DATA EVALUATION REPORT

1. Chemical: Endosulfan

2. Test Material: Thiodan 3EC

3. Study Type: Aquatic Field Study

4. Study Identification: Cornaby, B W, A F Maciorowski, M G Griffith, J E Navarro, S E Pomeroy, N G Reichenbach, J S Shuey, M G Yancey and S Hickey, 1989, Assessment of the Fate and Effects of endosulfan on Aquatic Ecosystems Adjacent to Agricultural fields Planted with Tomatoes, Study No: NO954-5700, Performed by Battelle and Hickey's Agri-Services for Hoechst Celanese Corporation, MRID# 411641-01

5. Review By: Daniel Rieder, Wildlife Biologist [signature] 4-23-91
Ecological Effects Branch
Hazard Evaluation Division

6. Approved By: Norman J. Cook, Head, Section 2 [signature] 4-24-91
Ecological Effects Branch
Hazard Evaluation Division

7. Conclusion: This study report has been reviewed and appears to describe a scientifically sound study. It provides useful information on the acute effects of endosulfan on fish. It does not, however, negate EEB's concern for the ecological hazards of endosulfan and, in fact, supports the presumption that endosulfan, when used according to the label on vegetables results in fish kills. Reductions in some aquatic taxonomic groups was suggested based on sample counts.

8. Recommendations: The EEB does not recommend that the study be conducted again. This study, along with other data, will permit evaluation of hazards associated with the use of endosulfan.

9. Background: This study was requested by EEB because endosulfan was presumed hazardous to aquatic organisms, and is expected to kill fish when used on agricultural crops such as vegetables.

10. Discussion of Individual Studies: NA

11. Materials and Methods:

PURPOSE OF STUDY: This study was intended to measure the fate and effects of endosulfan in a farm pond ecosystem after it has been applied to adjacent agricultural land. Various physical, chemical and biological characteristics were measured before, during and after application and runoff events.

SITES: Several pond sites were investigated. The study was conducted at four ponds; two treatment and two reference. All ponds contained largemouth bass and bluegill, however, the bass/bluegill balance varied between sites.

Pond C-27-1: Treatment site
1.4 hectares (3.5 acres) surface area
20.4 hectares (50.5 acres) drainage basin
14 hectares (35 acres) tomatoes
Bass/Bluegill balance: fair-to-good

Pond M-55-4: Reference site
0.8 hectares (2.1 acres) surface area
9.6 acres (23.6 hectares) drainage basin
8.5 hectares (21 acres) tomatoes
Bass/Bluegill balance: fair-to-poor

Pond M-55-8 Treatment site
0.9 hectares (2.3 acres) surface area
9.9 hectares (24.1 acres) drainage basin
8.5 hectares (21 acres) tomatoes
Bass/Bluegill balance: fair-to-poor

Pond T-4-1 Reference site
1 hectare (2.1 acres) surface area
15.2 hectares (37.4 acres) crop in drainage basin
10 hectares (25 acres) tomatoes
Bass/Bluegill balance: poor

Tomatoes were planted on both sides of all ponds.

SITE PREPARATION: Some ponds required removal of vegetation to enhance runoff potential and reinforcement of earthen dam spill ways. Flumes were installed at C-27-1 and M-55-8 (treatment ponds) to facilitate collection of runoff water. Weather stations were established at each site. Both treatment sites were equipped with sprinkler irrigation capabilities.

Three types of sampling stations were established at each site. Six pond zones, six field transects and 10 - 20 additional sample stations for various collecting purposes. Water, sediment and biota were collected from the pond zones. Soil and foliage were collected along the field transects. Application verification cards were placed at 10 stations at ground level within the field.

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Drift cards were placed on platforms at 35 stations around the field and pond perimeters and over the pond surface.

TREATMENT: Endosulfan in the form of Thiodan 3EC was applied at 1 lb ai/acre three times at 2-week intervals to each treatment site. Application was by ground equipment to the cropland adjacent to the ponds.

