COUNCIL OF EUROPE
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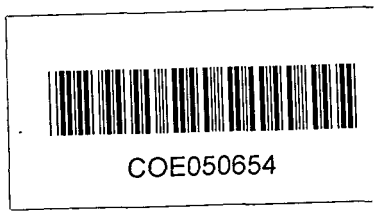
Strasbourg, 6 November 1968 CE/Nat (68) 71



EUROPEAN COMMITTEE FOR THE CONSERVATION
OF NATURE AND NATURAL RESOURCES

AD HOC STUDY GROUP ON PESTICIDES

Preliminary Assessment of harm to wildlife by different pesticides

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11.903
03.3/58.1

PRELIMINARY ASSESSMENT OF HARM TO WILDLIFE BY DIFFERENT PESTICIDES

Introduction

The application of any pesticide will always cause some harm to some wild organisms. The principal aim of this paper is to list those pesticides which are known to have caused serious casualities to species which are of special value to man, that is to mammals, birds, fish and bees (Table 1). Experience has shown that farmers and contractors frequently do not notice dead animals occurring in fields after the use of pesticides or, if they do notice them, they usually do not report their observations to agricultural advisers or to chemical manufacturers. So, when no wildlife casualties have been reported following the use of a certain pesticide, it cannot be assumed that none has occurred. Therefore a second list of chemicals is given here (Table 2); no reliable reports of wildlife casualties attributable to them are known to the author, but since all of them are "moderately toxic" (acute oral LD 50 for the rat is between 50 and 500) or are "highly toxic" (acute oral toxicity for the rat is less than 50), they are likely to cause mortality to wildlife on occasions.

A third list of chemicals is given in Table 3 in order to name those of lower toxicity which have been examined in this study and which have not caused serious hazards to wildlife so far as is known.

The nomenclature of pesticides follows that given in the British Standards Recommended Common Names for Pesticides (BS 1831, et seq.). Only the better known synonyms are given.

Pesticides affect different groups differently; it is axiomatic that most insecticides will harm beneficial insects, including bees, as well as pest species. In general, fish are more sensitive than land vertebrates; for example, most herbicides do not affect birds and mammals yet some are highly toxic to fish.

The hazard of a particular compound may depend on its formulation: for example, the amines of 2,4-D are more toxic than the esters. A dilute formulation of a very toxic pesticide may do less harm than a more concentrated formulation of a less toxic compound. Methods of application

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are also important. Some soil sterilants are highly toxic and yet cause no serious effect to birds and mammals; on the other hand, toxic seed dressings can be particularly harmful to wildlife, because the treated seed acts as a poisoned bait if it is left on the surface of the soil.

Many of the reported incidents can be traced to accidents or to the misuse of chemicals, for example spillages into rivers, the application of excessive quantities of pesticides, or their use when flowers are open and attractive to bees.

All pesticides are likely to have indirect ecological effects: if extensive some of these may be harmful. For example, the introduction of DDT and other insecticides in orchards has caused changes in prey/predator and competitive relationships in insect populations, so that previously rare species have increased and become pests. However, extremely little is known about indirect effects on mammals, birds and fish. Some insecticides potentiate others - nothing is known about the effects of potentiation on wildlife.

Evidence that a pesticide has caused harm to wildlife may be circumstantial only. Ideally, dead animals found after the application of a pesticide should be chemically analysed. If they are found to contain residues which are indicative of death, it can be assumed that the pesticide was the cause of death. Until recent years analytical methods had not been as fully developed as they are today and many of the accounts of incidents in earlier years consisted merely of records of dead animals picked up after chemical treatment. Such records mean little if only a few corpses are found, but if many are found it is likely that the chemical treatment did in fact cause the casualties. In this paper only incidents supported by chemical analysis or ones in which there is other strong evidence that the pesticide concerned did cause death are included in Table 1.

To reduce the size of the bibliography reference is made to key reviews wherever possible. These can be used for obtaining detailed references to the original papers.

