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Pre-Per Review
DRAFT

DATA EVALUATION REPORT

1. Chemical: Terbufos
2. Test Material: Counter 15G; granular; 15% ai.
3. Study Type: Avian Field Study - Actual Use Conditions -
Potential for Acute Mortality.

Species tested:

Mammals, birds, reptiles, fish (species lists appended).

4. Study Identification: Dingledine, John V. (1985). An
Evaluation of the Effects of Counter
15 G to Terrestrial Species Under
Actual Field Use Conditions. Performed
by Wildlife International, Ltd., St.
Michaels, Maryland; Submitted by
American Cyanamid Corp., Princeton,
New Jersey. Reg. No. 241-238;
Acc. No. 256982

5. Review By:

John J. Bascietto
Wildlife Biologist
Ecological Effects Branch/HED

Signature: *John J. Bascietto*

Date: *5/24/85*

6. Approved By:

Dave Coppage
Supervisory Biologist
Ecological Effects Branch/HED

Signature: *D. Coppage*

Date: *5/24/85*

7. Conclusions:

The study is scientifically sound. This study demonstrates that Counter 15G, when applied with ground equipment at 16 oz. per 1,000 ft of row, causes acute mortality of birds and reptiles. When applied aerially at 6.7 lbs. per acre (broadcast) significant mammal, bird, and reptile acute mortalities result. Fish are also killed by aerial applications. Exposure to terbufos was clearly demonstrated by analysis of whole-body residues of terbufos in vertebrates killed during this study.

This study demonstrates vertebrate field kills resulting from actual use exposure to terbufos. This study does not demonstrate an adequate margin of safety for this product because it is not a "population effects" type study.

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The study fulfills requirements for actual use condition testing of acute mortality potential as specified by the June, 1983 E.P.A. publication of re-registration guidance (Registration Standard). The study fulfills a requirement to study the incremental acute risk to birds and mammals posed by a proposed amendment to the re-registration standard to add aerial and ground broadcast applications for corn.

8. Recommendations:

Multi-year, multi-site avian, mammalian, and reptilian population studies should be undertaken to determine potential for population impacts. Studies may include, but not be limited to, effects on nesting and other reproductive parameters, behavioral ecology and population stability.

9. Background:

These studies were conducted to fulfill separate requirements for actual use condition field studies under 71-5 of the Pesticide Assessment Guidelines, Subdivision E - Simulated and actual field testing for mammals and birds. The ground application phase was performed to fulfill a requirement of the Registration Standard (June 1983) guidance. The aerial application phase was performed to support an incremental risk assessment, required by EEB review by Fekel, dated March 23, 1985, (EEB file review #14). The aerial application phase is considered a broadcast application - "over the crop" and unincorporated, as opposed to currently registered uses which incorporate the granules to one degree or another. Thus the aerial phase will be used to assess "broadcast" applications in general.

In a meeting of EEB, RD, American Cyanamid and Wildlife International on April 25, 1984, it was specifically agreed that the purpose and objective of this single-year use study was to establish whether acute mortality of mammals and birds (especially passerines) can be caused by applications of Counter 15G to corn, and if so, that exposure to terbufos (active ingredient in Counter) could be co-established in carcasses of any animals found dead in corn fields. The registrant specifically declined EEB's advice to monitor control fields (no Counter 15G applications), and insisted that they would rely instead on whole body residue analyses to indicate that mortality of a particular carcass was compound related. They specifically declined to run Acetyl Chlorinesterase Inhibition studies using EEB's recommended methods, and instead insisted that whole-body terbufos residue analysis would be sufficient to establish a causal relationship between observed mortality and terbufos exposure (see terbufos active ingredient file - memo of April 25, 1984, by John Bascietto).

10. Discussion of Individual Studies

This field study is composed of two (2) different applications: an at-planting ground application with soil incorporation of granules; and an aerial "broadcast," over the crop application (no incorporation) to an almost mature corn crop. Each phase was intended to simulate actual use conditions, and thus the validity of these studies should depend on how well they simulated the registered label and proposed label amendment (add aerial and ground broadcast).

Each phase uses the same methodologies for studying the end point of mortality, and to census the species exposed. These are avian population surveys (for species exposed) and carcass searches (for mortality). Carcass search efficiency studies and predator/scavenger removal studies were incorporated as checks on the carcass searches.

A third element of this field study is the residue analysis work, which was conducted by the sponsor's (American Cyanamid) laboratory. It had been agreed that the sponsor would prove that whole-body residue detection methodologies would be sensitive enough to detect at least whole-body (passerine bird species) residues associated with administration of a laboratory-determined LD₂₀ (see memo of April 25, 1984, meeting). Carcasses collected in the field by Wildlife International study personnel were shipped to the sponsor's laboratory for residue work-ups (see "Materials and Methods").

11. Materials and Methods:

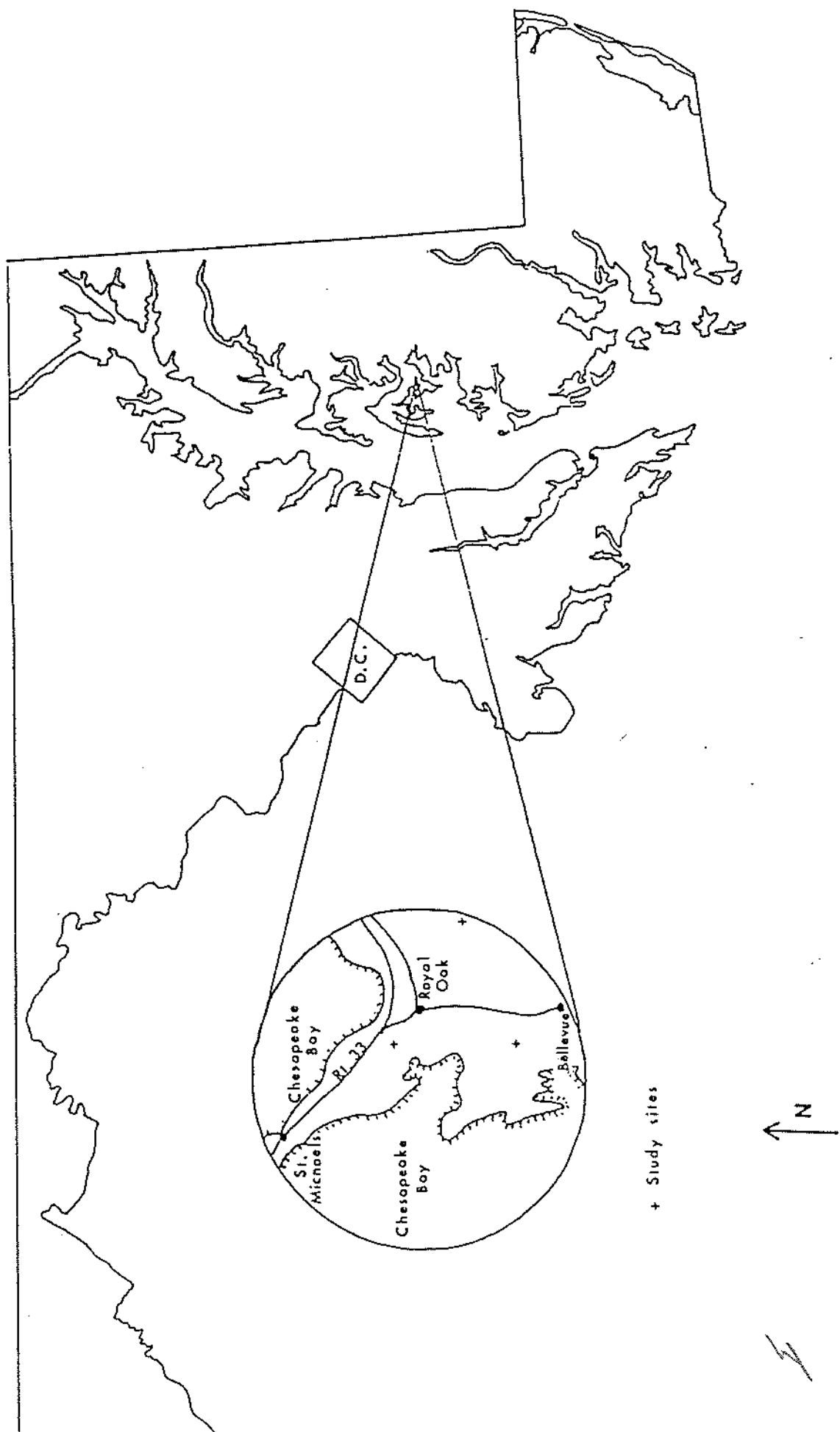
- A. Toxicant - Counter 15G - 15 percent granular terbufos organophosphate systemic insecticide-hemeticide on montmorillonite clay base.
- B. Study sites - The study was carried out on private agricultural land planted to field corn in Talbot County, Maryland. Fields were located approximately 10 miles southwest of Easton, MD on the Delmarva peninsula. Primary crops are corn and soybeans. This area lies in the Atlantic Coastal Plain and is on the eastern shore of the Chesapeake Bay (90 percent of the county is bounded by tidal water). The area, 25 feet above sea level is well drained by tidal creeks and rivers, although much of the surface water runs off through man-made ditches. The study sites drain to the Choptank River and Chesapeake Bay (Figs. 1 and 2).