DATES OF APPLICATION

Site	Treatment 1	Treatment 2	Treatment 3
C-27-1	5-27-88	6-10-88	6-27-88
M-55-8	5-27-88	6-11-88	6-23-88

MEASUREMENTS: The study was begun in 1987 to collect baseline data for all ponds. Weather condition monitoring, runoff, water quality and all biological sampling began in 1987 and continued through 1988.

Meteorological Conditions: Wind speed and direction at both treatment sites were measured continuously during endosulfan application. Rainfall was measured continuously by gauge at each site.

Residues: The following materials were collected for residue analysis.

- Mixed pesticide spray: before and after application
- Application verification cards: 30 minutes to 1 hour after application
- Drift cards: 30 minutes to 2.5 hours after application
- Foliage or leaf rinsate samples: 3-6 hours after 3 of the 6 applications
- Soil (top 5 cm): prior to and within 24 hours after each application, then approx. 7, 14, 28, 60, 90 and 180 days after third application
- Runoff water: collected from flumes when runoff occurred
- Pond water: before and within 3 hours of each application, the approx. 3, 7, 14, 28, 60, 90, and 180 days after third application
- Sediment: 1-2 days before and 1-2 days after each application and approx. 7, 14, 28, 60, 90, and 180 days after third application
- Fish: beginning 9 days before application and continuing through December, 1988

Ecological Characteristics: The following samples were collected to obtain information on the ecological condition of test ponds.

- Phytoplankton: every two weeks
- Zooplankton: every two weeks
- Benthic Macroinvertebrates: every two weeks
- Fish:
  >Incident Observation: searches for dead fish were conducted three times a week
  >Electro-fishing: every two weeks
  >Seining: every two weeks
- Pond metabolism: every two weeks
- Autotrophic index: every two weeks
- Macrophytes: every two weeks

Phytoplankton and **zooplankton** were collected using both water sampling bottles and pumps. The methods were occasionally used simultaneously for comparative purposes. The collected water was passed through filters to separate out the plankton. The separated residue was preserved in formalin for later identification.

Benthic organisms were collected via 4 sampling methods: Ekman dredge, artificial substrate samplers, kick-nets and emergent insect traps. The **Ekman dredge** was 15 cm X 15 cm (6"X6") and was used to collect organisms dwelling in the sediment. Once raised, the contents were sieved, placed in a sealable container and preserved with formalin. The **artificial substrate sampler** or the s-sampler consisted of 14 plastic cylinders tied together. The sampler was collected 4 weeks after lowering to the bottom at one of the sample zones. The growth on each sampler was collected via sieving the rinsate and preserved in formalin. The **kick-net** was used to collect littoral macro-invertebrates. It positioned with the straight edge on the substrate and moved along for 60 seconds. The contents were sieved and preserved. **Emergent insect traps** captured emerging insects and consisted of a pyramid shaped vinyl structure with an open bottom and a collection jar at the top. The collected insects were preserved and later counted and identified.

Effects to **fish** were measured via various means. **Mortality** was detected by walking the entire pond perimeter or surveying the perimeter by boat. These searches were conducted 2 to 4 days after each spraying event at all four ponds. From July to October, 1988, searches were conducted every Monday, Wednesday and Friday and after every runoff event. All dead or dying fish were collected by dip-net, and either frozen or placed in a 10% formalin solution. Record was made of location, species, size and weather conditions. **Electro-fishing** was conducted every two weeks, except in the hottest part of the summer, when it was only performed once a month. Fish collected thus were maintained live for identification, weighing and in 1988 to check for tags (for population estimates). **Seining** was conducted after pesticide application to examine reproductive success of sunfish species. **Mark-and-Recapture** studies were conducted via fish tagging. Bluegill and large-mouth bass obtained electro-fishing in Spring 1988 were tagged. An index to population was generated based on ratio of tagged to untagged fish obtained through electro-fishing during March to Mid June, and again from June to August.