It must be emphasised that this paper is a preliminary one. Most of the records of incidents were obtained in an ad hoc manner and not as the result of special studies. Also the search of the literature has been extensive but not exhaustive. Further experience of the effects of well-established and new pesticides in the field will make periodical reviews of this paper necessary.

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Conclusions

Despite many gaps in our knowledge about the effects of pesticides on wildlife useful conclusions can be based on the data provided in Table 1:-

(a) The most hazardous pesticides are those which combine high toxicity and great persistence. These chemicals kill animals both by direct and secondary poisoning. They become widely distributed and can accumulate in both terrestrial and aquatic environments; sometimes animals die or suffer sub-lethal effects as the result of their accumulation in food chains. Aldrin, dieldrin and heptachlor are examples of this group.

(b) Persistent pesticides are more hazardous than non-persistent pesticides of the same toxicity. For example, DDT is more hazardous than diazinon.

(c) Persistent compounds become so widely dispersed that some are now global environmental contaminants. If their levels in the total environment are high enough they can have effects on a whole species, not just on local populations of it.

(d) Among the non-persistent pesticides hazard is roughly proportional to toxicity, although hazard also depends to a large extent on formulation.

(e) Exposed poison baits and seed dressed with pesticides are particularly likely to cause harm to wildlife.

These conclusions are well-known to many individuals and organisations. Pesticide hazards to wildlife have been demonstrated in all the inhabited continents. To reduce hazards to man, domestic animals and wildlife, an increasing number of governments discourage the use of the more toxic and the more persistent pesticides and insist on, or encourage the use of less toxic and less persistent substitutes. Nevertheless, there are still many countries with very inadequate arrangements for the control of pesticides: the application of existing knowledge would much improve the situation.

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Acknowledgements

It is a pleasure to acknowledge the invaluable help of my colleague, Mr. J. L. F. Parslow, in preparing this report.

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Table 1. PESTICIDES KNOWN TO HAVE CAUSED MORTALITY AMONG WILDLIFE IN THE FIELD

