samples collected within the HRER. (The denominator in this ratio is twice the number of samples, since each sample was analyzed for aldrin and dieldrin and thus contributed two values.) For mourning doves (ZEMA), the number of soil samples collected within the HRER commonly exceeded 35 and ranged up to 200; in such cases, column 8 gives the proportion of BCRLs among the analyses for soil samples collected within the HRER/2. Columns 9-11 give the number of "hits" among the nearest six soil samples to the location of collection, up to a maximum distance of 1,200 feet. In the algorithm used in the IEA/RC for estimating ESC, the mean soil concentration at a grid point is usually estimated from the nearest six soil samples, up to a maximum of 1,200 feet in peripheral areas (see Appendix C.1.4). Although the two-stage procedure used in the IEA/RC for calculating ESC makes it difficult to calculate the contribution of BCRL replacement values to each computed value of ESC, the information in column 8 is expected to reflect this contribution in areas of high sampling density, whereas that in columns

9-11 is expected to reflect this contribution in areas of low sampling density. Columns 9-11, respectively, give the number of soil samples with 2, 1, and 0 "hits" for aldrin and dieldrin.

Column 12: Number of tissue "hits". Zero "hits" means both analytes were either BCRL or NA. For plants and earthworms, 1 "hit" means one of the analytes was above CRL, the other BCRL or N/A; 2 "hits" means both analytes were above CRL. For animals other than earthworms, 2 "hits" means dieldrin was above CRL (because most animals metabolize aldrin to dieldrin, a "hit" for dieldrin with BCRL for aldrin is treated as equivalent to 2 "hits" for plants or earthworms).

Column 13: Assigned weight (see next section). EPA also attempted to extract data on variability in soil concentrations around each tissue sampling location. However, with the information available, it was not possible to calculate a useful measure of this variability. This was because of the wide range of soil sampling densities and the high prevalence of BCRL replacements among the soil concentration values. Areas where the mapped soil values were relatively uniform (low variance) were usually those where the soil values were derived largely from BCRL replacements. In the few areas where the proportion of BCRLs was low, the variance in measured soil concentrations was very high, but was difficult to calculate because of irregular sampling designs. Although it would be desirable to analyze the spatial structure of the soil data and to identify areas of high and low variance, this was not possible with the available data.

Assignment of weights. Table 3 shows the weighting scheme developed by EPA. The data pairs are categorized by letter in descending order of assigned weight, such that categories A-C indicate high weight (low uncertainty of estimated BMF), categories D-G indicate low weight (high uncertainty of estimated BMF), and category H indicates zero weight. The data pairs are categorized by letters rather than numerical weights in order to permit exploration of different numerical weighting schemes. The categorizations incorporate information on different factors that lead to uncertainty, using scientific judgement to integrate the various factors as shown in the table.

Data pairs are initially categorized by the number of "hits" in the tissue sample. Samples with two "hits" as defined above follow the categorization in the upper half of Table 3; samples with one "hit" follow the categorization in the lower half of Table 3; samples with zero hits are placed in category H (zero weight). The data pairs are then characterized by the number of soil samples within the HRER: more than 10, 4-9, 1-3, or zero; data pairs with zero soil samples within the HRER are further characterized by the distance to the nearest soil sampling location (greater or less than 100 feet). The data pairs are finally characterized by the percentage of soil samples that are BCRL (>50%, 50-80%, or >80%). This percentage is derived from column 8 in Table 2 if the number of soil samples within the HRER is 4 or more, or from columns 9-11 in Table 2 if the number of soil samples within the HRER is 0-3.

After categorizing all the data pairs following the scheme in Table 3, EPA investigated the linearity of the relationships between TC and ESC. This investigation was limited to the only two species (ZEMA and CYLU) for which a reasonable number (more than 20) of paired samples were assigned non-zero weights based on the scheme presented in Table 3. Plotting TC against ESC within the screened data set for ZEMA indicated that TC increased with ESC up to ESC values of about ppm (combined aldrin/dieldrin concentrations in the 0-12 inch soil profile), but did not increase further above ESC = 1.5 ppm. A scatter plot of unscreened data for deer mice (PEMA), presented in the EPA/ORD report, August 1993, showed a similar nonlinear pattern, with a change in slope at about ESC = 3 ppm. The scatter plot for CYLU showed no clear dependence of TC on ESC, either at low values or high values of ESC (Figure 2). Because of the non-linearity, all data pairs for which ESC was greater than 3 ppm were assigned a zero weight (category H).

Step 3: Further screening and weighting of data on other analytes

For analytes other than aldrin/dieldrin, the screening and weighting procedures described in the previous section were applied only to data pairs for which one or both tissue concentrations were above CRL. For (DDT + DDE), the screening and weighting procedure was the same as that for (aldrin + dieldrin), except that animal samples for which only one analyte was above CRL (either

DDT or DDE being BCRL or NA) were characterized as one "hit" instead of two "hits". For endrin and mercury, only the upper half of Table 3 was used for assigning weights. Non-linearity of the relationship between TC and ESC was not investigated for any of these analytes; i.e., data pairs with high values of ESC were not assigned zero weight for that reason alone.

Results, Discussion, and Conclusions

Table 2 presents the results of the screening and weighting procedure for aldrin + dieldrin. Tables 4, 5 and 6 present the results of the screening and weighting procedure for DDT + DDE, endrin, and mercury, respectively, limited to the data pairs with one or two tissue "hits". Table 7 summarizes the number of data pairs for each analyte that are assigned high weights (categories A-C) and low weights (categories D-G).

A total of 752 biota samples were collected at RMA and analyzed for aldrin, dieldrin, DDE, DDT, endrin, and mercury (database provided by the Army, November 1993). Each was paired with an estimated soil concentration. For aldrin and dieldrin, the total number of pairs of all species assigned non-zero weights was 103, or only 14 percent of all samples collected and analyzed for aldrin and dieldrin. Of these 103 pairs, the majority were assigned low weights, representing high uncertainty and low confidence; 82 of the 103 pairs were assigned low weights, while only 21 (or 3 percent of all samples collected and analyzed for these chemicals) received high weights. Of the 82 pairs receiving low weights, most trophic boxes had a very small number of pairs with non-zero weights (e.g., 1 to 4 per species; see Table 7), with the remaining pairs being assigned zero weights. The only species having more than a few pairs assigned low weights are the grasshopper (ACRI, in 12 of 81 samples analyzed), black-tailed prairie dog (CYLU, in 27 of 128 samples analyzed), and deer mouse (PEMA, in 14 of 90 samples analyzed). Of all the biota samples analyzed for aldrin and dieldrin, birds were the only species assigned high weights, including the mourning dove (ZEMA, in 15 of 68 samples analyzed) and the western meadowlark (STNE, in 6 of 10 samples analyzed) (see Table 7).

For the other analytes, the total numbers of samples assigned non-zero weights are 6 for DDT + DDE, 26 for endrin, and 20 for mercury (Table 7). Only 14 samples (of which 8 are mourning

doves for endrin) are assigned "high" weights. The largest number of samples assigned non-zero weights within any species/analyte combination is 14 (earthworms, mercury, only one assigned "high" weight).

EPA considers that all these sample sizes, after screening and weighting, are inadequate for any meaningful estimation of BMF. The species/analyte combination that would provide the best basis for estimating BMF is the mourning dove for aldrin + dieldrin, with 15 samples given "high" weights and three more given "low" weights. The total of 18 samples with non-zero weights, however, is only 25% of the number of mourning doves collected, raising the possibility of screening biases. Mourning doves tend to receive high weights because they have large home ranges, often incorporating many soil sampling locations. However, for the same reason, estimates of their exposure are highly uncertain, because the home range circles include an extremely wide range of soil concentrations. Finally, mourning doves are relatively large, granivorous birds, and hence are poor models for the small, generally insectivorous nestling birds that form part of the diet of the American kestrel, the only predatory species for which birds are a significant part of the diet. For these reasons, EPA believes that a BMF value calculated from the screened data set for the mourning dove would not be a reliable or meaningful estimate of BMF for small birds for use in risk assessment at RMA. The same comments apply to mourning doves for endrin (N = 14). The western meadowlark (STNE) had six samples assigned "high" weights for aldrin + dieldrin, but this sample size is too small for reliable statistical estimation of BMF, given the high variance in both TC and ESC. Grasshoppers, prairie dogs, and deer mice had modest samples with non-zero weights for aldrin + dieldrin, but all these samples were assigned "low" weights and hence would not serve as a reliable basis for calculation. The same comment applies to the screened sample of worms for mercury (14 with non-zero weights, of which only 1 was assigned a "high" weight). No other species/analyte combination had nearly enough data pairs with non-zero weights to consider estimating a BMF.

Overall, EPA considers the field data from RMA inadequate to serve as the basis for calculating BMF_{obs} for any species/analyte combination. The main reasons why low or zero weights are assigned to so many data pairs are:

o The lack of co-location of tissue and soil samples in the large majority of cases;

o the high frequency of BCRLs in all cases except a few species for dieldrin; and

o the high frequency of sampling locations in which the value of ESC was above the range in which the relationship between TC and ESC appears to be linear.

As stated in Appendix C.6.1 (paragraph 6), the parties disagree about the applicability of this conclusion. The Army believes that it is applicable only to BMF as defined by EPA and estimated by the EPA approach, whereas EPA believes that it is applicable equally to BMF as defined by the Army and estimated by the "collocated distributions" approaches.

Because EPA judges the field data from RMA to be inadequate to serve as the basis for calculating BMF_{obs} for any species/analyte combination, EPA believes that literature data must be the primary source for estimates of BMF for use in the IEA/RC (step 2 in the "full EPA approach"). EPA believes that literature data are available, relevant, and useful for estimating BMFs for at least some combinations of species and contaminants (see Appendix C.6.1, paragraph 13). However, EPA believes that it would be desirable to have site-specific estimates of BMF to compare with the literature values (step 2c in the "full EPA approach"). Accordingly, EPA has recommended that a limited program for collecting additional field data should be conducted for this purpose (step 3 in the "full EPA approach"). To avoid the uncertainties that have resulted from attempts to use the existing data for this purpose, EPA recommends that the program should be designed specifically for estimating BMFs. In particular, the program should select sampling locations within the expected linear range of the TC/ESC relationship, should precisely co-locate tissue and soil samples, should be designed for spatial averaging of soil concentrations, and should use an analytical method sensitive enough to reduce the frequency of BCRLs to low levels. EPA believes that such a program (e.g., Phase II of the supplemental field study) could be carried out within one year and could lead to significant improvement in estimates of BMF and consequent estimates of risks to biota.

