

APPENDICES

Appendix -1

Organochlorine pesticides levels associated with biological effects in birds

All levels in mg/kg [ppm]

Species	Contaminant	Type of study	Tissue	Contaminant		Effects	Reference
				Source	Levels		
Black Ducks	DDE/DDT	Experimental	egg	Dietary 10 ppm	46	Shell thinning, increased shell	Longcore <i>et al.</i> , 1971
						Cracking, reduced duckling	
						Survival	
				30 ppm	144	Shell thinning, increased shell	
						Cracking, reduced duckling	
						Survival	
Loons	DDE/DDT	Field	egg		5.8	Eggshell structural abnormalities and some thinning	Fox <i>et al.</i> , 1980
Birds	DDT	Experimental		Skin, inhalation	595 to >2000	50 % mortality (5d on treated food and 3d on clean flour	Hudson <i>et al.</i> , 1984

Species	Contaminant	Type of study	Tissue	Contaminant		Effects	Reference
				Source	Levels		
Birds	DDT	Experimental		dietary	311 to 1869	50 % mortality	Hill <i>et al.</i> , 1975
Birds	DDD	Experimental		dietary	579 to 1869	50 % mortality	Hill <i>et al.</i> , 1975
Birds	DDE	Experimental		dietary	825 to 3572	50 % mortality	Hill <i>et al.</i> , 1975
Birds	DDT, DDE, DDD	Experimental	brain		10 DDT equivalents	Mortality	Stickel <i>et al.</i> , 1970
					1 DDT		
					equi. = 1mg/g DDT =5 mg/g DDD =15 mg/g DDE		
Birds	DDD						
Osprey	DDE	Field	Eggs		4.2	15 % shell thinning	Wiemeyer <i>et al.</i> , 1988
Bald	DDE	Field	Eggs		16	15 % shell thinning	Wiemeyer <i>et al.</i> ,

Species	Contaminant	Type of study	Tissue	Contaminant Source	Contaminant Levels	Effects	Reference
Eagle							1993
Birds	Aldrin	Experimental		dietary	34 to 155	50 % mortality	Hill <i>et al.</i> , 1975
Birds	Dieldrin	Experimental			37 to 169	50 % mortality	Hill <i>et al.</i> , 1975
Birds	Aldrin	Experimental			7 to 520	50 % mortality	Hudson <i>et al.</i> , 1984
Birds	Dieldrin	Experimental			9 to 381	50 % mortality	Hudson <i>et al.</i> , 1984
Birds	Dieldrin	Experimental	Brain		5	Mortality	Johnson <i>et al.</i> , 1981
Bids	Heptachlor	Experimental		dietary	92 to 480	50 % mortality	Hill <i>et al.</i> , 1975
Birds	Heptachlor	Experimental			> 2000	50 % mortality	Hudson <i>et al.</i> , 1984
Birds	Heptachlor	Experimental	Brain		> 8	Lethal/ mortality	Stickel <i>et al.</i> , 1979b

Species	Contaminant	Type of study	Tissue	Contaminant		Effects	Reference
				Source	Levels		
	Epoxicide						
Birds	Heptachlor Epoxicide	Field	Egg			Decreasing reproductive success on increase of residues	Blus <i>et al.</i> , 1984, Henny <i>et al.</i> , 1983
Quail	Endrin	Field	Field spray	1.3 to 1.7 kg l/ha	Mortality	Blus <i>et al.</i> , 1989	
		Experimental		Dietary	14 to 22	50 % mortality	Hill <i>et al.</i> , 1975
		Experimental			1 to 6	50 % mortality	Hudson <i>et al.</i> , 1984
Birds	Endrin	Experimental	Brain		>0.8	Mortality	Stickel <i>et al.</i> , 1979a
Brown pelican	Endrin	Field	any			No detrimental impact	Blus <i>et al.</i> , 1979
Birds	Chlordane	Experimental		Dietary	331 to 858	50 % mortality	Hill <i>et al.</i> , 1975
Birds	Chlordane	Experimental			14 to 1200	50 % mortality	Hudson <i>et al.</i> , 1975
Birds	Heptachlor	Experimental	Brain		3.4 to	Mortality	Stickel <i>et al.</i> ,