The climate is continental-humid (influenced by the Bay's proximity). The average annual air temp. is 56 °F (July average daily max. = 89 °F; Feb, average

- 6-A -

FIGURE 1

STUDY AREA MAP, TALBOT COUNTY, MARYLAND



- 7-A -

FIGURE 2

STUDY AREA MAP WITH PLOT LOCATIONS



daily minimum = 25 °F). Growing season is 198 days (frost-free period). Annual rainfall averages 44.65 inches.

The detailed climate observations for this study included daily min. and max. air temperature, precipitation (0.01 inch increments), cloud cover (%) and wind speed and direction were taken at the National Oceanographic and Atmospheric Administration's Weather station at Royal Oak, Maryland, which is within five (5) miles of all test fields (Table 1).

Soils of the study area include two main types: Keyport-Mattapex, level to gently sloping, moderately to well drained silty clay or silt loams; and Elkton-Othello-Barclay, level to nearly level somewhat poorly drained silty clay to silt loam.

Vegetation types adjacent to the actual study fields provided important "edge" habitat. Loblolly pine (Pinus taeda) and mixed hardwoods such as oaks (Quercus spp.), red maple (Acer rubrum), hickory (Carya spp.) and sweet gum (Liquidambar styraciflua). Hedgerows were also available and consisted of maples, sweet gum and eastern red cedar (Juniperus virginiana), and woody shrubs. Other border vegetation consisted of grass ditches and tree lines.

C. Experimental Design

Six study fields were selected for treatment - NO control fields were used. Five of the six fields were approximately the same size (approx 25 acres) while one was 12 acres in size. Distances between study sites (fields) ranged from 25 feet to five miles.

<u>Sites</u>	<u>Size</u>
Bushy Heath (BH)	26.8 acres
Camper (CA)	28 acres
Fox Harbor (FH)	12.3 acres
Ferry Neck I (FNI)	30 acres
Ferry Neck II (FNII)	20.1 acres
Normandie (ND)	18.1 acres

Fox harbor, the smallest field, employed conservation practice (no-till) while the other sites were tilled.

METEOROLOGICAL OBSERVATIONS

PAGE 1 OF 2

GROUND APPLICATION PHASE

DATE	TEMPERATURE °F		WIND DIRECTION	PERCENT CLOUD COVER	PRECIPITATION (INCHES)	COMMENTS
	Max.	Min.				
05/08/84	82	57	SW 10-15	50	0.67	Thunder, Damaging Wind
05/09/84	64	51	NW 10-20	50	NONE	-
05/10/84	66	50	NW 10-15	25	NONE	-
05/11/84	73	55	S 10-20	25	NONE	-
05/12/84	76	63	S 10-15	50	NONE	Traces of Rain
05/13/84	76	52	S 5-8	50	NONE	-
05/14/84	68	58	NS 15-20	NONE	NONE	-
05/15/84	63	50	NW 10-18	25	NONE	-
05/16/84	61	47	NW 15-20	50	NONE	-
05/17/84	66	44	N 10-20	50	NONE	-
05/18/84	65	44	V 5-10	100	NONE	-
05/19/84	86	55	SW 8-15	25	0.06	-
05/20/84	86	61	S 5-10	25	NONE	-
05/21/84	86	65	NW 2-6	NONE	NONE	-
05/22/84	89	63	S 10-15	NONE	NONE	-
05/23/84	80	65	S 10-15	75	0.58	-
05/24/84	76	57	N NW 8-12	NONE	NONE	-
05/25/84	79	62	S 10-15	NONE	NONE	-
05/26/84	86	70	SW 10-15	50	NONE	Traces of Rain
05/28/84	79	59	S 10-15	75	0.09	Thunder
05/29/84	73	66	SE 10-15	100	0.84	Thunder
05/31/84	66	52	NW 10-20	50	0.07	-
06/01/84	73	50	NW 10-15	50	NONE	-
06/03/84	83	52	SW 5-10	50	NONE	-
06/04/84	81	55	SW 8-12	25	NONE	-
06/07/84	91	68	V 2-4	NONE	NONE	-

(Continued)

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METEOROLOGICAL OBSERVATIONS

PAGE 2 OF 2

AERIAL APPLICATION PHASE

DATE	TEMPERATURE °F		WIND DIRECTION	PERCENT CLOUD COVER	PRECIPITATION (INCHES)	COMMENTS
	Max.	Min.				
07/22/84	85	68	SE 10-15	50	0.23	-
07/23/84	87	70	S SW 8-12	50	NONE	-
07/24/84	92	75	SW 10-15	25	NONE	-
07/25/84	88	68	NW 8-12	50	NONE	-
07/26/84	79	62	SE 5-10	100	0.04	- Applied with 22.5-1000
07/27/84	85	67	SW 8-12	50	0.23	-
07/28/84	77	66	N 8-12	75	NONE	-
07/29/84	75	59	SE 8-12	75	NONE	Traces
07/30/84	76	63	N 5-10	75	0.31	-
07/31/84	82	64	V 4-8	25	NONE	- Applied with 2000-4000 ft 10.5.84
08/01/84	86	69	SW 5-10	50	NONE	-
08/02/84	91	74	SW 2-6	50	0.03	-
08/03/84	88	73	SW 2-6	50	0.11	Thunder
08/04/84	90	71	N NW 5-10	25	0.03	Thunder
08/05/84	87	71	NW 8-12	50	NONE	Traces
08/06/84	90	66	SW 8-12	NONE	NONE	-
08/07/84	90	72	SW 8-12	25	NONE	-
08/09/84	91	70	V 4-12	50	0.05	Thunder
08/11/84	89	72	NE 8-12	50	NONE	-
08/14/84	88	72	E 4-8	50	NONE	-

In addition to the study area proper at Normandie site, a small 7-acre field adjacent to it also received Counter 15G treatments.

Applications of Counter 15G were made on the following schedules.

Ground Application Phase - began May 8, 1984

<u>Dates of Application</u>	<u>Study Field</u>
5/14/84	Ferry Neck I
5/14/84	Ferry Neck II
5/14/84	Bushy Heath
5/15/84	Camper
5/18/84	Fox Harbor
5/21/84	Normandie

Ground applications were made by a John Deere 7000 Max-Emerge planter at 17.4 lbs/acre (16 oz/100 row ft) on 30-inch center row spacing (2.61 lb ai per acre nominal rate). Applications were made at planting, as a band over the row, behind the double disk/furrow opener and in front of the soil-firming wheels, thus applications were soil incorporated.

Aerial Application Phase - began July 22, 1984

<u>Dates of Application</u>	<u>Study Field</u>
7/26/84	Ferry Neck I
7/26/84	Ferry Neck II
7/26/84	Fox Harbor
7/31/84	Bushy Heath
7/31/84	Camper
7/31/84	Normandie

About ten (10) weeks after planting, aerial applications were made by a 201C Weatherly (450 hp Pratt Whitney engine) airplane on swath width of 35 ft; at 110 mph; 30 feet above the crop (which was in "early tasseling"

stage). Counter was applied at approximately 9.2 lbs/acre (1.38 lb ai/acre). Granules were "broadcast", not covered, nor incorporated. "Nominal" rate of application was 6.7 lbs/acres.

D. Agricultural Practices

Fields were prepared for planting of corn using "standard" practices. Rows were 30" center. Prior to planting all sites except Fox Harbor were treated with 3.3 lbs ai of Lasso (Alachlor) and 2 lbs ai atrazine in 20 gallons water, per acre.