TABLE 1

RMA BIOTA SAMPLES: FREQUENCY OF POSITIVE FINDINGS (>CRLs)

Group	Species	No. of Samples	Number of Positive Findings							
			Aldrin	Dieldrin	Both	DDT	DDE	Both	Endrin	Hg
HERPS	AMBY	2	2	2	2	1	0	0	2	2
	PIME	3	0	3	0	0	1	0	0	0
	SCAP	2	0	2	0	0	0	0	0	1
INSCT	ACRI	81	0	41	0	3	0	0	4	0
	COLE	17	5	12	5	1	3	1	5	0
MDMML	CYLU	128	0	74	0	1	2	0	2	1
	SYAU	28	0	8	0	0	0	0	0	1
SHBRD	CHVO	5	0	5	0	3	5	3	2	5
SMBRD	POGR	5	0	3	0	0	0	0	0	0
	STNE	10	0	9	0	0	0	0	0	0
	ZEMA	68	1	45	1	0	2	0	13	0
SMMML	PEMA	90	6	63	6	3	5	1	2	7
	SPTR	3	0	3	0	0	0	0	0	0
TRPLT	BRTE	84	2	28	1	2	1	1	1	0
	COAR	4	0	0	0	0	0	0	0	0
	HEAN	89	3	21	3	1	2	0	2	0
	KOIR	42	1	4	0	1	0	0	1	0
	LASE	17	0	7	0	0	0	0	0	0
WORMS	OLIG	74	3	45	3	8	12	5	11	35
All Samples		752	23	378	21	24	33	11	43	52

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
18	B0797	AMBY	HERPS	0	0	410	0	4	1	1	2	G
18	B0798	AMBY	HERPS	0	0	410	0	4	1	1	2	G
116	B0486	PIME	HERPS	1	0	270	0/2	1	0	5	2	F
14	B1449	PIME	HERPS	1	0	340	2/2	0	0	5	2	H
80	B1460	PIME	HERPS	5	4	90	8/10	1	0	5	2	D
77	B1458	SCAP	HERPS	0	0	70	0	2	1	3	2	H
79	B1459	SCAP	HERPS	0	0	380	0	2	0	4	2	H
74	B0119	ACRI	INSCT	0	0	70	0	4	1	1	2	H
75	B0120	ACRI	INSCT	0	0	40	0	1	3	2	2	G
122	B0121	ACRI	INSCT	0	0	40	0	3	2	1	2	H
127	B0123	ACRI	INSCT	0	0	225	0	3	0	3	2	H
77	B0131	ACRI	INSCT	0	0	70	0	2	1	3	0	H
148	B0134	ACRI	INSCT	0	0	45	0	0	3	3	0	H
132	B0136	ACRI	INSCT	0	0	870	0	0	0	1	0	H
71	B0147	ACRI	INSCT	0	0	50	0	0	2	4	2	H
68	B0148	ACRI	INSCT	0	0	50	0	1	2	3	2	G
51	B0150	ACRI	INSCT	0	0	60	0	1	5	0	0	H
53	B0152	ACRI	INSCT	0	0	110	0	0	0	6	2	H
99	B0154	ACRI	INSCT	0	0	35	0	2	1	3	2	G
17	B0155	ACRI	INSCT	0	0	100	0	1	0	5	2	H
27	B0157	ACRI	INSCT	0	0	20	0	2	2	2	2	G
28	B0159	ACRI	INSCT	0	0	90	0	1	3	2	2	G
17	B0196	ACRI	INSCT	0	0	100	0	1	0	5	2	H
61	B0197	ACRI	INSCT	0	0	70	0	1	4	1	2	G
119	B0198	ACRI	INSCT	0	0	70	0	2	1	3	2	F
127	B0661	ACRI	INSCT	0	0	225	0	3	0	3	2	H
97	B0662	ACRI	INSCT	0	0	160	0	1	2	3	2	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
79	B0663	ACRI	INSCT	0	0	380	0	2	0	4	0	H
106	B0664	ACRI	INSCT	0	0	110	0	3	0	3	0	H
74	B0680	ACRI	INSCT	0	0	70	0	4	1	1	2	H
31	B0681	ACRI	INSCT	0	0	220	0	2	2	2	0	H
117	B0682	ACRI	INSCT	0	0	80	0	2	2	2	0	H
75	B0683	ACRI	INSCT	0	0	40	0	1	3	2	0	H
27	B0684	ACRI	INSCT	0	0	20	0	2	2	2	2	F
29	B0685	ACRI	INSCT	0	0	190	0	5	1	0	2	G
119	B0686	ACRI	INSCT	0	0	70	0	2	1	3	2	H
104	B0687	ACRI	INSCT	0	0	180	0	1	0	5	2	H
122	B0688	ACRI	INSCT	0	0	40	0	3	2	1	2	H
51	B0689	ACRI	INSCT	0	0	60	0	1	5	0	0	H
71	B0690	ACRI	INSCT	0	0	50	0	0	2	4	2	H
65	B0691	ACRI	INSCT	0	0	30	0	1	4	1	0	H
17	B0692	ACRI	INSCT	0	0	100	0	1	0	5	0	H
53	B0693	ACRI	INSCT	0	0	110	0	0	0	6	0	H
61	B0694	ACRI	INSCT	0	0	70	0	1	4	1	2	H
132	B0704	ACRI	INSCT	0	0	870	0	0	0	1	0	H
77	B0708	ACRI	INSCT	0	0	70	0	2	1	3	0	H
148	B0709	ACRI	INSCT	0	0	45	0	0	3	3	0	H
134	B0744	ACRI	INSCT	0	0	440	0	0	0	1	0	H
133	B0746	ACRI	INSCT	0	0	990	0	0	0	1	0	H
37	B0868	ACRI	INSCT	0	0	450	0	0	0	6	0	H
17	B1368	ACRI	INSCT	0	0	100	0	1	0	5	2	H
31	B1369	ACRI	INSCT	0	0	220	0	2	2	2	2	H
29	B1370	ACRI	INSCT	0	0	190	0	5	1	0	2	G
77	B1373	ACRI	INSCT	0	0	70	0	2	1	3	2	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
27	B1377	ACRI	INSCT	0	0	20	0	2	2	2	2	G
104	B1386	ACRI	INSCT	0	0	180	0	1	0	5	2	H
97	B1387	ACRI	INSCT	0	0	160	0	1	2	3	2	H
122	B1492	ACRI	INSCT	0	0	40	0	3	2	1	2	F
53	B1493	ACRI	INSCT	0	0	110	0	0	0	6	2	H
65	B1494	ACRI	INSCT	0	0	30	0	1	4	1	2	H
71	B1495	ACRI	INSCT	0	0	50	0	0	2	4	2	H
51	B1496	ACRI	INSCT	0	0	60	0	1	5	0	2	H
127	B1498	ACRI	INSCT	0	0	225	0	3	0	3	2	H
106	B1499	ACRI	INSCT	0	0	110	0	3	0	3	2	H
61	B1500	ACRI	INSCT	0	0	70	0	1	4	1	2	H
132	B1504	ACRI	INSCT	0	0	870	0	0	0	1	0	H
34	B1512	ACRI	INSCT	0	0	340	0	0	1	5	0	H
37	B1513	ACRI	INSCT	0	0	450	0	0	0	6	0	H
15	B1514	ACRI	INSCT	0	0	40	0	2	1	3	0	H
16	B1515	ACRI	INSCT	0	0	30	0	0	0	6	0	H
74	B1518	ACRI	INSCT	0	0	70	0	4	1	1	2	H
75	B1519	ACRI	INSCT	0	0	40	0	1	3	2	0	H
117	B1520	ACRI	INSCT	0	0	80	0	2	2	2	0	H
133	B1521	ACRI	INSCT	0	0	990	0	0	0	1	0	H
134	B1522	ACRI	INSCT	0	0	440	0	0	0	1	0	H
119	B1533	ACRI	INSCT	0	0	70	0	2	1	3	2	H
79	B1594	ACRI	INSCT	0	0	380	0	2	0	4	0	H
141	B1595	ACRI	INSCT	0	0	90	0	4	0	2	0	H
148	B1612	ACRI	INSCT	0	0	45	0	0	3	3	0	H
136	B1613	ACRI	INSCT	0	0	180	0	1	0	5	0	H
63	129	ACRI	INSCT	0	0	80	0	4	0	2	0	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
63	418	ACRI	INSCT	0	0	80	0	4	0	2	0	H
63	419	ACRI	INSCT	0	0	80	0	4	0	2	0	H
63	483	ACRI	INSCT	0	0	80	0	4	0	2	0	H
23	488	ACRI	INSCT	0	0	180	0	2	2	2	0	H
22	489	ACRI	INSCT	0	0	290	0	2	3	1	0	H
22	490	ACRI	INSCT	0	0	290	0	2	3	1	0	H
23	491	ACRI	INSCT	0	0	180	0	2	2	2	0	H
97	B0789	COLE	INSCT	0	0	160	0	1	2	3	2	H
128	B0790	COLE	INSCT	0	0	160	0	2	1	3	2	H
61	B0791	COLE	INSCT	0	0	70	0	1	4	1	2	H
134	B0793	COLE	INSCT	0	0	440	0	0	0	1	0	H
5	B0794	COLE	INSCT	0	0	240	0	0	1	5	2	G
17	B0808	COLE	INSCT	0	0	100	0	1	0	5	2	H
65	B0809	COLE	INSCT	0	0	30	0	1	4	1	2	H
130	B0818	COLE	INSCT	0	0	740	0	0	0	4	2	H
29	B0819	COLE	INSCT	0	0	190	0	5	1	0	2	G
141	B0820	COLE	INSCT	0	0	90	0	4	0	2	0	H
51	B1030	COLE	INSCT	0	0	60	0	1	5	0	2	H
17	B1649	COLE	INSCT	0	0	100	0	1	0	5	2	H
5	B1667	COLE	INSCT	0	0	240	0	0	1	5	0	H
61	B1668	COLE	INSCT	0	0	70	0	1	4	1	2	H
51	B1669	COLE	INSCT	0	0	60	0	1	5	0	2	H
97	B1670	COLE	INSCT	0	0	160	0	1	2	3	0	H
51	B0067	CYLU	MDMML	1	0	60	1/2	1	5	0	0	H
53	B0068	CYLU	MDMML	0	0	110	0	0	0	6	2	H
53	B0072	CYLU	MDMML	0	0	110	0	0	0	6	0	H
51	B0073	CYLU	MDMML	1	0	60	1/2	1	5	0	2	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
67	B0074	CYLU	MDMML	2	1	45	3/4	0	5	1	2	H
67	B0075	CYLU	MDMML	2	1	45	3/4	0	5	1	2	H
106	B0076	CYLU	MDMML	0	0	110	0	3	0	3	2	H
108	B0077	CYLU	MDMML	0	0	105	0	3	0	3	0	H
105	B0080	CYLU	MDMML	0	0	210	0	3	0	3	2	H
20	B0101	CYLU	MDMML	0	0	260	0	3	2	1	0	H
96	B0102	CYLU	MDMML	1	1	40	0/2	2	2	2	2	F
95	B0103	CYLU	MDMML	1	0	60	0/2	2	2	2	2	F
59	B0326	CYLU	MDMML	1	1	0	1/2	1	4	1	0	H
59	B0327	CYLU	MDMML	1	1	0	1/2	1	4	1	2	F
58	B0328	CYLU	MDMML	1	1	0	1/2	0	5	1	2	F
57	B0329	CYLU	MDMML	2	1	0	2/4	0	5	1	2	F
57	B0330	CYLU	MDMML	2	1	0	2/4	0	5	1	2	F
13	B0331	CYLU	MDMML	0	0	356	0	0	0	5	2	H
69	B0332	CYLU	MDMML	2	1	30	1/4	2	2	2	2	F
48	B0333	CYLU	MDMML	1	1	0	1/2	0	5	1	2	F
43	B0334	CYLU	MDMML	0	0	150	0	1	1	4	2	H
40	B0335	CYLU	MDMML	4	0	90	8/8	0	1	5	2	G
41	B0336	CYLU	MDMML	2	1	40	4/4	0	2	4	2	H
41	B0337	CYLU	MDMML	2	1	40	4/4	0	2	4	2	H
9	B0338	CYLU	MDMML	0	0	160	0	0	0	6	2	H
88	B0339	CYLU	MDMML	2	1	0	3/4	1	3	2	2	F
47	B0340	CYLU	MDMML	5	4	10	5/10	0	6	0	2	D
84	B0341	CYLU	MDMML	1	1	0	0/2	0	2	4	2	H
54	B0342	CYLU	MDMML	2	1	0	2/4	0	4	2	2	F
94	B0343	CYLU	MDMML	1	1	0	1/2	1	3	2	2	F
104	B0532	CYLU	MDMML	0	0	180	0	1	0	5	2	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
104	B0533	CYLU	MDMML	0	0	180	0	1	0	5	2	H
97	B0534	CYLU	MDMML	0	0	160	0	1	2	3	0	H
31	B0537	CYLU	MDMML	0	0	220	0	2	2	2	2	H
53	B0538	CYLU	MDMML	0	0	110	0	0	0	6	2	H
53	B0539	CYLU	MDMML	0	0	110	0	0	0	6	2	H
53	B0540	CYLU	MDMML	0	0	110	0	0	0	6	2	H
51	B0582	CYLU	MDMML	1	0	60	1/2	1	5	0	2	H
51	B0583	CYLU	MDMML	1	0	60	1/2	1	5	0	2	H
51	B0584	CYLU	MDMML	1	0	60	1/2	1	5	0	2	H
109	B0585	CYLU	MDMML	0	0	210	0	3	0	3	2	H
101	B0715	CYLU	MDMML	0	0	150	0	3	0	3	0	H
101	B0716	CYLU	MDMML	0	0	150	0	3	0	3	2	H
101	B0717	CYLU	MDMML	0	0	150	0	3	0	3	0	H
101	B0718	CYLU	MDMML	0	0	150	0	3	0	3	2	H
97	B0724	CYLU	MDMML	0	0	160	0	1	2	3	2	H
98	B0727	CYLU	MDMML	0	0	210	0	1	2	3	2	H
31	B0729	CYLU	MDMML	0	0	220	0	2	2	2	2	H
30	B0731	CYLU	MDMML	0	0	110	0	3	3	0	2	G
104	B0732	CYLU	MDMML	0	0	180	0	1	0	5	2	H
160	B0755	CYLU	MDMML	0	0	330	0	1	0	5	2	H
101	B0756	CYLU	MDMML	0	0	150	0	3	0	3	2	H
30	B0757	CYLU	MDMML	0	0	110	0	3	3	0	2	G
103	B0758	CYLU	MDMML	1	1	40	0/2	2	0	4	2	F
161	B0759	CYLU	MDMML	0	0	380	0	0	0	6	2	H
51	B0772	CYLU	MDMML	1	0	60	1/2	1	5	0	2	H
51	B0773	CYLU	MDMML	1	0	60	1/2	1	5	0	2	H
53	B0774	CYLU	MDMML	0	0	110	0	0	0	6	2	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
53	B0775	CYLU	MDMML	0	0	110	0	0	0	6	2	H
162	B0776	CYLU	MDMML	0	0	290	0	0	0	6	2	H
164	B0788	CYLU	MDMML	0	0	300	0	0	1	5	0	H
30	B1312	CYLU	MDMML	0	0	110	0	3	3	0	2	G
30	B1313	CYLU	MDMML	0	0	110	0	3	3	0	2	G
30	B1315	CYLU	MDMML	0	0	110	0	3	3	0	2	G
30	B1318	CYLU	MDMML	0	0	110	0	3	3	0	2	G
97	B1319	CYLU	MDMML	0	0	160	0	1	2	3	0	H
97	B1323	CYLU	MDMML	0	0	160	0	1	2	3	2	H
97	B1324	CYLU	MDMML	0	0	160	0	1	2	3	2	H
32	B1325	CYLU	MDMML	1	0	90	0	2	0	4	2	F
32	B1326	CYLU	MDMML	1	0	90	0	2	0	4	2	F
97	B1329	CYLU	MDMML	0	0	160	0	1	2	3	2	H
104	B1330	CYLU	MDMML	0	0	180	0	1	0	5	2	H
12	B1332	CYLU	MDMML	1	1	30	2/2	1	0	5	0	H
81	B1333	CYLU	MDMML	0	0	240	0	1	0	5	2	H
49	B1335	CYLU	MDMML	0	0	180	0	2	3	1	0	H
100	B1340	CYLU	MDMML	0	0	170	0	5	0	1	2	G
100	B1341	CYLU	MDMML	0	0	170	0	5	0	1	2	G
44	B1342	CYLU	MDMML	0	0	210	0	0	4	2	2	H
46	B1343	CYLU	MDMML	1	0	90	1/2	0	6	0	0	H
100	B1348	CYLU	MDMML	0	0	170	0	5	0	1	2	G
83	B1350	CYLU	MDMML	0	0	310	0	1	0	5	2	H
45	B1351	CYLU	MDMML	0	0	220	0	1	3	2	0	H
86	B1359	CYLU	MDMML	1	1	30	0/2	2	0	4	2	F
82	B1360	CYLU	MDMML	0	0	250	0	1	0	5	2	H
87	B1361	CYLU	MDMML	1	0	80	0/2	0	0	6	2	H

