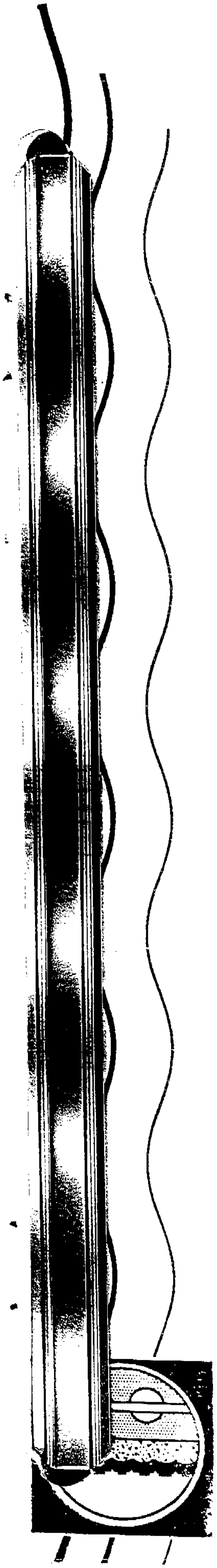

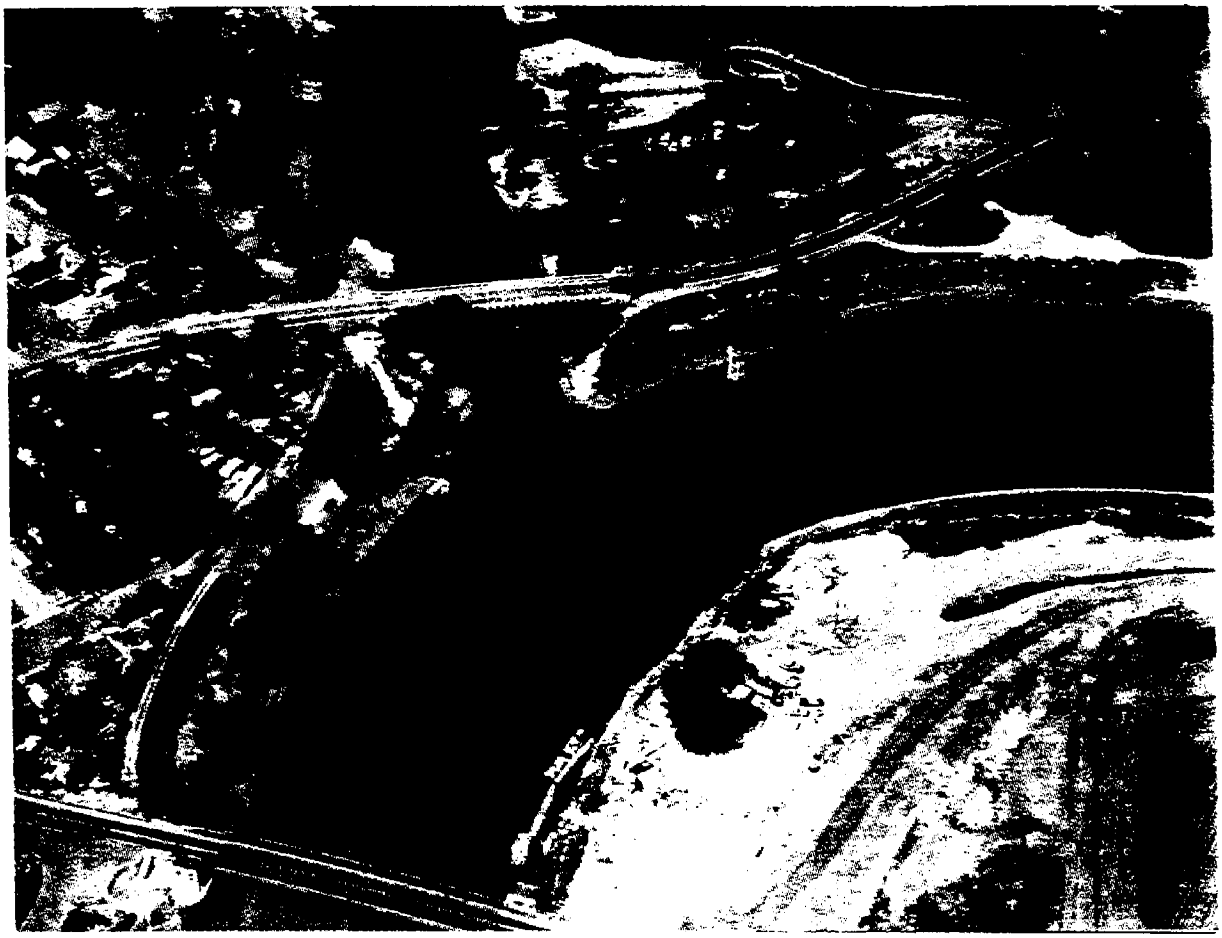

SACRAMENTO RIVER TOXIC CHEMICAL RISK ASSESSMENT PROJECT

FINAL PROJECT REPORT
APPENDIX A, B, C, D, E, F, G,

90-11WQ

October 1990

WATER RESOURCES CONTROL BOARD
STATE OF CALIFORNIA

SACRAMENTO RIVER TOXIC CHEMICAL RISK ASSESSMENT PROJECT
FINAL PROJECT REPORT

90-11WQ
OCTOBER 1990

APPENDIX A, B, C, D, E, F, G

PREPARED BY:

DIVISION OF WATER QUALITY
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARD,
CENTRAL VALLEY REGION

WATER RESOURCES CONTROL BOARD
STATE OF CALIFORNIA

SACRAMENTO RIVER TOXIC CHEMICAL
RISK ASSESSMENT PROJECT
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APPENDIX A, B, C, D, E, F, G

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APPENDIX A-1

E A-1

RIVER MILE LOCATIONS AND USGS/DWR STREAM FLOW GAUGE STATIONS
FOR THE SACRAMENTO RIVER AND ITS TRIBUTARIES

River Segment	Tributary	River Mile	USGS or DWR Station
Ia. Shasta Dam to Keswick Dam			
	Moccasin Cr.	313	
	Cornish Cr.	311	
	Motion Cr.	310	
	Flat Cr.	304	
	Spring Cr.	303	A2-1018
Ib. Keswick Dam to Bend Bridge			
	Rock Cr.	302	
	Middle Cr.	301	
	Salt Cr.	300	
	Olney Cr.	290	
	Clear Cr.	289	11372000
	Spring Gulch Cr.	285.5	
	Churn Cr.	284.5	A0-0850
	Stillwater Cr.	281	
	Cow Cr.	280	11374000
	Bear Cr.	277.5	A4-0750
	Ash Cr.	277	
	Anderson Cr.	274	
	Cottonwood Cr.	273.3	11376000
	Battle Cr.	271	11376550
	Frazier Cr.	268	
	Inks Cr.	264.5	
II. Bend Bridge to Hamilton City			
	Spring Cr.	258	
	Paynes Cr.	253	A0-4620
	Sevenmile Cr.	251	
	Blue Tent Cr.	248	
	Dibble Cr.	247	
	Brewery Cr.	246	
	Red Bank Cr.	243	11378800
	Salt Cr.	240	A0-0642
	Craig Cr.	239.5	
	Antelope Cr.	234.5	11379000
	Dye Cr.	234	
	Oat Cr.	233	
	N.Fork, Mill Cr.	231	A0-4440
	Elder Cr.	230.5	11379500
	Mill Cr.	230	11381500
	Thomes Cr.	225	11382000
	Toomes Cr.	222.5	
	Deer Cr.	219.5	11383500
	Jewett Cr.	215	
	Birch Cr.	209.5	
III. Hamilton City to Colusa			
	Pine Cr.	196	
	Big Chico Cr.	193	11384000
	Stony Cr.	190	11388000
IV. Colusa to Verona			
	Butte Sl. Outfall	138	A0-2967
	RD 108	98.5	A0-2933
	Colusa B. Drain	90	A0-2945
	Sacramento Sl.	80.5	A0-2925
	Feather River	79.75	11425000
V. Verona to Freeport			
	Natomas Canal	61.24	A0-0031
	American River	60	11446500
VI. Freeport to Collinsville			
	Elk Sl. Inlet	42	
	Cache Slough	14.5	

Sources: Sacramento River Aerial Atlas May 1984
Sacramento District, Army Corps of Engineers

Water Resources Data for California, Volume 4
Water Years 1977-1983 U.S. Geological Survey

Sacramento River monitoring stations:

Shasta Dam	A2-1046
Keswick Dam	11370500
Bend Bridge	11377100
Hamilton City	A0-2630
Colusa	11389

APPENDIX A-2

TABLE A-2
SACRAMENTO RIVER AND MAJOR INFLOWS: CUMULATIVE DISCHARGE, acre feet
Water Year 1977

River	Gaging	River		Sept 1 to Oct 31			Nov 1 to April 30			May 1 to Aug 31	
Segment	Station	Mile		total ac-ft	ac-ft/day		total ac-ft	ac-ft/day		total ac-ft	ac-ft/day
I.	Shasta Dam	314		(NA)			(NA)			(NA)	
	Keswick Dam	301		(631,300)	(10,349)		(1,919,200)	(10,603)		(2,213,500)	(17,996)
	Clear Cr.	289		6,264			23,886			12,581	
	Cow Cr.	280		5,080			33,450			9,525	
	Cottonwood Cr	273		11,510			36,380			20,510	
	Battle Cr.	271		30,453			91,085			53,799	
			Inflow:	53,307	874	Inflow:	184,801	1,021	Inflow:	96,415	783
II.	Bend Bridge	260		(700,400)	(11,481)		(2,181,900)	(12,054)		(2,272,300)	(18,474)
	Red Bank Cr.	243		0			469			511	
	Antelope Cr.	234		4,560			16,430			8,360	
	Elder Cr.	230		202			3,650			994	
	Mill Cr.	230		10,822			35,336			21,932	
	Thomes Cr.	225		649			11,243			3,781	
	Deer Cr.	220		10,650			34,359			18,447	
			Inflow:	26,883	441	Inflow:	101,487	560	Inflow:	54,025	439
III.	Hamilton City	199		(585,758)	(9,602)		(2,035,556)	(11,246)		(1,796,170)	(14,603)
	Big Chico Cr.	193		2,731			10,253			5,195	
	Stony Cr.	190		7,036			4,836			6,230	
			Inflow:	9,767	160	Inflow:	15,089	83	Inflow:	11,425	93
IV.	Colusa	143		(617,900)	(10,129)		(1,974,400)	(10,909)		(1,622,839)	(17,639)
	Butte Slough	138		28,073			4,864			708	
	RD 108	99		15,486			7,754			19,581	
	Colusa Drain	90		77,844			44,449			48,522	
	Sac. Slough	81		90,030			152,120			75,160	
	Feather R.	80		329,443			648,465			341,717	
			Inflow:	540,876	8,867	Inflow:	857,652	4,738	Inflow:	485,688	3,949
V.	Verona	79		(1,175,600)	(19,272)		(2,657,700)	(14,683)		(1,684,400)	(13,694)
	American R.	60		150,752			272,304			205,533	
			Inflow:	150,752	2,471	Inflow:	272,304	1,504	Inflow:	205,533	1,671
VI.	Freeport	59		(1,242,600)	(20,370)		(2,747,700)	(15,180)		(1,855,400)	(15,085)

Source: DWR, Central District; Water Resources Data, California (Vol 4), USGS.

SACRAMENTO RIVER AND MAJOR INFLOWS: CUMULATIVE DISCHARGE, acre feet
Water Year 1983

River	Gaging	River		Sept 1 to Oct 31			Nov 1 to April 30			May 1 to Aug 31	
Segment	Station	Mile		total ac-ft	ac-ft/day		total ac-ft	ac-ft/day		total ac-ft	ac-ft/day
I.	Shasta Dam	314		(NA)			(NA)			(NA)	
	Keswick Dam	301		(1,030,500)	(16,893)		(8,454,300)	(46,874)		(3,674,700)	(29,876)
	Clear Cr.	289		4,590			383,700			22,530	
	Cow Cr.	280		13,960			945,720			127,170	
	Cottonwood Cr	273		17,310			1,710,450			234,260	
	Battle Cr.	271		41,860			381,110			199,020	
			Inflow:	77,720	1,274	Inflow:	3,420,980	18,900	Inflow:	582,980	4,740
II.	Bend Bridge	260		(1,102,900)	(18,080)		(13,011,800)	(71,888)		(4,264,300)	(34,669)
	Red Bank Cr.	243		n/a			n/a			n/a	
	Antelope Cr.	234		n/a			n/a			n/a	
	Elder Cr.	230		1,228			186,940			30,925	
	Mill Cr.	230		20,570			251,910			129,630	
	Thomes Cr.	225		4,599			421,790			132,100	
	Deer Cr.	220		19,160			367,930			117,350	
			Inflow:	45,557	747	Inflow:	1,228,570	6,788	Inflow:	410,005	3,333
III.	Hamilton City	199		(1,041,120)	(17,068)		(14,675,310)	(81,079)		(4,120,470)	(33,500)
	Big Chico Cr.	193		4,630			217,740			24,220	
	Stony Cr.	190		22,820			1,091,680			211,430	
			Inflow:	27,450	450	Inflow:	1,309,420	7,234	Inflow:	235,650	1,916
IV.	Colusa	143		(1,085,100)	(17,788)		(10,329,500)	(57,069)		(4,297,400)	(34,938)
	+ Butte Slough	138		49,197			25,151			n/a	
	+ RD 108	99		n/a			n/a			n/a	
	Colusa Drain	90		111,770			53,131			110,527	
	+ Sac. Slough	81		108,750			n/a	432		n/a	
	Feather R.	80		900,500			10,017,800	55,347		3,709,000	
			Inflow:	1,170,217	19,184	Inflow:	10,096,082	55,779	Inflow:	3,819,527	31,053
V.	Verona	79		(2,227,000)	(36,508)		(17,860,000)	(98,674)		(8,241,000)	(67,000)
	American R.	60		382,400			3,946,500			2,052,200	
			Inflow:	382,400	6,269	Inflow:	3,946,500	21,804	Inflow:	2,052,200	16,684
VI.	Freeport	59		(2,661,000)	(43,622)		(21,150,000)	(116,850)		(10,155,000)	(82,560)

\+ There is no flow record for RD 108 or Butte Slough (May-August); Sacramento Slough was flooded from November through August.

