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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

FEB 26 1991

OFFICE OF
PESTICIDES AND TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: Transmittal of Ecological Effects Branch Risk Assessment for Diazinon PD-1

FROM: James W. Akerman, Chief
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Environmental Fate and Effects Division

TO: Janet Auerbach, Chief
Special Review Branch
Special Review and Reregistration Division

Attached is the Ecological Effects Branch Preliminary Diazinon Risk Assessment for incorporation into the Diazinon Special Review Position Document 1. If you have any questions on our assessment, or if we can be of further assistance, please let me know.

cc: Anne Barton

PRELIMINARY
DIAZINON
RISK ASSESSMENT
FOR
ECOLOGICAL EFFECTS

Ecological Effects Branch
Environmental Fate and Effects Division
Office of Pesticide Programs
U.S. Environmental Protection Agency

FEB 26 1991

I. INTRODUCTION

Diazinon is an active ingredient in over 1000 separate pesticide products. End-use products include dusts, granulars, pelleted/tableted, powders, powder/dust, microencapsulated, impregnated materials, emulsifiable concentrates, soluble concentrate/liquids, liquid ready-to-use, and pressurized liquid products. Including the various percent active ingredients in these products, there are approximately 111 different types of end-use formulations (12/12/88 EPA Index).

Diazinon is used on hundreds of specific use sites, including a wide variety of orchard crops, vegetable and fruit row crops, turf sites (other than golf course and sod farms), seed treatments, other noncrop areas, ornamental plants, building exteriors and perimeters, livestock and pet sprays, and indoor uses that could result in outdoor contamination (12/12/88 EPA Index).

Due to the high acute toxicity of diazinon to both birds and aquatic organisms and the widespread use of this chemical in many formulations as noted above, there appears to be a significant probability of acute effects, including mortality. Numerous documented bird kills, particularly involving applications to turf, reflect the substantial risk to birds. The present assessment selects representative uses and formulations to further evaluate and define this risk.

II. Avian Risk Assessment

A) Toxicity of Diazinon to Birds

Diazinon is one of the most acutely toxic pesticides to birds. Single-dose avian toxicity studies evaluated and described in the 1987 diazinon hearings have produced LD_{50} values for waterfowl, upland game, and songbirds that are mostly in the range of 1.8 - 10 mg/kg (L. Turner, W-2[1]). Data more recently submitted indicate mallard LD_{50} values of 1.18 - 1.97 mg ai/kg, depending on material tested, while brown-headed cowbird LD_{50} values indicated are 6.85 - 85.0 mg ai/kg, depending on material tested (USEPA, 1991). Pesticides with LD_{50} values less than 10 mg/kg are considered by Ecological Effects Branch (EEB) to be "very highly toxic" to the species tested.

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1. References beginning with "W-" refer to written witness statements in the 1987 diazinon cancellation hearings. Such designations are consistent with those used in all EPA briefs and related documents since the hearings.

Conventional avian dietary toxicity studies (i.e., with young birds) have produced LC_{50} values for waterfowl and upland game from < 47 ppm to 245 ppm, depending on species (L. Turner, W-2). Data more recently submitted indicate mallard LC_{50} values of 32 - 38 ppm ai and brown-headed cowbird LC_{50} values of 38 - 42 ppm ai, depending on test material (USEPA, 1991). Pesticides with LC_{50} values less than 50 ppm are considered by EEB to be "very highly toxic" to the species tested.

B) Exposure of Birds to Diazinon and Resulting Risk

Birds can be exposed to diazinon via residues on food, residues in water, dermal and inhalation exposure, and direct consumption of granules, for example. The present risk analysis will focus primarily on residues on food and direct consumption of granules as most available data relates to these risks. Because of the large number of formulations and use sites, exposure (and risk) estimates will be based on representative formulations, application rates and methods, and use sites.

Three major types of use sites have been selected: turf, orchard, and agricultural field crops (e.g., vegetables, fruits, grains). A fourth category, seed treatments, is also analyzed since it is a completely different kind of application, yet one that presents a clear potential for exposure and risk due to the direct treatment of avian food items (seeds).

Turf is considered by BEAD to be "probably the largest single market for diazinon", with 4-6 million pounds of active ingredient applied in the U.S. each year (Diazinon PQUA, 9-28-90). It is also the site with the largest number of known diazinon bird kills. Except for irrigation, there is no incorporation. Golf course and sod farm turf uses of diazinon have been cancelled by EPA (3-29-88 Final Decision and 7-12-90 Remand Decision) due to avian risk and are not included in the current review, except where data from these sites may be used to help evaluate risk on other turf sites.

Orchard use is a major one for diazinon. For example, the single largest non-turf diazinon use site shown by BEAD (9-28-90) is almonds (0.7 million pounds a.i. per year). Other orchard uses include apples, apricots, cherries, citrus, figs, filberts, nectarines, peaches, pears, pecans, plums, and walnuts. Orchards provide trees year-round for bird nesting habitat and cover. Applications are to the trees and thus there is no soil incorporation.

Diazinon is registered on an enormous number of agricultural row/field crops. BEAD reports that brussel sprouts has 67.5% (2,983 acres) of its total acreage treated with diazinon, the highest percent of any crop. Corn, however, has the largest number of diazinon treated acres (285,972) and total pounds of diazinon applied (268,876) of the row/field crops. These acres, though, comprise only 0.5% of the total acres of corn grown in the U.S. (BEAD, 9-28-90).

Turf includes both liquid and granular applications while orchards receive primarily liquid applications. Agricultural field crops include both liquid and granular applications. Granular applications to agricultural fields are made either before or at planting to bare fields and soil-incorporated. Liquid applications can also be made this way to the soil. Additionally, liquid foliar applications can be made to the plants during the growing season.

C) Selected Site Categories

1. Remaining Turf Uses

While diazinon use on golf courses and sod farms has been cancelled (EPA Final Decision, 3/29/88; EPA Remand Decision, 7/12/90), all other turf uses remain. These include, for example: home lawns; turf around apartment, commercial, and industrial buildings; parkland; roadsides; athletic fields; cemeteries.

Residues on turf under "worst-case" conditions, have been calculated by P. Mineau of the Canadian Wildlife Service to range from 53.3 - 105 ppm per lb. of diazinon applied in liquid formulation per acre, after irrigation. He indicates that irrigation (watering) does not always affect residues in a predictable way, and sometimes produces uneven residue distribution (EPA W-4).