TABLE ... RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
85	B1362	CYLU	MDMML	0	0	150	0	2	1	3	2	H
104	B1363	CYLU	MDMML	0	0	180	0	1	0	5	0	H
163	B1364	CYLU	MDMML	0	0	200	0	1	0	5	2	F
11	B1365	CYLU	MDMML	0	0	160	0	2	0	4	0	H
16	B1366	CYLU	MDMML	5	2	30	6/10	0	0	6	0	H
110	B1371	CYLU	MDMML	0	0	290	0	2	0	4	0	H
10	B1378	CYLU	MDMML	0	0	170	0	0	0	6	0	H
111	B1389	CYLU	MDMML	0	0	360	0	2	0	4	0	H
109	B1390	CYLU	MDMML	0	0	210	0	3	0	3	2	H
39	64	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
39	65	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
39	120	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
39	153	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
39	154	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
39	155	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
39	156	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
39	157	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
39	158	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
8	231	CYLU	MDMML	0	0	560	0	0	1	3	0	H
8	232	CYLU	MDMML	0	0	560	0	0	1	3	0	H
4	242	CYLU	MDMML	0	0	340	0	0	1	5	0	H
4	243	CYLU	MDMML	0	0	340	0	0	1	5	0	H
4	244	CYLU	MDMML	0	0	340	0	0	1	5	0	H
8	259	CYLU	MDMML	0	0	560	0	0	1	3	0	H
2	260	CYLU	MDMML	0	0	210	0	0	1	4	0	H
2	261	CYLU	MDMML	0	0	210	0	0	1	4	0	H
8	399	CYLU	MDMML	0	0	560	0	0	1	3	0	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
2	400	CYLU	MDMML	0	0	210	0	0	1	4	0	H
2	401	CYLU	MDMML	0	0	210	0	0	1	4	0	H
2	402	CYLU	MDMML	0	0	210	0	0	1	4	0	H
2	403	CYLU	MDMML	0	0	210	0	0	1	4	0	H
2	404	CYLU	MDMML	0	0	210	0	0	1	4	0	H
35	405	CYLU	MDMML	0	0	290	0	1	1	4	0	H
35	406	CYLU	MDMML	0	0	290	0	1	1	4	0	H
35	407	CYLU	MDMML	0	0	290	0	1	1	4	0	H
35	408	CYLU	MDMML	0	0	290	0	1	1	4	0	H
35	409	CYLU	MDMML	0	0	290	0	1	1	4	0	H
39	410	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
39	411	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
39	412	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
39	413	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
39	414	CYLU	MDMML	1	0	60	1/2	2	1	3	0	H
70	B0085	SYAU	MDMML	34	6	70	46/68	1	1	4	0	H
60	B0086	SYAU	MDMML	19	5	20	11/38	1	5	0	2	H
123	B0087	SYAU	MDMML	7	3	80	4/14	4	1	1	2	H
66	B0088	SYAU	MDMML	18	4	70	19/36	0	5	1	2	H
24	B0089	SYAU	MDMML	1	0	240	0/2	2	2	2	2	H
157	B0095	SYAU	MDMML	0	0	450	0	0	1	5	2	H
143	B0096	SYAU	MDMML	0	0	470	0	1	0	5	0	H
26	B0097	SYAU	MDMML	2	0	220	0/4	1	2	3	2	F
107	B0098	SYAU	MDMML	2	1	105	2/4	3	0	3	2	H
143	B0099	SYAU	MDMML	0	0	470	0	1	0	5	2	H
144	B0100	SYAU	MDMML	0	0	420	0	2	0	4	0	H
42	B0501	SYAU	MDMML	34	13	0	62/68	0	2	4	0	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
50	B0502	SYAU	MDMML	17	8	10	25/34	0	1	5	0	H
50	B0503	SYAU	MDMML	17	8	10	25/34	0	1	5	0	H
2	128	SYAU	MDMML	0	0	210	0	0	1	4	0	H
2	271	SYAU	MDMML	1	0	210	0/2	0	1	4	0	H
64	274	SYAU	MDMML	8	3	120	2/16	6	0	0	0	H
64	277	SYAU	MDMML	8	3	120	2/16	6	0	0	0	H
64	288	SYAU	MDMML	8	3	120	2/16	6	0	0	0	H
64	291	SYAU	MDMML	8	3	120	2/16	6	0	0	0	H
64	294	SYAU	MDMML	8	3	120	2/16	6	0	0	0	H
64	297	SYAU	MDMML	8	3	120	2/16	6	0	0	0	H
64	300	SYAU	MDMML	8	3	120	2/16	6	0	0	0	H
2	303	SYAU	MDMML	1	0	210	0/2	0	1	4	0	H
140	B1306	CHVO	SHBRD	9	8	40	14/18	1	2	3	2	H
140	B1307	CHVO	SHBRD	9	8	40	14/18	1	2	3	2	H
155	B1309	CHVO	SHBRD	0	0	530	0	1	0	5	2	H
156	B1310	CHVO	SHBRD	0	0	490	0	1	0	5	2	H
156	B1317	CHVO	SHBRD	0	0	490	0	1	0	5	2	H
25	B1327	POGR	SMBRD	0	0	280	0	1	2	3	2	H
126	B1344	POGR	SMBRD	0	0	220	0	1	2	3	2	H
51	B1357	POGR	SMBRD	2	1	60	2/4	1	5	0	2	H
52	B1358	POGR	SMBRD	5	1	60	7/10	0	4	2	0	H
153	B1411	POGR	SMBRD	0	0	340	0	2	0	4	0	H
97	B0719	STNE	SMBRD	22	4	160	28/44	1	2	3	2	C
97	B0720	STNE	SMBRD	22	4	160	28/44	1	2	3	2	C
97	B0721	STNE	SMBRD	22	4	160	28/44	1	2	3	2	C
30	B0736	STNE	SMBRD	6	3	110	3/12	3	3	0	2	B
30	B0742	STNE	SMBRD	6	3	110	3/12	3	3	0	2	B