Chemical	acute oral LD50, rat (mg./kg.)	Approx. year of introd.	Examples of wildlife incidents: Use	Location	Effects on wildlife	Refs.
**Aldrin oc. I	10-67	1949	Rice seed dressing	Southern States, U.S.A.	Widespread heavy mortality of Fulvous Tree Ducks Dendrocygna bicolor; population endangered.	(4)
			Cereal seed dressing	Britain	Several incidents involving mortality of birds.	(3)
			Japanese Beetle Popillia japonica control	Illinois, U.S.A.	Heavy mortality among game-birds and song birds; also some mammal deaths. Several species of graminivorous birds virtually eliminated in the area.	(2,5)
			Mosquito control	California, U.S.A.	Mortality among waterfowl recorded.	(1)
			Grasshopper control	California, U.S.A.	Effects on bird populations in the field have been slight but noticeable.	(1)
			Industrial accident - lakes contaminated	Colorado, U.S.A.	Heavy mortality of ducks and other waterfowl.	(6)
**Arsenicals Inorganic. I	13-100	1894	Forestry (chemical barking)	California, U.S.A. and Germany	Deer (and also other wild and domestic mammals) have died through licking bases of trees treated with sodium arsenite or consuming spillage.	(1,7,8)
			Potato haulm	Britain	Several reports of Rabbits Oryctolagus cuniculus killed; following treatment with lead arsenate; a few deaths of small rodents and birds also reported - but most incidents have involved small numbers only.	(9)
BHC (includes Lindane) oc. I	125-600	1945	Cereal seed dressing	Britain	Gamma-BHC implicated in several cases of mass deaths among graminivorous birds.	(3)
			Cockroach control	Switzerland	Damage to bees has occurred following treatment of forests.	(10)
			Cockroach control	Germany	Treatmont of forests at 200g/ha resulted in many casualties among adult insectivorous birds and especially their young.	(11)
**Carbaryl (=Sevin) carbamate. I,GR	560	1956	Grasshopper control	Colorado, U.S.A.	Bird population declined owing to loss of insect food; however no cases of acute poisoning observed.	(6)
*Chlordane oc. I	335	1950	Grasshopper control	California, U.S.A.	Some wildlife loss (deaths of fish and birds) usually results when chemical is used for this purpose.	(1)
Cyanide misc. organic. R		1886	Rabbit control	Britain	Badgers Meles meles and Foxes Vulpes vulpes are sometimes killed when HCN is used to gas Rabbits Oryctolagus cuniculus.	(12)
2,4-D (includes 2,4,5-T) subst.phenoxy. H.	400-666	1942	Scrub clearance	U.S.S.R.	Several cases of Elk Alces alces and other mammals and birds being killed during aerial applications of 2,4-D and/or 2,4,5-T.	(13)
			Forestry use	Sweden	"Mass deaths" of Great Tits Parus major followed an application of 2,4-D and 2,4,5-T.	(14)
			Field use	Britain, Germany, etc.	Deaths of bees have occurred following the spraying of nectar-producing plants when in flower.	(15,16)
*DDT oc. I	113-800	1944			Numerous, mainly minor, incidents involving wildlife deaths associated with the use of DDT have been reported from various parts of the world. The following examples may be cited:-	
			Dutch elm disease control	Maine, U.S.A. Michigan, New Hampshire Wisconsin	High application rates caused heavy mortality of song birds, especially American Robins Turdus migratorius, and included the virtual elimination of local populations. In one incident in Michigan, birds of 94 different species were known or suspected to have died.	(2)
			Rice seed dressing	California, U.S.A.	Some deaths of Mallards Anas platyrhynchus, Pheasants Phasianus colchicus and other birds.	(2)
			Orchard pests	Southern England	Some deaths of birds, especially Blackbirds Turdus merula, Song Thrushes Turdus ericetorum, also game birds.	(3,17)
			Pea pests	Britain	Several cases of bird mortality, mostly game birds	(3)
			(Secondary effects)	New England, U.S.A.	Decline and low breeding success of Ospreys Pandion haliaetus attributed to high DDT levels in adult birds and their eggs.	(18,19)
			(Secondary effects)	Michigan, U.S.A.	Low hatching success of Herring Gull Larus argentatus eggs associated with high DDT residues.	(20)

Table 1 contd.