TABLE A-2, continued

SACRAMENTO RIVER AND MAJOR INFLOWS: CUMULATIVE DISCHARGE, acre feet

Water Year 1980

River Segment	Gaging Station	River Mile		Sept 1 to Oct 31			Nov 1 to April 30			May 1 to Aug 31	
				total ac-ft	ac-ft/day		total ac-ft	ac-ft/day		total ac-ft	ac-ft/day
I.	Shasta Dam	314		(NA)			(NA)			(NA)	
	Keswick Dam	301		(626,000)	(10,262)		(4,514,700)	(24,943)		(2,396,600)	(19,484)
	Clear Cr.	289		6,500			49,477			13,093	
	Cow Cr.	280		14,870			569,190			36,080	
	Cottonwood Cr	273		15,220			676,880			57,260	
	Battle Cr.	271		33,428			274,688			98,656	
			Inflow:	70,018	1,148	Inflow:	1,570,235	8,675	Inflow:	205,089	1,667
II.	Bend Bridge	260		(722,000)	(11,836)		(6,687,800)	(36,949)		(2,509,500)	(20,402)
	Red Bank Cr.	243		0			42,215			408	
	Antelope Cr.	234		6,260			127,520			17,310	
	Elder Cr.	230		827			85,057			5,590	
	Mill Cr.	230		15,241			192,015			64,570	
	Thomes Cr.	225		4,630			268,442			22,245	
	Deer Cr.	220		13,113			233,522			45,526	
			Inflow:	40,071	657	Inflow:	948,771	5,242	Inflow:	155,649	1,265
III.	Hamilton City	199		(1,032,820)	(16,931)		(14,675,310)	(81,079)		(4,120,470)	(33,450)
	Big Chico Cr.	193		3,672			121,594			10,326	
	Stony Cr.	190		11,318			508,105			85,502	
			Inflow:	14,990	246	Inflow:	629,699	3,479	Inflow:	95,828	779
IV.	Colusa	143		(631,600)	(10,354)		(6,414,900)	(35,441)		(1,723,800)	(14,015)
	Butte Slough	138		60,860			66,640			49,880	
	RD 108	99		14,128			40,379			49,277	
	Colusa Drain	90		91,410			74,664			189,160	
	+ Sac. Slough	81		81,370			n/a			223,400	
	Feather R.	80		498,439			5,973,001			1,397,927	
			Inflow:	746,207	12,233	Inflow:	6,154,684	34,004	Inflow:	1,909,644	15,526
V.	Verona	79		(1,353,700)	(22,192)		(11,775,500)	(65,058)		(3,237,900)	(26,324)
	American R.	60		309,191			2,767,113			887,650	
			Inflow::	309,191	5,069	Inflow:	2,767,113	15,288	Inflow:	887,650	7,217
VI.	Freeport	59		(1,640,200)	(26,888)		(13,529,500)	(74,748)		(4,044,500)	(32,882)

\+ Sacramento Slough was flooded from November through April.

APPENDIX B

T. B-1

THE SACRAMENTO RIVER AND TRIBUTARIES BELOW DAMS:
NPDES-WDR PERMIT LISTINGS AND EFFLUENT/RECEIVING WATER MONITORING REQUIREMENTS.

River Segment	Map ID No.	Discharger (County)	Effluent Type *	Discharge (MGD)	CVRWQCB WDR No. (NPDES No.)	Flow	BOD	DO	pH	Temp.	Tur.	Set. Mat.	Susp. Mat.	Total Coliform	Res. Chlorine	EC	COD
						(See page 10 for abbreviations)											
I.	1	City of Redding Redding Regional Wastewater Treatment Facility (Shasta Co)	STP/WWTP	8.8	87-066	C	W	W	W		W	D	W	W	D	M	
					(CA0079731)	Toxicity: 96-hour King salmon bioassay (2xY)											
	2	Siller Brothers, Inc Anderson Sawmill (Shasta Co)	LDR/SWD	unknown-w	87-098				E		E	E	E				E
					(CA0081205)	Toxicity: tannins and lignins, 96-hour Rainbow trout bioassay (E)											
	3	Sierra Pacific Industries Anderson Division (Shasta Co)	LDR/SWD	unknown-w	87-134			W	E		E	E	E				
					(CA0082066)	Toxicity: 96-hour bioassay, tannins and lignins (E)											
	4	P&M Cedar Products Inc Anderson Division (Shasta Co)	LDR/SWD	unknown-w	87-137				M		E	E	E			M	Q
					(CA0082074)	Toxicity: tannins and lignins, TDS (Q); 96-hour Rainbow trout bioassay (M)											
	5	Shasta Dam Area P.U.D. Wastewater Treatment Plant (Shasta Co)	STP/WWTP	0.7	85-049	C	W	W	2xW	W		2xW	W	2xW	C		
					(CA0079511)	Toxicity: 96-hour Rainbow trout bioassay (twice yearly)											
	6	Shasta Dam Area P.U.D. Water Treatment Plant (Shasta Co)	WTP	0.05	86-196	D			2xM		2xW	2xM					
					(CA0081345)	Toxicity: none											
	7	Shasta Dam Area P.U.D. Summit City WT Facility (Shasta Co)	WTP	0.025	83-142	D			M		M	M					
					(CA0004693)	Toxicity: none											
	8	Bella Vista Water District Water Treatment Plant (Shasta Co)	WTP	1.5	86-195	D			2xM		2xW	2xM					
					(CA0080799)	Toxicity: none											
	9	Sierra Pacific Industries Redding Division (Shasta Co)	LDR/SWD	unknown-w	87-067				E		E	E	E				E
					(CA0081400)	Toxicity: 96-hr bioassay, oil & grease, tannins & lignins (E); PCP (M)											

TABLE B-1, continued.

River Segment	Map ID No.	Discharger (County)	Effluent Type *	Discharge (MGD)	CVRWQB Order No. (NPDES No.)	Flow	BOD	DO	pH	Temp.	Tur.	Set. Mat.	Susp. Mat.	Total Coliform	Res. Chlorine	EC	COD
I. (cont'd)	10	City of Anderson Sewage Treatment Plant (Shasta Co)	STP/WWTP	1.2	83-141 (CA0077704)	D	W	W	W			D	W	W	C		
						Toxicity: 96-hour bioassay (twice yearly)											
	11	Latona Lumber Company Inc Anderson (Shasta Co)	LDR/SWD	unknown-w	87-068 (CA0081990)				E		E	E	E				E
						Toxicity: tannins and lignins, 96-hour Rainbow trout bioassay (E)											
	12	Calaveras Cement Inc (Shasta Co)	SWD	unknown-w	86-220 (CA0081191)				E	2xM	E	E	E				
						Toxicity: none											
	13	Simpson Paper Co (Shasta Co)	PPW	14.85	83-067 (CA0004065)	C	D	W	D	W	W	D	D	M		D	
						Toxicity: mercaptans (M), resin acids (M), sulfate soaps (M), NH4-N (M), Kjeldhal-N (M), NO3-N (M), total P (M), color (D), toxicity w/salmonoids (W)											
	14	Roseburg Lumber Co (Shasta Co)	LDR/SWD	unknown	83-114 (CA0004031)	D			E		E	E	E				E
						Toxicity: 96-hour Rainbow trout bioassay (each event)											
	15	Roseburg Forest Products Inc Sawmill No. 4 (Shasta Co)	LDR/PCW	unknown-w	87-158 (CA0079936)				M		M	M	M				
						Toxicity: tannins and lignins (monthly)											
	16	Shasta Co Service Area 17 Cottonwood WWTP (Shasta Co)	STP/WWTP	0.40	84-012 (CA0081507)	D	2xW		2xW			D	2xW	2xW	D	M	
						Toxicity: 96-hour King salmon bioassay (monthly)											
	17	Signal Energy Systems Inc Signal Cottonwood Energy Facility (Shasta Co)	SWD	unknown	87-083 (CA0081957)				E		E	E		M		E	E
						Toxicity: groundwater monitoring (W); TDS (M); tannins and lignins (E)											
	18	California Dept Fish and Game Darrah Springs Fish Hatchery (Shasta Co)	FHW	26.7	85-280 (CA0004561)	M		M	M	M	M	M	M		D		
						Toxicity: daily log of chemical useage											
	19	Mt. Lassen Trout Farms Inc Battle Cr Trout Facility (Tehama Co)	FHW	5.16	87-135 (CA0081167)	W		W	W	W		M	M				
						Toxicity: daily log of chemical useage											

River Segment	Map ID No.	Discharger (County)	Effluent Type *	Discharge (MGD)	CVRWQB Order No. (NPDES No.)	Flow	BOD	DO	pH	Temp.	Tur.	Set. Mat.	Susp. Mat.	Total Coliform	Res. Chlorine	EC	COD
I. (cont'd)	20	US Fish and Wildlife Service Coleman Fish Hatchery (Shasta Co)	FHW	67.0	83-112 (CA0004201)	D Toxicity: none		W	W	W	W	W	2xM				
	21	Mt. Lassen Trout Farms Inc Jeffcoat Facility (Tehama Co)	FHW	3.9	87-136 (CA0082104)	W Toxicity: daily log of all chemical useage			W			W	W				
	22	Macon Springs Fish Hatchery Willow Springs Facility (Tehama Co)	FHW	4.0	87-191 (CA0082163)	W Toxicity: daily log of all chemical useage			W			M	M				
	23	USFWS and USBR Tehama-Colusa Fish Facilities (Tehama Co)	FHW	16.1 (Jun-Nov)	84-131 (CA0010671)	D Toxicity: herbicide (usually Acrolein) (daily)					D	D			D		
	24	Mt Lassen Trout Farms Inc Carl's Facility (Tehama Co)	FHW	5.2	87-192 (CA0082155)	W Toxicity: daily log of all chemical useage			W			M	M				
	25	Rio Alto Water District Lake California (Tehama Co)	STP/WWTP	0.64	83-111 (CA0077852)	D Toxicity: MBAS (weekly)	W	W	D			D	3xW	W	D		
II.	26	Mt. Lassen Trout Farms Inc Dales Facility (Tehama Co)	FHW	3.6	85-340 (CA0080381)	W Toxicity: daily log of chemical useage			W			M					
	27	Mt. Lassen Trout Farms Inc Meadowbrook Facility (Tehama Co)	FHW	2.16	85-339 (CA0080373)	W Toxicity: daily log of chemical useage			W			M					
	28	City of Red Bluff Wastewater Treatment Plant (Tehama Co)	STP/WWTP	1.90	86-123 (CA0078891)	D Toxicity: TDS (M), standard minerals (M), 96-hour bioassay (twice yearly), reclamation water supply (D & W)	W		3xW			D	W	W	D	M	

TABLE B-1, continued.

River Segment	Map ID No.	Discharger (County)	Effluent Type *	Discharge (MGD)	CVRWQB Order No. (NPDES No.)	Flow	BOD	DO	pH	Temp.	Tur.	Set. Mat.	Susp. Mat.	Total Coliform	Res. Chlorine	EC	COD
II. (cont'd)	29	Packaging Company of Ca. Molded Pulp Mill (Tehama Co)	PPW	2.70	84-011 (CA0004821)	C	3xW	M	D	C	3xW	D	D				
						Toxicity: % survival of salmon eggs (weekly)											
	30	Crane Mills (Tehama Co)	LDR	unknown	84-101 (CA0004073)				E		E						E
						Toxicity: tannins and lignins (each event)											
	31	City of Corning Industrial and Domestic Wastewater Treatment Plant (Tehama Co)	STP/WWTP	2.46	86-129 (CA0004995)	D	W	W	D	W	W	D	W	W	D	D	
						Toxicity: TDS, 96-hour bioassay, chlorides, standard minerals, unionized ammonia (W); reclamation water supply (D & W)											
	32	Olives, Incorporated (Tehama Co)	FPW	0.055	83-070 (CA0081469)	D			W	D						W	
						Toxicity: none											
	33	Bell-Carter Foods, Inc (Tehama Co)	PCW	0.19	86-001 (CA0081639)	D			W	D						W	
						Toxicity: none											
III.	34	City of Chico (Butte Co)	STP/WWTP	5.0	84-055 (CA0079081)	C	W	W	D	W		D	W	W	D	M	
						Toxicity: 96-hour bioassay (monthly)											
IV.	35	City of Colusa (Colusa Co)	STP/WWTP	0.50	85-046 (CA0078999)	D	M	W	W			D	M	W	D	M	
						Toxicity: none											
	36	Maxwell Public Utility Dist. (Colusa Co)	STP/WWTP	0.20	85-144 (CA0079987)	D	M	M	D			D	M	W	W		
						Toxicity: none											
	37	City of Williams (Colusa Co)	STP/WWTP	0.50	85-143 (CA0077933)	D	M	W	D			D	M	W	W		
						Toxicity: none											
	38	City of Willows (Glenn Co)	STP/WWTP	1.12	84-135 (CA0078034)	D	W	M	D			W	W	W		M	
						Toxicity: none											
	39	Glenn Milk Producers Assoc. (Glenn Co)	PCW FPW	0.47	82-131 (CA0077763)	C	W	D	D	D		W	W				
						Toxicity: none											

River Segment	Map ID No.	Discharger (County)	Effluent Type *	Discharge (MGD)	CVRWQB Order No. (NPDES No.)	Flow	BOD	DO	pH	Temp.	Tur.	Set. Mat.	Susp. Mat.	Total Coliform	Res. Chlorine	EC	COD
IV. (cont'd)	40	Greenleaf Power Corp. Greenleaf Unit 1 Cogeneration Facility (Sutter Co)	PCW	0.121	85-002 (CA0081566)	D			W	T			M		W	W	
						Toxicity: oil and grease (M)											
	41	Richvalle Sanitary District (Butte Co)	STP/WWTP	0.03	84-136 (CA0079634)	C	M	M	D			D	M	W	D	M	
						Toxicity: none											
	42	City of Biggs (Butte Co)	STP/WWTP	0.35	84-137 (CA0078930)	C	W		W			W	W	W			
						Toxicity: none											
	43	Tri Valley Growers Gridley Plant (Butte Co)	PCW	4.0	83-138 (CA0003921)	C			2xW	2xW	C	2xW				2xW	2xW
						Toxicity: none											
	44	Sewerage Commission-- Oroville Region (Butte Co)	STP/WWTP	6.50	84-061 (CA0079235)	C	W	W	D	W		D	W	W	D	W	
						Toxicity: TDS (M), chloride ion (M), 96-hour bioassay (M)											
	45	Linda County Water District Water Pollution Control Plant (Yuba Co)	STP/WWTP	1.5 (only during floods)	87-140 (CA0079651)	D	W	W	D	W	W	D	W	W	D	W	
						Toxicity: Bioassay (Y); groundwater monitoring (Q)											
	46	City of Yuba City Water Reclamation Plant (Yuba Co)	STP/WWTP	7.0	84-095 (CA0079260)	D	W		D			D	W	W	D	W	
						Toxicity: 96-hour bioassay (monthly)											
	47	Beale Air Force Base Wastewater Treatment Plant (Yuba Co)	STP/WWTP	5.0	86-080 (CA0110299)	D	W	W	D			D	W	W	D		
						Toxicity: 96-hour bioassay, Hg, Ag, Cr(VI), B, Pb, Cu, Ba, Cd, cyanide (Q); pentachlorophenol, oil and grease (M)											
	48	Erickson Lumber Co (Yuba Co)	PCW LDR	0.01	78-211 (CA004642)	Monitoring: none											
						Toxicity: none											
	49	Olivehurst Public Utility Dist. (Yuba Co)	STP/WWTP	1.0	83-084 (CA0077836)	D	W	W	D			D	W	W	D	D	
						Toxicity: none											

River Segment	Map ID No.	Discharger (County)	Effluent Type *	Discharge (MGD)	CVRWQB Order No. (NPDES No.)	Flow	BOD	DO	pH	Temp.	Tur.	Set. Mat.	Susp. Mat.	Total Coliform	Res. Chlorine	EC	COD
IV.	50	Hammonton Golden Village	STP/WWTP	0.05	84-066	D	W	W	D	W		D	W	W	D		
(cont'd)		(Yuba Co)			(CA0081574)	Toxicity: none											
	51	Lincoln Clay Products Inc	SWD	0.5	87-023	E			E		E	E	E				
		(Placer Co)			(CA0077801)	Toxicity: none											
	52	Lake Wildwood Special Improve.	STP/WWTP	0.25	85-072	D	2xW	W	D	W	D	D	2xW	2xW	D	2xY	
		Zone 1, Sanitation Dist No. 1			(CA0077828)	Toxicity: TDS (2xY), standard minerals (Y)											
		(Nevada Co)															
	53	City of Live Oak	STP/WWTP	1.6	87-174	D	M	W	W	W	W	D	M	W	D	W	
		(Sutter Co)			(CA0079022)	Toxicity: TDS (M); Cu, Cd, Cr, Pb, Zn (Y)											
	54	Formica Corporation	PCW/SWD	1.0	87-159	D			D	D			2xM			M	Q
		Sierra Plant			(CA0004057)	Toxicity: phenols (2xM)											
		(Placer Co)															
	55	NEC Electronics	PCW	0.76	87-021	D		D	D	D			M			D	M
		(Placer Co)			(CA0081922)	Toxicity: Total Toxic Organics (Y); flouride, total dissolved solids (M); water supply monitoring (M & Y)											
	56	Gladding, McBean & Co	PCW ->	0.04	84-013		2xM	2xM	2xM	2xM			M			M	M
		(Placer Co)	SWD ->	unknown	(CA0004332)	Toxicity: oil and grease (M); groundwater monitoring											
V.	57	Tenco Tractor Inc	TIS	0.0025	84-203	Monitoring: none											
		(Sutter Co)			(CA0077879)	Toxicity: none											
	58	Placer County Sewer	STP/WWTP	2.18	87-099	D	2xW	W	D	W		2xW	2xW	2xW	D	M	
		Maintenance District No.1			(CA0079316)	Toxicity: standard minerals (yearly), TDS (yearly)											
		(Placer Co)															
	59	Placer County Sewer	STP/WWTP	0.3	84-107	D	W	W	D	W	D	W	W	2xW	D	M	
		Maintenance District No.3			(CA0079367)	Toxicity: TDS, standard minerals (Y); unionized ammonia (W)											
		(Placer Co)															

**** c ous maximum

TABLE B-1, continued.