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
19	B1382	STNE	SMBRD	2	0	280	0/4	3	2	1	2	F
19	B1383	STNE	SMBRD	2	0	280	0/4	3	2	1	2	F
148	B1388	STNE	SMBRD	17	7	45	26/34	0	3	3	2	C
150	B1408	STNE	SMBRD	1	1	80	2/2	0	2	4	0	H
17	B1409	STNE	SMBRD	6	2	100	10/12	1	0	5	2	H
147	B0637	ZEMA	SMBRD	28	2	130	38/56	0	3	3	0	H
152	B0638	ZEMA	SMBRD	23	17	80	32/46	2	0	4	0	H
151	B0639	ZEMA	SMBRD	25	13	20	38/50	1	0	5	0	H
102	B0640	ZEMA	SMBRD	25	8	50	44/50	0	0	6	2	F
27	B0641	ZEMA	SMBRD	47	9	20	31/94	2	2	2	2	H
16	B0648	ZEMA	SMBRD	48	23	30	33/46	0	0	6	2	C
16	B0649	ZEMA	SMBRD	48	23	30	33/46	0	0	6	2	C
72	B0650	ZEMA	SMBRD	103	36	40	52/72	1	3	2	0	H
74	B0651	ZEMA	SMBRD	132	35	70	43/70	4	1	1	2	H
104	B0652	ZEMA	SMBRD	15	3	180	20/36	1	0	5	2	C
74	B0653	ZEMA	SMBRD	132	35	70	43/70	4	1	1	2	H
122	B0654	ZEMA	SMBRD	35	8	40	27/70	3	2	1	2	H
137	B0730	ZEMA	SMBRD	5	1	330	9/10	1	0	5	2	G
17	B0735	ZEMA	SMBRD	12	7	100	10/24	1	0	5	2	A
17	B0738	ZEMA	SMBRD	12	7	100	10/24	1	0	5	2	A
135	B0739	ZEMA	SMBRD	15	5	225	27/30	0	1	5	0	H
17	B0740	ZEMA	SMBRD	12	7	100	10/24	1	0	5	2	A
17	B0743	ZEMA	SMBRD	12	7	100	10/24	1	0	5	2	A
61	B0768	ZEMA	SMBRD	68	24	70	57/136	1	4	1	2	H
61	B0769	ZEMA	SMBRD	68	24	70	57/136	1	4	1	2	H
61	B0770	ZEMA	SMBRD	68	24	70	57/136	1	4	1	0	H
61	B0771	ZEMA	SMBRD	68	24	70	57/136	1	4	1	2	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
122	B0784	ZEMA	SMBRD	35	8	40	27/70	3	2	1	2	H
76	B0785	ZEMA	SMBRD	79	37	50	41/74	2	0	4	0	H
76	B0786	ZEMA	SMBRD	79	37	50	41/74	2	0	4	2	H
122	B0787	ZEMA	SMBRD	35	8	40	27/70	3	2	1	2	A
75	B0916	ZEMA	SMBRD	107	37	40	43/74	1	3	2	2	C
17	B0917	ZEMA	SMBRD	12	7	100	10/24	1	0	5	2	A
17	B0918	ZEMA	SMBRD	12	7	100	10/24	1	0	5	0	H
75	B0919	ZEMA	SMBRD	107	37	40	43/74	1	3	2	2	H
75	B0920	ZEMA	SMBRD	107	37	40	43/74	1	3	2	0	H
61	B0921	ZEMA	SMBRD	68	24	70	57/136	1	4	1	2	H
61	B0922	ZEMA	SMBRD	68	24	70	57/136	1	4	1	0	H
124	B0940	ZEMA	SMBRD	15	9	150	14/30	4	1	1	2	H
124	B0941	ZEMA	SMBRD	15	9	150	14/30	4	1	1	0	H
91	B1005	ZEMA	SMBRD	85	25	50	44/100	0	2	4	0	H
74	B1006	ZEMA	SMBRD	132	35	70	43/70	4	1	1	2	H
92	B1007	ZEMA	SMBRD	85	25	80	44/50	0	2	4	2	H
27	B1384	ZEMA	SMBRD	47	9	20	31/94	2	2	2	2	H
74	B1396	ZEMA	SMBRD	132	35	70	43/70	4	1	1	2	H
77	B1397	ZEMA	SMBRD	23	14	70	31/46	2	1	3	0	H
146	B1406	ZEMA	SMBRD	14	1	490	19/28	2	0	4	0	H
145	B1407	ZEMA	SMBRD	5	0	450	8/10	2	0	4	0	H
149	B1410	ZEMA	SMBRD	12	2	420	19/24	0	3	3	2	C
74	B1416	ZEMA	SMBRD	132	35	70	43/70	4	1	1	2	H
90	B1417	ZEMA	SMBRD	85	25	35	44/50	0	1	5	0	H
118	B1418	ZEMA	SMBRD	70	10	240	10/20	2	1	3	2	H
118	B1419	ZEMA	SMBRD	70	10	240	10/20	2	1	3	2	H
154	B1420	ZEMA	SMBRD	9	2	160	14/18	1	0	5	2	D