Chemical	acute oral LD50, rat (mg./kg.)	Approx. year of introd.	Examples of wildlife incidents: Use	Location	Effects on wildlife	Refs.
DDT contd.			Gypsy moth Porthetria dispar and biting flies	New York, U.S.A.	Heavy mortality among trout (Salmo) fry	(2)
			Spruce budworm Choristoneura fumiferana	New Brunswick and British Columbia Canada	Salmon and Trout (Salmo spp.) populations reduced and reproduction curtailed.	(2)
			Mosquito control	Florida, U.S.A. New Jersey, U.S.A.	Deaths of crabs, fish, frogs, lizards, snakes.	(2)
			Mosquito control	Cyprus	Freshwater fish populations in country "devastated"	(22)
**Dieldrin (HEOD) oc. I	34-100	1949	Cereal seed dressing	Britain	Many incidents involving large-scale mortality of graminivorous birds, especially Woodpigeons Columba palumbus, game birds, finches; often large numbers - hundreds, even thousands of birds killed. Secondary poisoning of predatory birds, also Badgers Meles meles and Foxes Vulpes vulpes frequently recorded.	(3,17,23, 24)
			Wheat seed dressing	Switzerland	Hundreds of Woodpigeons Columba palumbus killed in one incident.	(11)
			Lucerne pests	Hungary	Heavy losses reported among game birds and mammals.	(25)
			Japanese Beetle Popillia japonica etc.	Virginia, U.S.A. Illinois, U.S.A.	In both cases heavy mortality of Quail Colinus virginianus, song birds, water birds, also Rabbits Sylvilagus sp. and some other mammals.	(2)
			Rice pests	California, U.S.A.	Emergency, high dose, application killed hundreds of birds (e.g. 400 egrets Casmerodius albus?, 100 Mourning Doves Zenaidura macroura), thousands of fish, etc.	(1)
			Forest pests (especially cockroaches)	Germany	Aerial spraying at 200g/ha resulted in deaths of many insectivorous birds and their broods.	(11)
			Imported Fire Ant Solenopsis saevissima	Alabama, U.S.A.	Very heavy and widespread mortality of Quail Colinus virginianus and other animals (birds, mammals, fish, amphibia, reptiles).	(26,27)
			Sheep parasites (Secondary effects)	Scotland	Feeding on sheep carrion reduced breeding success in Golden Eagles Aquila chrysaetos.	(28)
			Cole-rape seed pests	Netherlands	Aerial spraying caused deaths of Hares Lepus europaeus.	(29)
			Sandfly larvae	Florida, U.S.A.	Heavy mortality of fish recorded.	(2)
**Dimethoate op. I,A	245	1961	(Secondary effects)	Britain	One incident of secondary poisoning in Blue Tits Parus caeruleus from eating poisoned honey bees Apis mellifera.	(30)
**DNOC subst.phenols.	7-40 H,I.	1892	As herbicide	Europe	Some confirmed incidents (and many unverified reports) of wildlife kills involving either DNOC or "dinitro compounds" - see e.g. under Sodium monochloroacetate; animals affected include game birds, Skylarks Alauda arvensis, Woodpigeons Columba palumbus, also Rabbits Oryctolagus cuniculus and Hares Lepus europaeus.	(1)
*Endrin oc. I,A,R	10	1951	Vole/mice control	Germany and Switzerland	Deaths of Hares Lepus europaeus and domestic cats have resulted from the use of the chemical as a rodenticide.	(10)
			Vole/mice control	Britain	Illegal use as rodenticide is known to have caused serious mortality of fish when adjacent waterways became contaminated. The chemical is extremely toxic to fish. (It has also been used illegally in Britain to control bird pests, and this has resulted in mortality of protected species.)	(30)
			Aphis control, potatoes	California, U.S.A.	Use has caused mortality amongst Pheasants Phasianus colchicus.	(31)
			Cutworm control	California, U.S.A.	Heavy Rabbit Sylvilagus sp. mortality recorded.	(2)
			Aphis control, soft fruit	California, U.S.A.	Some mortality of game birds recorded.	(31)
			Aphis control, Soft fruit	Britain	Three or more minor incidents involving mortality of Rabbits Oryctolagus cuniculus, game birds, finches, etc.	(3)

Table 1 contd.

