Ecological Soil Screening Levels
for
Zinc

Interim Final

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1.0 INTRODUCTION

Ecological Soil Screening Levels (Eco-SSLs) are concentrations of contaminants in soil that are protective of ecological receptors that commonly come into contact with and/or consume biota that live in or on soil. Eco-SSLs are derived separately for four groups of ecological receptors: plants, soil invertebrates, birds, and mammals. As such, these values are presumed to provide adequate protection of terrestrial ecosystems. Eco-SSLs are derived to be protective of the conservative end of the exposure and effects species distribution, and are intended to be applied at the screening stage of an ecological risk assessment. These screening levels should be used to identify the contaminants of potential concern (COPCs) that require further evaluation in the site-specific baseline ecological risk assessment that is completed according to specific guidance (U.S. EPA, 1997, 1998, and 1999). The Eco-SSLs are not designed to be used as cleanup levels and the United States (U.S.) Environmental Protection Agency (EPA) emphasizes that it would be inappropriate to adopt or modify the intended use of these Eco-SSLs as national cleanup standards.

The detailed procedures used to derive Eco-SSL values are described in separate documentation (U.S. EPA, 2003, 2005). The derivation procedures represent the collaborative effort of a multi-stakeholder group consisting of federal, state, consulting, industry, and academic participants led by what is now the U.S. EPA Office of Solid Waste and Emergency Response (OSWER).

This document provides the Eco-SSL values for zinc and the documentation for their derivation. This document provides guidance and is designed to communicate national policy on identifying zinc concentrations in soil that may present an unacceptable ecological risk to terrestrial receptors. The document does not, however, substitute for EPA's statutes or regulations, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on EPA, states, or the regulated community, and may not apply to a particular situation based upon the circumstances of the site. EPA may change this guidance in the future, as appropriate. EPA and state personnel may use and accept other technically sound approaches, either on their own initiative, or at the suggestion of potentially responsible parties, or other interested parties. Therefore, interested parties are free to raise questions and objections about the substance of this document and the appropriateness of the application of this document to a particular situation. EPA welcomes public comments on this document at any time and may consider such comments in future revisions of this document.

2.0 SUMMARY OF ECO-SSLs FOR ZINC

Zinc is found in almost all minerals and is ranked as the twenty-third most abundant element in the earth's crust. The principal ores of zinc are sphalerite, smithsonite, calamine, and franklinite (O'Neill, 2001; Lide, 2005). Elemental zinc is not found in the environment but instead occurs in compounds in the 2+ oxidation state, often as zinc sulfide or zinc oxide (HSDB).

Zinc is released to the environment from both natural and anthropogenic sources, the latter being the most important. Zinc has many commercial uses as coatings to prevent corrosion for electrical apparatus such as dry cell batteries, and mixed with other metals to make alloys like brass, and bronze (O'Neill, 2001). Zinc compounds such as zinc chloride, zinc oxide and zinc sulfate are used in herbicides, fungicides and bacteriostats. Zinc may also be released to the environment from its use in rubbers, paints, and cosmetics (ATSDR, 2005; Goodwin, 1998; ANL, 2005) and as the result of metal smelting, mining, electroplating, coal and oil combustion, and waste incineration (ATSDR, 2005; Ursinyova, 1999). Urban runoff from building siding and roofs, automobile brakes, tires, and oil leakage is another important source of zinc in the environment (Davis, 2001)(HSDB).

Total zinc content in soils is dependent on the composition of the parent rock material (Kiekens, 1990; HSDB). The total amount of zinc in soils is distributed as one of three forms: 1) free ions (Zn2+) and organo-zinc complexes in soil solution; 2) adsorbed and exchangeable zinc in the colloidal fraction of the soil and 3) secondary minerals and insoluble complexes in the solid phase of the soil. The distribution of zinc among the forms is dependant on the concentration of Zn2+ and other ions in the solution, the kind and amount of adsorption sites associated with the solid phase of the soil, the concentration of all ligands capable of forming organo-zinc complexes, and pH and redox potential of soil (Alloway, 1990). Background concentrations reported for many metals in U.S. soils are described in Attachment 1-4 of the Eco SSL guidance (U.S. EPA, 2003). Typical background concentrations of zinc in U.S. soils are plotted in Figure 2.1 for both eastern and western U.S. soils.

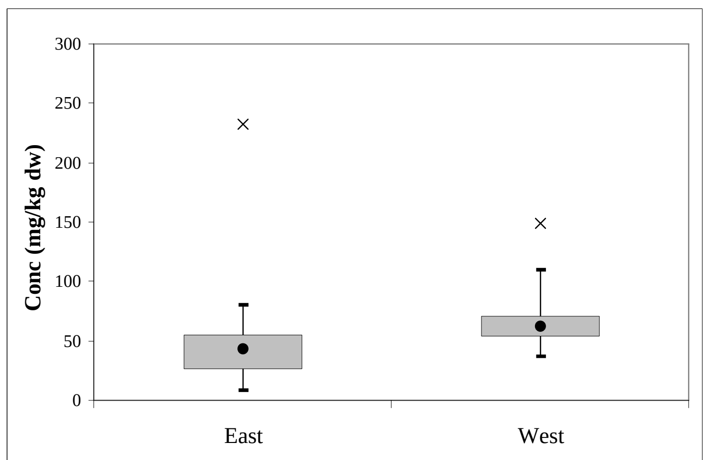
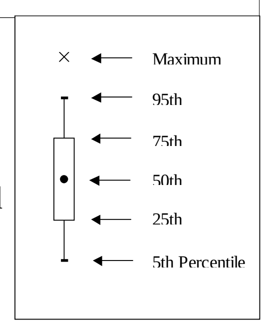


Figure 2.2 Typical Background Concentrations of Zinc in U.S. Soils



Zinc is expected to demonstrate low mobility in most soils, and is strongly adsorbed to soils at pH 5 or greater (Evans, 1989; Blume, 1991; Christensen, 1996). Only those fractions of zinc in soil which are soluble or may be solubilized are bioavailable. Compared to total zinc content of soils, concentrations of zinc in soil solution are low. The solubility of zinc increases at decreasing pH (Alloway, 1990). The bioavailability of zinc in soils is also influenced by total zinc content, pH, organic matter, microbial activity, moisture, and interactions with other macro and micronutrients (Kiekens, 1990; HSDB).

Zinc is an essential trace element for higher plants and animals. In higher plants zinc is absorbed as the divalent cation (Zn 2+) which is a metal component of enzymes or a functional, structural or regulatory cofactor of a large number of enzymes. Zinc is involved in carbohydrate and protein metablolism and is required for the synthesis of indoleacetic acid. In plants, zinc deficiency is commonly indicated by stunted growth, interveinal chlorosis, and leaf symptomatology such as small leaves, malformations, and dieback while zinc excess commonly produces iron chlorosis (Chapman, 1966, Kiekens, 1990).

In animals, zinc is an essential nutrient for regulating a number of metalloenzymes (ATSDR, 2005). Absorption of zinc occurs from all segments of the intestine, although the largest proportion of zinc absorption occurs from the duodenum (ATSDR, 2005). Following absorption by the intestine, zinc is rapidly distributed to the liver, kidneys, prostate, muscles, bones, and pancreas. Zinc salts adversely affect tissues, interfere with the metabolism of other ions such as copper, calcium, and iron, and inhibit erythrocyte production and function (ATSDR, 2005; WHO, 2001; ECB, 2004; HSDB).

Zinc deficiency has been associated with dermatitis, anorexia, growth retardation, poor wound healing, hypogonadism with impaired reproductive capacity, and impaired immune function (ATSDR, 2005). Nutritional requirements of zinc for common mammalian and avian test organisms are compiled in Attachment 4-3 of the Eco-SSL guidance (U.S. EPA, 2003, 2005). Zinc excess in avian species is associated with decreased body weight, gizzard and pancreatic lesions, and biochemical changes (WHO, 2001). Mammalian studies have shown vomiting, depressed growth rate, purgation, and ataxia (Clarke, 1981; Friberg, 1986; HSDB).

The Eco-SSL values derived to date for Zinc are summarized in Table 2.1.

Table 2.1 Zinc Eco-SSLs (mg/kg dry weight in soil)

Plants	Soil Invertebrates	Wildlife	
		Avian	Mammalian
160	120	46	79

Eco-SSL values were derived for all receptor groups. The Eco-SSL values for zinc range from 46 mg/kg dry weight (dw) for avian wildlife to 160 mg/kg dw for terrestrial plants. The Eco-SSL for avian wildlife is less than the 25th percentile of reported background soil concentrations of zinc in western U.S. soils and less than the 75th percentile for eastern U.S. soils (Figure 2.1). The Eco-SSL for mammalian wildlife is less than the 96th percentile for both eastern and western U.S. soils (Figure 2.1). The Eco-SSLs for plants and soil invertebrates are higher than the 95th percentile for both eastern and western U.S. soils. The avian and mammalian Eco-SSL values are based on exposures of receptors consuming zinc in soil invertebrates.

3.0 ECO-SSL FOR TERRESTRIAL PLANTS

Of the papers identified from the literature search process, 680 papers were selected for acquisition for further review. Of those papers acquired, 78 met all 11 Study Acceptance Criteria (U.S. EPA, 2003; Attachment 3-1). Each of these papers were reviewed and the studies were scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 3-2). Thirty-nine study results received an Evaluation Score greater than ten (U.S. EPA, 2003; Attachment 3-1). These studies are listed in Table 3.1.

The studies in Table 3.1 are sorted by bioavailability score. There are five studies with a bioavailability score of 2 that are eligible for Eco-SSL derivation. These results were used to derive the plant Eco-SSL for zinc (U.S. EPA, 2003; Attachment 3-2). The Eco-SSL is the geometric mean of the maximum acceptable toxicant concentration (MATC) values for three species under different test conditions (pH and % organic matter (OM)) and is equal to 160 mg/kg dw.

4.0 ECO-SSL FOR SOIL INVERTEBRATES

Of the papers identified from the literature search process, 162 papers were selected for acquisition for further review. Of those papers acquired, 26 met all 11 Study Acceptance Criteria (U.S. EPA 2003; Attachment 3-1). Each of these papers were reviewed and the studies were scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 3-2). Forty studies received an Evaluation Score greater than ten. These studies are listed in Table 4.1.

The studies in Table 4.1 are sorted by bioavailability score. There are six studies with a bioavailability score of 2 that are eligible for Eco-SSL derivation. These results were used to derive the soil invertebrate Eco-SSL for zinc (U.S. EPA, 2003; Attachment 3-2). The Eco-SSL is the geometric mean of the EC_{10} and MATC values for at least three test species under different test conditions (pH and OM%) and is equal to 120 mg/kg dw.

Table 3.1 Plant Toxicity Data - Zinc

Reference	IP Number	Study ID	Test Organism		Soil pH	OM%	Bio-availability Score	ERE	Tox Parameter	Tox Value (Soil Conc at mg/kg dw)	Total Evaluation Score	Eligible for Eco-SSL Derivation?	Used for Eco-SSL?
White et al., 1979b	57096	d	soybean	*Glycine max*	6.5	1.2	2	GRO	MATC	185	13	Y	Y
Roszyk et al., 1988	13624	p	oats	*Avena sp.*	4.3	0.8	2	GRO	MATC	143	18	Y	Y
Roszyk et al., 1988	13624	b	oats	*Avena sp.*	5.3	2.6	2	GRO	MATC	155	18	Y	Y
Roszyk et al., 1988	13624	u	oats	*Avena sp.*	5.7	1.3	2	GRO	MATC	159	18	Y	Y
Sheppard et al., 1993	4146	b	lettuce	*Lactuca sativa*	6.3	<1	2	GRO	MATC	173	12	Y	Y
									Geometric Mean	160			
Data Not Used to Derive Plant Eco-SSL													
De Haan et al., 1985	5048	e	oats	*Avena sativa*	5.4	7	1	GRO	MATC	283	11	N	N
Roszyk et al., 1988	13624	l	mustard	*Brassica sp.*	5.3	2.6	2	GRO	LOAEC	105	18	N	N
Roszyk et al., 1988	13624	a	oats	*Avena sp.*	4.2	0.7	2	GRO	LOAEC	95	17	N	N
Roszyk et al., 1988	13624	n	mustard	*Brassica sp.*	4.2	0.7	2	GRO	LOAEC	95	17	N	N
Singh and Jeng, 1993	12400		Ryegrass	*Lolium*	6.0	0.1	2	GRO	NOAEC	50	14	N	N
Monette, 1978	45950	a	spinach	*Spinacia oleracea*	6.9	1.9	2	GRO	NOAEC	20	12	N	N
Monette, 1978	45950	b	barley	*Hordeum vulgare*	6.9	1.9	2	GRO	NOAEC	20	12	N	N
White et al., 1979b	57096	a	soybean	*Glycine max*	5.5	1.2	2	GRO	LOAEC	131	12	N	N
Rehab and Wallace, 1978	46710	b	cotton	*Gossypium barbadense*	6.6	2.4	1	GRO	MATC	283	14	Y	N
Roszyk et al., 1988	13624	zc	oats	*Avena sp.*	5.7	5.7	1	GRO	MATC	319	18	Y	N
Roszyk et al., 1988	13624	d	oats	*Avena sp.*	5.6	2.3	1	GRO	MATC	361	17	Y	N
Roszyk et al., 1988	13624	z	oats	*Avena sp.*	5.9	2.3	1	GRO	MATC	169	17	Y	N
Roszyk et al., 1988	13624	g	mustard	*Brassica sp.*	5.6	2.3	1	GRO	MATC	177	17	Y	N
Rehab and Wallace, 1978	46710	a	cotton	*Gossypium hirsutum*	6.6	2.4	1	GRO	MATC	283	14	Y	N
Dang et al., 1990	12906	E	onion	*Allium Cepa*	8.3	0.5	1	GRO	MATC	141	11	Y	N
Dang et al., 1990	12906	H	Fenugreek	*Trigonella foenum*	8.3	0.5	1	GRO	MATC	283	11	Y	N
Roszyk et al., 1988	13624	zb	Seradela	*Ornithopus compressus*	5.6	5.2	1	GRO	LOAEC	102	17	N	N
Roszyk et al., 1988	13624	ze	Seradela	*Ornithopus compressus*	5.7	5.7	1	GRO	LOAEC	95	17	N	N
Roszyk et al., 1988	13624	zi	oats	*Avena sp.*	5.6	5.2	1	GRO	NOAEC	440	16	N	N
Roszyk et al., 1988	13624	zh	oats	*Avena sp.*	7.1	3.7	1	GRO	NOAEC	475	16	N	N
Kadar and Morvai, 1998	12988	a	Carrot	*Daucus carota*	7.0	1.032	1	GRO	MATC	57	17	Y	N
Kadar and Morvai, 1998	12988	b	garden pea	*Pisum sativum*	7.0	1.032	1	GRO	MATC	34	17	Y	N
Roszyk et al., 1988	13624	kl	mustard	*Brassica sp.*	5.9	2.3	1	GRO	NOAEC	420	15	N	N
Singh et al., 1991	12701		wheat	*Triticum aestivum*	8.2	0.086	1	GRO	MATC	113	13	Y	N

Table 3.1 Plant Toxicity Data - Zinc

Reference	IP Number	Study ID	Test Organism		Soil pH	OM%	Bio-availability Score	ERE	Tox Parameter	Tox Value (Soil Conc at mg/kg dw)	Total Evaluation Score	Eligible for Eco-SSL Derivation?	Used for Eco-SSL?
Kucharski and Niklewska, 1992	13292		common bean	*Phaseolus vulgaris*	7.1	0.32	1	GRO	MATC	330	13	Y	N
Biro et al., 1998	12986	b	red clover	*Trifolium pratense L.*	7.0	3.00	1	GRO	MATC	90	11	Y	N
Biro et al., 1998	12986	a	alfalfa	*Medicago sativa*	7.0	3.00	1	GRO	NOAEC	270	11	N	N
Mehta and Singh, 1988	13724		mustard	*Brassica sp.*	8.5	0.55	1	GRO	NOAEC	30	11	N	N
Roszyk et al., 1988	13624	zm	mustard	*Brassica sp.*	7.1	3.7	0	GRO	MATC	157	16	Y	N
Roszyk et al., 1988	13624	t	oats	*Avena sp.*	7.0	3.3	0	GRO	MATC	162	16	Y	N
Sheppard et al., 1993	4146	c	mustard	*Brassica rapa*	7.9	2.70	0	GRO	MATC	424	12	Y	N
Roszyk et al., 1988	13624	zf	oats	*Avena sp.*	7.1	3.7	0	GRO	NOAEC	475	16	N	N
Voros et al., 1998	12985	a	red clover	*Trifolium pratense L.*	7.5	6.50	0	GRO	NOAEC	275	12	N	N
Voros et al., 1998	12985	b	red clover	*Trifolium pratense L.*	7.5	6.50	0	GRO	NOAEC	275	12	N	N

EC_{10} = Effect concentration for 10% of test population
EC_{25} = Effect concentration for 25% of test population
EC_{50} = Effect concentration for 50% of test population
ERE = Ecologically relevant endpoint
GRO = Growth
LOAEC = Lowest observed adverse effect concentration
MATC = Maximum acceptable toxicant concentration. Geometric mean of NOAEC and LOAEC.
N = No
NOAEC = No observed adverse effect concentration

ns = Not specified
OM = Organic matter content
PHY = Physiology
REP = Reproduction
Y = yes
cnbd = Could Not Be Determined
Bioavailability Score described in *Guidance for Developing Eco-SSLs* (U.S. EPA, 2003)
Total Evaluation Score described in *Guidance for Developing Eco-SSLs* (U.S. EPA, 2003)

Table 4.1 Invertebrate Toxicity Data - Zinc

Reference	IP Number	Study ID	Test Organism		Soil pH	OM%	Bio-availability Score	ERE	Tox Parameter	Tox Value (Soil Conc at mg/kg dw)	Total Evaluation Score	Eligible for Eco-SSL Derivation?	Used for Eco-SSL?
Smit et al., 1998	11279		Springtail	*Folsomia candida*	4.8	2.4	2	REP	EC_{10}	99	15	Y	Y
Korthals et al., 1998	13828		Nematode	multiple	4.1	4.0	2	POP	MATC	35	13	Y	Y
Korthals et al., 1996	4402		Nematode	multiple	4.1	3.2	2	POP	MATC	141	13	Y	Y
Smit and Van Gestel, 1997	4434		Springtail	*Folsomia candida*	4.5	1.9	2	REP	EC_{10}	116	17	Y	Y
Smit and Van Gestel, 1998	6159	b	Springtail	*Folsomia candida*	4.7	2.4	2	REP	EC_{10}	136	17	Y	Y
Smit and Van Gestel, 1998	6159	d	Springtail	*Folsomia candida*	4.7	2.4	2	REP	EC_{10}	355	17	Y	Y
									Geometric Mean	120			
Data not Used to Derive Soil Invertebrate Eco-SSL													
Spurgeon and Hopkin, 1996	4067	a	Earthworm	*Eisenia fetida*	4.0	5.0	2	REP	NOAEC	115	16	N	N
Spurgeon and Hopkin, 1996	4067	b	Earthworm	*Eisenia fetida*	5.0	5.0	2	REP	NOAEC	85	16	N	N
Peredney and Williams, 2000b	56449	y	Nematode	*Caenorhabditis elegans*	4	1.14	2	MOR	LC_{50}	54.2	13	N	N
Peredney and Williams, 2000b	56449	aa	Nematode	*Caenorhabditis elegans*	4	4.2	2	MOR	LC_{50}	186	13	N	N
Donkin and Dusenbery, 1994	7877	b	Nematode	*Caenorhabditis elegans*	5.1	3.0	2	MOR	LC_{50}	255	15	N	N
Van Gestel and Hensbergen, 1997	10987		Springtail	*Folsomia candida*	6.0	10.0	1	REP	EC_{10}	399	13	Y	N
Sandifer and Hopkin, 1996	4056	a	Springtail	*Folsomia candida*	6.0	10.0	1	REP	MATC	863	14	Y	N
Sandifer and Hopkin, 1996	4056	b	Springtail	*Folsomia candida*	5.0	10.0	1	REP	MATC	548	14	Y	N
Sandifer and Hopkin, 1996	4056	c	Springtail	*Folsomia candida*	4.5	10.0	1	REP	MATC	548	14	Y	N
Spurgeon et al., 1997	4442	a	Earthworm	*Eisenia fetida*	6.0	10.0	1	REP	LOAEC	190	13	Y	N
Smit and Van Gestel, 1998	6159	a	Springtail	*Folsomia candida*	6.0	10.0	1	REP	EC_{10}	269	17	Y	N
Smit and Van Gestel, 1998	6159	c	Springtail	*Folsomia candida*	7.0	2.0	1	REP	EC_{10}	1059	17	Y	N
Van Gestel et al., 1993	6828		Earthworm	*Eisenia andrei*	6.0	10.0	1	REP	MATC	423	12	Y	N
Sandifer and Hopkin, 1997	758		Springtail	*Folsomia candida*	6.0	10.0	1	REP	MATC	548	15	Y	N
Spurgeon and Hopkin, 1996a	7870		Earthworm	*Eisenia fetida*	6.0	10.0	1	REP	MATC	466	12	Y	N
Posthuma et al., 1997	2380	a	Earthworm	*Enchytraeus crypticus*	6.4	10.0	1	REP	EC_{50}	188	13	N	N
Posthuma et al., 1997	2380	b	Earthworm	*Enchytraeus crypticus*	6.4	10.0	1	REP	EC_{50}	336	13	N	N
Spurgeon and Hopkin, 1996	4067	c	Earthworm	*Eisenia fetida*	6.0	5.0	1	REP	NOAEC	97	16	N	N
Spurgeon and Hopkin, 1996	4067	d	Earthworm	*Eisenia fetida*	4.0	10.0	1	REP	NOAEC	161	16	N	N
Spurgeon and Hopkin, 1996	4067	e	Earthworm	*Eisenia fetida*	5.0	10.0	1	REP	NOAEC	183	16	N	N
Spurgeon et al., 1994	4364		Earthworm	*Eisenia fetida*	6.3	10.0	1	REP	EC_{50}	276	11	N	N
Spurgeon et al., 1997	4442	c	Earthworm	*Eisenia fetida*	6.0	10.0	1	REP	EC_{50}	234	13	N	N
Smit and Van Gestel, 1996	7869	a	Springtail	*Folsomia candida*	6.0	3.3	1	REP	EC_{50}	348	15	N	N

Table 4.1 Invertebrate Toxicity Data - Zinc

Reference	IP Number	Study ID	Test Organism		Soil pH	OM%	Bio-availability Score	ERE	Tox Parameter	Tox Value (Soil Conc at mg/kg dw)	Total Evaluation Score	Eligible for Eco-SSL Derivation?	Used for Eco-SSL?
Smit and Van Gestel, 1996	7869	b	Springtail	*Folsomia candida*	6.0	3.0	1	REP	EC_{50}	185	15	N	N
Neuhauser et al., 1985a	17707		Earthworm	*Eisenia fetida*	6.0	10.0	1	MOR	LC50	232	14	N	N
Conder and Lanno, 2000	46691		Earthworm	*Eisenia andrei*	6.5	10.0	1	MOR	ILL	631	16	N	N
Peredney and Williams, 2000a	53082		Nematode	*Caenorhabditis elegans*	4	10	1	MOR	LC_{50}	670	12	N	N
Peredney and Williams, 2000b	56449	ac	Nematode	*Caenorhabditis elegans*	4	10	1	MOR	LC_{50}	661	12	N	N
Donkin and Dusenbery, 1994	7877	a	Nematode	*Caenorhabditis elegans*	6.2	1.7	1	MOR	LC_{50}	183	15	N	N
Donkin and Dusenbery, 1994	7877	c	Nematode	*Caenorhabditis elegans*	6.1	3.4	1	MOR	LC_{50}	392	15	N	N
Donkin and Dusenbery, 1994	7877	d	Nematode	*Caenorhabditis elegans*	6.2	2.2	1	MOR	LC_{50}	549	15	N	N
Spurgeon and Hopkin, 1995	6822		Earthworm	*Eisenia fetida*	6.1	10.0	1	GRO	NOAEC	237	11	N	N
Spurgeon and Hopkin, 1996a	7870		Earthworm	*Eisenia fetida*	6.0	10.0	1	REP	MATC	466	12	Y	N
Spurgeon and Hopkin, 1996	4067	f	Earthworm	*Eisenia fetida*	6.0	10.0	0	REP	NOAEC	553	16	N	N

EC_{10} = Effect concentration for 10% of test population
EC_{50} = Effect concentration for 50% of test population
ERE = Ecologically relevant endpoint
GRO = Growth
ILL = Incipient lethal level
LC_{50} = Concentration lethal to 50% of test population
LOAEC = Lowest observed adverse effect concentration
MATC = Maximum acceptable toxicant concentration
MOR = Mortality
N = No
NOAEC = No observed adverse effect concentration
OM = Organic matter content
POP = Population
REP = Reproduction
Y = Yes
Bioavailability Score described in *Guidance for Developing Eco-SSLs* (U.S.EPA, 2003)
Total Evaluation Score described in *Guidance for Developing Eco-SSLs* (U.S. EPA, 2003)

5.0 ECO-SSL FOR AVIAN WILDLIFE

The derivation of the Eco-SSL for avian wildlife was completed as two parts. First, the toxicity reference value (TRV) was derived according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5). Second, the Eco-SSL (soil concentration) was back-calculated for each of three surrogate species representing different trophic levels based on the wildlife exposure model and the TRV (U.S. EPA, 2003).

5.1 Avian TRV

The literature search completed according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-1) identified 10,410 papers with possible toxicity data for either avian or mammalian species. Of these studies, 10,259 were rejected for use as described in Section 7.5. Of the remaining studies, 53 contained data for avian test species. These papers were reviewed and the data were extracted and scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-3 and 4-4). The results of the data extraction and review are provided as Table 5.1. The complete results are included as Appendix 5-1.

Within the reviewed papers, there are 168 results for biochemical (BIO), behavior (BEH), physiology (PHY), pathology (PTH), reproduction (REP), growth (GRO), and survival (MOR) effects that meet the Data Evaluation Score of >65 for use to derive the TRV (U.S. EPA, 2003; Attachment 4-4). These data are plotted in Figure 5.1 and correspond directly with the data presented in Table 5.1. The no-observed adverse effect level (NOAEL) results for growth and reproduction are used to calculate a geometric mean. This result is examined in relationship to the lowest bounded lowest-observed adverse effect level (LOAEL) for reproduction, growth, and survival to derive the TRV according to procedures in the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5).

A geometric mean of the NOAEL values for reproduction and growth was calculated at 66.1 mg zinc/kg bw/day. This value is lower than the lowest bounded LOAEL for reproduction, growth, or survival. Therefore, the TRV is equal to the geometric mean of NOAEL values within the reproduction and growth effect groups and is equal to 66.1 mg zinc/kg bw/day.

Table 5.1
Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Zinc
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Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose* (mg/kg bw/day)	LOAEL Dose* (mg/kg bw/day)	Total
Biochemical (BIO)																		
1	Hamilton et al, 1979	6655	Japanese quail (*Coturnix japonica*)	2	U	FD	14	d	0	d	JV	B	CHM	HMGL	BL	21.5		73
2	Hamilton et al, 1981	6403	Japanese quail (*Coturnix japonica*)	3	U	FD	7	d	1	d	JV	B	CHM	HMGL	BL	54.3	109	76
3	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	6	U	FD	140	d	40	w	SM	F	CHM	LIPD	LI	55	105	72
4	Gasaway and Buss, 1972	9261	Mallard duck (*Anas platyrhynchos*)	4	U	FD	45	d	7	w	JV	B	CHM	HMCT	BL	76.5	153	76
5	Berg and Martinson, 1972	93	Chicken (*Gallus domesticus*)	7	U	FD	2	w	1	d	JV	NR	CHM	ASHC	BO	114	172	71
6	Southern and Baker, 1983	6368	Chicken (*Gallus domesticus*)	3	U	FD	14	d	8	d	JV	M	CHM	HMGL	BL	177	354	76
7	Hamilton et al, 1979	6655	Japanese quail (*Coturnix japonica*)	6	U	FD	14	d	0	d	JV	B	CHM	HMCT	BL		22.3	73
8	Lefevre et al, 1982	392	Chicken (*Gallus domesticus*)	2	U	FD	5	w	1	d	JV	NR	CHM	HMCT	BL		63.2	71
9	Lu et al, 1990	8008	Chicken (*Gallus domesticus*)	2	U	FD	4	d	14	d	JV	B	ENZ	GENZ	PS		65.7	66
10	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	5	U	FD	3	w	40	w	SM	F	CHM	LIPD	LI		88	66
11	Pimentel et al, 1992	5617	Chicken (*Gallus domesticus*)	2	M	FD	3	w	1	d	JV	B	CHM	HMGL	WO		132	70
12	Sandoval et al, 1998	7245	Chicken (*Gallus domesticus*)	2	U	FD	1	w	1	d	JV	F	CHM	MCPR	LI		138	69
13	Oh et al, 1979	6627	Chicken (*Gallus domesticus*)	2	U	FD	4	w	1	d	JV	NR	CHM	GBCM	LI		252	66
14	Bafundo et al, 1984	2517	Chicken (*Gallus domesticus*)	2	U	FD	14	d	8	d	JV	F	CHM	HMGL	WO		284	69
15	Dean et al, 1991	5681	Chicken (*Gallus domesticus*)	2	M	FD	1	w	1	d	JV	M	CHM	GBCM	SR		757	71
Behavior (BEH)																		
16	Baker and Halpin, 1988	5917	Chicken (*Gallus domesticus*)	2	M	FD	14	d	8	d	JV	M	FDB	FCNS	WO	15.0		69
17	Sandoval et al, 1997	5247	Chicken (*Gallus domesticus*)	4	U	FD	20	d	1	d	JV	B	FDB	FCNS	WO	45.4	68.1	79
18	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	6	U	FD	140	d	40	w	SM	F	FDB	FCNS	WO	55	105	75
19	Gibson et al, 1986	6048	Chicken (*Gallus domesticus*)	6	U	FD	10	w	30	w	JV	F	FDB	FCNS	WO	57.3	66.5	75
20	Gibson et al, 1986	6048	Chicken (*Gallus domesticus*)	6	U	FD	10	w	30	w	JV	F	FDB	FCNS	WO	64.1	123	75
21	Dewar et al, 1983	37018	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	B	FDB	FCNS	WO	65.6	131	75
22	Stevenson et al, 1987	8184	Chicken (*Gallus domesticus*)	9	U	FD	140	d	28	w	JV	F	FDB	FCNS	WO	78.2	104	75
23	Henry et al, 1987	6039	Chicken (*Gallus domesticus*)	4	U	FD	1	w	1	d	JV	M	FDB	FCNS	WO	92.3	185	79
24	Stevenson et al, 1987	8184	Chicken (*Gallus domesticus*)	9	U	FD	140	d	28	w	JV	F	FDB	FCNS	WO	99.9	133	75
25	Dewar et al, 1983	37018	Chicken (*Gallus domesticus*)	3	U	FD	4	d	18	mo	AD	F	FDB	FCNS	WO	159	319	74
26	Oh et al, 1979	6627	Chicken (*Gallus domesticus*)	6	U	FD	4	w	1	d	JV	NR	FDB	FCNS	WO	252	503	75
27	Bartov, 1996	5373	Chicken (*Gallus domesticus*)	4	U	FD	2	w	1	w	JV	F	FDB	FCNS	WO	315	629	75
28	Lu and Combs, 1988	5903	Chicken (*Gallus domesticus*)	2	U	FD	15	d	1	d	JV	NR	FDB	FCNS	WO		21.6	68
29	Stahl et al, 1989	5820	Chicken (*Gallus domesticus*)	2	U	FD	20	d	1	d	JV	B	FDB	FDNG	WO		31.0	73
31	Lu and Combs, 1988	5866	Chicken (*Gallus domesticus*)	2	U	FD	12	d	20	d	JV	NR	FDB	FCNS	WO		58.5	68
32	Lefevre et al, 1982	392	Chicken (*Gallus domesticus*)	2	U	FD	5	w	1	d	JV	NR	FDB	FCNS	WO		63.2	74
33	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	5	U	FD	1	w	40	w	SM	F	FDB	FCNS	WO		88	69
34	Gasaway and Buss, 1972	9261	Mallard duck (*Anas platyrhynchos*)	4	U	FD	10	d	7	w	JV	B	FDB	FCNS	WO		126	73
35	Pimentel et al, 1992	5617	Chicken (*Gallus domesticus*)	2	M	FD	3	w	1	d	JV	B	FDB	FCNS	WO		132	73
36	Stepinska et al, 1987	5770	Chicken (*Gallus domesticus*)	2	U	FD	5	d	71	w	SM	F	FDB	FCNS	WO		205	69
37	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	5	U	FD	1	w	40	w	SM	F	FDB	FCNS	WO		367	69
38	Wight et al, 1986	1624	Chicken (*Gallus domesticus*)	2	U	FD	5	d	NR	NR	SM	F	FDB	FCNS	WO		517	68
39	Bartov et al, 1994	7956	Chicken (*Gallus domesticus*)	3	U	FD	1	w	1	w	JV	F	FDB	FCNS	WO		686	69
40	Bartov, 1996	5373	Chicken (*Gallus domesticus*)	4	U	FD	2	w	1	w	JV	F	FDB	FCNS	WO		1370	69
Physiology (PHY)																		
41	Gibson et al, 1986	6048	Chicken (*Gallus domesticus*)	6	U	FD	10	w	30	w	JV	F	PHY	FDCV	WO	57.3	66.5	75
42	Gibson et al, 1986	6048	Chicken (*Gallus domesticus*)	6	U	FD	10	w	30	w	JV	F	PHY	FDCV	WO	64.1	123	75
43	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	M	PHY	FDCV	WO	74.3	111	79
44	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	M	PHY	FDCV	WO	75.7	114	79
45	Stevenson et al, 1987	8184	Chicken (*Gallus domesticus*)	9	U	FD	140	d	28	w	LB	F	PHY	FDCV	WO	83.3	99.9	75
46	Stevenson et al, 1987	8184	Chicken (*Gallus domesticus*)	9	U	FD	140	d	28	w	JV	F	PHY	FDCV	WO	88.6	106	75
47	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	M	PHY	FDCV	WO	155	232	79
48	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	M	PHY	FDCV	WO	159	239	79
49	Henry et al, 1987	6039	Chicken (*Gallus domesticus*)	4	U	FD	1	w	1	d	JV	M	PHY	FDCV	WO	164		71
50	Southern and Baker, 1983	6368	Chicken (*Gallus domesticus*)	3	U	FD	14	d	8	d	JV	M	PHY	FDCV	WO	177	354	79
51	Oh et al, 1979	6627	Chicken (*Gallus domesticus*)	6	U	FD	4	w	1	d	JV	NR	PHY	FDCV	WO	252	503	75
52	Lu and Combs, 1988	5903	Chicken (*Gallus domesticus*)	2	U	FD	8	d	1	d	JV	NR	PHY	DIFD	WO		21.6	68
53	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	M	PHY	FDCV	WO		74.7	73
54	Bafundo et al, 1984	2517	Chicken (*Gallus domesticus*)	2	U	FD	14	d	8	d	JV	M	PHY	FDCV	WO		284	72
55	Bartov, 1996	5373	Chicken (*Gallus domesticus*)	4	U	FD	2	w	1	w	JV	F	PHY	FDCV	WO		315	69
56	Bartov, 1996	5373	Chicken (*Gallus domesticus*)	4	U	FD	2	w	1	w	JV	F	PHY	FDCV	WO		1370	69
Pathology (PTH)																		
57	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	6	U	FD	140	d	40	w	SM	F	ORW	ORWT	SP	55	105	75
58	Lefevre et al, 1982	392	Chicken (*Gallus domesticus*)	2	U	FD	5	w	1	d	JV	NR	ORW	ORWT	LU	63.2		67
59	Gibson et al, 1986	6048	Chicken (*Gallus domesticus*)	6	U	FD	10	w	30	w	JV	F	ORW	SMIX	LI	75.1	91.6	75
60	Gibson et al, 1986	6048	Chicken (*Gallus domesticus*)	6	U	FD	10	w	30	w	JV	F	ORW	SMIX	LI	120	128	75