Fox Harbor field received 1.33 lbs. atrazine and 2.67 lbs Bladex (cyanazine) in 30 gallons of water per acre. Liquid nitrogen at 1.1 lbs per gallon was applied to all fields at planting at 15 lbs nitrogen per acre. Total nitrogen applied during the season was 150 lbs per acre.

(Fox Harbor field used "no-till" conservation practice).

E. Calibration of Application Equipment

Ground phase - nominal rate = 17.4 lbs/acre (16 oz/1000 ft).

Speed: 7 miles/hr.

Calibration plot length: 500 feet

Planter flow gauge No.: 18

Three separate rows were checked twice

<u>Row</u>	<u>Oz/500 ft of Row</u>
A	8.1 (16.2 oz/1000')
	8.1 (16.2 oz/1000')
B	8.3 (16.6 oz/1000')
	8.3 (16.6 oz/1000')
C	8.0 (16.0 oz/1000')
	8.0 (16.0 oz/1000')

compared to nominal rate of 16 oz/1000 feet of row.

Aerial Phase - nominal rate = 6.7 lbs/acre.

Swath Width: 35 ft

Height: 30 ft

Speed: 110 mph

Calibration was on ground. 150 lbs of Counter 15G placed in hopper. 1 mile = 5,280 ft x 35 ft = 184,000 ft²/mile or 4.2 a/mile.

4.2 a x 6.7 lbs/a = 28.1 lbs/mile.

110 mph = 1 mile/32.7 sec, or nominal delivery of 25.8 lbs/30 seconds.

Total Counter applied on July 26, 1984, was 576 lbs on 62.4 acres or 9.2 lbs/acre (includes swath overlap and edge overruns).

Total Counter applied on July 31, 1984 was 724 lbs on 79.9 acres or 9.1 lbs/acre (includes swath overlap and edge overruns).

Nominal label rate = 6.7 lbs/acre.

F. Avian Surveys

Two (2) teams of observers walked transects that ran along the field's edge, completely encircling each field. Points along transects were marked by lettered stakes, to aid in orientation. Observations were recorded on microcassette. These included location, activity, habitat type, and species. Birds further than 100 feet from the field edge or flying overhead approximately 100 feet or more were not recorded. Surveys were not conducted in the rain. Each survey was completed in about one hour, beginning close to sunrise and continuing until each team had completed surveys on three or fewer study fields. Order of field search and transect routes were varied on a regular basis to control for time bias. The same teams surveyed the same three fields throughout the study.

Pre- and post-treatment surveys were run with both ground and aerial phases according to the attached schedule (Table 2).

All animal sightings were recorded along with observations of birds made during the surveys.

G. Carcass Searches

Treated fields were systematically searched, for any signs of affected animal species and mortality, e.g., carcasses and feather spots. Two teams of searchers conducted these searches. Carcass searches usually began 24 hours after application, were generally on the same schedule as the avian surveys but were carried out regardless of weather. There was no pre-treatment carcass searching.

STUDY ACTIVITY SCHEDULE

GROUND APPLICATION PHASE

PAGE 1 OF 3

DATE	FIELD					
	FERRY NECK I	FERRY NECK II	FOX HARBOR	BUSHY HEATH	CAMPER	NORMANDIE
05/08/84	BS	<i>Var</i>	-	BS	BS	-
05/09/84	BS	BS	BS	-	BS	-
05/10/84	BS	BS	BS	-	BS	-
05/11/84	BS	BS	BS	BS	BS	-
05/12/84	BS	BS	BS	BS	BS	-
05/13/84	BS	BS	BS	BS	BS	-
05/14/84	*BS	*BS	BS	*BS CS	BS	-
05/15/84	BS CS	BS CS	BS	BS CS	*BS CS	-
05/16/84	BS CS	BS CS	BS	BS CS	BS CS	BS
05/17/84	BS CS	BS CS	BS	BS CS	BS CS	BS
05/18/84	BS CS	BS CS	*BS CS	BS CS	BS CS	BS
05/19/84	BS CS	BS CS PR	BS CS	BS CS PR	BS CS	BS
05/20/84	BS CS	BS CS PR	BS CS	BS CS PR	BS CS	BS
05/21/84	BS CS	BS CS PR	BS CS	BS CS PR	BS CS	*BS CS
05/22/84	PR	-	BS CS	-	BS CS PR	BS CS
05/23/84	BS CS PR <i>Rain</i>	BS CS <i>2</i>	BS CS	BS CS <i>2</i>	<i>R</i> PR	<i>BS CS</i>
05/24/84	PR	-	BS CS	-	BS CS PR	BS CS
05/25/84	BS CS PR	BS CS	BS CS	BS CS	PR	BS CS

BS = Bird Survey

CS = Carcass Search

PR = Predator Removal Survey

* = Day of Application of Counter 15 G

(Continued)

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STUDY ACTIVITY SCHEDULE

GROUND APPLICATION PHASE

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DATE	FIELD					
	FERRY NECK I	FERRY NECK II	FOX HARBOR	BUSHY HEATH	CAMPER	NORMANDIE
05/26/84	-	-	-	-	BS CS	BS CS
05/27/84	-	-	CS	-	-	CS
05/28/84	BS CS	BS CS	BS	BS CS	-	BS CS
05/29/84	-	-	BS CS	-	CS	BS
05/30/84	-	-	-	-	-	CS
05/31/84	-	-	PR	-	BS	BS PR
06/01/84	-	-	BS CS PR	-	-	BS CS PR
06/02/84	CS	CS	PR	CS	CS	PR
06/03/84	BS	BS	PR	BS	BS	PR
06/04/84	-	-	BS CS	-	-	BS CS
06/06/84	CS	CS	CS	CS	CS	-
06/07/84	-	-	-	-	-	BS CS
06/11/84	-	-	-	-	-	CS

BS = Bird Survey

CS = Carcass Search

PR = Predator Removal Survey

(Continued)

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STUDY ACTIVITY SCHEDULE
AERIAL APPLICATION PHASE
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DATE	FIELD					
	FERRY NECK I	FERRY NECK II	FOX HARBOR	BUSHY HEATH	CAMPER	NORMANDIE
07/22/84	BS	BS	BS	-	-	-
07/23/84	BS	BS	BS	BS	BS	BS
07/24/84	BS	BS	BS	BS	BS	BS
07/25/84	BS	BS	BS	BS	BS	BS
07/26/84	*BS	*BS	*BS	BS	BS	BS
07/27/84	CS	CS	CS	BS	BS	BS
07/28/84	BS CS	BS CS	BS CS	BS	BS	BS
07/29/84	BS CS	BS CS	BS CS	BS	BS	BS
07/30/84	RO CS	RO CS	RO CS	RO	RO	RO
07/31/84	BS CS	BS CS	BS CS	*BS	*BS	*BS
08/01/84	BS CS	BS CS	BS CS	CS	CS	CS
08/02/84	BS CS	BS CS	BS CS	BS CS	BS CS	BS CS
08/03/84	-	-	-	BS CS	BS CS	BS CS
08/04/84	BS CS	BS CS	BS CS	BS CS	BS CS	BS CS
08/05/84	-	-	-	BS CS	BS CS	BS CS
08/06/84	BS CS	BS CS	BS CS	BS CS	BS CS	BS CS
08/07/84	-	-	-	BS CS	BS CS	BS CS
08/09/84	BS CS	BS CS	BS CS	BS CS	BS CS	BS CS
08/11/84	-	-	-	BS CS	BS CS	BS CS
08/13/84	PR	PR	PR	-	-	-
08/14/84	PR	PR	PR	BS CS PR	BS CS PR	BS CS PR
08/15/84	PR	PR	PR	PR	PR	PR
08/16/84	PR	PR	PR	PR	PR	PR
08/17/84	-	-	-	PR	PR	PR

BS = Bird Survey

CS = Carcass Search

PR = Predator Removal Survey

* = Day of Application of Counter 15 G

RO = Bird Survey Rained Out

Searches were conducted along transects through each field and along each field's perimeter. Intensive searching was carried out 10 ft to either side of the transect line, but observations were not strictly limited to this area. Distinctive vegetation types were also searched. At these sites an observer searched a line 20 feet long perpendicular to both sides of the transect (established by markers).

For the ground application phase, searching of the actual field area was done by walking two evenly spaced transects through the field. Carcass searching following aerial applications was performed by searching transects which ran parallel to the field edge and 20-25 feet into the corn. Approximate time for each field search was one hour. Transect routes were routinely alternated. Dead or affected animals were collected for residue analysis of terbufos and metabolites.