Chemical	acute oral LD50, rat (mg./kg.)	Approx. year of introd.	Examples of wildlife incidents: Use	Location	Effects on wildlife	Refs.
**Heptachlor oc. I	60-130	1951	Cereal seed dressing	Britain	Many incidents involving heavy mortality of graminivorous birds, especially Woodpigeons Columba palumbus and game birds.	(3,17)
			Japanese Beetle Popillia japonica control	Illinois, U.S.A.	Applications at 2.2 kg./ha caused the virtual elimination of several species of graminivorous birds.	(2,5)
			Imported Fire Ant Solenopsis saevissima	Alabama, U.S.A.	Applications at 2.2 kg./ha produced heavy mortality of birds, mammals, fish, amphibia, etc.; Quail Colinus virginianus populations remained depressed for at least three years.	(2,26,27)
Kepone oc. I	95-132	1960	Imported Fire Ant Solenopsis saevissima	Alabama, U.S.A.	Several dead/dying Quail Colinus virginianus reported in trials of this compound.	(4)
*Mecarbam op. I	31-35	1961	Industrial accident	Britain	Accidental pollution of a river killed virtually all fish for a distance of 15 miles downstream from discharge.	(30)
Mecoprop subst.phenoxy. H	930	1956	Weed control in Barley	Britain	Three pairs of Partridges Perdix perdix (in pens) died after a field 100 m. away was sprayed.	(32)
Metaldehyde aldehyde. M	500-600 (guinea pig)	1940	Slug control	Britain	Several verified reports of domestic animals (dogs, cats, poultry, ducks) dying after eating slug pellets or poisoned slugs. Also some unpublished and mainly unconfirmed reports of wild birds (Woodpigeons Columba palumbus, Pheasants Phasianus colchicus) being killed.	(30)
Organomercury Compounds misc. organic. F*	14-210	1914	Cereal seed dressing	Sweden	Many serious incidents involving heavy mortality of seed-eating birds. Secondary poisoning recorded (birds of prey, owls) and low reproductive success of White-Tailed Eagle Haliaetus albicilla, Eagle Owl Bubo bubo, Tawny Owl Strix aluco and Long-eared Owl Asio otus attributed to these compounds. Note that alkyl mercury compounds are more hazardous to wildlife than other organomercury compounds, because they are more slowly eliminated from the animal body.	(14,33)
			Cereal seed dressing	Britain	Several incidents involving the deaths of large numbers of birds (e.g. 3,000-4,000 Woodpigeons Columba palumbus in one case) following sowing, especially when liquid dressings using alkyl compounds were used.	(3,17)
Paraquat dipyridyl. H.	157	1958	Weed control	Britain	There are a few reports of deaths of Hares Lepus europaeus; also one of Greenfinches Chloris chloris which fed on treated weeds immediately after spraying.	(30)
**Parathion (includes Methyl Parathion) op. I,A.	2-30	1944	Orchard pests	Washington, U.S.A., British Columbia, Canada	Field observations in both of these states indicate that slight bird losses normally occur following spraying.	(1)
			Orchard pests	Netherlands	Many dead Blackbirds Turdus merula and thrushes Turdus ericetorum found after orchard was sprayed with a 0.06% solution.	(11)
			Orchard pests (Citrus fruit)	California, U.S.A.	Song birds frequently killed when orchards sprayed, but extent of losses are not known.	(1)
			Orchard pests (Citrus fruit)	South Africa	In one incident, 791 birds of various species were found dead immediately after spraying.	(11)
			'Misuse'	Netherlands	Masses of birds found dead.	(11)
			Not Known	Sweden	3,000 Black-headed Gulls Larus ridibundus killed in one incident.	(14)
			Not Known	Sweden	5,000-15,000 Starlings Sturnus vulgaris were killed following the use of Parathion and DDT.	(14)
**Phosphamidon op. I,A.	17-18	1957	Spruce budworm Choristoneura fumiferana	New Brunswick Canada	Serious bird losses followed a heavy aerial application.	(34,35)
			Larch bud moth Eucosma griseana	Switzerland	Aerial spraying caused loss of 60-80% of original bird population; 76 dead adult insectivorous birds collected in 20 ha. Population normal the next year.	(10)

Table 1 contd.