Table 5.1
Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Zinc

Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose* (mg/kg bw/day)	LOAEL Dose* (mg/kg bw/day)	Total
61	Stevenson et al, 1987	8184	Chicken (*Gallus domesticus*)	9	U	FD	140	d	28	w	JV	F	ORW	SMIX	GZ	125	167	75
62	Stevenson et al, 1987	8184	Chicken (*Gallus domesticus*)	9	U	FD	140	d	28	w	JV	F	ORW	SMIX	GZ	129	194	75
63	Stahl et al, 1989	5820	Chicken (*Gallus domesticus*)	2	U	FD	20	d	1	d	JV	B	ORW	SMIX	LI		31.0	73
30	Stahl et al, 1989	5820	Chicken (*Gallus domesticus*)	2	U	FD	20	d	1	d	JV	B	ORW	SMIX	LI		35.4	73
64	Lu and Combs, 1988	5903	Chicken (*Gallus domesticus*)	2	U	FD	8	d	1	d	JV	NR	HIS	GHIS	PS		41.7	68
65	Dewar et al, 1983	37018	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	B	HIS	USTR	GZ		65.6	69
66	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	5	U	FD	3	w	40	w	SM	F	ORW	ORWT	LI		88	69
67	Gasaway and Buss, 1972	9261	Mallard duck (*Anas platyrhynchos*)	4	U	FD	10	d	7	w	JV	B	ORW	SMIX	AR		126	73
68	Dewar et al, 1983	37018	Chicken (*Gallus domesticus*)	4	U	FD	4	w	2	w	JV	B	HIS	USTR	GZ		143	68
69	Dewar et al, 1983	37018	Chicken (*Gallus domesticus*)	3	U	FD	4	d	18	mo	AD	F	HIS	USTR	GZ		159	69
70	Dean et al, 1991	5681	Chicken (*Gallus domesticus*)	2	M	FD	4	w	1	d	JV	M	HIS	GHIS	TY		199	74
71	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	5	U	FD	3	w	40	w	SM	F	ORW	ORWT	SP		367	69
72	Van Vleet et al, 1981	80	Duck (*Anas platyrhynchos*)	2	U	FD	15	d	1	d	JV	M	HIS	NCRO	PS		401	72
73	Van Vleet et al, 1981	80	Duck (*Anas platyrhynchos*)	2	U	FD	15	d	1	d	JV	M	HIS	NCRO	PS		803	72
74	Berry and Brake, 1990	7089	Chicken (*Gallus domesticus*)	2	U	FD	49	d	66	w	LB	F	ORW	SMIX	DT		988	67
Reproduction (REP)																		
75	Kaya et al, 2001	48543	Chicken (*Gallus domesticus*)	5	U	FD	12	w	NR	NR	LB	F	REP	PROG	WO	13.8		75
76	Schisler and Kienholz, 1967	8798	Chicken (*Gallus domesticus*)	2	U	FD	14	w	48	w	LB	F	REP	PROG	WO	14.4		70
77	Jensen and Maurice, 1980	9749	Chicken (*Gallus domesticus*)	3	U	FD	6	w	NR	NR	LB	F	REP	PROG	WO	24.7	98.8	82
78	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	6	U	FD	140	d	40	w	LB	F	REP	PROG	WO	55	105	81
79	Gibson et al, 1986	6048	Chicken (*Gallus domesticus*)	6	U	FD	10	w	30	w	JV	F	REP	PROG	WO	57.3	66.5	81
80	Stevenson et al, 1987	8184	Chicken (*Gallus domesticus*)	9	U	FD	140	d	28	w	JV	F	REP	PROG	WO	63.9	76.7	81
81	Gibson et al, 1986	6048	Chicken (*Gallus domesticus*)	6	U	FD	10	w	30	w	LB	F	REP	PROG	WO	64.1	123	81
82	Stevenson et al, 1987	8184	Chicken (*Gallus domesticus*)	9	U	FD	140	d	28	w	LB	F	REP	PROG	WO	67.8	84.8	81
83	Stahl, et al, 1990	5764	Chicken (*Gallus domesticus*)	4	U	FD	12	w	56	w	LB	F	REP	PROG	WO	106		71
84	Gasaway and Buss, 1972	9261	Mallard duck (*Anas platyrhynchos*)	4	U	FD	60	d	7	w	JV	M	REP	TEWT	TE		31.2	79
85	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	5	U	FD	1	w	40	w	SM	F	REP	PROG	WO		88	75
86	Jensen and Maurice, 1980	9749	Chicken (*Gallus domesticus*)	2	U	FD	6	w	NR	NR	LB	F	REP	PROG	WO		101	79
87	Stepinska et al, 1987	5770	Chicken (*Gallus domesticus*)	2	U	FD	5	d	71	w	LB	F	REP	PROG	WO		205	75
88	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	5	U	FD	1	w	40	w	LB	F	REP	PROG	WO		367	75
89	Berry and Brake, 1985	6144	Chicken (*Gallus domesticus*)	2	U	FD	4	d	60	w	LB	F	REP	RHIS	OD		988	73
90	Berry and Brake, 1990	7089	Chicken (*Gallus domesticus*)	2	U	FD	49	d	66	w	LB	F	REP	RHIS	OD		988	73
Growth (GRO)																		
91	Schisler and Kienholz, 1967	8798	Chicken (*Gallus domesticus*)	2	U	FD	14	w	48	w	JV	F	GRO	BDWT	WO	14.4		68
92	Baker and Halpin, 1988	5917	Chicken (*Gallus domesticus*)	2	M	FD	14	d	8	d	JV	M	GRO	BDWT	WO	15.0		73
93	Mohanna and Nys, 1999	5090	Chicken (*Gallus domesticus*)	2	U	FD	16	d	5	d	JV	NR	GRO	BDWT	WO	16.1		68
94	Hamilton et al, 1979	6655	Japanese quail (*Coturnix japonica*)	2	U	FD	14	d	0	d	JV	B	GRO	BDWT	WO	21.5		80
95	Hill, 1974	1369	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	B	GRO	BDWT	WO	28.7		76
96	Stahl et al, 1989	5820	Chicken (*Gallus domesticus*)	2	U	FD	20	d	1	d	JV	B	GRO	BDWT	WO	35.4		68
97	Hill, 1990	5734	Chicken (*Gallus domesticus*)	2	U	FD	19	d	1	d	JV	F	GRO	BDWT	WO	36.6		76
98	Hamilton et al, 1981	6403	Japanese quail (*Coturnix japonica*)	3	U	FD	14	d	1	d	JV	B	GRO	BDWT	WO	43.3	86.6	83
99	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	6	U	FD	140	d	40	w	SM	F	GRO	BDWT	WO	55.0	105	79
100	Harland et al, 1975	6887	Japanese quail (*Coturnix japonica*)	2	U	FD	1	w	1	d	JV	B	GRO	BDWT	WO	55.1		77
101	Berg and Martinson, 1972	93	Chicken (*Gallus domesticus*)	7	U	FD	2	w	1	d	JV	NR	GRO	BDWT	WO	55.3	111	78
102	Lefevre et al, 1982	392	Chicken (*Gallus domesticus*)	2	U	FD	5	w	1	d	JV	NR	GRO	BDWT	WO	63.2		76
103	Sandoval et al, 1998	7245	Chicken (*Gallus domesticus*)	4	U	FD	3	w	1	d	JV	M	GRO	BDWT	WO	70.6	106	84
104	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	M	GRO	BDWT	WO	74.3	111	83
105	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	M	GRO	BDWT	WO	74.7	112	83
106	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	M	GRO	BDWT	WO	75.0	150	79
107	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	M	GRO	BDWT	WO	75.7	114	83
108	Hill, 1974	92	Chicken (*Gallus domesticus*)	5	U	FD	2	w	1	d	JV	B	GRO	BDWT	WO	85.9	172	82
109	Hamilton et al, 1979	6655	Japanese quail (*Coturnix japonica*)	6	U	FD	14	d	8	d	JV	B	GRO	BDWT	WO	86.8	174	86
110	Henry et al, 1987	6039	Chicken (*Gallus domesticus*)	4	U	FD	1	w	1	d	JV	M	GRO	BDWT	WO	92.3	185	83
111	Gibson et al, 1986	6048	Chicken (*Gallus domesticus*)	6	U	FD	10	w	30	w	JV	F	GRO	BDWT	WO	96.9	145	79
112	Stevenson et al, 1987	8184	Chicken (*Gallus domesticus*)	9	U	FD	140	d	28	w	JV	F	GRO	BDWT	WO	99.1	149	79
113	Sandoval et al, 1999	5067	Chicken (*Gallus domesticus*)	2	U	FD	7	d	14	d	JV	M	GRO	BDWT	WO	103		68
114	Sandoval et al, 1999	5067	Chicken (*Gallus domesticus*)	2	U	FD	7	d	14	d	JV	M	GRO	BDWT	WO	103		68
115	Stahl, et al, 1990	5764	Chicken (*Gallus domesticus*)	3	U	FD	44	w	24	w	LB	F	GRO	BDWT	WO	129		69
116	Stevenson et al, 1987	8184	Chicken (*Gallus domesticus*)	9	U	FD	140	d	28	w	LB	F	GRO	BDWT	WO	129	194	79
117	Bafundo et al, 1984	2517	Chicken (*Gallus domesticus*)	2	U	FD	14	d	8	d	JV	F	GRO	BDWT	WO	142		67
118	Dewar et al, 1983	37018	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	B	GRO	BDWT	WO	143	286	79
119	Vohra and Kratzer, 1968	14404	Turkey (*Meleagris gallopavo*)	7	U	FD	21	d	NR	NR	JV	B	GRO	BDWT	WO	148	297	77
120	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	M	GRO	BDWT	WO	155	232	83

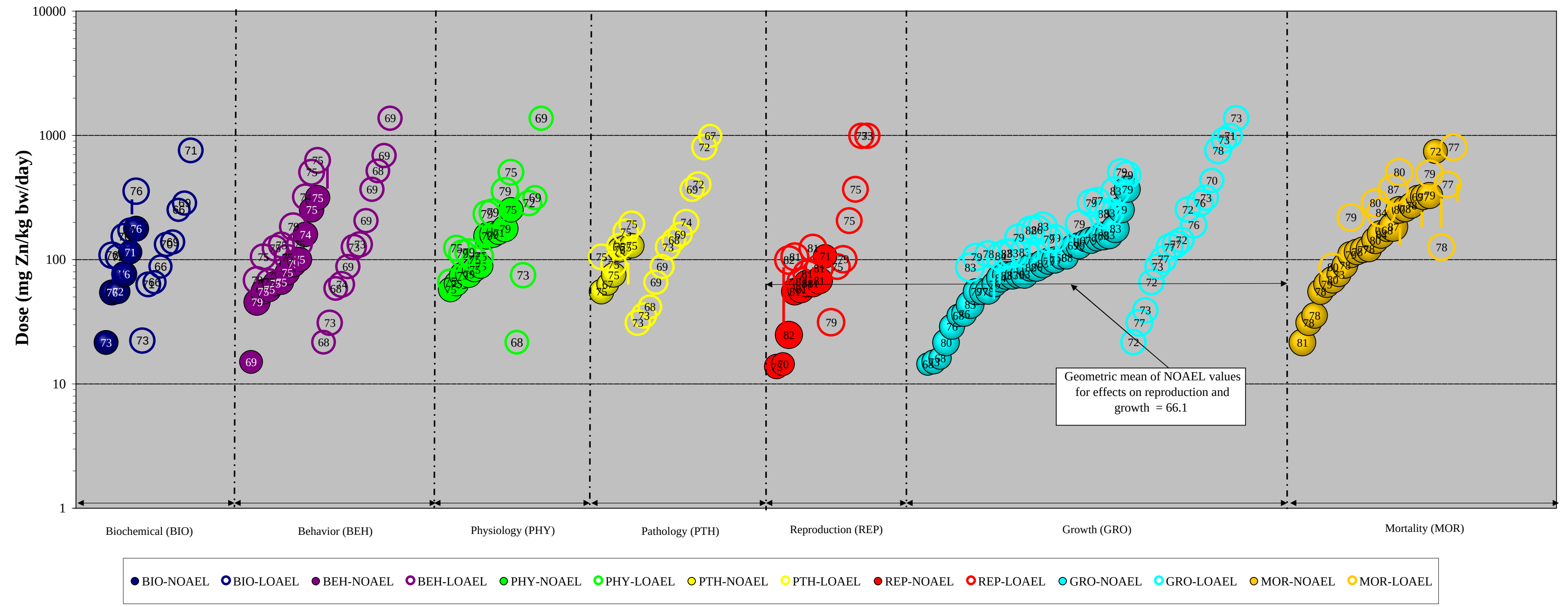
Table 5.1
Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Zinc

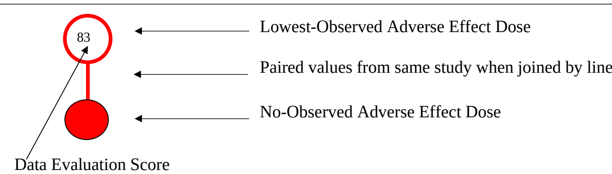
Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose* (mg/kg bw/day)	LOAEL Dose* (mg/kg bw/day)	Total
121	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	M	GRO	BDWT	WO	158	237	83
122	Southern and Baker, 1983	6368	Chicken (*Gallus domesticus*)	3	U	FD	14	d	8	d	JV	M	GRO	BDWT	WO	177	354	83
123	Oh et al, 1979	6627	Chicken (*Gallus domesticus*)	6	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO	252	503	79
124	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	5	U	FD	1	w	40	w	SM	F	GRO	BDWT	WO	367	480	79
125	Lu and Combs, 1988	5903	Chicken (*Gallus domesticus*)	2	U	FD	15	d	1	d	JV	NR	GRO	BDWT	WO		21.6	72
126	Stahl et al, 1989	5820	Chicken (*Gallus domesticus*)	2	U	FD	20	d	1	d	JV	B	GRO	BDWT	WO		31.0	77
127	Lu and Combs, 1988	5866	Chicken (*Gallus domesticus*)	2	U	FD	6	d	20	d	JV	NR	GRO	BDWT	WO		39.0	73
128	Lu et al, 1990	8008	Chicken (*Gallus domesticus*)	2	U	FD	7	d	14	d	JV	B	GRO	BDWT	WO		65.7	72
129	Jackson et al, 1986	6133	Chicken (*Gallus domesticus*)	5	U	FD	21	d	40	w	SM	F	GRO	BDWT	WO		88	73
130	Jensen and Maurice, 1980	9749	Chicken (*Gallus domesticus*)	2	U	FD	6	w	NR	NR	SM	F	GRO	BDWT	WO		101	77
131	Gasaway and Buss, 1972	9261	Mallard duck (*Anas platyrhynchos*)	4	U	FD	10	d	7	w	JV	B	GRO	BDWT	WO		126	77
132	Pimentel et al, 1992	5617	Chicken (*Gallus domesticus*)	2	M	FD	3	w	1	d	JV	B	GRO	BDWT	WO		132	77
133	Dewar et al, 1983	37018	Chicken (*Gallus domesticus*)	4	U	FD	4	w	2	w	JV	B	GRO	BDWT	WO		143	72
134	Berg and Martinson, 1972	93	Chicken (*Gallus domesticus*)	2	U	FD	2	w	1	d	JV	NR	GRO	BDWT	WO		252	72
135	Bafundo et al, 1984	6273	Chicken (*Gallus domesticus*)	2	U	FD	14	d	8	d	JV	M	GRO	BDWT	WO		190	76
136	Bafundo et al, 1984	2517	Chicken (*Gallus domesticus*)	2	U	FD	14	d	8	d	JV	M	GRO	BDWT	WO		284	76
137	Bartov, 1996	5373	Chicken (*Gallus domesticus*)	4	U	FD	2	w	1	w	JV	F	GRO	BDWT	WO		315	73
138	Rama and Planas, 1981	6435	Chicken (*Gallus domesticus*)	2	U	FD	9	w	1	d	JV	NR	GRO	BDWT	WO		433	70
139	Dean et al, 1991	5681	Chicken (*Gallus domesticus*)	2	M	FD	1	w	1	d	JV	M	GRO	BDWT	WO		757	78
140	Bartov et al, 1994	7956	Chicken (*Gallus domesticus*)	3	U	FD	2	w	1	w	JV	F	GRO	BDWT	WO		914	73
141	Palafox and Ho-A, 1980	6545	Chicken (*Gallus domesticus*)	2	U	FD	5	d	38	w	JV	F	GRO	BDWT	WO		988	71
142	Bartov, 1996	5373	Chicken (*Gallus domesticus*)	4	U	FD	2	w	1	w	JV	F	GRO	BDWT	WO		1370	73
Survival (MOR)																		
143	Hamilton et al, 1979	6655	Japanese quail (*Coturnix japonica*)	2	U	FD	14	d	0	d	JV	B	MOR	MORT	WO	21.5		81
144	Stahl et al, 1989	5820	Chicken (*Gallus domesticus*)	2	U	FD	20	d	1	d	JV	B	MOR	MORT	WO	31.0		78
145	Stahl et al, 1989	5820	Chicken (*Gallus domesticus*)	2	U	FD	20	d	1	d	JV	B	MOR	MORT	WO	35.4		78
146	Harland et al, 1975	6887	Japanese quail (*Coturnix japonica*)	2	U	FD	1	w	1	d	JV	B	MOR	MORT	WO	55.1		78
147	Lefevre et al, 1982	392	Chicken (*Gallus domesticus*)	2	U	FD	5	w	1	d	JV	NR	MOR	MORT	WO	63.2		79
148	Gibson et al, 1986	6048	Chicken (*Gallus domesticus*)	6	U	FD	10	w	30	w	JV	F	MOR	MORT	WO	68.8	87.1	80
149	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	10	U	FD	4	w	1	w	JV	M	MOR	SURV	WO	75.6		73
150	Hamilton et al, 1981	6403	Japanese quail (*Coturnix japonica*)	3	U	FD	14	d	1	d	JV	B	MOR	MORT	WO	89.5		78
151	Blalock and Hill, 1988	5868	Chicken (*Gallus domesticus*)	3	U	FD	12	d	1	d	JV	F	MOR	MORT	WO	109	219	79
152	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	M	MOR	SURV	WO	115		78
153	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	M	MOR	SURV	WO	120		77
154	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	M	MOR	SURV	WO	121		78
155	Dewar et al, 1983	37018	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	B	MOR	MORT	WO	143	286	80
156	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	M	MOR	SURV	WO	159	239	84
157	Hill, 1974	92	Chicken (*Gallus domesticus*)	5	U	FD	5	w	1	d	JV	B	MOR	MORT	WO	172		68
158	Hamilton et al, 1979	6655	Japanese quail (*Coturnix japonica*)	6	U	FD	14	d	0	d	JV	B	MOR	MORT	WO	183	366	87
159	Oh et al, 1979	6627	Chicken (*Gallus domesticus*)	6	U	FD	4	w	1	d	JV	NR	MOR	MORT	WO	252	503	80
160	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	M	MOR	SURV	WO	255		78
161	Roberson and Schaible, 1960	14538	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	M	MOR	SURV	WO	272		78
162	Dewar et al, 1983	37018	Chicken (*Gallus domesticus*)	3	U	FD	4	d	18	mo	AD	F	MOR	MORT	WO	319		69
163	Hill, 1974	1369	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	B	MOR	MORT	WO	320		77
164	Dewar et al, 1983	37018	Chicken (*Gallus domesticus*)	4	U	FD	4	w	2	w	JV	B	MOR	MORT	WO	327	491	79
165	Vohra and Kratzer, 1968	14404	Turkey (*Meleagris gallopavo*)	7	U	FD	21	d	NR	NR	JV	B	MOR	MORT	WO	741		72
166	Gasaway and Buss, 1972	9261	Mallard duck (*Anas platyrhynchos*)	4	U	FD	30	d	7	w	JV	B	MOR	MORT	WO		126	78
167	Van Vleet et al, 1981	80	Duck (*Anas platyrhynchos*)	2	U	FD	15	d	1	d	JV	M	MOR	MORT	WO		401	77
168	Van Vleet et al, 1981	80	Duck (*Anas platyrhynchos*)	2	U	FD	15	d	1	d	JV	M	MOR	MORT	WO		803	77

AD = adult; AR = adrenal gland ; ASHC = ash content; AT = alimentary tract; B = both; BDWT = body weight changes; BEH = behavior; BIO = biochemical; BL = blood; BO = bone; w = body weight; CHM = chemical changes; d = day; DIFD = digestibility of food; DT = digestive tract; ENZ = enyzme level changes; F = female; FCNS = food consumption; FD = food; FDB = feeding behavior; FDCV = food conversion efficiency; FDNG = feeding behavior; GBCM = general biochemical ; GENZ = general enzyme changes; GHIS = general histology; GRO = growth; GZ = gizzard; HIS = histological changes; HMCT = hematocrit; HMGL = hemoglobin; ITX = intoxication; JV = juvenile; kg = kilograms; LB = egg-laying bird; LI = liver; LIPD = lipid; LOAEL = lowest observed adverse effect level; LU = lung; mg = milligrams; mo = months; M = male; M = measured; MCPR = microsomal proteins; MOR = effects on mortality and survival; MORT = mortality; NCRO = necrosis; NOAEL = No Observed Advese Effect Level; NR = Not reported; OD = oviduct; ORW = organ weight changes; ORWT = organ weight changes; PHY = physiology; PROG = progeny counts/numbers; PS = pancreas; PTH = pathology; REP = reproduction; RHIS = reprodutive organ histology; SM = sexually mature; SMIX = weight relative to body weight; SP = spleen; SR = serum; SURV = survival; TE = testes; TEWT USTR = ultrastructural changes; w = weeks; WI = wings; WO = whole organism; yr = year.

*NOAEL and LOAEL values that are equal and from the same reference represent different experimental designs.

Figure 5.1 Avian TRV Derivation for Zinc





<u>Wildlife TRV Derivation Process</u>

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are at least three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

3) The geometric mean is equal to 66.1 mg zinc/kg bw/d. This value is lower than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.

3) The avian wildlife TRV for zinc is equal to 66.1 mg zinc/kg bw/day which is the geometric mean of NOAEL values for effects on reproduction and growth.

5.2 Estimation of Dose and Calculation of the Eco-SSL

Three separate Eco-SSL values were calculated for avian wildlife, one for each of three surrogate receptor species representing different trophic levels. The avian Eco-SSLs were calculated according to the Eco-SSL guidance (U.S. EPA, 2003) and are summarized in Table 5.2.

Table 5.2 Calculation of the Avian Eco-SSLs for Zinc

Surrogate Receptor Group	TRV for Zinc (mg dw/kg bw/d) [1]	Food Ingestion Rate (FIR)[2] (kg dw/kg bw/d)	Soil Ingestion as Proportion of Diet (P_s)[2]	Concentration of Zinc in Biota Type (i)[2,3] (B_i) (mg/kg dw)	Eco-SSL (mg/kg dw)[4]
Avian herbivore (dove)	66.1	0.190	0.139	$\ln(B_i) = 0.554 * \ln(Soil_j) + 1.575$ where i = plants	950
Avian ground insectivore (woodcock)	66.1	0.214	0.164	$\ln(B_i) = 0.328 * \ln(Soil_j) + 4.449$ where i = earthworms	46
Avian carnivore (hawk)	66.1	0.0353	0.057	$\ln(B_i) = 0.0706 * \ln(Soil_j) + 4.3632$ where i = mammals	30,000

[1] The process for derivation of wildlife TRVs is described in Attachment 4-5 of U.S. EPA (2003).
[2] Parameters (FIR, P_s, B_i values, regressions) are provided in U.S. EPA (2003) Attachment 4-1 (revised February 2005).
[3] B_i = Concentration in biota type (i) which represents 100% of the diet for the respective receptor.
[4] HQ = [FIR * ($Soil_j * P_s + B_i$)] / TRV solved for HQ=1 where $Soil_j$ = Eco-SSL (Equation 4-2; U.S. EPA, 2003).

6.0 ECO-SSL FOR MAMMALIAN WILDLIFE

The derivation of the Eco-SSL for mammalian wildlife was completed as two parts. First, the TRV was derived according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5). Second, the Eco-SSL (soil concentration) was back-calculated for each of three surrogate receptor species based on the wildlife exposure model and the TRV (U.S. EPA, 2003).

6.1 Mammalian TRV

The literature search was completed according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-2) and identified 10,410 papers with possible toxicity data for zinc for either avian or mammalian species. Of these studies, 10,259 were rejected for use as described in Section 7.5. Of the remaining papers, 99 contained data for mammalian test species. These papers were reviewed and the data were extracted and scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-3 and 4-4). The results of the data extraction and review are summarized in Table 6.1. The complete results are provided as Appendix 6-1.

Table 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Zinc

Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose* (mg/kg bw/day)	LOAEL Dose* (mg/kg bw/day)	Total
Biochemical (BIO)																		
1	Brandt, 1983	2033	Mink (*Mustela vison*)	3	M	FD	4	mo	90	d	JV	M	CHM	MCHC	PL	10.4	20.1	81
2	Van der Schee et al, 1980	21171	Sheep (*Ovis aries*)	3	M	FD	98	d	NR	NR	JV	M	CHM	HMCT	BL	12		66
3	Hill and Miller, 1983	45270	Pig (*Sus scrofa*)	3	U	FD	4	w	NR	NR	GE	F	ENZ	ALPH	SR	25.0	250	70
4	Reeves and Newman, 1997	21067	Rat (*Rattus norvegicus*)	2	U	FD	7	w	21	d	JV	M	CHM	HMCT	BL	30.4		72
5	Gaynor et al, 1988	47892	Cattle (*Bos taurus*)	2	M	FD	4	w	NR	NR	LC	F	CHM	PRTL	MK	30.6		67
6	Mengo et al., 1991	21240	Rat (*Rattus norvegicus*)	3	U	FD	3	mo	1	mo	JV	M	CHM	CHOL	BL	32.1	96.4	70
7	Gaynor et al, 1988	47892	Cattle (*Bos taurus*)	2	M	FD	5	w	NR	NR	LC	F	CHM	PRTL	MK	33.2		67
8	Brzoska et al, 2001	36302	Rat (*Rattus norvegicus*)	2	U	DR	12	w	2	mo	JV	M	CHM	CALC	TB	40.0		72
9	Ott et al., 1966	14536	Cattle (*Bos taurus*)	6	U	FD	12	w	NR	NR	JV	B	CHM	PCLV	BL	42.6	55.7	71
10	Brink et al, 1959	14525	Pig (*Sus scrofa*)	6	U	FD	42	d	NR	NR	JV	NR	CHM	HMGL	BL	43.5	87.1	77
11	Ott et al., 1966	14537	Sheep (*Ovis aries*)	8	U	FD	7	w	NR	NR	JV	M	CHM	PCLV	BL	51.2	68.3	72
12	Ott et al., 1966	14537	Sheep (*Ovis aries*)	4	U	GV	11	d	NR	NR	JV	M	CHM	HMGL	BL	53.2	106	75
13	Bentley and Grubb, 1991	40436	Rabbit (*Oryctolagus cuniculus*)	3	U	FD	22	w	NR	NR	JV	B	CHM	HMGL	BL	56.5	282	74
14	Maita et al, 1981	43680	Rat (*Rattus norvegicus*)	4	U	FD	13	w	5	w	JV	M	CHM	HMGL	BL	234	2514	73
15	Maita et al, 1981	43680	Rat (*Rattus norvegicus*)	4	U	FD	13	w	5	w	JV	F	CHM	HEMT	BL	243	2486	73
16	Whanger and Weswig, 1970	22300	Rat (*Rattus norvegicus*)	4	U	FD	10	w	21	d	JV	M	CHM	GBCM	BL	356	711	75
17	Maita et al, 1981	43680	Mouse (*Mus musculus*)	4	U	FD	13	w	5	w	JV	M	CHM	HMGL	BL	458	4927	73
18	Maita et al, 1981	43680	Mouse (*Mus musculus*)	4	U	FD	13	w	5	w	JV	F	CHM	HMGL	BL	479	4878	73
19	O'Neil-Cutting et al, 1981	14656	Rat (*Rattus norvegicus*)	2	U	FD	18	w	NR	NR	JV	M	CHM	HMGL	BL	597		70
20	Urabe and Hayakawa, 1990	40997	Rat (*Rattus norvegicus*)	2	U	FD	42	d	NR	NR	JV	M	CHM	PRTL	LI	1684		71
21	Nakamura et al., 1983	638	Rat (*Rattus norvegicus*)	2	U	FD	11	w	NR	NR	JV	F	CHM	GLUC	SR		8.71	66
22	L'Abbe and Fischer, 1984	36982	Rat (*Rattus norvegicus*)	3	M	FD	6	w	NR	NR	JV	M	CHM	GBCM	SR		10.7	74
23	Elliot and Walker, 1968	38623	Pig (*Sus scrofa*)	2	U	FD	4	w	NR	NR	JV	B	CHM	HMGL	WO		14.9	70
24	L'Abbe and Fischer, 1984	36983	Rat (*Rattus norvegicus*)	2	U	FD	2	w	NR	NR	JV	M	ENZ	CCOX	LI		21.6	69
25	Subramanian et al, 2000	21011	Rat (*Rattus norvegicus*)	2	U	FD	6	w	NR	NR	JV	M	CHM	HMGL	PL		28.2	66
26	Shankar et al, 1986	46830	Rat (*Rattus norvegicus*)	2	U	FD	120	d	40	d	JV	F	CHM	CHOL	SR		28.9	66
27	Tran, et. al, 1999	21015	Rat (*Rattus norvegicus*)	3	U	FD	7	d	NR	NR	JV	M	CHM	MCPR	IN		35.2	70
28	Kadiiska et al, 1985	19290	Rat (*Rattus norvegicus*)	2	U	DR	30	d	NR	NR	JV	M	ENZ	P450	LI		40.5	69
29	Reeves et al, 1994	37015	Rat (*Rattus norvegicus*)	2	U	FD	2	w	NR	NR	JV	M	CHM	GBCM	LI		56	68
30	Van Vleet et al, 1981	149	Pig (*Sus scrofa*)	2	U	FD	2	w	NR	NR	JV	M	ENZ	GLPX	BL		99.1	70
31	Yamaguchi et al, 1982	37010	Rat (*Rattus norvegicus*)	3	U	OR	30	d	3	w	JV	M	CHM	CALC	SR		100	72
32	Tantcheva et al, 1993	39802	Rat (*Rattus norvegicus*)	2	U	DR	30	d	NR	NR	JV	M	ENZ	AHDX	LI		100	69
33	Jaw and Jeffery, 1988	36967	Rat (*Rattus norvegicus*)	2	U	FD	8	d	NR	NR	JV	F	CHM	GBCM	LI		103	70
34	Hsu et al, 1975	14376	Pig (*Sus scrofa*)	2	U	FD	2	w	4	w	JV	NR	ENZ	ALPH	SR		354	66
35	Thawley, et. al., 1978	36953	Rat (*Rattus norvegicus*)	2	U	FD	6	w	NR	NR	JV	M	CHM	HMGL	BL		578	70
36	Settlemire and Matrone, 1967	38015	Rat (*Rattus norvegicus*)	2	U	FD	5	w	4-6	w	JV	M	CHM	HMGL	BL		667	69
37	Ogiso, et. al., 1974	42961	Rat (*Rattus norvegicus*)	2	U	FD	15	d	NR	NR	JV	M	CHM	HMGL	BL		956	70
38	Scott and Magee, 1979	43264	Rat (*Rattus norvegicus*)	2	U	FD	1	w	NR	NR	JV	B	CHM	HMGL	BL		968	70
39	Pettersen, et al, 2002	36374	Mouse (*Mus musculus*)	3	U	FD	3	w	4	w	JV	B	CHM	NACO	HE		1419	70
40	Gautam et al, 2001	36346	Rat (*Rattus norvegicus*)	2	U	FD	2	w	NR	NR	JV	NR	CHM	CALC	LI		1782	69
41	Rana et. al, 1985	13236	Rat (*Rattus norvegicus*)	2	U	GV	30	d	90	d	JV	M	CHM	GLYC	LI		5000	72
Behavior (BEH)																		
42	Shankar et al, 1986	46830	Rat (*Rattus norvegicus*)	2	U	FD	120	d	40	d	JV	F	FDB	FCNS	WO	28.9		69
43	Gaynor et al, 1988	47892	Cattle (*Bos taurus*)	2	M	FD	4	w	NR	NR	LC	F	FDB	FCNS	WO	30.6		70
44	Gaynor et al, 1988	47892	Cattle (*Bos taurus*)	2	M	FD	5	w	NR	NR	LC	F	FDB	FCNS	WO	33.2		70
45	Henry et al, 1997	40409	Sheep (*Ovis aries*)	6	U	FD	3	d	NR	NR	JV	M	FDB	FCNS	WO	34.9	46.5	80
46	Miller et al., 1989	14685	Cattle (*Bos taurus*)	3	U	FD	10	w	NR	NR	LC	F	FDB	FCNS	WO	38.3	76.5	80
47	Ott et al, 1966	14535	Sheep (*Ovis aries*)	8	U	FD	6	w	NR	NR	JV	NR	FDB	FDNG	WO	38.6	57.9	75
48	Brink et al, 1959	14525	Pig (*Sus scrofa*)	6	U	FD	42	d	NR	mo	JV	NR	FDB	FCNS	WO	47.5	94.9	80
49	Schell and Kornegay, 1996	42234	Pig (*Sus scrofa*)	4	M	FD	2	w	23	d	JV	B	FDB	FCNS	WO	106		70
50	Aulerich et al, 1991	46274	Mink (*Mustela vison*)	4	M	FD	144	d	>1	yr	AD	M	FDB	FCNS	WO	165		79
51	Maita et al, 1981	43680	Rat (*Rattus norvegicus*)	4	U	FD	13	w	5	w	JV	M	FDB	FCNS	WO	234	2514	76
52	Aulerich et al, 1991	46274	Mink (*Mustela vison*)	4	M	FD	144	d	10-12	w	JV	M	FDB	FCNS	WO	297		77
53	Aulerich et al, 1991	46274	Mink (*Mustela vison*)	4	M	FD	144	d	10-12	w	JV	F	FDB	FCNS	WO	324		75
54	Aulerich et al, 1991	46274	Mink (*Mustela vison*)	4	M	FD	144	d	>1	yr	AD	F	FDB	FCNS	WO	327		75
55	Ketcheson et al, 1969	37837	Rat (*Rattus norvegicus*)	3	U	FD	14	d	NR	NR	LC	F	FDB	FCNS	WO	470		69
56	Urabe and Hayakawa, 1990	40997	Rat (*Rattus norvegicus*)	2	U	FD	42	d	NR	NR	JV	M	FDB	FCNS	WO	1684		74
57	Subramanian et al, 2000	21011	Rat (*Rattus norvegicus*)	2	U	FD	6	w	NR	NR	JV	M	FDB	FCNS	WO		28.2	69
58	Brzoska et al, 2001	36302	Rat (*Rattus norvegicus*)	2	U	DR	12	w	2	mo	JV	M	FDB	WCON	WO		40	75
Physiology (PHY)																		
59	Ott et al, 1966	14535	Sheep (*Ovis aries*)	8	U	FD	6	w	NR	NR	JV	NR	PHY	FDCV	WO	19.9	39.7	**75**