Application rates on turf sites currently range from 1.7 - 4.1 lb ai/A, based on labels examined for this review. With these ranges of residues/lb ai and rates, residues could range from 90.6 ppm to 430.5 ppm. Even at the low end of this range, residues far exceed most LC_{50} values for waterfowl that may graze on treated turf.

Residues may also be found in or on invertebrate prey, including invertebrates killed by the insecticide or coming to the ground surface due to irrigation. Irrigation can also result in puddles where birds could be further exposed to diazinon.

Granular diazinon products can kill birds directly, through the consumption of the granules themselves. Research of Balcomb, et. al. (1984) showed that just 5 diazinon 14G granules per bird were sufficient to kill 80% of the house sparrows tested and 100% of the red-winged blackbirds tested. This number of granules could easily be consumed by birds inadvertently or intentionally while foraging. Granules

could be mistaken for food or adhere to the surface of invertebrates (e.g., earthworms) or other food items. Granules could also be picked up as intended grit to aid digestion.

--Terrestrial Field Studies

Five terrestrial field studies on turf were submitted to EPA and reviewed for the diazinon hearings regarding golf courses and sod farms. Four of these were on golf courses and one was on home lawns. These studies and EEB comments on them are summarized as follows (Felkel, W-12; Felkel, 1988):

a) Sudden Valley, Washington (golf course); (Kendall, et. al., 1987)

Brief Summary of Study Results:

85 American wigeon were killed following one Diazinon AG500 application at an attempted 2 lb ai/A rate, to nine fairways, in October, 1986. Investigators hazed birds to prevent still further mortality.

Turf residues after application and before irrigation on the day of application were reported from 183-363 ppm; after irrigation, reported values were 100-333 ppm. Catch-pan samples to measure actual application rates reportedly showed variation from 0.94-5.15 lb ai/A (mean = 2.6).

The wigeon died following a reported feeding period of only 30-40 minutes, in the late afternoon on the application day. Diazinon residues in the GI tracts and severely depressed brain AChE levels confirmed diazinon as the cause of death.

Brief Summary of Reviewer Comments:

The study clearly demonstrates the potential for severe mortality when birds feed intensively on treated turf. Despite the uneven application, all application day residue values on grass exceed the level of diazinon (47 ppm) reported to kill 100% of young mallards in the lab. Because of the hazing activity, the 85 reported wigeon deaths can only be considered a minimum--considerably more may have died if the study had continued as designed.

No search efficiency or scavenger removal estimates were made by the investigators. Hence, it is not known what proportion of actual mortality was found. Since carcass searches were conducted in the morning, mortalities of the previous day might have been missed if scavengers were active at night, for example.

The study was conducted during a migratory period, when there may have been a rapid turnover of individuals using the site. Except for gulls, it is not clearly reported whether birds were even on the treated areas, let alone feeding there. This was not a population study and birds were not marked or banded. The census

data cannot be used to indicate little or no effect on species other than wigeon.

b) Birch Bay, Washington (Sea Links golf course); (Kendall, et. al., 1987)

Brief Summary of Study Results:

Three additional wigeon were killed in this spring, 1987 study, despite hazing tactics (including firecrackers) used to prevent their exposure. The study focused on Canada Geese. Despite a reported low proportion of time geese spent on the treated turf, 2-3 geese were observed with symptoms of organophosphate poisoning, almost certainly due to diazinon.

Diazinon was applied two times, seven days apart, at an attempted rate of 2 lb ai/A. The measured application rates were reportedly only 1.40-1.69 lb ai/A for the first application and 1.17-1.55 lb ai/A for the second application. Turf residues reported for the day of the first application were 102-135 ppm before irrigation and 33.2-55.6 after irrigation. Following spraying on the day of the second application, reported residues before and after irrigation were 134-215 ppm and 6.74-45.4 ppm, respectively.

Brief Summary of Reviewer Comments:

This study demonstrates the potential for avian mortality, sickness, and incapacitation, despite a small area treated (approximately 2.5 acres), application rates consistently less than the reported intended rate, the hazing tactics, an adjacent unsearched marsh where sick or dying birds may have escaped detection, and the information that geese spent the majority of their time feeding in untreated areas. It seems likely that without these study deficiencies, the number of sick or dead birds reported could have been considerably higher.

c) Connecticut Study (Redding Country Club golf course); (Palmer, et. al., 1987)

Brief Summary of Results:

Two diazinon applications at an attempted 2 lb ai/A were made 7-8 days apart to 5 fairways, tees, and greens, followed by 0.25" irrigation. Turf residues following irrigation on the application day were reported to be 32.8-75.9 ppm for the first application and 38.8-95.2 for the second application. Canada geese were the focus of the study.

One goose showed signs of toxicity following the second application. The geese spent far more time, both before and after diazinon application, in untreated rough than in treated area. They spent no time at all on treated area on the application day, or on days 4, 5, 6, and 7 after the first application. The geese spent no time at all on the treated area on the day of the second application, or on days 2, 3, 4, and 5 following the second application.

The scavenger removal test showed heavy pressure. 87% of placed carcasses were removed within 72 hours of placement. 24 of 26 scavenged carcasses were removed at night. 80% of placed mallard carcasses were removed by scavengers the first night after placement.

Brief Summary of Reviewer Comments:

As with the above studies, this study demonstrates that residues, even after irrigation, can exceed the level lethal to 100% of mallards in lab studies, thereby indicating a substantial potential for hazard to any grazing waterfowl. The fact that only one goose showed signs of toxicity may well be related to the low exposure, noted above. Feeding in untreated areas would not be expected to pose a hazard, of course. Carcass searches of fairways, tees, and greens were conducted in the morning. Given the high nighttime scavenger removal rate documented, a large percentage of any birds dying in the daytime may well have been removed at night before the next carcass search.

d) Virginia Study (Greendale Golf Course); (Fletcher, 1987)

Brief Summary of Results:

Two diazinon applications at an attempted rate of 2 lb ai/A, 7 days apart, were made to 6 fairways in October, 1986. Reported application day residues on turf were 113-144 ppm after irrigation following the first application, and 129-168 ppm after irrigation following the second application.

Behavioral effects in two robins were noted, but no avian mortality was reported. Extremely heavy scavenger removal of test carcasses was reported (e.g., 92% removal at 48 hours).