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
125	B1443	ZEMA	SMBRD	18	2	160	23/36	2	1	3	2	C
21	B1444	ZEMA	SMBRD	23	7	160	14/46	1	4	1	2	H
21	B1445	ZEMA	SMBRD	23	7	160	14/46	1	4	1	2	H
21	B1446	ZEMA	SMBRD	23	7	160	14/46	1	4	1	2	H
21	B1447	ZEMA	SMBRD	23	7	160	14/46	1	4	1	2	H
122	B1448	ZEMA	SMBRD	35	8	40	27/70	3	2	1	0	H
159	B1489	ZEMA	SMBRD	15	2	320	28/30	1	0	5	0	H
62	B1497	ZEMA	SMBRD	69	11	180	75/138	3	1	2	2	C
71	B1501	ZEMA	SMBRD	200	59	50	50/118	0	2	4	2	H
121	B1502	ZEMA	SMBRD	41	8	140	30/82	2	1	3	2	H
109	B1503	ZEMA	SMBRD	9	3	210	7/18	3	0	3	2	B
71	B1505	ZEMA	SMBRD	200	59	50	50/118	0	2	4	2	H
127	B1506	ZEMA	SMBRD	0	0	225	0	3	0	3	0	H
61	B1507	ZEMA	SMBRD	68	24	70	57/136	1	4	1	2	H
71	B1508	ZEMA	SMBRD	200	59	50	50/118	0	2	4	2	A
38	B1509	ZEMA	SMBRD	9	3	10	16/18	0	0	6	0	H
93	B1510	ZEMA	SMBRD	5	0	550	0/10	0	0	6	0	H
33	B1511	ZEMA	SMBRD	9	0	450	17/18	0	1	5	0	H
158	B1516	ZEMA	SMBRD	8	1	270	14/16	1	0	5	0	H
1	B0013	PEMA	SMMML	0	0	820	0	0	1	2	2	H
3	B0015	PEMA	SMMML	0	0	560	0	0	0	3	0	H
127	B0018	PEMA	SMMML	0	0	225	0	3	0	3	2	H
122	B0037	PEMA	SMMML	1	1	40	0/2	3	2	1	2	H
78	B0041	PEMA	SMMML	0	0	140	0	3	0	3	2	H
142	B0042	PEMA	SMMML	2	0	80	2/4	3	0	3	2	H
119	B0047	PEMA	SMMML	1	0	70	1/2	2	1	3	0	H
29	B0052	PEMA	SMMML	0	0	190	0	5	1	0	2	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
97	B0056	PEMA	SMMML	0	0	160	0	1	2	3	2	H
27	B0057	PEMA	SMMML	1	1	20	2/2	2	2	2	2	F
74	B0059	PEMA	SMMML	2	0	70	2/4	4	1	1	2	H
61	B0060	PEMA	SMMML	3	0	70	4/6	1	4	1	2	H
51	B0061	PEMA	SMMML	1	0	60	1/2	1	5	0	2	H
79	B0063	PEMA	SMMML	0	0	380	0	2	0	4	2	H
71	B0064	PEMA	SMMML	3	0	50	6/6	0	2	4	2	H
148	B0066	PEMA	SMMML	2	1	45	1/4	0	3	3	2	F
53	B0070	PEMA	SMMML	0	0	110	0	0	0	6	2	H
77	B0071	PEMA	SMMML	1	0	70	0/2	2	1	3	2	H
17	B0081	PEMA	SMMML	1	0	100	2/2	1	0	5	2	H
5	B0082	PEMA	SMMML	0	0	240	0	0	1	5	0	H
109	B0083	PEMA	SMMML	0	0	210	0	3	0	3	2	H
131	B0084	PEMA	SMMML	0	0	750	0	0	0	1	0	H
128	B0094	PEMA	SMMML	0	0	160	0	2	1	3	0	H
134	B0479	PEMA	SMMML	0	0	440	0	0	0	1	0	H
127	B0528	PEMA	SMMML	0	0	225	0	3	0	3	2	H
122	B0529	PEMA	SMMML	1	1	40	0/2	3	2	1	2	H
141	B0541	PEMA	SMMML	1	0	90	0/2	4	0	2	0	H
77	B0542	PEMA	SMMML	0	0	70	0	2	1	3	2	H
119	B0545	PEMA	SMMML	1	0	70	1/2	2	1	3	2	H
104	B0546	PEMA	SMMML	0	0	180	0	1	0	5	2	H
3	B0547	PEMA	SMMML	0	0	560	0	0	0	3	0	H
97	B0548	PEMA	SMMML	0	0	160	0	1	2	3	2	H
5	B0549	PEMA	SMMML	0	0	240	0	0	1	5	0	H
74	B0551	PEMA	SMMML	2	0	70	2/4	4	1	1	2	H
117	B0556	PEMA	SMMML	1	0	80	1/2	2	2	2	2	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
128	B0557	PEMA	SMMML	0	0	160	0	2	1	3	0	H
75	B0558	PEMA	SMMML	3	1	40	2/6	1	3	2	2	F
109	B0559	PEMA	SMMML	0	0	210	0	3	0	3	2	H
134	B0562	PEMA	SMMML	0	0	440	0	0	0	1	0	H
31	B0565	PEMA	SMMML	0	0	220	0	2	2	2	2	H
27	B0566	PEMA	SMMML	1	1	20	2/2	2	2	2	2	F
79	B0567	PEMA	SMMML	0	0	380	0	2	0	4	2	H
29	B0568	PEMA	SMMML	0	0	190	0	5	1	0	2	H
133	B0569	PEMA	SMMML	0	0	990	0	0	0	1	0	H
61	B0578	PEMA	SMMML	3	0	70	4/6	1	4	1	2	H
71	B0581	PEMA	SMMML	3	0	50	6/6	0	2	4	2	H
65	B0587	PEMA	SMMML	2	1	30	3/4	1	4	1	0	H
130	B0589	PEMA	SMMML	0	0	740	0	0	0	4	0	H
51	B0590	PEMA	SMMML	1	0	60	1/2	1	5	0	2	H
16	B0604	PEMA	SMMML	5	2	30	6/10	0	0	6	2	D
15	B0605	PEMA	SMMML	3	1	40	1/6	2	1	3	0	H
34	B0609	PEMA	SMMML	0	0	340	0	0	1	5	0	H
37	B0611	PEMA	SMMML	0	0	450	0	0	0	6	0	H
36	B0615	PEMA	SMMML	0	0	350	0	4	0	2	0	H
148	B0616	PEMA	SMMML	2	1	45	1/4	0	3	3	2	F
29	B1215	PEMA	SMMML	0	0	190	0	5	1	0	2	H
3	B1216	PEMA	SMMML	0	0	560	0	0	0	3	0	H
17	B1217	PEMA	SMMML	1	0	100	2/2	1	0	5	2	H
109	B1218	PEMA	SMMML	0	0	210	0	3	0	3	2	H
27	B1219	PEMA	SMMML	1	1	20	2/2	2	2	2	2	F
5	B1220	PEMA	SMMML	0	0	240	0	0	1	5	0	H
74	B1221	PEMA	SMMML	2	0	70	2/4	4	1	1	2	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
75	B1222	PEMA	SMMML	3	1	40	2/6	1	3	2	2	F
119	B1223	PEMA	SMMML	1	0	70	1/2	2	1	3	2	F
127	B1224	PEMA	SMMML	0	0	225	0	3	0	3	2	H
97	B1225	PEMA	SMMML	0	0	160	0	1	2	3	2	H
122	B1226	PEMA	SMMML	1	1	40	0/2	3	2	1	2	C
141	B1227	PEMA	SMMML	1	0	90	0/2	4	0	2	2	H
117	B1228	PEMA	SMMML	1	0	80	1/2	2	2	2	2	H
77	B1229	PEMA	SMMML	1	0	70	0/2	2	1	3	2	H
79	B1230	PEMA	SMMML	0	0	380	0	2	0	4	2	H
134	B1231	PEMA	SMMML	0	0	440	0	0	0	1	2	H
104	B1235	PEMA	SMMML	0	0	180	0	1	0	5	2	H
136	B1240	PEMA	SMMML	0	0	180	0	1	0	5	2	H
30	B1245	PEMA	SMMML	0	0	110	0	3	3	0	2	G
16	B1253	PEMA	SMMML	5	2	30	6/10	0	0	6	0	H
15	B1254	PEMA	SMMML	3	1	40	1/6	2	1	3	2	F
37	B1289	PEMA	SMMML	0	0	450	0	0	0	6	0	H
51	B1292	PEMA	SMMML	1	0	60	1/2	1	5	0	2	H
36	B1293	PEMA	SMMML	0	0	350	0	4	0	2	0	H
34	B1294	PEMA	SMMML	0	0	340	0	0	1	5	2	H
133	B1295	PEMA	SMMML	0	0	990	0	0	0	1	0	H
61	B1297	PEMA	SMMML	3	0	70	4/6	1	4	1	2	F
71	B1298	PEMA	SMMML	3	0	50	6/6	0	2	4	2	H
130	B1299	PEMA	SMMML	0	0	740	0	0	0	4	0	H
148	B1300	PEMA	SMMML	2	1	45	1/4	0	3	3	2	F
53	B1303	PEMA	SMMML	0	0	110	0	0	0	6	2	H
65	B1328	PEMA	SMMML	2	1	30	3/4	1	4	1	2	F
65	B0478	SPTR	SMMML	2	1	30	3/4	1	4	1	2	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
31	B0480	SPTR	SMMML	0	0	220	0	2	2	2	2	H
58	B0497	SPTR	SMMML	2	1	0	2/4	0	5	1	2	F
132	B0019	BRTE	TRPLT	0	0	870	0	0	0	1	0	H
133	B0020	BRTE	TRPLT	0	0	990	0	0	0	1	0	H
1	B0021	BRTE	TRPLT	0	0	820	0	0	1	2	0	H
3	B0022	BRTE	TRPLT	0	0	560	0	0	0	3	0	H
6	B0023	BRTE	TRPLT	0	0	510	0	0	1	5	0	H
148	B0024	BRTE	TRPLT	0	0	45	0	0	3	3	0	H
141	B0026	BRTE	TRPLT	0	0	90	0	4	0	2	0	H
119	B0027	BRTE	TRPLT	0	0	70	0	2	1	3	1	H
75	B0028	BRTE	TRPLT	0	0	40	0	1	3	2	1	G
122	B0029	BRTE	TRPLT	0	0	40	0	3	2	1	2	F
127	B0030	BRTE	TRPLT	0	0	225	0	3	0	3	1	H
67	B0031	BRTE	TRPLT	0	0	45	0	0	5	1	0	H
61	B0032	BRTE	TRPLT	0	0	70	0	1	4	1	1	H
51	B0033	BRTE	TRPLT	0	0	60	0	1	5	0	1	G
29	B0036	BRTE	TRPLT	0	0	190	0	5	1	0	0	H
5	B0104	BRTE	TRPLT	0	0	240	0	0	1	5	0	H
130	B0105	BRTE	TRPLT	0	0	740	0	0	0	4	0	H
134	B0106	BRTE	TRPLT	0	0	440	0	0	0	1	0	H
17	B0107	BRTE	TRPLT	0	0	100	0	1	0	5	2	H
128	B0109	BRTE	TRPLT	0	0	160	0	2	1	3	0	H
128	B0269	BRTE	TRPLT	0	0	160	0	2	1	3	0	H
148	B0391	BRTE	TRPLT	0	0	45	0	0	3	3	0	H
3	B0570	BRTE	TRPLT	0	0	560	0	0	0	3	0	H
5	B0571	BRTE	TRPLT	0	0	240	0	0	1	5	0	H
130	B0572	BRTE	TRPLT	0	0	740	0	0	0	4	0	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
133	B0573	BRTE	TRPLT	0	0	990	0	0	0	1	0	H
134	B0574	BRTE	TRPLT	0	0	440	0	0	0	1	0	H
79	B0575	BRTE	TRPLT	0	0	380	0	2	0	4	0	H
77	B0576	BRTE	TRPLT	0	0	70	0	2	1	3	1	H
141	B0577	BRTE	TRPLT	0	0	90	0	4	0	2	1	G
128	B0592	BRTE	TRPLT	0	0	160	0	2	1	3	0	H
119	B0593	BRTE	TRPLT	0	0	70	0	2	1	3	1	H
117	B0594	BRTE	TRPLT	0	0	80	0	2	2	2	0	H
75	B0595	BRTE	TRPLT	0	0	40	0	1	3	2	1	H
104	B0596	BRTE	TRPLT	0	0	180	0	1	0	5	0	H
109	B0597	BRTE	TRPLT	0	0	210	0	3	0	3	1	H
127	B0598	BRTE	TRPLT	0	0	225	0	3	0	3	1	H
71	B0621	BRTE	TRPLT	0	0	50	0	0	2	4	1	H
65	B0622	BRTE	TRPLT	0	0	30	0	1	4	1	1	H
51	B0623	BRTE	TRPLT	0	0	60	0	1	5	0	0	H
61	B0624	BRTE	TRPLT	0	0	70	0	1	4	1	1	H
97	B0626	BRTE	TRPLT	0	0	160	0	1	2	3	1	H
31	B0627	BRTE	TRPLT	0	0	220	0	2	2	2	0	H
17	B0628	BRTE	TRPLT	0	0	100	0	1	0	5	0	H
27	B0629	BRTE	TRPLT	0	0	20	0	2	2	2	0	H
29	B0630	BRTE	TRPLT	0	0	190	0	5	1	0	1	H
1	B0631	BRTE	TRPLT	0	0	820	0	0	1	2	0	H
34	B0632	BRTE	TRPLT	0	0	340	0	0	1	5	0	H
36	B0633	BRTE	TRPLT	0	0	350	0	4	0	2	0	H
37	B0634	BRTE	TRPLT	0	0	450	0	0	0	6	0	H
15	B0635	BRTE	TRPLT	0	0	40	0	2	1	3	1	H
16	B0636	BRTE	TRPLT	0	0	30	0	0	0	6	0	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
119	B1232	BRTE	TRPLT	0	0	70	0	2	1	3	1	H
36	B1255	BRTE	TRPLT	0	0	350	0	4	0	2	0	H
134	B1256	BRTE	TRPLT	0	0	440	0	0	0	1	0	H
133	B1257	BRTE	TRPLT	0	0	990	0	0	0	1	0	H
5	B1258	BRTE	TRPLT	0	0	240	0	0	1	5	0	H
34	B1259	BRTE	TRPLT	0	0	340	0	0	1	5	0	H
15	B1260	BRTE	TRPLT	0	0	40	0	2	1	3	0	H
130	B1261	BRTE	TRPLT	0	0	740	0	0	0	4	0	H
3	B1262	BRTE	TRPLT	0	0	560	0	0	0	3	0	H
37	B1263	BRTE	TRPLT	0	0	450	0	0	0	6	0	H
16	B1264	BRTE	TRPLT	0	0	30	0	0	0	6	0	H
117	B1265	BRTE	TRPLT	0	0	80	0	2	2	2	0	H
75	B1266	BRTE	TRPLT	0	0	40	0	1	3	2	0	H
148	B1268	BRTE	TRPLT	0	0	45	0	0	3	3	0	H
141	B1270	BRTE	TRPLT	0	0	90	0	4	0	2	0	H
77	B1271	BRTE	TRPLT	0	0	70	0	2	1	3	0	H
79	B1272	BRTE	TRPLT	0	0	380	0	2	0	4	0	H
61	B1273	BRTE	TRPLT	0	0	70	0	1	4	1	1	H
71	B1274	BRTE	TRPLT	0	0	50	0	0	2	4	1	H
65	B1275	BRTE	TRPLT	0	0	30	0	1	4	1	0	H
51	B1276	BRTE	TRPLT	0	0	60	0	1	5	0	0	H
104	B1278	BRTE	TRPLT	0	0	180	0	1	0	5	0	H
127	B1279	BRTE	TRPLT	0	0	225	0	3	0	3	1	H
17	B1280	BRTE	TRPLT	0	0	100	0	1	0	5	0	H
109	B1281	BRTE	TRPLT	0	0	210	0	3	0	3	0	H
27	B1282	BRTE	TRPLT	0	0	20	0	2	2	2	1	H
30	B1283	BRTE	TRPLT	0	0	110	0	3	3	0	0	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
97	B1284	BRTE	TRPLT	0	0	160	0	1	2	3	1	H
29	B1285	BRTE	TRPLT	0	0	190	0	5	1	0	1	H
122	B1286	BRTE	TRPLT	0	0	40	0	3	2	1	1	G
56	484	COAR	TRPLT	0	0	170	0	1	0	5	0	H
56	485	COAR	TRPLT	0	0	170	0	1	0	5	0	H
56	486	COAR	TRPLT	0	0	170	0	1	0	5	0	H
55	498	COAR	TRPLT	0	0	40	0	1	0	5	0	H
61	B0199	HEAN	TRPLT	0	0	70	0	1	4	1	1	H
51	B0200	HEAN	TRPLT	0	0	60	0	1	5	0	0	H
71	B0201	HEAN	TRPLT	0	0	50	0	0	2	4	1	H
17	B0202	HEAN	TRPLT	0	0	100	0	1	0	5	2	H
31	B0203	HEAN	TRPLT	0	0	220	0	2	2	2	1	H
97	B0204	HEAN	TRPLT	0	0	160	0	1	2	3	1	H
109	B0205	HEAN	TRPLT	0	0	210	0	3	0	3	1	H
122	B0206	HEAN	TRPLT	0	0	40	0	3	2	1	1	G
74	B0207	HEAN	TRPLT	0	0	70	0	4	1	1	1	G
119	B0208	HEAN	TRPLT	0	0	70	0	2	1	3	1	H
128	B0224	HEAN	TRPLT	0	0	160	0	2	1	3	0	H
77	B0225	HEAN	TRPLT	0	0	70	0	2	1	3	0	H
79	B0226	HEAN	TRPLT	0	0	380	0	2	0	4	0	H
6	B0227	HEAN	TRPLT	0	0	510	0	0	1	5	0	H
130	B0228	HEAN	TRPLT	0	0	740	0	0	0	4	0	H
132	B0229	HEAN	TRPLT	0	0	870	0	0	0	1	0	H
133	B0230	HEAN	TRPLT	0	0	990	0	0	0	1	0	H
134	B0231	HEAN	TRPLT	0	0	440	0	0	0	1	0	H
36	B0712	HEAN	TRPLT	0	0	350	0	4	0	2	0	H
37	B0713	HEAN	TRPLT	0	0	450	0	0	0	6	0	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
141	B0800	HEAN	TRPLT	0	0	90	0	4	0	2	0	H
29	B0801	HEAN	TRPLT	0	0	190	0	5	1	0	1	H
17	B0802	HEAN	TRPLT	0	0	100	0	1	0	5	0	H
71	B0803	HEAN	TRPLT	0	0	50	0	0	2	4	1	H
65	B0805	HEAN	TRPLT	0	0	30	0	1	4	1	0	H
51	B0807	HEAN	TRPLT	0	0	60	0	1	5	0	0	H
74	B0812	HEAN	TRPLT	0	0	70	0	4	1	1	1	G
75	B0813	HEAN	TRPLT	0	0	40	0	1	3	2	1	H
117	B0814	HEAN	TRPLT	0	0	80	0	2	2	2	1	H
119	B0816	HEAN	TRPLT	0	0	70	0	2	1	3	1	H
104	B0821	HEAN	TRPLT	0	0	180	0	1	0	5	0	H
127	B0822	HEAN	TRPLT	0	0	225	0	3	0	3	0	H
27	B0823	HEAN	TRPLT	0	0	20	0	2	2	2	0	H
61	B0824	HEAN	TRPLT	0	0	70	0	1	4	1	0	H
109	B0825	HEAN	TRPLT	0	0	210	0	3	0	3	0	H
122	B0826	HEAN	TRPLT	0	0	40	0	3	2	1	0	H
132	B0827	HEAN	TRPLT	0	0	870	0	0	0	1	0	H
31	B0828	HEAN	TRPLT	0	0	220	0	2	2	2	0	H
3	B0829	HEAN	TRPLT	0	0	560	0	0	0	3	0	H
134	B0830	HEAN	TRPLT	0	0	440	0	0	0	1	0	H
5	B0927	HEAN	TRPLT	0	0	240	0	0	1	5	0	H
97	B0928	HEAN	TRPLT	0	0	160	0	1	2	3	0	H
128	B0929	HEAN	TRPLT	0	0	160	0	2	1	3	0	H
148	B0930	HEAN	TRPLT	0	0	45	0	0	3	3	0	H
133	B0931	HEAN	TRPLT	0	0	990	0	0	0	1	0	H
79	B0932	HEAN	TRPLT	0	0	380	0	2	0	4	0	H
104	B1450	HEAN	TRPLT	0	0	180	0	1	0	5	0	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
127	B1451	HEAN	TRPLT	0	0	225	0	3	0	3	1	H
74	B1452	HEAN	TRPLT	0	0	70	0	4	1	1	1	G
117	B1453	HEAN	TRPLT	0	0	80	0	2	2	2	0	H
75	B1454	HEAN	TRPLT	0	0	40	0	1	3	2	0	H
122	B1455	HEAN	TRPLT	0	0	40	0	3	2	1	0	H
119	B1456	HEAN	TRPLT	0	0	70	0	2	1	3	1	H
109	B1457	HEAN	TRPLT	0	0	210	0	3	0	3	0	H
30	B1464	HEAN	TRPLT	0	0	110	0	3	3	0	0	H
97	B1465	HEAN	TRPLT	0	0	160	0	1	2	3	0	H
17	B1466	HEAN	TRPLT	0	0	100	0	1	0	5	0	H
27	B1467	HEAN	TRPLT	0	0	20	0	2	2	2	0	H
29	B1468	HEAN	TRPLT	0	0	190	0	5	1	0	0	H
51	B1469	HEAN	TRPLT	0	0	60	0	1	5	0	0	H
53	B1470	HEAN	TRPLT	0	0	110	0	0	0	6	0	H
71	B1471	HEAN	TRPLT	0	0	50	0	0	2	4	2	H
61	B1472	HEAN	TRPLT	0	0	70	0	1	4	1	1	H
65	B1473	HEAN	TRPLT	0	0	30	0	1	4	1	0	H
3	B1474	HEAN	TRPLT	0	0	560	0	0	0	3	0	H
5	B1475	HEAN	TRPLT	0	0	240	0	0	1	5	0	H
134	B1476	HEAN	TRPLT	0	0	440	0	0	0	1	0	H
132	B1477	HEAN	TRPLT	0	0	870	0	0	0	1	0	H
133	B1478	HEAN	TRPLT	0	0	990	0	0	0	1	0	H
79	B1480	HEAN	TRPLT	0	0	380	0	2	0	4	0	H
141	B1482	HEAN	TRPLT	0	0	90	0	4	0	2	0	H
128	B1483	HEAN	TRPLT	0	0	160	0	2	1	3	0	H
37	B1486	HEAN	TRPLT	0	0	450	0	0	0	6	0	H
16	B1487	HEAN	TRPLT	0	0	30	0	0	0	6	0	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
15	B1488	HEAN	TRPLT	0	0	40	0	2	1	3	0	H
63	415	HEAN	TRPLT	0	0	80	0	4	0	2	0	H
63	416	HEAN	TRPLT	0	0	80	0	4	0	2	0	H
63	417	HEAN	TRPLT	0	0	80	0	4	0	2	0	H
63	420	HEAN	TRPLT	0	0	80	0	4	0	2	0	H
63	496	HEAN	TRPLT	0	0	80	0	4	0	2	0	H
7	503	HEAN	TRPLT	0	0	460	0	0	1	5	0	H
7	504	HEAN	TRPLT	0	0	460	0	0	1	5	0	H
23	505	HEAN	TRPLT	0	0	180	0	2	2	2	0	H
23	506	HEAN	TRPLT	0	0	180	0	2	2	2	0	H
63	576	HEAN	TRPLT	0	0	80	0	4	0	2	0	H
63	577	HEAN	TRPLT	0	0	80	0	4	0	2	0	H
63	578	HEAN	TRPLT	0	0	80	0	4	0	2	0	H
63	579	HEAN	TRPLT	0	0	80	0	4	0	2	0	H
127	B0122	KOIR	TRPLT	0	0	225	0	3	0	3	1	H
109	B0124	KOIR	TRPLT	0	0	210	0	3	0	3	0	H
77	B0130	KOIR	TRPLT	0	0	70	0	2	1	3	0	H
79	B0132	KOIR	TRPLT	0	0	380	0	2	0	4	0	H
148	B0133	KOIR	TRPLT	0	0	45	0	0	3	3	0	H
130	B0135	KOIR	TRPLT	0	0	740	0	0	0	4	0	H
134	B0137	KOIR	TRPLT	0	0	440	0	0	0	1	0	H
1	B0138	KOIR	TRPLT	0	0	820	0	0	1	2	0	H
3	B0139	KOIR	TRPLT	0	0	560	0	0	0	3	0	H
5	B0140	KOIR	TRPLT	0	0	240	0	0	1	5	0	H
51	B0149	KOIR	TRPLT	0	0	60	0	1	5	0	0	H
53	B0151	KOIR	TRPLT	0	0	110	0	0	0	6	0	H
97	B0153	KOIR	TRPLT	0	0	160	0	1	2	3	0	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
17	B0156	KOIR	TRPLT	0	0	100	0	1	0	5	1	H
29	B0158	KOIR	TRPLT	0	0	190	0	5	1	0	0	H
17	B0695	KOIR	TRPLT	0	0	100	0	1	0	5	0	H
65	B0696	KOIR	TRPLT	0	0	30	0	1	4	1	1	H
51	B0697	KOIR	TRPLT	0	0	60	0	1	5	0	1	G
53	B0698	KOIR	TRPLT	0	0	110	0	0	0	6	0	H
148	B0701	KOIR	TRPLT	0	0	45	0	0	3	3	0	H
79	B0702	KOIR	TRPLT	0	0	380	0	2	0	4	0	H
141	B0703	KOIR	TRPLT	0	0	90	0	4	0	2	0	H
134	B0705	KOIR	TRPLT	0	0	440	0	0	0	1	0	H
130	B0706	KOIR	TRPLT	0	0	740	0	0	0	4	0	H
77	B0710	KOIR	TRPLT	0	0	70	0	2	1	3	0	H
34	B0711	KOIR	TRPLT	0	0	340	0	0	1	5	0	H
1	B0747	KOIR	TRPLT	0	0	820	0	0	1	2	0	H
3	B0748	KOIR	TRPLT	0	0	560	0	0	0	3	0	H
5	B0749	KOIR	TRPLT	0	0	240	0	0	1	5	0	H
77	B0750	KOIR	TRPLT	0	0	70	0	2	1	3	0	H
29	B0760	KOIR	TRPLT	0	0	190	0	5	1	0	0	H
97	B0761	KOIR	TRPLT	0	0	160	0	1	2	3	0	H
31	B0762	KOIR	TRPLT	0	0	220	0	2	2	2	0	H
104	B0764	KOIR	TRPLT	0	0	180	0	1	0	5	0	H
109	B0765	KOIR	TRPLT	0	0	210	0	3	0	3	0	H
130	B0799	KOIR	TRPLT	0	0	740	0	0	0	4	0	H
16	B0810	KOIR	TRPLT	0	0	30	0	0	0	6	0	H
15	B0811	KOIR	TRPLT	0	0	40	0	2	1	3	0	H
148	B1479	KOIR	TRPLT	0	0	45	0	0	3	3	0	H
77	B1481	KOIR	TRPLT	0	0	70	0	2	1	3	1	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
34	B1484	KOIR	TRPLT	0	0	340	0	0	1	5	0	H
37	B1485	KOIR	TRPLT	0	0	450	0	0	0	6	0	H
65	B0475	LASE	TRPLT	0	0	30	0	1	4	1	0	H
75	B0476	LASE	TRPLT	0	0	40	0	1	3	2	1	H
119	B0477	LASE	TRPLT	0	0	70	0	2	1	3	1	H
51	B0495	LASE	TRPLT	0	0	60	0	1	5	0	0	H
61	B0496	LASE	TRPLT	0	0	70	0	1	4	1	1	H
61	B0699	LASE	TRPLT	0	0	70	0	1	4	1	0	H
128	B0700	LASE	TRPLT	0	0	160	0	2	1	3	0	H
132	B0707	LASE	TRPLT	0	0	870	0	0	0	1	0	H
133	B0745	LASE	TRPLT	0	0	990	0	0	0	1	0	H
27	B0763	LASE	TRPLT	0	0	20	0	2	2	2	0	H
127	B0766	LASE	TRPLT	0	0	225	0	3	0	3	1	H
122	B0767	LASE	TRPLT	0	0	40	0	3	2	1	1	H
65	B0804	LASE	TRPLT	0	0	30	0	1	4	1	0	H
51	B0806	LASE	TRPLT	0	0	60	0	1	5	0	1	H
117	B0815	LASE	TRPLT	0	0	80	0	2	2	2	0	H
119	B0817	LASE	TRPLT	0	0	70	0	2	1	3	1	H
130	B1032	LASE	TRPLT	0	0	740	0	0	0	4	0	H
1	B0038	OLIG	WORMS	0	0	820	0	0	1	2	0	H
119	B0039	OLIG	WORMS	0	0	70	0	2	1	3	1	H
3	B0040	OLIG	WORMS	0	0	560	0	0	0	3	0	H
142	B0044	OLIG	WORMS	0	0	80	0	3	0	3	1	H
97	B0045	OLIG	WORMS	0	0	160	0	1	2	3	1	H
30	B0046	OLIG	WORMS	0	0	110	0	3	3	0	1	H
29	B0048	OLIG	WORMS	0	0	190	0	5	1	0	2	G
127	B0049	OLIG	WORMS	0	0	225	0	3	0	3	1	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
122	B0050	OLIG	WORMS	0	0	40	0	3	2	1	1	G
106	B0053	OLIG	WORMS	0	0	110	0	3	0	3	1	H
132	B0054	OLIG	WORMS	0	0	870	0	0	0	1	0	H
78	B0055	OLIG	WORMS	0	0	140	0	3	0	3	1	H
77	B0058	OLIG	WORMS	0	0	70	0	2	1	3	1	H
67	B0062	OLIG	WORMS	0	0	45	0	1	2	3	1	H
6	B0065	OLIG	WORMS	0	0	510	0	0	1	5	0	H
79	B0069	OLIG	WORMS	0	0	380	0	2	0	4	0	H
17	B0078	OLIG	WORMS	0	0	100	0	1	0	5	2	H
68	B0079	OLIG	WORMS	0	0	50	0	1	2	3	1	H
3	B0525	OLIG	WORMS	0	0	560	0	0	0	3	0	H
1	B0526	OLIG	WORMS	0	0	820	0	0	1	2	0	H
97	B0527	OLIG	WORMS	0	0	160	0	1	2	3	1	H
141	B0530	OLIG	WORMS	0	0	90	0	4	0	2	1	G
104	B0531	OLIG	WORMS	0	0	180	0	1	0	5	0	H
5	B0535	OLIG	WORMS	0	0	240	0	0	1	5	0	H
77	B0543	OLIG	WORMS	0	0	70	0	2	1	3	1	H
79	B0544	OLIG	WORMS	0	0	380	0	2	0	4	1	H
127	B0550	OLIG	WORMS	0	0	225	0	3	0	3	1	H
130	B0552	OLIG	WORMS	0	0	740	0	0	0	4	0	H
148	B0553	OLIG	WORMS	0	0	45	0	0	3	3	0	H
109	B0554	OLIG	WORMS	0	0	210	0	3	0	3	1	H
128	B0555	OLIG	WORMS	0	0	160	0	2	1	3	1	H
75	B0560	OLIG	WORMS	0	0	40	0	1	3	2	1	H
117	B0561	OLIG	WORMS	0	0	80	0	2	2	2	2	G
134	B0563	OLIG	WORMS	0	0	440	0	0	0	1	0	H
29	B0564	OLIG	WORMS	0	0	190	0	5	1	0	1	H