River Segment	Map ID No.	Discharger (County)	Effluent Type *	Discharge (MGD)	CVRWQB Order No. (NPDES No.)	Flow	BOD	DO	pH	Temp.	Tur.	Set. Mat.	Susp. Mat.	Total Coliform	Res. Chlorine	EC	COD
V. (cont'd)	60	USAF- McClellan Air Force Base Storm & Cooling Water Discharge (Sacramento Co)	PCW -> SWD ->	0.095 unknown	87-160 (CA0004359)	M		W	W	2xW	W		W			2xW	W
						Toxicity: Cu,Ni,Zn,Cr,Cr(VI),Ag,Pb,Cd,Cl,B,phenol (M); cyanide, oil & grease (W); 96-hour bioassay (M); volatile organics-EPA 601,602 (2xW)											
	61	USAF- McClellan Air Force Base Ground Water Extraction & Trtmt Sys (Sacramento Co)	TGW	1.44	87-194 (CA0081850)	C		2xW	2xW	2xW	2xW		W			2xW	
						Toxicity: acetone, methyl ethyl ketone, methyl isobutal ketone,Cu,Ni,Cr,Zn, Pb,Cd,cyanide,Sb,Se,Hg,Na,Cl, aldrin, phenol (W); 96-hour bioassay (M); volatile orgaics-EPA 601,602 (W); Base Neutral Acids-EPA 625 (M)											
	62	City of Auburn (Placer Co)	STP/WWTP	1.55	84-097 (CA0077712)	D	2xW	W	D			2xW	2xW	2xW	D	M	
						Toxicity: TDS, standard minerals (Y)											
	63	Placer Co Service Area 11 Sabre City WWTP (Placer Co)	STP/WWTP	0.045	86-100 (CA0078786)	C	W	W	2xW	W	W	2xW	W	W	2xW	2xW	
						Toxicity: none											
	64	City of Roseville Regional WWTP (Placer Co)	STP/WWTP	18.0	87-202 (CA0079502)	D	3xW	W	D	W	W	D	3xW	3xW	C	D	
						Toxicity: TDS (M); MBAS, grease & oil (W); 96-hour bioassay (3xM); Cu,Ni,Cr, Cd,Pb,Hg,Zn, std min, priority pollutants (Q); groundwater monitoring (Y)											
	65	Aerojet General Corp (Sacramento Co)	SWD -> PCW ->	48.0 (w) 0.2	85-242 (CA0004111)	Continuous: TOC, pH, DO, EC, NO3, ClO4, Na. At various intervals: COD, organic halogen, suspended solids, oil and grease, NH3-N, N, Cl2-R, turb, temp, N2H4, TDS, 17 heavy metals, 30 volatile cmpds, 11 acid cmpds, 45 base/neutral cmpds											
	66	Calif Dept of Fish and Game American River Trout Hatchery Nimbus Salmon and Steelhead Hatchery (Sacramento Co)	FHW -> ->	 9.2-18.4 7.0-23.0	87-203 (CA0004774)	D		W	W		W	W			Q		
						Toxicity: chloroform (Q)											
	67	California Office of State Printing (Sacramento Co)	PCW	5.1	87-041 (CA0078875)	D			M	D		M					
						Toxicity: Fe, well water supply (M); volatile organics-EPA 601,602 (M/Q)											
	68	City of Sacramento Sac River Water Trtmt Plant (Sacramento Co)	WTP	1.06 (45 days/yr)	85-151 (CA0005037)	C			2xW		W	2xW	2xW		W		
						Toxicity: total and dissolved Al (W), dissolved Cr (W), river flow (D)											

TABLE B-1, continued.

River Segment	Map ID No.	Discharger (County)	Effluent Type *	Discharge (MGD)	CVRWQB Order No. (NPDES No.)	Flow	BOD	DO	pH	Temp.	Tur.	Set. Mat.	Susp. Mat.	Total Coliform	Res. Chlorine	EC	COD
V. (cont'd)	69	State of California Central Heating and Cooling Plant (Sacramento Co)	PCW	7.85	84-122 (CA0078581)	W			W	D						M	
						Toxicity: Fe (monthly)											
	70	Shell Oil Company Sacramento Plant (Yolo Co)	IYS	unknown	87-022 (CA0080781)	W			W								
						Toxicity: oil and grease (W)											
	71	East Yolo Community Serv Dist West Sacramento STP (Yolo Co)	STP/WWTP	5.0	85-003 (CA0079171)	D	2xW	M	D	D	M	2xW	2xW	4xW	D	2xW	
						Toxicity: 96-hour bioassay (M), TDS (2xW), standard minerals (Y)											
	72	Sacramento Reg Co San Dist Combined Wastewater Control Sys (Sacramento Co)	STP/WWTP/ SWD	0-130 (4-5x/yr)	85-342 (CA0079111)	E			E			E	E	E	E		
						Toxicity: Sacramento River flow (daily mean and range) (E)											
	73	Tosco Corp (Sacramento Co)	IYS	0.001-w	84-039 (CA0078522)	W			W								W
						Toxicity: oil and grease (W)											
VI.	74	Sacramento Reg Co San Dist Sacramento Regional WWTP (Sacramento Co)	STP/WWTP	180.0	85-245 (CA0077682)	D	D	W	D	D		D	D	D	D	2xW	
						Toxicity: TDS (2xW), NH4-N (2xW), grease and oil (M), standard minerals (Q), 96-hour bioassay (W), N (M), river dilution ratio (D)											
	75	Procter and Gamble Mfg Co (Sacramento Co)	PCW	6.5	87-139 (CA0004316)	W		W	W	D						W	W
						Toxicity: none											
	76	Delta Sugar Corporation (Yolo Co)	PCW	7.5 March-Nov .35 Nov-March	85-142 (CA0004901)	C	W	W	D	D		D	W		AR	M	
						Toxicity: none											
	77	Newhall Land Farming Co Dixon Dryer Division (Yolo Co)	FPW	0.19	84-132 (CA0004855)	D	M		W	D		W	M	M		W	
						Toxicity: none											
	78	Stillwater Orchard Co (Sacramento Co)	PCW	0.0065	84-040 (CA0004928)				W	W							
						Toxicity: none											

TABLE B-1, continued.

River Segment	Map ID No.	Discharger (County)	Effluent Type *	Discharge (MGD)	CVRWQB Order No. (NPDES No.)	Flow	BOD	DO	pH	Temp.	Tur.	Set. Mat.	Susp. Mat.	Total Coliform	Res. Chlorine	EC	COD
VI. (cont'd)	79	City of Vacaville Industrial Waste Trtmt Facility (Solano Co)	STP/WWTP	1.4	86-200 (CA0078018)	D	W	W	D	W		D	W	2xW	D	W	
						Toxicity: none											
	80	City of Vacaville Easterly Treatment Plant (Solano Co)	STP/WWTP	8.0	84-133 (CA0077691)	D	2xW	M	D	D	M	D	2xW	2xW	D		
						Toxicity: test sewage sludge for heavy metals and PCBs (2xY)											
	81	Wickes Forest Industries Wickes Wood Preserving (Solano Co)	TIS	0.011	84-038 (CA0081531)	D											
						Toxicity: effluent and receiving: Cr (2xW), Cr(VI) (W), Cu (W), As (2xW); groundwater: Cr, Cr(VI), Cu, As, elevation, pH (all monthly)											
	82	City of Davis (Yolo Co)	STP/WWTP	5.0	85-278 (CA0079049)	C	W	D	D			D	W	3xW	D	M	
						Toxicity: none											
	83	City of Woodland Domestic Wastewater Trtmt Facility (Yolo Co)	STP/WWTP	8.0-w	87-093 (CA0077950)	D	W	W	D	W		D	W	W	W	M	
						Toxicity: none											
	84	Hunt Wesson Food, Inc (Yolo Co)	FPW	1.0 July-Oct	84-065 (CA0079227)	C	W	W	D			D	W			W	
						Toxicity: groundwater: COD, pH, nitrate, EC (quarterly); soil profile: pH, EC, NO3-N, N (yearly)											
	85	U.C. Davis (Yolo Co)	STP/WWTP	4.16	85-073 (CA0077895)	D	W	W	D			D	W	W	D	M	
						Toxicity: none											
	86	City of Rio Vista (Solano Co)	STP/WWTP	0.60	84-134 (CA0079588)	D	M		D			D	M	2xW	D	M	
						Toxicity: 96-hour bioassay											

* Effluent type:
FHW- Fish Hatchery Waste
FPW- Food Processing Waste
IYS- Industrial Yard Storm Runoff
LDR- Logdeck Runoff
PCW- Plant Cooling Water
PPW- Pulp Paper Process Waste
STP/WWTP- Sewage/Wastewater Treatment Plant
SWD- Storm Water Discharge
TIS- Treated Industrial Steam Cleaning Waste
TGW- Treated Ground Water
WTP- Water Treatment Plant

* Permit abbreviations:
D: measured daily
W: measured weekly
M: measured monthly
Q: measured quarterly
E: measured for each event
2xW, etc: measured twice a week
C: monitored continuously
AR: measured as required

BOD: biological oxygen demand
DO: dissolved oxygen
Temp: temperature
Tur: turbidity
Set Mat: settlable matter
Susp Mat: suspended matter
Res chlorine: residual chlorine
EC: electrical conductivity/specific conductance
COD: chemical oxygen demand
TDS: total dissolved solids

Discharge values listed are design flows, and may be greater than average flows.
w: winter flow only

updated through 31 December 1987

NOTE: Table 1-3 is a summary of this table

APPENDIX C-1

TABLE C-1
ACREAGES AND DISCHARGE POINTS FOR SACRAMENTO VALLEY WATER AGENCIES (1987)

AGENCY NAME	TOTAL ACRES	RICE ACRES	DISCHARGE POINT
Biggs W. Gridley W.D.	20000 I (1)	14000	Butte Creek and Morrison Slough
Brown's Valley I.D.	11000 I	1702	Jack Slough
Butte Creek D.D.	67083 I	-	Butte Creek
Butte Slough I.D.	-	-	Butte Creek
Butte Water District	14000 I	3400	Morrison Slough
Colusa County W.D.	46000	64	Colusa Basin Drain
Cordua I.D.	8500	7000	Jack Slough
Cortina Water District	500 I	0	Colusa Basin Drain
Davis Water District	960 I	240	Colusa Basin Drain
Drainage District No. 2	7431	-	Butte Creek
Drainage District No. 100	5000 I	-	Butte Creek
Drainage District No. 200	5000	5000	Butte Creek
Drainage 501 & 502	-	-	Butte Creek
Dunnigan W.D.	10500 I	0	Colusa Basin Drain
Durham Mutual W.D.	1500 I	120	Butte Creek
Feather River W.D.	8000 I	250	Sutter Bypass to Sacramento Slough
Glenn-Colusa I.D.	172500	82677	Colusa Basin Drain
Glenn Valley W.D.	-	-	Colusa Basin Drain

TABLE C-1, continued

AGENCY NAME	TOTAL ACRES	RICE ACRES	DISCHARGE POINT
Glide I.D.	7600 I	1000	Colusa Basin Drain
Hallwood Irrigation Co.	-	-	Jack Slough
Holthouse W.D.	1400 I	0	Colusa Basin Drain
Kanawha W.D.	15000 I	2500	Colusa Basin Drain
Lagrande W.D.	1400 I	980	Colusa Basin Drain
4M W.D.	900 I	0	Colusa Basin Drain
Maxwell I.D.	7000 I	3000	Colusa Basin Drain
Meridian Farms Water Co.	-	-	Sutter Bypass to Sacramento Slough
M & T., Inc.	-	-	Butte Slough
Natomas Central Mutual W.D.	35343 I	15000	Sacramento River
Orland-Artois W.D.	20000 I	2770	Colusa Basin Drain
Orland Unit W.D.	21000	0	Colusa Basin Drain
Pleasant Grove - Verona Mutual W.D.	7600 I	3000	Cross Canal
Priceton Cordora Glenn I.D.	13500 I	5200	Colusa Basin Drain
Provident I.D.	15000 I	14250	Colusa Basin Drain
Ramirez W.D.	2092 I	2092	Jack Slough
Reclamation District 10	-	-	Jack Slough
Reclamation Districts 70 & 1660	33000	3500	Sutter Bypass to Sacramento Slough

AGENCY NAME	TOTAL ACRES	RICE ACRES	DISCHARGE POINT
Reclamation District 108	47700 I	16900	Sacramento River
Reclamation District 479	6000 I	1000	Colusa Basin Drain
Reclamation District 787	9383	2270	Colusa Basin Drain
Reclamation District 833	38000 I	38000	Butte Creek
Reclamation District 1000	55000	15600	Sacramento River
Reclamation District 1001	32000 I	6000	Cross Canal
Reclamation District 1004	23600 I	10500	Butte Creek
Reclamation District 1660	-	-	Sutter Bypass to Sacramento Slough
Reclamation District 2035	18000 I	6700- 11000	Tule Canal to Toe Drain to Sac. R.
Reclamation District 2047	230000	-	Colusa Basin Drain
Reclamation District 2056	8600 I	1000	Wadsworth Canal to Sac. Slough
Richvale I.D.	27500	17065	Butte Creek
Sartain Mutual Water Co.	767	580	Butte Creek
South Sutter W.D.	42000 I	20000	Cross Canal
Sutter Extension W.D.	25000	11000	Sutter Bypass to Sacramento Slough
Sutter Mutual Water Co. R.D. 1500 & R.D. 1660	46746 I	14000	Sutter Bypass to Sacramento Slough
Tisdale I.D.	-	-	Sutter Bypass to Sacramento Slough
West Side W.D.	12000 I	1000- 1200	Colusa Basin Drain

AGENCY NAME	TOTAL ACRES	RICE ACRES	DISCHARGE POINT
Western Canal W.D.	-	35000	Butte Creek
Willow Creek Mutual W.D.	4500 I	2200	Colusa Basin Drain
Yolo County Flood Control & Water Cons. District	191000	4000	Toe Drain to Sacramento River
Yolo - Zamora W.D.	21500	approx.0	Colusa Basin Drain

(1) I = Total irrigated acres versus total area within district.