Pond metabolism was determined from results of measuring dissolved oxygen concentrations. The increase in pond DO from dawn to dusk is a measure of net production, while the decrease of DO from dusk to dawn indicates the amount of respiration occurring.

An **autotrophic index** was obtained by examining periphyton populations. Periphyton were collected on glass slides in sampling devices suspended near the waters surface. These slides were transported to the laboratory for analysis to determine periphyton growth over the two-week sampling period.

Macrophyte abundance was determined quantitatively, and recorded on maps of the pond. Symbols were drawn on the maps where macrophytes were observed.

12. Reported Results: The following discussions are extracted from the summaries and conclusions provided in the report. The raw data were not provided on computer disk, nor were they provided in the format EEB requested in the December 16, 1988 meeting. This format would enhance the analysis process and reduce review time. The registrant acknowledged this request in a follow-up letter about the meeting dated January 6, 1989.

PHYSICAL AND CHEMICAL CONDITIONS

Rainfall was below the annual average by 25 cm (10 in.) with approximately 104 cm (41 in.) falling in 1988. Figure 40 (Attachment 1) presents the rainfall events at each of the four ponds.

Runoff events were measured at each of the two treatment sites. The events are number sequentially, regardless of where they occurred. Table 8 and 9 (Attachment 2) shows the dates and amount of precipitation triggering runoff. Seventeen runoff events occurred, 10 at C-27-1 and 7 at M-55-8. Two events at C-27-1 were induced via irrigation.

Water Quality measurements results are presented in Attachment 3. One factor that merits attention is that the reports indicates that several water quality parameters (conductivity, acidity, nitrate, orthophosphate and total organic carbon) peaked in 1988 higher than in 1987. This was attributed to the removal of vegetation prior to the 1988 growing season. Total suspended solids were measured during 1988, but not 1987. It would seem likely that this measurement would have also increased due to the clearing.

ENDOSULFAN RESIDUES

Sampling for endosulfan residues was conducted before, during and after application over an 8-month period from May, 1988 to December, 1988. Determinations included alpha-endosulfan, beta endosulfan and endosulfan sulfate (degradate) for application cards, foliage rinsate, drift cards, soil, runoff water, pond water, sediment and fish. In the residue level (totals and means) reported, if the individual endosulfan concentration was less than the detection limit, zero was used for the calculation of the total. The detection limits for the various matrices are presented below:

Matrix	Detection Limit
Application cards	3 ug/m^2
Foliage rinsates	10 ug/m^2
Drift cards	0.6 (3 cards) ug/m^2
	0.8 (2 cards) ug/m^2
	1.7 (1 card) ug/m^2
Soil	10 ug/kg
Runoff water	5 ng/L
Pond water	5 ng/L
Sediment	5 ug/kg
Fish	10 ug/kg

Application cards yielded concentrations ranging from 53,400 to 91,000 ug/m^2. The average for all six application was 71,800 ug/m^2. According to calculations presented in the report, this means that an average of 0.8 lb ai/acre of the 1 lb ai/acre reached the ground. This took into account field spike recovery (for application cards) of 80%.

Rinsate from foliage and leaves was analyzed and resulted in an average of 7,090 ug/m^2 of tomato leaf total endosulfan residues.

Drift Cards around the field, around the pond and on the pond surface were placed just before spraying began. The following table presents resulting concentrations for each spray. These values, in ug/m^2 compare to the concentrations measured on application verification cards (X=71,800).

Site No	App No	Field Edges	Pond Edge	Pond Surface
C-27-1	1	ND - 560	13.8 - 760	X = 166
	2	ND - 750	94 - 610	X = 218
	3	ND - 990	10.3 - 230	X = 28.1
M-55-8	1	ND - 300	ND - 14.4	X = 2
	2	ND - 1170	ND - 43.8	X = 2.2
	3	8.7 - 407	33.5 - 170	X = 99.3

Soil concentrations were similar in the two treatment fields. Concentrations peaked immediately after the third application, but decreased by 86 percent by December, 180 days later. Initial

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ratios of alpha/beta/sulfate forms of endosulfan were initially 63/33/5, but by December had shifted to 5/54/41.