H. Carcass Search Efficiency Trials

A controlled test employing two separate trials was conducted to measure success of the observers in finding carcasses. These occurred at the end of each phase's search period.

For the first trial a known number of bobwhite quail carcasses were placed on transect along field perimeter (not at a treated field site). Observers to be tested did not know the placement of the birds. Birds were not intentionally hidden but placed within a "reasonable distance of the transect. Observers performed the normal carcass search procedures to measure their search efficiency.

The second trial was done in a section of one of the fields used in the treatments (Bushy Heath) (occurred after the last "real" carcass searches). Both trials simulated actual field conditions and habitat types encountered during the actual carcass searches.

I. Predator Removal Evaluation

As a further check on the carcass search observations the effect of predator removal and scavenging was evaluated. Carcasses (25 or 18) were placed within the regular study area, some in the field (4 of 25), others either at field edge or into the adjacent vegetation. Each carcass was marked by an orange flag. Carcasses were observed at 24, 48, and 72 hours after placement for condition and/or presence. Carcasses were recorded as either "intact," "scavenged" or "removed." These predator removal trials were conducted at the end of

each application phase (i.e., after finishing all surveys and carcass search work).

J. Residue Work

A separate study was established to test the sensitivity of the whole-body residue analysis plan proposed by Cyanamid to link exposure to terbufos with any carcasses found. Two (2) dosages, i.e., an LD₂₀ = 15 mg/kg and an LD₅₀ = 30 mg/kg were administered to groups of five male and five female bobwhite quail. The LD₅₀ and LD₂₀ doses were administered by Wildlife International by crop intubation via a stainless steel catheter. The dose was dispersed in corn oil. Birds not killed within 48 hours of dosing were sacrificed. Dead and sacrificed birds were frozen and shipped to American Cyanamid (Princeton, New Jersey) for analysis of terbufos and related metabolites.

At Cyanamid's laboratory, samples were prepared for analysis by grinding the whole carcass in a Hobart food chopper with dry ice. Samples were analyzed for total CL 92,100-related residues by Method M-1479 as described in report C-2483 (Appendix XXVI of the study report as submitted to EPA). This is a gas chromatographic determination with a limit of detection = 0.05 ppm. Method uses Tracor Model 550 gas chromatograph equipped with a flame photometric detector in the phosphorous mode.

The residue analyses of all carcasses found during the operational phases of this study were conducted in the same manner as the residue method validation study just described.

K. Analysis of the Data

Avian survey results were transferred from tape to summary tables and maps. Ground and aerial phases were analyzed separately. No statistical analyses were performed "due to the variability in daily observations." The author states (p. 15-16) "It was felt that direct observation of the data would be more useful in detecting biologically significant changes that may or may not be statistically significant."

Tabulated data categories included: 1) total number of bird observations; 2) total number of bird observations in field; 3) total number of birds observed feeding in the field; 4) total number of singing males; 5) total number of different bird species.

Flock observations (>10 birds) were recorded separately from observations of individual birds to prevent masking of potential changes in resident populations.

12. Reported Results

Ground Application Phase

Bird Surveys

- 87 bird species identified. 6-62 daily observations per site (daily average = 29 observations per site).
- Days 1-3 post application - average bird numbers at ND, FNII and BH decreased compared to pre-treatment; FNI increased average comparatively; FH or CA exhibited similar pre- and post-treatment average daily totals.
- The author states: "no pattern of change in total bird numbers at the test sites that could be attributed to Counter 15G".

- A trend to reduction of post-application bird numbers actually in the tilled portion of corn fields (actual crop portion) at FNII, CA and BH.

Averaged percent of birds actually in corn crop (compared to the total number of observations in a field) was consistently lower post-application, at all sites except ND.

- 34 bird species observed standing or feeding in the treatment portion of the fields.
- Of these 34 species evidence of post-application reduction in bird numbers of eastern king bird, chipping sparrow, common grackle, American robin, bluejay, brown thrasher and European starling (except at FH where no reduction in numbers of these species was detected). Eastern kingbird and common grackle were most frequently reduced in numbers of observations, post-applications.
- Apparently no change in number of different species was detected (ranging from 9 at FH to 18 at ND).
- Numbers of singing males on plots were low but decreased slightly at FNI and FNII on Days 1-3 post-application. Numbers at others increased on Day 1-3 post-application. Numbers stabilized after Day 3 post-application (2-7 birds per field).
- The author states that there was no detectable change in the numbers of individuals of commonly occurring territorial bird species mapped (Appendix XI of the study) as a compilation of observations, however, only one (1) set of maps is presented in Appendix XI - unlabeled as to "pre-" or "post" application observations. (N.B.- Appendix IX is not attached to this DER).

- During the bird surveys many other vertebrate species were observed such as: eastern cottontails (Sylvilagus floridanus) (the most frequent), white-tailed deer (Odocoileus virginianus), squirrels (Sciurus spp.), woodchuck, opossum, muskrats, snakes, turtles and toads. (No surveys of nocturnal animals were made). Results are listed in Appendix XII.

Carcass Searching

- Table 6 is a summary of observations.
- A total of two (2) dead birds, seven (7) feather spots, and three (3) dead reptiles were found (2 snake species at FNI - 1 turtle at FNII).
- Three (3) additional birds (bluejay, brown-headed cowbird and robin) were found poisoned, but alive (lower limb rigidity, wing droop, salivation).
- A total of eight (8) animals were found in approximately 152 man-hours.
- Only the affected bluejay and unidentified dead fledgling (probably an eastern bluebird) had detectable residues of 0.15 - 0.24 ppm. Other residue findings were <0.05 ppm.
- Except for ND, all fields had 1 dead carcass.
- Most fields had three to four (3-4) observations of carcasses, feather spots, or affected but live animals, except FH, which had one (1) affected robin and one dead mourning dove (both had < 0.05 ppm) and CA which had one (1) "badly decomposed black snake (no residue work-up and a group of feathers.
- The last dead animal found was the dead mourning dove at FH with < 0.05 ppm (14 days after treatment); the last feather spot was at BH on 6/6/84, (22 days after treatment).
- The (probable) eastern bluebird fledgling was found dead on day 9 post-application under a known active eastern bluebird nest site. It had terbufos and related residue = 0.15 ppm.
- The three (3) "affected" birds - those exhibiting cholinergic poisoning symptoms - a bluejay, a cowbird, and a robin all recovered after being collected, caged and observed. The robin was found 6 hours after application; the jay was found 12 to 14 hours after application; the cowbird was found 4 days after application.
- Results of the residue analyses are shown in Table 7.

Results

Aerial Application Phase

Bird Surveys

- Total daily bird observations ranged from 12-61; averaged 31 per day (excluding flocks).
- 67 different bird species were identified.
- Post-application total bird observations noticeably decreased at CA (which had an initial pre-application total higher than all others) but remained about the same at all other sites except for ND which had a slight post-treatment reduction (37 ± 11.9 down to 29 ± 8.9 Day 2-5) of total bird observations (totals are means + S.D. calculated over the entire survey period or sub-periods indicated (Table 8)).
- A reduction in the mean numbers of birds actually observed in treated crop occurred post-application in all fields except BH (Table 9) which increased relative to pre-application. Severe reductions were noticed in all fields except BH on Day 2 post-application, and Day 3 for all except for ND and BH which increased relative to pre-application means.
- 78 species were actually observed in the treated crop. (Appendix XVI).
- Post-application reductions of birds actually in the treated crop lasted through Day 5, on the average; however, CA was reduced more than 50 percent for at least through the end of the study, FNII reduced almost 50 % through the end of the study, and FH reduced about 25 % through the end of the study. FNI recovered to pre-treatment levels after Day 7, while BH increased total numbers by more than 50 percent by Day 3 post-treatment. After an initial increase of 40 % on Day 3 post-, ND returned to pre-application numbers by Day 5 after treatment (Table 9).
- Indications of a reduction in numbers of birds observed in the treated crop occurred in ten species: American robin, common grackle, red-winged blackbird, blue grosbeak, indigo bunting, house sparrow, chipping sparrow, northern cardinal, chickadee and orchard oriole. Only BH site did not a reduction in numbers of at least one species. CA site experienced a reduction in number of observations of six species. Common grackle and red-winged blackbird were the most frequently noted to show a reduction in numbers.