Brief Summary of Reviewer's Comments:

Unlike the above Sea Links and Connecticut studies, no documentation at all is made of the amount of time birds spent feeding on treated turf. While the report cites 11 species as seen on the treatment area, no information is provided as to how many individuals were exposed, whether they were feeding, or how long they were present on the treated turf.

Even if substantial exposure occured (and there is no evidence that it did), the extremely high scavenger removal rate means that a large percentage of any resulting mortalities may not have been found. If scavenger removal occured largely at night, any birds dying after a carcass search (and removed by scavengers) would not be seen in the next day's carcass search. For the days of application, this would include any bird dying more than 4 hours after early morning application, when the last carcass search was conducted. The days of application are particularly important because of the higher residues and risks usually present on these days.

e) Georgia Study (Mellott, et. al., 1987)

Brief Summary of Results:

This home and commercial lawn study involved application at an attempted 4 lb ai/A of liquid and granular formulations, during October and November, 1986. 34 residential front lawns and 1 commercial property were studied.

The report notes that "most species occurred infrequently on both study sites". 37% of the species observed at the residential site were seen on lawns, while only the blue jay was seen on the lawn at the commercial site. One carcass with diazinon residues was found, as well as other remains not suitable for analysis.

Brief Summary of Reviewer's Comments:

This study is seriously flawed and has little to contribute to the assessment of the risks of diazinon. Exposed birds could easily fly to any backyard or to numerous front yards not included in the study. Any sick or dying birds in these nearby areas would likely go undetected. No report was made of the actual time birds were exposed on turf, or even what the turf, insect, or seed residues were.

For most songbirds in most home lawn settings, consumption of contaminated insects by adults and young during the breeding season may present the greatest hazard from diazinon. Because this study was conducted in the fall, it could not possibly address this hazard. No carcass searches were conducted on the days of application, although residues and hence risk were likely greatest at this time.

Documented Field Kills on Turf

Testimony of Ward Stone at the hearings (W-5) included documentation of 52 separate incidents in which wildlife were killed by diazinon used on turf. Twenty of these incidents were on golf courses (Table 1) and the remaining 32 (Table 2) were on other turf sites that are included in this Special Review. Although diazinon use on golf courses has been cancelled, these incidents are included here because they are descriptive of the mortality that can occur when birds are exposed to diazinon on turf.

As can be seen, bird kills on these remaining turf sites have occurred in numerous geographic areas, and at a variety of types of areas (e.g., home lawns, condominium and office building lawns, parks, baseball field). Both liquid formulations (12 incidents) and granular formulations (11 incidents) have been involved (for 8 incidents the formulation was not reported or was uncertain and 1 incident involved a "bait"). Both waterfowl (28 incidents) and songbirds (4 incidents) have been killed.

Additional bird kill incidents definitely or apparently involving diazinon application to turf, but not included in the above 52 incidents, are summarized in Table 3. Sites include home lawns, turf around apartment/condominium and commercial buildings, turf near ponds, a school yard, and two golf courses. Both liquid and granular formulations were involved. Birds included waterfowl, songbird, and blackbird species.

The number of documented field kills is believed to be only a very small fraction of the total mortality actually resulting from diazinon application to grassy sites. Poisoned birds may move off-site to less conspicuous areas before dying. Those dying on-site may be consumed or removed from the site by scavengers, such as cats, dogs, crows, vultures, or foxes. All grassy areas are not regularly traversed by people looking for bird kills.

Bird kills that are found may not get reported to authorities capable of investigating the kill and documenting the cause. People may not realize the importance of reporting bird kills, they may not feel they have the time to do so, they may not know who to call, or the call may be long-distance and thus discourage potential callers. If kills are not reported promptly there will be little chance of documenting the cause, since tissues and residues can deteriorate quickly. If the authority receiving the kill report does not have adequate staff and laboratory resources to adequately investigate (and most towns, counties, and states do not have these), the kill will go undocumented. Even if documented, there is no current requirement that all localities report such kills to EPA or other centralized facility capable of maintaining complete records.

TABLE 1

Diazinon Bird Kills on Golf Courses Cited in 1987 Cancellation Hearings

W. Stone Incident Number	State/ Prov.	Formulation	Number/Species of Birds Affected
2	NY	liquid (AG500)	4 Canada geese dead 16 Canada geese sick
9	NY	liquid (AG500)	4 Canada geese dead
10	CA	liquid (Best Diazinon)	3 Canada geese dead
18	NY	liquid (Prentox Diazinon AG500)	700 brant dead
20	CA	liquid (Ciba-Geigy AG500)	30 American wigeon dead
24	CO	NR	28 Canada geese dead
26	KY	granular	11 mallards (semi-domestic) dead
27	MI	liquid	4 Canada geese dead 5 mallards dead 3 red-winged blackbirds dead
28	VA	liquid	$\geq$ 1 Canada goose dead
29	NY	granular (14G)	19 brant dead
32	NY	emulsifiable liquid	31 brant dead
33	NY	NR	10 Canada geese dead
35	NY	granular (14G)	50-60 brant dead
36	CT	granular (Scott's Proturf Insecticide #1)	> 24 mallards dead
41-42	NJ	liquid	A total of 32 Canada geese were killed in these 2 golf course incidents and 3 other incidents (#38-40) in Table 2
44	NY	liquid	24 Canada geese dead
46	CA	NR	100 wigeon dead coots dead (number NR)
47	MI	NR	14 Canada geese dead 1 sick Canada goose sacrificed
49	NY	liquid	35 Canada geese dead
51	CA	probably liquid	800-1,000 wigeon dead

TABLE 2

Diazinon Bird Kills on Other Turf Sites

Cited in 1987 Cancellation Hearings

W. Stone Incident Number	State/ Prov.	Application Site	Formulation	Number/Species of Birds Affected
1.	CA	office blg. lawn	NR	2 mallards killed
3.	OR	lawn, state park	granular	4 Canada geese killed
4.	Ontario	condominium lawns	liquid	≥ 8 Canada geese killed
5.	NY	home lawn	granular?	3 mallard ducklings killed
6.	NY	home lawn	granular	7 domestic ducks killed
7.	WA	home lawn	granular	7 domestic ducks killed
8.	IN	condominium lawn	granular	40 mallards killed 6 mallards sick; recovered
11.	NY	home lawn	granular	1 American robin killed, 3-4 debilitated
12.	WA	lawn, office blg.	NR	50 wigeon and gadwall killed
13.	TX	lawns	"bait"	68-70 mallards killed
14.	CT	home lawn	liquid	24 brown-headed cowbirds killed
15.	MI	lawn	NR	2 mallards killed
16.	MN	lawn	granular	12 domesticated mallards killed
17.	MI	lawns (around lake)	NR	6 Canada geese killed
19.	British Columbia	turf at park	NR	20+ ducks (unspecified) killed
21.	WA	lawn	liquid	21 wigeon killed 7 mallards killed 1 Canada goose killed