TABLE . RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
65	B0600	OLIG	WORMS	0	0	30	0	1	4	1	1	H
17	B0601	OLIG	WORMS	0	0	100	0	1	0	5	1	H
119	B0602	OLIG	WORMS	0	0	70	0	2	1	3	1	H
89	B0603	OLIG	WORMS	0	0	10	0	0	2	4	1	H
16	B0606	OLIG	WORMS	0	0	30	0	0	0	6	1	H
15	B0607	OLIG	WORMS	0	0	40	0	2	1	3	1	H
37	B0613	OLIG	WORMS	0	0	450	0	0	0	6	1	H
115	B0614	OLIG	WORMS	0	0	160	0	1	1	4	1	H
113	B0617	OLIG	WORMS	0	0	370	0	1	1	4	0	H
112	B0618	OLIG	WORMS	0	0	460	0	1	1	4	0	H
34	B0619	OLIG	WORMS	0	0	340	0	0	1	5	1	H
114	B0620	OLIG	WORMS	0	0	120	0	1	1	4	0	H
75	B1233	OLIG	WORMS	0	0	40	0	1	3	2	1	H
65	B1234	OLIG	WORMS	0	0	30	0	1	4	1	1	H
134	B1236	OLIG	WORMS	0	0	440	0	0	0	1	0	H
148	B1237	OLIG	WORMS	0	0	45	0	0	3	3	1	H
77	B1238	OLIG	WORMS	0	0	70	0	2	1	3	1	H
79	B1239	OLIG	WORMS	0	0	380	0	2	0	4	1	H
141	B1252	OLIG	WORMS	0	0	90	0	4	0	2	1	G
130	B1277	OLIG	WORMS	0	0	740	0	0	0	4	0	H
37	B1288	OLIG	WORMS	0	0	450	0	0	0	6	0	H
34	B1290	OLIG	WORMS	0	0	340	0	0	1	5	1	H
128	B1291	OLIG	WORMS	0	0	160	0	2	1	3	1	H
5	B1296	OLIG	WORMS	0	0	240	0	0	1	5	0	H
120	B1301	OLIG	WORMS	0	0	410	0	1	0	5	0	H
127	B1304	OLIG	WORMS	0	0	225	0	3	0	3	1	H
16	B1305	OLIG	WORMS	0	0	30	0	0	0	6	1	H