Species	Contaminant	Type of study	Tissue	Contaminant		Effects	Reference
				Source	Levels		
	ore epoxide				8.3		1979b
Birds	Oxychlor dane	Experimental	Brain		1.1 to 5.0	Mortality	Stickel <i>et al</i> , 1979b
Birds	HCH	Experimental	LD50		118 to >1400	50 % mortality	Hudson <i>et al</i> , 1984
Birds	Lindane	Experimental	LD50		75 to >2000	50 % mortality	Schfer <i>et al</i> , 1983
Birds	HCH	Experimental	LC50		400 to 5000	50 % mortality	Hill <i>et al</i> , 1975
Birds	Lindane	Experimental	LC50		400 to 5000	50 % mortality	Hill <i>et al</i> , 1975
Ring- necked Pheasant	Lindane	Field	Eggs		10	Unaffected	Ash and Taylor 1964
Double- crested Cormorant	DDE	Experimental	Egg		10	20 % Eggshell thinning	Pearce <i>et al</i> , 1979

Species	Contaminant	Type of study	Tissue	Contaminant Source	Contaminant Levels	Effects	Reference
Double-crested Cormorant	DDE	Field	Egg		>= 9	Impairment of breeding success	King and Kryniasty 1986
Peregrine Falcon	DDE	Field	Egg		20	Critical level which Eggshell thinning and decrease in population observed	Ambrose <i>et al.</i> , 1988
Brown Pelican	DDE	Calculated	Egg		8	20 % Eggshell thinning	Blus <i>et al.</i> , 1984
Black-crowned Night Heron	DDE	Calculated	Egg		54	20 % Eggshell thinning	Blus <i>et al.</i> , 1984
Brown Pelican	DDE	Field	Eggshell		18 % shell thinning	Critical shell thinning (at 5 ppm) exhibit population decline	Blus <i>et al.</i> , 1984
Black-crowned Night Heron	DDE	Field	Eggshell		18 % shell thinning	Critical shell thinning (at 36 ppm) exhibit population decline	Blus <i>et al.</i> , 1984
	DDE	Field	Egg		12	Breeding success decrease by 27-58 %	Blus <i>et al.</i> , 1984

Species	Contaminant	Type of study	Tissue	Contaminant		Effects	Reference
				Source	Levels		
Brown Pelican	DDE	Field	Egg		3	Critique: Total failure to reproduce at 3.7	Blus <i>et al.</i> , 1984
Brown Pelican	DDE	Calculated	Eggshell		16%	Critical: breeding success decreased	Blus <i>et al.</i> , 1984
Black-crowned Night Heron	DDE	Calculated	Eggshell		13%	Critical: breeding success decreased	Blus <i>et al.</i> , 1984
White-faced Ibis	DDE	Field	Egg		>4	Eggshell thinning and impaired the breeding success	Henny and Heron
			Eggshell		20%	Low reproductive success of individual and population	Anderson and Hickey 1972
Japanese Quail			muscle	oral	6	Hyperactivity and increased porphyrin excretion	Fletcher, 1972
			muscle		7	Hyperactivity and increased porphyrin excretion	

Species	Contaminant	Type of study	Tissue	Contaminant		Effects	Reference
				Source	Levels		
Chicken			muscle	dietary	12	No effect on health and general condition	Avrahami and Steele, 1972
Sentinel Mallards	Oxychlor dane		breast	10 days	nd	Increased hepatic BROD, PROD & EROD activity correlated to PCB and	Custer <i>et al.</i> , 1996
			muscle	52 days	nd		
				100 days	0.05	oxychlor dane levels	
Black Duck	Toxapha ne		carcass	dietary 10 ppm	8 6	Increased Ca concentration in vertebrae	Mehrle <i>et al.</i> , 1979
				50 ppm	40	Impaired growth and bone development in ducklings	
			carcass	dietary 10 ppm	<0.5	No adverse reproductive effects	Haseltine <i>et al.</i> , 1980
				50 ppm	<0 5	No adverse reproductive	