(2) Some areas are serviced by irrigation or water districts and a reclaimation district therefore some acreages may be listed more than once.

APPENDIX C-2

TABLE C-2

PHYSICAL AND CHEMICAL PROPERTIES OF PESTICIDES USED IN THE SACRAMENTO VALLEY.

References (numbered in parentheses) are found following Table C-2.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
ACEPHATE (30560-19-1)	183.2 (1)	650,000* (2,3,4,5)	1.7 X 10-6 @20 (1,4)	-2.04 (6) -0.85* (7) 0.14* (5)	0.27 (6) 0.91* (7)	30* (5) 5-10 (8)		LOG BCF: -1.07 (7)
ALACHLOR (1597-260-8)	269.8 (1)	242* (3,5,10, 84)	2.2 X 10-5* @25 (1,3,10) 3.7 x 10-6 @10, 2.7 x 10-5 @ 26.7 1.6 x 10-4 @43.3 (84)	1.83* (5,11) 4.72* (12)	2.47* (11) 3.94* (12) 2.29* (13)	30* (5)	6-7 (3) PERSIST.: MOD. TO HIGH (14)	LOG BCF: 1.05* (11) 3.33* (12) MAY BE TRANSPORTED WITH SURFACE RUNOFF. (3)
ALKYLARYLPOLY/ OXYRTHYLENE/GLYCOL	N/A							
ALUMINUM PHOSPHIDE (20859-73-8)	57.95 (174)	REACTS W/ WATER (16))						
AMITROLE (61-82-5)	84 (1,17)	45,800* (17) 279,000 (18) 280,000* (5,19,20)	1 X 10-5* @20 (1)	-0.15* (17) -2.78* (11) 0.52* (21, 23,3,5) -0.70* (7)	1.25* (17) -0.14* (11) 1.66* (5,21) 0.99* (7)	14-45 DAYS (24)	2-6 (25)	LOG BCF: -2.6* (15) -0.95 (7) 0.01 (21) 0.00* (17) NO RESIDUES IN SOIL 2 MONTHS AFTER APPLICATION. (20)

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
ANTOR (38727-55-8)		105 @ 25 (3)						NO RESIDUES IN SOILS IN THE NEXT YEAR. (3)
AROMATIC PETROLEUM DISTILLATE	N/A							
AROMATIC PETROLEUM SOLVENTS	N/A							
ATRAZINE (1912-24-9)	215 (17) 215.7 (1)	25.2* (17) 69.8 (26) 33 @25*(5,27) 35 (10) 29.9-34.9 VARYING W/ PH (28) 33 @ 27 (84)	0.16* (17) 3. X 10-7* @20 (1,10,27) 5.7 X 10-8 @10, 8.4 X 10-7 @26.7, 9.4 @42.3 (84)	2.82* (17) 2.78* (12) 2.63 (29) 2.60* (12) 2.78/0.81 (21) 3.8* (5)	2.87 (17) 2.89* (12) 2.81 (29) 2.79* (12) 2.17* (13) 1.2-2.7 (30) 0.81 (5)	42-180 (24)	6-26 (31). PERSIST.: HIGH TO VERY HIGH (32) 3-14 (118)	NEELY PARTITIONING: 20.6% IN AIR 69.18% IN WATER 5.29% IN GROUND 4.94% IN HYDROSOIL* (17) LOG BCF: 0.48-1.0 (76)
AZINPHOSMETHYL (8650-0)	317.3 (1)	29.9 (33) 29 @25 (34) 33* (5)	2.2 X 10-7* @20 (1)	-1.48* (15) -0.38* (12,5) 2.18* (35) 2.75* (36)	1.17* (5,12) 0.56* (15) 2.56* (35) 2.87* (36)	30* (5) <14 (24) 17.3 @30, PH 5 (37) 1.2 IN POND (37)	2 ON SURFACE, 4 INCORPORATED (38)	HIGH SOIL ABSORPTION. (37) WATER WILL INCREASE LOSS FROM SOIL. (39) LOG BCF: 2.21* (15) -0.7* (12) 1.32 (35) 1.77 (36)
BENOMYL	292 (17)	556 (17)	NEGLIGIBLE*	2.86* (17)	2.89* (17)	30* (5)	13-26 (TURF)	NEELY PARTITIONING:

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
BENOMYL, CON'T. (17804-35-2)		4* (5)	@20 (1)	1.07* (15, 11,5) 2.3* (12) 2.53 (21)	1.96* (11) 2.75 (21) 1.96* (5)	>180 (24)	AND 26-52 (SOIL) (41) 13-52 (SOIL) (42)	0.00% IN AIR 86.05% IN WATER 7.21% IN GROUND 6.73% IN HYDROSOIL (17)* 0.45* (15) 1.60 (21) 1.42* (12)
BENSULFURON METHYL	410 (185)	120 (185)	2.3 X 10 3 (185)	2.4 (185) @ PH 1.5 2.18 (185) @ PH 5 0.6 (185) @ PH 7 -1 (185) @ PH 9	1.84 (185) IN SANDY LOAM 1.97 (185) IN SILTY LOAM 1.88 (185) IN SANDY LOAM 2.28 (185) IN SILTY LOAM	162 (185)	4-20 (185)	
BENTAZON, SODIUM SALT (25057-89-0)	240 (17)	4460* (17) 500* (5)	1.48* (17)	3.81* (17) 2.5* (5)	3.40* (17)	10-30 (81)		NEELY PARTITIONING: 86.21% IN AIR 5.64% IN WATER 4.21% IN GROUND 3.93% IN HYDROSOIL* (17) NOT ABSORBED ON ANY OF 12 ILLINOIS SOILS. <2% OF AMOUNT APPLIED WAS EVER RECOVERED IN LEACHATE. (81)

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
BLUE VITRIOL (7758-99-8)	249.70 (174)	SOLUBLE (40)						
BOLERO (28249-77-6)	257.8 (169)	30 @20 (169)	1.48 X 10-6 (169)	1.7* (11) 3.42 (169)	2.3* (11)	5-7 IN RICE FIELD (183)	.5-1 IN RICE FIELD (184)	LOG BCF: 0.94* (15) HIGH TAILWATER RUNOFF POTENTIAL (DEPENDING ON) AGRICULTURAL PRACTICES. (169)
BROMACIL (314-40-9)	261.1 (1)	813 (33) 815* (5)	1.85 X 10-5* @20 (1)	2.61* (11) 1.33* (12,5)	2.80* (11) 2.10* (12,5) 1.2/2.1 (30)	42-180 (24)	6-26 (44) 21-26 (45) 3-14 (118)	LOG BCF: 1.66* (15) 0.65* (12)
BROMOXYNIL OCTANOATE (1689-99-2)	402 (17) 403 (1)	.201* (17) 130* (5)	5 X 10-7*(1)	5.77* (17) 5.88* (11,5)	4.47* (17) 4.58* (11,5)		2 IN HEAVY CLAY @25 (46)	LOG BCF: 4.15* (17) 4.25* (15)
CAPTAFOL (2425-06-1)	349.09 (174)	1.4* (5,33,47)	NEGLIGIBLE* (1)	2.47* (15) 3.02* (11) 4.4* (5)	2.72* (15) 3.02* (11) 2.72* (5)	1 (24)		LOG BCF: 1.55* (15) 1.99* (12)
CAPTAN (133-06-2)	300 (17) 300.6 (1)	5.98* (17) .499 (33) 3 (5) 3.3 (48) <0.5 (49)	7.38 X 10-6* @20 (1) 1 X 10-5 @25 (49) 6 X 10-5 @25 (50) <1 X 10-5 (48)	3.52* (17) 2.13* (11,15) 2.35* (50, 23,5)	3.25* (17) 2.54* (11,5) 2.66* (51)	<14 (24) 1* (5) 4 HRS. @ 20, pH 4, <2 MIN. @ pH 10, 170 MIN. IN RIVER (58)	<2 (31) 3-4 DAYS AT 100 PPM, >65 DAYS AT 1000 PPM (42) <2 (50) <3 (118)	LOG BCF: 2.38* (17) 1.28* (15) 1.46* (51) NEELY PARTITIONING: 0.0% IN AIR 57.45% IN WATER 22.01% IN GROUND 20.54% IN HYDROSOIL* (17)

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
CARBARYL (63-25-2)	201 (1,177)	7,290* (17) 39.8 @ 30 (33) 40* (10,5,8) 34 (52) 120 (48)	1.98* (17) 2.95 X 10-5* @20 (1) 1000 X 10-6 (10) <4 X 10-5 (48) 5 X 10-3 @26 (43)	1.82* (17) 2.37* (15, 11,5) 2.38* (12) 2.34 (53) 2.36 (54) 1.81 (55) 2.3 (57)	2.32* (17) 2.67* (5, 12,11) 2.65 (53) 2.66 (54) 2.3/1.8 (30)	8* (5) <14 (24) 3.2 HRS. @ pH 9, 1.3 DAYS @ pH 8, 13 DAYS @ pH 7, 4.4 MONTHS @pH 6, 3.6 YEARS @ pH 5 (58) 52-200 DAYS IN RIVER (58) 2.2 HRS. (87) <7 (26)	45-180 (31) 8 (41) 21 (56) 3-14 (118)	NEELY PARTITIONING: 1.22% IN AIR 97.34% IN WATER 0.74% IN GROUND 0.69% IN HYDROSOIL* (17) LOG BCF: 1.03* (17) 1.47* (15) 1.48* (12) 1.45 (53) 1.46 (54)
CARBOFURAN (1563-66-2)	221 (17)	175* (17) 698 @30 (57) 700* (5,10)	0.20* (17) 9.3 X 10-6 @20 (1) 20 X 10-6 (10)	2.3* (17) 2.55* (15,11) 2.26* (12) 2.4* (5)	2.58* (17) 2.76* (11,5) 2.61* (12)	8* (5) 42-180 (24)	4-8 (80) 6-26 (31) 6-16 (41) 3-14 (118)	NEELY PARTITIONING: 4.77% AIR 91.16% IN WATER 2.1% IN GROUND 1.96% IN HYDROSOIL* (17)
CARBON DISULFIDE (75-15-0)	76.1 (17, 1)	385,000*(17) 1685 (59) 220 (60) 2200 (61)	356* (17) 2.64 X 10 2* @20 (1) 357.1 (60) 400 (62)	2.16 (6) 1.93 (64) 1.84 (6) 1.94* (12)	1.33* (17) 2.55 (6) 2.43* (64,12) 2.38 (6)			NEELY PARTITIONING: 4.08% IN AIR 95.9% IN WATER 0.01% IN GROUND

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
CARBON DISULFIDE, CON'T.								0.01% IN HYDROSOIL* (17) DOES NOT ACCUMULATE IN SOIL UNDER MOST CONDITIONS. (60)
CARBON TETRACHLORIDE	153 (17) 153.8 (1)	367* (17) 800* (5)	110* (17) 84.5* @20 (1) 100 (65)	2.87* (17) 2.6* (5) 2.83/2.66 (23)	2.89* (17)	1* (5)		NEELY PARTITIONING: 92.23% IN AIR 6.67% IN WATER 0.57% IN GROUND 0.53% IN HYDROSOIL* (17)
2-CHLORO-N-(2-ETHYL-6-METHYLPHENYL)-n-(2 METHYLPHENYL)-N-(2-METH	N/A							
CHLORDANE (57-74-9)	409.8 (1)	12000* (5)	7.38 X 10-6 @20 (1)	5.94* (11,5) 6.00 (29) 5.06* (12) 5.34* (21) 2.78 (66)	4.61* (11,5) 4.64 (29) 4.13* (12) 4.28* (21) 2.89 (66)	42-180 (24)	>26 (31) >416 (67) >52 (68) 3-14 (118)	LOG BCF: 4.29* (15) 4.34 (29) 4.13* (12) 4.28* (21) 2.89 (66) NO LEACHING - HIGH ACCUMULATION POTENTIAL. (68) 35% RECOVERED FROM RIVER WATER AFTER 8 WEEKS. (26)
CHLOROPICRIN (76-06-2)	164 (17) 164.4 (1)	12.1* (17) 1615 @25 (69) 2000 (5,70)	24* (17) 1.83 X 10 @20 (1,70) 40 @33.8 (71)	1.59* (17) 0.45* (11) 2.44 (6) 2.32 (64)	2.20* (17) 1.62* (11) 2.70 (6) 2.64 (64)		<2 (31) PERSIST.: 1-3 (56)	LOG BCF: 0.86* (17) -0.04* (15) 1.52 (6) 1.45 (64)

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
CHLOROPICRIN,CON'T.					2.6* (5)			NEELY PARTITIONING: 8.28% IN AIR 90.93% IN WATER 0.41% IN GROUND 0.38% IN HYDROSOIL (17)*
CHLOROTHALONIL (1897-45-6)	265.9 (5, 17, 48)	0.421* (17) 0.598 @25 (33) 0.6 (5,48)	3.17 X 10-3* @20 (1) 0.01 @40 (48)	3.86* (17,11) 3.83* (12) 4.7* (5)	3.43* (17) 3.48* (12) 3.46* (5)	7* (5)		NEELY PARTITIONING: 0.00% IN AIR 38.16% IN WATER 31.99% IN GROUND 29.85% IN HYDROSOIL (17)* LOG BCF: 2.64* (17) 2.65* (11) 2.63* (12)
CHLORPHYRIFOS (5598-13-0)	257.4 (1) 350.5 (73)	19.9 (69) 0.3* (5) 0.4 (73) 2 (74)	1.38 X 10-5* @20 (1) 1.87 X 10-5 @25 (73,74)	5.11* (15) 4.82 (29,75) 4.81 (75) 3.06* (12,5) 5.11* (11)	4.16* (11) 4.00 (29,75) 3.04* (12,5) 4.13 (13)	<14 (24) >100 (76) 30* (5) 120 @ 20, pH 6.1, 53 @ 20, pH 7.4 (78)	2-6 (31) PERSIST.: 9-52 (72) 2-4 (77)	LOG BCF: 3.64* (15) 3.41 (29) 3.40 (75) 2.03* (12)
COPPER (7440-50-8)		INSOLUBLE (79)						
COPPER HYDROXIDE (20427-59-2)	97.56 (174)	INSOLUBLE (79)						

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
COPPER OXYCHLORIDE	N/A							
SULFATE								
COPPER-ZINC SULFATE	N/A							
COMPLEX								
COPPER SULFATE (BASIC)		143,000 (79)						
CYHEXATIN	385.16	<1 (48,57)	NEGLIGIBLE				8-26 (80)	NO LEACHING. RUNOFF
(13121-70-5)	(175)		@20 (1,48)					UNLIKELY. (80)
								SOME CARRY OVER OF SOIL
								RESIDUES. SURFACE RUNOFF
								UNLIKELY EXCEPT VIA
								ADSORBED PARTICLES. (80)
2,4-D	220 (17)	81.70* (17)	1.71* (17)	2.68* (17)	2.79* (17)	<14 (180)	.5 (107)	NEELY PARTITIONING:
(94-75-7)	221.1 (1)	3988 (81)	6.1 x 10-5*	2.98* (11)	3.00* (11)		<1 (173)	46.58% IN AIR
		519 (28)	@25* (1)	2.81* (12,21	2.91* (12)		<3 (118)	48.25% IN WATER
		600 @ 20		2.74* (12,21	2.87* (12)			2.67 % IN GROUND
		540 @ 20		3.11 (82)	3.07 (82)			2.49% IN HYDROSOIL (17)*
		900 @25			1.3 (13)			LOG BCF: 1.71* (17)
		(169)			0.7-1.3 (30)			1.95* (15)
								2.06 (82)
								1.76* (12)
								1.82* (12)
								RUNOFF LOSS AVERAGES 4.1%
								OF THE AMOUNT APPLIED. (89)