Table 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)

Zinc

Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose* (mg/kg bw/day)	LOAEL Dose* (mg/kg bw/day)	Total
60	Gaynor et al, 1988	47892	Cattle (*Bos taurus*)	2	M	FD	4	w	NR	mo	LC	F	PHY	FDCV	WO	30.6		70
61	Gaynor et al, 1988	47892	Cattle (*Bos taurus*)	2	M	FD	5	w	NR	NR	LC	F	PHY	FDCV	WO	33.2		70
62	Brink et al, 1959	14525	Pig (*Sus scrofa*)	6	U	FD	42	d	NR	NR	JV	NR	PHY	FDCV	WO	38.3	76.7	80
63	Schell and Kornegay, 1996	42234	Pig (*Sus scrofa*)	4	M	FD	2	w	23	d	JV	F	PHY	FDCV	WO	106		70
64	Maita et al, 1981	43680	Mouse (*Mus musculus*)	4	U	FD	13	w	5	w	JV	M	PHY	FDCV	WO	458	4927	72
65	Maita et al, 1981	43680	Mouse (*Mus musculus*)	4	U	FD	13	w	5	w	JV	F	PHY	FDCV	WO	479	4878	76
66	Urabe and Hayakawa, 1990	40997	Rat (*Rattus norvegicus*)	2	U	FD	42	d	NR	NR	JV	M	PHY	FDCV	WO	1684		74
67	Maita et al, 1981	43680	Rat (*Rattus norvegicus*)	4	U	FD	13	w	5	w	JV	M	PHY	FDCV	WO	2514		67
68	Mutafova-Yamolieva, et al, 1993	39780	Rat (*Rattus norvegicus*)	2	U	DR	30	d	NR	NR	JV	M	PHY	GPHY	VD		100	72
69	Cox and Hale, 1962	14526	Pig (*Sus scrofa*)	3	U	FD	69	d	NR	NR	JV	NR	PHY	FDCV	WO		134	66
	Pathology (PTH)																	
70	Hill et. al., 1983	45143	Pig (*Sus scrofa*)	3	U	FD	12	mo	7-8	mo	GE	F	ORW	SMIX	LI	8.23	82.3	73
71	Ott et al., 1966	14537	Sheep (*Ovis aries*)	8	U	FD	7	w	NR	NR	JV	M	ORW	ORWT	LI	18.6	37.3	75
72	Reeves and Newman, 1997	21067	Rat (*Rattus norvegicus*)	2	U	FD	7	w	3	w	JV	M	HIS	USTR	IN	30.4		66
73	Brzoska et al, 2001	36302	Rat (*Rattus norvegicus*)	2	U	DR	12	w	2	mo	JV	M	ORW	ORWT	TB	40		75
74	Maita et al, 1981	43680	Rat (*Rattus norvegicus*)	4	U	FD	13	w	5	w	JV	M	ORW	ORWT	BR	234	2514	76
75	Maita et al, 1981	43680	Rat (*Rattus norvegicus*)	4	U	FD	13	w	5	w	JV	F	ORW	ORWT	LI	243	2486	76
76	Maita et al, 1981	43680	Mouse (*Mus musculus*)	4	U	FD	13	w	5	w	JV	M	ORW	ORWT	BR	458	4927	76
77	Maita et al, 1981	43680	Mouse (*Mus musculus*)	4	U	FD	13	w	5	w	JV	F	ORW	ORWT	BR	479	4878	76
78	O'Neil-Cutting et al, 1981	14656	Rat (*Rattus norvegicus*)	2	U	FD	18	w	NR	NR	JV	M	ORW	ORWT	LI	597		71
79	Urabe and Hayakawa, 1990	40997	Rat (*Rattus norvegicus*)	2	U	FD	42	d	NR	NR	JV	M	ORW	ORWT	LI	1684		71
80	Seidenberg et al 1986	113	Mouse (*Mus musculus*)	2	U	GV	4	d	NR	NR	GE	F	GRS	BDWT	WO		8.89	80
81	Augey, et al, 1977	14524	Mouse (*Mus musculus*)	2	U	DR	12	mo	1.5-2	mo	JV	B	HIS	USTR	PS		70.1	68
82	Davies, et al, 1977	14527	Sheep (*Ovis aries*)	2	M	FD	26	d	1	w	JV	M	ORW	ORWT	KI		75.7	77
83	Van Vleet et al, 1981	149	Pig (*Sus scrofa*)	2	U	FD	10	w	NR	NR	JV	M	HIS	GLSN	HE		99.1	73
84	Yamaguchi et al, 1982	37010	Rat (*Rattus norvegicus*)	3	U	OR	30	d	3	w	JV	M	ORW	ORWT	FM		100	75
85	Ferguson and Leaver, 1972	42635	Rat (*Rattus norvegicus*)	2	M	FD	10	w	21-28	d	JV	B	HIS	USTR	HM		181	77
86	Rana et. al, 1985	13236	Rat (*Rattus norvegicus*)	2	U	GV	30	d	90	d	JV	M	ORW	SMIX	LI		5000	75
	Reproduction (REP)																	
87	Hill et. al., 1983	45143	Pig (*Sus scrofa*)	3	U	FD	12	mo	7-8	mo	GE	F	REP	ODVP	WO	8.23	82.3	79
88	Seidenberg et al 1986	113	Mouse (*Mus musculus*)	2	U	GV	4	d	NR	NR	GE	F	REP	PRWT	NR	8.89		82
89	Alaoui et al, 1985	36854	Rat (*Rattus norvegicus*)	2	U	FD	5	w	NR	NR	JV	M	REP	ORWT	TE	9.64		71
90	Cerklewski, 1979	37008	Rat (*Rattus norvegicus*)	2	U	FD	37	d	105	d	LC	F	REP	PRWT	WO	14.4		80
91	Food and Drug Res. Lab, 1973	42289	Mouse (*Mus musculus*)	3	U	GV	10	d	NR	NR	GE	F	REP	PRFM	WO	30.0		77
92	Khera and Shah, 1979	21134	Rat (*Rattus norvegicus*)	2	U	FD	4	d	NR	NR	GE	F	REP	PRWT	WO	34.0		69
93	Miller et al., 1989	14685	Cattle (*Bos taurus*)	3	U	FD	14	w	NR	NR	LC	F	REP	PRWT	WO	37.9	75.9	86
94	Amemiya et al, 1986	21069	Rat (*Rattus norvegicus*)	2	U	FD	21	d	NR	NR	GE	F	REP	PRWT	WO	41.2		74
95	Evenson et al, 1993	14660	Rat (*Rattus norvegicus*)	2	U	FD	8	w	3	w	JV	M	REP	TEWT	TE	42.1		70
96	Food and Drug Res. Lab, 1973	42289	Rat (*Rattus norvegicus*)	4	U	GV	10	d	NR	NR	GE	F	REP	PRFM	WO	42.5		77
97	Food and Drug Res. Lab, 1974	42292	Rabbit (*Oryctolagus cuniculus*)	5	U	GV	13	d	NR	NR	GE	F	REP	PRFM	WO	60.0		77
98	Food and Drug Res. Lab, 1973	42289	Hamster (*Mesocricetus auratus*)	3	U	GV	5	d	NR	NR	GE	F	REP	PRFM	WO	88.0		77
99	Shrader et al, 1978	21138	Rat (*Rattus norvegicus*)	2	U	FD	21	d	NR	NR	GE	F	REP	PRWT	WO	89.6		73
100	Hirsch and Hurley, 1978	21139	Rat (*Rattus norvegicus*)	2	U	FD	12	d	NR	NR	GE	F	REP	PRWT	WO	89.6		75
101	Hill et al, 1983	35659	Pig (*Sus scrofa*)	3	U	FD	20	w	NR	NR	LC	F	REP	RHIS	WO	97.8		70
102	Webster, 1979	823	Mouse (*Mus musculus*)	4	U	FD	19	d	4	mo	GE	F	REP	PRWT	WO	101		79
103	Anderson et al., 1993	139	Mouse (*Mus musculus*)	2	U	FD	13	w	12	w	JV	M	REP	PRWT	WO	110		74
104	Schlicker and Cox, 1968	25	Rat (*Rattus norvegicus*)	2	U	FD	36	d	NR	NR	GE	F	REP	PRWT	WO	167		73
105	Ketcheson et al, 1969	37837	Rat (*Rattus norvegicus*)	3	U	FD	14	d	NR	NR	LC	F	REP	PRWT	WO	181	452	81
106	Maita et al, 1981	43680	Rat (*Rattus norvegicus*)	4	U	FD	13	w	5	w	JV	M	REP	ORWT	TE	234	2514	82
107	Chu and Cox, 1970	42767	Rat (*Rattus norvegicus*)	2	U	FD	21	d	NR	NR	LC	F	REP	GREP	WO	347		74
108	Maita et al, 1981	43680	Mouse (*Mus musculus*)	4	U	FD	13	w	5	w	JV	M	REP	ORWT	TE	458	4927	82
109	Maita et al, 1981	43680	Mouse (*Mus musculus*)	4	U	FD	13	w	5	w	JV	F	REP	ORWT	OV	479	4878	82
110	Bui, et al, 1998	21045	Rat (*Rattus norvegicus*)	2	M	GV	7	d	NR	NR	GE	F	REP	PRWT	WO	975		80
111	Maita et al, 1981	43680	Rat (*Rattus norvegicus*)	4	U	FD	13	w	5	w	JV	F	REP	ORWT	OV	2486		71
112	Kumar, 1976	43587	Rat (*Rattus norvegicus*)	2	U	FD	17	d	100	d	GE	F	REP	RSEM	WO		12.2	78
113	Barone et al, 1998	21042	Rat (*Rattus norvegicus*)	2	U	FD	10	d	NR	NR	GE	F	REP	PROG	WO		81.1	73
114	Newman et al, 2002	48540	Rat (*Rattus norvegicus*)	2	U	FD	16	d	NR	NR	GE	F	REP	PROG	WO		232	81
115	Pal and Pal, 1987	14664	Rat (*Rattus norvegicus*)	2	U	FD	18	d	120-130	d	GE	F	REP	GREP	WO		326	78
116	Chu and Cox, 1972	42670	Rat (*Rattus norvegicus*)	2	U	FD	14	d	NR	NR	LC	F	REP	PRWT	WO		326	72
117	Cox et al, 1969	42838	Rat (*Rattus norvegicus*)	2	U	FD	22	d	NR	NR	GE	F	REP	PRWT	WO		353	74
118	Schlicker and Cox, 1968	25	Rat (*Rattus norvegicus*)	2	U	FD	18	d	NR	NR	GE	F	REP	PRWT	WO		424	74
	Growth (GRO)																	

Table 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Zinc

Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose* (mg/kg bw/day)	LOAEL Dose* (mg/kg bw/day)	Total
119	Attia, et al, 1987	36003	Water buffalo (*Bubalus bubalis*)	5	U	FD	90	d	7-9	mo	JV	M	GRO	BDWT	WO	4.33		69
120	Huerta et al, 2002	25973	Cattle (*Bos taurus*)	2	U	FD	50	d	18	mo	JV	F	GRO	BDWT	WO	4.78		68
121	Huerta et al, 2002	25973	Cattle (*Bos taurus*)	2	U	FD	50	d	18	mo	JV	F	GRO	BDWT	WO	4.78		68
122	Alaoui et al, 1985	36854	Rat (*Rattus norvegicus*)	2	U	FD	5	w	NR	NR	JV	M	GRO	BDWT	WO	9.64		69
123	Hill et. al., 1983	45143	Pig (*Sus scrofa*)	3	U	FD	8	mo	7-8	mo	GE	F	GRO	GGRO	WO	10.3	103	77
124	Weigarnd and Kirchgessner, 197	41855	Rat (*Rattus norvegicus*)	4	U	FD	12	d	NR	NR	JV	M	GRO	BDWT	WO	11.7		68
125	Eisemann et al, 1979	43242	Pig (*Sus scrofa*)	2	M	FD	16	w	6-8	w	JV	B	GRO	BDWT	WO	13.5		69
126	Cerklewski, 1979	37008	Rat (*Rattus norvegicus*)	2	U	FD	37	d	105	d	LC	F	GRO	BDWT	WO	14.4		78
127	Elliot and Walker, 1968	38623	Pig (*Sus scrofa*)	2	U	FD	4	w	NR	NR	JV	B	GRO	BDWT	WO	14.9		68
128	Cerklewski and Forbes, 1976	2627	Rat (*Rattus norvegicus*)	2	U	FD	7	w	NR	NR	JV	M	GRO	BDWT	WO	15.7		69
129	Wapnir and Lee, 1993	39821	Rat (*Rattus norvegicus*)	2	U	FD	3	w	NR	NR	JV	M	GRO	BDWT	WO	15.7		68
130	Agarwal et al, 1986	21084	Rat (*Rattus norvegicus*)	2	U	FD	14	d	9-10	w	SM	M	GRO	BDWT	WO	18.0		72
131	Brandt, 1983	2033	Mink (*Mustela vison*)	3	M	FD	4	mo	90	d	JV	M	GRO	BDWT	WO	20.2		82
132	Shankar et al, 1986	46830	Rat (*Rattus norvegicus*)	2	U	FD	120	d	40	d	JV	F	GRO	BDWT	WO	28.9		73
133	Food and Drug Res. Lab, 1973	42289	Mouse (*Mus musculus*)	3	U	GV	10	d	NR	NR	GE	F	GRO	BDWT	WO	30.0		75
134	Reeves and Newman, 1997	21067	Rat (*Rattus norvegicus*)	2	U	FD	7	w	3	w	JV	M	GRO	BDWT	WO	30.4		79
135	Gaynor et al, 1988	47892	Cattle (*Bos taurus*)	2	M	FD	4	w	NR	NR	LC	F	GRO	BDWT	WO	30.6		74
136	Gaynor et al, 1988	47892	Cattle (*Bos taurus*)	2	M	FD	5	w	NR	NR	LC	F	GRO	BDWT	WO	33.2		74
137	Khera and Shah, 1979	21134	Rat (*Rattus norvegicus*)	2	U	FD	4	d	NR	NR	GE	F	GRO	BDWT	WO	34		67
138	Evenson et al, 1993	14660	Rat (*Rattus norvegicus*)	2	U	FD	8	w	3	w	JV	F	GRO	BDWT	WO	42.1		68
139	Food and Drug Res. Lab, 1973	42289	Rat (*Rattus norvegicus*)	4	U	GV	10	d	NR	NR	GE	F	GRO	BDWT	WO	42.5		75
140	Brink et al, 1959	14525	Pig (*Sus scrofa*)	6	U	FD	42	d	NR	NR	JV	NR	GRO	BDWT	WO	43.5	87.1	84
141	Miller et al., 1989	14685	Cattle (*Bos taurus*)	3	U	FD	14	w	NR	NR	LC	F	GRO	BDWT	WO	63.7		69
142	Reeves et al, 1994	37015	Rat (*Rattus norvegicus*)	2	U	FD	2	w	NR	NR	JV	M	GRO	BDWT	WO	56		75
143	Food and Drug Res. Lab, 1974	42292	Rabbit (*Oryctolagus cuniculus*)	5	U	GV	12	d	NR	NR	GE	F	GRO	BDWT	WO	60.0		75
144	Food and Drug Res. Lab, 1973	42289	Hamster (*Mesocricetus auratus*)	3	U	GV	5	d	NR	NR	GE	F	GRO	BDWT	WO	88.0		75
145	Bui, et al, 1998	21045	Rat (*Rattus norvegicus*)	2	M	GV	7	d	NR	NR	GE	F	GRO	BDWT	WO	97.5		69
146	Van Vleet et al, 1981	149	Pig (*Sus scrofa*)	2	U	FD	10	w	NR	NR	JV	M	GRO	BDWT	WO	99.1		73
147	Schell and Kornegay, 1996	42234	Pig (*Sus scrofa*)	4	M	FD	2	w	23	d	JV	B	GRO	BDWT	WO	103		69
148	Schell and Kornegay, 1996	42234	Pig (*Sus scrofa*)	4	M	FD	23	d	23	d	JV	B	GRO	BDWT	WO	106		74
149	Anderson et al., 1993	139	Mouse (*Mus musculus*)	2	U	FD	13	w	12	w	JV	M	GRO	BDWT	WO	110		81
150	Maita et al, 1981	43680	Rat (*Rattus norvegicus*)	4	U	FD	13	w	5	w	JV	M	GRO	BDWT	WO	234	2514	80
151	Bentley and Grubb, 1991	40436	Rabbit (*Oryctolagus cuniculus*)	3	U	FD	22	w	NR	NR	JV	B	GRO	BDWT	WO	282		68
152	Llewellyn et al, 1985	2203	Golden hamster (*Mesocricetus auratus*)	2	U	FD	18	w	NR	NR	JV	M	GRO	BDWT	WO	295		67
153	Maita et al, 1981	43680	Mouse (*Mus musculus*)	4	U	FD	13	w	5	w	JV	M	GRO	BDWT	WO	458	4927	80
154	Ketcheson et al, 1969	37837	Rat (*Rattus norvegicus*)	3	U	FD	14	d	NR	NR	LC	F	GRO	BDWT	WO	470		73
155	Maita et al, 1981	43680	Mouse (*Mus musculus*)	4	U	FD	13	w	5	w	JV	F	GRO	BDWT	WO	479	4878	80
156	O'Neil-Cutting et al, 1981	14656	Rat (*Rattus norvegicus*)	2	U	FD	18	w	NR	NR	JV	M	GRO	BDWT	WO	597		77
157	Zhang et al, 1995	39356	Mouse (*Mus musculus*)	2	M	FD	10	d	8	w	JV	F	GRO	BDWT	WO	825		68
158	Zhang et al, 1995	39356	Mouse (*Mus musculus*)	2	M	FD	10	d	8	w	JV	F	GRO	BDWT	WO	845		73
159	Zhang et al, 1995	39356	Mouse (*Mus musculus*)	2	M	FD	10	d	8	w	JV	F	GRO	BDWT	WO	846		68
160	Pettersen, et al, 2002	36374	Mouse (*Mus musculus*)	3	U	FD	3	w	4	w	JV	B	GRO	BDWT	WO	1419	2838	83
161	Urabe and Hayakawa, 1990	40997	Rat (*Rattus norvegicus*)	2	U	FD	42	d	NR	NR	JV	M	GRO	BDWT	WO	1684		78
162	Maita et al, 1981	43680	Rat (*Rattus norvegicus*)	4	U	FD	13	w	5	w	JV	F	GRO	BDWT	WO	2486		69
163	Nakamura et al., 1983	638	Rat (*Rattus norvegicus*)	2	U	FD	11	w	NR	NR	JV	F	GRO	BDWT	WO		8.71	73
164	Rosa et al, 1986	47007	Sheep (*Ovis aries*)	2	U	FD	56	d	NR	NR	SM	M	GRO	BDWT	WO		16.1	71
165	Subramanian et al, 2000	21011	Rat (*Rattus norvegicus*)	2	U	FD	6	w	NR	NR	JV	M	GRO	BDWT	WO		28.2	73
166	Davies, et al, 1977	14527	Sheep (*Ovis aries*)	2	M	FD	26	d	1	w	JV	M	GRO	BDWT	WO		75.7	81
167	Barone et al, 1998	21042	Rat (*Rattus norvegicus*)	2	U	FD	10	d	NR	NR	GE	F	GRO	BDWT	WO		81.1	71
168	Hsu et al, 1975	14376	Pig (*Sus scrofa*)	2	U	FD	13	w	4	w	JV	NR	GRO	BDWT	WO		89.1	73
169	Schlicker and Cox, 1968	25	Rat (*Rattus norvegicus*)	2	U	FD	18	d	NR	NR	GE	F	GRO	BDWT	WO		424	68
170	Settlemire and Matrone, 1967	38015	Rat (*Rattus norvegicus*)	2	U	FD	5	w	4-6	w	JV	M	GRO	BDWT	WO		667	76
171	Ogiso, et. al., 1974	42961	Rat (*Rattus norvegicus*)	2	U	FD	15	d	NR	NR	JV	M	GRO	BDWT	WO		956	77
172	Scott and Magee, 1979	43264	Rat (*Rattus norvegicus*)	2	U	FD	1	w	NR	NR	JV	M	GRO	BDWT	WO		968	77
Survival (MOR)																		
173	Seidenberg et al 1986	113	Mouse (*Mus musculus*)	2	U	GV	4	d	NR	NR	GE	F	MOR	MORT	WO	8.89		85
174	Van der Schee et al, 1980	21171	Sheep (*Ovis aries*)	3	M	FD	98	d	NR	NR	JV	M	MOR	MORT	WO	12.0		83
175	Food and Drug Res. Lab, 1973	42289	Mouse (*Mus musculus*)	3	U	GV	10	d	NR	NR	GE	F	MOR	SURV	WO	30.0		76
176	Food and Drug Res. Lab, 1973	42289	Rat (*Rattus norvegicus*)	4	U	GV	10	d	NR	NR	GE	F	MOR	SURV	WO	42.5		76
177	Brink et al, 1959	14525	Pig (*Sus scrofa*)	6	U	FD	42	d	NR	NR	JV	NR	MOR	MORT	WO	43.5	87.1	85
178	Food and Drug Res. Lab, 1974	42292	Rabbit (*Oryctolagus cuniculus*)	5	U	GV	13	d	NR	NR	GE	F	MOR	MORT	WO	60.0		76
179	Ott et al, 1966	14535	Sheep (*Ovis aries*)	8	U	FD	6	w	NR	NR	JV	NR	MOR	MORT	WO	82.9	99.5	80

Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose* (mg/kg bw/day)	LOAEL Dose* (mg/kg bw/day)	Total
180	Willoughby et al, 1972	14385	Horse (*Equus caballus*)	2	M	FD	9	w	3-4	w	JV	F	MOR	MORT	WO	83.7		78
181	Food and Drug Res. Lab, 1973	42289	Hamster (*Mesocricetus auratus*)	3	U	GV	5	d	NR	NR	GE	F	MOR	SURV	WO	88.0		76
182	Aulerich et al, 1991	46274	Mink (*Mustela vison*)	4	M	FD	144	d	>1	yr	AD	M	MOR	MORT	WO	165		80
183	Aulerich et al, 1991	46274	Mink (*Mustela vison*)	4	M	FD	144	d	10-12	w	JV	M	MOR	MORT	WO	297		84
184	Aulerich et al, 1991	46274	Mink (*Mustela vison*)	4	M	FD	144	d	10-12	w	JV	F	MOR	MORT	WO	324		84
185	Aulerich et al, 1991	46274	Mink (*Mustela vison*)	4	M	FD	114	d	>1	yr	AD	F	MOR	MORT	WO	327		80
186	Maita et al, 1981	43680	Mouse (*Mus musculus*)	4	U	FD	13	w	5	w	JV	M	MOR	MORT	WO	458	4927	81
187	Maita et al, 1981	43680	Rat (*Rattus norvegicus*)	4	U	FD	13	w	5	w	JV	F	MOR	MORT	WO	2486		70
188	Maita et al, 1981	43680	Rat (*Rattus norvegicus*)	4	U	FD	13	w	5	w	JV	M	MOR	MORT	WO	2514		79
189	Maita et al, 1981	43680	Mouse (*Mus musculus*)	4	U	FD	13	w	5	w	JV	F	MOR	MORT	WO	4878		79
190	Van Vleet et al, 1981	149	Pig (*Sus scrofa*)	2	U	FD	10	w	NR	NR	JV	M	MOR	MORT	WO		99.1	78

AD = adult; AHDX = aniline hydroxylase; ALPH = alkaline phosphatase; B = both; BDWT = body weight changes; BEH = behavior; BI = bile; BIO = biochemical; BL = blood; BR = brain; bw = body weight; CALC = calcium; CCOX = cytochrome C-oxidase; CHM = chemical changes; CHOL = cholesterol; d = day; DIFD = digestibility of food; DR = Drinking water; DT - digestive tract; ENZ = enyzme level changes; F = female; FCNS = food consumption; FD = food; FDB = feeding behavior; FDCV = food conversion efficiency; FDNG = feeding behavior; FM = femur; FO = foot; GBCM = general biochemical changes; GE = gestation; GGRO = general growth changes; GLPX = glutathione peroxidase; GLSN = gross lesions; GLUC = glucose; GLYC = glycogen; GPHY = general pysiology changes; GRO = growth; GREP = general reproduction; GRS = gross body weight changes; GT = gastrointestinal tract; GV = gavage; HA = hair; HE = heart; HEMT = hematocrit; HIS = histological changes; HM = humerus; HMCT = hematocrit; HMGL = hemoglobin; HRM = hormone changes; IN = intestinal tract; ITX = intoxication; JV = juvenile; kg = kilograms; KI = kidney; LC = lactation; LD = lipid; LI = liver; LOAEL = lowest observed adverse effect level; mg = milligrams; mo = months; M = male; M = measured; MCHC = mean corpuscular hemoglobin; MCPR = microsomal proteins; MK = milk, lactating females; MOR = effects on mortality and survival; MORT = mortality; MPH = morphology; MT = multiple; MU = muscle; NACO = sodium; NOAEL = No Observed Advese Effect Level; NCRO = necrosis; NR = Not reported; NMVM = number of movements; ODVP = offspring development; OR = other oral; ORW = organ weight changes; ORWT = organ weight changes; OV = ovary; P450 = cytochrome P450; PCLV = packed cell volume; PHY = physiology; PL = plasma; PRFM = pregnant females in a population; PROG = progeny numbers/counts; PRTL = protein, total; PRWT = progeny weight; PS = pancreas; PTH = pathology; RBCE = red blood cell count; REP = reproduction; RHIS = reproductive organ histology; RSEM = resorbed embryos; SH = stomach; SK = skin; SM = sexually mature; SMIX = weight relative to body weight; SP = spleen; SPCL = sperm cell counts; SR = serum; SURV = survival; TB = tibia; TE = testes; TEWT = testes weight; TS = thymus; TWBC = white blood cell count, total; U = unmeasured; UR = urine; USTR = ultrastructural changes; VD = Vas deferens; VTMA = vitamin A; w = weeks; WCON = water consumption; WO = whole organism.

*NOAEL and LOAEL values that are equal and from the same reference represent different experimental designs.
These are designated with different Phase numbers in Appendix 6.1.

Within the reviewed papers there are 190 results for biochemical (BIO), behavior (BEH), physiology (PHY), pathology (PTH), reproduction (REP), growth (GRO), and survival (MOR) endpoints with a total Data Evaluation Score >65 that were used to derive the TRV (U.S. EPA 2003; Attachment 4-4). These data are plotted in Figure 6.1 and correspond directly with the data presented in Table 6.1. The NOAEL results for growth and reproduction are used to calculate a geometric mean NOAEL. This geometric mean is examined in relationship to the lowest bounded LOAEL for reproduction, growth, and survival to derive the TRV according to the Eco-SSL guidance (U.S. EPA 2003; Attachment 4-5).

A geometric mean of the NOAEL values for reproduction and growth was calculated at 75.4 mg zinc/kg bw/day. This value is lower than the lowest bounded LOAEL for reproduction, growth, or mortality results. Therefore, the TRV is equal to the geometric mean of the NOAEL values for reproduction and growth and is equal to 75.4 mg zinc/kg bw/day.

6.2 Estimation of Dose and Calculation of the Eco-SSL

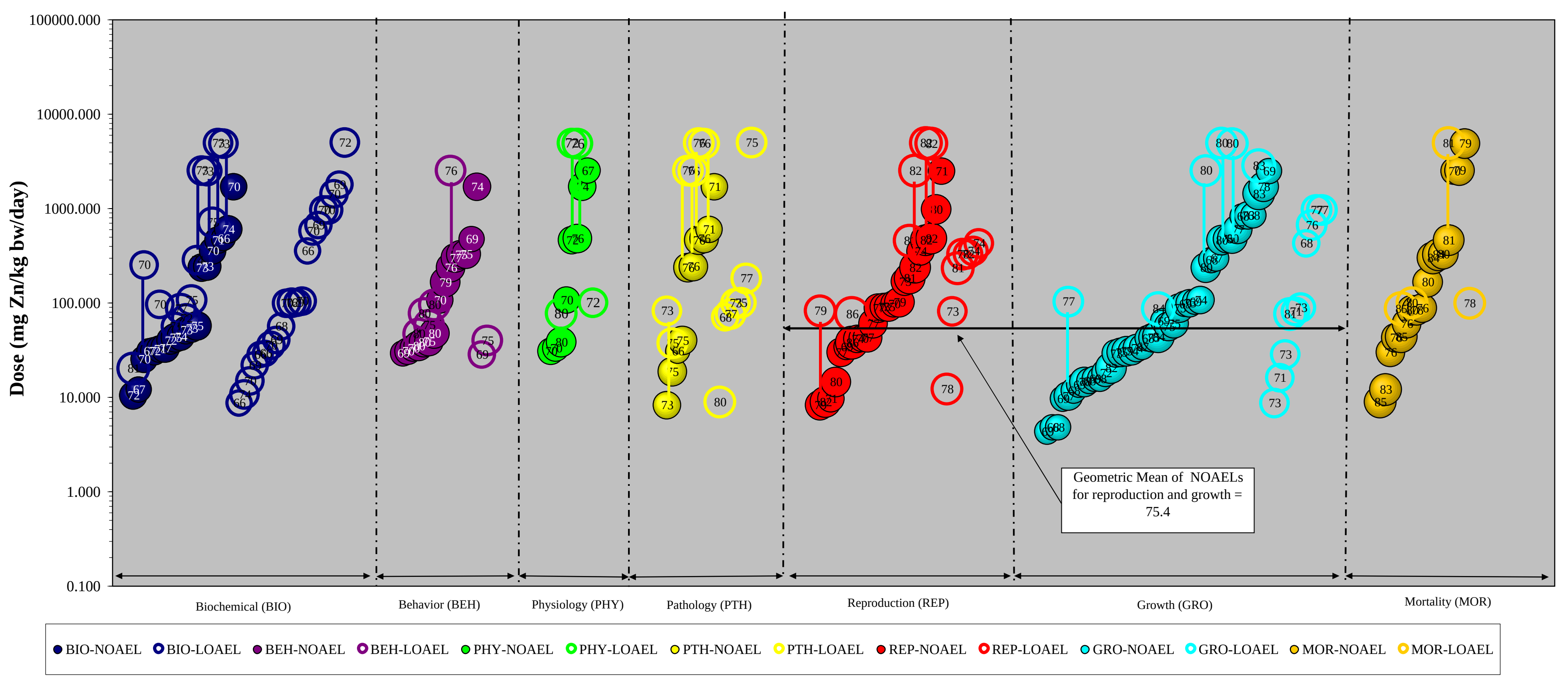
Three separate Eco-SSL values were calculated for mammalian wildlife, one for each of three surrogate receptor groups representing different trophic levels. The mammalian Eco-SSLs derived for Zinc were calculated according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5) and are summarized in Table 6.2.

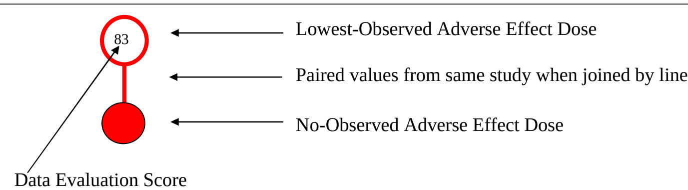
Table 6.2 Calculation of the Mammalian Eco-SSLs for Zinc

Surrogate Receptor Group	TRV for Zinc (mg dw/kg bw/d) [1]	Food Ingestion Rate (FIR)[2] (kg dw/kg bw/d)	Soil Ingestion as Proportion of Diet (P_s)[2]	Concentration of Zinc in Biota Type (i)[2,3] (B_i) (mg/kg dw)	Eco-SSL (mg/kg dw)[4]
Mammalian herbivore (vole)	75.4	0.0875	0.032	$\ln(B_i) = 0.554 * \ln(Soil_j) + 1.575$ where i = plants	6,800
Mammalian ground insectivore (shrew)	75.4	0.209	0.030	$\ln(B_i) = 0.328 * \ln(Soil_j) + 4.449$ where i = earthworms	79
Mammalian carnivore (weasel)	75.4	0.130	0.043	$\ln(B_i) = 0.0706 * \ln(Soil_j) + 4.3632$ where i = mammals	10,000

[1] The process for derivation of wildlife TRVs is described in Attachment 4-5 of U.S. EPA (2003).
[2] Parameters (FIR, P_s, B_i values, regressions) are provided in U.S. EPA (2003) Attachment 4-1 (revised February 2005).
[3] B_i = Concentration in biota type (i) which represents 100% of the diet for the respective receptor.
[4] $HQ = [FIR * (Soil_j * P_s + B_i)] / TRV$ solved for HQ=1 where $Soil_j$ = Eco-SSL (Equation 4-2; U.S. EPA, 2003).

Figure 6.1 Mammalian TRV Derivation for Zinc





Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

3) The geometric mean is equal to 75.4 mg zinc/kg bw/d and is lower than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.

4) The mammalian wildlife TRV for zinc is equal to 75.4 mg zinc/kg bw/day which is the geometric mean of NOAEL results within the reproduction and growth effect groups.

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7.5 References Rejected for Use in Derivation of Wildlife TRV

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Diss characterization and metabolism of alpha-2u-globulin -- a male sex-dependent protein of the rat. *838449 ORDER NO: AAD84-00485*

Diss characterization, fate and environmental risk assessment of microbial, elemental and toxic components of fractionated broiler litter during storage and reutilization. *01295605 ORDER NO: AAD93-16361*

Diss characterization of avian immune response genes expressed during development and cellular activation|. *01673822 ORDER NO: AAD99-09754*

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Diss characterization of dna-binding proteins which regulate expression of the chicken apo very low-density lipoprotein ii gene. *01394008 ORDER NO: AADNN-90263*

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Diss the effects of postnatal zinc deficiency on spatial learning in rats. *01126547 ORDER NO: AAD13-40717*

Diss the effects of prenatal and postnatal zinc deficiency on development of long-term memory in the rat. *693987 ORDER NO: AAD80-20378*

Nut def effects of prenatal nutrition on learning and motivation in rats.| .