Chemical	acute oral LD_{50}, rat (mg./kg.)	Approx. year of introd.	Examples of wildlife incidents: Use	Location	Effects on wildlife	Refs.
Rotenone (Derris) naturally occurring. I	132	1870			Highly toxic to fish, and used in control of coarse fish in some countries; however, no serious accidental incidents known.	
**Schradan op. I, A.	10	1945	Aphis control Brassicas	Britain	Several incidents concerning the deaths of birds and Rabbits Oryctolagus cuniculus and other mammals, especially in 1952 when the chemical was applied more extensively than usual to deal with a heavy aphis infestation.	(1,9,21)
Sodium fluoroacetate (Compound 1080) misc. organic. R	3	1946	Squirrel control	California, U.S.A.	Several incidents involving the loss of game birds and, especially, domestic animals (notably dogs which ate poisoned squirrels).	(1)
*Sodium monochloro-acetate subst.aliphatic acids. H.	300-400	1951	Weed control in White Clover	Denmark	170 Grey Lag Geese Anser anser found dead after field was treated with 'monochloroacetate'.	(11)
			Potato haulm	Sweden	"Thousands" of Chaffinches Fringilla coeleba died in one locality after treatment of potato haulm with 'monochloroacetate' and dinitro compounds.	(14)
Strychnine plant derived. R	16	1820	Vertebrate pests (squirrels, Red-winged Blackbirds Ageliaus phoeniceus, etc.)	California, U.S.A.	Several incidents reported involving the loss of game birds, pigeons, etc. Wildlife losses following the use of strychnine for the control of mammal pests have occurred in various other parts of the world.	(1)
*TDE (=DDD) oc. I	2500	1944	Gnat control	California, U.S.A. (Clear Lake)	Heavy mortality of Western Grebes Aechmophorus occidentalis and reduction of breeding population as a result of accumulation of the chemical in fish, following its application to lake waters in several successive years.	(1,36)
			Tipulid fly control	California, U.S.A.	Mortality of birds and Kangaroo Rats Dipodomys sp.	(31)
**TEPP op. I	1-2	1939	Ash tree pests	California, U.S.A.	Large numbers of Cedar Waxwings Bombycilla cedrorum killed.	(1)
			Orchard pests	Washington, U.S.A.	Several hundred dead or sick Pheasants Phasianus colchicus found in one year (1947); up to 60 Pheasants found in a single orchard. (Now no longer in wide-scale use,)	(1)
Thallium misc. inorganic. R	15-25	1920	Squirrel control	U.S.A.	Many examples of mortality among graminivorous birds and mammals. Secondary poisoning (of owls, birds of prey, etc.) also recorded.	(1)
Thiram dithiocarbamate. F.	865	1935	Seed dressing	France	Laboratory experiments show that levels likely to be encountered in the field can affect reproduction in Red-legged Partridges Alectoris rufa.	(37)
*Toxaphene oc. I	69	1949	Mosquito control	U.S.A.	Several incidents recorded involving the poisoning of large numbers of fish.	(1)
			Rough fish control	California, U.S.A.	Use at low-levels caused substantial mortality among Pelicans Pelecanus sp.)	(31)
			Forest pests	California, U.S.A.	Deaths of 40-50 Jays Aphelocoma sp. and 'some' woodpeckers followed spraying in one incident.	(1)
			Mosquito control	N. Dakota, U.S.A.	Experimental application (at 1.7 kg./ha) to lake surface killed 8% of bird population (mainly Coots Fulica americana, young ducks)	(1)
			Mosquito control	N. Dakota, U.S.A.	Experimental application (oil formulation, at 2.2 kg./ha) to lake caused heavy mortality of birds. All birds that entered water died; others in dense marginal vegetation were killed. No young birds observed for five weeks after spraying.	(1)
			Crop pests	U.S.A.	Several incidents reported involving the loss of game birds, geese, etc. However, field applications at normal crop insect levels do not usually cause serious wildlife losses.	(1)
			Rodent control	U.S.A.	Experimental use at high rates of application caused death of game birds, rabbits Sylvilagus sp., etc. and led to secondary poisoning of dogs.	(1)
			Grasshopper control	Colorado, U.S.A.	Aerial application (at 2.2 kg./ha) contaminated pond and caused deaths of many aquatic animals, also reptiles and 20 birds.	(6,38)

Table 1 contd.

Chemical	acute oral LD50, rat (mg./kg.)	Approx. year of introd.	Examples of wildlife incidents: Use	Location	Effects on wildlife	Refs.
Toxaphene contd.			Crop pests	California, U.S.A.	Heavy mortality of fish-eating birds recorded at one lake in each year, 1960-63; a total of more than 1,100 birds was killed.	(31)
Warfarin misc. organic. R	58-323	1944	Control of rats	Britain and U.S.A.	A few cases known of secondary poisoning of domestic animals, but wildlife has apparently not been affected. When used in buildings hazard to wildlife is negligible.	(1,30)
Zinc phosphide misc.inorganic. R	40	19th Century	Control of vertebrate pests	Netherlands	Broadcast poisoned wheat killed 500-1000 of a flock of 7,000 wild grey geese. (Elsewhere secondary poisoning has affected domestic animals, but not wild ones so far as is known.)	(1)

NOTES TO TABLE 1

* Pesticides thus marked are moderately toxic to bees (LD50 2.0-10 µg./bee)
** " " " " highly " " " (LD50 0.001-1.99 µg./bee)

The information given beneath the common name of each pesticide refers to (a) the chemical grouping to which it belongs; and (b) the normal use to which it is put. In general, the classification of the British Agricultural Chemicals Approval Scheme has been followed.