Runoff occurred from both natural rainfall, and irrigation (conducted specifically to induce runoff). At C-27-1 there were two induced and eight natural runoff events. At M-55-8 there were seven natural runoff events. Runoff from C-27-1 contained a maximum mean total endosulfan of 203,000 ng/L (203 ppb). Runoff from M-55-8 contained a maximum mean total endosulfan of 79,600 ng/L (79 ppb). Endosulfan was present in all runoff events following application.

Pond water received concentration of endosulfan through both drift and runoff. This, even though application was by ground equipment. Concentrations of total endosulfan reached 257 ng/L (pptr) in C-27-1 and 53.6 ng/L (pptr) in M-55-8 following the second application. Endosulfan reach both treatment ponds through runoff following the third application. Concentrations reached an average of 1,310 ng/L (pptr) in C-27-1 and 583 ng/L (pptr) in M-55-8. See Attachment 4, Figures 70 and 71, which show concentration in pond water during the treatment year.

Sediment concentrations peaked at 43.5 ug/Kg (ppb) in C-27-1 and 99.6 ug/Kg (ppb) in M-55-8 immediately following the first major runoff event. Concentrations in both ponds had declined to at or near the detection level by December.

Fish were sampled and analyzed for residues. Only endosulfan was found in fish, and that in fish from C-27-1. concentrations ranged from below detection to 21.6 ug/Kg (ppb). Alpha- and beta-endosulfan were never detected. Endosulfan was never detected in fish collected from M-55-8.

ECOLOGICAL MEASURES

Phytoplankton: Qualitatively, trends in relative abundance for the major groups were similar in both the treatment and reference ponds. Quantitatively, densities reflected seasonal trends, with the highest densities in mid to late summer. Generally, densities in the treatment ponds were similar to, or significantly higher than the reference ponds. There was, however, a significant decrease in phytoplankton density in C-27-1 relative to M-55-4 after the first and second applications of endosulfan (weeks 74 and 76, May 29 and June 12, 1988). Pond M-55-8 (treatment) had a higher diversity than M-55-4 (reference) after endosulfan application.

Zooplankton: The relative abundance was similar in the reference and control ponds. Changes occurring tended to be an increase in 1988, in both treatment and reference ponds. Quantitatively, densities reflected seasonal trends and were generally higher in the treatment ponds than the reference ponds for both post-spray and year-end times. However, there were significant decreases in both M-55-8 and C-27-1 (treatment ponds) during weeks 76 and 102.

Benthic Macroinvertebrates:

Kick-net results indicated that relative abundance was more stable in the treatment ponds than the reference ponds. All the data collected thus were combined into 4 higher taxonomic groups to examine relative abundance. In treatment pond C-27-1, oligochaetes decreased after application, while chironomids increased. In M-55-8, relative abundance of chironomids decreased for weeks 74-76 after applications, but increased in abundance for the remainder of the year.

Emergent insects collected via pyramid funnel trap were primarily (95%) chironomid. Therefore, this group was the only one analyzed quantitatively. Both treatment ponds had reduced chironomid emergence rates during application. This reduction apparently disappeared after treatment ended. Reference pond M-55-4 was compared against C-27-1, T-4-1 was compared against M-55-8.

Ekman Dredge samples produced primarily chironomids, oligochaetes and chaoborids. According to the report, similarity of ponds based on pretreatment sampling was used to determine which reference ponds would be compared to the treatment ponds. For comparing chironomid densities, T-4-1 was compared against both C-27-1 and M-55-8. But for oligochaetes and chaoborids, M-55-4 was selected for the comparison. Chironomid densities were lower in C-27-1 than in T-4-1 during the application period and lower in M-55-8 than in T-4-1 during the post spray period. Chaoborid densities were not different during the post-spray period (May 22-Sept. 3), but were lower in the reference pond (T-4-1) than in C-27-1 and higher in T-4-1 than in M-55-8 during the year end period (Sept. 3 - Dec). Oligochaetes densities were lower in C-27-1 (treatment pond) than in M-55-4 (reference pond).