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
2,4-D, ALKONALAMINE SALTS		10,000* (5)		1.5* (5)		30 (5)		
2,4-D, BUTOXYETHANOL ESTER	321.1 (1)	INSOLUBLE (25)	1.7 X 10-3 @25 (170) 4.5 X 10-6 @25 (1,170)	5.14* (11,5)	4.17* (11,5)	12* (58) 14 (58)		LOG BCF: 0.84-1.70 (168) 1.39 (168) 2.26 (168)
2,4-D, DIMETHYLAMINE SALTS		100,000* (5)	NEGLIGIBLE* @38 (1)	0.36* (12) 2.74* (12)	1.57* (12)	30* (5)		LOG BCF: -0.12* (12) 1.76* (12)
2,4-D, N-OLEYL-1,3-PROPYLENEDIAMINE SALT	766.6 (25)	INSOLUBLE (25)						
2,4-D, PROPYLENEGLYCOL BUTYLETHER ESTER	344.0 (1)		8.46 X 10-6* @24.8 (1) 3 X 10-6 @25 (169)	5.43* (11)	4.33* (11)			LOG BCF: 3.89* (15)
D-D MIXTURE	112 (1)	2795 (16) 2700* (5) 2000 (48)	35 @20 (1,48)	1.9* (5) 1.98 (18)		70* (5)		DOES NOT ACCUMULATE IN SOIL. (83)
1,2-DICHLOROPROPANE	112.9 (18)	2700 (18)	42 @ 20 (18)	2.28 (18)			2-12 (22)	
1,3-DICHLOROPROPENE	110.9 (18)	2700 (18)	25 @ 20 (18)	1.98 (18)			3 (23) .5-3 (22)	

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
DACTHAL (1861-32-1)	331.99 (123)	0.5 @25 (123)	<0.5 @ 40 (123)	4.95* (21)			13 (171,172) 100 (25)	NO DEGREDATION IN STERILE SOILS. (171) DOES NOT LEACH IN ANY SOILS MICROBIAL BREAKDOWN IS PRIMARY FACTOR IN DISAPPEARANCE. (25)
DIAZINON (333-4-5)	304 (17) 304.3 (1)	79.9* (17) 40* (5) 39.9 @20 (57) 40.5 (52)	4.1 X 10-4* @20 (1)	3.70* (17) 3.22* (11) 1.95* (21) 1.92* (12,21) 4.22* (15) 1.9* (5) 3.14 (52)	3.34* (17) 3.13* (11) 2.44* (21) 2.42* (12)	70* (5) 14-45 (24) 37 HRS. @ 70, pH 6 (58)	4-6 (80) 14-45 (14) PERSIST.: 1.5 (56) 2-4 (77) 3-14 (118)	LOG BCF: 2.52* (17) 2.93* (15) 1.14* (21) 1.12* (12) 2.18 (52) 2.18 (52)
DICAMBA, DIMETHYL-AMINE SALT (1918-00-9)	149 (1)	4,500 (19)	3.4 X 10-5* @25 (1,19)				3.5 (107)	PROBABLY WILL NOT PERSIST MONTHS IN SOIL. (19)
DIELDRIN (60-57-1)	380.9 (85)	.185 @25 (33) .25 (28) .468 (52) .185/.155/ (28)	5.4 X 10-6 @25 (86)	3.28* (15) 5.48 (87) 6.2 (137) 4.56* (21) 4.08* (21) 3.91* (12) 4.41* (12) 4.32 (52)	3.16* (15) 4.36 (87) 3.78* (12) 3.86* (21) 3.60* (21) 3.50* (12)	>180 (24)	>150 (85) >26 (31) 55-75 (41) 350 (67) 3-14 (118)	LOG BCF: 2.19* (15) 3.93 (29) 3.20 (21) 2.82 (21) 2.69* (12) 3.08* (12)
DIFENZOQUAT (43222-48-6)	360.44 (88)	760,000 (48,88)	1 X 10-7 (88)	0.82* (11)	0.93* (11)			LOG BCF: -1.05* (15) STRONGLY ADSORBED TO SOIL

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
DIFENZOQUAT, CON'T.								PARTICLES, NOT LEACHED, NOT CARRIED IN RUNOFF.(25)
DIMETHOATE (60-51-5)	229 (17, 1,5)	92,400* (17) 25,000* (33,5)	6.27 X 10-6* (1)	0.95* (17) -3.2* (11) 0.5* (90,21) -0.29* (91,5) 1.5 (137)	1.85* (17) -0.36* (11) 1.65 (90) 1.22* (91,5)	56* (5) 45-180 (24) 56 (26)	<2 (31) .5 IN SANDY LOAM (92) PERSIST.: 3-4 (56)	LOG BCF: 0.35* (17) -2.93* (11) -0.01 (90) -0.63 (91)
DIQUAT DIBROMIDE (85-00-7)		SOLUBLE*(1)	1 X 10-7* @20 (1)	-4.52* (15) -3.25* (12) -3.55* (94)	-1.08* (15) -0.93* (12) -0.55 (94)	<14 (24)	1.5 (95)	LOG BCF: -3.97* (15) 2.97* (12) 3.20 (94)
DIURON (330-54-1)	233 (17) 233.1 (1)	32.1* (17) 41.9 (97) 37.3 (28) 42* (5)	0.00* (17) 1.49 X 10-7* @20 (1)	2.90* (17) 2.39* (11) 2.77* (96,5)	2.91* (17) 2.68* (11,5) 2.88 (96) 2.50* (13)	60* (5) 45-180 (24) (24)	6-26 (31)	NEELY PARTITIONING: 0.89% IN AIR 84.16% IN WATER 7.74% IN GROUND 7.22% IN HYDROSOIL* (17)
DNBP (88-85-7)	240 (17)	26.9* (17) 50* (5) 0.0052g/ 100 ML (25)	2.2 X 10-3* (1) 1 @ 151, 760 @ 332 (25)	4.02* (17) 3.35* (15) 3.66* (12)	3.2* (11,5) 3.37* (12)	14-45 (24)	2-6 (31) PERSIST.: 2-4 (25)	LOG BCF: 2.77* (17) 2.25* (15) 2.49* (12) NOT TIGHTLY ADSORBED BY SOILS. CAN LEACH WITH RAINFALL. MICROBIAL BREAKDOWN IS COMMON. (25)
DNBP, AMINE SALTS (88-85-7)	N/A							

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
DICOFOL (115-32-2)	370.5 (1)	0.3 (98)	5.7 X 10-7* @25 (1)	4.98* (11)	4.09* (11)	3 MIN. @ @ PH10.2 2 60 MIN. @ PH 8.2 2 (98)	>5 YEARS (98)	LOG BCF: 3.53* (15)
DISULFOTON (298-04-4)	274.4 (1)	24.9 (33) 25* (5)	1.8 X 10-4* (1)	1.69* (11) 1.93* (99,5)	2.3* (11) 2.43* (99,5)	70* (5) 23 @40 (101) 320 @ 20 (101)	6-14 (80,101) 2-6 (102)	LOG BCF: 0.94 (15) 1.12 (99) ADSORPTION ON WET SOIL IS ONLY TEMPORARY - DRY SOIL WOULD BIND TIGHTER. (103)
DIPHENAMID (957-51-7)	293.3 (1)	259 (33) 260 (93)	3.69 X 10-7* @20 (1)	2.53*(11) 2.29* (21) 2.17* (12)	2.75* (11) 2.62* (21) 2.56* (12)	6-26 (24)	6-26 (31) PERSIST.: 12-26 (123) 26-34 (56)	DECOMPOSES SLOWLY IN SOIL. (93)
ENDOSULFAN (115-29-7)	407 (1)	0.1* (5) 0.06-0.26 (43,136)	`1 X 10-5 @25 (105) 7.38 X 10-6* @20 (1) 9 X 10-3 @80 (136)	3.55 (82) 5.2* (5)	3.31 (82)	14* (5) 35 @ PH 7; 150 @PH 5.5 (106) <14 (24) 3-4 (136) <7 (26)	8, WHEN SOIL INCORPORATED. (104,106,107) 32 (36) 1 (150)	STABLE TO SUNLIGHT. (136) HALF LIFE IS MONTHS ANAEROBICALLY, 1 WEEK AEROBICALLY. MAJOR RUNOFF CONTRIBUTION IS DUE TO SEDIMENT. (136)
ETHION	384.48	1.99 (16)	1.5 X 10-6	2.91* (15)	2.96* (15)	45-180		LOG BCF: 1.90* (15)

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS).	ENVIRONMENTAL FATE
ETHION, CON'T. (563-12-2)	(108)	2.0* (5, 108,109)	@25 (108)	0.91* (12, 5,21)	1.87* (12) 4.19* (13)	(24) 28-56 IN RIVER WATER (109) 28* (5)		0.32* (12)
ETHEPHON	144 (17)	13700* (17)	NEGLIGIBLE* @20 (1)	1.11* (17)	1.94* (17)		3.3 DAYS IN CLAY, 4.9 DAYS IN LOAM, 9.7 DAYS IN SAND (110)	LOG BCF: 0.48* (17)
ETHYLENE DIBROMIDE (106-93-4)	187 (17) 187.9 (1)	9.37* (17) 4281 @ 30 (33)	7.79* (17) 17.4 @ 30 (111,113) 11 @25 (112)	1.73* (17) 1.79* (11) 1.76* (12)	2.27* (17) 2.35* (11) 2.33* (12) 1.64* (13)	10* (5) 273 YRS. @ PH 10, 273,000 YRS. @ PH 7 (114)	25 @ PH 5.8 IN LOAMY SAND (115)	LOG BCF: 0 97* (17) 1.01* (15) 0.99* (12) PHOTOLYSIS T 1/2 = 380 DAYS. HYDROLYSIS T 1/2 = 16 YRS. (116)
FENSULFOTHION (115-90-2)	308.3 (155)	1535 @25 (33) 1600 (155) 1540 @25 (48)	NEGLIGIBLE @20 (1)	2.88* (11) 0.87* (12)	2.94* (11) 1.85* (12)	45-180 (24) 112 (156)	2-6 (77) 7-130, VARYING W/ CONC. (157) PERSIST.: 15 (31)	RUNOFF WATER CONTAINS HIGH CONCENTRATIONS OF FENSULFOTHION. (157)
GLYPHOSATE, ISOPROPYLAMINE SALT (1071-83-6)	169.1 (139)	1000-2000 @25 (139)	NEGLIGIBLE @20 (1,139)	-2.77 @20PPM -3.22 @ 100 PPM (139)		<60 (139)	2 (FOREST), 19 (SAND) (139)	NO EVIDENCE OF PHOTO-CHEMICAL DEGREDATION OR VOLATILIZATION. MICROBIAL

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
GLYPHOSATE, CON'T.								DEGREDATION IS MAJOR ROUTE OF LOSS. (139)
HEXAZINONE (51235-04-2)	252 (17)	1.82* (17) 3.3g/100g @ 25 (25)	6.4 X 10-5 @86 2 X 10-7 @ 25 (25)	4.33* (17)	3.69* (17)		16-20 IN LAB. 4 -24 IN FIELD (25)	NEELY PARTITIONING: 0.00% IN AIR 17.29% IN WATER 42.78% IN GROUND 39.93% IN HYDROSOIL* (17) LOG BCF: 3.02* (17)
IMIDAN (732-11-6)	317.3 (1)	24.9 @ 25 (57) 25* (5)	1.9 X 10-4* @20 (1)	-0.89* (11) 2.83* (5, 129) 1.4* (7)	0.89* (11) 2.92* (5,12 9) 2.13* (7)	30* (5)	.5 - 3 IN SANDY LOAM (159)	LOG BCF: -1.10* (11) 0.71 (7) 1.84 (129)
IPC (122-42-9)	179 (17) 179.2 (1)	729* (17) 250 (25)	2.77* (17) 1.17 X 10-6* @20 (1)	2.59* (17) 2.83* (11) 1.04* (15)	2.74* (17) 2.92* (11)	<14 (24)	<2 (31)	NEELY PARTITIONING: 13.89% IN AIR 79.22% IN WATER 3.57% IN GROUND 3.3% IN HYDROSOIL* (17)
MALATHION	330.4 (1)	145* (5,72)	1 X 10-4* @20 (1) 4 X 10-5 (72)	2.16* (11) 1.85* (12) 2.62* (12) 2.89 (129)	2.55* (11) 2.38* (12) 2.80* (12) 2.90 (129)	14 (24) 16 HRS. (63) 22 HRS. (58)	.75 DAY (44) <2 (31) PERSIST.: 2 DAYS (45) 1 WEEK (69)	LOG BCF: 1.31* (11) 1.06* (12) 1.67* (12) 1.88 (129) 85% GONE AFTER 3 DAYS.

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
MALATHION, CON'T.						<7 (26)	<3 (118)	(32) 75% LOST AFTER ONE WEEK. (26)
MANEB (12427-38-2)	265.3 (154)	SLIGHTLY SOLUBLE (33,154)	NEGLIGIBLE* @20 (1, 154)					
MANEB, WITH ZN ION (8018-01-7)		SLIGHTLY (33)	NEGLIGIBLE* @20 (1)					
MCPA, DIMETHYLAMINE SALT (94-74-6)	200 (17)	800* (5) 74.30* (17) SOLUBLE (25)	0.12* (17)	2.82* (17) 2* (5)	2.87* (17)	30* (5)	PERSIST.: UP TO 1 MONTH IN MOIST SOILS UP TO 6 MONTHS IN DRIER CLIMATE (25)	LOG BCF: 1.82* (17) NEELY PARTITIONING: 6.1% IN AIR 81.81% IN WATER 6.25% IN GROUND 5.84% IN HYDROSOIL (17)*
MCPA, SODIUM SALT (3653-48-3)	288.7 (11)	SOLUBLE (25)	6.1 X 10-5* @25 (11)	0.33* (11)	1.56* (11)	14-45 (24)	2-6 (31) .5-1 IN FLOODED SOIL, .5 IN UPLAND SOIL (153) PERSIST: <4 IN MOIST SOIL, <26 IN DRY SOIL (25)	LOG BCF: -0.14* (15)
META-SYSTOX (8022-00-2)	246* (1)	3327 (3)	4.7 X 10-6*(1)	-0.39* (11)	1.16* (11)	40 (101)	<4 (101)	LOG BCF: -0.71* (15)