TABLE 2. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ALDRIN PLUS DIELDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples Having Hits w/in Search Radius: 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
112	B1308	OLIG	WORMS	0	0	460	0	1	1	4	1	H
113	B1334	OLIG	WORMS	0	0	370	0	1	1	4	1	H
73	357	OLIG	WORMS	0	0	30	0	0	5	1	0	H
129	358	OLIG	WORMS	0	0	450	0	1	0	3	0	H
129	501	OLIG	WORMS	0	0	450	0	1	0	3	0	H
129	502	OLIG	WORMS	0	0	450	0	1	0	3	0	H
129	543	OLIG	WORMS	0	0	450	0	1	0	3	0	H
129	545	OLIG	WORMS	0	0	450	0	1	0	3	0	H
129	546	OLIG	WORMS	0	0	450	0	1	0	3	0	H
129	567	OLIG	WORMS	0	0	450	0	1	0	3	0	H

TABLE 3. ASSIGNMENT OF WEIGHTS TO TC/ESC DATA PAIRS

Percentage ofSoil Samples BCRL	Number of Soil Samples Within HRER				
	> 10	4-9	1-3	0 nearest soil sample < 100'	0 nearest soil sample > 100'
	Number of tissue 'hits" = 2				
<50%	A	B	C	F	G
50-80%	C	D	F	G	H
>80%	F	G	H	H	H
	Number of tissue "hits" = 1				
<50%	C	D	F	G	H
50-80%	E	F	G	H	H
>80%	G	H	H	H	H

Note: all samples for which the number of tissue hits = 0 are assigned to category H (zero weight)

TABLE 4. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR DDE PLUS DDT

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs Within HR Circle	Number of Samples With Hits Within Search Radius			# of Tissue Hits	Rank
								2 hits	1 hit	0 hits		
18	B0798	AMBY	HERPS	0	0	410	0	0	2	4	1	H
14	B1449	PIME	HERPS	1	0	340	0/2	0	0	2	1	H
74	B0680	ACRI	INSCT	0	0	70	0	3	1	2	1	G
31	B0681	ACRI	INSCT	0	0	220	0	0	0	6	1	H
37	B0868	ACRI	INSCT	0	0	450	0	0	0	0	1	H
128	B0790	COLE	INSCT	0	0	160	0	3	0	3	1	H
61	B1668	COLE	INSCT	0	0	70	0	0	1	5	1	H
105	B0080	CYLU	MDMML	0	0	210	0	2	1	3	1	H
57	B0329	CYLU	MDMML	2	1	0	4/4	1	0	5	1	H
104	B0532	CYLU	MDMML	0	0	180	0	1	1	4	1	H
140	B1306	CHVO	SHBRD	9	8	40	16/18	1	1	4	1	H
140	B1307	CHVO	SHBRD	9	8	40	16/18	1	1	4	1	H
155	B1309	CHVO	SHBRD	0	0	530	0	0	1	5	2	H
156	B1310	CHVO	SHBRD	0	0	490	0	0	1	5	2	H
156	B1317	CHVO	SHBRD	0	0	490	0	0	1	5	2	H
16	B0649	ZEMA	SMBRD	48	23	30	71/96	0	1	5	1	E
74	B1006	ZEMA	SMBRD	132	37	70	51/74	3	1	2	1	E
127	B0018	PEMA	SMMML	0	0	225	0	1	0	5	1	H
74	B0551	PEMA	SMMML	2	0	70	3/4	3	1	2	1	C
65	B0587	PEMA	SMMML	2	1	30	4/4	0	2	4	1	H
74	B1221	PEMA	SMMML	2	0	70	3/4	3	1	2	1	C
127	B1224	PEMA	SMMML	0	0	225	0	1	0	5	1	H
71	B1298	PEMA	SMMML	3	0	50	6/6	1	0	5	2	H
141	B0577	BRTE	TRPLT	0	0	90	0	0	2	4	2	H
15	B0635	BRTE	TRPLT	0	0	40	0	0	3	3	1	G
132	B0229	HEAN	TRPLT	0	0	870	0	0	0	0	1	H

TABLE 4. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR DDE PLUS DDT

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs Within HR Circle	Number of Samples With Hits Within Search Radius 2 hits	1 hit	0 hits	# of Tissue Hits	Rank
133	B0230	HEAN	TRPLT	0	0	990	0	0	0	0	1	H
71	B0803	HEAN	TRPLT	0	0	50	0	1	0	5	1	H
29	B0760	KOIR	TRPLT	0	0	190	0	1	1	4	1	H
29	B0048	OLIG	WORMS	0	0	190	0	1	1	4	1	H
106	B0053	OLIG	WORMS	0	0	110	0	2	1	3	1	H
128	B0555	OLIG	WORMS	0	0	160	0	3	0	3	2	H
117	B0561	OLIG	WORMS	0	0	80	0	2	0	4	1	H
134	B0563	OLIG	WORMS	0	0	440	0	0	0	0	1	H
65	B0600	OLIG	WORMS	0	0	30	0	0	2	4	1	H
115	B0614	OLIG	WORMS	0	0	160	0	1	0	5	2	H
112	B0618	OLIG	WORMS	0	0	460	0	1	0	5	1	H
114	B0620	OLIG	WORMS	0	0	120	0	1	0	5	2	H
79	B1239	OLIG	WORMS	0	0	380	0	0	2	4	1	H
128	B1291	OLIG	WORMS	0	0	160	0	3	0	3	1	H
120	B1301	OLIG	WORMS	0	0	410	0	1	0	5	2	H
112	B1308	OLIG	WORMS	0	0	460	0	1	0	5	2	H