- Table 12 indicates that the number of singing males was not appreciably reduced at any site. FNII experienced a slight reduction of 3 on Day 2, CA and ND reduced by 2 each on Day 2. All except for FNII and CA recovered to preapplication levels or greater, by Day 14.
- Losses of chipping sparrows and eastern kingbird (singing males) were noted on CA and FNII respectively by the end of the study. (The mapped compilation of singing males thought to be reduced in number did not indicate pre- and post-treatment birds.)
- Five animal observations are indicated in Appendix XX and included many of the same species observed during the ground application phase.

Carcass Searches - aerial phase

- Table 13 is a summary of observations.
- Many more species were killed and more carcasses were found than in the ground phase, including nocturnal species such as shrews. Markedly fewer "affected" but live finds than during ground phase.
- Significantly more mammals were killed than birds (total numbers).
- Medium-sized mammals such as cottontail rabbits, raccoons, skunks, and woodchucks were killed.
- Each 20-30 acre field had at least six (6) evident or actual mortalities (carcasses, feather spots, decomposition odor), but two fields had 9-11 such observations.
- Several groups of dead fish were found in water adjacent to sites.
- Residue work correlated very well with carcasses which were frozen and shipped to the lab. Not all evidence found was shipped for analysis of residues. It is obvious that exposure occurred and caused acute mortality in the birds, mammals, reptiles and fish that were analyzed. Levels of terbufos residue and related metabolites ranged from 0.09 ppm to 8.47 ppm (Table 14).

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 KEN/H/S
 TABLE 1

MEAN NUMBER OF TOTAL BIRD OBSERVATIONS BY STUDY SITE

GROUND APPLICATION

Field Observed	Pre-Application Average \pm SD	Post-Application Average \pm SD				
		Day 1 Total	Days 1-3	Days 1-5	Days 1-7	Days 1-20
Ferry Neck I	26 \pm 13.3	39	34 \pm 5.0	31 \pm 5.2	27 \pm 8.1	25 \pm 8.0
Ferry Neck II	37 \pm 6.9	31	30 \pm 8.1	28 \pm 6.4	26 \pm 6.2	29 \pm 7.0
Fox Harbor	17 \pm 7.7	16	20 \pm 3.5	19 \pm 9.2	19 \pm 7.5	20 \pm 6.8
Bushy Heath	26 \pm 6.4	18	17 \pm 3.1	20 \pm 4.0	20 \pm 4.5	20 \pm 3.2
Camper	44 \pm 10.9	57	47 \pm 16.7	45 \pm 12.5	44 \pm 10.7	42 \pm 10.2
Normandie	39 \pm 9.6	26	29 \pm 3.1	32 \pm 6.7	31 \pm 6.8	33 \pm 7.4

TABLE 2

PERCENT OF BIRD OBSERVATIONS IN THE FIELD BY STUDY SITE

GROUND APPLICATION

Field Observed	Pre-Application Average \pm SD	Post-Application Average \pm SD				
		Day 1 Total	Days 1-3	Days 1-5	Days 1-7	Days 1-20
Ferry Neck I	15.6 \pm 15.8	12.8	4.3 \pm 7.4	5.4 \pm 7.4	7.9 \pm 8.4	5.1 \pm 7.6
Ferry Neck II	10.4 \pm 7.8	19.4	6.5 \pm 11.2	3.9 \pm 8.7	3.3 \pm 7.2	2.7 \pm 5.9
Fox Harbor	4.9 \pm 7.3	0	0	1.3 \pm 2.9	0.9 \pm 2.4	1.1 \pm 2.4
Bushy Heath	31.8 \pm 10.1	16.7	18.4 \pm 9.4	15.1 \pm 10.8	12.9 \pm 9.7	15.2 \pm 19.7
Camper	23.8 \pm 13.0	24.6	15.2 \pm 10.7	12.3 \pm 8.6	10.3 \pm 8.0	9.0 \pm 9.2
Normandie	20.4 \pm 7.5	26.9	22.1 \pm 6.8	24.1 \pm 7.1	20.1 \pm 11.7	16.5 \pm 10.7

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TABLE 3

SUMMARY OF BIRD SPECIES SHOWING A REDUCTION IN NUMBERS
GROUND APPLICATION

<u>SPECIES*</u>	<u>FERRY NECK I</u>	<u>FERRY NECK II</u>	<u>FOX HARBOR</u>	<u>BUSHY HEATH</u>	<u>CAMPER</u>	<u>NORMANDIE</u>
Eastern Kingbird	X	-	-	-	X	X
Chipping Sparrow	-	X	-	-	-	-
Common Grackle	-	-	-	X	X	X
American Robin	-	-	-	-	X	-
Bluejay	-	-	-	-	-	X
Brown Thrasher	-	-	-	-	-	X
European Starling	-	-	-	-	-	X

* Only those species observed in the treated fields were considered.

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TABLE 4

NUMBER OF BIRD SPECIES BY STUDY SITE

GROUND APPLICATION

Field Observed	Pre-Application Average \pm SD	Post-Application Average \pm SD			
		Day 1 Total	Days 1-3	Days 1-5	Days 1-7
Ferry Neck I	12 \pm 3.0	17	14 \pm 2.6	14 \pm 1.9	13 \pm 2.4
Ferry Neck II	16 \pm 3.8	15	12 \pm 3.1	13 \pm 3.0	13 \pm 2.5
Fox Harbor	9 \pm 2.3	11	11 \pm 1.0	10 \pm 4.0	10 \pm 3.6
Bushy Heath	11 \pm 2.7	11	9 \pm 2.1	10 \pm 2.2	11 \pm 2.1
Camper	17 \pm 2.9	14	14 \pm 2.5	15 \pm 2.8	14 \pm 2.5
Normandie	18 \pm 4.7	17	15 \pm 2.1	16 \pm 1.9	15 \pm 3.1
					12 \pm 2.7
					15 \pm 2.8
					11 \pm 3.0
					11 \pm 1.8
					14 \pm 2.4
					16 \pm 3.4

TABLE 5

NUMBER OF SINGING MALES BY STUDY SITE

GROUND APPLICATION

Field Observed	Pre-Application Average \pm SD	Post-Application Average \pm SD			
		Day 1 Total	Days 1-3	Days 1-5	Days 1-7
Ferry Neck I	5 \pm 2.4	3	3 \pm 0.6	4 \pm 2.1	4 \pm 1.4
Ferry Neck II	6 \pm 2.6	5	4 \pm 1.2	6 \pm 3.0	7 \pm 3.0
Fox Harbor	3 \pm 2.4	5	6 \pm 1.5	5 \pm 3.0	4 \pm 2.7
Bushy Heath	0 \pm 0.9	4	2 \pm 2.0	2 \pm 1.5	2 \pm 2.2
Camper	2 \pm 1.7	4	5 \pm 2.3	5 \pm 1.7	5 \pm 1.7
Normandie	6 \pm 3.5	8	7 \pm 3.1	7 \pm 2.4	7 \pm 2.4
					5 \pm 1.8
					7 \pm 2.8
					5 \pm 2.3
					2 \pm 2.0
					4 \pm 1.9
					6 \pm 2.3

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CARCASS SEARCH RESULTS BY STUDY SITE - GROUND APPLICATION

DATE	FERRY NECK I	FERRY NECK II	FOX HARBOR	RUSHY HEATH	CAMPER	NORMANDIE
05/14/84	*	*	-	*	-	-
05/15/84	1 bluejay found in woods, signs of acute toxicity - 0.24 ppm	-	-	-	*	-
05/16/84	1 dead snake in field - less than 0.05 ppm	1 dead box turtle in field - less than 0.05 ppm	-	-	-	-
05/18/84	1 lethargic garter snake	Small group of feathers in hedge-row	* 1 robin on field edge, signs of acute toxicity - less than 0.05 ppm	Male brown-headed cowbird on fence row. Signs of acute toxicity - less than 0.05 ppm	1 badly decomposed black snake	-
05/20/84	-	-	2	Group of black feathers in field	-	-
05/21/84	-	-	2	-	-	* Bobwhite feathers in field
05/22/84	-	-	1	-	-	Group of large black feathers - appeared old
05/23/84	-	a few feathers	2	Dead small fledgling in field found during bird survey - 0.15 ppm	-	Bobwhite feathers in field

* Day of Application.