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
METHAMIDOPHOS (10265-92-6)	141.1* (1) 141* (17)	4,777,000* (17) 90,000 (5, 3) 71,000,000 (151)	3 X 10-4* @ 30 (1) 1 X 10-4 @20 (3)	-0.66* (12) -0.87* (17) 0.8* (5) -0.66 (151)	1.02* (12) 0.86* (17)	16 (101) 170* (5)	.5 (101)	LOG BCF: -0.92* (12)
METHIDATHION	302.3* (1)	239 @ 25 (33) <1000 (148)	2.3 X 10-6* (1)	-2.81* (11) -3.12* (5)	-0.15* (11) -0.32* (5)	30* (5) 30 (148)	1-3 (148) 3-16 (149)	
METHOMYL	162* (17) 162.1* (1)	489* (17) 58,000 @25 (5, 57) 24 @25 (43)	2.91* (17) 3.69 X 10-5* @20 (1) 1.6 X 10-4 @40 (181) 5 X 10-5 @25 (182,43)	2.38* (17) -3.24* (11) 0.48* (5,35)	2.63* (17) -0.38* (11) 1.64 (35) 2.20 (13)	30* (5)	<4-6 (41) <0.5 (78) .5-2 (9)	NEELY PARTITIONING: 20.67% IN AIR 75.29% IN WATER 2.09% IN GROUND 1.95% IN HYDROSOIL (17) ONLY 1.8% OF APPLIED METHOMYL REMAINED AFTER 1 MONTH. 70.7% WAS LOST VIA VOLATILIZATION. (160)
METHOXYCHLOR (72-43-5)	345.7 (1)	0.98 @ 25 (18) 0.10 (28, 147)	5 X 10-7* @20 (1)	5.33* (11, 144,12,21) 4.3* (146,21) 3.31 (145)	4.28* (11) 3.72 (146) 3.18 (145)	14-42 (24)	>26 (31) 1-1.5 (41)	OVER 14 MONTHS, 0.004% OF THE PESTICIDE APPLIED IS FOUND IN RUNOFF. (158)
METHYL BROMIDE (74-83-9)	94.9 (1)	27,600* (17) 13,200 @ @25 (59)	1630* (17) 1.38 X 10 3* @20 (1)	1.07* (17) 1.09* (11) 1.19 (142)	1.91* (17) 1.97* (11) 2.02 (142)	30* (5)	<2 (31)	NEELY PARTITIONING: 73.09% IN AIR 26.84% IN WATER

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
METHYL BROMIDE, CON'T.		13,400* (5) 3,400 @ 25 (143) 13,900 @ 450 MM HG, 17,000 @ 700 MM HG, 20,500 @ 650 MM HG (28) 13,000 @25 (43)	1420 @20 (43)					0.04% IN GROUND 0.03% IN HYDROSOIL (17)* LOG BCF: 0.44* (17) 0.46* (15) 0.54 (142)
METHYL-2-(4-2,4-DI-CHLOROPHENOXY)PHENOXY) PROPANOATE (51338-27-3)	341 (140)	50,000 (139) 3000 @22 (140)	2.58 X 10-5 TORR @20 (140)					<14% OF APPLIED HERBICIDE RECOVERED AT END OF GROWING SEASON. (141)
METHYL PARATHION (298-00-0)	263.2 (1)	55 @ 25 (33) 57* (5) 25 @20 (161) 50 @25 (162,43) 55-60 @25 (163) 50 (176)	9.7 X 10-6* @20 (1, 43) 0.5 @ 109 (163) <20 @30 (162) 9.1 X 10-3 (176)	3.72* (15) 2.04* (21,5)	3.4* (11) 2.49* (21,5) 3.99 (13)	<14 (24) 14* (5) <7 (26)	2-6 (31) .5-1.5 (41) 2.74 DAYS (152) <3 (118)	LOG BCF: 2.54* (11) 1.21* (21) ONLY 25% OF SAMPLE RECOVERED AFTER 1 WEEK. (26)
MEVINPHOS	224.1 (1)	MISCIBLE	2.18 X 10-4*	-0.17* (11)	1.28* (11)		SAND:12 HRS.	

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
MEVINPHOS, CON'T.		(57,138)	@20 (1) 2.9 X 10-3 @70 (138)				CLAY: 3 HRS. MUCK: 9 HRS. PEAT:12 HRS. PEAT/SAND: 3 HRS. (144)	
MINERAL OIL (8012-95-1)	327 (1)		7.4 X 10-6* @20 (1)					
MOLINATE (2212-67-1)	187 (17) 187.3 (123, 169)	2.70* (17) 880 (52) 800 (123, 5,169)	5.6 X 10-3 @25 (123, 169)	4.58* (17) 3.3* (5) 3.21 (52) 3.2 (169)	3.82* (17) 3.5* (5)	14* (3) 5.4 IN FLOODED FIELD (169)	3 IN LOAM @ 70-80 (25)	NEELY PARTITIONING: 0.23% IN AIR 10.5% IN WATER 46.17% IN GROUND 43.10% IN HYDROSOIL (17)*
NALED (300-76-5)	380.8 (1) 381 (135)	ALMOST INSOLUBLE (157)	2 X 10-3* @20 (1) 2 X 10-4 @20 (135)	2.47* (15) 1.38 (99) 1.36* (12)	2.72* (15) 2.13 (99) 2.12* (12)	<14 (24)		LOG BCF: 1.55* (15) 0.69 (99) 0.67* (12)
NAPROMIDE	271.4 (1)	73 @ 20 (125)	2 X 10-6* @20 (1)	2.91* (15)	2.96* (15) 2.83* (13)		PERSIST.: >26 (133) @ 28, 8-13, VARYING W/ pH (134)	LOG BCF: 1.90* (15)
PARAQUAT DICHLORIDE (1910-42-5)	357.2 (1)	1,000,000* (5)	1 X 10-7* @20 (1)	-6.96* (11) -8.29* (6, 5,21)	-2.41* (11) -3.13* (6,5) 4.19* (13)	30* (5)	3-14 (118)	LOG BCF: -5.90* (15) -6.95 (6) WHEN BOUND TO SOIL,

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
PARAQUAT, CON'T.					4.7/4.8 (30)			IS VERY PERSISTENT. (25)
PARATHION	291.3 (1)	23.9 @25 (33) 24 (5,175) 9 (161) 24 @ 25 (43)	3.78 X 10-5* (1)	4.2* (11) 2.15 (164) 3.83 (36) 3.81* (5) 3.1 (137) 3.8 (175)	3.66* (11) 2.55 (164) 3.46 (36) 3.68* (11)	<14 (24) 14* (5) 170 @ 20, pH 6.1, 130 @ pH 7.4 (78) 65 HRS. @ pH 7.5-8.0 (58)	2-6 (31) PERSIST.: 2-4 (77) 2.92 DAYS (152) 3-14 (118)	STRONG BINDING ON ORGANIC SURFACES. (179) RUNOFF CONTAMINATION IS COMMON, BUT WATER HALF-LIFE IS SHORT SO AQUEOUS ENVIRONMENT ISN'T AT RISK. (165)
PETROLEUM DISTILLATES (8002-05-9)	N/A							
PETROLEUM HYDROCARBONS	N/A							
PETROLEUM OIL, PARAFFIN BASED	N/A							
PETROLEUM OIL, UNCLASSIFIED	N/A							
PHOSALONE (2310-17-0)	367.82 (128)	9.98 (33) 0* (5) 10 (128)	0.02 MG/M3 @40 (128)	3.33* (11) 4.30* (7, 129,5)	3.19* (11) 3.72* (7, 129,5)	7* (5) 9 @pH 9 STABLE @pH 5-7 (131)	1 (128) .5-1 (132) 1-2 (131)	PHOSALONE "NEARLY IMMOBILE IN FOUR SOILS" (3)

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
PHOSPHAMIDON (13171-21-6)	299.7 (1) 299.5 (124)	SOLUBLE (125)	2.5 X 10-5* @20 (1,124) 8.4 X 10-5 @30 (124)	0.09* (11) -0.09* (15)	1.33* (11)	<14 (24)	2-4 (126)	HALF LIFE IN SOIL "JUST A FEW DAYS." (127) LOG BCF: -0.47* (15)
POLY-1-PARA-MENTHENE	N/A							
PROPANIL 707-98-8	218 (1,123)	225* (57,5) 500 (123)	1.06 X 10-5 (1)	3.12* (11, 12,21)	3.07* (11, 12,5)	30* (5)	PERSIST.: 1-3 DAYS (123)	>95% DISSIPATED WITHIN 7 DAYS AT 20. (123)
PROPARGITE (2312-35-8)	350.5 (1)	10* (5)	7.38 X 10-8 @20 (1)	2.55* (11) 3.8* (5)	2.76* (11,5)	14* (5)		LOG BCF: 1.61* (15)
SILVEX, PROPYLENE		SLIGHTLY	LOW (25)				2.5 (107)	
SIMAZINE (122-34-9)	201.0 (177)	19.6* (17) 5 (10,16,5 2 @ 0, 3.5 @20, 84 @ 85 (25) 15.1 @26 (28) 5 @ pH7 (28) 2 (166) 84 @85 (3)	NEGLIGIBLE @20* (1) 9.2 X 10-10 @20, 3.6 X 10-8 @ 30, 9.0 X 10-7 @ 50 (25) 6 X 10-9 @20 (10,139 3.6 X 10-8 @30 (3)	4.07/0.21 (21,64) 2.51* (17) 2.18 (7,167) 1.94 (7) 0.21 (144) 2.17 (35)	2.70* (17) 2.56 (7) 2.43 (7) 3.59 (64) 1.49 (144) 4.7/4.8 (30)	30 (25)	3-14 (118) 5 @ 25 (177)	CAN BE WASHED LATERALLY WITH SOIL PARTICLES. LEACHING IS LIMITED BY ITS WATER SOLUBILITY. MICROBIAL BREAKDOWN IS SIGNIFICANT. (130)

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
SODIUM CHLORATE (7775-09-9)	106.44 (174)	500,000 (16) 790,000 @0 (16)						
SODIUM METABORATE (7775-19-1)		730,000 (16)						
SULFUR (7704-34-9)	32.06 (174)	INSOLUBLE (16)	1 @ 183.8 (174)					
TOXAPHENE (8001-35-2)	413.8 (1)	2.99* @20 (12) 3 (5,119, 120) 0.5 @25 (43)	2.21 X 10-1* (1) 0.17-0.40 @25 (119) 10-6 @25 (120) 0.2-0.4 @ 25 (100)	6.82* (15) 3.33 (18) 6.44* (12) 4* (5)	4.88* (12) 3.19* (18, 5)	3600* (5) 30-180 (24)	52 (121) 520 (121) 572 (122) >26 (31) 572 (67)	LOG BCF: 4.99* (15) 2.2 (18) 4.69* (12) VOLATILIZATION IS MAJOR LOSS MECHANISM. VOLATILIZATION STOPS IF SOIL IS DRY. (120)
VINYL POLYMER	N/A							
XYLENE	106.2 (1,117)	130 @ 25 (59) 198* (5) INSOLUBLE (100)	6.0* @ 20 (1,18) 10 @ 30 (117) 7-9 @ 25 (100)	3.43* (11) 3.33 (35) 2.7* (5)	3.24* (11) 3.33 (35) 3.24* (5)	1* (5)		PARTITIONING: 99.1% IN AIR 0.7% IN WATER <0.1% IN SOIL <0.1% IN SEDIMENT <0.1% IN FISH DOES NOT BIODEGRADE* (17)

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

TABLE C-2, continued.

CHEMICAL CAS NUMBER	MOLECULAR WEIGHT	WATER SOLUBILITY (PPM)	VAPOR PRESSURE (MM HG)	LOG Kow	LOG Koc	HYDROLYSIS T 1/2 (DAYS)	SOIL T 1/2 (WEEKS)	ENVIRONMENTAL FATE
XYLENE RANGE AROMATICS								
ZIRAM (137-30-4)	305.82 (174)	65* (5)	NEGLIGIBLE* (1)	3.1* (5)		90* (5)		

*DENOTES CALCULATED (VERSUS MEASURED) VALUES.

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APPENDIX C-3

TABLE C-3

HIGH USE MATERIALS REPORTED IN PURS WITH INSUFFICIENT CHEMICAL PROPERTY DATA. CHEMICALS USED DURING MAY-OCTOBER, BUT LACK Kow OR SOIL T 1/2 DATA

CHEMICAL	SOIL T 1/2 (DAYS)	LOG Kow	TOTAL POUNDS APPLIED IN 1982
ACEPHATE	-	-2.04	17838
ANTOR	-	-	6371
ALUMINUM PHOSPHIDE	-	-	6111
AROMATIC PET. SOLVENT	-	-	154256
AROMATIC PET. DISTILLATES	-	-	8434
CAPTAFOL	-	3.95 *	90183
CARBON DISULFIDE	-	2.00	6029
2-CHLORO-N-(2-ETHYL-6-METHYLPHENYL) -n-(2-METHYLPHENYL)-N-(2-METHYL)	-	-	6266
CHLOROTHANONIL	-	4.34 *	46434
CYHEXATIN	119	-	4334
2,4-D,N-OLEYL-1,3-PROPYLENE-DIAMINE SALT	-	-	N/A
D-D MIXTURE	-	1.98	700573
DICAMBA, DIMETHYLAMINE SALT	24.5	-	6707
DNBP, AMINE SALTS	-	-	2492
ETHION	-	2.61 *	4798
MANEB	-	-	26010
MANEB, WITH ZINC ION	-	-	53593
NALED	-	1.38	4832
PETROLEUM DISTILLATES	-	-	181260
PETROLEUM HYDROCARBONS	-	-	88995
POLY-1-PARA-MENTHENE	-	-	4152
PROPARGITE	-	3.52 *	106414
SILVEX, PROPYLENE GLYCOL BUTYL ETHER ESTER	17.5	-	39747
SULFUR	-	-	2160686
VINYL POLYMER	-	-	3991
XYLENE	-	3.33	158865
XYLENE RANGE AROMATIC SOLVENTS	-	-	94546

* Calculated (as opposed to measured) values.

APPENDIX C-4

TABLE C-4

SUMMARY OF MOLINATE AND THIOBENCARB CONCENTRATIONS IN AGRICULTURAL DRAIN EFFLUENT DISCHARGING TO THE SACRAMENTO RIVER.

MOLINATE

AGRICULTURAL DRAIN (1)	YEAR	SURVEILLANCE PERIOD	OBSERVATIONS (n) (2)	CONCENTRATION RANGE (ppb)	DURATION OF DETECTION	REFERENCE(6)
Colusa Basin Drain	1987	4/29-6/29	15	<1.0-43	59 days (5/1-6/29)	j
	1986	5/27	1	<5.0	ND (3)	i
	1985	4/26-6/26	15	0-95	57 days (5/1-6/26)	h
	1984	4/25-6/27	14	.8-120	56 days (5/2-6/27)	g
	1983	4/27-7/11	17	<1-211	54 days (5/18-7/11)	e
	1982	5/6-7/14	16	<1-204	47 days (5/21-7/7)	e
	1981	3/9-9/28	29	<1-310	77 days (4/27-7/13)	c
	1981	4/30-8/14	16	10-340	74 days (4/30-7/14)	b
	1980	2/19-12/15	25	<1.3-190	ND	c
	1980	6/10-9/8	8	<1-60	---	b
Reclamation Slough (4)	1986	6/5	1	7.8	1 day (6/5)	i
	1982	5/6-7/14	16	<1-82	47 days (5/21-7/7)	d
	1981	4/30-8/14	16	<1-187	75 days (4/30-7/14)	b
Sycamore Slough (RD108)	1986	5/28-6/5	2	1.7-13.0	8 days (5/28-6/5)	i
	1985	4/26-6/26	15	0-47	49 days (5/8-6/26)	h
	1983	6/7-6/21	3	11-60	---	f
	1982	5/6-7/14	16	<1-187	49 days (5/25-714)	d
Sacramento Slough	1987	4/29-6/29	15	<1.0-22	49 days (5/11-6/29)	j
	1986	5/27	1	4.7	1 day (5/27)	i
	1984	4/25-6/27	14	0-46	49 days (5/9-6/27)	h
	1983	4/27-7/11	17	<1-68	46 days (5/26-7/11)	d
Butte Slough	1987	4/29-6/29	15	<1.0-44	49 days (5/11-6/29)	j
	1986	5/29-6/12	3	34.0-38.0	14 days (5/29-6/12)	i
	1982	5/6-7/14	16	<1-187	47 days (5/21-7/7)	d
Natomas Drain (RD1000)	1985	4/26-6/26	15	0-8	41 days (5/16-6/26)	h
	1984	4/25-6/27	14	0-49	43 days (5/15-6/27)	g
	1983	6/7-6/21	3	14-90	ND	f
	1982	5/6-7/14	16	<1-141	47 days (5/21-7/7)	d
	1976	5/18-7/20	9	<20-210	42 days (5/25-7/6)	a
Liberty Cut (5)	1983	6/23	2	59,84	ND	f
Toe Drain (5)	1986	6/2	1	2.0	1 day (6/2)	i
	1983	6/17-6/23	4	98-57	ND	f
Sutter Bypass	1985	4/26-6/26	15	0-38	50 days (5/8-6/26)	h
	1984	4/25-6/27	14	0-42	49 days (5/9-6/26)	g

(1) Data selected from stations located near the outfall to the Sacramento River.