Species	Contaminant	Type of study	Tissue	Contaminant		Effects	Reference
				Source	Levels		
						effects	
Mallard	Dieldrin		muscle	dietary 0.3 ppm	<1.0	None	Nebeker et al, 1992
				16.4 ppm	5	Significant growth reduction, some mortality	
				48.0 ppm	10	Significant growth reduction, some mortality	
				Source	Levels		
Black Ducks	DDE/DDT	Experimental	egg	Dietary 10 ppm	46	Shell thinning, increased shell	Longcore et al, 1971
						Cracking, reduced duckling Survival	
				30 ppm	144	Shell thinning, increased shell	
						Cracking, reduced duckling Survival	
Loons	DDE/DDT	field	egg		5.8	Eggshell structural abnormalities and some thinning	Fox et al, 1980

Species	Contaminant	Type of study	Tissue	Contaminant		Effects	Reference
				Source	Levels		
Birds	DDT	Experimental		Skin, inhalation	595 to >2000	50 % mortality (5d on treated food and 3d on clean flour)	Hudson <i>et al.</i> , 1984
Birds	DDT	Experimental		dietary	311 to 1869	50 % mortality	Hill <i>et al.</i> , 1975
Birds	DDD	Experimental		dietary	579 to 1869	50 % mortality	Hill <i>et al.</i> , 1975
Birds	DDE	Experimental		dietary	825 to 3572	50 % mortality	Hill <i>et al.</i> , 1975
Birds	DDT, DDE, DDD	Experimental	brain		10 DDT equivalent 1 DDT equi. = 1mg/g DDT =5 mg/g DDD =15 mg/g DDE	Mortality	Stickel <i>et al.</i> , 1970
Birds	DDD						

Species	Contaminant	Type of study	Tissue	Contaminant Source	Contaminant Levels	Effects	Reference
Osprey	DDE	Field	Eggs		4 2	15 % shell thinning	Wiemeyer <i>et al</i> , 1988
Bald Eagle	DDE	Field	Eggs		16	15 % shell thinning	Wiemeyer <i>et al</i> , 1993
Birds	Aldrin	Experimental		dietary	34 to 155	50 % mortality	Hill <i>et al</i> , 1975
Birds	Dieldrin	Experimental			37 to 169	50 % mortality	Hill <i>et al</i> , 1975
Birds	Aldrin	Experimental			7 to 520	50 % mortality	Hudson <i>et al</i> , 1984
Birds	Dieldrin	Experimental			9 to 381	50 % mortality	Hudson <i>et al</i> , 1984
Birds	Dieldrin	Experimental	Brain		5	Mortality	Johnson <i>et al</i> , 1981
Bids	Heptachlor	Experimental		dietary	92 to 480	50 % mortality	Hill <i>et al</i> , 1975
Birds	Heptachlor	Experimental			> 2000	50 % mortality	Hudson <i>et al</i> ,

Species	Contaminant	Type of study	Tissue	Contaminant		Effects	Reference
				Source	Levels		
	or						1984
Birds	Heptachlor Epoxide	Experimental	Brain		> 8	Lethal/ mortality	Stickel <i>et al</i> , 1979b
Birds	Heptachlor Epoxide	Field	Egg			Decreasing reproductive success on increase of residues	Blus <i>et al</i> , 1984, Henry <i>et al</i> ., 1983
Quail	Endrin	Field	Field spray	13 to 17 kg l/ha	Mortality	Blus <i>et al</i> , 1989	
		Experimental		Dietary	14 to 22	50 % mortality	Hill <i>et al</i> , 1975
		Experimental			1 to 6	50 % mortality	Hudson <i>et al</i> ., 1984
Birds	Endrin	Experimental	Brain		>0.8	Mortality	Stickel <i>et al</i> ., 1979a
Brown pelican	Endrin	Field	any			No detrimental impact	Blus <i>et al</i> , 1979
Birds	Chlordane	Experimental		Dietary	331 to 858	50 % mortality	Hill <i>et al</i> , 1975