The following abbreviations are used:-

oc	organochlorine	A	Acaricide
op	organophosphorus	H	Herbicide
misc.	miscellaneous	F	Fungicide
subst.	substituted	GR	Growth regulator
		M	Molluscicide
		I	Insecticide
		R	Rodenticide

Table 2

LIST OF MODERATELY AND HIGHLY TOXIC CHEMICALS WHICH, HOWEVER, ARE NOT KNOWN TO HAVE CAUSED SERIOUS HARM TO WILDLIFE OTHER THAN BEES. NOTE THAT MOST OF THE CHEMICALS LISTED ARE MODERATELY OR HIGHLY TOXIC TO BEES

(a) Highly toxic chemicals (acute oral LD 50 for rat: 1-50 mg./kg.)

Azinphos-ethyl	(1953)	Fentin acetate	(1958)
Azinphos-methyl	(1953)	Isodrin	(1951)
Carbophenothion	(1965)	Medinoterb acetate	(1967)
Chlorfenvinphos	(1964)	Mercuric chloride	(1892)
Demeton	(1951)	Mevinphos	(1955)
Demeton-S-methyl	(1951)	Nicotine	(1746)
Dimefox	(1949)	Pentachloraphenol	(1940)
Dinoseb	(1945)	Phorate	(1955)
Disulfoton	(1957)	Sodium fluoride	(19th century.)
Endosulfan	(1956)	Sulfotep	(1945)
Endothal	(1956)	Thionazin	(1962)

(b) Moderately toxic chemicals (acute oral LD 50 for rat: 50-500 mg./kg.)

Arprocarb	(1963)	Dimexan	(1960)
Azobenzene	(1936)	Dinoseb acetate	(c. 1960)
Bromoxynil	(1964)	Diquat	(1959)
Copper salts	(1885)	Dithianon	(1960)
D-D mixture	(1943)	Ethion	(1955)
Di-allate	(1961)	Ethoate methyl	(1963)
Diazinon	(1955)	Fenchlorphos	(1954)
Dichlorvos	(1957)	Fentin hydroxide	(1961)
Formothion	(1962)	Phenkapton	(1957)
Ioxynil	(1964)	Phosalone	(1964)
Mercurous chloride	(1929)	Trichlorphon	(1952)
Morphothion	(1957)	Trifluralin	(1965)
Oxydemeton-methyl	(1962)	Vamixothion	(1962)

The date given in brackets refers to the year in which the pesticide was introduced. In many cases these dates are very approximate.

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Table 3

PESTICIDES OF LOW TOXICITY
NOT KNOWN TO HAVE HARMED WILDLIFE

Ametryne
Aminotriazole
Ammonium sulfamate
Atrazine
Barban
Benazolin
Binapacryl
Bromacil
Captan
Chlorbenside
Chlorbenzilate
Chlorbufam
Chloroxuron
Chlorthion
Cresylic acid
Cycluron
Dalapon
Dazomet
2, 4, D-B
Desmetryne
Dicamba
Dichlofluanid
Dichlorprop
Dicloran
Dicofol
Dinocap
Dithiocarbamates
Diuron
Fenoprop
Fenuron
Formaldehyde
Lenacil
Lime sulphur
Linuron
Maleic hydrazide
Malathion
Mancozeb
Maneb
Manganese
MCPA
MCPB
Menazon
Metham Sodium
Methoxychlor
Metiram
Metobromuron
Monolinuron
Monuron
Nabam
Petroleum oils
Picloram
Prometryne
Propachlor
Pyrazon
Pyrethrum
Quinomethoate
Quintozene
Simazine
Sodium chlorate
Sodium trichloroacetate
Sulphur
Tar oil
TBA
Tecnazene
Tri-allate
Ureas
Zineb
Ziram