CARCASS SEARCH RESULTS BY STUDY SITE - GROUND APPLICATION

DATE	FERRY NECK I	FERRY NECK II	FOX HARBOR	BUSHY HEATH	CAMPER	MYRMADIE
05/24/84 20 76 71	-	-	- 6 27 40 41 - 10	-	-	-
05/28/84 - 1000, 1091	-	-	-	-	-	-
05/29/84 - 1000, 1091	-	-	- 11	-	Group of feathers in yard	-
05/30/84 31 1000, 1091	-	-	- 16 23	-	-	-
06/01/84 20 30 10 30	-	-	11 11 dead mourning 15 dove in field found 16 during bird survey 17 - less than 0.05 18 ppm	-	-	-
06/06/84	-	-	19	Group of black feathers on wood edge	-	-
Total No. 1 Carcasses	1	1	1	1	1	0

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Ground Results

TABLE 7

RESULTS OF ANALYSIS FOR TERBUFOS RESIDUES

GROUND APPLICATION

DATE	DAY*	FIELD	ANIMAL	RESIDUE (PPM)
05/15/84	1	FN I	Affected bluejay	0.24
05/16/84	2	FN I	Black rat snake	**
05/16/84	2	FN II	Box turtle	**
05/18/84	0	FH	Affected American robin	**
06/01/84	14	FH	Mourning dove	**
05/18/84	4	BH	Affected Brown-headed cowbird	**
05/23/84	9	BH	Fledgling	0.15

* Days after application.

** Below detection limit of 0.05 ppm.
 (BH = Bushy Heath, CA = Camper, FH = Fox Harbor, FN I = Ferry Neck I,
 FN II = Ferry Neck II, ND = Normandie).

Results

Aerial Application Phase

Bird Surveys

- Total daily bird observations ranged from 12-61; averaged 31 per day (excluding flocks).
- 67 different bird species were identified.
- Post-application total bird observations noticeably decreased at CA (which had an initial pre-application total higher than all others) but remained about the same at all other sites except for ND which had a slight post-treatment reduction (37 ± 11.9 down to 29 ± 8.9 Day 2-5) of total bird observations (totals are means + S.D. calculated over the entire survey period or sub-periods indicated (Table 8)).
- A reduction in the mean numbers of birds actually observed in treated crop occurred post-application in all fields except BH (Table 9) which increased relative to pre-application. Severe reductions were noticed in all fields except BH on Day 2 post-application, and Day 3 for all except for ND and BH which increased relative to pre-application means.
- 78 species were actually observed in the treated crop. (Appendix XVI).
- Post-application reductions of birds actually in the treated crop lasted through Day 5, on the average; however, CA was reduced more than 50 percent for at least through the end of the study, FNII reduced almost 50 % through the end of the study, and FH reduced about 25 % through the end of the study. FNI recovered to pre-treatment levels after Day 7, while BH increased total numbers by more than 50 percent by Day 3 post-treatment. After an initial increase of 40 % on Day 3 post-, ND returned to pre-application numbers by Day 5 after treatment (Table 9).
- Indications of a reduction in numbers of birds observed in the treated crop occurred in ten species: American robin, common grackle, red-winged blackbird, blue grosbeak, indigo bunting, house sparrow, chipping sparrow, northern cardinal, chickadee and orchard oriole. Only BH site did not a reduction in numbers of at least one species. CA site experienced a reduction in number of observations of six species. Common grackle and red-winged blackbird were the most frequently noted to show a reduction in numbers.

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TABLE 8

MEAN NUMBER OF TOTAL BIRD OBSERVATIONS BY STUDY SITE

AERIAL APPLICATION

Ground

Field Observed	Pre-Application Average \pm SD	Post-Application Average \pm SD				
		Day 2 Total	Days 2-3	Days 2-5	Days 2-7	Days 2-14
Ferry Neck I	26 ¹³ 21 \pm 9.5	34 ¹⁵ 23	19 \pm 6.4	20 \pm 5.2	23 \pm 7.1	23 \pm 5.9
Ferry Neck II	33 ¹⁷ 32 \pm 9.5	30 ¹⁸ 34	36 \pm 2.1	36 \pm 2.1	37 \pm 2.6	35 \pm 3.8
Fox Harbor	17 ¹ 26 \pm 7.6	20 ¹⁵ 24	33 \pm 12.7	31 \pm 9.9	31 \pm 8.2	28 \pm 8.5
Bushy Heath	26 25 \pm 7.7	17 ¹³ 27	35 \pm 11.3	29 \pm 10.1	33 \pm 10.6	32 \pm 9.0
Camper	44 ¹⁰ 48 \pm 12.0	47 ¹⁷ 37	34 \pm 5.0	36 \pm 11.6	32 \pm 12.8	34 \pm 10.9
Normandie	34 ¹⁰ 37 \pm 11.9	29 ¹³ 30	31 \pm 1.4	29 \pm 8.9	33 \pm 9.1	35 \pm 7.6

Aerial Resistant
TABLE 9

PERCENT OF BIRD OBSERVATIONS IN THE FIELD BY STUDY SITE

AERIAL APPLICATION

Ground
~ DAY 2

Field Observed	Pre-Application Average \pm SD	Day 2 Total	Post-Application Average \pm SD			
			Days 2-3	Days 2-5	Days 2-7	Days 2-14
Ferry Neck I	11.2 \pm 16.4	17 4.3	2.2 \pm 3.1	5.8 \pm 6.6	9.6 \pm 8.44	10.8 \pm 6.7
Ferry Neck II	8.0 \pm 5.2	20 2.9	1.5 \pm 2.1	4.5 \pm 5.4	4.9 \pm 3.9	5.3 \pm 4.3
Fox Harbor	14.2 \pm 10	0 0	4.8 \pm 3.4	8.3 \pm 7.8	13.0 \pm 8.9	10.7 \pm 8.0
Bushy Heath	6.9 \pm 5.1	17 11.1	16.0 \pm 6.9	10.3 \pm 7.8	13.0 \pm 7.4	14.0 \pm 8.0
Camper	21.6 \pm 8.1	25 16.2	9.8 \pm 9.1	7.9 \pm 5.9	6.6 \pm 5.6	8.1 \pm 7.2
Normandie	11.6 \pm 4.6	27 3.3	18.9 \pm 21.9	12.7 \pm 15.5	13.0 \pm 12.0	11.0 \pm 10.1

Aerial Rescues

TABLE 10

SUMMARY OF BIRD SPECIES SHOWING A REDUCTION IN NUMBERS
AERIAL APPLICATION

SPECIES*	FERRY NECK I	FERRY NECK II	FOX HARBOR	BUSHY HEATH	CAMPER	NORMANDIE
Common Grackle	X	-	-	-	-	X
Red-winged Blackbird	-	X	-	-	X	-
Orchard Oriole	-	-	X	-	-	-
American Robin	-	-	-	-	X	-
House Sparrow	-	-	-	-	X	-
Chickadee	-	-	-	-	X	-
Chipping Sparrow	-	-	-	-	X	-
Northern Cardinal	-	-	-	-	X	-
Blue Grosbeak	-	-	-	-	-	X
Indigo Bunting	-	-	-	-	-	X

* Only those species observed in the treated field were considered.

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- There was an apparent reduction in numbers of birds using treated fields after treatments, possibly due to the presence of a persistent odor of organophosphate pesticide on the test sites.
- Deaths of the black rat snakes and box turtle may not have been compound related (ground application).
- A mourning dove collected (dead) on Day 14 after ground application was not likely to be killed due to exposure to Counter.
- Recovery from sublethal exposures may also occur in birds unless they fall to predation while still affected.
- The results of the search efficiency and predator removal trials conducted are "consistent with results of other researchers."

Aerial Phase

- Avian surveys showed similar bird populations and observations to those of the ground phase.
- "No substantial evidence" was obtained to lead to the conclusion that "any significant impact occurred on avian populations."
- There were less birds observed using corn fields after treatments. However, the height of the crop made it more difficult to survey the actual crop field and any bird use of it. Many bird species did use the fields for perching and feeding, however, but a decline in this use was noted following aerial treatment.
- Reasons for variability in surveys are similar to those given in the ground phase report. Further complicating the survey picture, however, was a breakdown in territorial behavior and increased flocking during the aerial phase. These also contributed heavily to variation in observations.
- The woodchuck found dead on Day 18 after treatment by air is not attributed to Counter 15G because of the late collection date and because "no residues" were detected.
- Granules of 15G were observable on corn foliage and on the ground after aerial application.
- Mammal tracks, carcass collections, and partially eaten corn cobs confirmed mammal use of corn fields.
- "Potential routes of exposure for mammals include dermal and oral contact, through grooming and inadvertent ingestion while feeding."