Species	Contaminant	Type of study	Tissue	Contaminant Source	Levels	Effects	Reference
Birds	Chlordane	Experimental			14 to 1200	50 % mortality	Hudson <i>et al.</i> , 1975
Birds	Heptachlor epoxide	Experimental	Brain		3.4 to 8.3	Mortality	Stickel <i>et al.</i> , 1979b
Birds	Oxychlor dane	Experimental	Brain		1.1 to 5.0	Mortality	Stickel <i>et al.</i> , 1979b
Birds	HCH	Experimental	LD50		118 to >1400	50 % mortality	Hudson <i>et al.</i> , 1984
Birds	Lindane	Experimental	LD50		75 to >2000	50 % mortality	Schfer <i>et al.</i> , 1983
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Ring-necked Pheasant	Lindane	Field	Eggs		10	Unaffected	Ash and Taylor 1964

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				Source	Levels		
Double-crested Cormorant	DDE	Experimental	Egg		10	20 % Eggshell thinning	Pearce <i>et al.</i> , 1979
Double-crested Cormorant	DDE	Field	Egg		>= 9	Impairment of breeding success	King and Krysty 1986
Peregrine Falcon	DDE	Field	Egg		20	Critical level which Eggshell thinning and decrease in population observed	Ambrose <i>et al.</i> , 1988
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Brown Pelican	DDE	Field	Eggshell		18 % shell thinning	Critical shell thinning (at 5 ppm) exhibit population decline	Blus <i>et al.</i> , 1984
Black-crowned Night	DDE	Field	Eggshell		18 % shell thinning	Critical shell thinning(at 36 ppm) exhibit population	Blus <i>et al.</i> , 1984

Species	Contaminant	Type of study	Tissue	Contaminant Source	Contaminant Levels	Effects	Reference
Heron						decline	
	DDE	Field	Egg		12	Breeding success decrease by 27-58 %	Blus <i>et al.</i> , 1984
Brown Pelican	DDE	Field	Egg		3	Critical: Total failure to reproduce at 3.7	Blus <i>et al.</i> , 1984
Brown Pelican	DDE	Calculated	Eggshell		16%	Critical: breeding success decreased	Blus <i>et al.</i> , 1984
Black-crowned Night Heron	DDE	Calculated	Eggshell		13%	Critical: breeding success decreased	Blus <i>et al.</i> , 1984
White-faced Ibis	DDE	Field	Egg		>4	Eggshell thinning and impaired the breeding success	Henny and Heron
			Eggshell		20%	Low reproductive success of individual and population	Anderson and Hickey 1972
Japanese Quail			muscle	oral	6	Hyperactivity and increased	Fletcher, 1972

Species	Contaminant	Type of study	Tissue	Contaminant		Effects	Reference
				Source	Levels		
						porphyrin excretion	
			muscle		7	Hyperactivity and increased	
						porphyrin excretion	
Chicken			muscle	dietary	12	No effect on health and	Avrahi and Steele, 1972
						general condition	
Sentinel Mallards	Oxychlorane		breast	10 days	nd	Increased hepatic BROD, PROD &	Custer et al., 1996
			muscle	52 days	nd	EROD activity correlated to PCB and	
				100 days	0.05	oxychlorane levels	
Black Duck	Toxaphene		carcass	dietary 10 ppm	8.6	Increased Ca concentration in vertebrae	Mehrle et al., 1979
				50 ppm	40	Impaired growth and bone	
						development in ducklings	

Species	Contaminant	Type of study	Tissue	Contaminant		Effects	Reference
				Source	Levels		
			carcass	dietary 10 ppm	<0.5	No adverse reproductive effects	Haseltine <i>et al.</i> , 1980
				50 ppm	<0.5	No adverse reproductive effects	
Mallard	Dieldrin		muscle	dietary 0.3 ppm	<1.0	None	Nebeker <i>et al.</i> , 1992
				16.4 ppm	5	Significant growth reduction,	
						some mortality	
				48.0 ppm	10	Significant growth reduction,	
						some mortality	
				Source	Levels		
Black Ducks	DDE/DD T	Experimental	egg	Dietary 10 ppm	46	Shell thinning, increased shell	Longcore <i>et al.</i> , 1971
						Cracking, reduced duckling	
						Survival	
						Shell thinning, increased shell	
				30 ppm	144	Cracking, reduced duckling	

Species	Contaminant	Type of study	Tissue	Contaminant		Effects	Reference
				Source	Levels		
						Survival	
Loons	DDE/DD T	field	egg		5.8	Eggshell structural abnormalities	Fox <i>et al</i> , 1980