Artificial samplers showed an increase in chironomid biomass from 1987 to 1988 in C-27-1, M-55-4 and T-4-1 (1 treatment and 2 references). In M-55-8 (treatment), chironomids were less abundant in 1988 than in 1987.

Fish:

Dead fish were observed in all ponds during the 1988 season. However, there were markedly more deaths in the treatment ponds than the reference ponds.

<u>Pond</u> <u>Number of Dead Fish</u>

Pond	Number of Dead Fish
C-27-1	447
M-55-8	227
T-4-1	75
M-55-4	17

Attachment 5 shows runoff events and fish die-offs.

Community Structure of fish was described as exhibiting variation throughout the baseline year and treatment year, with no definite trends related to endosulfan treatment.

Recruitment of Lepomis spp was occurring in all ponds up to 6 weeks after the last application. No mention was made of the magnitude of recruitment per pond. The discussion on largemouth bass said nothing about the occurrence of recruitment after application.

Population estimates were highly variable, making interpretation difficult. No definite conclusions on the effect of endosulfan could be made.

13. Study Author's Conclusions:

See **attachment 6 SUMMARY** of the study excerpted from the report.

14. Reviewer's Discussion:

A. Test Procedure: The test procedure was essentially what EEB had requested. However, the design (two treatment replicates and two reference replicates) is inadequate to show results, with any statistical probability. When the treatment and reference results fail to reflect a treatment related response, it is not justification for concluding that the treatment pond was unaffected by endosulfan.

B. Statistical Analysis:

Diversities Indices were calculated, however, organisms were not identified to genus and species.

Analysis of Variance was performed using either sequential samples in one pond, or samples from different zones or stations within one pond. At no time, were samples from different ponds combined to perform ANOVA statistics. Sequential samples from one site and even samples from different sample stations within one pond are not independent of each other and should not be combined to perform ANOVA calculations.

No independent statistical analysis was performed beyond calculating means for various parameters for comparison during the treatment years. It is considered non-productive to perform statistics on data with such high variability when only two replicates were used. The variability would be expected to negate virtually all treatment effect.

According to the report, when comparing results, reference/treatment pond pairs were selected based on their "pretreatment" similarities. In no cases, were replicates from two reference ponds combined and compared to replicates from treatment ponds. The following "reviewer conclusions" were based partly on analysis of the summary tables and figures, and partly on analysis of raw data provided on computer disk.

C. Discussion of Results:

FISH KILL

Fish mortality was observed in both treatment and reference ponds. Numbers of kills were higher in treatment ponds than reference ponds. The dead fish in the treatment ponds are attributed to endosulfan. No explanation was given for the dead fish in the reference ponds (T-4-1 and M-55-4). However, the report indicated that T-4-1 was shallower which could have resulted in higher temperatures and overcrowding. However, according to the reported data, the temperature in T-4-1 was not higher than in the other ponds. Nor was the dissolved oxygen markedly lower.

It was stated that the majority of the treatment pond kills occurred in the three days following the first runoff after the third treatment. Conversely, virtually none of the fish dying in the reference ponds died during that time period.

According to reviewer calculation using raw fish mortality data, there were more fish killed in each of the pond than reported.

Pond	Number of Dead Fish
C-27-1	493
M-55-8	273
T-4-1	124
M-55-4	81

Two points are noteworthy concerning reference pond T-4-1, where 75 (or 124) dead fish were found during the study. In the baseline chemical analysis of the sediment soil for that pond, toxaphene was found at from 4 to 6 ppb. Toxaphene is highly toxic

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to fish with an LC50 of as low as 2 ppb[1]. It is not know if toxaphene may have contributed to the mortality in this pond. Toxaphene was apparently not found in any of the other ponds. Also, T-4-1 is the only pond where fish were added to modify the fish community structure.