22.	CT	baseball field	granular	60 brown-headed cowbirds killed
23.	MI	lawn, office blg.	liquid	6 Canada geese killed
25.	WA	lawn, park	granular	3 mallards killed
26.	KY	lawn (around clubhouse and lake)	granular	11 semi-domestic mallards killed
30.	NY	lawn, park	NR	16 Canada geese killed
31.	NY	lawn, condo-minium	liquid	81 Canada geese killed
34.	MI	lawn	liquid	25 Canada geese killed
37.	KY	lawn, home	granular	4 mallards killed
38.	NJ	lawns	liquid	A total of 32 Canada geese were killed in these 3 lawn sites and 2 other golf course sites not listed here
39.	NJ	lawns	liquid	
40.	NJ	lawns	liquid	
43.	ID	lawn	liquid	15 unidentified sparrows died (incl. some distressed indivs. euthanized)
45.	British Columbia	lawn, private	NR	17+ wigeon and mallards killed
48.	NY	lawn, office blg.	liquid	12 Canada geese killed
50.	CT	lawn, estate	liquid	31 Canada geese killed
52.	NY	lawn, estate	granular	100 mallards and black ducks (mostly mallards) killed; 100 other birds poisoned but recovered

Diazinon Field Kills in Addition to the 52 Incidents on Turf Described by W. Stone in Diazinon Hearing Testimony

T--turf and other grassy sites

O--agricultural and other remaining sites, including diazinon field kills where the application site is uncertain

TABLE 3.

Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
T-53	IL	9-18-87 9-19-87	Apparently turf, in a residential area near a road	diazinon-impregnated fertilizer and a liquid formulation	approx. 5.5 lb ai/A	10 "dead or dying" geese	Ciba-Geigy (attachment to 10-19-87 letter)
T-54	NY		Apparently turf, at a residence	NR		12 pet pigeons "disabled or dead"	9-10-87 C-G letter
T-55	NJ		Turf around commercial building	liquid		29 geese	11-24-87 C-G letter
T-56	OH	8-12-88	Turf at apartment complex	diazinon/ fertilizer combination product	NR	20 geese and 5 ducks killed	1) C-G memo of 9-2-88 2) tel. report of D. Rieder w/ J. Ward (EPA Reg. 5)
T-57	IN	9-23-90 to 9/26/90	Turf at condominium complex	5G	2lb FP/ 1000 ft^2	approx. 47 ducks	IN Dept. Nat. Resources (W. Faatz) 10-11-90 letter

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Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
T-58	NY	5-8-89	home lawn	Spectracide 6000 (5% ai)	NR	two robins affected; one died	8-3-89 DEC letter
T-59	NY	8-7-89	home lawn	NR	NR	one robin dead	12-14-89 DEC letter
T-60	NY	7-20-89	apparently home lawn	granular	NR	two Canada geese dead	9-20-89 DEC memo
T-61	NY	8-18-89	home lawn	granular	NR	one robin dead	12-14-89 DEC memo
T-62	NY	12-14-89	home lawn	granular	NR	two crows debilitated, then died	12-14-89 DEC memo
T-63	IN	NR	condominium turf	Printox 14G	1lb FP/ 1000 ft^2	approx. 40 birds dead (apparently all waterfowl)	9-11-89 IN DNR (W. Faatz) letter
T-64	IN	NR (case investigated 8-23-89)	turf near pond	14G	NR	approx. 20 ducks dead	10/31/89 letter w/ 10/13/89 IN Pesticide Investigator report
T-65	MD	Between 5/15-16 1989 application and 5/21/89 investigation)	golf course turf	granular	NR (mixed w/ granular chlorpyrifos)	10 robins, 6 starlings, 5 grackles, 1 mallard dead (collected); others dead but mown over and not considerered suitable for collecting	8/8/89 MD DNR letter (G. Taylor)

Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
T-66	MI	7-14-87	residential lawn	liquid (carbaryl also applied)	NR	five Canada geese dead	MI DNR Necropsy #87403/4/5/6/7
T-67	MI	4-21-89 (collected)	residential lawn	NR	NR	two mallards (one sick, one dead)	MI DNR Necropsy #89254
T-68	NJ	10-12-87 to 10-19-87	turf in vicinity of pond	Diazinon AG4E (48.1% ai)	4 oz/ 1000 ft^2	apparently a total of 32 geese dead (two Canada geese collected)	NJ DEP Acc. No. K-78
T-69	NJ	6-22-89	lawn	NR	NR	three mallards dead	NJ DEP Acc. No. M-34 a-c
T-70	NY	8-4-87	residential lawn	granular (3.33% ai)	3.6 lb FP/ 1000 ft^2 (5.2 lb ai/A) reported	two bluejays dead	NY DEC 8-19-87 and 8-25-87 memos
T-71	NY	8-15-87	residential lawn	granular (5% ai)	label: 2.5 lb FP/1000 ft^2 (5.4 lb ai/A)	one Rouen mallard dead	NY DEC 8-26-87 memo
T-72	OH	6-3-86	lawn at apt. complex	LESSCO insecticide/ fertilizer combination	NR	waterfowl dead (number and species NR)	USFWS Inv. Rep #1528AP
T-73	IN	9-4-87 to 9-8-87	lawn at apt. complex (around pond)	granular	NR	30 ducks (species NR)	IN DNR letter (Mark Bennett) rec'd 9-22-87
T-74	CA	9/83-11/83	turf--CA Japanese Beetle Eradication Project (JBEP)	NR	NR	5 ducks, 1 goose dead	8/2/84 CA memo (Dennis Thompson, DVM)

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Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
T-75	CA	10/5/83	JBEP (residence)	NR	NR	2 ducks dead 2 other ducks reportedly died, not submitted	Ibid.
T-76	CA	9/13/83	JBEP (residence)	NR	NR	3 magpies dead	Ibid.
T-77	CA	3/7/84	JBEP (residence)	NR	NR	1 robin dead	Ibid.
T-78	CA	3/8/84	JBEP (residence)	NR	NR	1 robin dead	Ibid.
T-79	CA	3/12/84	JBEP (schoolyard)	NR	NR	2 wild birds dead (species NR)	Ibid.
T-80	CA	9/15/83	JBEP (residence)	NR	NR	2 "chicks" dead (species NR) Cited as "probable" death due to diazinon (previous 6 incidents cited as "confirmed")	Ibid.
T-81	WA	1981	home lawn	NR	NR	4 or 5 Canada geese dead	Diazinon SR docket #31--att. to 6/23/86 EEB memo
T-82	WA	3/4/83	home lawn	granular	NR	3 mallards dead (collected) approx. 20 additional birds dead	Ibid.

Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
T-83	WA	spring, 1984	lawn at apt. complex	Diazinon EC	NR	ducks (#NR)	Ibid.
T-84	WA	spring, 1984	home lawn	granular (5G)	NR	ducks (#NR)	Ibid.
T-85	WA	early summer 1985	golf course	liquid	NR	2 geese dead 2-3 other geese affected	Ibid.

TABLE 4.

Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
O-1	ND	approx. 7/87	trees	NR	NR	1 northern oriole 1 yellow-shafted flicker other birds reportedly affected	8/17/87 ND State U. Vet. Diag. Lab report
O-2	NY	4/71	corn	liquid (treated seed)	NR	1 Canada goose dead	Stone and Gradoni, 1985 DEC Public. Case #35
O-3	NY	4/22/77	corn	possibly treated seed and/or granular	NR	1 Canada goose dead 3 others "probably poisoned"	Ibid. Case #39
O-4	NY	5/22/83-6/1/83	corn	treated seed (carbofuran also applied to seed and field)	NR	20 wood ducks dead (2 sick, recovered) 2 killdeer dead (1 sick, recovered) 1 mallard dead 1 grackle dead 1 blue jay dead	" Case #47 (also in Stone & Gradoni, 1985, NES)
O-5	NM	5/6/80 (5/5/80*)	alfalfa	liquid	NR	125 (129*) gadwall and American wigeon dead 12 (12*) Canada geese dead 1 pheasant dead (sick*) 1 Canada goose sick*	" Case #32 *USFWS/ NWHRC 11/1/88 letter
O-6	NM	4/2/82 (4/18/82*)	alfalfa	liquid	NR	Ross' goose (8 dead*) snow goose (5 dead*)	" Case #33 *USFWS letter above

Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
O-7	TX	2/70	unident. row crop	liquid	NR	12 mourning doves, green jays dead	" Case #52
O-8	NY	9/21/80	trees	liquid (mixed with kelthane)	NR	10+ mallards dead	Ibid. Case #45
O-9	WA	6/21/82	trees	liquid	"greater than recommended concentration"	10 Canada geese dead 7 robins, hummingbird, and others dead #NR -- house sparrows, starlings 1 gopher dead	" Case #54
O-10	MD	4/82	pond (direct applic. to water)	NR	NR	#NR -- great blue heron	" Case #14
O-11	NJ	7/6/77	suburban rooftop	bait to kill birds	NR	42 blue jays, common grackles, house sparrows	" Case #26
O-12	GA	6/81	uncertain	NR	NR	3 blue jays dead	" Case #7
O-13	GA	2/18/83	"	NR	NR	27 grackles dead	" Case #8
O-14	IL	6/83	"	NR	NR	17 mallards dead also 1 robin dead* *USFWS/NWHRC 11/1/88 letter	" Case #10
O-15	IL	1/84	"	NR	NR	190 mallards dead	" Case #11
O-16	MI	6/25/80	"	NR	NR	5 mallards dead 1 mallard paralyzed	" Case #16
O-17	MI	7/28/82	" (bird found dead on pond at apt. complex)	NR	NR	1 Canada goose dead	" Case #18

Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
O-18	MI	6/19/83	" (bird picked up from pond)	NR	NR	1 Canada goose dead	" Case #19
O-19	NY	5/84	uncertain	NR	NR	5 brant dead	" Case #48
O-20	NY	4/28/84 (approx.)	" (bird may have flown through aerial spray of fields)	liquid	NR	1 downy woodpecker dead	" Case #50
O-21	NY	7/29/84	uncertain (possibly a private residence)	NR	NR	2 blue jays dead	" Case #51
O-22	CA	NR (dead birds rec'd 3-18-88)	Concession stand	ant crystals	NR	20 coots affected (all died?)	CA Pesticide Lab Report P-1123 (4-25-88)
O-23	CA	NR (dead birds rec'd 6-6-88)	Home exterior	liquid	NR	4 yellow-billed magpies dead	CA Pesticide Lab Report P-1154 (7-6-88)
O-24	OR	4-2-87	Building interior	encapsulated	NR	200 parrots exposed; 40 died	M. Watson and K. Kadlec, EPA Region 10 (tel.)
O-25	CA	NR (dead birds rec'd 3-2-88)	unknown (birds found at Lake Murray, San Diego Co.)	NR	NR	approx. 100 birds ($\geq$ 50 coots) dead	CA Pesticide Lab Report P-1121 (3-30-88)
O-26	CA	NR (dead birds rec'd 8-11-88)	residential area	liquid and granular	NR	14 yellow-billed magpies dead	CA Pesticide Lab Report P-1180 (9-7-88)

Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
O-27	CA	NR (dead birds rec'd 7-6-88)	unknown (birds found in residential area)	NR	NR	house finches (number NR)	CA Pesticide Lab Report P-1169 (9-7-88)
O-28	CA	NR	sewage treatment pond	NR	NR	NR	E. Littrell CA Dept. F&G 3/24/88 (tel.)
O-29	WY	NR	rangeland	liquid	5.0-8.0 oz/A	8 dead birds (total) of four species: horned lark western meadowlark lark bunting chestnut-collared longspur	McEwen, et. al. (1972)
O-30	NY	NR (dead bird rec'd 9-26-87)	Birds found in residential area; fruit trees sprayed nearby	liquid	NR	four bluejays dead	11-18-87 DEC memo
O-31	NY	8-2-88	NR; birds found in residential area (pond)	NR	NR	two mallards dead (one diagnosed as poisoned by diazinon)	9-26-88 DEC memo
O-32	NY	7-29-89	NR; bird found in residential area	NR	NR	one robin dead	12-14-89 DEC memo
O-33	NY	5-3-90	NR; birds found in residential area	NR	NR	two mallards dead	7-3-90 DEC letter

Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
O-34	CA	NR (dead birds rec'd 12-12-88)	NR; birds found in suburban area	NR	NR	several yellow-billed magpies	CA Pesticide Lab Report P-1201/1202
O-35	CA	NR (within month of O-34)	NR; birds found in suburban area	NR	NR	several additional yellow-billed magpies	CA Pesticide Lab Report P-1201/1202
O-36	MI	NR (bird collected 6-22-87)	NR	NR	NR	six ducks dead (one mallard colected); listed as a "possible" diazinon poisoning	MI DNR Necropsy #87355
O-37	MI	6-9-87	NR; birds found on lake shore	NR	NR	12 geese dead (two Canada geese collected)	MI DNR Necropsy #87356/7
O-38	MI	6-14-88 6-15-88	NR; birds found on lake (shore?)	NR	NR	20 geese dead (two Canada geese collected) (lindane possibly also involved)	MI DNR Necropsy #88411/2
O-39	MI	NR (dead bird rec'd 7-29-88)	NR	NR	NR	12 ducks dead (one mallard examined)	MI DNR Necropsy #88484
O-40	MI	7-25-88	NR	NR	NR	7 Canada geese dead (three examined)	MI DNR Necropsy #88537/8/9
O-41	MI	6-20-89 (collected)	NR; birds found in residential backyard	NR	NR	6 Canada goose goslings dead	MI DNR Necropsy #89459/60/1/2/3/4
O-42	NJ	4-15-88 (date birds began dying)	around home foundation	5% granular	NR; label attached: 3.2 oz FP/100 ft^2	9 mallards dead	NJ DEP Acc. No. L-20 a-c

Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
O-43	VA	1986	NR; birds found in residential backyard	NR	NR	2 purple martins dead	VA Dept. Game & Inland Fisheries 8-24-89 letter
O-44	VA	5-23-89	NR	NR	NR	mallards dead (number NR)	USFWS-NWHRC April-June 1989 Quarterly Wildlife Mortality Report
O-45	NY	8-26-87	uncertain; probable: illegal poisoning on cornfields; possible: other use such as turf	NR	NR	3 red-winged blackbirds dead	NY DEC 12-11-87 memo
O-46	NY	8-31-87	possibly cornfields to illegally poison birds	NR	NR	2 red-winged blackbirds dead	NY DEC 1-4-88 memo
O-47	NY	NR; dead bird rec'd 9/25/87	uncertain; possibly fruit trees	NR	NR	4 blue jays dead 1 blue jay sick but recovered	NY DEC 11-18-87 memo
O-48	NY	6-24-87	NR (dead bird found in brook)	NR	NR	1 mallard duckling dead	NY DEC 10-26-87 letter
O-49	NY	8-25-87	likely an intentional poisoning; birds found dead at lake	NR	NR	4 mallards dead	NY DEC 10-26-87 letter
O-50	NY	NR	NR; birds found in residential area	NR	NR	1 immature robin >1 nestling robin (apparently all dead)	NY DEC 10-23-87 letter

Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
O-51	CA	NR; samples rec'd 2-17-88	probably diazinon disposal down a drain; dead birds found in sewage treatment pond	NR	NR	30 ducks dead	CA Pesticide Lab Report #P-1117/1118 (4-25-88)
O-52	Saskatchewan (SK)	6/89	island in large park (specific site--e.g., turf or trees, NR)	liquid	NR	66 Canada goose goslings dead	F. Leighton, G. Wobeser, & M. Spinator (1990?), SK
O-53	NY	5/3/86	uncertain (but "probable turfgrass source")	NR	NR	2 Canada geese dead	NY DEC 3/87 Public. (Stone & Gradoni) Case #3
O-54	NY	5/14/86	uncertain (but "probable intentional poisoning")	NR	NR	7 rock doves (common pigeons) dead	Ibid. Case #4
O-55	NV	12/17/86	NR ("suspect diazinon poisoning")	NR	NR	25 wigeon dead	USFWS/NWHRC 5/26/88 letter
O-56	WA	6/18/82	NR	NR	NR	10 Canada geese dead 6 robins dead "numerous" hummingbirds dead "numerous" house sparrows dead 1 vole dead	USFWS/NWHRC 11/1/88 letter
O-57	WA	6/29/83	NR	NR	NR	35 Canada geese dead	Ibid.

Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
O-58	WA	5/13/83	NR	NR	NR	12 mallards dead 1 Canada goose dead	Ibid.
O-59	VA	1/1/83	NR	NR	NR	60 blackbirds, grackles dead	Ibid.
O-60	WA	3/4/83 ("Suspect Diazinon")	NR	NR	NR	9 mallards dead	Ibid.
O-61	PA	8/20/84 ("Suspect Diazinon")	NR	NR	NR	22 Canada geese dead	Ibid.
O-62	NY	8/1/85	NR	NR	NR	5 Canada geese dead or dying	10/9/85 NY DEC memo (W. Stone)
O-63	NY	7/19/85	NR	NR	NR	1 mallard dead; others reportedly found dead or dying (# NR)	10/9/85 NY DEC memo (#2) (W. Stone)
O-64	NY	4/21/85	NR	NR	NR	1 domestic chicken dead	10/8/85 NY DEC memo (W. Stone)
O-65	NY	NR	NR (but birds found near corn fields)	NR (parathion also found, in gizzard)	NR	11 grackles dead 2 red-winged blackbirds dead	1984-85 NY DEC Progress Report

Incident Number	State/ Prov.	Date(s) of Incident	Application Site	Formulation	Application Rate	Number/Species of Birds Affected	Source(s) of Report
O-66	MD	3/13/72	agricultural	NR (chlorpyrifos and DDVP also involved)	NR	2 domestic chickens, 3 ducks dead	4/7/72 EPA Pesticide Episode Report
O-67	BC	5/74	orchard	liquid	NR	8 Canada geese dead	Diazinon Docket #79 (P. Mineau)
O-68	BC	7/80	orchard	liquid	NR	8 Canada geese dead	Ibid.
O-69	BC	5/81	orchard	liquid	NR	6 Canada geese (goslings) dead	Ibid.
O-70	BC	6/72	NR	NR	NR	5 ducks (species NR) dead	Ibid.
O-71	BC	1/81	NR	NR	NR	37 wigeon dead	Ibid.
O-72	BC	1/82-2/82	NR	NR	NR	10+ Canada geese dead	Ibid.
O-73	BC	1/83	NR	NR	NR	10+ Canada geese (goslings) dead	Ibid.