TABLE 5. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ENDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples With Hits W/in Search Radius 1hit	Number of Samples With Hits W/in Search Radius 0 hits	# of Tissue Hits	Rank
18	B0797	AMBY	HERPS	0	0	410	0	6	0	1	G
18	B0798	AMBY	HERPS	0	0	410	0	6	0	1	G
75	B0683	ACRI	INSCT	0	0	50	0	0	6	1	H
71	B0690	ACRI	INSCT	0	0	50	0	2	4	1	G
71	B1489	ACRI	INSCT	0	0	50	0	2	4	1	G
61	B0791	COLE	INSCT	0	0	100	0	3	3	1	G
17	B0808	COLE	INSCT	0	0	100	0	1	5	1	H
29	B0819	COLE	INSCT	0	0	190	0	4	2	1	G
61	B1668	COLE	INSCT	0	0	70	0	3	3	1	G
51	B1669	COLE	INSCT	0	0	60	0	2	4	1	F
59	B0327	CYLU	MDMML	0	0	0	0	1	5	1	H
57	B0329	CYLU	MDMML	2	1	0	1/2	3	3	1	F
140	B1306	CHVO	SHBRD	12	3	40	6/12	1	5	1	C
156	B1317	CHVO	SHBRD	0	0	490	0	0	6	1	H
17	B1409	STNE	SMBRD	0	0	100	0	1	5	1	H
102	B0640	ZEMA	SMBRD	13	7	50	12/13	0	6	1	F
27	B0641	ZEMA	SMBRD	42	8	20	16/42	2	4	1	A
16	B0649	ZEMA	SMBRD	41	22	30	37/41	1	5	1	F
74	B0651	ZEMA	SMBRD	122	35	70	105/122	2	4	1	F
104	B0652	ZEMA	SMBRD	14	3	180	11/14	1	5	1	C
17	B0735	ZEMA	SMBRD	12	6	100	5/12	1	5	1	A
17	B0738	ZEMA	SMBRD	12	6	100	5/12	1	5	1	A
17	B0743	ZEMA	SMBRD	12	6	100	5/12	1	5	1	A
61	B0771	ZEMA	SMBRD	70	30	70	34/70	3	3	1	A
17	B0917	ZEMA	SMBRD	12	6	100	5/12	1	5	1	A
71	B1508	ZEMA	SMBRD	145	52	50	112/145	2	4	1	C

TABLE 5. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR ENDRIN

Loc.	ID No.	Spec.	Group	# of Samples HRER.	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples With Hits W/in Search Radius 1hit	Number of Samples With Hits W/in Search Radius 0 hits	# of Tissue Hits	Rank
71	B1298	PEMA	SMMML	3	0	50	3/3	2	4	1	F
17	B0202	HEAN	TRPLT	0	0	100	0	1	5	1	H
71	B0803	HEAN	TRPLT	0	0	50	0	2	4	1	G
30	B0046	OLIG	WORMS	0	0	110	0	4	2	1	G
29	B0048	OLIG	WORMS	0	0	190	0	4	2	1	G
127	B0049	OLIG	WORMS	0	0	225	0	1	5	1	H
78	B0055	OLIG	WORMS	0	0	140	0	2	4	1	H
67	B0062	OLIG	WORMS	0	0	45	0	1	5	1	H
17	B0078	OLIG	WORMS	0	0	100	0	1	5	1	H
29	B0564	OLIG	WORMS	0	0	190	0	4	2	1	G
75	B1233	OLIG	WORMS	0	0	40	0	1	5	1	H
65	B1234	OLIG	WORMS	0	0	30	0	1	5	1	H
79	B1239	OLIG	WORMS	0	0	300	0	2	4	1	H
16	B1305	OLIG	WORMS	0	0	30	0	0	6	1	H

TABLE 6. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR MERCURY

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples With Hits W/In Search Radius 1hit	Number of Samples With Hits W/In Search Radius 0 hits	# of Tissue Hits	Rank
18	B0797	AMBY	HERPS	0	0	450	0	3	3	1	H
18	B0798	AMBY	HERPS	0	0	450	0	3	3	1	H
79	B1459	SCAP	HERPS	0	0	340	0	2	4	1	H
42	B0501M	SYAU	MDMML	24	8	0	21/24	0	6	1	F
101	B0715	CYLU	MDMML	0	0	210	0	0	6	1	H
140	B1306	CHVO	SHBRD	7	6	50	6/7	0	6	1	G
140	B1307	CHVO	SHBRD	7	6	50	6/7	0	6	1	G
155	B1309	CHVO	SHBRD	0	0	530	0	0	6	1	H
156	B1310	CHVO	SHBRD	0	0	490	0	0	6	1	H
156	B1317	CHVO	SHBRD	0	0	490	0	0	6	1	H
1	B0013	PEMA	SMMML	0	0	710	0	0	6	1	H
142	B0042	PEMA	SMMML	2	0	80	0/2	2	4	1	F
17	B0586	PEMA	SMMML	1	0	90	1/1	0	6	1	H
130	B0589	PEMA	SMMML	0	0	730	0	0	4	1	H
16	B0604	PEMA	SMMML	4	1	40	0/4	5	1	1	B
71	B1298	PEMA	SMMML	4	0	70	1/4	4	2	1	B
1	B0038	OLIG	WORMS	0	0	710	0	0	2	1	H
142	B0044	OLIG	WORMS	0	0	80	0	2	4	1	G
97	B0045	OLIG	WORMS	0	0	130	0	2	4	1	H
29	B0048	OLIG	WORMS	0	0	90	0	2	4	1	G
106	B0053	OLIG	WORMS	0	0	110	0	0	6	1	H
78	B0055	OLIG	WORMS	0	0	130	0	1	5	1	H
67	B0062	OLIG	WORMS	0	0	35	0	4	2	1	F
68	B0079	OLIG	WORMS	0	0	60	0	3	3	1	G
97	B0527	OLIG	WORMS	0	0	130	0	2	4	1	H
141	B0530	OLIG	WORMS	0	0	90	0	2	4	1	G

TABLE 6. RESULTS OF SCREENING AND WEIGHTING PROCEDURE FOR MERCURY

Loc.	ID No.	Spec.	Group	# of Samples HRER	# of Samples HRER/2	Distance to Nearest Soil Sample (ft)	BCRLs within HR circle	Number of Samples With Hits W/in Search Radius 1hit	Number of Samples With Hits W/in Search Radius 0 hits	# of Tissue Hits	Rank
104	B0531	OLIG	WORMS	0	0	330	0	0	6	1	H
77	B0543	OLIG	WORMS	0	0	170	0	3	3	1	H
127	B0550	OLIG	WORMS	0	0	225	0	3	3	1	H
130	B0552	OLIG	WORMS	0	0	730	0	0	4	1	H
128	B0555	OLIG	WORMS	0	0	80	0	1	5	1	H
75	B0560	OLIG	WORMS	0	0	40	0	0	6	1	H
29	B0564	OLIG	WORMS	0	0	90	0	2	4	1	G
65	B0600	OLIG	WORMS	0	0	85	0	3	3	1	G
17	B0601	OLIG	WORMS	0	0	90	0	0	6	1	H
119	B0602	OLIG	WORMS	0	0	60	0	1	5	1	H
89	B0603	OLIG	WORMS	1	0	10	0/1	2	4	1	C
16	B0606	OLIG	WORMS	0	0	40	0	5	1	1	F
15	B0607	OLIG	WORMS	0	0	40	0	2	4	1	G
115	B0614	OLIG	WORMS	0	0	190	0	0	6	1	H
113	B0617	OLIG	WORMS	0	0	370	0	0	6	1	H
112	B0618	OLIG	WORMS	0	0	460	0	0	6	1	H
75	B1233	OLIG	WORMS	0	0	40	0	0	6	1	H
65	B1234	OLIG	WORMS	0	0	35	0	3	3	1	G
148	B1237	OLIG	WORMS	0	0	40	0	2	4	1	G
79	B1239	OLIG	WORMS	0	0	340	0	2	4	1	H
141	B1252	OLIG	WORMS	0	0	90	0	2	4	1	G
34	B1290	OLIG	WORMS	0	0	160	0	0	6	1	H
128	B1291	OLIG	WORMS	0	0	80	0	1	5	1	H
16	B1305	OLIG	WORMS	0	0	40	0	5	1	1	F
113	B1334	OLIG	WORMS	0	0	370	0	0	6	1	H

TABLE 7. NUMBERS OF SAMPLES ASSIGNED NON-ZERO WEIGHT USING EPAS PROCEDURE

Group	Species	No. of Samples	ALDRIN + DIELDRIN		DDE +DDT		ENDRIN		MERCURY	
			high weight	low weight	high weight	low weight	high weight	low weight	high weight	low weight
HERPS	AMBY	2	0	2	0	0	0	2	0	0
	PIME	3	0	2	0	0	0	0	0	0
	SCAP	2	0	0	0	0	0	0	0	0
INSCT	ACRI	81	0	12	0	1	0	2	0	0
	COLE	17	0	2	0	0	0	4	0	0
MDMML	CYLU	128	0	27	0	0	0	1	0	0
	SYAU	28	0	1	0	0	0	0	0	1
SHBRD	CHVO	5	0	0	0	0	1	0	0	2
SMBRD	POGR	5	0	0	0	0	0	0	0	0
	STNE	10	6	2	0	0	0	0	0	0
	ZEMA	68	15	3	0	2	8	3	0	0
SMMML	PEMA	90	0	14	2	0	0	1	2	1
	SPTR	3	0	1	0	0	0	0	0	0
TRPLT	BRTE	84	0	6	0	1	0	0	0	0
	COAR	4	0	0	0	0	0	0	0	0
	HEAN	89	0	4	0	0	0	1	0	0
	KOIR	42	0	1	0	0	0	0	0	0
	LASE	17	0	0	0	0	0	0	0	0
WORMS	OLIG	74	0	5	0	0	0	3	1	13
All samples		752	21	82	2	4	9	17	3	17

APPENDIX C.6.3

STATE'S POSITION ON THE ESTIMATION OF BMF

State's Position on the Estimation of BMF

The State of Colorado has reviewed the three approaches for estimating RMA-specific BMFs and strongly believes that EPA's method is the most scientifically defensible. It is the only approach which tests the fundamental hypothesis that the data collected at RMA can be used to relate measured biota-tissue concentrations to the soil concentrations to which the organisms are exposed. The other two methods impose an assumed correlation between soil and tissue concentrations despite the fact that the data show no such correlation. As explained in detail by the Army and EPA, the data-collection programs for soil and biota were not for the specific purpose of estimating contaminant uptake and therefore did not address the many factors which confound this relationship (for example, physiologic differences and specific knowledge about the organisms' true exposure areas). The second phase of the Supplemental field Program, which at present has not been designed by the parties, would need to specifically address these confounding factors to explain and reduce the current lack of correlation between soil and tissue concentrations.