Diss the effects of radiation pasteurization on biochemical and mineral parameters in the blood and livers of weanling rats fed soy, meat and soy-meat combination diets (food irradiation). *01628491 ORDER NO: AAD98-20665*

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Diss effects of the antituberculous drug ethambutol on zinc balance, distribution, and turnover: short-term studies modeling chronic toxicity. *0958957 ORDER NO: AAD87-08971*

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Diss the effects of zinc and copper supplementation on blood lipids and trace minerals deposition of young male rats fed either coconut oil or corn oil. *816484 ORDER NO: AAD83-15653*

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Diss erythroid development and gata-1. *01420833 ORDER NO: AADAA-IC423078*

Diss etiology and physiology of chemical-induced tibial dyschondroplasia in broiler chickens|. *01124219 ORDER NO: AAD90-27533*

Diss experimental copper deficiency in the golden hamster and in healthy adult. *800202 ORDER NO: AAD83-01960*

Diss experimental copper deficiency in the golden hamster and in healthy adult men. *800202 ORDER NO: AAD83-01960*

Diss an experimental study of alcoholism in rats: modification in the metabolism of zinc and its relation with the morphological lesions in liver and testes original title: estudio experimental del alcoholismo en ratas: alteraciones del metabolismo del zinc y su relacion con las lesiones en el higado y los testiculos. *1042323 ORDER NO: NOT AVAILABLE FROM UNIVERSITY MICROFILMS INT'L.*

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Diss identification and characterization of krk-1, a novel kidney specific krab-domain containing zinc finger protein (transcription factor). *01598926 ORDER NO: AAD98-00873*

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Diss the influence of environmental, nutritional, and management factors on feathering and incidence of dermatitis of broiler chickens. *699794 ORDER NO: AAD80-26067*

Diss influence of faba bean diets with different levels of zinc on nutritional status and immune response in mice original title: influencia de la ingestion de dietas de vicia faba l. con diferentes niveles de zinc sobre el estado nutritivo y la respuesta inmune de raton. *01140851 ORDER NO: NOT AVAILABLE FROM UNIVERSITY MICROFILMS INT'L.*

CP influence of inhibitors of protein synthesis on zinc metabolism.| au-n.j. 08903, usa. *Proceedings of the Society for Experimental Biology and Medicine*|

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Diss the interaction of dietary protein and zinc deficiencies with heligmosomoides polygyrus infection in mice. *01464914 ORDER NO: AADAA-IMM00005*

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Diss interactions among silicon, copper, zinc, iron and ascorbic acid in the rat. *01482245 ORDER NO: AADAA-I9613050*

Diss interactions among zinc, copper, iron, manganese, and ascorbic acid in the japanese quail (dietary supplements, toxicity, perosis, trace elements, anemia). *887582 ORDER NO: AAD85-14498*

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Diss murine model. *865959 ORDER NO: AAD84-28042|*

Diss mutations within the ery1 transcriptional unit are associated with juvenile lethality, neuromuscular tremors and germ cell defects in jdf2 mutant mice and pigmentation abnormalities in p(x) and p(m) alleles. *01695772 ORDER NO: AAD99-23343*

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Diss olfactory and photoperiodic mediation of reproduction in the rat (rattus norvegicus). *846785 ORDER NO: AAD84-13535*

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Diss oral dimercaptosuccinic acid and ongoing exposure to lead (chelation)|+. *01391103 ORDER NO: AAD95-02198*

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HHE purification, inhibition and mechanistic studies of clostridium histolyticum and human neutrophil collagenases. *929270 ORDER NO: AAD86-19145*

Diss rapid effects of dietary zinc on the epithelium of the small intestine in zinc deficient rats. *01557715 ORDER NO: AADMM-14384*

Diss the rapid effects of dietary zinc on the structure and function of the lower gastrointestinal tract of the rat. *01512429 ORDER NO: AADMM-09652*

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Diss the sensory regulation of maternal aggression in lactating norway rats (rattus norvegicus). *01408840 ORDER NO: AADAA-I9511978*

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Diss a study of the human x-linked inhibitory apoptosis protein xiap and its murine homologue miap-3. *01672988 ORDER NO: AADNQ-32444*

Diss a study of zinc concentration in hair as an indication of zinc imbalances. *755383 ORDER NO: AAD81-19631*

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Literature Rejection Categories		
Rejection Criteria	**Description**	**Receptor**
ABSTRACT (Abstract)	Abstracts of journal publications or conference presentations.	Wildlife Plants and Soil Invertebrates
ACUTE STUDIES (Acu)	Single oral dose or exposure duration of three days or less.	Wildlife
AIR POLLUTION (Air P)	Studies describing the results for air pollution studies.	Wildlife Plants and Soil Invertebrates
ALTERED RECEPTOR (Alt)	Studies that describe the effects of the contaminant on surgically-altered or chemically-modified receptors (e.g., right nephrectomy, left renal artery ligature, hormone implant, etc.).	Wildlife
AQUATIC STUDIES (Aquatic)	Studies that investigate toxicity in aquatic organisms.	Wildlife Plants and Soil Invertebrates
ANATOMICAL STUDIES (Anat)	Studies of anatomy. Instance where the contaminant is used in physical studies (e.g., silver nitrate staining for histology).	Wildlife
BACTERIA (Bact)	Studies on bacteria or susceptibility to bacterial infection.	Wildlife Plants and Soil Invertebrates
BIOACCUMULATION SURVEY (Bio Acc)	Studies reporting the measurement of the concentration of the contaminant in tissues.	Wildlife Plants and Soil Invertebrates
BIOLOGICAL PRODUCT (BioP)	Studies of biological toxicants, including venoms, fungal toxins, *Bacillus thuringiensis*, other plant, animal, or microbial extracts or toxins.	Wildlife Plants and Soil Invertebrates
BIOMARKER (Biom)	Studies reporting results for a biomarker having no reported association with an adverse effect and an exposure dose (or concentration).	Wildlife
CARCINOGENICITY STUDIES (Carcin)	Studies that report data only for carcinogenic endpoints such as tumor induction. Papers that report systemic toxicity data are retained for coding of appropriate endpoints.	Wildlife Plants and Soil Invertebrates
CHEMICAL METHODS (Chem Meth)	Studies reporting methods for determination of contaminants, purification of chemicals, etc. Studies describing the preparation and analysis of the contaminant in the tissues of the receptor.	Wildlife Plants and Soil Invertebrates
CONFERENCE PROCEEDINGS (CP)	Studies reported in conference and symposium proceedings.	Wildlife Plants and Soil Invertebrates
DEAD (Dead)	Studies reporting results for dead organisms. Studies reporting field mortalities with necropsy data where it is not possible to establish the dose to the organism.	Wildlife Plants and Soil Invertebrates
DISSERTATIONS (Diss)	Dissertations are excluded. However, dissertations are flagged for possible future use.	Wildlife
DRUG (Drug)	Studies reporting results for testing of drug and therapeutic effects and side-effects. Therapeutic drugs include vitamins and minerals. Studies of some minerals may be included if there is potential for adverse effects.	Wildlife Plants and Soil Invertebrates
DUPLICATE DATA (Dup)	Studies reporting results that are duplicated in a separate publication. The publication with the earlier year is used.	Wildlife Plants and Soil Invertebrates

Literature Rejection Categories		
Rejection Criteria	**Description**	**Receptor**
ECOLOGICAL INTERACTIONS (Ecol)	Studies of ecological processes that do not investigate effects of contaminant exposure (e.g., studies of "silver" fox natural history; studies on ferrets identified in iron search).	Wildlife Plants and Soil Invertebrates
EFFLUENT (Effl)	Studies reporting effects of effluent, sewage, or polluted runoff.	Wildlife Plants and Soil Invertebrates
ECOLOGICALLY RELEVANT ENDPOINT (ERE)	Studies reporting a result for endpoints considered as ecologically relevant but is not used for deriving Eco-SSLs (e.g., behavior, mortality).	Plants and Soil Invertebrates
CONTAMINANT FATE/METABOLISM (Fate)	Studies reporting what happens to the contaminant, rather than what happens to the organism. Studies describing the intermediary metabolism of the contaminant (e.g., radioactive tracer studies) without description of adverse effects.	Wildlife Plants and Soil Invertebrates
FOREIGN LANGUAGE (FL)	Studies in languages other than English.	Wildlife Plants and Soil Invertebrates
FOOD STUDIES (Food)	Food science studies conducted to improve production of food for human consumption.	Wildlife
FUNGUS (Fungus)	Studies on fungus.	Wildlife Plants and Soil Invertebrates
GENE (Gene)	Studies of genotoxicity (chromosomal aberrations and mutagenicity).	Wildlife Plants and Soil Invertebrates
HUMAN HEALTH (HHE)	Studies with human subjects.	Wildlife Plants and Soil Invertebrates
IMMUNOLOGY (IMM)	Studies on the effects of contaminants on immunological endpoints.	Wildlife Plants and Soil Invertebrates
INVERTEBRATE (Invert)	Studies that investigate the effects of contaminants on terrestrial invertebrates are excluded.	Wildlife
IN VITRO (In Vit)	*In vitro* studies, including exposure of cell cultures, excised tissues and/or excised organs.	Wildlife Plants and Soil Invertebrates
LEAD SHOT (Lead shot)	Studies administering lead shot as the exposure form. These studies are labeled separately for possible later retrieval and review.	Wildlife
MEDIA (Media)	Authors must report that the study was conducted using natural or artificial soil. Studies conducted in pore water or any other aqueous phase (e.g., hydroponic solution), filter paper, petri dishes, manure, organic or histosoils (e.g., peat muck, humus), are not considered suitable for use in defining soil screening levels.	Plants and Soil Invertebrates
METHODS (Meth)	Studies reporting methods or methods development without usable toxicity test results for specific endpoints.	Wildlife Plants and Soil Invertebrates
MINERAL REQUIREMENTS (Mineral)	Studies examining the minerals required for better production of animals for human consumption, unless there is potential for adverse effects.	Wildlife
MIXTURE (Mix)	Studies that report data for combinations of single toxicants (e.g. cadmium and copper) are excluded. Exposure in a field setting from contaminated natural soils or waste application to soil may be coded as Field Survey.	Wildlife Plants and Soil Invertebrates

Literature Rejection Categories		
Rejection Criteria	**Description**	**Receptor**
MODELING (Model)	Studies reporting the use of existing data for modeling, i.e., no new organism toxicity data are reported. Studies which extrapolate effects based on known relationships between parameters and adverse effects.	Wildlife Plants and Soil Invertebrates
NO CONTAMINANT OF CONCERN (No COC)	Studies that do not examine the toxicity of Eco-SSL contaminants of concern.	Wildlife Plants and Soil Invertebrates
NO CONTROL (No Control)	Studies which lack a control or which have a control that is classified as invalid for derivation of TRVs.	Wildlife Plants and Soil Invertebrates
NO DATA (No Data)	Studies for which results are stated in text but no data is provided. Also refers to studies with insufficient data where results are reported for only one organism per exposure concentration or dose (wildlife).	Wildlife Plants and Soil Invertebrates
NO DOSE or CONC (No Dose)	Studies with no usable dose or concentration reported, or an insufficient number of doses/concentrations are used based on Eco-SSL SOPs. These are usually identified after examination of full paper. This includes studies which examine effects after exposure to contaminant ceases. This also includes studies where offspring are exposed in utero and/or lactation by doses to parents and then after weaning to similar concentrations as their parents. Dose cannot be determined.	Wildlife Plants and Soil Invertebrates
NO DURATION (No Dur)	Studies with no exposure duration. These are usually identified after examination of full paper.	Wildlife Plants and Soil Invertebrates
NO EFFECT (No Efct)	Studies with no relevant effect evaluated in a biological test species or data not reported for effect discussed.	Wildlife Plants and Soil Invertebrates
NO ORAL (No Oral)	Studies using non-oral routes of contaminant administration including intraperitoneal injection, other injection, inhalation, and dermal exposures.	Wildlife
NO ORGANISM (No Org) or NO SPECIES	Studies that do not examine or test a viable organism (also see in vitro rejection category).	Wildlife Plants and Soil Invertebrates
NOT AVAILABLE (Not Avail)	Papers that could not be located. Citation from electronic searches may be incorrect or the source is not readily available.	Wildlife Plants and Soil Invertebrates
NOT PRIMARY (Not Prim)	Papers that are not the original compilation and/or publication of the experimental data.	Wildlife Plants and Soil Invertebrates
NO TOXICANT (No Tox)	No toxicant used. Publications often report responses to changes in water or soil chemistry variables, e.g., pH or temperature. Such publications are not included.	Wildlife Plants and Soil Invertebrates
NO TOX DATA (No Tox Data)	Studies where toxicant used but no results reported that had a negative impact (plants and soil invertebrates).	Plants and Soil Invertebrates
NUTRIENT (Nutrient)	Nutrition studies reporting no concentration related negative impact.	Plants and Soil Invertebrates
NUTRIENT DEFICIENCY (Nut def)	Studies of the effects of nutrient deficiencies. Nutritional deficient diet is identified by the author. If reviewer is uncertain then the administrator should be consulted. Effects associated with added nutrients are coded.	Wildlife
NUTRITION (Nut)	Studies examining the best or minimum level of a chemical in the diet for improvement of health or maintenance of animals in captivity.	Wildlife
OTHER AMBIENT CONDITIONS (OAC)	Studies which examine other ambient conditions: pH, salinity, DO, UV, radiation, etc.	Wildlife Plants and Soil Invertebrates

Literature Rejection Categories		
Rejection Criteria	**Description**	**Receptor**
OIL (Oil)	Studies which examine the effects of oil and petroleum products.	Wildlife Plants and Soil Invertebrates
OM, pH (OM, pH)	Organic matter content of the test soil must be reported by the authors, but may be presented in one of the following ways; total organic carbon (TOC), particulate organic carbon (POC), organic carbon (OC), coarse particulate organic matter (CPOM), particulate organic matter (POM), ash free dry weight of soil, ash free dry mass of soil, percent organic matter, percent peat, loss on ignition (LOI), organic matter content (OMC). With the exception of studies on non-ionizing substances, the study must report the pH of the soil, and the soil pH should be within the range of $4 and #8.5. Studies that do not report pH or report pH outside this range are rejected.	Plants and Soil Invertebrates
ORGANIC METAL (Org Met)	Studies which examine the effects of organic metals. This includes tetraethyl lead, triethyl lead, chromium picolinate, phenylarsonic acid, roxarsone, 3-nitro-4-phenylarsonic acid,, zinc phosphide, monomethylarsonic acid (MMA), dimethylarsinic acid (DMA), trimethylarsine oxide (TMAO), or arsenobetaine (AsBe) and other organo metallic fungicides. Metal acetates and methionines are not rejected and are evaluated.	Wildlife
LEAD BEHAVIOR OR HIGH DOSE MODELS (Pb Behav)	There are a high number of studies in the literature that expose rats or mice to high concentrations of lead in drinking water (0.1, 1 to 2% solutions) and then observe behavior in offspring, and/or pathology changes in the brain of the exposed dam and/or the progeny. Only a representative subset of these studies were coded. Behavior studies examining complex behavior (learned tasks) were also not coded.	Wildlife
PHYSIOLOGY STUDIES (Phys)	Physiology studies where adverse effects are not associated with exposure to contaminants of concern.	Wildlife
PLANT (Plant)	Studies of terrestrial plants are excluded.	Wildlife
PRIMATE (Prim)	Primate studies are excluded.	Wildlife
PUBL AS (Publ as)	The author states that the information in this report has been published in another source. Data are recorded from only one source. The secondary citation is noted as Publ As.	Wildlife Plants and Soil Invertebrates
QSAR (QSAR)	Derivation of Quantitative Structure-Activity Relationships (QSAR) is a form of modeling. QSAR publications are rejected if raw toxicity data are not reported or if the toxicity data are published elsewhere as original data.	Wildlife Plants and Soil Invertebrates
REGULATIONS (Reg)	Regulations and related publications that are not a primary source of data.	Wildlife Plants and Soil Invertebrates
REVIEW (Rev)	Studies in which the data reported in the article are not primary data from research conducted by the author. The publication is a compilation of data published elsewhere. These publications are reviewed manually to identify other relevant literature.	Wildlife Plants and Soil Invertebrates

Literature Rejection Categories		
Rejection Criteria	**Description**	**Receptor**
SEDIMENT CONC (Sed)	Studies in which the only exposure concentration/dose reported is for the level of a toxicant in sediment.	Wildlife Plants and Soil Invertebrates
SCORE (Score)	Papers in which all studies had data evaluation scores at or lower then the acceptable cut-off (#10 of 18) for plants and soil invertebrates).	Plants and Soil Invertebrates
SEDIMENT CONC (Sed)	Studies in which the only exposure concentration/dose reported is for the level of a toxicant in sediment.	Wildlife Plants and Soil Invertebrates
SLUDGE	Studies on the effects of ingestion of soils amended with sewage sludge.	Wildlife Plants and Soil Invertebrates
SOIL CONC (Soil)	Studies in which the only exposure concentration/dose reported is for the level of a toxicant in soil.	Wildlife
SPECIES	Studies in which the species of concern was not a terrestrial invertebrate or plant or mammal or bird.	Plants and Soil Invertebrates Wildlife
STRESSOR (QAC)	Studies examining the interaction of a stressor (e.g., radiation, heat, etc.) and the contaminant, where the effect of the contaminant alone cannot be isolated.	Wildlife Plants and Soil Invertebrates
SURVEY (Surv)	Studies reporting the toxicity of a contaminant in the field over a period of time. Often neither a duration nor an exposure concentration is reported.	Wildlife Plants and Soil Invertebrates
REPTILE OR AMPHIBIAN (Herp)	Studies on reptiles and amphibians. These papers flagged for possible later review.	Wildlife Plants and Soil Invertebrates
UNRELATED (Unrel)	Studies that are unrelated to contaminant exposure and response and/or the receptor groups of interest.	Wildlife
WATER QUALITY STUDY (Wqual)	Studies of water quality.	Wildlife Plants and Soil Invertebrates
YEAST (Yeast)	Studies of yeast.	Wildlife Plants and Soil Invertebrates

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Appendix 5-1

Avian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Zinc

June 2007

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Appendix 5.1 Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Zinc

Ref			Exposure																				Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Endpoint Number	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg/day or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
Biochemical																																													
1	6655	Hamilton et al, 1979	Zinc carbonate	100	Japanese quail (*Coturnix japonica*)	2	2	0/125	mg/kg diet	N	na	ADL	U	FD	14	d	0	d	JV	B	C	3	BIO	CHM	HMGL	BL	125		Y	0.0448	N	0.00771	21.5		10	10	5	10	6	1	4	10	10	7	73
2	6403	Hamilton et al, 1981	Zinc carbonate	100	Japanese quail (*Coturnix japonica*)	1	3	0/250/500	mg/kg diet	N	na	ADL	U	FD	7	d	1	d	JV	B	C	2	BIO	CHM	HMGL	BL	250	500	Y	0.023	N	0.00499	54.3	109	10	10	5	10	6	1	10	10	10	4	76
3	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	6	0/55/105/125/159/148	mg/kg bw/d	N	na	ADL	U	FD	140	d	40	w	SM	F	C	6	BIO	CHM	LIPD	LI	55	105	Y	1.67	Y	na	55	105	10	10	5	5	7	1	10	10	10	4	72
4	9261	Gasaway and Buss, 1972	Zinc carbonate	100	Mallard duck (*Anas platyrhynchos*)	1	4	0/3000/6000/9000/12000	mg/kg diet	N	na	ADL	U	FD	45	d	7	w	JV	B	C	5	BIO	CHM	HMCT	BL	3000	6000	N	1.2	Y	0.0306	76.5	153	10	10	5	10	6	1	10	10	10	4	76
5	93	Berg and Martinson, 1972	Zinc Oxide	100	Chicken (*Gallus domesticus*)	2	7	0/200/400/800/1200/1600/2000	mg/kg diet	N	na	ADL	U	FD	2	w	1	d	JV	NR	C	2	BIO	CHM	ASHC	BO	800	1200	Y	0.076	N	0.01087	114	172	10	10	5	5	6	1	10	10	10	4	71
6	6368	Southern and Baker, 1983	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	3	0/2000/4000	mg/kg diet	N	na	ADL	U	FD	14	d	8	d	JV	M	C	3	BIO	CHM	HMGL	BL	2000	4000	Y	0.301	N	0.02664	177	354	10	10	5	10	6	1	10	10	10	4	76
7	6655	Hamilton et al, 1979	Zinc carbonate	100	Japanese quail (*Coturnix japonica*)	1	6	0/125/250/500/1000/2000	mg/kg diet	N	na	ADL	U	FD	14	d	0	d	JV	B	C	3	BIO	CHM	HMCT	BL		125	Y	0.0405	N	0.00722		22.3	10	10	5	10	6	1	4	10	10	7	73
8	392	Lefevre et al, 1982	Zinc chloride	100	Chicken (*Gallus domesticus*)	1	2	0/800	mg/kg diet	N	na	ADL	U	FD	5	w	1	d	JV	NR	C	4	BIO	CHM	HMCT	BL		800	Y	0.253	Y	0.02		63.2	10	10	5	10	7	1	4	10	10	4	71
9	8008	Lu et al, 1990	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	na	ADL	U	FD	4	d	14	d	JV	B	C	3	BIO	ENZ	GENZ	PS		500	Y	1.042	Y	0.137		65.7	10	10	5	5	7	1	4	10	10	4	66
10	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	3	5	0/216/163/88/98	mg/kg bw/d	N	na	ADL	U	FD	3	w	40	w	SM	F	C	1	BIO	CHM	LIPD	LI		88	Y	1.62	Y	na		88	10	10	5	5	7	1	4	10	10	4	66
11	5617	Pimentel et al, 1992	Zinc	100	Chicken (*Gallus domesticus*)	1	2	0/1549.3	mg/kg diet	N	na	ADL	M	FD	3	w	1	d	JV	B	C	3	BIO	CHM	HMGL	WO		1549.3	Y	0.1217	Y	0.0104		132	10	10	10	4	7	1	4	10	10	4	70
12	7245	Sandoval et al, 1998	Zinc oxide	100	Chicken (*Gallus domesticus*)	3	2	0/1000	mg/kg diet	N	na	ADL	U	FD	1	w	1	d	JV	F	C	1	BIO	CHM	MCPR	LI		1000	N	0.084	N	0.0116		138	10	10	5	10	5	1	4	10	10	4	69
13	6627	Oh et al, 1979	Zinc acetate	100	Chicken (*Gallus domesticus*)	2	2	0/4000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	NR	C	5	BIO	CHM	GBCM	LI		4000	Y	0.714	Y	0.0449		252	10	10	5	5	7	1	4	10	10	4	66
14	2517	Bafundo et al, 1984	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/4000	mg/kg diet	N	na	ADL	U	FD	14	d	8	d	JV	F	C	1	BIO	CHM	HMGL	WO		4000	N	0.564	N	0.04009		284	10	10	5	10	5	1	4	10	10	4	69
15	5681	Dean et al, 1991	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/5280	mg/kg diet	N	na	ADL	M	FD	1	w	1	d	JV	M	C	3	BIO	CHM	GBCM	SR		5280	Y	0.09	Y	0.0129		757	10	10	10	5	7	1	4	10	10	4	71
Behavior																																													
16	5917	Baker and Halpin, 1988	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/318	mg/kg diet	N	na	ADL	M	FD	14	d	8	d	JV	M	C	2	BEH	FDB	FCNS	WO	318		N	0.564	Y	0.0266	15.0		10	10	10	10	6	4	4	1	10	4	69
17	5247	Sandoval et al, 1997	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/400/800/1200	mg/kg diet	N	na	ADL	U	FD	20	d	1	d	JV	B	C	1	BEH	FDB	FCNS	WO	800	1200	N	0.564	Y	0.032	45.4	68.1	10	10	5	10	6	4	10	10	10	4	79
18	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	6	0/55/105/125/159/148	mg/kg bw/d	N	na	ADL	U	FD	140	d	40	w	SM	F	C	3	BEH	FDB	FCNS	WO	55	105	Y	1.86	Y	na	55	105	10	10	5	5	7	4	10	10	10	4	75
19	6048	Gibson et al, 1986	Zinc acetate	100	Chicken (*Gallus domesticus*)	2	6	0/114.7/133/162.1/107.4/135.9	mg/d	N	na	ADL	U	FD	10	w	30	w	JV	F	C	2	BEH	FDB	FCNS	WO	114.7	133	Y	2	Y	0.1167	57.3	66.5	10	10	5	5	7	4	10	10	10	4	75
20	6048	Gibson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	6	0/113.4/218.3/202.3/196.3/216.3	mg/d	N	na	ADL	U	FD	10	w	30	w	JV	F	C	1	BEH	FDB	FCNS	WO	113.4	218.3	Y	1.77	Y	0.1256	64.1	123	10	10	5	5	7	4	10	10	10	4	75
21	37018	Dewar et al, 1983	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	4	0/1000/2000/4000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	B	C	4	BEH	FDB	FCNS	WO	1000	2000	Y	0.669	Y	0.0439	65.6	131	10	10	5	5	7	4	10	10	10	4	75
22	8184	Stevenson et al, 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	9	0/0.5/0.75/1.00/1.25/1.5/2.0/3.0/4.0	g/kg diet	N	na	ADL	U	FD	140	d	28	w	JV	F	C	1	BEH	FDB	FCNS	WO	1.5	2	Y	1.9	Y	0.099	78.2	104	10	10	5	5	7	4	10	10	10	4	75
23	6039	Henry et al, 1987	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/500/1000/1500	mg/kg diet	N	na	ADL	U	FD	1	w	1	d	JV	M	C	2	BEH	FDB	FCNS	WO	500	1000	N	0.084	Y	0.0155	92.3	185	10	10	5	10	6	4	10	10	10	4	79
24	8184	Stevenson et al, 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	9	0/0.5/0.75/1.0/1/.25/1.50/2.0/3.0/4.0	g/kg diet	N	na	ADL	U	FD	140	d	28	w	JV	F	C	1	BEH	FDB	FCNS	WO	1.5	2	Y	1.411	Y	0.094	99.9	133	10	10	5	5	7	4	10	10	10	4	75
25	37018	Dewar et al, 1983	Zinc oxide	100	Chicken (*Gallus domesticus*)	3	3	0/10000/20000	mg/kg diet	N	na	ADL	U	FD	4	d	18	mo	AD	F	C	2	BEH	FDB	FCNS	WO	10000	20000	N	1.6	Y	0.0255	159	319	10	10	5	5	6	4	10	10	10	4	74
26	6627	Oh et al, 1979	Zinc acetate	100	Chicken (*Gallus domesticus*)	1	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	NR	C	2	BEH	FDB	FCNS	WO	4000	8000	Y	0.714	Y	0.0449	252	503	10	10	5	5	7	4	10	10	10	4	75
27	5373	Bartov, 1996	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	4	0/0.25/0.50/1.0	% in diet	N	na	ADL	U	FD	2	w	1	w	JV	F	C	2	BEH	FDB	FCNS	WO	0.25	0.50	Y	0.406	Y	0.0511	315	629	10	10	5	5	7	4	10	10	10	4	75
28	5903	Lu and Combs, 1988	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	2	0/1000	mg/kg diet	N	na	X	U	FD	15	d	1	d	JV	NR	C	2	BEH	FDB	FCNS	WO		1000	N	0.328	Y	0.0071		21.6	10	10	5	5	6	4	4	10	10	4	68
29	5820	Stahl et al, 1989	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/2183	mg/kg diet	N	na	ADL	U	FD	20	d	1	d	JV	B	C	3	BEH	FDB	FDNG	WO		2183	N	0.564	Y	0.008		31.0	10	10	5	10	6	4	4	10	10	4	73
30	5866	Lu and Combs, 1988	zinc oxide	100	Chicken (*Gallus domesticus*)	2	2	0/1000	mg/kg diet	N	na	ADL	U	FD	12	d	20	d	JV	NR	C	2	BEH	FDB	FCNS	WO		1000	N	0.564	Y	0.033		58.5	10	10	5	5	6	4	4	10	10	4	68
31	392	Lefevre et al, 1982	Zinc chloride	100	Chicken (*Gallus domesticus*)	1	2	0/800	mg/kg diet	N	na	ADL	U	FD	5	w	1	d	JV	NR	C	3	BEH	FDB	FCNS	WO		800	Y	0.253	Y	0.02		63.2	10	10	5	10	7	4	4	10	10	4	74
32	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	3	5	0/216/163/88/98	mg/kg bw/d	N	na	ADL	U	FD	1	w	40	w	SM	F	C	1	BEH	FDB	FCNS	WO		88	Y	1.62	Y	na		88	10	10	5	5	7	4	4	10	10	4	69
33	9261	Gasaway and Buss, 1972	Zinc carbonate	100	Mallard duck (*Anas platyrhynchos*)	1	4	0/3000/6000/9000/12000	mg/kg diet	N	na	ADL	U	FD	10	d	7	w	JV	B	C	1	BEH	FDB	FCNS	WO		3000	N	1.2	Y	0.0504		126	10	10	5	10	6	4	4	10	10	4	73
34	5617	Pimentel et al, 1992	Zinc	100	Chicken (*Gallus domesticus*)	1	2	0/1549.3	mg/kg diet	N	na	ADL	M	FD	3	w	1	d	JV	B	C	2	BEH	FDB	FCNS	WO		1549.3	Y	0.1217	Y	0.0104		132	10	10	10	4	7	4	4	10	10	4	73
35	5770	Stepinska et al, 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/20000	mg/kg diet	N	na	ADL	U	FD	5	d	71	w	SM	F	C	2	BEH	FDB	FCNS	WO		20000	Y	1.889	Y	0.0194		205	10	10	5	5	7	4	4	10	10	4	69
36	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	5	0/367/480/505/325	mg/kg bw/d	N	na	ADL	U	FD	1	w	40	w	SM	F	C	3	BEH	FDB	FCNS	WO		367	Y	1.34	Y	na		367	10	10	5	5	7	4	4	10	10	4	69
37	1624	Wight et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/20000	mg/kg diet	N	na	ADL	U	FD	5	d	NR	NR	SM	F	C	1	BEH	FDB	FCNS	WO		20000	N	1.3	Y	0.0336		517	10	10	5	5	6	4	4	10	10	4	68
38	7956	Bartov et al, 1994	Zinc Oxide	100	Chicken (*Gallus domesticus*)	1	3	0/0.7/0.8	% in diet	N	na	ADL	U	FD	1	w	1	w	JV	F	C	2	BEH	FDB	FCNS	WO		0.7	Y	0.245	Y	0.024		686	10	10	5	5	7	4	4	10	10	4	69
39	5373	Bartov, 1996	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	4	0/0.65/0.75/0.85	% in diet	N	na	ADL	U	FD	2	w	1	w	JV	F	C	2	BEH	FDB	FCNS	WO		0.65	Y	0.139	Y	0.0293		1370	10	10	5	5	7	4	4	10	10	4	69
Physiology																																													
40	6048	Gibson et al, 1986	Zinc acetate	100	Chicken (*Gallus domesticus*)	2	6	0/114.7/133/162.1/107.4/135.9	mg/d	N	na	ADL	U	FD	10	w	30	w	JV	F	C	4	PHY	PHY	FDCV	WO	114.7	133	Y	2	Y	0.1167	57.3	66.5	10	10	5	5	7	4	10	10	10	4	75
41	6048	Gibson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	6	0/113.4/218.3/202.3/196.3/216.3	mg/d	N	na	ADL	U	FD	10	w	30	w	JV	F	C	3	PHY	PHY	FDCV	WO	113.4	218.3	Y	1.77	Y	0.1256	64.1	123	10	10	5	5	7	4	10	10	10	4	75
42	14538	Roberson and Schaible, 1960	Zinc oxide	100	Chicken (*Gallus domesticus*)	6	3	0/1000/1500	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	3	PHY	PHY	FDCV	WO	1000	1500	Y	0.497	N	0.03692	74.3	111	10	10	5	10	6	4	10	10	10	4	79
43	14538	Roberson and Schaible, 1960	Zinc sulfate	100	Chicken (*Gallus domesticus*)	5	3	0/1000/1500	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	3	PHY	PHY	FDCV	WO	1000	1500	Y	0.47	N	0.0356	75.7	114	10	10	5	10	6	4	10	10	10	4	79
44	8184	Stevenson et al, 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	9	0/0.5/0.75/1.0/1/.25/1.50/2.0/3.0/4.0	g/kg diet	N	na	ADL	U	FD	140	d	28	w	LB	F	C	3	PHY	PHY	FDCV	WO	1.25	1.5	Y	1.411	Y	0.094	83.3	99.9	10	10	5	5	7	4	10	10	10	4	75
45	8184	Stevenson et al, 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	9	0/0.5/0.75/1.00/1.25/1.5/2.0/3.0/4.0	g/kg diet	N	na	ADL	U	FD	140	d	28	w	JV	F	C	3	PHY	PHY	FDCV	WO	1.25	1.5	Y	1.411	Y	0.10	88.6	106	10	10	5	5	7	4	10	10	10	4	75
46	14538	Roberson and Schaible, 1960	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	4	0/1000/2000/3000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	3	PHY	PHY	FDCV	WO	2000	3000	Y	0.441	N	0.03415	155	232	10	10	5	10	6	4	10	10	10	4	79
47	14538	Roberson and Schaible, 1960	Zinc carbonate	100	Chicken (*Gallus domesticus*)	3	4	0/1000/2000/3000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	3	PHY	PHY	FDCV	WO	2000	3000	Y	0.407	N	0.03242	159	239	10	10	5	10	6	4	10	10	10	4	79
48	6039	Henry et al, 1987	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/500/1000/1500	mg/kg diet	N	na	ADL	U	FD	1	w	1	d	JV	M	C	3	PHY	PHY	FDCV	WO	1000		N	0.084	Y	0.0138	164		10	10	5	10	6	4	4	8	10	4	71
49	6368	Southern and Baker, 1983	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	3	0/2000/4000	mg/kg diet	N	na	ADL	U	FD	14	d	8	d	JV	M	C	2	PHY	PHY	FDCV	WO	2000	4000	Y	0.301	N	0.02664	177	354	10	10	5	10	6	4	10	10	10	4	79
50	6627	Oh et al, 1979	Zinc acetate	100	Chicken (*Gallus domesticus*)	1	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	NR	C	4	PHY	PHY	FDCV	WO	4000	8000	Y	0.714	Y	0.0449	252	503	10	10	5	5	7	4	10	10	10	4	75
51	5903	Lu and Combs, 1988	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	2	0/1000	mg/kg diet	N	na	ADL	U	FD	8	d	1	d	JV	NR	C	3	PHY	PHY	DIFD	WO		1000	N	0.328	Y	0.0071		21.6	10	10	5	5	6	4	4	10	10	4	68
52	14538	Roberson and Schaible, 1960	Zinc carbonate	100	Chicken (*Gallus domesticus*)	7	3	0/1000/1500	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	3	PHY	PHY	FDCV	WO		1000	Y	0.49	N	0.03658		74.7	10	10	5	10	6	4	4	10	10	4	73
53	2517	Bafundo et al, 1984	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/4000	mg/kg diet	N	na	ADL	U	FD	14	d	8	d	JV	M	C	3	PHY	PHY	FDCV	WO		4000	N	0.564	N	0.04009		284	10	10	5	10	5	4	4	10	10	4	72