- The impact on the local raccoon and cottontail population is "uncertain".
- Small mammals were found only after the aerial application. This could be due to greater availability of granules; also small mammals are "usually" more abundant later in the season.
- 2 days of rainfall occurring shortly after the aerial applications to FNI, FNII, and FH may account for fewer carcasses being located at these sites. Fewer granules could be observed on the ground and foliage at these sites.
- The 2 groups of dead fish were probably killed due to exposure to Counter 15G as residues were found.
- The treatments by air with Counter 15G did result in exposure but "a significant impact" on avian populations was not observed. Evidence suggests bird use of the fields does decline after treatment. The duration of this decline is about 2-9 days post-application.
- "It was apparent from the number of mammal carcasses collected that aerial application of Counter 15G does lead to some mammalian mortality."

Quality Assurance

Quality assurance report and audit schedule is contained on separate sheets after the title, sponsor, and contractor identification report sheet. Lee F. Doggett (QA Officer) attested to the accuracy of the report with respect to the data obtained and to the conformance of this study with "Good Laboratory Practices" as published by U.S. EPA (Fed. Register, Vol. 48, No. 230, Nov. 29, 1983, p. 53946-53969). Ms. Doggett signed the QA certification on Jan. 24, 1985.

14. Reviewer's Discussion and Interpretation of the Study

A. Test Procedures

General Comments

Since there are no standard protocols to follow in performing field studies, EEB rated the protocol and procedures according to how well the study simulated expected "real-world" conditions, expected application methods, agricultural practices, application rates, exposure of wildlife and appropriateness of the methods of study to the stated objectives.

The sponsors and study directors specifically declined to include the control field(s) which EEB had

suggested. Such fields may have been useful as pre-carcass search controls for nonspecific mortality, predation and scavenging. The lack of control fields, while not in itself a reason for rejecting this study, does effectively limit the information extractable from the study.

The Ferry Neck I and II fields are too close (basically adjacent to each other) to be considered separate study sites. These sites should be considered one site of 50 acres.

Avian Census

The avian census techniques were useful and appropriate to study the species and relative numbers of each species exposed during both phases of the study. However, these methods are insufficient for a "population study" because the methods used did not address common population study parameters such as sex and year class distribution, breeding condition, nesting success, physiological conditions, etc. . (The sex distribution and breeding conditions were only superficially addressed by cursory observations of "singing" males.) Migration and recruitment, albiet difficult to study, were also not addressed in this study.

The avian census was useful however, in determining the specific "pre- and post-" application use of the actual crop (tilled area) and of crop avoidance (or attraction) after application.

Overall, the significant investment of man-hours in the avian surveys was not justified compared to the usefulness of the information obtained. To summarize, then, the avian census was useful only in determining what species were exposed, use of the tilled portion of the crop, and relative numbers of birds exposed.

No systematic mammal survey was undertaken thus no "population" study of mammals was possible in the current study design. Observations of mammals were limited to sightings during the avian census, and to the carcasses found. These do give some idea of the species exposed and their relative use of corn fields for general activity.

Carcass Searching

Carcass searching activity was generally done in accordance with the proposed methods, however, there is no assurance that the particular transects chosen were the most appropriate, although during the early searches search personnel could see most of the open fields. Aerial phase

carcass searches were of crop perimeters only; and there was little sampling of the crop itself. Frequency of mortality in the crop interior was not measured directly; this figure will have to be estimated. Use of the crop interior was probably better determined for birds however, because of the avian census conducted at the same time.

The carcass searches, particularly post-aerial application searches, should have been carried out for a longer period of time, since a dead woodchuck was found on the last scheduled carcass search. The search should have been carried out at least until no further compound related carcasses were found. However, the author claims that the woodchuck's death was not caused by *terbufos* (no residue found).

Again, the lack of control fields precludes a comparison to non-compound-related mortality. The small size of most sites really limits the confidence of the results to the small rodents since their territories were more likely not to extend much beyond the search areas. This cannot be said for the birds and medium to large mammals.

The predator removal and scavenging estimates were performed in a satisfactory systematic fashion, except for the initial ground phase trials where studies were not carried out beyond 48 hours. Efficiency trials indicated that the observers got better with practice, but they retrieved only about one (1) in every two (2) carcasses available. This percentage has resulted from other studies of this type. The author did not offer an analysis of how these results may have impacted the validity of his carcass search results. EEB will assume that more carcasses than were reported, were actually on or near treatment sites. We will assign estimated mortality figures based on intact carcasses reported, plus feather spots, decomposing odor, badly decomposed carcasses, partial carcasses or other evidence of mortality. Normally only one extra carcass per site will be assigned based solely on accounting for predator removal and scavenging, unless evidence of scavenging already exists, in which case no extra carcasses will be added to the total.

The aerial applications were three (3) weeks late (relative to original protocol) because the sponsor did not obtain the required EUP. Because of the delay, hasty application of the material to fields resulted in applications to three (3) fields immediately prior to rainfall. The carcass data clearly illustrates that the rainfall had a mitigating effect on mortality - i.e., significantly fewer carcasses were found after rainfall

applications; probably the result of a decrease in residual terbufos available on the wetted granules.

EEB considers the "affected" but recovered birds as "ecologically dead." We do not believe that these birds would have recovered, nor escaped predation had they not been collected and observed in the laboratory. EEB also considers "feather spots" and reports of "odor of dead animal" as indicating a dead carcass was present. The lack of control fields to indicate the expected rate of such finds regardless of treatments requires EEB to consider such reports as compound-related mortality, even in the absence of residue information.

Although the study did not include aquatic organisms exposure and survey, the fact that residues were found in dead fish in waters adjacent to the field indicates the potential for acute hazard to fish by aerial application (the pilot could not prevent contamination of the river). Dead fish were found both with and without rainfall/runoff, thus the routes of exposure to fish remain uncertain. The need for an aquatic field study is indicated by this result.

Residue Analysis

The submitted analytical methods and LD₂₀ correlation with residues are sufficient to satisfy the exposure analysis requirements for this study, for whole-body residues of mammals and birds. However, no terbufos toxicity data was generated for reptiles to validate the correlation with this group. We are assuming the LD₂₀ for reptiles is above 0.05 PPM (the limit of detection).

The treatment of carcasses prior to shipping for analysis was not adequately explained. It is unclear as to whether the carcasses were frozen, and if so, how quickly and to what temperature (?). This information would have been helpful in interpreting residue findings.

Application Precision / Calibration

Ground phase - Acceptable, commonly used methods and equipment were used. Calibration of equipment and delivery of granules was acceptable.

Aerial phase - An acceptable level of precision was not accomplished. Between 10 percent and 30 percent excess

pesticide was delivered to the fields. The aerial applicators did not use flaggers or spotters to guide the airplane. The lack of precision was not satisfactorily explained. The airplane may have delivered pesticide directly into adjacent rivers, apparently killing some fish. It is likely that one reason for imprecise (excessive) pesticide delivery, is that field borders and adjacent habitats were also treated.

The amount of pesticide actually delivered to the crop area itself was not directly measured. Precision was established by back-calculating from number of pounds loaded in hopper bins and numbers of acres treated. An explanation was requested from American Cyanamid, detailing in writing the calibration and application procedures used. It was not available for this DER.

14B. Statistical Analysis Validation

Since no statistical analysis nor statements of statistical significance were offered by the study author, no statistical validation was performed by EEB.

14C. Results/Discussion

General Comments

The study demonstrated through a systematic, quantitative approach that terbufos 15 percent ai granular pesticide (Counter 15G), when used as directed on registered and proposed labels for treatment of corn fields, causes substantial mortality of nontarget vertebrates including mammals, birds (particularly Passeriformes), and reptiles. The study conclusively demonstrated substantial exposure to terbufos of nontarget wildlife thorough both soil incorporated, and particularly through unincorporated aerially broadcast methods of application. The study conclusively demonstrated that the aerial broadcast treatments provide for a very significant increase in exposure of nontarget organisms over that experienced through incorporated use and a very significant increase in acute mortality of birds, mammals and reptiles using treated fields for routine activities.

The study, as performed did not (and because of design, could not) conclusively make any determination regarding an adequate margin of safety for populations of birds, mammals, reptiles or fish. The study established only that:
1) substantial acute mortality results from both application methods; 2) significantly greater acute mortality (especially

to mammals) results from aerial applications; 3) that exposure is clearly demonstrable (in both aerial and ground phases) through whole-body residue analysis of carcasses collected in and near treated fields. As an incidental observation, the study showed that aerial treatments can cause fish kills when used on fields adjacent to streams and rivers. The route of exposure in these cases (runoff or direct contamination) was not investigated nor was it readily apparent from the data.