Irrigation was influential in both runoffs resulting in fish die-offs. In C-27-1, runoff caused the runoff directly. In M-55-8, natural rainfall caused the runoff, but substantial amounts of irrigation water had been applied to the field just previous to the rain, thoroughly soaking the soil. This would have enhanced the ability of the rain to cause runoff.

ELECTRO-SHOCKING DATA

The following table shows the average number of largemouth bass caught (by electro-shocking) in 1987 for July, August, September, October and November.

	POND							
1987	C-27-1(T)		M-55-8(T)		M-55-4(R)		T-4-1(R)	
MONTH	YOY	ADL	YOY	ADL	YOY	ADL	YOY	ADL
JULY	7	17	1	10	6	23	116	3
AUG	7	7	0	2	9	10	0	4
SEP	9	13	1	8	3	7	0	7
OCT	8	8	4	4	41	19	6	26
NOV	6	6	8	4	12	15	0	24
TOTAL	37	51	14	28	60	74	122	64
NO/MONTH	**7.4**	**10.2**	**2.8**	**5.6**	**12**	**14.8**	**24.4**	**12.8**

The following table shows the average number of largemouth bass caught during 1988 for the same time period as 1987.

1988	C-27-1(T)		M-55-8(T)		M-55-4(R)		T-4-1(R)	
MONTH	YOY	ADL	YOY	ADL	YOY	ADL	YOY	ADL
JULY	0	3	9	1	70	7	16	12
AUG	0	3	5	5	55	4	7	4
SEP	0	8	2	6	16	3	4	12
OCT	0	4	1	8	34	5	9	12
NOV	0	7	0	8	30	6	3	13
TOTAL	0	25	17	28	205	25	39	53

[1] Mayer and Ellerseick, 1986, Manual of Acute Toxicity: Interpretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals, USDOI, FWS Resource Publication 160, MRID # 40098001.

NO/MONTH	**0**	**5**	**3.4**	**5.6**	**41**	**5**	**7.8**	**10.6**

In C-27-1, no young-of-the-year were captured after treatment. In most cases, the treatment ponds had lower numbers than reference ponds.

Furthermore, treatment young-of-the-year numbers were lower than baseline year in treatment ponds, while reference YOY increased from the baseline year to the treatment year.

AVERAGE NUMBER YOY PER MONTH

BASE Trt: 5.1	BASE Ref: 18.2
'88 Trt: 1.7	'88 Ref: 24.4

AVERAGE NUMBER ADULT PER MONTH

BASE Trt: 7.9	BASE Ref: 13.8
'88 Trt: 5.3	'88 Ref: 7.8

AVERAGE NUMBER (YOY AND ADULT) PER MONTH[2]

BASE Trt: 6.5	BASE Ref: 16
'88 Trt: 3.5	'88 Ref: 16.1

The average number per month for both young-of-the-year and adults tended to remain about the same for the reference ponds while dropping markedly in the treatment ponds.

Combined largemouth bass numbers in the two ponds were reduced by endosulfan based on electro-shocking capture results. The young-of-the-year were severely impacted.

Bluegill capture results were less demonstrative of adverse effects.

TOTAL BLUEGILL CAPTURE VIA ELECTRO-SHOCKING

	Pre-Application (65, 68, 70, 72)	Post-Application (74, 76, 82, 86)	Year-End (90, 94, 98, 102
M-55-8[T]	142	91	133
C-27-1[T]	97	48	83
M-55-4[R]	252	88	84
T-4-1 [R]	9	27	135

It is difficult to draw any conclusions from these results, since reductions occurred in both the treatment and reference ponds, and the numbers of the "year-end" captures seemed to

[2] Summed NO/MONTH totals divided by number of totals (4).

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increase in all but one of the reference ponds. These results do not provide convincing evidence that the fish kills failed to have an adverse effect on fish populations.

As was indicated in the discussion of procedure above, due to the limited number of replicates, it is not possible to draw conclusions about the response of fish populations to endosulfan.