Ref			Exposure																				Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Endpoint Number	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg/day or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
54	5373	Bartov, 1996	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	4	0/0.25/0.50/1.0	% in diet	N	na	ADL	U	FD	2	w	1	w	JV	F	C	3	PHY	PHY	FDCV	WO		0.25	Y	0.406	Y	0.0511		315	10	10	5	5	7	4	4	10	10	4	69
55	5373	Bartov, 1996	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	4	0/0.65/0.75/0.85	% in diet	N	na	ADL	U	FD	2	w	1	w	JV	F	C	3	PHY	PHY	FDCV	WO		0.65	Y	0.139	Y	0.0293		1370	10	10	5	5	7	4	4	10	10	4	69
Pathology																																													
56	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	6	0/55/105/125/159/148	mg/kg bw/d	N	na	ADL	U	FD	140	d	40	w	SM	F	C	5	PTH	ORW	ORWT	SP	55	105	Y	1.86	Y	na	55	105	10	10	5	5	7	4	10	10	10	4	75
57	392	Lefevre et al, 1982	Zinc chloride	100	Chicken (*Gallus domesticus*)	1	2	0/800	mg/kg diet	N	na	ADL	U	FD	5	w	1	d	JV	NR	C	5	PTH	ORW	ORWT	LU	800		Y	0.253	Y	0.02	63.2		10	10	5	10	7	4	4	3	10	4	67
58	6048	Gibson et al, 1986	Zinc acetate	100	Chicken (*Gallus domesticus*)	2	6	0/114.7/133/162.1/107.4/135.9	mg/d	N	na	ADL	U	FD	10	w	30	w	JV	F	C	5	PTH	ORW	SMIX	LI	133	162.1	Y	1.77	Y	0.0694	75.1	91.6	10	10	5	5	7	4	10	10	10	4	75
59	6048	Gibson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	6	0/113.4/218.3/202.3/196.3/216.3	mg/d	N	na	ADL	U	FD	10	w	30	w	JV	F	C	4	PTH	ORW	SMIX	LI	202.3	216.3	Y	1.69	Y	0.072	120	128	10	10	5	5	7	4	10	10	10	4	75
60	8184	Stevenson et al, 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	9	0/0.5/0.75/1.00/1.25/1.5/2.0/3.0/4.0	g/kg diet	N	na	ADL	U	FD	140	d	28	w	JV	F	C	5	PTH	ORW	SMIX	GZ	3	4	Y	1.726	Y	0.072	125	167	10	10	5	5	7	4	10	10	10	4	75
61	8184	Stevenson et al, 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	9	0/0.5/0.75/1.0/1/.25/1.50/2.0/3.0/4.0	g/kg diet	N	na	ADL	U	FD	140	d	28	w	JV	F	C	5	PTH	ORW	SMIX	GZ	2	3	Y	1.333	Y	0.086	129	194	10	10	5	5	7	4	10	10	10	4	75
62	5820	Stahl et al, 1989	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/2183	mg/kg diet	N	na	ADL	U	FD	20	d	1	d	JV	B	C	4	PTH	ORW	SMIX	LI		2183	N	0.564	Y	0.008		31.0	10	10	5	10	6	4	4	10	10	4	73
63	5820	Stahl et al, 1989	Zinc carbonate	100	Chicken (*Gallus domesticus*)	2	2	0/2171	mg/kg diet	N	na	ADL	U	FD	20	d	1	d	JV	B	C	4	PTH	ORW	SMIX	LI	2171		N	0.564	Y	0.0092		35.4	10	10	5	10	6	4	4	10	10	4	73
64	5903	Lu and Combs, 1988	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	na	ADL	U	FD	8	d	1	d	JV	NR	C	3	PTH	HIS	GHIS	PS		500	N	0.084	Y	0.00701		41.7	10	10	5	5	6	4	4	10	10	4	68
65	37018	Dewar et al, 1983	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	4	0/1000/2000/4000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	B	C	3	PTH	HIS	USTR	GZ		1000	Y	0.669	Y	0.0439		65.6	10	10	5	5	7	4	4	10	10	4	69
66	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	3	5	0/216/163/88/98	mg/kg bw/d	N	na	ADL	U	FD	3	w	40	w	SM	F	C	1	PTH	ORW	ORWT	LI		88	Y	1.62	Y	na		88	10	10	5	5	7	4	4	10	10	4	69
67	9261	Gasaway and Buss, 1972	Zinc carbonate	100	Mallard duck (*Anas platyrhynchos*	1	4	0/3000/6000/9000/12000	mg/kg diet	N	na	ADL	U	FD	10	d	7	w	JV	B	C	2	PTH	ORW	SMIX	AR		3000	N	1.2	Y	0.0504		126	10	10	5	10	6	4	4	10	10	4	73
68	37018	Dewar et al, 1983	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	4	0/2000/4000/6000	mg/kg diet	N	na	ADL	U	FD	4	w	2	w	JV	B	C	3	PTH	HIS	USTR	GZ		2000	Y	0.551	N	0.03948		143	10	10	5	5	6	4	4	10	10	4	68
69	37018	Dewar et al, 1983	Zinc oxide	100	Chicken (*Gallus domesticus*)	3	3	0/10000/20000	mg/kg diet	N	na	ADL	U	FD	4	d	18	mo	AD	F	C	3	PTH	HIS	USTR	GZ		10000	Y	1.6	Y	0.0255		159	10	10	5	5	7	4	4	10	10	4	69
70	5681	Dean et al, 1991	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/5280	mg/kg diet	N	na	ADL	M	FD	4	w	1	d	JV	M	C	4	PTH	HIS	GHIS	TY		5280	Y	0.35	Y	0.0132		199	10	10	10	5	7	4	4	10	10	4	74
71	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	5	0/367/480/505/325	mg/kg bw/d	N	na	ADL	U	FD	3	w	40	w	SM	F	C	5	PTH	ORW	ORWT	SP		367	Y	1.34	Y	na		367	10	10	5	5	7	4	4	10	10	4	69
72	80	Van Vleet et al, 1981	Zinc sulfate	100	Duck (*Anas platyrhynchos*)	2	2	0/3000	mg/kg diet	N	na	ADL	U	FD	15	d	1	d	JV	M	C	1	PTH	HIS	NCRO	PS		3000	N	0.092	N	0.01231		401	10	10	5	10	5	4	4	10	10	4	72
73	80	Van Vleet et al, 1981	Zinc sulfate	100	Duck (*Anas platyrhynchos*)	1	2	0/6000	mg/kg diet	N	na	ADL	U	FD	15	d	1	d	JV	M	C	1	PTH	HIS	NCRO	PS		6000	N	0.092	N	0.01231		803	10	10	5	10	5	4	4	10	10	4	72
74	7089	Berry and Brake, 1990	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/2	% in diet	N	na	ADL	U	FD	49	d	66	w	LB	F	C	2	PTH	ORW	SMIX	DT		2	N	1.6	N	0.07903		988	10	10	5	5	5	4	4	10	10	4	67
Reproduction																																													
75	48543	Kaya et al, 2001	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	5	0/200	mg/kg diet	N	na	ADL	U	FD	12	w	NR	NR	LB	F	C	2	REP	REP	PROG	WO	200		Y	1.8	Y	0.124	13.8		10	10	5	5	7	10	4	10	10	4	75
76	8798	Schisler and Kienholz, 1967	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/330	mg/kg diet	N	na	ADL	U	FD	14	w	48	w	LB	F	C	1	REP	REP	PROG	WO	330		Y	2.262	N	0.09901	14.4		10	10	5	10	6	10	4	1	10	4	70
77	9749	Jensen and Maurice, 1980	Zinc sulfate	100	Chicken (*Gallus domesticus*)	2	3	0/500/2000	mg/kg diet	N	na	ADL	U	FD	6	w	NR	NR	LB	F	C	1	REP	REP	PROG	WO	500	2000	N	1.6	N	0.07903	24.7	98.8	10	10	5	10	5	10	8	10	10	4	82
78	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	6	0/55/105/125/159/148	mg/kg bw/d	N	na	ADL	U	FD	140	d	40	w	LB	F	C	4	REP	REP	PROG	WO	55	105	Y	1.86	Y	na	55	105	10	10	5	5	7	10	10	10	10	4	81
79	6048	Gibson et al, 1986	Zinc acetate	100	Chicken (*Gallus domesticus*)	2	6	0/114.7/133/162.1/107.4/135.9	mg/d	N	na	ADL	U	FD	10	w	30	w	JV	F	C	3	REP	REP	PROG	WO	114.7	133	Y	2	Y	0.1167	57.3	66.5	10	10	5	5	7	10	10	10	10	4	81
80	8184	Stevenson et al, 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	9	0/0.5/0.75/1.00/1.25/1.5/2.0/3.0/4.0	g/kg diet	N	na	ADL	U	FD	140	d	28	w	JV	F	C	2	REP	REP	PROG	WO	1.25	1.5	Y	1.955	Y	0.1	63.9	76.7	10	10	5	5	7	10	10	10	10	4	81
81	6048	Gibson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	6	0/113.4/218.3/202.3/196.3/216.3	mg/d	N	na	ADL	U	FD	10	w	30	w	LB	F	C	2	REP	REP	PROG	WO	113.4	218.3	Y	1.77	Y	0.1256	64.1	123	10	10	5	5	7	10	10	10	10	4	81
82	8184	Stevenson et al, 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	9	0/0.5/0.75/1.0/1/.25/1.50/2.0/3.0/4.0	g/kg diet	N	na	ADL	U	FD	140	d	28	w	LB	F	C	2	REP	REP	PROG	WO	1	1.25	Y	1.371	Y	0.093	67.8	84.8	10	10	5	5	7	10	10	10	10	4	81
83	5764	Stahl, et al, 1990	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	3	0/200/2000	mg/kg diet	N	na	ADL	U	FD	12	w	56	w	LB	F	C	3	REP	REP	PROG	WO	2000		Y	2.057	Y	0.109	106		10	10	5	10	7	10	4	1	10	4	71
84	9261	Gasaway and Buss, 1972	Zinc carbonate	100	Mallard duck (*Anas platyrhynchos*	1	4	0/3000/6000/9000/12000	mg/kg diet	N	na	ADL	U	FD	60	d	7	w	JV	M	C	4	REP	REP	TEWT	TE		3000	N	1.2	Y	0.0125		31.2	10	10	5	10	6	10	4	10	10	4	79
85	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	3	5	0/216/163/88/98	mg/kg bw/d	N	na	ADL	U	FD	1	w	40	w	SM	F	C	1	REP	REP	PROG	WO		88	Y	1.62	Y	na		88	10	10	5	5	7	10	4	10	10	4	75
86	9749	Jensen and Maurice, 1980	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/2000	mg/kg diet	N	na	ADL	U	FD	6	w	NR	NR	LB	F	C	1	REP	REP	PROG	WO		2000	Y	1.523	N	0.07654		101	10	10	5	10	6	10	4	10	10	4	79
87	5770	Stepinska et al, 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/20000	mg/kg diet	N	na	ADL	U	FD	5	d	71	w	LB	F	C	1	REP	REP	PROG	WO		20000	Y	1.889	Y	0.0194		205	10	10	5	5	7	10	4	10	10	4	75
88	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	5	0/367/480/505/325	mg/kg bw/d	N	na	ADL	U	FD	1	w	40	w	LB	F	C	4	REP	REP	PROG	WO		367	Y	1.34	Y	na		367	10	10	5	5	7	10	4	10	10	4	75
89	6144	Berry and Brake, 1985	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/20000	mg/kg diet	N	na	ADL	U	FD	4	d	60	w	LB	F	C	3	REP	REP	RHIS	OD		20000	N	1.6	N	0.07903		988	10	10	5	5	5	10	4	10	10	4	73
90	7089	Berry and Brake, 1990	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/2	% in diet	N	na	ADL	U	FD	49	d	66	w	LB	F	C	1	REP	REP	RHIS	OD		2	N	1.6	N	0.07903		988	10	10	5	5	5	10	4	10	10	4	73
Growth																																													
91	8798	Schisler and Kienholz, 1967	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/330	mg/kg diet	N	na	ADL	U	FD	14	w	48	w	JV	F	C	2	GRO	GRO	BDWT	WO	330		Y	2.262	N	0.09901	14.4		10	10	5	10	6	8	4	1	10	4	68
92	5917	Baker and Halpin, 1988	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/318	mg/kg diet	N	na	ADL	M	FD	14	d	8	d	JV	M	C	1	GRO	GRO	BDWT	WO	318		N	0.564	Y	0.0266	15.0		10	10	10	10	6	8	4	1	10	4	73
93	5090	Mohanna and Nys, 1999	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/170	mg/kg diet	N	na	ADL	U	FD	16	d	5	d	JV	NR	C	1	GRO	GRO	BDWT	WO	170		N	0.580	Y	0.0548	16.1		10	10	5	10	6	8	4	1	10	4	68
94	6655	Hamilton et al, 1979	Zinc carbonate	100	Japanese quail (*Coturnix japonica*)	2	2	0/125	mg/kg diet	N	na	ADL	U	FD	14	d	0	d	JV	B	C	1	GRO	GRO	BDWT	WO	125		Y	0.0448	N	0.00771	21.5		10	10	5	10	6	8	4	10	10	7	80
95	1369	Hill, 1974	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	na	ADL	U	FD	3	w	1	d	JV	B	C	1	GRO	GRO	BDWT	WO	500		N	1.042	N	0.05978	28.7		10	10	5	10	5	8	4	10	10	4	76
96	5820	Stahl et al, 1989	Zinc carbonate	100	Chicken (*Gallus domesticus*)	2	2	0/2171	mg/kg diet	N	na	ADL	U	FD	20	d	1	d	JV	B	C	2	GRO	GRO	BDWT	WO	2171		N	0.564	Y	0.0092	35.4		10	10	5	10	6	8	4	1	10	4	68
97	5734	Hill, 1990	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/515	mg/kg diet	N	na	ADL	U	FD	19	d	1	d	JV	F	M	1	GRO	GRO	BDWT	WO	515		N	0.564	N	0.04009	36.6		10	10	5	10	5	8	4	10	10	4	76
98	6403	Hamilton et al, 1981	Zinc carbonate	100	Japanese quail (*Coturnix japonica*)	1	3	0/250/500	mg/kg diet	N	na	ADL	U	FD	14	d	1	d	JV	B	C	1	GRO	GRO	BDWT	WO	250	500	Y	0.044	N	0.00762	43.3	86.6	10	10	5	10	6	8	10	10	10	4	83
99	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	6	0/55/105/125/159/148	mg/kg bw/d	N	na	ADL	U	FD	140	d	40	w	SM	F	C	2	GRO	GRO	BDWT	WO	55	105	Y	2.18	Y	na	55	105	10	10	5	5	7	8	10	10	10	4	79
100	6887	Harland et al, 1975	Zinc carbonate	100	Japanese quail (*Coturnix japonica*)	1	2	0/250	mg/kg diet	N	na	ADL	U	FD	1	w	1	d	JV	B	C	2	GRO	GRO	BDWT	WO	250		Y	0.02205	N	0.005	55.1		10	10	5	10	6	8	4	10	10	4	77
101	93	Berg and Martinson, 1972	Zinc Oxide	100	Chicken (*Gallus domesticus*)	2	7	0/200/400/800/1200/1600/2000	mg/kg diet	N	na	ADL	U	FD	2	w	1	d	JV	NR	C	1	GRO	GRO	BDWT	WO	400	800	Y	0.084	N	0.0116	55.3	111	10	10	5	5	6	8	10	10	10	4	78
102	392	Lefevre et al, 1982	Zinc chloride	100	Chicken (*Gallus domesticus*)	1	2	0/800	mg/kg diet	N	na	ADL	U	FD	5	w	1	d	JV	NR	C	2	GRO	GRO	BDWT	WO	800		Y	0.253	Y	0.02	63.2		10	10	5	10	7	8	4	8	10	4	76
103	7245	Sandoval et al, 1998	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/500/1000/1500	mg/kg diet	N	na	ADL	U	FD	3	w	1	d	JV	M	C	1	GRO	GRO	BDWT	WO	1000	1500	Y	0.521	Y	0.0368	70.6	106	10	10	5	10	7	8	10	10	10	4	84
104	14538	Roberson and Schaible, 1960	Zinc oxide	100	Chicken (*Gallus domesticus*)	6	3	0/1000/1500	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	1	GRO	GRO	BDWT	WO	1000	1500	Y	0.497	N	0.03692	74.3	111	10	10	5	10	6	8	10	10	10	4	83
105	14538	Roberson and Schaible, 1960	Zinc carbonate	100	Chicken (*Gallus domesticus*)	7	3	0/1000/1500	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	1	GRO	GRO	BDWT	WO	1000	1500	Y	0.49	N	0.03658	74.7	112	10	10	5	10	6	8	10	10	10	4	83
106	14538	Roberson and Schaible, 1960	Zinc carbonate	100	Chicken (*Gallus domesticus*)	3	4	0/1000/2000/3000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	1	GRO	GRO	BDWT	WO	1000	2000	Y	0.483	N	0.03624	75.0	150	10	10	5	10	6	8	10	10	6	4	79

Ref			Exposure																				Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Endpoint Number	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg/day or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
107	14538	Roberson and Schaible, 1960	Zinc sulfate	100	Chicken (*Gallus domesticus*)	5	3	0/1000/1500	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	1	GRO	GRO	BDWT	WO	1000	1500	Y	0.47	N	0.0356	75.7	114	10	10	5	10	6	8	10	10	10	4	83
108	92	Hill, 1974	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	5	0/200/500/1000/2000	mg/kg diet	N	na	ADL	U	FD	2	w	1	d	JV	B	C	1	GRO	GRO	BDWT	WO	1000	2000	N	0.328	N	0.02817	85.9	172	10	10	5	10	5	8	10	10	10	4	82
109	6655	Hamilton et al, 1979	Zinc carbonate	100	Japanese quail (*Coturnix japonica*)	1	6	0/125/250/500/1000/2000	mg/kg diet	N	na	ADL	U	FD	14	d	8	d	JV	B	C	1	GRO	GRO	BDWT	WO	500	1000	Y	0.0436	N	0.00757	86.8	174	10	10	5	10	6	8	10	10	10	7	86
110	6039	Henry et al, 1987	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/500/1000/1500	mg/kg diet	N	na	ADL	U	FD	1	w	1	d	JV	M	C	1	GRO	GRO	BDWT	WO	500	1000	N	0.084	Y	0.0155	92.3	185	10	10	5	10	6	8	10	10	10	4	83
111	6048	Gibson et al, 1986	Zinc	100	Chicken (*Gallus domesticus*)	3	6	0/1/2/3/4/5	g/kg diet	N	na	ADL	U	FD	10	w	30	w	JV	F	C	1	GRO	GRO	BDWT	WO	2	3	Y	1.77	Y	0.0858	96.9	145	10	10	5	5	7	8	10	10	10	4	79
112	8184	Stevenson et al, 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	9	0/0.5/0.75/1.00/1.25/1.5/2.0/3.0/4.0	g/kg diet	N	na	ADL	U	FD	140	d	28	w	JV	F	C	4	GRO	GRO	BDWT	WO	2	3	Y	1.876	Y	0.093	99.1	149	10	10	5	5	7	8	10	10	10	4	79
113	5067	Sandoval et al, 1999	Zinc chloride	100	Chicken (*Gallus domesticus*)	3	2	0/1000	mg/kg diet	N	na	ADL	U	FD	7	d	14	d	JV	M	C	1	GRO	GRO	BDWT	WO	1000		N	0.564	Y	0.058	103		10	10	5	10	6	8	4	1	10	4	68
114	5067	Sandoval et al, 1999	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/1000	mg/kg diet	N	na	ADL	U	FD	7	d	14	d	JV	M	C	2	GRO	GRO	BDWT	WO	1000		N	0.564	Y	0.058	103		10	10	5	10	6	8	4	1	10	4	68
115	5764	Stahl, et al, 1990	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	3	0/200/2000	mg/kg diet	N	na	ADL	U	FD	44	w	24	w	LB	F	C	1	GRO	GRO	BDWT	WO	2000		Y	1.766	Y	0.114	129		10	10	5	10	7	8	4	1	10	4	69
116	8184	Stevenson et al, 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	9	0/0.5/0.75/1.0/1/.25/1.50/2.0/3.0/4.0	g/kg diet	N	na	ADL	U	FD	140	d	28	w	LB	F	C	4	GRO	GRO	BDWT	WO	2	3	Y	1.333	Y	0.086	129	194	10	10	5	5	7	8	10	10	10	4	79
117	2517	Bafundo et al, 1984	Zinc carbonate	100	Chicken (*Gallus domesticus*)	2	2	0/2000	mg/kg diet	N	na	ADL	U	FD	14	d	8	d	JV	F	C	1	GRO	GRO	BDWT	WO	2000		N	0.564	N	0.04009	142		10	10	5	10	5	8	4	1	10	4	67
118	37018	Dewar et al, 1983	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	4	0/1000/2000/4000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	B	C	1	GRO	GRO	BDWT	WO	2000	4000	Y	0.615	Y	0.0439	143	286	10	10	5	5	7	8	10	10	10	4	79
119	14404	Vohra and Kratzer, 1968	Zinc oxide	100	Turkey (*Meleagris gallopavo*)	1	7	0/1000/2000/4000/5950/8000/10000	mg/kg diet	N	na	ADL	U	FD	21	d	NR	NR	JV	B	C	1	GRO	GRO	BDWT	WO	2000	4000	N	0.5	N	0.03706	148	297	10	10	5	5	5	8	10	10	10	4	77
120	14538	Roberson and Schaible, 1960	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	4	0/1000/2000/3000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	1	GRO	GRO	BDWT	WO	2000	3000	Y	0.441	N	0.03415	155	232	10	10	5	10	6	8	10	10	10	4	83
121	14538	Roberson and Schaible, 1960	Zinc sulfate	100	Chicken (*Gallus domesticus*)	4	4	0/1000/2000/3000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	1	GRO	GRO	BDWT	WO	2000	3000	Y	0.419	N	0.03304	158	237	10	10	5	10	6	8	10	10	10	4	83
122	6368	Southern and Baker, 1983	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	3	0/2000/4000	mg/kg diet	N	na	ADL	U	FD	14	d	8	d	JV	M	C	1	GRO	GRO	BDWT	WO	2000	4000	Y	0.301	N	0.02664	177	354	10	10	5	10	6	8	10	10	10	4	83
123	6627	Oh et al, 1979	Zinc acetate	100	Chicken (*Gallus domesticus*)	1	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	NR	C	2	GRO	GRO	BDWT	WO	4000	8000	Y	0.714	Y	0.0449	252	503	10	10	5	5	7	8	10	10	10	4	79
124	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	5	0/367/480/505/325	mg/kg bw/d	N	na	ADL	U	FD	1	w	40	w	SM	F	C	2	GRO	GRO	BDWT	WO	367	480	Y	1.34	Y	na	367	480	10	10	5	5	7	8	10	10	10	4	79
125	5903	Lu and Combs, 1988	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	2	0/1000	mg/kg diet	N	na	ADL	U	FD	15	d	1	d	JV	NR	C	1	GRO	GRO	BDWT	WO		1000	N	0.328	Y	0.0071		21.6	10	10	5	5	6	8	4	10	10	4	72
126	5820	Stahl et al, 1989	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/2183	mg/kg diet	N	na	ADL	U	FD	20	d	1	d	JV	B	C	2	GRO	GRO	BDWT	WO		2183	N	0.564	Y	0.008		31.0	10	10	5	10	6	8	4	10	10	4	77
127	5866	Lu and Combs, 1988	zinc oxide	100	Chicken (*Gallus domesticus*)	2	2	0/1000	mg/kg diet	N	na	ADL	U	FD	6	d	20	d	JV	NR	C	1	GRO	GRO	BDWT	WO		1000	Y	0.000564	Y	0.022		39.0	10	10	5	5	7	8	4	10	10	4	73
128	8008	Lu et al, 1990	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	na	ADL	U	FD	7	d	14	d	JV	B	C	2	GRO	GRO	BDWT	WO		500	N	1.042	Y	0.137		65.7	10	10	5	5	6	8	4	10	10	4	72
129	6133	Jackson et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	3	5	0/216/163/88/98	mg/kg bw/d	N	na	ADL	U	FD	21	d	40	w	SM	F	C	1	GRO	GRO	BDWT	WO		88	Y	1.62	Y	na		88	10	10	5	5	7	8	4	10	10	4	73
130	9749	Jensen and Maurice, 1980	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/2000	mg/kg diet	N	na	ADL	U	FD	6	w	NR	NR	SM	F	C		GRO	GRO	BDWT	WO		2000	Y	1.523	N	0.07654		101	10	10	5	10	6	8	4	10	10	4	77
131	9261	Gasaway and Buss, 1972	Zinc carbonate	100	Mallard duck (*Anas platyrhynchos*)	1	4	0/3000/6000/9000/12000	mg/kg diet	N	na	ADL	U	FD	10	d	7	w	JV	B	C	3	GRO	GRO	BDWT	WO		3000	N	1.2	Y	0.0504		126	10	10	5	10	6	8	4	10	10	4	77
132	5617	Pimentel et al, 1992	Zinc	100	Chicken (*Gallus domesticus*)	1	2	0/1549.3	mg/kg diet	N	na	ADL	M	FD	3	w	1	d	JV	B	C	1	GRO	GRO	BDWT	WO		1549.3	Y	0.1217	Y	0.0104		132	10	10	10	4	7	8	4	10	10	4	77
133	37018	Dewar et al, 1983	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	4	0/2000/4000/6000	mg/kg diet	N	na	ADL	U	FD	4	w	2	w	JV	B	C	1	GRO	GRO	BDWT	WO		2000	Y	0.551	N	0.03948		143	10	10	5	5	6	8	4	10	10	4	72
134	93	Berg and Martinson, 1972	Zinc Oxide	100	Chicken (*Gallus domesticus*)	1	2	0/2000	mg/kg diet	N	na	ADL	U	FD	2	w	1	d	JV	NR	C	1	GRO	GRO	BDWT	WO		2000	Y	0.109	N	0.01375		252	10	10	5	5	6	8	4	10	10	4	72
135	6273	Bafundo et al, 1984	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/2000	mg/kg diet	N	na	ADL	U	FD	14	d	8	d	JV	M	C	1	GRO	GRO	BDWT	WO		2000	N	0.244	N	0.0116		190	10	10	5	10	5	8	4	10	10	4	76
136	2517	Bafundo et al, 1984	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/4000	mg/kg diet	N	na	ADL	U	FD	14	d	8	d	JV	M	C	2	GRO	GRO	BDWT	WO		4000	N	0.564	N	0.04009		284	10	10	5	10	5	8	4	10	10	4	76
137	5373	Bartov, 1996	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	4	0/0.25/0.50/1.0	% in diet	N	na	ADL	U	FD	2	w	1	w	JV	F	C	1	GRO	GRO	BDWT	WO		0.25	Y	0.406	Y	0.0511		315	10	10	5	5	7	8	4	10	10	4	73
138	6435	Rama and Planas, 1981	Zinc	100	Chicken (*Gallus domesticus*)	1	2	0/5000	mg/kg diet	N	na	ADL	U	FD	9	w	1	d	JV	NR	C	1	GRO	GRO	BDWT	WO		5000	N	0.32	N	0.02772		433	10	10	5	4	5	8	4	10	10	4	70
139	5681	Dean et al, 1991	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/5280	mg/kg diet	N	na	ADL	M	FD	1	w	1	d	JV	M	C	1	GRO	GRO	BDWT	WO		5280	Y	0.09	Y	0.0129		757	10	10	10	5	7	8	4	10	10	4	78
140	7956	Bartov et al, 1994	Zinc Oxide	100	Chicken (*Gallus domesticus*)	1	3	0/0.7/0.8	% in diet	N	na	ADL	U	FD	2	w	1	w	JV	F	C	1	GRO	GRO	BDWT	WO		0.7	Y	0.245	Y	0.032		914	10	10	5	5	7	8	4	10	10	4	73
141	6545	Palafox and Ho-A, 1980	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/20	mg/g diet	N	na	ADL	U	FD	5	d	38	w	JV	F	C	1	GRO	GRO	BDWT	WO		20	N	1.6	N	0.07903		988	10	10	5	5	5	8	4	10	10	4	71
142	5373	Bartov, 1996	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	4	0/0.65/0.75/0.85	% in diet	N	na	ADL	U	FD	2	w	1	w	JV	F	C	1	GRO	GRO	BDWT	WO		0.65	Y	0.139	Y	0.0293		1370	10	10	5	5	7	8	4	10	10	4	73
Survival																																													
143	6655	Hamilton et al, 1979	Zinc carbonate	100	Japanese quail (*Coturnix japonica*)	2	2	0/125	mg/kg diet	N	na	ADL	U	FD	14	d	0	d	JV	B	C	2	MOR	MOR	MORT	WO	125		Y	0.0448	N	0.00771	21.5		10	10	5	10	6	9	4	10	10	7	81
144	5820	Stahl et al, 1989	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/2183	mg/kg diet	N	na	ADL	U	FD	20	d	1	d	JV	B	C	1	MOR	MOR	MORT	WO	2183		N	0.564	Y	0.008	31.0		10	10	5	10	6	9	4	10	10	4	78
145	5820	Stahl et al, 1989	Zinc carbonate	100	Chicken (*Gallus domesticus*)	2	2	0/2171	mg/kg diet	N	na	ADL	U	FD	20	d	1	d	JV	B	C	1	MOR	MOR	MORT	WO	2171		N	0.564	Y	0.0092	35.4		10	10	5	10	6	9	4	10	10	4	78
146	6887	Harland et al, 1975	Zinc carbonate	100	Japanese quail (*Coturnix japonica*)	1	2	0/250	mg/kg diet	N	na	ADL	U	FD	1	w	1	d	JV	B	C	1	MOR	MOR	MORT	WO	250		Y	0.02205	N	0.005	55.1		10	10	5	10	6	9	4	10	10	4	78
147	392	Lefevre et al, 1982	Zinc chloride	100	Chicken (*Gallus domesticus*)	1	2	0/800	mg/kg diet	N	na	ADL	U	FD	5	w	1	d	JV	NR	C	1	MOR	MOR	MORT	WO	800		Y	0.253	Y	0.02	63.2		10	10	5	10	7	9	4	10	10	4	79
148	6048	Gibson et al, 1986	Zinc acetate	100	Chicken (*Gallus domesticus*)	2	6	0/114.7/133/162.1/107.4/135.9	mg/d	N	na	ADL	U	FD	10	w	30	w	JV	F	C	1	MOR	MOR	MORT	WO	107.4	135.9	Y	1.56	Y	0.0381	68.8	87.1	10	10	5	5	7	9	10	10	10	4	80
149	14538	Roberson and Schaible, 1960	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	10	0/200/300/400/500/600/700/800/900/1000	mg/kg diet	N	na	ADL	U	FD	4	w	1	w	JV	M	C	2	MOR	MOR	SURV	WO	1000		Y	0.473	N	0.03575	75.6		10	10	5	5	6	9	4	10	10	4	73
150	6403	Hamilton et al, 1981	Zinc carbonate	100	Japanese quail (*Coturnix japonica*)	1	3	0/250/500	mg/kg diet	N	na	ADL	U	FD	14	d	1	d	JV	B	C	3	MOR	MOR	MORT	WO	500		Y	0.04	N	0.00716	89.5		10	10	5	10	6	9	4	10	10	4	78
151	5868	Blalock and Hill, 1988	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	3	0/1000/2000	mg/kg diet	N	na	ADL	U	FD	12	d	1	d	JV	F	C	2	MOR	MOR	MORT	WO	1000	2000	Y	0.164	N	0.01794	109	219	10	10	5	5	6	9	10	10	10	4	79
152	14538	Roberson and Schaible, 1960	Zinc oxide	100	Chicken (*Gallus domesticus*)	6	3	0/1000/1500	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	2	MOR	MOR	SURV	WO	1500		Y	0.455	N	0.03486	115		10	10	5	10	6	9	4	10	10	4	78
153	14538	Roberson and Schaible, 1960	Zinc sulfate	100	Chicken (*Gallus domesticus*)	5	3	0/1000/1500	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	2	MOR	MOR	SURV	WO	1500		N	0.402	N	0.03216	120		10	10	5	10	5	9	4	10	10	4	77
154	14538	Roberson and Schaible, 1960	Zinc carbonate	100	Chicken (*Gallus domesticus*)	7	3	0/1000/1500	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	2	MOR	MOR	SURV	WO	1500		Y	0.39	N	0.03153	121		10	10	5	10	6	9	4	10	10	4	78
155	37018	Dewar et al, 1983	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	4	0/1000/2000/4000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	B	C	2	MOR	MOR	MORT	WO	2000	4000	Y	0.615	Y	0.0439	143	286	10	10	5	5	7	9	10	10	10	4	80
156	14538	Roberson and Schaible, 1960	Zinc carbonate	100	Chicken (*Gallus domesticus*)	3	4	0/1000/2000/3000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	2	MOR	MOR	SURV	WO	2000	3000	Y	0.407	N	0.03242	159	239	10	10	5	10	6	9	10	10	10	4	84
157	92	Hill, 1974	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	5	0/200/500/1000/2000	mg/kg diet	N	na	ADL	U	FD	5	w	1	d	JV	B	C	2	MOR	MOR	MORT	WO	2000		N	0.328	N	0.02817	172		10	10	5	10	5	9	4	1	10	4	68
158	6655	Hamilton et al, 1979	Zinc carbonate	100	Japanese quail (*Coturnix japonica*)	1	6	0/125/250/500/1000/2000	mg/kg diet	N	na	ADL	U	FD	14	d	0	d	JV	B	C	2	MOR	MOR	MORT	WO	1000	2000	Y	0.0374	N	0.00685	183	366	10	10	5	10	6	9	10	10	10	7	87
159	6627	Oh et al, 1979	Zinc acetate	100	Chicken (*Gallus domesticus*)	1	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	NR	C	1	MOR	MOR	MORT	WO	4000	8000	Y	0.714	Y	0.0449	252	503	10	10	5	5	7	9	10	10	10	4	80
160	14538	Roberson and Schaible, 1960	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	4	0/1000/2000/3000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	2	MOR	MOR	SURV	WO	3000		Y	0.337	N	0.02867	255		10	10	5	10	6	9	4	10	10	4	78
161	14538	Roberson and Schaible, 1960	Zinc sulfate	100	Chicken (*Gallus domesticus*)	4	4	0/1000/2000/3000	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	M	C	2	MOR	MOR	SURV	WO	3000		Y	0.282	N	0.02553	272		10	10	5	10	6	9	4	10	10	4	78