Specific Comments

Ground Applications This study demonstrated extensive use of corn fields by birds and mammals and also some use by reptiles. The number of species visiting and using corn fields was impressive and indicated extensive exposure of many species, families, and orders (see species lists attached).

The results of the avian census weakly indicate some avoidance of the treated sites immediately after application, however, the results are extremely variable. One portion of the split Ferry Neck site actually had increased bird observations immediately after application. EEB concludes that no substantial changes in use of sites by birds occurred after soil incorporation.

Observations of birds' use of the tilled portion of the fields indicate only that particular passerine species including eastern kingbird, chipping sparrow, grackle, robin, bluejay, thrasher and starling avoided fields after treatment (7 out of 34 observed species in tilled portions). EEB cannot verify the conclusions regarding the territorial birds because the data were not clearly presented.

Carcass Searches after Ground Application. EEB counted "affected" birds as ecologically dead (see "Test Procedures" sec. 14A). We counted all snake carcasses as compound-related kills (see 14A). In addition, we are estimating that only 50 percent efficiency in searches resulted in this phase and that about 20 percent of carcasses available will be removed in each 24-hour period.

The following table summarizes EEB's estimates of the compound-related mortality results based on intact carcasses found, feather spots, decomposed carcasses, as well as other signs of mortality also see "General Comments", 14.A - "Carcass Searches").

Ground Phase Carcass Search

<u>Site</u> (size)	<u>Estimated Number of Compound-Related Mortalities</u> (Actual Number of Intact Carcasses Reported ≥0.05 ppm)			
	<u>Bird</u>	<u>Small Mammal</u>	<u>Large Mammal</u>	<u>Reptile</u>
Ferry Neck I & II (50.1 Acres)	5 (1) 0.1/Acre	-	-	4 (3) 0.08/Acre
Fox Harbor (12.3 Acres)	2 (1) 0.16/Acre	-	-	
Bushy Heath (26.8 Acres)	5 (2) 0.19/Acre	-	-	
Camper (28 Acres)	2 (0) 0.07/Acre	-	-	2 (1) 0.07/Acre
Normandie (18.1 Acres)	3 (0) 0.17/Acre	-	-	

Reptiles were assigned only one extra carcass per field. Based on larger sizes of snakes and turtles they were probably harder to miss ("open" crop at this time). Thus, the losses to predators and scavengers might not be as large as for small birds. The birds were assigned extra carcasses (in addition to intact carcass) based on the presence of feather spots or other evidence of mortality, predator and scavenger removal of about 20 percent in 24 hours, and efficiency of search of about 50 percent. EEB's figures are probably underestimated.

The soil incorporation apparently helped protect mammals. Reptiles and birds, however, were killed at a rate ranging from .07 - 0.19 per acre per 3-week period. Rain occurred sufficiently late in the search period such that it was judged not to be a factor in mitigating mortality in this phase. Most mortality occurred within a week after applications by ground equipment.

One of the contaminated carcasses found during the ground application was that of a small fledgling eastern bluebird (0.15 ppm pound). This bird was found dead on 5/23/84, on the ground directly under its nest. One could speculate that terbufos may have been carried to nests by parents, however, nesting was not investigated during this study.

Aerial Phase

The results of bird and mammal observations resembled those found for the ground application phase in terms of species "richness" and number of observations, however, 17 fewer species were observed in this later season. The Camper site experienced a noticeable decrease in total post-treatment observations, but others remained about equal, pre- and post-treatment, with substantial daily variation in total bird observations made.

The aerial broadcast treatment resulted in a demonstrated avoidance of the tilled portion of fields (receiving most granules) except at one site (BH). This avoidance lasted for about the first three (3) days after applications and probably resulted from a strong odor of organophosphate emerging from the crop.

Fewer avian species (6 less) relative to ground phase were observed frequenting the tilled portion of the crop even before treatment (later season). Post application reductions of numbers of individuals using the crop were evident through Day 5 post-treatment, except for Camper which had a 50 percent reduction throughout the post-treatment census. Orioles, chickadee, cardinal, red-winged blackbird, indigo bunting, robin, house and chipping sparrows, blue grosbeaks and grackle particularly avoided the treated crop (especially the red-winged blackbirds and grackles). Chipping sparrow and eastern kingbird singing males were observed to abandon their territories by the end of the study. This was not necessarily compound-related but may reflect some temporal variations. Likewise, the general decrease in numbers of species observed in the area by the end of the study could be a temporal effect and not necessarily be compound-related. The census data were extremely variable; insufficient information was collected to draw conclusions regarding "population" effects, however (see "test procedure" sec. 14A).

The aerial applications obviously provided a very significant increase in exposure to nontarget mammals and birds. In a previous review EEB predicted (based on laboratory data) that these mammals would be 17 to 18x more sensitive to terbufos. The results of the carcass searches validate this prediction. Numerous individuals of a variety of mammal species were found. Most carcasses contained whole-body residues of terbufos or related metabolites. Carcasses were found for a longer period of time (actually thru the end of the scheduled search period). Medium-sized mammals, such as cottontail rabbit (Sylvilagus floridanus), raccoon (Procyon lotor) and even woodchuck (Marmota monax) were killed, indicating the potency of this poison to mammals.

Rain immediately after an application to two (2) sites resulted in markedly fewer observations of vertebrate carcasses, feathers, decomposition, etc., compared to fields not receiving rainfall shortly after applications. Also, the fields receiving rainfall had markedly fewer mammalian kills (only 1 dead rice rat on Day 4 post-treatment and 1 woodchuck on Day 14 with residues < 0.05 ppm) and a greater percentage of bird kills than fields not receiving rainfall after applications.

The same criteria applied to assigning extra carcasses in the ground phase were used to estimate the mortality in the aerial phase (table below).

<u>Site</u> (size)	<u>Estimated Number of Compound-Related Mortalities in the Aerial Phase (Actual Number of Intact Carcasses Reported > 0.05 ppm)</u>			
	<u>Bird</u>	<u>Small** Mammal</u>	<u>Large*** Mammal</u>	<u>Reptile</u>
Ferry Neck* I & II (50.1 Acres)	5 (1) .09/Acre	4 (2) .07/A	1 (0) .02/A	-
Fox Harbor* (12.3 Acres)	4 (0) 0.33/Acre	-	-	-
Bushy Heath (26.8 Acres)	4 (2) 0.15/Acre	3 (1) 0.11/A	1 (1) 0.03/A	-
Camper (28 Acres)	6 (3) 0.21/Acre	2 (1) 0.17/A	-	2 (1) 0.07/Acre
Normandie (18.1 Acres)	1 (0) 0.06/Acre	7 (4) 0.39/A	6 (4) 0.33/A	-

*These fields were rained on immediately after granule application, reducing the exposure.

**These include small rodents, and shrews.

***These are cottontail rabbit, raccoon, skunk, or woodchuck.

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Birds were killed at a slightly higher rate (0.06 - 0.33/A) than during the ground phase (0.07 - 0.19/A). Mammals, not killed with soil incorporated use, suffered heavy mortality rates of about 0.07 - 0.39/A for small rodents and shrews, to about 0.02 - 0.33/A for larger cottontails and raccoons.

Whole-body residue exposure evidence was striking in birds, reptiles, and both small and large mammal carcasses (up to 6.14 ppm in dead raccoons; up to 8.5 ppm in dead birds) indicating very significant increases in exposure relative to the ground application phase (max. of 0.24 ppm found in "affected" birds). Incidental dead fish contained up to 0.93 ppm terbufos (adjacent to FN and ND sites).

14D. Adequacy of Study

1. Classification: (Applies to Requirements for Field Studies of Acute mortality only).
 - A. Ground Phase - Core for 15G soil incorporated at 17.4 lbs per acre (product basis).
 - B. Aerial Phase - Core for 15G aerial broadcast at 6.7 lbs per acre (product basis).
2. Rationale: The studies demonstrated the potential for acute mortality associated with each type of application and also demonstrated that the mortality observed can be directly associated with exposure to terbufos and related metabolites.
3. Repair: N/A

15. Completion of One-Liner

May 17, 1985

16. CBI Appendix

Protocols and species lists appended.

Ecological Effects Branch Reviews - Terbufos

Pages 44 through 81 are not included. The pages contain a detailed test protocol submitted by American Cyanamid.