(2) (n) = number of days sampled.

(3) ND: Not determined due to insufficient data.

(4) Discharges to the Sacramento River via Sacramento Slough.

(5) Discharges to the Northern Delta at Prospect Slough.

THIOBENCARB

AGRICULTURAL DRAIN (1)	YEAR	SURVEILLANCE PERIOD	OBSERVATIONS	CONCENTRATION RANGE (ppb)	DURATION OF DETECTION	REFERENCE(6)
Colusa Basin Drain	1987	4/29-6/29	15	<0.5-3.7	18 days (5/21-6/8)	j
	1986	5/27	1	<1.0	ND (3)	i
	1985	4/26-6/26	15	0-19	49 days (5/8-6/26	h
	1984	4/25-6/27	14	0-7.5	36 days (5/15-6/20)	g
	1983	4/27-7/11	17	<.5-11.3	43 days (5/31-7/11)	e
	1982	5/6-7/14	16	<1-57	40 days (5/21-6/30)	d
	1981	4/30-8/14	16	<1-21	49 days (5/12-6/30)	b
Reclamation Slough (4)	1986	6/5	1	4.9	1 day (6/5)	i
	1982	5/6-7/14	16	<1-48	47 days (5/21-7/7)	d
	1981	4/30-8/14	16	<1-39	28 days (5/18-6/15)	b
Sycamore Slough (RD108)	1986	5/28-6/5	2	1.0-24.0	8 days (5/28-6/5)	i
	1985	4/26-6/26	15	0-53	30 days (5/13-6/26)	h
	1982	5/6-7/14	16	<1-110	40 days (5/21-6/30)	d
Sacramento Slough	1987	4/29-6/29	15	<0.5-0.6	1 day (6/4)	j
	1986	5/27	1	<1.0	ND	i
	1984	4/25-6/27	14	0-7.8	29 days (5/24-6/20)	g
	1983	4/27-7/11	17	<.5-4.9	38 days (6/3-7/11)	e
Butte Slough	1987	4/29-6/29	15	<0.5	ND	j
	1986	5/29-6/12	3	<0.5-1.0	1 day (6/5)	i
	1982	5/6-7/14	16	<1-10	39 days (5/25-6/30)	d
Natomas Drain (RD1000)	1985	4/26-6/26	15	0-8.9	30 days (5/27-6/26)	h
	1984	4/25-6/27	14	0-49	36 days (5/22-6/27)	g
	1983	6/7-6/21	3	2.3-14	ND	f
Liberty Cut (5)	1986	6/2	1	<0.5	ND	i
	1983	6/23	3	2.5,3	ND	f
Toe Drain (5)	1986	6/2	1	<0.5	ND	i
	1983	6/17-6/23	5	2.4-3	ND	f
Sutter Bypass	1985	4/26-6/26	15	0-4.4	23 days (5/20-6/12)	h
	1984	4/25-6/27	14	0-2.1	22 days (5/22-6/13)	g

(6) a = Van de Pol and Plescia, 1978
b = Finlayson et al, 1982
c = Tanji et al, 1982
d = Finlayson and Lew, 1983a
e = Finlayson and Lew, 1983b
f = Cornacchia and Schnagl, 1983
g = Finlayson and Lew, 1984
h = Finlayson and Lew, 1985
i = Calif. Dept. Food and Ag, 1986
j = Calif. Dept. Food and Ag, 1987

APPENDIX C-5

TABLE C-5

SUMMARY OF METHYL PARATHION, ETHYL PARATHION, AND MCPA CONCENTRATIONS
IN AGRICULTURAL DRIAN EFFLUENT DISCHARGING TO THE SACRAMENTO RIVER
1980 - 1982

Agricultural Drain	Year	Surveillance Period	No. of Observations	Methyl Parathion Concentration Range (ug/l)	Methyl Parathion Duration of Detection	Ethyl Parathion Concentration Range (ug/l)	Ethyl Parathion Duration of Detection	MCPA Concentration Range (ug/l)	MCPA Duration of Detection	Reference
Colusa Basin Drain	1980	2/19 - 12/15	13	ND	ND	<1 - .25	1 day (5/12)	<1 - <3	ND	Tanji
	1981	6/10 - 9/8	18	<.1 - 2.3	84 days (6/16-9/18)	<.1	ND	<3.0	ND	Finlayson et al
	1981	3/9 - 9/28	29	<.1 - 5	70 days (5/11-7/20)	<.1 - .34	1 day (5/18)	<.25 - 14	1 day (7/20)	Tanji
	1981	4/30 - 8/14	16	<1 - 3.7	21 days (5/12-6/2)	<1	ND	NA	NA	Finlayson et al
	1982	5/11 - 7/14	15	<1 - 6	18 days (5/21-6/8)	<1	ND	NA	NA	Stauffer
Natomas Drain	1982	5/11 - 7/14	15	<1 - 2	8 days (5/28-6/4)	<1 - 2	1 day (6/4)	NA	NA	Stauffer
Sutter Bypass	1982	5/11 - 7/14	15	<1 - 2	13 days (5/28-6/11)	<1 - 1	10 days (6/1-6/11)	NA	NA	Stauffer
Reclamation Sl.	1981	4/30 - 8/14	16	<1 - 1.1	1 day (5/12)	<1.0	ND	NA	NA	Finlayson et al
	1982	5/11 - 7/14	15	<1 - 2	18 days (5/28-6/15)	<1 - 2	14 days (6/1-6/15)	NA	NA	Stauffer
RD 108	1982	5/11 - 7/14	15	<1 - 6	11 days (5/21-6/1)	<1 - 2	1 day (6/1)	NA	NA	Stauffer
Butte Slough	1982	5/11 - 7/14	15	<1 - 1	11 days (5/28-6/8)	<1	ND	NA	NA	Stauffer

NA: Not Analyzed　　ND: Not Detected

APPENDIX C-6

TABLE C-6
MOLINATE AND THIOBENCARB RESIDUES IN FISH COLLECTED FROM THE SACRAMENTO VALLEY AGRICULTURAL DRAINS (1982 - 1985)
(Finlayson and Lew, 1982 - 1985).

					MOLINATE		THIOBENCARB	
					TISSUE (muscle)		TISSUE (muscle)	
Location and Species	Year	No. of Samples *	Fish Length (cm)	Fish Weight (g)	ng/gm	BCF	ng/gm	BCF
COLUSA BASIN DRAIN								
White catfish	May 1985	5 (6)	27-40	307-1114	130-200	2-3	120-3200	7-178
(ICTALURUS CATUS)	June 1984	6 (10)	31-39	356-1023	<100	NA	<100-120	up to 27
	June 1983	5 (15)	23-49	326-1070	600-1800	600-1800	500-3400	58-395
Channel catfish	June 1984	1 (1)	36	813	<100	NA	<100	NA
(ICTALURUS PUNCTATUS)	June 1983	2 (5)	34-44	391-543	1400-1600	13-14	2900-4600	375-535
	June 1982	1 (4)	15	116	410	2	1500	33
Largemouth bass (MICROPTERUS SALMOIDES)	June 1984	1 (1)	37	990	120	2	280	62
Common carp	June 1983	4 (4)	38-44	>1000-1150	570-810	NA	500-2600	NA
(CYPRINUS CARPIO)	June 1982	1 (2)	13	92	390	2	630	14
SUTTER BYPASS								
Largemouth bass	May 1985	1 (1)	28	454	70	2	130	42
(MICROPTERUS SALMOIDES)	June 1984	3 (8)	27-35	335-992	<100-280	up to 8	<100-130	up to 130
	June 1982	1 (1)	21	229	530	3	720	80
Black crappie	May 1985	2 (2)	16-21	110-158	<50-50	up to 2	50-90	16-29
(POMOXIS NIGROMACULATUS)	June 1984	1 (1)	32	530	<100	NA	<100	NA
	June 1982	1 (2)	17	162	1500	9	2600	289
Common carp (CYPRINUS CARPIO)	June 1982	1 (1)	32	680	NA	NA	2800	311
Channel Catfish (ICTALURUS PUNCTATUS)	June 1982	1 (1)	30	447	600	4	2300	256
RECLAMATION SLOUGH								
Common carp (CYPRINUS CARPIO)	June 1982	1 (2)	NA	NA	1400	24	1400	45

* Number of analyses with total fish analyzed in parentheses. All values are for fish collected alive.

APPENDIX C-7

TABLE C-7

MASS BALANCE OF THIOBENCARB EMISSIONS DISCHARGED TO THE SACRAMENTO RIVER, 1985.

DATE	RD 108 MEASURED (kg/day)	SACRAMENTO SL. MEASURED (kg/day)	COLUSA BASIN DR. MEASURED (kg/day)	TOTAL EMISSIONS (kg/day)	SACRAMENTO RIVER *		
					FLOW (cfs)	PREDICTED (kg/day)	MEASURED (kg/day)
MAY 7	0	0	2.6	3	9670	0.1	<1.0
MAY 12	0	0	16.6	17	10600	0.6	<1.0
MAY 15	4	0	25	29	11000	1.1	1.2
MAY 19	11.2	9.4	28.4	49	13000	1.5	1.0
MAY 22	11.3	19.7	25.8	57	11800	2	2.1
MAY 26	13.7	22.3	44.2	80	12800	2.6	1.7
MAY 29	13.8	26.2	54.4	94	14000	2.8	2.5
JUNE 2	9.4	30.7	66.6	107	14100	3.1	4.1
JUNE 5	2.3	15.8	30	48	12500	1.6	1.9
JUNE 9	1.6	10.5	10.3	22	10700	0.9	0.9
JUNE 12	1.8	5.6	5.1	13	10900	0.5	0.6
JUNE 19	0.9	1.5	2.7	5	10100	0.2	<1.0
JUNE 26	0	0	3.6	4	11100	0.1	<1.0

* CONCENTRATIONS MEASURED AT VILLAGE MARINA; FLOWS RECORDED AT VERONA (USGS STATION NUMBER 11425500).
"PREDICTED" CALCULATED BY SUMMING THE DRAIN EMISSIONS AND DIVIDING BY THE RIVER FLOW.

APPENDIX C-8

TABLE C-8

TOXIC SUBSTANCES MONITORING PROGRAM, 1977-1984

Organic Chemicals Below Detection Limits

Fish muscle, Sacramento River at Hood

CHEMICAL	DETECTION LIMIT, ppb	YEAR(S) ANALYZED	CHEMICAL	DETECTION LIMIT, ppb	YEAR(S) ANALYZED
Aldrin	5,5	1978, 1982	alpha-HCH	2,2	1983, 1984
Atrazine	20	1982	beta-HCH	10,10,10	1982, 1983, 1984
Benefin	5	1982	delta-HCH	2,2,5	1982, 1983, 1984
gamma-BHC	5	1982	gamma-HCH	2,2	1983, 1984
Carbaryl	3000	1982	Heptachlor	5	1982
Carbophenothion	20	1982	Heptachlor epoxide	5,5,5,5	1977, 1982, 1983, 1984
CDEC	5	1982	Hexachlorobenzene	2,2	1983, 1984
Chlorbenside	5,5,5	1982, 1983, 1984	Malathion	20	1982
alpha-Chlordene	5,5,5	1982, 1983, 1984	Methidathion	100	1982
gamma-Chlordane	5,5,5	1982, 1983, 1984	Methoxychlor	30	1982
trans-Chlordane	5,5	1983, 1984	Mirex	20	1982
oxy-Chlordane	5,5	1983, 1984	Nitrofen	10	1982
Chloroneb	30	1982	cis-Nonachlor	5,5,5	1982, 1983, 1984
Chlorpyrifos	5,10,10	1982, 1983, 1984	Omite	2000	1982
Dacthol	5,5,5	1982, 1983, 1984	ethyl-Parathion	5,10,10	1977, 1982, 1983
p,p-DDMS	30,30,30,30	1980, 1982, 1983,1984	methyl-Parathion	5,10,10	1977, 1982, 1983
o,p-DDD	10,10,10	1980, 1983, 1984	1242 PCB	50,50,50	1982, 1983, 1984
o,p-DDE	10,10,10	1980, 1983, 1984	1248 PCB	50,50,50	1982, 1983, 1984
p,p-DDMU	15,15,15,15	1979, 1980, 1983, 1984	1244 PCB	50	1982
o,p-DDT	10,10,10,10	1977, 1982, 1983, 1984	PCNB	5	1982
p,p-DDT	10	1983	Perthane	150	1982
DEF	40	1982	Phenkapton	25	1982
Diazinon	50,50,50	1982, 1983, 1984	Phorate	60	1982
Dichlofenthion	10	1982	Pronamide	300	1982
Dicofol	100,100	1982, 1984	Ronnel	5	1982
Dieldrin	5,5	1982, 1984	Simazine	20	1982
Dipbenamid	300	1982	Strobane	200	1982
Endosulfan I	5,5,5,5	1977, 1982, 1983, 1984	Tetradifon	20	1982
Endrin	15,15, 15	1982, 1983, 1984	Toxaphene	400,100,100,100	1977, 1982, 1983, 1984
Ethion	20	1982	2,4-D Acid	400	1982
Fenitrothion	10	1982	2,4-D isobutyl ester	100	1982
Fenthion	20	1982	2,4-D N-butyl ester	100	1982
Fonofos	5	1982	2,4-D isopropyl ester	100	1982
Gothion	300	1982			

References: Woodard, 1979; McCleneghan et al., 1979; McCleneghan et al., 1980; McCleneghan et al, 1981; La Caro et al, 1982; La Caro et al, 1983; Watkins et al, 1983; Agee et al., 1985; Watkins et al, 1985.