Ref			Exposure																				Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Endpoint Number	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg/day or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
162	37018	Dewar et al, 1983	Zinc oxide	100	Chicken (*Gallus domesticus*)	3	3	0/10000/20000	mg/kg diet	N	na	ADL	U	FD	4	d	18	mo	AD	F	C	1	MOR	MOR	MORT	WO	20000		N	1.6	Y	0.0255	319		10	10	5	5	6	9	4	10	6	4	69
163	1369	Hill, 1974	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	na	ADL	U	FD	3	w	1	d	JV	B	C	2	MOR	MOR	MORT	WO	500		N	0.001042	N	0.00067	320		10	10	5	10	5	9	4	1	10	4	68
164	37018	Dewar et al, 1983	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	4	0/2000/4000/6000	mg/kg diet	N	na	ADL	U	FD	4	w	2	w	JV	B	C	2	MOR	MOR	MORT	WO	4000	6000	Y	0.377	N	0.03084	327	491	10	10	5	5	6	9	10	10	10	4	79
165	14404	Vohra and Kratzer, 1968	Zinc oxide	100	Turkey (*Meleagris gallopavo*)	1	7	0/1000/2000/4000/5950/8000/10000	mg/kg diet	N	na	ADL	U	FD	21	d	NR	NR	JV	B	C	2	MOR	MOR	MORT	WO	10000		N	0.5	N	0.03706	741		10	10	5	5	5	9	4	10	10	4	72
166	9261	Gasaway and Buss, 1972	Zinc carbonate	100	Mallard duck (*Anas platyrhynchos*)	1	4	0/3000/6000/9000/12000	mg/kg diet	N	na	ADL	U	FD	30	d	7	w	JV	B	C	2	MOR	MOR	MORT	WO		3000	N	1.2	Y	0.0504		126	10	10	5	10	6	9	4	10	10	4	78
167	80	Van Vleet et al, 1981	Zinc sulfate	100	Duck (*Anas platyrhynchos*)	2	2	0/3000	mg/kg diet	N	na	ADL	U	FD	15	d	1	d	JV	M	C	2	MOR	MOR	MORT	WO		3000	N	0.092	N	0.01231		401	10	10	5	10	5	9	4	10	10	4	77
168	80	Van Vleet et al, 1981	Zinc sulfate	100	Duck (*Anas platyrhynchos*)	1	2	0/6000	mg/kg diet	N	na	ADL	U	FD	15	d	1	d	JV	M	C	3	MOR	MOR	MORT	WO		6000	N	0.092	N	0.01231		803	10	10	5	10	5	9	4	10	10	4	77
Data Not Used to Derive TRV																																													
169	48543	Kaya et al, 2001	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	5	0/200	mg/kg diet	N	na	ADL	U	FD	12	w	NR	NR	AD	F	C	3	BEH	FDB	FCNS	WO	200		N	1.8	Y	0.124	13.8		10	10	5	5	6	4	4	10	6	4	64
170	48543	Kaya et al, 2001	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	5	0/200	mg/kg diet	N	na	ADL	U	FD	12	w	NR	NR	AD	F	C	1	PTH	GRS	BDWT	WO	200		Y	1.8	Y	0.124	13.8		10	10	5	5	7	4	4	10	6	4	65
171	48543	Kaya et al, 2001	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	5	0/200	mg/kg diet	N	na	ADL	U	FD	12	w	NR	NR	AD	F	C	4	PHY	PHY	FDCV	WO	200		Y	1.8	Y	0.124	13.8		10	10	5	5	7	4	4	6	6	4	61
172	5090	Mohanna and Nys, 1999	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/170	mg/kg diet	N	na	ADL	U	FD	16	d	5	d	JV	NR	C	3	PHY	PHY	FDCV	WO	170		N	0.580	Y	0.0548	16.1		10	10	5	10	6	4	4	1	10	4	64
173	5090	Mohanna and Nys, 1999	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/170	mg/kg diet	N	na	ADL	U	FD	16	d	5	d	JV	NR	C	2	BEH	FDB	FCNS	WO	170		N	0.58	Y	0.0548	16.1		10	10	5	10	6	4	4	1	10	4	64
174	5820	Stahl et al, 1989	Zinc carbonate	100	Chicken (*Gallus domesticus*)	2	2	0/2171	mg/kg diet	N	na	ADL	U	FD	20	d	1	d	JV	B	C	3	BEH	FDB	FCNS	WO	2171		N	0.564	Y	0.0092	35.4		10	10	5	10	6	4	4	1	10	4	64
175	5903	Lu and Combs, 1988	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	na	ADL	U	FD	8	d	1	d	JV	NR	C	1	GRO	GRO	BDWT	WO	500		N	0.084	Y	0.00701	41.7		10	10	5	5	6	8	4	1	10	4	63
176	5903	Lu and Combs, 1988	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	na	ADL	U	FD	8	d	1	d	JV	NR	C	2	BEH	FDB	FCNS	WO	500		N	0.084	Y	0.00701	41.7		10	10	5	5	6	4	4	1	10	4	59
177	14531	Mehring et al, 1956	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	6	0/168/252/371/540/778	mg/kg diet	N	na	ADL	U	FD	5	w	4	w	JV	B	C	1	GRO	GRO	BDWT	WO	778		Y	1.1953	N	0.06537	42.5		10	10	5	5	6	8	4	1	10	4	63
178	14531	Mehring et al, 1956	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	6	0/168/252/371/540/778	mg/kg diet	N	na	ADL	U	FD	5	w	4	w	JV	B	C	2	PHY	PHY	FDCV	WO	778		Y	1.1953	N	0.06537	42.5		10	10	5	5	6	4	4	1	3	4	52
179	5841	Hill, 1989	Zinc sulfate hepathydrate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	na	ADL	U	FD	10	d	1	d	JV	F	C	2	BIO	CHM	HMCT	BL	500		Y	0.328	N	0.02817	42.9		10	10	5	10	6	1	4	1	10	4	61
180	8008	Lu et al, 1990	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	na	ADL	U	FD	7	d	14	d	JV	B	C	1	BEH	FDB	FCNS	WO	500		N	1.042	Y	0.137	65.7		10	10	5	5	6	4	4	1	10	4	59
181	5067	Sandoval et al, 1999	Zinc chloride	100	Chicken (*Gallus domesticus*)	3	2	0/1000	mg/kg diet	N	na	ADL	U	FD	7	d	14	d	JV	M	C	3	PHY	PHY	FDCV	WO	1000		N	0.564	N	0.04009	71.1		10	10	5	10	5	4	4	1	10	4	63
182	5067	Sandoval et al, 1999	Zinc chloride	100	Chicken (*Gallus domesticus*)	3	2	0/1000	mg/kg diet	N	na	ADL	U	FD	7	d	14	d	JV	M	C	2	BEH	FDB	FCNS	WO	1000		N	0.564	N	0.04009	71.1		10	10	5	10	5	4	4	1	10	4	63
183	5247	Sandoval et al, 1997	Zinc oxide	100	Chicken (*Gallus domesticus*)	3	4	0/400/800/1200	mg/kg diet	N	na	ADL	U	FD	20	d	1	d	JV	B	C	1	BEH	FDB	FCNS	WO	1200		N	0.564	Y	0.0346	73.6		10	10	5	5	6	4	4	1	10	4	59
184	14538	Roberson and Schaible, 1960	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	10	0/200/300/400/500/600/700/800/900/1000	mg/kg diet	N	na	ADL	U	FD	4	w	1	w	JV	M	C	1	GRO	GRO	BDWT	WO	1000		Y	0.473	N	0.03575	75.6		10	10	5	5	6	8	4	1	10	4	63
185	14538	Roberson and Schaible, 1960	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	10	0/200/300/400/500/600/700/800/900/1000	mg/kg diet	N	na	ADL	U	FD	4	w	1	w	JV	M	C	3	PHY	PHY	FDCV	WO	1000		Y	0.473	N	0.03575	75.6		10	10	5	5	6	4	4	1	10	4	59
186	5247	Sandoval et al, 1997	Zinc carbonate	100	Chicken (*Gallus domesticus*)	2	4	0/400/800/1200	mg/kg diet	N	na	ADL	U	FD	20	d	1	d	JV	B	C	1	BEH	FDB	FCNS	WO	1200		N	0.564	Y	0.0361	76.8		10	10	5	10	6	4	4	1	10	4	64
187	5247	Sandoval et al, 1997	Zinc metal	100	Chicken (*Gallus domesticus*)	4	4	0/400/800/1200	mg/kg diet	N	na	ADL	U	FD	20	d	1	d	JV	B	C	1	BEH	FDB	FCNS	WO	1200		N	0.564	Y	0.0393	83.6		10	10	5	10	6	4	4	1	10	4	64
188	5067	Sandoval et al, 1999	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/1000	mg/kg diet	N	na	ADL	U	FD	7	d	14	d	JV	M	C	3	PHY	PHY	FDCV	WO	1000		Y	0.564	Y	0.058	103		10	10	5	10	7	4	4	1	10	4	65
189	5067	Sandoval et al, 1999	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/1000	mg/kg diet	N	na	ADL	U	FD	7	d	14	d	JV	M	C	1	BEH	FDB	FCNS	WO	1000		Y	0.564	Y	0.058	103		10	10	5	10	7	4	4	1	10	4	65
190	7245	Sandoval et al, 1998	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/500/1000/1500	mg/kg diet	N	na	ADL	U	FD	3	w	1	d	JV	M	C	2	BEH	FDB	FCNS	WO	1500		Y	0.49	Y	0.0342	105		10	10	5	10	7	4	4	1	10	4	65
191	5067	Sandoval et al, 1999	Zinc acetate	100	Chicken (*Gallus domesticus*)	2	2	0/1000	mg/kg diet	N	na	ADL	U	FD	7	d	14	d	JV	M	C	1	GRO	GRO	BDWT	WO	1000		N	0.564	Y	0.065	115		10	10	5	5	6	8	4	1	10	4	63
192	5067	Sandoval et al, 1999	Zinc acetate	100	Chicken (*Gallus domesticus*)	2	2	0/1000	mg/kg diet	N	na	ADL	U	FD	7	d	14	d	JV	M	C	3	PHY	PHY	FDCV	WO	1000		N	0.564	Y	0.065	115		10	10	5	5	6	4	4	1	10	4	59
193	5067	Sandoval et al, 1999	Zinc acetate	100	Chicken (*Gallus domesticus*)	2	2	0/1000	mg/kg diet	N	na	ADL	U	FD	7	d	14	d	JV	M	C	2	BEH	FDB	FCNS	WO	1000		N	0.564	Y	0.065	115		10	10	5	5	6	4	4	1	10	4	59
194	5764	Stahl, et al, 1990	Zinc sulfate	100	Chicken (*Gallus domesticus*)	1	3	0/200/2000	mg/kg diet	N	na	ADL	U	FD	69	d	24	w	LB	F	C	2	BEH	FDB	FCNS	WO	2000		Y	1.766	Y	0.114	129		10	10	5	10	7	4	4	1	10	4	65
195	2517	Bafundo et al, 1984	Zinc carbonate	100	Chicken (*Gallus domesticus*)	2	2	0/2000	mg/kg diet	N	na	ADL	U	FD	14	d	8	d	JV	F	C	2	PHY	PHY	FDCV	WO	2000		N	0.564	N	0.04009	142		10	10	5	10	5	4	4	1	10	4	63
196	6840	Kincaid, et al, 1976	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	4	0/600/1200/2400	mg/kg diet	N	na	ADL	U	FD	4	w	1	d	JV	B	C	1	GRO	GRO	BDWT	WO	2400		Y	0.633	N	0.04322	164		10	10	5	5	6	8	4	1	10	4	63
197	5681	Dean et al, 1991	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/5280	mg/kg diet	N	na	ADL	M	FD	4	w	1	d	JV	M	C	2	BEH	FDB	FCNS	WO	5280		Y	0.35	Y	0.0132	199		10	10	10	5	7	4	4	1	10	4	65
198	5868	Blalock and Hill, 1988	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	3	0/1000/2000	mg/kg diet	N	na	ADL	U	FD	12	d	1	d	JV	F	C	1	GRO	GRO	BDWT	WO	2000		Y	0.13	N	0.01542	237		10	10	5	5	6	8	4	1	10	4	63
199	93	Berg and Martinson, 1972	Zinc Oxide	100	Chicken (*Gallus domesticus*)	3	4	0/400/1200/2000	mg/kg diet	N	na	ADL	U	FD	2	w	1	d	JV	NR	C	1	GRO	GRO	BDWT	WO	2000		Y	0.113	N	0.01408	249		10	10	5	5	6	8	4	1	10	4	63
200	93	Berg and Martinson, 1972	Zinc Oxide	100	Chicken (*Gallus domesticus*)	3	4	0/400/1200/2000	mg/kg diet	N	na	ADL	U	FD	2	w	1	d	JV	NR	C	2	BIO	CHM	ASHC	BO	2000		Y	0.113	N	0.01408	249		10	10	5	5	6	1	4	1	10	4	56
201	6273	Bafundo et al, 1984	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/2000	mg/kg diet	N	na	ADL	U	FD	14	d	8	d	JV	M	C	3	BIO	CHM	HMGL	BL	2000		N	0.244	N	0.0116	190		10	10	5	10	5	1	4	1	10	4	60
202	6273	Bafundo et al, 1984	Zinc carbonate	100	Chicken (*Gallus domesticus*)	1	2	0/2000	mg/kg diet	N	na	ADL	U	FD	14	d	8	d	JV	M	C	2	PHY	PHY	FDCV	WO	2000		N	0.244	N	0.0116	190		10	10	5	10	5	4	4	1	10	4	63
203	80	Van Vleet et al, 1981	Zinc sulfate	100	Duck (*Anas platyrhynchos*)	2	2	0/3000	mg/kg diet	N	na	ADL	U	FD	15	d	1	d	JV	M	C	3	BIO	ENZ	GLPX	BL	3000		N	0.092	N	0.01231	401		10	10	5	10	5	1	4	3	10	4	62
204	1624	Wight et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/20000	mg/kg diet	N	na	ADL	U	FD	5	d	NR	NR	SM	F	C	3	PTH	HIS	GHIS	GZ	20000		N	1.3	Y	0.0336	517		10	10	5	5	6	4	4	1	10	4	59
205	6144	Berry and Brake, 1985	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/20000	mg/kg diet	N	na	ADL	U	FD	7	d	60	w	AD	F	C	4	MOR	MOR	MORT	WO	20000		N	1.6	N	0.07903	988		10	10	5	5	5	9	4	10	3	4	65
206	6735	Kalamah et al, 1995	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/20000	mg/kg diet	N	na	ADL	U	FD	7	d	50	w	LB	F	C	1	REP	REP	PROG	WO	20000		N	1.6	N	0.07903	988		10	10	5	5	5	10	4	1	10	4	64
207	6735	Kalamah et al, 1995	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	2	0/20000	mg/kg diet	N	na	ADL	U	FD	7	d	50	w	LB	F	C	1	REP	REP	PROG	WO	20000		N	1.6	N	0.07903	988		10	10	5	5	5	10	4	1	10	4	64
208	6144	Berry and Brake, 1985	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/20000	mg/kg diet	N	na	ADL	U	FD	4	d	60	w	AD	F	C	2	PTH	ORW	ORWT	LI	20000		N	1.6	N	0.07903	988		10	10	5	5	5	4	4	10	3	4	60
209	8181	Berry et al., 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	3	0/20000	mg/kg diet	N	na	ADL	U	FD	4	d	1	yr	AD	F	C	1	MOR	MOR	MORT	WO	20000		N	1.6	N	0.07903	988		10	10	5	5	5	9	4	10	3	4	65
210	2196	Lesson and Summers, 1982	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	4	0/200/400/800	mg/kg diet	N	na	ADL	U	FD	21	d	1	d	JV	M	C	1	GRO	GRO	BDWT	WO	800		N	0.564	Y	0.7363	1044		10	10	5	5	6	8	4	1	10	4	63
211	2196	Lesson and Summers, 1982	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	4	0/200/400/800	mg/kg diet	N	na	ADL	U	FD	21	d	1	d	JV	M	C	3	PHY	PHY	FDCV	WO	800		N	0.564	Y	0.7366	1045		10	10	5	5	6	4	4	1	10	4	59
212	2196	Lesson and Summers, 1982	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	4	0/200/400/800	mg/kg diet	N	na	ADL	U	FD	21	d	1	d	JV	M	C	2	BEH	FDB	FCNS	WO	800		N	0.564	Y	0.7366	1045		10	10	5	5	6	4	4	1	10	4	59
213	48543	Kaya et al, 2001	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	5	0/200	mg/kg diet	N	na	ADL	U	FD	12	w	NR	NR	AD	F	C	5	BIO	CHM	PCON	PL		200	Y	1.85	Y	0.124		13.4	10	10	5	5	7	1	4	10	6	4	62
214	5866	Lu and Combs, 1988	zinc oxide	100	Chicken (*Gallus domesticus*)	1	10	0/200/300/400/500/600/800/1000/2000	mg/kg diet	N	na	ADL	U	FD	14	d	1	d	JV	NR	C	1	BIO	CHM	GBCM	PL		200	N	0.328	N	0.02817		17.2	10	10	5	5	5	1	4	10	10	4	64
215	5530	Mandour and Korshom, 1992	Zinc	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	na	ADL	U	FD	2	w	14	w	JV	B	C	1	BIO	CHM	CHOL	SR		500	N	1.6	N	0.07903		24.7	10	10	5	4	5	1	4	10	10	4	63
216	5903	Lu and Combs, 1988	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	na	ADL	U	FD	8	d	1	d	JV	NR	C	4	BIO	ENZ	GENZ	PS		500	N	0.084	Y	0.00701		41.7	10	10	5	5	6	1	4	10	10	4	65

Ref			Exposure																				Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Endpoint Number	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg/day or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
217	5903	Lu and Combs, 1988	Zinc oxide	100	Chicken (*Gallus domesticus*)	3	10	0/200/300/400/500/600/800/1000	mg/kg diet	N	na	ADL	U	FD	14	d	1	d	JV	NR	C	1	BIO	ENZ	GENZ	PS		1000	N	0.328	N	0.02817		85.9	10	10	5	5	5	1	4	10	10	4	64
218	5868	Blalock and Hill, 1988	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	3	0/1000/2000	mg/kg diet	N	na	ADL	U	FD	12	d	1	d	JV	F	C	3	BIO	CHM	HMGL	BL		1000	Y	0.164	N	0.01794		109	10	10	5	5	6	1	4	10	10	4	65
219	7245	Sandoval et al, 1998	Zinc acetate	100	Chicken (*Gallus domesticus*)	2	2	0/1000	mg/kg diet	N	na	ADL	U	FD	1	w	1	d	JV	F	C	1	BIO	CHM	MCPR	LI		1000	N	0.084	N	0.0116		138	10	10	5	5	5	1	4	10	10	4	64
220	93	Berg and Martinson, 1972	Zinc Oxide	100	Chicken (*Gallus domesticus*)	1	2	0/2000	mg/kg diet	N	na	ADL	U	FD	2	w	1	d	JV	NR	C	2	BIO	CHM	ASHC	BO		2000	Y	0.109	N	0.01375		252	10	10	5	5	6	1	4	10	10	4	65
221	5619	Pimentel et al, 1992	Zinc	100	Chicken (*Gallus domesticus*)	1	2	0/2052.62	mg/kg diet	N	na	ADL	U	FD	21	d	1	d	JV	B	C	1	BIO	CHM	HMGL	BL		2052.6	N	0.0397	N	0.00712		368	10	10	5	4	5	1	4	10	10	4	63
222	1624	Wight et al, 1986	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/20000	mg/kg diet	N	na	ADL	U	FD	5	d	NR	NR	SM	F	C	2	BIO	ENZ	GLPX	PS		20000	N	1.3	Y	0.0336		517	10	10	5	5	6	1	4	10	10	4	65
223	6435	Rama and Planas, 1981	Zinc	100	Chicken (*Gallus domesticus*)	1	2	0/5000	mg/kg diet	N	na	ADL	U	FD	2	s	1	d	JV	NR	C	2	BIO	CHM	HMGL	BL		5000	Y	0.075	N	0.01078		719	10	10	5	4	6	1	4	10	10	4	64
224	6144	Berry and Brake, 1985	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/20000	mg/kg diet	N	na	ADL	U	FD	4	d	60	w	AD	F	C	1	GRO	GRO	BDWT	WO		20000	N	1.6	N	0.07903		988	10	10	5	5	5	8	4	10	3	4	64
225	7089	Berry and Brake, 1990	Zinc oxide	100	Chicken (*Gallus domesticus*)	1	2	0/2	% in diet	N	na	ADL	U	FD	49	d	66	w	LB	F	C	3	BIO	CHM	GBCM	SG		2	N	1.6	N	0.07903		988	10	10	5	5	5	1	4	10	10	4	64
226	8181	Berry et al., 1987	Zinc oxide	100	Chicken (*Gallus domesticus*)	2	3	0/20000	mg/kg diet	N	na	ADL	U	FD	4	d	1	yr	AD	F	C	1	BIO	CHM	PCLV	BL		20000	N	1.6	N	0.07903		988	10	10	5	5	5	1	4	10	3	4	57

All abbreviations and definitions are used in coding stuides are available from Attachment 4-3 of the Eco-SSL guidance(U.S. EPA 2003).

Duplicate values for NOAELs and LOAELs for the same reference represent results from different experimental designs and are identified by different Phase numbers.

Appendix 6-1

Mammalian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Zinc

June 2007

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Ref			Exposure																		Effects								Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
Biochemical																																													
1	2033	Brandt, 1983	Zinc sulfate	100	Mink (*Mustela vison*)	1	3	0/171/330	mg/kg diet	N	na	ADL	M	FD	4	mo	90	d	JV	M	C	NR	BIO	CHM	MCHC	PL	171	330	Y	1.985	N	0.1207024	10.4	20.1	10	10	10	10	6	1	10	10	10	4	81
2	21171	Van der Schee et al, 1980	Zinc sulfate heptahydrate	100	Sheep (*Ovis aries*)	1	3	0/223/409	mg/kg diet	N	na	ADL	M	FD	98	d	NR	NR	JV	M	C	COM	BIO	CHM	HMCT	BL	409		N	34	Y	1	12		10	10	10	10	6	1	4	1	10	4	66
3	45270	Hill and Miller, 1983	Zinc oxide	100	Pig (*Sus scrofa*)	1	3	0/500/5000	mg/kg diet	N	na	ADL	U	FD	4	w	NR	NR	GE	F	C	COM	BIO	ENZ	ALPH	SR	500	5000	Y	55.1	Y	2.75	25.0	250	10	10	5	5	7	1	8	10	10	4	70
4	21067	Reeves and Newman, 1997	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/350	mg/kg diet	N	na	ADL	U	FD	7	w	21	d	JV	M	C	COM	BIO	CHM	HMCT	BL	350		N	0.267	N	0.0232033	30.4		10	10	5	10	5	1	4	10	10	7	72
5	47892	Gaynor et al, 1988	Zinc sulfate	100	Cattle (*Bos taurus*)	2	2	0/1264.0	mg/kg diet	N	na	ADL	M	FD	4	w	NR	NR	LC	F	C	COM	BIO	CHM	PRTL	MK	1264		Y	623.2	Y	15.1	30.6		10	10	10	10	7	1	4	1	10	4	67
6	21240	Mengo et al., 1991	Zinc acetate	35.64	Rat (*Rattus norvegicus*)	1	3	0/1000/3000	mg/kg diet	N	na	ADL	U	FD	3	mo	1	mo	JV	M	C	COM	BIO	CHM	CHOL	BL	1000	3000	N	0.217	N	0.0195671	32.1	96.4	10	10	5	5	5	1	10	10	10	4	70
7	47892	Gaynor et al, 1988	Zinc chloride	100	Cattle (*Bos taurus*)	1	2	0/1386.4	mg/kg diet	N	na	ADL	M	FD	5	w	NR	NR	LC	F	C	COM	BIO	CHM	PRTL	MK	1386.4		Y	626.2	Y	15	33.2		10	10	10	10	7	1	4	1	10	4	67
8	36302	Brzoska et al, 2001	Zinc chloride	100	Rat (*Rattus norvegicus*)	1	2	0/8.0	mg/org/d	N	na	ADL	U	DR	12	w	2	mo	JV	M	C	COM	BIO	CHM	CALC	TB	8		Y	0.2	Y	0.0335	40.0		10	5	5	10	7	1	4	10	10	10	72
9	14536	Ott et al., 1966	Zinc oxide	100	Cattle (*Bos taurus*)	2	6	0/0.5/0.9/1.3/1.7/2.1	g/kg diet	N	na	ADL	U	FD	12	w	NR	NR	JV	B	C	COM	BIO	CHM	PCLV	BL	1.3	1.7	N	270	N	8.85	42.6	55.7	10	10	5	5	6	1	10	10	10	4	71
10	14525	Brink et al, 1959	Zinc carbonate	100	Pig (*Sus scrofa*)	1	6	0/0.05/0.10/0.20/0.40/0.80	% in diet	N	na	ADL	U	FD	42	d	NR	NR	JV	NR	C	COM	BIO	CHM	HMGL	BL	0.1	0.2	Y	47.99915	Y	2.09	43.5	87.1	10	10	5	10	7	1	10	10	10	4	77
11	14537	Ott et al., 1966	Zinc oxide	100	Sheep (*Ovis aries*)	1	8	0/0.5/1.0/1.5/2.0/2.5/3.0/3.5	g/kg diet	N	na	ADL	U	FD	7	w	NR	NR	JV	M	C	NR	BIO	CHM	PCLV	BL	1.5	2	Y	44.5	Y	1.52	51.2	68.3	10	10	5	5	7	1	10	10	10	4	72
12	14537	Ott et al., 1966	Zinc sulfate	100	Sheep (*Ovis aries*)	2	4	0/2.0/4.0/6.0	g/org/day	N	na	DLY	U	GV	11	d	NR	NR	JV	M	C	NR	BIO	CHM	HMGL	BL	2	4	Y	37.6	Y	1.4	53.2	106	10	8	5	10	7	1	10	10	10	4	75
13	40436	Bentley and Grubb, 1991	Zinc carbonate	100	Rabbit (*Oryctolagus cuniculus*)	1	3	0/1000/5000	ug/g	N	na	ADL	U	FD	22	w	NR	NR	JV	B	C	COM	BIO	CHM	HMGL	BL	1000	5000	Y	3	N	0.1694925	56.5	282	10	10	5	10	6	1	8	10	10	4	74
14	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	4	4	0/23.2/234/2514	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	BIO	CHM	HMGL	BL	234	2514	Y	0.43	Y	0.0236	234	2514	10	10	5	10	7	1	6	10	10	4	73
15	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	3	4	0/24.5/243/2486	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	BIO	CHM	HEMT	BL	243	2486	Y	0.255	Y	0.0156	243	2486	10	10	5	10	7	1	6	10	10	4	73
16	22300	Whanger and Weswig, 1970	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	4	0/1000/4000/8000	mg/kg diet	N	na	ADL	U	FD	10	w	21	d	JV	M	C	LAB	BIO	CHM	GBCM	BL	4000	8000	N	0.235	N	0.0208917	356	711	10	10	5	10	5	1	10	10	10	4	75
17	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	2	4	0/42.7/458/4927	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	BIO	CHM	HMGL	BL	458	4927	Y	0.0453	Y	0.006	458	4927	10	10	5	10	7	1	6	10	10	4	73
18	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	1	4	0/46.4/479/4878	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	BIO	CHM	HMGL	BL	479	4878	Y	0.0446	Y	0.00416	479	4878	10	10	5	10	7	1	6	10	10	4	73
19	14656	O'Neil-Cutting et al, 1981	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/0.75	% in diet	N	na	ADL	U	FD	18	w	NR	NR	JV	M	C	COM	BIO	CHM	HMGL	BL	0.75		Y	0.438	N	0.034853	597		10	10	5	10	6	1	4	10	10	4	70
20	40997	Urabe and Hayakawa, 1990	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/30	mg/g diet	N	na	ADL	U	FD	42	d	NR	NR	JV	M	C	LAB	BIO	CHM	PRTL	LI	30		Y	0.253	Y	0.0142	1684		10	10	5	10	7	1	4	10	10	4	71
21	638	Nakamura et al., 1983	zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/200	ug/g	N	na	ADL	U	FD	11	w	NR	NR	JV	F	C	LAB	BIO	CHM	GLUC	SR		200	Y	0.1838	Y	0.008		8.71	10	10	5	5	7	1	4	10	10	4	66
22	36982	L'Abbe and Fischer, 1984	Zinc sulfate	100	Rat (*Rattus norvegicus*)	1	3	0/120/240	mg/kg diet	N	na	ADL	M	FD	6	w	NR	NR	JV	M	C	COM	BIO	CHM	GBCM	SR		120	N	0.235	N	0.0208917		10.7	10	10	10	10	5	1	4	10	10	4	74
23	38623	Elliot and Walker, 1968	Zinc carbonate	100	Pig (*Sus scrofa*)	1	2	0/478	mg/kg diet	N	na	ADL	U	FD	4	w	NR	NR	JV	B	C	COM	BIO	CHM	HMGL	WO		478	Y	84	N	2.622493		14.9	10	10	5	10	6	1	4	10	10	4	70
24	36983	L'Abbe and Fischer, 1984	Zinc sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/240	mg/kg diet	N	na	ADL	U	FD	2	w	NR	NR	JV	M	C	COM	BIO	ENZ	CCOX	LI		240	N	0.217	N	0.0195671		21.6	10	10	5	10	5	1	4	10	10	4	69
25	21011	Subramanian et al, 2000	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/400	mg/kg diet	N	na	ADL	U	FD	6	w	NR	NR	JV	M	C	LAB	BIO	CHM	HMGL	PL		400	Y	0.198	Y	0.01395		28.2	10	10	5	5	7	1	4	10	10	4	66
26	46830	Shankar et al, 1986	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/400	mg/kg diet	N	na	ADL	U	FD	120	d	40	d	JV	F	C	COM	BIO	CHM	CHOL	SR		400	Y	0.2779	Y	0.0201		28.9	10	10	5	5	7	1	4	10	10	4	66
27	21015	Tran, et. al, 1999	Zinc chloride	100	Rat (*Rattus norvegicus*)	1	3	0/400/1000	mg/kg diet	N	na	ADL	U	FD	7	d	NR	NR	JV	M	C	COM	BIO	CHM	MCPR	IN		400	Y	0.25	N	0.0219818		35.2	10	10	5	10	6	1	4	10	10	4	70
28	19290	Kadiiska et al, 1985	Zinc sulfate	40.5	Rat (*Rattus norvegicus*)	1	2	0/100	mg/kg bw/d	N	na	DLY	U	DR	30	d	NR	NR	JV	M	C	COM	BIO	ENZ	P450	LI		100	Y	0.175	N	0.0206238		40.5	10	5	5	10	10	1	4	10	10	4	69
29	37015	Reeves et al, 1994	Zinc	100	Rat (*Rattus norvegicus*)	1	2	0/56	mg/kg bw/d	N	na	ADL	U	FD	2	w	NR	NR	JV	M	C	COM	BIO	CHM	GBCM	LI		56	Y	0.1728	N	0.0162262		56	10	10	5	4	10	1	4	10	10	4	68
30	149	Van Vleet et al, 1981	Zinc sulfate	100	Pig (*Sus scrofa*)	1	2	0/3000	mg/kg diet	N	na	ADL	U	FD	2	w	NR	NR	JV	M	C	COM	BIO	ENZ	GLPX	BL		3000	Y	61.3	N	2.02418		99.1	10	10	5	10	6	1	4	10	10	4	70
31	37010	Yamaguchi et al, 1982	Zinc sulfate	100	Rat (*Rattus norvegicus*)	1	3	0/100/1000	mg/kg bw/d	N	na	DLY	U	OR	30	d	3	w	JV	M	C	COM	BIO	CHM	CALC	SR		100	N	0.071	N	0.0078107		100	10	8	5	10	10	1	4	10	10	4	72
32	39802	Tantcheva et al, 1993	Zinc chloride	100	Rat (*Rattus norvegicus*)	1	2	0/100	mg/kg bw/d	N	na	ADL	U	DR	30	d	NR	NR	JV	M	C	COM	BIO	ENZ	AHDX	LI		100	Y	0.145	N	0.0174127		100	10	5	5	10	10	1	4	10	10	4	69
33	36967	Jaw and Jeffery, 1988	Zinc chloride	100	Rat (*Rattus norvegicus*)	1	2	0/1150	ug/g	N	na	ADL	U	FD	8	d	NR	NR	JV	F	C	COM	BIO	CHM	GBCM	LI		1150	Y	0.22	N	0.0197892		103	10	10	5	10	6	1	4	10	10	4	70
34	14376	Hsu et al, 1975	Zinc oxide	100	Pig (*Sus scrofa*)	1	2	0/4000	mg/kg diet	N	na	ADL	U	FD	2	w	4	w	JV	NR	C	DOM	BIO	ENZ	ALPH	SR		4000	Y	16.3	Y	1.446		354	10	10	5	5	7	1	4	10	10	4	66
35	36953	Thawley, et. al., 1978	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/0.6	% in diet	N	na	ADL	U	FD	6	w	NR	NR	JV	M	C	COM	BIO	CHM	HMGL	BL		0.6	Y	0.15	N	0.0144445		578	10	10	5	10	6	1	4	10	10	4	70
36	38015	Settlemire and Matrone, 1967	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/0.75	% in diet	N	na	NR	U	FD	5	w	4-6	w	JV	M	C	LAB	BIO	CHM	HMGL	BL		0.75	N	0.235	N	0.0208917		667	10	10	5	10	5	1	4	10	10	4	69
37	42961	Ogiso, et. al., 1974	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/1	% in diet	N	na	ADL	U	FD	15	d	NR	NR	JV	M	C	COM	BIO	CHM	HMGL	BL		1	Y	0.1558	N	0.0149021		956	10	10	5	10	6	1	4	10	10	4	70
38	43264	Scott and Magee, 1979	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/0.75	% in diet	N	na	ADL	U	FD	1	w	NR	NR	JV	B	C	COM	BIO	CHM	HMGL	BL		0.75	Y	0.029	N	0.0037415		968	10	10	5	10	6	1	4	10	10	4	70
39	36374	Pettersen et al, 2002	Zinc chloride	100	Mouse (*Mus musculus*)	1	3	0/10/20	g/kg diet	N	na	ADL	U	FD	3	w	4	w	JV	B	C	LAB	BIO	CHM	NACO	HE		10	Y	0.017	N	0.002412		1419	10	10	5	10	6	1	4	10	10	4	70
40	36346	Gautam et al, 2001	Zinc acetate	35.64	Rat (*Rattus norvegicus*)	1	2	0/5	g/kg bw	N	na	ADL	U	FD	2	w	NR	NR	JV	NR	C	WLD	BIO	CHM	CALC	LI		5	N	0.06	N	0.0068014		1782	10	10	5	5	10	1	4	10	10	4	69
41	13236	Rana et. al, 1985	Zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/5.0	g/kg bw/d	N	na	DLY	U	GV	30	d	90	d	JV	M	C	LAB	BIO	CHM	GLYC	LI		5	Y	0.1	N	0.0103504		5000	10	8	10	5	10	1	4	10	10	4	72
Behavior																																													
42	46830	Shankar et al, 1986	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/400	mg/kg diet	N	na	ADL	U	FD	120	d	40	d	JV	F	C	COM	BEH	FDB	FCNS	WO	400		Y	0.2779	Y	0.0201	28.9		10	10	5	5	7	4	4	10	10	4	69
43	47892	Gaynor et al, 1988	Zinc sulfate	100	Cattle (*Bos taurus*)	2	2	0/1264.0	mg/kg diet	N	na	ADL	M	FD	4	w	NR	NR	LC	F	C	COM	BEH	FDB	FCNS	WO	1264		Y	623.2	Y	15.1	30.6		10	10	10	10	7	4	4	1	10	4	70
44	47892	Gaynor et al, 1988	Zinc chloride	100	Cattle (*Bos taurus*)	1	2	0/1386.4	mg/kg diet	N	na	ADL	M	FD	5	w	NR	NR	LC	F	C	COM	BEH	FDB	FCNS	WO	1386.4		Y	626.2	Y	15	33.2		10	10	10	10	7	4	4	1	10	4	70
45	40409	Henry et al, 1997	Zinc sulfate heptahydrate	100	Sheep (*Ovis aries*)	1	6	0/500/1000/1500/2000/2500	mg/kg diet	N	na	ADL	U	FD	3	d	NR	NR	JV	M	C	DOM	BEH	FDB	FCNS	WO	1500	2000	Y	44.7	Y	1.04	34.9	46.5	10	10	5	10	7	4	10	10	10	4	80
46	14685	Miller et al., 1989	Zinc sulfate	100	Cattle (*Bos taurus*)	1	3	0/1000/2000	mg/kg diet	N	na	ADL	U	FD	10	w	NR	NR	LC	F	C	COM	BEH	FDB	FCNS	WO	1000	2000	Y	575	Y	22	38.3	76.5	10	10	5	10	7	4	10	10	10	4	80
47	14535	Ott et al, 1966	Zinc oxide	100	Sheep (*Ovis aries*)	1	8	0/0.5/1.0/1.5/2.0/2.5/3.0/3.5	g/kg diet	N	na	ADL	U	FD	6	w	NR	NR	JV	NR	C	NR	BEH	FDB	FDNG	WO	1	1.5	Y	45.3	Y	1.75	38.6	57.9	10	10	5	5	7	4	10	10	10	4	75
48	14525	Brink et al, 1959	Zinc carbonate	100	Pig (*Sus scrofa*)	1	6	0/0.05/0.10/0.20/0.40/0.80	% in diet	N	na	ADL	U	FD	42	d	NR	mo	JV	NR	C	COM	BEH	FDB	FCNS	WO	0.2	0.4	Y	77.51894	Y	1.84	47.5	94.9	10	10	5	10	7	4	10	10	10	4	80
49	42234	Schell and Kornegay, 1996	Zinc sulfate	100	Pig (*Sus scrofa*)	2	4	0/218/624/830	mg/d	N	na	ADL	M	FD	2	w	23	d	JV	B	C	COM	BEH	FDB	FCNS	WO	830		Y	7.82	Y	0.34	106		10	10	10	10	7	4	4	1	10	4	70
50	46274	Aulerich et al, 1991	Zinz sulfate heptahydrate	100	Mink (*Mustela vison*)	3	4	0/66.2/105.7/164.8	mg/kg bw/d	N	na	ADL	M	FD	144	d	>1	yr	AD	M	C	NR	BEH	FDB	FCNS	WO	164.8		N	1.18	Y	0.233	165		10	10	10	10	7	4	4	10	10	4	79
51	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	4	4	0/23.2/234/2514	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	BEH	FDB	FCNS	WO	234	2514	Y	0.43	Y	0.0236	234	2514	10	10	5	10	7	4	6	10	10	4	76
52	46274	Aulerich et al, 1991	Zinz sulfate heptahydrate	100	Mink (*Mustela vison*)	1	4	0/113.3/229.8/297.4	mg/kg bw/d	N	na	ADL	M	FD	144	d	10-12	w	JV	M	C	NR	BEH	FDB	FCNS	WO	297.4		N	1.02	Y	0.269	297		10	10	10	10	7	4	4	8	10	4	77
53	46274	Aulerich et al, 1991	Zinz sulfate heptahydrate	100	Mink (*Mustela vison*)	2	4	0/104.3/227.5/323.6	mg/kg bw/d	N	na	ADL	M	FD	144	d	10-12	w	JV	F	C	NR	BEH	FDB	FCNS	WO	323.6		N	0.583	Y	0.19	324		10	10	10	10	7	4	4	6	10	4	75
54	46274	Aulerich et al, 1991	Zinz sulfate heptahydrate	100	Mink (*Mustela vison*)	4	4	0/76.8/178.2/326.7	mg/kg bw/d	N	na	ADL	M	FD	144	d	>1	yr	AD	F	C	NR	BEH	FDB	FCNS	WO	326.7		N	0.596	Y	0.175	327		10	10	10	10	7	4	4	10	6	4	75
55	37837	Ketcheson et al, 1969	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	3	0/0.2/0.5	% in diet	N	na	ADL	U	FD	14	d	NR	NR	LC	F	C	COM	BEH	FDB	FCNS	WO	0.5		N	0.252	Y	0.0237	470		10	10	5	5	7	4	4	10	10	4	69
56	40997	Urabe and Hayakawa, 1990	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/30	mg/g diet	N	na	ADL	U	FD	42	d	NR	NR	JV	M	C	LAB	BEH	FDB	FCNS	WO	30		Y	0.253	Y	0.0142	1684		10	10	5	10	7	4	4	10	10	4	74