2. Orchards

Diazinon is registered for use in apple, almond (California only), apricot, cherry, nectarine, peach, pear, plum/prune, and walnut (California only) orchards. Typical orchard use involves the application of one or more (usually several) liquid foliar sprays. Application rates of 0.75 lb ai/A to 4.5 lb ai/A are permitted, depending on crop and pest (C-G 50W label with EPA comments dated 2/16/90).

Orchards provide trees for avian nesting and cover. Perhaps the greatest dietary exposure to birds would occur via contaminated insects. Applications would typically occur in the spring and summer, the avian breeding season. Even birds that typically eat seeds or other plant matter at other times of the year, eat largely insects during the breeding season. Furthermore, young would be fed such animal matter almost exclusively (Martin, et. al., 1953).

At 4.5 lb ai/A, initial residues on insects may be as high as 238 ppm, based on Kenaga (1973). Such residues greatly exceed many avian LC_{50} values. While residues would decline with time, repeat applications would keep boosting the residues up, presenting a continued risk over the breeding season. Even the lowest rate (0.75 lb ai/A) could produce initial residues on insects of 43.5 ppm, exceeding lowest avian LC_{50} levels. Aerial application is currently permitted with peaches, nectarines, plums, prunes, cherries, apricots, almonds, and walnuts. Aerial application provides the potential for increased avian exposure due to drift and inadvertent direct application to adjacent habitat.

Terrestrial field studies in apples were conducted in Pennsylvania and Washington states in 1989 (Kendall, et. al., 1990). These studies are currently under review in EEB. The application rate was 3 lb ai/A (the highest rate for apples), with six applications to each Pennsylvania test orchard and five to each Washington test orchard, at approximately two week intervals (p. 7). Applications were all made with ground equipment.

A total of 127 dead birds or remains in Pennsylvania and 260 dead birds or remains in Washington were found during carcass searches and other activities (p. 9). In addition, totals of 71 and 101 dead starling nestlings were found in nest boxes on treatment sites in Pennsylvania and Washington, respectively (p. 51).

Species with depressed brain cholinesterase identified in dead birds include robin, cardinal, starling, and chipping sparrow in Pennsylvania (p. 60), and robin, Canada goose, killdeer, and black-billed magpie in Washington (p. 61). 87 brains (of 127 dead birds) were analyzed in Pennsylvania, while 48 brains (of 260 dead birds) were checked in Washington.

Only 15% of the remains found in Washington were "fresh and intact", while the majority were feather spots (p. 62).

The report claims that the only mortalities that "can be ascribed to diazinon with a high degree of probability" are 12 Canada geese and four nestling killdeer, based on brain cholinesterase depression and levels of residues in the gastrointestinal tracts (p. 81). The authors' attempt to use levels of diazinon in the GI tract to determine whether diazinon caused the death is not standard, and may not be appropriate. Usually, if a bird has depressed cholinesterase indicative of pesticide poisoning, the simple presence of a particular pesticide in the GI tract is considered confirmation of the lethal agent. The report did not make any claim as to what did kill the birds other than the Canada geese and killdeer.

Reproductive effects were examined using starling nest boxes. Egg survival rate, hatching success, and nestling survival rates were reported to be significantly different between treatment and controls in Pennsylvania but not Washington (p. 49). When EEB review of these studies is completed, additional comments may be warranted.

3. Fruit and Vegetable Row Crops with Pre-plant or At-plant Granular Diazinon Application

Diazinon granular products are registered for use pre-plant incorporated on beans, beets, broccoli, brussel sprouts, cabbage, carrots, cauliflower, celery, collards, cucumber, endive, ginseng, kale, lettuce, melons, mustard, onions, parsley, peas, peppers, potatoes, radishes, spinach, squash, sweet corn, sweet potatoes, Swiss chard, tomatoes, and turnips. Application to sugar beets is pre-plant or at-plant and application to sugarcane (Florida only) is at-plant. Applications are almost all broadcast with incorporation, with rate of 1-4 lb ai/A (C-G 14G label EPA accepted 12/12/89 and personal communication, D. Pilitt).

As with turf applications of granular diazinon, birds can be exposed via direct consumption of the granules themselves. Birds may select granules intentionally as a grit source, may mistake granules as a food source, may inadvertently pick up granules while searching for other food items, or may ingest granules adhering to the surface of other food items. These direct exposures to granules are probably the greatest sources of exposure to diazinon for these sites and application methods. Unlike turf applications, agricultural applications require incorporation into the soil, 1-8" depending on target pest (C_G 14G label EPA accepted 12/12/89). While this may reduce the numbers of granules available to foraging birds, it takes only 1-5 granules to kill small birds, as shown earlier.

Based on the research of Erbach and Tollefson (1983), EEB assumes there will be approximately 15% of applied granules remaining at or near the soil surface following broadcast application and incorporation. At the maximum label rate of 4 lb ai/A (28 lb of 14.3% ai formulation, C-G 12/12/89 label), there would be 0.000092 lb ai/ft^2 (43,560 ft^2/A) or 0.000042 kg ai/ft^2 (0.45359 kg/lb), or approximately 42 mg ai/ft^2 in granules at or near the soil surface. There would be 1/4 of this at the lowest rate of 1 lb ai/A, or 10.5 mg ai/ft^2.

LD_{50} values for birds are mostly in the range of 1.2-10 mg/kg as noted earlier. To compare these values to the above calculations of the amount of diazinon/ft^2 requires that the weight of the bird be considered. The lowest value for a small, sparrow-sized bird is approximately 2.5 mg/kg (Balcomb, et. al., 1984). The reported average field sparrow (Spizella pusilla, a typical sparrow of agricultural fields) weight is 0.0125 kg (Dunning, 1984). Thus, an individual sparrow would require only about 0.03 mg diazinon (2.5 mg/kg X 0.0125 kg) to receive an LD_{50} dose.