PHYTOPLANKTON DIVERSITY

Attachment 7.1, Figure 82 suggests that in C-27-1, diversity of phytoplankton may have declined immediately after high water column concentration while the reference pond increased. Endosulfan concentrations in C-27-1 was twice as high as in M-55-8. Which may explain why there was not a concurrent decrease in diversity in M-55-8.

ZOOPLANKTON DIVERSITY

Attachment 7.2, Figure 94 suggest that in C-27-1 zooplankton diversity again dropped immediately after peak in water column concentration. There may also have been a drop in M-55-8. The actual amount of diversity was not different than reference T-4-1, but while both treatment ponds were declining, both reference ponds were increasing.

SAMPLE ANALYSIS BY MONTH DURING TREATMENT YEAR USING LOTUS

Using the data on disks, the reviewer analyzed the results of Zooplankton sampling, Ekman Dredge sampling, Kicknet sampling and Emergent Insect trapping. It was not possible to derive statistical significance from the results, since there was only two replicates. Analysis involved comparison of numbers in treatment samples to reference pond samples. Where numbers in the reference samples were higher after application; this was considered a possible adverse effect.

Zooplankton

Several taxa showed decreases in treatment samples compared to reference samples. These included Centropyxis, Cyclotrichium, Cephalodella, Collotheca, Conochiloides, Bosmina and Diaptomus for August and September, 1988. Ciliate sp., Anuraeopsis, Filinia, Hexarthra, Testudinella, Trichocerca, Chydorus, and Cyclops showed declines in sample numbers in July, but not in August and September. Taxa exhibiting low treatment sample numbers compared to reference for July through September included Lecane, Monostyla, Platyias, and Trichotria. Showing declines in July and August, but not September were Nauplii, Diaphanosoma, Copepodite, and Alona.

Ekman Dredge

The treatment year results from July to October were analyzed using LOTUS III. Analysis was month by month. For each taxa collected and identified, the average number counted per sample day in the treatment ponds was compared to the reference ponds for each month. The following taxa were fewer in the treatment samples than reference samples for all months: Nematoda, Hirudinea, Ostracoda, Oecetis, and Orthotrichia. Chironomidae, Ceratopogonidae, Oxyethira sp., Planorbidae, Turbellaria, Caenis sp., Enallagma, Pelecypoda, Physella, Tetragoneuria all showed possible reductions based on sample counts in one or more sampling months from July to October.

Kicknet

During phase 4, kicknet sample counts showed lower values in treatment than control during July, August, September and October, 1988 for the following taxa; Dromogomphus, Oecetis, Heleidae, Tabanidae, and Physella. Nematoda, Oxyathira, Ceratapagonidae, and Pelecypoda exhibited reduced numbers in the treatment compared to reference samples in July and August after applications of endosulfan. The following taxa showed reduced numbers in samples from 3 of the 4 months after application, Turbellaria, Naucoridae, Orthothricia, Berosus, Peltodytes, Coleoptera, Culex, and Diptera.

Emergent Insect Data

A few taxa collected as emergent insects demonstrated reduced numbers based on sample counts. Oecetis and Orthotrichia numbers were lower in 3 of the 4 months following endosulfan applications. The reductions of this group were not as marked as the other groups.

INTERPRETATION OF STUDY RESULTS

The noted reductions in the invertebrate samples preclude a statement that endosulfan failed to have an adverse effect. These reductions may represent treatment related effects. The fish mortality certainly represents treatment related effects. The study supports EEB's presumption that endosulfan will kill fish when used on vegetable crops.

D. Category of Study: Meets requirements for a field study.

Rationale: The study was conducted according to EEB requirements. It provides information useful in characterizing the affects of endosulfan to aquatic organisms when used on vegetable crops.

15. Completion of One-Liner: NA
16. CBI Attachments: The tables attached are considered CBI.

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Page_____ is not included in this copy.

Pages 15 through 32 are not included.

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