Ref			Exposure																		Effects								Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
57	21011	Subramanian et al, 2000	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/400	mg/kg diet	N	na	ADL	U	FD	6	w	NR	NR	JV	M	C	LAB	BEH	FDB	FCNS	WO		400	Y	0.198	Y	0.01395		28.2	10	10	5	5	7	4	4	10	10	4	69
58	36302	Brzoska et al, 2001	Zinc chloride	100	Rat (*Rattus norvegicus*)	1	2	0/8.0	mg/org/d	N	na	ADL	U	DR	12	w	2	mo	JV	M	C	COM	BEH	FDB	WCON	WO		8	Y	0.2	Y	0.0335		40	10	5	5	10	7	4	4	10	10	10	75
Physiology																																													
59	14535	Ott et al, 1966	Zinc oxide	100	Sheep (*Ovis aries*)	1	8	0/0.5/1.0/1.5/2.0/2.5/3.0/3.5	g/kg diet	N	na	ADL	U	FD	6	w	NR	NR	JV	NR	C	NR	PHY	PHY	FDCV	WO	0.5	1	Y	45.3	Y	1.8	19.9	39.7	10	10	5	5	7	4	10	10	10	4	75
60	47892	Gaynor et al, 1988	Zinc sulfate	100	Cattle (*Bos taurus*)	2	2	0/1264.0	mg/kg diet	N	na	ADL	M	FD	4	w	NR	mo	LC	F	C	COM	PHY	PHY	FDCV	WO	1264		Y	623.2	Y	15.1	30.6		10	10	10	10	7	4	4	1	10	4	70
61	47892	Gaynor et al, 1988	Zinc chloride	100	Cattle (*Bos taurus*)	1	2	0/1386.4	mg/kg diet	N	na	ADL	M	FD	5	w	NR	NR	LC	F	C	COM	PHY	PHY	FDCV	WO	1386.4		Y	626.2	Y	15	33.2		10	10	10	10	7	4	4	1	10	4	70
62	14525	Brink et al, 1959	Zinc carbonate	100	Pig (*Sus scrofa*)	1	6	0/0.05/0.10/0.20/0.40/0.80	% in diet	N	na	ADL	U	FD	42	d	NR	NR	JV	NR	C	COM	PHY	PHY	FDCV	WO	0.1	0.2	Y	47.99915	Y	2.09	38.3	76.7	10	10	5	10	7	4	10	10	10	4	80
63	42234	Schell and Kornegay, 1996	Zinc sulfate	100	Pig (*Sus scrofa*)	2	4	0/218/624/830	mg/d	N	na	ADL	M	FD	2	w	23	d	JV	F	C	COM	PHY	PHY	FDCV	WO	830		Y	7.82	Y	0.34	106		10	10	10	10	7	4	4	1	10	4	70
64	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	2	4	0/42.7/458/4927	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	PHY	PHY	FDCV	WO	458	4927	Y	0.0453	Y	0.006	458	4927	10	10	5	10	7	4	6	10	6	4	72
65	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	1	4	0/46.4/479/4878	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	PHY	PHY	FDCV	WO	479	4878	Y	0.0327	Y	0.00416	479	4878	10	10	5	10	7	4	6	10	10	4	76
66	40997	Urabe and Hayakawa, 1990	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/30	mg/g diet	N	na	ADL	U	FD	42	d	NR	NR	JV	M	C	LAB	PHY	PHY	FDCV	WO	30		Y	0.253	Y	0.0142	1684		10	10	5	10	7	4	4	10	10	4	74
67	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	4	4	0/23.2/234/2514	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	PHY	PHY	FDCV	WO	2514		Y	0.371	Y	0.0213	2514		10	10	5	10	7	4	4	3	10	4	67
68	39780	Mutafova-Yamolieva, et al, 1993	Zinc Sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/100	mg/kg bw/d	N	na	ADL	U	DR	30	d	NR	NR	JV	M	C	COM	PHY	PHY	GPHY	VD		100	Y	0.1	N	0.0124634		100	10	5	5	10	10	4	4	10	10	4	72
69	14526	Cox and Hale, 1962	Zinc oxide	100	Pig (*Sus scrofa*)	1	3	0/0.2/0.4	% in diet	N	na	ADL	U	FD	69	d	NR	NR	JV	NR	C	COM	PHY	PHY	FDCV	WO		0.4	Y	59.10309	Y	1.98		134	10	10	5	5	7	4	4	10	10	4	66
Pathology																																													
70	45143	Hill et. al., 1983	Zinc oxide	100	Pig (*Sus scrofa*)	1	3	0/500/5000	mg/kg diet	N	na	ADL	U	FD	12	mo	7-8	mo	GE	F	C	COM	PTH	ORW	SMIX	LI	500	5000	Y	167	Y	2.75	8.23	82.3	10	10	5	5	7	4	8	10	10	4	73
71	14537	Ott et al., 1966	Zinc oxide	100	Sheep (*Ovis aries*)	1	8	0/0.5/1.0/1.5/2.0/2.5/3.0/3.5	g/kg diet	N	na	ADL	U	FD	7	w	NR	NR	JV	M	C	NR	PTH	ORW	ORWT	LI	0.5	1	Y	48.3	Y	1.8	18.6	37.3	10	10	5	5	7	4	10	10	10	4	75
72	21067	Reeves and Newman, 1997	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/350	mg/kg diet	N	na	ADL	U	FD	7	w	3	w	JV	M	C	COM	PTH	HIS	USTR	IN	350		N	0.267	N	0.0232033	30.4		10	10	5	10	5	4	4	1	10	7	66
73	36302	Brzoska et al, 2001	Zinc chloride	100	Rat (*Rattus norvegicus*)	1	2	0/8.0	mg/org/d	N	na	ADL	U	DR	12	w	2	mo	JV	M	C	COM	PTH	ORW	ORWT	TB	8		Y	0.2	Y	0.0335	40		10	5	5	10	7	4	4	10	10	10	75
74	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	4	4	0/23.2/234/2514	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	PTH	ORW	ORWT	BR	234	2514	Y	0.43	Y	0.0236	234	2514	10	10	5	10	7	4	6	10	10	4	76
75	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	3	4	0/24.5/243/2486	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	PTH	ORW	ORWT	LI	243	2486	Y	0.255	Y	0.0156	243	2486	10	10	5	10	7	4	6	10	10	4	76
76	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	2	4	0/42.7/458/4927	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	PTH	ORW	ORWT	BR	458	4927	Y	0.0453	Y	0.006	458	4927	10	10	5	10	7	4	6	10	10	4	76
77	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	1	4	0/46.4/479/4878	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	PTH	ORW	ORWT	BR	479	4878	Y	0.0446	Y	0.0052	479	4878	10	10	5	10	7	4	6	10	10	4	76
78	14656	O'Neil-Cutting et al, 1981	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/0.75	% in diet	N	na	ADL	U	FD	18	w	NR	NR	JV	M	C	COM	PTH	ORW	ORWT	LI	0.75		Y	0.438	N	0.034853	597		10	10	5	10	6	4	4	8	10	4	71
79	40997	Urabe and Hayakawa, 1990	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/30	mg/g diet	N	na	ADL	U	FD	42	d	NR	NR	JV	M	C	LAB	PTH	ORW	ORWT	LI	30		N	0.253	Y	0.0142	1684		10	10	5	10	6	4	4	8	10	4	71
80	113	Seidenberg et al 1986	Zinc chloride	47.98	Mouse (*Mus musculus*)	1	2	0/150	mg/kg/d	N	na	DLY	U	GV	4	d	NR	NR	GE	F	C	LAB	PTH	GRS	BDWT	WO		150	Y	0.037	N	0.0045711		8.89	10	8	10	10	10	4	4	10	10	4	80
81	14524	Augey, et al, 1977	Zinc sulfate	100	Mouse (*Mus musculus*)	1	2	0/0.5	g/L	N	na	ADL	U	DR	12	mo	1.5-2	mo	JV	B	C	LAB	PTH	HIS	USTR	PS		0.5	Y	0.031	N	0.0043437		70.1	10	5	5	10	6	4	4	10	10	4	68
82	14527	Davies, et al, 1977	Zinc sulfate	100	Sheep (*Ovis aries*)	1	2	0/2065	mg/kg diet	N	na	3 per d	M	FD	26	d	1	w	JV	M	C	COM	PTH	ORW	ORWT	KI		2065	N	34	N	1.246902		75.7	10	10	10	10	5	4	4	10	10	4	77
83	149	Van Vleet et al, 1981	Zinc sulfate	100	Pig (*Sus scrofa*)	1	2	0/3000	mg/kg diet	N	na	ADL	U	FD	10	w	NR	NR	JV	M	C	COM	PTH	HIS	GLSN	HE		3000	Y	61.3	N	2.02418		99.1	10	10	5	10	6	4	4	10	10	4	73
84	37010	Yamaguchi et al, 1982	Zinc sulfate	100	Rat (*Rattus norvegicus*)	1	3	0/100/1000	mg/kg bw/d	N	na	DLY	U	OR	30	d	3	w	JV	M	C	COM	PTH	ORW	ORWT	FM		100	N	0.071	N	0.0078107		100	10	8	5	10	10	4	4	10	10	4	75
85	42635	Ferguson and Leaver, 1972	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/2040	mg/kg diet	N	na	ADL	M	FD	10	w	21-28	d	JV	B	C	LAB	PTH	HIS	USTR	HM		2040	N	0.235	N	0.0208917		181	10	10	10	10	5	4	4	10	10	4	77
86	13236	Rana et. al, 1985	Zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/5.0	g/kg bw/d	N	na	DLY	U	GV	30	d	90	d	JV	M	C	LAB	PTH	ORW	SMIX	LI		5	Y	0.1	N	0.0103504		5000	10	8	10	5	10	4	4	10	10	4	75
Reproduction																																													
87	45143	Hill et. al., 1983	Zinc oxide	100	Pig (*Sus scrofa*)	1	3	0/500/5000	mg/kg diet	N	na	ADL	U	FD	12	mo	7-8	mo	GE	F	C	COM	REP	REP	ODVP	WO	500	5000	Y	167	Y	2.75	8.23	82.3	10	10	5	5	7	10	8	10	10	4	79
88	113	Seidenberg et al 1986	Zinc chloride	47.98	Mouse (*Mus musculus*)	1	2	0/150	mg/kg/d	N	na	DLY	U	GV	4	d	NR	NR	GE	F	C	LAB	REP	REP	PRWT	NR	150		Y	0.037	N	0.0045711	8.89		10	8	10	10	10	10	4	6	10	4	82
89	36854	Alaoui et al, 1985	Zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/150	mg/kg diet	N	na	ADL	U	FD	5	w	NR	NR	JV	M	C	COM	REP	REP	ORWT	TE	150		Y	0.126	Y	0.0081	9.64		10	10	5	5	7	10	4	6	10	4	71
90	37008	Cerklewski, 1979	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/120	mg/kg diet	N	na	ADL	U	FD	37	d	105	d	LC	F	C	LAB	REP	REP	PRWT	WO	120		Y	0.3742	Y	0.045	14.4		10	10	5	10	7	10	4	10	10	4	80
91	42289	Food and Drug Res. Lab, 1973	Zinc sulfate	100	Mouse (*Mus musculus*)	1	3	0/6.5/30.0	mg/kg bw/d	N	na	DLY	U	GV	10	d	NR	NR	GE	F	C	DOM	REP	REP	PRFM	WO	30		Y	0.0415	N	0.0050233	30.0		10	8	10	10	10	10	4	1	10	4	77
92	21134	Khera and Shah, 1979	Zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/34	mg/kg bw/d	N	na	ADL	U	FD	4	d	NR	NR	GE	F	C	COM	REP	REP	PRWT	WO	34		Y	0.275	N	0.0237732	34.0		10	10	5	5	10	10	4	1	10	4	69
93	14685	Miller et al., 1989	Zinc sulfate	100	Cattle (*Bos taurus*)	1	3	0/1000/2000	mg/kg diet	N	na	ADL	U	FD	14	w	NR	NR	LC	F	C	COM	REP	REP	PRWT	WO	1000	2000	Y	580	Y	22	37.9	75.9	10	10	5	10	7	10	10	10	10	4	86
94	21069	Amemiya et al, 1986	zinc (unspecified)	100	Rat (*Rattus norvegicus*)	1	2	0/1000	ug/g	N	na	ADL	U	FD	21	d	NR	NR	GE	F	C	COM	REP	REP	PRWT	WO	1000		Y	0.34	Y	0.014	41.2		10	10	5	4	7	10	4	10	10	4	74
95	14660	Evenson et al, 1993	Zinc chloride	100	Rat (*Rattus norvegicus*)	1	2	0/500	mg/kg diet	N	na	ADL	U	FD	8	w	3	w	JV	M	C	COM	REP	REP	TEWT	TE	500		Y	0.319	N	0.0268579	42.1		10	10	5	10	6	10	4	1	10	4	70
96	42289	Food and Drug Res. Lab, 1973	Zinc sulfate	100	Rat (*Rattus norvegicus*)	2	4	0/2.0/9.1/42.5	mg/kg bw/d	N	na	DLY	U	GV	10	d	NR	NR	GE	F	C	DOM	REP	REP	PRFM	WO	42.5		Y	0.269	N	0.023346	42.5		10	8	10	10	10	10	4	1	10	4	77
97	42292	Food and Drug Res. Lab, 1974	Zinc sulfate	100	Rabbit (*Oryctolagus cuniculus*)	1	5	0/0.6/2.8/13.0/60.0	mg/kg bw/d	N	na	DLY	U	GV	13	d	NR	NR	GE	F	C	DOM	REP	REP	PRFM	WO	60		Y	3.21	N	0.1791859	60.0		10	8	10	10	10	10	4	1	10	4	77
98	42289	Food and Drug Res. Lab, 1973	Zinc sulfate	100	Hamster (*Mesocricetus auratus*)	3	4	0/4.1/19.0/88.0	mg/kg bw/d	N	na	DLY	U	GV	5	d	NR	NR	GE	F	C	DOM	REP	REP	PRFM	WO	88		Y	0.1131	N	0.0114526	88.0		10	8	10	10	10	10	4	1	10	4	77
99	21138	Shrader et al, 1978	Zinc (unspecified)	100	Rat (*Rattus norvegicus*)	1	2	0/1000	mg/kg diet	N	na	ADL	U	FD	21	d	NR	NR	GE	F	C	LAB	REP	REP	PRWT	WO	1000		Y	0.225	N	0.0201582	89.6		10	10	5	4	6	10	4	10	10	4	73
100	21139	Hirsch and Hurley, 1978	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/1000	mg/kg diet	N	na	ADL	U	FD	12	d	NR	NR	GE	F	C	COM	REP	REP	PRWT	WO	1000		Y	0.225	N	0.0201582	89.6		10	10	5	10	6	10	4	6	10	4	75
101	35659	Hill et al, 1983	Zinc oxide	100	Pig (*Sus scrofa*)	1	3	0/500/5000	mg/kg diet	N	na	ADL	U	FD	20	w	NR	NR	LC	F	C	COM	REP	REP	RHIS	WO	5000		Y	140.6	Y	2.75	97.8		10	10	5	5	6	10	4	6	10	4	70
102	823	Webster, 1979	Zinc chloride	100	Mouse (*Mus musculus*)	1	4	0/200/400/800	mg/kg diet	N	na	ADL	U	FD	19	d	4	mo	GE	F	C	LAB	REP	REP	PRWT	WO	800		Y	0.032	N	0.0040569	101		10	10	5	10	6	10	4	10	10	4	79
103	139	Anderson et al., 1993	Zinc chloride	100	Mouse (*Mus musculus*)	1	2	0/110.2	mg/kg bw/d	N	na	ADL	U	FD	13	w	12	w	JV	M	C	LAB	REP	REP	PRWT	WO	110.2		Y	0.000042	N	0.0000191	110		10	10	5	10	10	10	4	1	10	4	74
104	25	Schlicker and Cox, 1968	Zinc oxide	100	Rat (*Rattus norvegicus*)	2	2	0/0.2	% in diet	N	na	NR	U	FD	36	d	NR	NR	GE	F	C	COM	REP	REP	PRWT	WO	0.2		N	0.338	N	0.0281661	167		10	10	5	5	5	10	4	10	10	4	73
105	37837	Ketcheson et al, 1969	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	3	0/0.2/0.5	% in diet	N	na	ADL	U	FD	14	d	NR	NR	LC	F	C	COM	REP	REP	PRWT	WO	0.2	0.5	Y	0.262	Y	0.0237	181	452	10	10	5	5	7	10	10	10	10	4	81
106	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	4	4	0/23.2/234/2514	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	REP	REP	ORWT	TE	234	2514	Y	0.43	Y	0.0236	234	2514	10	10	5	10	7	10	6	10	10	4	82
107	42767	Chu and Cox, 1970	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/0.4	% in diet	N	na	ADL	U	FD	21	d	NR	NR	LC	F	C	COM	REP	REP	GREP	WO	0.4		Y	0.268	N	0.0232747	347		10	10	5	5	6	10	4	10	10	4	74
108	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	2	4	0/42.7/458/4927	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	REP	REP	ORWT	TE	458	4927	Y	0.0453	Y	0.006	458	4927	10	10	5	10	7	10	6	10	10	4	82
109	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	1	4	0/46.4/479/4878	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	REP	REP	ORWT	OV	479	4878	Y	0.0446	Y	0.0052	479	4878	10	10	5	10	7	10	6	10	10	4	82
110	21045	Bui, et al, 1998	Zinc	100	Rat (*Rattus norvegicus*)	1	2	0/0.09746	mg/g bw	N	na	ADL	M	GV	7	d	NR	NR	GE	F	V	COM	REP	REP	PRWT	WO	0.9746		Y	0.2562	N	0.0224289	975		10	8	10	4	10	10	4	10	10	4	80
111	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	3	4	0/24.5/243/2486	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	REP	REP	ORWT	OV	2486		Y	0.231	Y	0.0149	2486		10	10	5	10	7	10	4	1	10	4	71

Appendix 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Zinc
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Ref			Exposure																		Effects								Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
112	43587	Kumar, 1976	Zinc sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/150	mg/kg diet	N	na	NR	U	FD	17	d	100	d	GE	F	C	COM	REP	REP	RSEM	WO		150	N	0.3846	N	0.0313209		12.2	10	10	5	10	5	10	4	10	10	4	78
113	21042	Barone et al, 1998	Zinc	100	Rat (*Rattus norvegicus*)	1	2	0/1000	mg/kg diet	N	na	ADL	U	FD	10	d	NR	NR	GE	F	C	LAB	REP	REP	PROG	WO		1000	Y	0.3945	N	0.0319821		81.1	10	10	5	4	6	10	4	10	10	4	73
114	48540	Newman et al, 2002	Zinc acetate dihydrate	100	Rat (*Rattus norvegicus*)	1	2	0/232	mg/kg bw/d	N	na	ADL	U	FD	16	d	NR	NR	GE	F	C	COM	REP	REP	PROG	WO		232	N	0.229	N	0.0204523		232	10	10	5	5	10	10	4	10	10	7	81
115	14664	Pal and Pal, 1987	Zinc sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/4000	mg/kg diet	N	na	ADL	U	FD	18	d	120-130	d	GE	F	C	COM	REP	REP	GREP	WO		4000	N	0.3846	N	0.0313209		326	10	10	5	10	5	10	4	10	10	4	78
116	42670	Chu and Cox, 1972	Zinc	100	Rat (*Rattus norvegicus*)	1	2	0/0.4	% in diet	N	na	ADL	U	FD	14	d	NR	NR	LC	F	C	DOM	REP	REP	PRWT	WO		0.4	N	0.3846	N	0.0313209		326	10	10	5	4	5	10	4	10	10	4	72
117	42838	Cox et al, 1969	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/0.4	% in diet	N	na	ADL	U	FD	22	d	NR	NR	GE	F	C	COM	REP	REP	PRWT	WO		0.4	Y	0.245	N	0.0216198		353	10	10	5	5	6	10	4	10	10	4	74
118	25	Schlicker and Cox, 1968	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/0.4	% in diet	N	na	NR	U	FD	18	d	NR	NR	GE	F	C	COM	REP	REP	PRWT	WO		0.4	Y	0.0872	N	0.0092483		424	10	10	5	5	6	10	4	10	10	4	74
Growth																																													
119	36003	Attia, et al, 1987	Zinc Oxide	100	Water buffalo (*Bubalus bubalis*)	1	5	0/460.28/527.70/1072.50/1129.26	mg/org/d	N	na	ADL	U	FD	90	d	7-9	mo	JV	M	C	DOM	GRO	GRO	BDWT	WO	1129.3		Y	261	N	6.659402	4.33		10	10	5	5	6	8	4	1	10	10	69
120	25973	Huerta et al, 2002	Zinc sulfate	100	Cattle (*Bos taurus*)	1	2	0/200	mg/kg diet	N	na	ADL	U	FD	50	d	18	mo	JV	F	C	COM	GRO	GRO	BDWT	WO	200		Y	379	N	9.048949	4.78		10	10	5	10	6	8	4	1	10	4	68
121	25973	Huerta et al, 2002	Zinc methionine	100	Cattle (*Bos taurus*)	2	2	0/200	mg/kg diet	N	na	ADL	U	FD	50	d	18	mo	JV	F	C	COM	GRO	GRO	BDWT	WO	200		Y	379	N	9.048949	4.78		10	10	5	10	6	8	4	1	10	4	68
122	36854	Alaoui et al, 1985	Zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/150	mg/kg diet	N	na	ADL	U	FD	5	w	NR	NR	JV	M	C	COM	GRO	GRO	BDWT	WO	150		Y	0.126	Y	0.0081	9.64		10	10	5	5	7	8	4	6	10	4	69
123	45143	Hill et. al., 1983	Zinc oxide	100	Pig (*Sus scrofa*)	1	3	0/500/5000	mg/kg diet	N	na	ADL	U	FD	8	mo	7-8	mo	GE	F	C	COM	GRO	GRO	GGRO	WO	500	5000	Y	134	Y	2.75	10.3	103	10	10	5	5	7	8	8	10	10	4	77
124	41855	Weigarnd and Kirchgessner, 1978	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	1	4	0/444/789/1701	ug/org/d	N	na	ADL	U	FD	12	d	NR	NR	JV	M	C	COM	GRO	GRO	BDWT	WO	1701		Y	0.145	N	0.0140476	11.7		10	10	5	10	6	8	4	1	10	4	68
125	43242	Eisemann et al, 1979	Zinc oxide	100	Pig (*Sus scrofa*)	1	2	0/581	mg/kg diet	N	na	ADL	M	FD	16	w	6-8	w	JV	B	C	LAB	GRO	GRO	BDWT	WO	581		Y	91	Y	2.11	13.5		10	10	10	5	7	8	4	1	10	4	69
126	37008	Cerklewski, 1979	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/120	mg/kg diet	N	na	ADL	U	FD	37	d	105	d	LC	F	C	LAB	GRO	GRO	BDWT	WO	120		Y	0.3742	Y	0.045	14.4		10	10	5	10	7	8	4	10	10	4	78
127	38623	Elliot and Walker, 1968	Zinc carbonate	100	Pig (*Sus scrofa*)	1	2	0/478	mg/kg diet	N	na	ADL	U	FD	4	w	NR	NR	JV	B	C	COM	GRO	GRO	BDWT	WO	478		Y	84	N	2.622493	14.9		10	10	5	10	6	8	4	1	10	4	68
128	2627	Cerklewski and Forbes, 1976	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/200	mg/kg diet	N	na	ADL	U	FD	7	w	NR	NR	JV	M	C	LAB	GRO	GRO	BDWT	WO	200		Y	0.23	Y	0.018	15.7		10	10	5	10	7	8	4	1	10	4	69
129	39821	Wapnir and Lee, 1993	Zinc sulfate	40.5	Rat (*Rattus norvegicus*)	1	2	0/0.44	g/kg diet	N	na	ADL	U	FD	3	w	NR	NR	JV	M	C	COM	GRO	GRO	BDWT	WO	0.44		Y	0.25	N	0.0219818	15.7		10	10	5	10	6	8	4	1	10	4	68
130	21084	Agarwal et al, 1986	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/200	mg/kg diet	N	na	NR	U	FD	14	d	9-10	w	SM	M	C	LAB	GRO	GRO	BDWT	WO	200		Y	0.216	N	0.019493	18.0		10	10	5	5	6	8	4	10	10	4	72
131	2033	Brandt, 1983	Zinc sulfate	100	Mink (*Mustela vison*)	1	3	0/171/330	mg/kg diet	N	na	ADL	M	FD	4	mo	90	d	JV	M	C	NR	GRO	GRO	BDWT	WO	330		Y	1.9	N	0.1164373	20.2		10	10	10	10	6	8	4	10	10	4	82
132	46830	Shankar et al, 1986	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/400	mg/kg diet	N	na	ADL	U	FD	120	d	40	d	JV	F	C	COM	GRO	GRO	BDWT	WO	400		Y	0.2779	Y	0.0201	28.9		10	10	5	5	7	8	4	10	10	4	73
133	42289	Food and Drug Res. Lab, 1973	Zinc sulfate	100	Mouse (*Mus musculus*)	1	3	0/6.5/30.0	mg/kg bw/d	N	na	DLY	U	GV	10	d	NR	NR	GE	F	C	DOM	GRO	GRO	BDWT	WO	30		Y	0.0415	N	0.0050233	30.0		10	8	10	10	10	8	4	1	10	4	75
134	21067	Reeves and Newman, 1997	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/350	mg/kg diet	N	na	ADL	U	FD	7	w	3	w	JV	M	C	COM	GRO	GRO	BDWT	WO	350		N	0.267	N	0.0232033	30.4		10	10	5	10	5	8	4	10	10	7	79
135	47892	Gaynor et al, 1988	Zinc sulfate	100	Cattle (*Bos taurus*)	2	2	0/1264.0	mg/kg diet	N	na	ADL	M	FD	4	w	NR	NR	LC	F	C	COM	GRO	GRO	BDWT	WO	1264		Y	623.2	Y	15.1	30.6		10	10	10	10	7	8	4	1	10	4	74
136	47892	Gaynor et al, 1988	Zinc chloride	100	Cattle (*Bos taurus*)	1	2	0/1386.4	mg/kg diet	N	na	ADL	M	FD	5	w	NR	NR	LC	F	C	COM	GRO	GRO	BDWT	WO	1386.4		Y	626.2	Y	15	33.2		10	10	10	10	7	8	4	1	10	4	74
137	21134	Khera and Shah, 1979	Zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/34	mg/kg bw/d	N	na	ADL	U	FD	4	d	NR	NR	GE	F	C	COM	GRO	GRO	BDWT	WO	34		Y	0.275	N	0.0237732	34		10	10	5	5	10	8	4	1	10	4	67
138	14660	Evenson et al, 1993	Zinc chloride	100	Rat (*Rattus norvegicus*)	1	2	0/500	mg/kg diet	N	na	ADL	U	FD	8	w	3	w	JV	F	C	COM	GRO	GRO	BDWT	WO	500		Y	0.319	N	0.0268579	42.1		10	10	5	10	6	8	4	1	10	4	68
139	42289	Food and Drug Res. Lab, 1973	Zinc sulfate	100	Rat (*Rattus norvegicus*)	2	4	0/2.0/9.1/42.5	mg/kg bw/d	N	na	DLY	U	GV	10	d	NR	NR	GE	F	C	DOM	GRO	GRO	BDWT	WO	42.5		Y	0.269	N	0.023346	42.5		10	8	10	10	10	8	4	1	10	4	75
140	14525	Brink et al, 1959	Zinc carbonate	100	Pig (*Sus scrofa*)	1	6	0/0.05/0.10/0.20/0.40/0.80	% in diet	N	na	ADL	U	FD	42	d	NR	NR	JV	NR	C	COM	GRO	GRO	BDWT	WO	0.1	0.2	Y	47.99915	Y	2.09	43.5	87.1	10	10	5	10	7	8	10	10	10	4	84
141	14685	Miller et al., 1989	Zinc sulfate	100	Cattle (*Bos taurus*)	1	3	0/1000/2000	mg/kg diet	N	na	ADL	U	FD	14	w	NR	NR	LC	F	C	COM	GRO	GRO	BDWT	WO	2000		Y	565	Y	18	63.7		10	10	5	10	7	8	4	1	10	4	69
142	37015	Reeves et al, 1994	Zinc	100	Rat (*Rattus norvegicus*)	1	2	0/56	mg/kg bw/d	N	na	ADL	U	FD	2	w	NR	NR	JV	M	C	COM	GRO	GRO	BDWT	WO	56		Y	0.1728	N	0.0162262	56		10	10	5	4	10	8	4	10	10	4	75
143	42292	Food and Drug Res. Lab, 1974	Zinc sulfate	100	Rabbit (*Oryctolagus cuniculus*)	1	5	0/0.6/2.8/13.0/60.0	mg/kg bw/d	N	na	DLY	U	GV	12	d	NR	NR	GE	F	C	DOM	GRO	GRO	BDWT	WO	60		Y	3.21	N	0.1791859	60.0		10	8	10	10	10	8	4	1	10	4	75
144	42289	Food and Drug Res. Lab, 1973	Zinc sulfate	100	Hamster (*Mesocricetus auratus*)	3	4	0/4.1/19.0/88.0	mg/kg bw/d	N	na	DLY	U	GV	5	d	NR	NR	GE	F	C	DOM	GRO	GRO	BDWT	WO	88		Y	0.1131	N	0.0114526	88.0		10	8	10	10	10	8	4	1	10	4	75
145	21045	Bui, et al, 1998	Zinc	100	Rat (*Rattus norvegicus*)	1	2	0/0.09746	mg/g bw	N	na	ADL	M	GV	7	d	NR	NR	GE	F	V	COM	GRO	GRO	BDWT	WO	0.0975		Y	0.2562	N	0.0224289	97.5		10	8	10	4	10	8	4	1	10	4	69
146	149	Van Vleet et al, 1981	Zinc sulfate	100	Pig (*Sus scrofa*)	1	2	0/3000	mg/kg diet	N	na	ADL	U	FD	10	w	NR	NR	JV	M	C	COM	GRO	GRO	BDWT	WO	3000		Y	61.3	N	2.02418	99.1		10	10	5	10	6	8	4	6	10	4	73
147	42234	Schell and Kornegay, 1996	Zinc oxide	100	Pig (*Sus scrofa*)	1	4	0/236/572/762	mg/d	N	na	ADL	M	FD	2	w	23	d	JV	B	C	COM	GRO	GRO	BDWT	WO	762		Y	7.4	Y	0.26	103		10	10	10	5	7	8	4	1	10	4	69
148	42234	Schell and Kornegay, 1996	Zinc sulfate	100	Pig (*Sus scrofa*)	2	4	0/218/624/830	mg/d	N	na	ADL	M	FD	23	d	23	d	JV	B	C	COM	GRO	GRO	BDWT	WO	830		Y	7.82	Y	0.34	106		10	10	10	10	7	8	4	1	10	4	74
149	139	Anderson et al., 1993	Zinc chloride	100	Mouse (*Mus musculus*)	1	2	0/110.2	mg/kg bw/d	N	na	ADL	U	FD	13	w	12	w	JV	M	C	LAB	GRO	GRO	BDWT	WO	110.2		Y	0.000042	N	0.0000191	110		10	10	5	10	10	8	4	10	10	4	81
150	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	4	4	0/23.2/234/2514	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	GRO	GRO	BDWT	WO	234	2514	Y	0.43	Y	0.0236	234	2514	10	10	5	10	7	8	6	10	10	4	80
151	40436	Bentley and Grubb, 1991	Zinc carbonate	100	Rabbit (*Oryctolagus cuniculus*)	1	3	0/1000/5000	ug/g	N	na	ADL	U	FD	22	w	NR	NR	JV	B	C	COM	GRO	GRO	BDWT	WO	5000		Y	3	N	0.1694925	282		10	10	5	10	6	8	4	1	10	4	68
152	2203	Llewellyn et al, 1985	Zinc carbonate	100	Golden hamster (*Mesocricetus auratus*)	1	2	0/3000	mg/kg diet	N	na	ADL	U	FD	18	w	NR	NR	JV	M	C	LAB	GRO	GRO	BDWT	WO	3000		N	0.134	N	0.0131655	295		10	10	5	10	5	8	4	1	10	4	67
153	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	2	4	0/42.7/458/4927	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	GRO	GRO	BDWT	WO	458	4927	Y	0.0453	Y	0.006	458	4927	10	10	5	10	7	8	6	10	10	4	80
154	37837	Ketcheson et al, 1969	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	3	0/0.2/0.5	% in diet	N	na	ADL	U	FD	14	d	NR	NR	LC	F	C	COM	GRO	GRO	BDWT	WO	0.5		Y	0.252	Y	0.0237	470		10	10	5	5	7	8	4	10	10	4	73
155	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	1	4	0/46.4/479/4878	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	GRO	GRO	BDWT	WO	479	4878	Y	0.0446	Y	0.00416	479	4878	10	10	5	10	7	8	6	10	10	4	80
156	14656	O'Neil-Cutting et al, 1981	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/0.75	% in diet	N	na	ADL	U	FD	18	w	NR	NR	JV	M	C	COM	GRO	GRO	BDWT	WO	0.75		Y	0.438	N	0.034853	597		10	10	5	10	6	8	4	10	10	4	77
157	39356	Zhang et al, 1995	Zinc oxide	100	Mouse (*Mus musculus*)	1	2	0/6010	mg/kg diet	N	na	ADL	M	FD	10	d	8	w	JV	F	C	COM	GRO	GRO	BDWT	WO	6010		Y	0.0205	N	0.0028133	825		10	10	10	5	6	8	4	1	10	4	68
158	39356	Zhang et al, 1995	Zinc sulfate	100	Mouse (*Mus musculus*)	2	2	0/6075	mg/kg diet	N	na	ADL	M	FD	10	d	8	w	JV	F	C	COM	GRO	GRO	BDWT	WO	6075		Y	0.019	N	0.002643	845		10	10	10	10	6	8	4	1	10	4	73
159	39356	Zhang et al, 1995	Zinc methionine	100	Mouse (*Mus musculus*)	3	2	0/6135	mg/kg diet	N	na	ADL	M	FD	10	d	8	w	JV	F	C	COM	GRO	GRO	BDWT	WO	6135		Y	0.02	N	0.0027568	846		10	10	10	5	6	8	4	1	10	4	68
160	36374	Pettersen, et al, 2002	Zinc chloride	100	Mouse (*Mus musculus*)	1	3	0/10/20	g/kg diet	N	na	ADL	U	FD	3	w	4	w	JV	B	C	LAB	GRO	GRO	BDWT	WO	10	20	Y	0.017	N	0.002412	1419	2838	10	10	5	10	6	8	10	10	10	4	83
161	40997	Urabe and Hayakawa, 1990	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/30	mg/g diet	N	na	ADL	U	FD	42	d	NR	NR	JV	M	C	LAB	GRO	GRO	BDWT	WO	30		Y	0.253	Y	0.0142	1684		10	10	5	10	7	8	4	10	10	4	78
162	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	3	4	0/24.5/243/2486	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	GRO	GRO	BDWT	WO	2486		Y	0.231	Y	0.0149	2486		10	10	5	10	7	8	4	1	10	4	69
163	638	Nakamura et al., 1983	zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/200	ug/g	N	na	ADL	U	FD	11	w	NR	NR	JV	F	C	LAB	GRO	GRO	BDWT	WO		200	Y	0.1838	Y	0.008		8.71	10	10	5	5	7	8	4	10	10	4	73
164	47007	Rosa et al, 1986	Zinc carbonate	100	Sheep (*Ovis aries*)	1	2	0/1000	mg/kg diet	N	na	NR	U	FD	56	d	NR	NR	SM	M	C	DOM	GRO	GRO	BDWT	WO		1000	Y	74.4	Y	1.2		16.1	10	10	5	10	7	8	4	10	3	4	71
165	21011	Subramanian et al, 2000	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/400	mg/kg diet	N	na	ADL	U	FD	6	w	NR	NR	JV	M	C	LAB	GRO	GRO	BDWT	WO		400	Y	0.198	Y	0.01395		28.2	10	10	5	5	7	8	4	10	10	4	73
166	14527	Davies, et al, 1977	Zinc sulfate	100	Sheep (*Ovis aries*)	1	2	0/2065	mg/kg diet	N	na	3 per d	M	FD	26	d	1	w	JV	M	C	COM	GRO	GRO	BDWT	WO		2065	N	34	N	1.246902		75.7	10	10	10	10	5	8	4	10	10	4	81
167	21042	Barone et al, 1998	Zinc	100	Rat (*Rattus norvegicus*)	1	2	0/1000	mg/kg diet	N	na	ADL	U	FD	10	d	NR	NR	GE	F	C	LAB	GRO	GRO	BDWT	WO		1000	Y	0.3945	N	0.0319821		81.1	10	10	5	4	6	8	4	10	10	4	71
168	14376	Hsu et al, 1975	Zinc oxide	100	Pig (*Sus scrofa*)	1	2	0/4000	mg/kg diet	N	na	ADL	U	FD	13	w	4	w	JV	NR	C	DOM	GRO	GRO	BDWT	WO		4000	Y	64.92	Y	1.446		89.1	10	10	5	5	7	8	4	10	10	4	73