To calculate how many LD_{50} doses there would be in a square foot of field, one simply divides the amount of diazinon/ft^2 by the amount of diazinon required for an LD_{50} dose. At the maximum application rate of 4 lb ai/A, there would be roughly 1400 LD_{50}s/ft^2 ($\frac{42 \text{ mg ai/ft}^2}{0.03 \text{ mg ai/LD}_{50}}$). At the minimum rate of 1 lb ai/A, there would be 1/4 of this, or roughly 350 LD_{50}'s/ft^2. As residues leach from the granules, dietary items could be exposed at that time, providing an additional route of exposure.

Terrestrial field studies were conducted for pre-plant incorporated use of diazinon in carrots in Wisconsin and Texas by Bio-Life, Ltd. during 1989 (Fletcher, et. al., 1990). These studies are under review in EEB. In Wisconsin, broadcast applications of the maximum label rate (4lb ai/A) of a 14G product were made to a total of 13 treatment sites, followed by incorporation. Despite carcass searches including up to 100% of study sites, no mortality that could be ascribed by the authors to diazinon was found. The authors claimed that they had substantial numbers of ground-feeding birds using the treatment sites following application. They believed that the lack of mortality found was due largely to a high degree of incorporation of granules.

Agricultural practices following broadcast application reportedly included use of a chisel plow, a cultipacker, a smoothing drag, disking equipment, bedding equipment, and planting equipment including a packing drum and equipment to place and press in the seed (pp. 19, 35). This study is not applicable to carrots or other crops grown using

substantially different pre-plant/planting practices, where more granules may remain at or near the soil surface. When EEB review of this study is complete, additional comments may be warranted.

4. Vegetable and Fruit Foliar Applications

Diazinon is registered for foliar applications to a wide variety of crops. Based on labels reviewed, the highest rate appears to be for cranberries. Labels (e.g., AG500) call for 2-3 lb ai/400 gallons of water, with a minimum of 400 gallons applied per acre. Thus, if more than 400 gal/A are applied, the lb ai/A would increase. All caneberry crops (blackberries, boysenberries, dewberries, loganberries, rasberries) can receive up to 2 lb ai/A. Sweet corn has a 1.25 lb ai/A maximum foliar rate, while that for strawberries is 1 lb ai/A. Rates of 0.75 lb ai/A appear for several crops, while a 0.5 lb ai/A rate appears many times.

The greatest avian dietary exposure with liquid foliar applications to agricultural crops may be to contaminated insects. At 3 lb ai/A, there could be initial residues on small insects of 174 ppm (3 X 58 ppm, based on Kenaga, 1973), well above avian LC_{50} levels. If a small, insectivorous bird consumed 26-32% of its body weight/day (Tucker, 1975), it would receive 45-56 mg/kg (0.26 X 174 ppm & 0.32 X 174 ppm), many times an LD_{50} dose. Even a 0.5 lb ai/A rate could result in a lethal dose of 7.5-9.3 mg/kg [0.26 X (0.5 X 58 ppm) & 0.32 X (0.5 X 58 ppm)].

Dermal exposure, inhalation exposure, and water consumption from contaminated puddles are all examples of exposures that would further increase risk. Aerial application of diazinon is currently permitted for head lettuce and tomatoes. This provides the potential for increased avian exposure due to drift and inadvertent direct application to adjacent habitat.

5. Seed Treatments

Seed treatments involve application of diazinon to corn and other seeds at planting time. At a current application rate of 1.8 oz. of a 15% ai product per 50 lbs. seed and approximately 1,350 corn seeds/lb (McArdle, 1989), there would be 0.113 mg diazinon/seed if the diazinon were applied uniformly to all seeds. In comparison, Balcomb, et. al. (1984) found that diazinon 14G granules weigh 0.331 mg on average, and thus each granule contains approximately 0.046 mg diazinon on average. Hence, the residue on a treated seed is approximately 2.5 times the amount of diazinon found in a typical 14G granule.

Thus, the amount of diazinon on a single corn seed could easily kill a small bird. For example, in Balcomb, et. al. (1984), one diazinon granule per bird killed 40%, and five killed 80%, of the house sparrows tested. Five granules/bird killed 100% of the redwinged blackbirds tested. Since the residue on the corn seed is approximately 2.5X greater, it would take 2.5X fewer seeds than granules to kill a bird. If diazinon is not applied uniformly to seeds (e.g., due to impecise manual mixing), some will contain even more than 0.113 mg diazinon, presenting an even greater hazard.

Seeds are reportedly planted 1-2" below the ground surface, with up to 24,000 planted/acre (McArdle, 1989). Many birds can easily probe to this depth in search of food. Given the attractiveness of seeds to birds and the lethal amounts of diazinon found on even a single seed, a substantial risk to birds is present.

Documented Field Kills on Known Sites Other Than Turf, and Unknown Sites

Additional bird kill incidents involving diazinon application to other sites, including unknown application sites, are summarized in Table 4. Application sites include trees or orchards, corn, alfalfa, a concession stand, building exterior and interior, ponds, and rangeland. Formulations included liquids, granulars, crystals or encapsulated, and treated seed. Birds killed include waterfowl, songbirds, gallinaceous birds, shorebirds, hummingbird, woodpecker, and others. As described for turf sites, the number of documented field kills is considered only a very small fraction of actual kills. Since most non-turf sites are less regularly walked by people and/or have taller vegetation than turf, the percent of kills documented is likely even lower than for turf.

7. Risk to Endangered/Threatened Species

EEB assumes there is a risk to endangered/threatened terrestrial wildlife if they are exposed to pesticide levels $\geq$ 1/10 laboratory bird/mammal LC_{50} or LD_{50}, and aquatic wildlife if exposed to levels $\geq$ 1/20 aquatic LC_{50} (assumed no-effect levels). To date, EEB has formally consulted with USFWS on diazinon for many use sites, including corn, cotton, soybeans, sorghum, small grains, rangeland, and golf courses/sod farms. All of these consultations resulted in Biological Opinions from USFWS indicating jeopardy to endangered/threatened species (USFWS 1983a, 1983b, 1983c, 1984, 1986). Diazinon exceeded criteria for birds, reptiles, aquatic life, and insects. Diazinon is one of the first 50 pesticides to be included in the ongoing endangered species implementation project. A new consultation with USFWS under this project will include all diazinon outdoor use sites.

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