Appendix 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Zinc

Ref			Exposure																		Effects								Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
169	25	Schlicker and Cox, 1968	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/0.4	% in diet	N	na	NR	U	FD	18	d	NR	NR	GE	F	C	COM	GRO	GRO	BDWT	WO		0.4	Y	0.0872	N	0.0092483		424	10	10	5	5	6	8	4	10	6	4	68
170	38015	Settlemire and Matrone, 1967	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/0.75	% in diet	N	na	NR	U	FD	5	w	4-6	w	JV	M	C	LAB	GRO	GRO	BDWT	WO		0.75	N	0.235	N	0.0208917		667	10	10	5	10	5	8	4	10	10	4	76
171	42961	Ogiso, et. al., 1974	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/1	% in diet	N	na	ADL	U	FD	15	d	NR	NR	JV	M	C	COM	GRO	GRO	BDWT	WO		1	Y	0.1558	N	0.0149021		956	10	10	5	10	6	8	4	10	10	4	77
172	43264	Scott and Magee, 1979	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/0.75	% in diet	N	na	ADL	U	FD	1	w	NR	NR	JV	M	C	COM	GRO	GRO	BDWT	WO		0.75	Y	0.029	N	0.0037415		968	10	10	5	10	6	8	4	10	10	4	77
Survival																																													
173	113	Seidenberg et al 1986	Zinc chloride	47.98	Mouse (*Mus musculus*)	1	2	0/150	mg/kg/d	N	na	DLY	U	GV	4	d	NR	NR	GE	F	C	LAB	MOR	MOR	MORT	WO	150		Y	0.037	N	0.0045711	8.89		10	8	10	10	10	9	4	10	10	4	85
174	21171	Van der Schee et al, 1980	Zinc sulfate heptahydrate	100	Sheep (*Ovis aries*)	1	3	0/223/409	mg/kg diet	N	na	ADL	M	FD	98	d	NR	NR	JV	M	C	COM	MOR	MOR	MORT	WO	409		N	34	Y	1	12.0		10	10	10	10	6	9	4	10	10	4	83
175	42289	Food and Drug Res. Lab, 1973	Zinc sulfate	100	Mouse (*Mus musculus*)	1	3	0/6.5/30.0	mg/kg bw/d	N	na	DLY	U	GV	10	d	NR	NR	GE	F	C	DOM	MOR	MOR	SURV	WO	30		Y	0.0415	N	0.0050233	30.0		10	8	10	10	10	9	4	1	10	4	76
176	42289	Food and Drug Res. Lab, 1973	Zinc sulfate	100	Rat (*Rattus norvegicus*)	2	4	0/2.0/9.1/42.5	mg/kg bw/d	N	na	DLY	U	GV	10	d	NR	NR	GE	F	C	DOM	MOR	MOR	SURV	WO	42.5		Y	0.269	N	0.023346	42.5		10	8	10	10	10	9	4	1	10	4	76
177	14525	Brink et al, 1959	Zinc carbonate	100	Pig (*Sus scrofa*)	1	6	0/0.05/0.10/0.20/0.40/0.80	% in diet	N	na	ADL	U	FD	42	d	NR	NR	JV	NR	C	COM	MOR	MOR	MORT	WO	0.1	0.2	Y	47.99915	Y	2.09	43.5	87.1	10	10	5	10	7	9	10	10	10	4	85
178	42292	Food and Drug Res. Lab, 1974	Zinc sulfate	100	Rabbit (*Oryctolagus cuniculus*)	1	5	0/0.6/2.8/13.0/60.0	mg/kg bw/d	N	na	DLY	U	GV	13	d	NR	NR	GE	F	C	DOM	MOR	MOR	MORT	WO	60		Y	3.21	N	0.1791859	60.0		10	8	10	10	10	9	4	1	10	4	76
179	14535	Ott et al, 1966	Zinc oxide	100	Sheep (*Ovis aries*)	1	8	0/0.5/1.0/1.5/2.0/2.5/3.0/3.5	g/kg diet	N	na	ADL	U	FD	6	w	NR	NR	JV	NR	C	NR	MOR	MOR	MORT	WO	2.5	3	Y	40.7	Y	1.35	82.9	99.5	10	10	5	5	7	9	10	10	10	4	80
180	14385	Willoughby et al, 1972	Zinc oxide	100	Horse (*Equus caballus*)	1	2	0/5400	mg/kg diet	N	na	ADL	M	FD	9	w	3-4	w	JV	F	C	COM	MOR	MOR	MORT	WO	5400		N	181.44	Y	2.81232	83.7		10	10	10	5	6	9	4	10	10	4	78
181	42289	Food and Drug Res. Lab, 1973	Zinc sulfate	100	Hamster (*Mesocricetus auratus*)	3	4	0/4.1/19.0/88.0	mg/kg bw/d	N	na	DLY	U	GV	5	d	NR	NR	GE	F	C	DOM	MOR	MOR	SURV	WO	88		Y	0.1131	N	0.0114526	88.0		10	8	10	10	10	9	4	1	10	4	76
182	46274	Aulerich et al, 1991	Zinz sulfate heptahydrate	100	Mink (*Mustela vison*)	3	4	0/66.2/105.7/164.8	mg/kg bw/d	N	na	ADL	M	FD	144	d	>1	yr	AD	M	C	NR	MOR	MOR	MORT	WO	164.8		N	1.18	Y	0.233	165		10	10	10	10	7	9	4	10	6	4	80
183	46274	Aulerich et al, 1991	Zinz sulfate heptahydrate	100	Mink (*Mustela vison*)	1	4	0/113.3/229.8/297.4	mg/kg bw/d	N	na	ADL	M	FD	144	d	10-12	w	JV	M	C	NR	MOR	MOR	MORT	WO	297.4		N	1.02	Y	0.269	297		10	10	10	10	7	9	4	10	10	4	84
184	46274	Aulerich et al, 1991	Zinz sulfate heptahydrate	100	Mink (*Mustela vison*)	2	4	0/104.3/227.5/323.6	mg/kg bw/d	N	na	ADL	M	FD	144	d	10-12	w	JV	F	C	NR	MOR	MOR	MORT	WO	323.6		N	0.583	N	0.0440896	324		10	10	10	10	7	9	4	10	10	4	84
185	46274	Aulerich et al, 1991	Zinz sulfate heptahydrate	100	Mink (*Mustela vison*)	4	4	0/76.8/178.2/326.7	mg/kg bw/d	N	na	ADL	M	FD	114	d	>1	yr	AD	F	C	NR	MOR	MOR	MORT	WO	326.7		N	0.596	Y	0.175	327		10	10	10	10	7	9	4	10	6	4	80
186	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	2	4	0/42.7/458/4927	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	MOR	MOR	MORT	WO	458	4927	Y	0.0453	Y	0.006	458	4927	10	10	5	10	7	9	6	10	10	4	81
187	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	3	4	0/24.5/243/2486	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	MOR	MOR	MORT	WO	2486		Y	0.231	Y	0.0149	2486		10	10	5	10	7	9	4	1	10	4	70
188	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	4	4	0/23.2/234/2514	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	MOR	MOR	MORT	WO	2514		Y	0.371	Y	0.0213	2514		10	10	5	10	7	9	4	10	10	4	79
189	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	1	4	0/46.4/479/4878	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	MOR	MOR	MORT	WO	4878		Y	0.0327	Y	0.0036	4878		10	10	5	10	7	9	4	10	10	4	79
190	149	Van Vleet et al, 1981	Zinc sulfate	100	Pig (*Sus scrofa*)	1	2	0/3000	mg/kg diet	N	na	ADL	U	FD	10	w	NR	NR	JV	M	C	COM	MOR	MOR	MORT	WO		3000	Y	61.3	N	2.02418		99.1	10	10	5	10	6	9	4	10	10	4	78
Data Not Used to Derive TRV																																													
191	36003	Attia, et al, 1987	Zinc Oxide	100	Water buffalo (*Bubalus bubalis*)	1	5	0/460.28/527.70/1072.50/1129.26	mg/org/d	N	na	ADL	U	FD	90	d	6-9	mo	JV	F	C	DOM	BIO	CHM	CALC	SR	1129.3		Y	261	N	6.659402	4.33		10	10	5	5	6	1	4	1	10	10	62
192	21006	Sinha, et al, 1989	Zinc	100	Rat (*Rattus norvegicus*)	1	3	0/500/1000	mg/kg diet	N	na	ADL	U	FD	6	w	NR	NR	JV	B	C	COM	GRO	GRO	BDWT	WO	1000		Y	0.156	Y	0.00129	8.27		10	10	5	4	7	8	4	1	10	4	63
193	21006	Sinha, et al, 1989	Zinc	100	Rat (*Rattus norvegicus*)	1	3	0/500/1000	mg/kg diet	N	na	ADL	U	FD	6	w	NR	NR	JV	B	C	COM	REP	REP	ORWT	OV	1000		Y	0.156	Y	0.00129	8.27		10	10	5	4	7	10	4	1	10	4	65
194	21006	Sinha, et al, 1989	Zinc	100	Rat (*Rattus norvegicus*)	1	3	0/500/1000	mg/kg diet	N	na	ADL	U	FD	6	w	NR	NR	JV	B	C	COM	BEH	FDB	FCNS	WO	1000		Y	0.156	Y	0.00129	8.27		10	10	5	10	7	4	4	1	10	4	65
195	43230	Caster and Doster, 1979	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/100	mg/kg diet	N	na	ADL	U	FD	27	d	NR	NR	JV	M	C	COM	BIO	CHM	CHOL	PL	100		N	0.235	N	0.0208917	8.89		10	10	5	10	5	1	4	1	10	4	60
196	36854	Alaoui et al, 1985	Zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/150	mg/kg diet	N	na	ADL	U	FD	5	w	NR	NR	JV	M	C	COM	PTH	ORW	ORWT	LI	150		Y	0.126	Y	0.0081	9.64		10	10	5	5	7	4	4	6	10	4	65
197	36854	Alaoui et al, 1985	Zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/150	mg/kg diet	N	na	ADL	U	FD	5	w	NR	NR	JV	M	C	COM	BEH	FDB	FCNS	WO	150		Y	0.126	Y	0.0081	9.64		10	10	5	5	7	4	4	6	10	4	65
198	36854	Alaoui et al, 1985	Zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/150	mg/kg diet	N	na	ADL	U	FD	5	w	NR	NR	JV	M	C	COM	PHY	PHY	FDCV	WO	150		Y	0.126	Y	0.0081	9.64		10	10	5	5	7	4	4	6	10	4	65
199	36897	Karouani et al, 1985	Zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/150	mg/kg diet	N	na	ADL	U	FD	5	w	NR	NR	JV	M	C	COM	GRO	GRO	BDWT	WO	150		N	0.267	N	0.0232033	13.0		10	10	5	5	5	8	4	1	10	4	62
200	43242	Eisemann et al, 1979	Zinc oxide	100	Pig (*Sus scrofa*)	1	2	0/581	mg/kg diet	N	na	ADL	M	FD	12	w	6-8	w	JV	B	C	LAB	BIO	CHM	CHOL	LI	581		Y	91	Y	2.11	13.5		10	10	10	5	7	1	4	1	10	4	62
201	43242	Eisemann et al, 1979	Zinc oxide	100	Pig (*Sus scrofa*)	1	2	0/581	mg/kg diet	N	na	ADL	M	FD	16	w	6-8	w	JV	B	C	LAB	BEH	FDB	FCNS	WO	581		Y	91	Y	2.11	13.5		10	10	10	5	7	4	4	1	10	4	65
202	43242	Eisemann et al, 1979	Zinc oxide	100	Pig (*Sus scrofa*)	1	2	0/581	mg/kg diet	N	na	ADL	M	FD	16	w	6-8	w	JV	B	C	LAB	PHY	PHY	FDCV	WO	581		Y	91	Y	2.11	13.5		10	10	10	5	7	4	4	1	10	4	65
203	14533	Miller et al., 1970	Zinc oxide	100	Cattle (*Bos taurus*)	1	3	0/200/600	mg/kg diet	N	na	ADL	U	FD	7	d	113	d	JV	M	C	COM	BEH	FDB	FCNS	WO	600		Y	110	Y	2.51	13.7		10	10	5	5	7	4	4	1	10	4	60
204	14533	Miller et al., 1970	Zinc sulfate	100	Cattle (*Bos taurus*)	2	2	0/600	mg/kg diet	N	na	ADL	U	FD	7	d	113	d	JV	M	C	COM	BEH	FDB	FCNS	WO	600		Y	110	Y	2.54	13.9		10	10	5	10	7	4	4	1	10	4	65
205	14532	Miller et al, 1965	Zinc oxide	100	Cattle (*Bos taurus*)	1	4	0/5.1/9.4/17.3	g/org/d	N	na	ADL	U	FD	6	w	NR	NR	LC	F	C	COM	GRO	GRO	BDWT	WO	17.3		Y	1142.4	Y	5.68	15.1		10	10	5	5	7	8	4	1	10	4	64
206	2627	Cerklewski and Forbes, 1976	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/200	mg/kg diet	N	na	ADL	U	FD	7	w	NR	NR	JV	M	C	LAB	BIO	ENZ	ALAD	KI	200		Y	0.23	Y	0.018	15.7		10	10	5	10	7	1	4	1	10	4	62
207	2627	Cerklewski and Forbes, 1976	Zinc carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/200	mg/kg diet	N	na	ADL	U	FD	7	w	NR	NR	JV	M	C	LAB	BEH	FDB	FCNS	WO	200		Y	0.23	Y	0.018	15.7		10	10	5	10	7	4	4	1	10	4	65
208	39821	Wapnir and Lee, 1993	Zinc sulfate	40.5	Rat (*Rattus norvegicus*)	1	2	0/0.44	g/kg diet	N	na	ADL	U	FD	3	w	NR	NR	JV	M	C	COM	BIO	CHM	GBCM	LI	0.44		Y	0.25	N	0.0219818	15.7		10	10	5	10	6	1	4	3	10	4	63
209	47007	Rosa et al, 1986	Zinc carbonate	100	Sheep (*Ovis aries*)	1	2	0/1000	mg/kg diet	N	na	NR	U	FD	56	d	NR	NR	SM	M	C	DOM	BEH	FDB	FCNS	WO	1000		Y	74.4	Y	1.2	16.1		10	10	5	10	7	4	4	1	3	4	58
210	21071	Coppen and Davies, 1987	Zinc	100	Rat (*Rattus norvegicus*)	1	2	0/160	mg/kg diet	N	na	ADL	U	FD	14	d	NR	NR	JV	M	C	LAB	GRO	GRO	BDWT	WO	160		Y	0.1	N	0.0103504	16.6		10	10	5	4	6	8	4	1	10	4	62
211	21084	Agarwal et al, 1986	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/200	mg/kg diet	N	na	NR	U	FD	14	d	9-10	w	SM	M	C	LAB	REP	REP	TEWT	TE	200		Y	0.216	N	0.019493	18.0		10	10	5	5	6	10	4	1	10	4	65
212	21084	Agarwal et al, 1986	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/200	mg/kg diet	N	na	NR	U	FD	14	d	9-10	w	SM	M	C	LAB	PTH	ORW	ORWT	LI	200		Y	0.216	N	0.019493	18.0		10	10	5	5	6	4	4	1	10	4	59
213	21084	Agarwal et al, 1986	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/200	mg/kg diet	N	na	NR	U	FD	14	d	9-10	w	SM	M	C	LAB	BIO	ENZ	LADH	TE	200		Y	0.216	N	0.019493	18.0		10	10	5	5	6	1	4	1	10	4	56
214	3733	Banis et al 1969	ZnO	100	Rat (*Rattus norvegicus*)	1	2	0/200	mg/kg diet	N	na	ADL	U	FD	3	w	5	w	JV	NR	C	NR	GRO	GRO	BDWT	WO	200		Y	0.1228	N	0.012254	20.0		10	10	5	5	6	8	4	3	10	4	65
215	3733	Banis et al 1969	ZnO	100	Rat (*Rattus norvegicus*)	1	2	0/200	mg/kg diet	N	na	ADL	U	FD	3	w	5	w	JV	NR	C	NR	BIO	CHM	HMGL	BL	200		Y	0.1228	N	0.012254	20.0		10	10	5	5	6	1	4	3	10	4	58
216	48541	Dhawan et al, 1992	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	1	2	0/227	mg/L	N	na	ADL	U	DR	6	w	NR	NR	JV	M	C	COM	BIO	ENZ	ALPH	LI	227		Y	0.18	N	0.0211534	26.7		10	5	5	10	6	1	4	6	10	4	61
217	668	Bonner et al 1980	Zinc	100	Rat (*Rattus norvegicus*)	1	2	0/300	mg/kg diet	N	na	NR	U	FD	48	w	NR	NR	JV	M	C	NR	GRO	GRO	BDWT	WO	300		Y	0.1	N	0.0103504	31.1		10	10	5	4	6	8	4	1	10	4	62
218	14532	Miller et al, 1965	Zinc oxide	100	Cattle (*Bos taurus*)	1	4	0/5.1/9.4/17.3	g/org/d	N	na	ADL	U	FD	6	w	NR	NR	LC	F	C	COM	BIO	ENZ	ALPH	SR	17.3		Y	504.8483	Y	5.68	34.3		10	10	5	5	7	1	4	1	10	4	57
219	14532	Miller et al, 1965	Zinc oxide	100	Cattle (*Bos taurus*)	1	4	0/5.1/9.4/17.3	g/org/d	N	na	ADL	U	FD	6	w	NR	NR	LC	F	C	COM	BEH	FDB	FCNS	WO	17.3		Y	504.8483	Y	5.68	34.3		10	10	5	5	7	4	4	1	10	4	60
220	21069	Amemiya et al, 1986	zinc (unspecified)	100	Rat (*Rattus norvegicus*)	1	2	0/1000	ug/g	N	na	ADL	U	FD	21	d	NR	NR	GE	F	C	COM	GRO	GRO	BDWT	WO	1000		Y	0.34	Y	0.014	41.2		10	10	5	4	7	8	4	1	10	4	63
221	21069	Amemiya et al, 1986	zinc (unspecified)	100	Rat (*Rattus norvegicus*)	1	2	0/1000	ug/g	N	na	ADL	U	FD	21	d	NR	NR	GE	F	C	COM	BIO	CHM	CALC	PL	1000		Y	0.34	Y	0.014	41.2		10	10	5	4	7	1	4	8	10	4	63
222	21069	Amemiya et al, 1986	zinc (unspecified)	100	Rat (*Rattus norvegicus*)	1	2	0/1000	ug/g	N	na	ADL	U	FD	21	d	NR	NR	GE	F	C	COM	BEH	FDB	FCNS	WO	1000		Y	0.34	Y	0.014	41.2		10	10	5	4	7	4	4	1	10	4	59
223	10493	Bunn and Matrone, 1966	Zinc oxide	100	Mouse (*Mus musculus*)	1	3	0/200/400	mg/kg diet	N	na	ADL	U	FD	5	w	NR	NR	JV	M	C	LAB	BIO	CHM	HMGL	BL	400		N	0.02695	N	0.0035227	52.3		10	10	5	5	5	1	4	1	10	4	55
224	10493	Bunn and Matrone, 1966	Zinc oxide	100	Mouse (*Mus musculus*)	1	3	0/200/400	mg/kg diet	N	na	ADL	U	FD	5	w	NR	NR	JV	M	C	LAB	GRO	GRO	BDWT	WO	400		Y	0.02695	N	0.0035227	52.3		10	10	5	5	6	8	4	1	10	4	63

Ref			Exposure																		Effects							Conversion to mg/kg bw/day				Result		Data Evaluation Score											
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
225	14524	Augey, et al, 1977	Zinc sulfate	100	Mouse (*Mus musculus*)	1	2	0/0.5	g/L	N	na	ADL	U	DR	6	mo	1.5-2	mo	JV	B	C	LAB	BIO	CHM	GLUC	PL	0.5		Y	0.031	N	0.0043437	70.1		10	5	5	10	6	1	4	1	10	4	56
226	14524	Augey, et al, 1977	Zinc sulfate	100	Mouse (*Mus musculus*)	1	2	0/0.5	g/L	N	na	ADL	U	DR	12	mo	1.5-2	mo	JV	B	C	LAB	GRO	GRO	BDWT	WO	0.5		Y	0.031	N	0.0043437	70.1		10	5	5	10	6	8	4	1	10	4	63
227	14685	Miller et al., 1989	Zinc sulfate	100	Cattle (*Bos taurus*)	1	3	0/1000/2000	mg/kg diet	N	na	ADL	U	FD	14	w	NR	NR	LC	F	C	COM	BIO	CHM	PCLV	BL	2000		Y	565	Y	22	77.9		10	10	5	10	7	1	4	1	10	4	62
228	14536	Ott et al., 1966	Zinc oxide	100	Cattle (*Bos taurus*)	1	4	0/1.1/2.1/3.1	g/kg diet	N	na	ADL	U	FD	35	d	NR	NR	JV	M	C	COM	BIO	CHM	HMGL	BL	3.1		N	270	Y	6.87	78.9		10	10	5	5	6	1	4	1	10	4	56
229	34167	Elsenhans et al, 1993	Zinc sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/1000	mg/kg diet	N	na	ADL	U	FD	2	w	NR	NR	NR	F	C	COM	GRO	GRO	BDWT	WO	1000		N	0.35	N	0.0289855	82.8		10	10	5	10	5	8	4	3	3	4	62
230	14385	Willoughby et al, 1972	Zinc oxide	100	Horse (*Equus caballus*)	1	2	0/5400	mg/kg diet	N	na	ADL	M	FD	9	w	3-4	w	JV	B	C	COM	BIO	CHM	PCLV	BL	5400		N	181.44	Y	2.81232	83.7		10	10	10	5	6	1	4	1	10	4	61
231	14376	Hsu et al, 1975	Zinc oxide	100	Pig (*Sus scrofa*)	1	2	0/4000	mg/kg diet	N	na	ADL	U	FD	13	w	4	w	JV	NR	C	DOM	BEH	FDB	FCNS	WO	4000		Y	64.92	Y	1.446	89.1		10	10	5	5	7	4	4	3	10	4	62
232	38511	Katouli, et al, 1999	Zinc oxide	100	Pig (*Sus scrofa*)	1	2	0/2500	mg/kg diet	N	na	ADL	U	FD	4	w	35	d	JV	B	C	DOM	GRO	GRO	BDWT	WO	2500		N	31.5	N	1.17103	92.9		10	10	5	5	5	8	4	1	10	4	62
233	45270	Hill and Miller, 1983	Zinc oxide	100	Pig (*Sus scrofa*)	1	3	0/500/5000	mg/kg diet	N	na	ADL	U	FD	20	w	NR	NR	GE	F	C	COM	GRO	GRO	BDWT	WO	5000		Y	140.6	Y	2.75	97.8		10	10	5	5	7	8	4	1	10	4	64
234	42234	Schell and Kornegay, 1996	Zinc oxide	100	Pig (*Sus scrofa*)	1	4	0/236/572/762	mg/d	N	na	ADL	M	FD	2	w	23	d	JV	B	C	COM	BEH	FDB	FCNS	WO	762		Y	7.4	Y	0.26	103		10	10	10	5	7	4	4	1	10	4	65
235	42234	Schell and Kornegay, 1996	Zinc oxide	100	Pig (*Sus scrofa*)	1	4	0/236/572/762	mg/d	N	na	ADL	M	FD	2	w	23	d	JV	B	C	COM	PHY	PHY	FDCV	WO	762		Y	7.4	Y	0.26	103		10	10	10	5	7	4	4	1	10	4	65
236	14526	Cox and Hale, 1962	Zinc oxide	100	Pig (*Sus scrofa*)	1	3	0/0.2/0.4	% in diet	N	na	ADL	U	FD	69	d	NR	NR	JV	NR	C	COM	BIO	CHM	HMGL	BL	0.4		Y	59.10309	Y	1.98	134		10	10	5	5	7	1	4	1	10	4	57
237	14526	Cox and Hale, 1962	Zinc oxide	100	Pig (*Sus scrofa*)	1	3	0/0.2/0.4	% in diet	N	na	ADL	U	FD	69	d	NR	NR	JV	NR	C	COM	GRO	GRO	BDWT	WO	0.4		Y	59.10309	Y	1.98	134		10	10	5	5	7	8	4	1	10	4	64
238	14526	Cox and Hale, 1962	Zinc oxide	100	Pig (*Sus scrofa*)	1	3	0/0.2/0.4	% in diet	N	na	ADL	U	FD	69	d	NR	NR	JV	NR	C	COM	BEH	FDB	FCNS	WO	0.4		Y	59.10309	Y	1.98	134		10	10	5	5	7	4	4	1	10	4	60
239	45142	Hill et al, 1983	Zinc oxide	100	Pig (*Sus scrofa*)	1	3	0/500/5000	mg/kg diet	N	na	ADL	U	FD	3	w	7-8	mo	LC	F	C	COM	BIO	CHM	CALC	MK	5000		Y	100	Y	2.75	138		10	10	5	5	7	1	4	1	10	4	57
240	42838	Cox et al, 1969	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/0.4	% in diet	N	na	ADL	U	FD	22	d	NR	NR	GE	F	C	COM	PTH	ORW	ORWT	LI	0.4		Y	0.245	N	0.0216198	353		10	10	5	5	6	4	4	6	10	4	64
241	14662	Ansari et al, 1976	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	8	0/1200/2400/3600/4800/6000/720	mg/kg diet	N	na	ADL	U	FD	21	d	35	d	JV	M	C	COM	GRO	GRO	BDWT	WO	8400		Y	0.1893	Y	0.019	843		10	10	5	5	7	8	4	1	10	4	64
242	14662	Ansari et al, 1976	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	8	0/1200/2400/3600/4800/6000/720	mg/kg diet	N	na	ADL	U	FD	21	d	35	d	JV	M	C	COM	BEH	FDB	FCNS	WO	8400		Y	0.1893	Y	0.019	843		10	10	5	5	7	4	4	1	10	4	60
243	21045	Bui, et al, 1998	Zinc	100	Rat (*Rattus norvegicus*)	1	2	0/0.09746	mg/g bw	N	na	ADL	M	GV	7	d	NR	NR	GE	F	V	COM	BIO	CHM	MCPR	LI	0.9746		Y	0.2562	N	0.0224289	975		10	8	10	4	10	1	4	1	10	4	62
244	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	3	4	0/24.5/243/2486	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	BEH	FDB	FCNS	WO	2486		Y	0.231	Y	0.0149	2486		10	10	5	10	7	4	4	1	10	4	65
245	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Rat (*Rattus norvegicus*)	3	4	0/24.5/243/2486	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	PHY	PHY	FDCV	WO	2486		Y	0.231	Y	0.0149	2486		10	10	5	10	7	4	4	1	10	4	65
246	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	1	4	0/46.4/479/4878	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	F	C	COM	BEH	FDB	FCNS	WO	4878		Y	0.0327	Y	0.0036	4878		10	10	5	10	7	4	4	1	10	4	65
247	43680	Maita et al, 1981	Zinc sulfate heptahydrate	100	Mouse (*Mus musculus*)	2	4	0/42.7/458/4927	mg/kg bw/d	N	na	ADL	U	FD	13	w	5	w	JV	M	C	COM	BEH	FDB	FCNS	WO	4927		Y	0.0386	Y	0.0054	4927		10	10	5	10	7	4	4	1	10	4	65
248	21006	Sinha, et al, 1989	Zinc	100	Rat (*Rattus norvegicus*)	1	3	0/500/1000	mg/kg diet	N	na	ADL	U	FD	3	w	NR	NR	JV	B	C	COM	BIO	ENZ	ALPH	OV		500	Y	0.204	Y	0.00179		4.39	10	10	5	4	7	1	4	10	10	4	65
249	45042	Katya-Katya et al., 1984	Zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/200	mg/kg diet	N	na	ADL	U	FD	3	mo	10	w	JV	M	C	LAB	BIO	CHM	CHOL	PL		200	N	0.462	N	0.036416		15.8	10	10	5	5	5	1	4	10	10	4	64
250	21131	Perry et al, 1980	Zinc acetate	100	Rat (*Rattus norvegicus*)	1	2	0/200	mg/L	N	na	ADL	U	DR	18	mo	NR	NR	JV	F	C	COM	PHY	PHY	BLPR	WO		200	N	0.179	N	0.0210476		23.5	10	5	5	5	5	4	4	10	10	4	62
251	39430	Reeves, 1995	Zinc	100	Rat (*Rattus norvegicus*)	1	2	0/350	mg/kg diet	N	na	ADL	U	FD	5	d	8	w	JV	B	C	COM	BIO	CHM	GBCM	IN		350	N	0.267	N	0.0232033		30.4	10	10	5	4	5	1	4	10	10	4	63
252	668	Bonner et al 1980	Zinc	100	Rat (*Rattus norvegicus*)	1	2	0/300	mg/kg diet	N	na	NR	U	FD	8	w	NR	NR	JV	M	C	NR	BIO	ENZ	ALPH	BO		300	Y	0.1	N	0.0103504		31.1	10	10	5	4	6	1	4	10	10	4	64
253	21042	Barone et al, 1998	Zinc	100	Rat (*Rattus norvegicus*)	1	2	0/1000	mg/kg diet	N	na	ADL	U	FD	10	d	NR	NR	GE	F	C	LAB	BIO	CHM	MCPR	LI		1000	Y	0.3945	N	0.0319821		81.1	10	10	5	4	6	1	4	10	10	4	64
254	42767	Chu and Cox, 1970	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/0.4	% in diet	N	na	ADL	U	FD	21	d	NR	NR	LC	F	C	COM	BIO	ENZ	GENZ	MK		0.4	Y	0.268	N	0.0232747		347	10	10	5	5	6	1	4	10	10	4	65
255	42838	Cox et al, 1969	Zinc oxide	100	Rat (*Rattus norvegicus*)	1	2	0/0.4	% in diet	N	na	ADL	U	FD	22	d	NR	NR	GE	F	C	COM	BIO	CHM	CALC	KI		0.4	Y	0.245	N	0.0216198		353	10	10	5	5	6	1	4	10	10	4	65

All abbreviations and definitions are used in coding stuides are available from Attachment 4-3 of the Eco-SSL guidance (U.S. EPA 2003).

Duplicate values for NOAELs and LOAELs for the same reference represent results from different experimental designs and are identified by different Phase numbers.