APPENDIX D

TABLE D.1

1985 SACRAMENTO RIVER METALS SAMPLING -- RESULTS OF ANALYSES *

SORT	ID	LOCATION	DATE	pH lab	EC lab	Temp F	hard mg/l	s.sol. mg/l	Al ppm	As(tot/dis) ppm	B ppm	Ca ppm	Cd(tot/dis) ppm
E	CO	Colusa	10MAY85	8.2	160	60	54	--	<.2	<.01	<.10	12	<.05
E	CO	Colusa	10MAY85	8.2	160	60	55	--	<.2	<.05	<.10	11	<.05
F	CB	Colusa Basin Drain	10MAY85	8.0	560	64	135	--	1.1	<.01	0.13	23	<.05
G	SS	Sacramento Slough	10MAY85	8.0	340	65	121	--	0.77	<.01	<.10	21	<.05
H	VM	Village Marina	10MAY85	8.0	175	60	57	--	0.37	<.01	<.10	12	<.05
I	HO	Hood	10MAY85	7.8	140	63	45	--	0.38	<.01	<.10	9.4	<.05
A	SD	Shasta Dam	3JUN85	--	--	48	46	--	<.20	.0014/.0012	<.10	11	<.001/<.001
B	KD	Keswick Dan	3JUN85	--	--	50	45	--	<.20	.0012/.0012	<.10	11	<.001/<.001
C	RB	Red Bluff	3JUN85	--	--	59	48	--	0.23	.0012/.0011	<.10	11	<.001/<.001
D	HC	Hamilton City	3JUN85	--	--	59	50	--	0.25	.0014/.0014	<.10	12	<.001/<.001
E	CO	Colusa	3JUN85	--	--	66	54	--	0.3	.0015/.0015	<.10	12	<.001/<.001
F	CB	Colusa Basin Drain	3JUN85	--	--	67	133	--	1.2	.0023/.0019	0.26	25	<.001/<.001
F	CB	Colusa Basin Drain	3JUN85	--	--	67	132	--	1.2	.0022/.0020	0.26	26	<.001/<.001
G	SS	Sacramento Slough	3JUN85	--	--	68	117	--	0.66	.0034/.0031	<.10	23	<.001/<.001
H	VM	Village Marina	3JUN85	--	--	65	64	--	0.41	.0013/.0012	0.1	14	<.001/<.001
I	HO	Hood	3JUN85	--	--	67	59	--	0.25	.0013/.0012	<.10	13	<.001/<.001
J	RV	Rio Vista	3JUN85	--	--	66	60	--	0.36	.0014/.0014	<.10	13	<.001/<.001
E	CO	Colusa	19JUN85	8.1	--	70	66	18	0.23	<.1	0.11	13	<.005
F	CB	Colusa Basin Drain	19JUN85	7.9	--	79	210	120	1.6	<.1	0.55	34	<.005
G	SS	Sacramento Slough	19JUN85	7.8	--	79	150	69	0.72	<.1	0.12	28	<.005
H	VM	Village Marina	19JUN85	7.8	--	74	60	12	0.2	<.1	0.11	12	<.005
I	HO	Hood	19JUN85	7.6	--	71	60	14	0.2	<.1	0.11	10	<.005
J	RV	Rio Vista	19JUN85	--	--	68	--	--	0.48	<.1	<.1	12	<.005

* If only one value is reported, it is for the total metal.

All below detection limits (ppm): Hg (<.001, <.005), Sb (<.02, <.06), Se(<.005, <.01, <.1), Sn(<.04).

Analysis by: 1) California Analytical (CAL): Al, As, B, Ca, Cd, Cr, Cu, Fe, Mg, Mn, Na, Ni, Sb, Sn, Zn (ICPS).

2) Anlab: pH, EC, hardness, suspended solids, Cd(t/d), Cr(t/d), Cu(t/d), Hg(t/d), Ni(t/d), Zn(t/d). (graphite furnice).

3) DWR's Bryte Laboratory: Se(t/d).

4) UC Davis: As(t/d).

LOCATION	DATE	Cr(tot/dis) ppm	Cu(tot/dis) ppm	Fe ppm	Mg ppm	Mn ppm	Na ppm	Ni(tot/dis) ppm	Zn(tot/dis) (Anlab)	Zn (CAL)
Colusa	10MAY85	<.01	.004/.001	0.28	6.8	0.021	8.7	<.05	--	0.047
Colusa	10MAY85	<.01	.003/.001	0.2	6.1	0.02	7.8	<.05	--	0.042
Colusa Basin Drain	10MAY85	<.01	.012/.006	1.6	18.0	0.11	55.0	<.05	--	0.051
Sacramento Slough	10MAY85	<.01	.012/.002	1.0	16.0	0.18	20.0	<.05	--	0.041
Village Marina	10MAY85	<.01	.006/.004	0.39	7.2	0.031	11.0	<.05	--	0.042
Hood	10MAY85	<.01	.008/.006	0.25	5.5	0.023	8.6	<.05	--	0.044
Shasta Dam	3JUN85	.009/.001	.010/.003	<.05	5.3	<.015	7.5	<.005/<.005	--	0.035
Keswick Dan	3JUN85	.010/<.001	.005/.004	0.11	5.3	<.015	7.2	<.005/<.005	--	0.063
Red Bluff	3JUN85	.009/.001	.004/.003	0.17	5.7	<.015	8.4	<.005/<.005	--	0.041
Hamilton City	3JUN85	.010/<.001	.010/.002	0.19	6.0	<.015	8.6	<.005/<.005	--	<.01
Colusa	3JUN85	.010/.001	.006/.003	0.26	6.6	0.02	8.9	.007/<.005	--	0.033
Colusa Basin Drain	3JUN85	.017/.001	.017/.009	1.5	19.0	0.12	58	.011/<.005	--	<.01
Colusa Basin Drain	3JUN85	.017/.001	.018/.008	1.6	19.0	0.13	59	.012/<.005	--	0.045
Sacramento Slough	3JUN85	.013/.001	.011/.005	0.89	17.0	0.11	17	.008/<.005	--	0.041
Village Marina	3JUN85	.013/.001	.020/.003	0.55	8.3	0.045	14	.006/<.005	--	0.042
Hood	3JUN85	.012/<.001	.007/.004	0.31	7.4	0.024	13	<.005/<.005	--	<.01
Rio Vista	3JUN85	.014/.001	.013/.004	0.54	8.2	0.025	18	.008/<.005	--	0.044
Colusa	19JUN85	0.012	.004/.002	0.31	6.2	0.024	9.2	<.04	--	<.01
Colusa Basin Drain	19JUN85	0.017	.016/.016	2.2	27	0.300	85	<.04	--	0.012
Sacramento Slough	19JUN85	0.014	.011/.003	1.1	20	0.210	22	<.04	--	0.058
Village Marina	19JUN85	0.013	.003/.002	0.25	6	0.026	8.3	<.04	--	0.05
Hood	19JUN85	0.015	.004/.002	0.4	5.2	0.033	8.8	<.04	--	0.059
Rio Vista	19JUN85	<.01	<.05	0.93	9.4	0.037	30	<.04	--	0.057

SORT	ID	LOCATION	DATE	pH lab	EC lab	Temp F	hard mg/l	s.sol. mg/l	Al ppm	As(tot/dis) ppm	B ppm	Ca ppm	Cd(tot/dis) ppm
A	SD	Shasta Dam	13AUG85	--	--	56	48	--	<.1	<.005	<.1	12	<.005
B	KD	Keswick Dam	13AUG85	--	--	56	46	--	<.1	<.005	<.1	11	<.001/<.001
B	KD	Keswick Dam	13AUG85	--	--	56	45	--	0.15	<.005	<.1	11	<.005
C	RB	Red Bluff	13AUG85	--	--	61	46	--	0.15	<.005	<.1	11	<.005
D	HC	Hamilton City	13AUG85	--	--	63	47	--	0.15	<.005	<.1	11	<.005
E	CO	Colusa	13AUG85	--	--	69	48	--	0.18	<.005	<.1	12	<.005
F	CB	Colusa Basin Drain	13AUG85	--	--	70	130	--	0.70	<.005	0.24	27	<.001/<.001
F	CB	Colusa Basin Drain	13AUG85	--	--	70	130	--	0.75	<.005	0.23	27	<.005
G	SS	Sacramento Slough	13AUG85	--	--	73	133	--	0.45	<.005	0.12	27	<.005
H	VM	Village Marina	13AUG85	--	--	70	65	--	0.33	<.005	0.11	15	<.005
I	HO	Hood	13AUG85	--	--	68	57	--	0.25	<.005	0.17	13	<.001/<.001
J	RV	Rio Vista	13AUG85	--	--	67	63	--	0.43	<.005	0.11	13	<.005
C	RB	Red Bluff	3SEPT85	*7.8	--	--	*54	<1/1	<.2	<.01	<.1	10	<.001/<.001
E	CO	Colusa	3SEPT85	*8.1	--	--	*65	15/7	--	--	--	--	--
F	CB	Colusa Basin Drain	3SEPT85	*8.4	--	--	*157	173/140	0.69	<.01	0.21	26	<.001/<.001
G	SS	Sacramento Slough	3SEPT85	*8.3	--	--	*200	84/83	--	--	--	--	--
H	VM	Village Marina	3SEPT85	*8.1	--	--	*95	41/41	--	--	--	--	-
J	RV	Rio Vista	3SEPT85	*7.9	--	--	*110	8/-	0.37	<.01	0.1	15	<.001/<.001
A	SD	Shasta Dam	2OCT85	7.9	--	--	48	--	--	--	--	--	--
B	KD	Kewsick Dam	2OCT85	7.8	--	--	46	--	--	--	--	--	--
C	RB	Red Bluff	2OCT85	7.8	--	--	45	--	0.24	<.005	<.10	8.4	<.001/<.001
E	CO	Colusa	2OCT85	8.1	--	--	57	--	--	--	--	--	--
F	CB	Colusa Basin Drain	2OCT85	8.1	--	--	130	--	0.91	<.005	0.14	27.0	<.001/<.001
G	SS	Sacramento Slough	2OCT85	8.0	--	--	150	--	--	--	--	--	--
K	FR	Feather River	2OCT85	8.2	--	--	97	--	--	--	--	--	--
H	VM	Village Marina	2OCT85	8.0	--	--	63	--	--	--	--	--	--
L	AM	American River	2OCT85	7.5	--	--	21	--	--	--	--	--	--
I	HO	Hood	2OCT85	7.7	--	--	53	--	--	--	--	--	--
J	RV	Rio Vista	2OCT85	8.1	--	--	68	--	<.20	<.005	<.10	14.0	<.001/.002

* average of 2 replicates

TABLE D.1 (continued)

LOCATION	DATE	Cr(tot/dis) ppm	Cu(tot/dis) ppm	Fe ppm	Mg ppm	Mn ppm	Na ppm	Ni(tot/dis) ppm	Zn(tot/dis) (Anlab)	Zn (CAL)
Shasta Dam	13AUG85	.009/.005	.005/.003	0.066	5.4	<.015	7	.005/<.005	--	0.051
Keswick Dam	13AUG85	.005/<.001	.005/.004	0.094	5.6	<.015	6.6	<.005/<.005	.002/.002	0.057
Keswick Dam	13AUG85	.009/.005	.003/.003	0.083	5.5	<.015	6.6	<.005/<.005	--	0.052
Red Bluff	13AUG85	.009/.005	.010/.005	0.12	5.6	<.015	7.3	<.005/<.005	--	0.054
Hamilton City	13AUG85	.009/.004	.006/.003	0.12	5.8	<.015	7.15	.005/<.005	--	0.053
Colusa	13AUG85	.010/.004	.006/.003	0.2	6.1	0.016	7.4	<.005/<.005	--	0.050
Colusa Basin Drain	13AUG85	.022/.005	.013/.003	1.0	18	0.13	37	.011/<.005	.020/.001	0.058
Colusa Basin Drain	13AUG85	<.01	<.05	1.0	18	0.12	36	<.05	--	0.050
Sacramento Slough	13AUG85	.016/<.001	.012/.003	0.68	18	0.11	20	.015/.011	--	0.056
Village Marina	13AUG85	.015/.005	.011/.003	0.4	8.3	0.036	12	.008/<.005	--	0.061
Hood	13AUG85	.011/.004	.007/.002	0.33	6.9	0.03	10	<.005/<.005	.002/.001	0.057
Rio Vista	13AUG85	.016/.004	.008/.005	0.63	8.7	0.042	20	<.005/<.005	--	0.058
Red Bluff	3SEPT85	.013/.004	*.003/.001	0.098	6.1	<.015	7.8	<.005/<.005	*.006/.004	0.066
Colusa	3SEPT85	--	*.003/.002	--	--	--	--	--	--	
Colusa Basin Drain	3SEPT85	.037/.006	*.013/.006	1	18	0.12	40	<.005/<.005	*.018/.002	0.057
Sacramento Slough	3SEPT85	--	*.008/.006	--	--	--	--	--	--	
Village Marina	3SEPT85	--	*.005/.003	--	--	--	--	--	--	
Rio Vista	3SEPT85	.021/.005	*.004/.002	0.34	9.5	0.018	18	<.005/<.005	*.003/.002	0.055
Shasta Dam	2OCT85	--	.002/<.001	--	--	--	--	--	.001/.001	
Kewsick Dam	2OCT85	--	.003/.001	--	--	--	--	--	.011/.006	
Red Bluff	2OCT85	.001/<.001	.002/<.001	0.19	6.5	<.015	5.8	<.005/<.005	.005/.001	0.049
Colusa	2OCT85	--	.004/.002	--	--	--	--	--	.005/<.001	
Colusa Basin Drain	2OCT85	.014/.002	.021/.004	1.30	19.0	0.16	42.0	<.005/<.005	.022/.001	0.046
Sacramento Slough	2OCT85	--	.009/.004	--	--	--	--	--	.010/<.001	
Feather River	2OCT85	--	.009/.003	--	--	--	--	--	.007/<.001	
Village Marina	2OCT85	--	.004/.002	--	--	--	--	--	.003/.002	
American River	2OCT85	--	.001/.001	--	--	--	--	--	.001/.001	
Hood	2OCT85	--	.005/.003	--	--	--	--	--	.007/.002	
Rio Vista	2OCT85	.002/<.001	.004/.004	0.23	9.1	<.015	16.0	<.005/<.005	.003/<.001	0.042

*average of 7 replicates

TABLE D.1 (continued)

SORT	ID	LOCATION	DATE	pH lab	EC lab	Temp	hard mg/l	s.sol. mg/l	Al ppm	As(tot/dis) ppm	B ppm	Ca ppm	Cd(tot/dis) ppm
B	KD	Keswick Dam	8NOV85	--	--	--	--	--	<.20	<.2	<.10	9.5	<.005
F	CB	Colusa Basin Drain	8NOV85	--	--	--	--	--	0.79	<.2	0.17	24.0	<.005
H	VM	Village Marina	8NOV85	--	--	--	72	10	--	--	--	--	<.001/<.001
L	AM	American River	8NOV85	--	--	-	23	24	--	--	--	--	<.001/<.001
I	HO	Hood	8NOV85	--	--	--	44	5	--	--	--	--	<.001/<.001
J	RV	Rio Vista	8NOV85	--	--	--	62	28	<.20	<.2	.10	14.0	<.001/<.001
A	SD	Shasta Dam	20NOV85*	--	--	--	62	<2	--	--	--	--	--
M	CS	Spring Creek Dam	20NOV85*	--	--	--	32	4	--	--	--	--	.17/.16
B	KD	Kewsick Dam	20NOV85*	--	--	-	44	6	--	--	--	--	--
C	RB	Red Bluff	20NOV85*	--	--		[illegible]	6	--	--	--	--	<.001/<.001
E	CO	Colusa	20NOV85*	--	--	--	57	5	--	--	--	--	--
F	CB	Colusa Basin Drain	20NOV85*	--	--	--	130	44	-	--	--	--	<.001/<.001
G	SS	Sacramento Slough	20NOV85*	--	--	--	140	14	--		--	--	--
K	FR	Feather River	20NOV85*	--	--	--	40	6	--	--		--	--
H	VM	Village Marina	20NOV85*	--	--	--	64	18	--	--	--	-	--
L	AM	American River	20NOV85*	--	--	--	22	28	--	--	--	--	--
I	HO	Hood	20NOV85*	--	--	--	54	6	--	--	--	--	--
J	RV	Rio Vista	20NOV85*	--	--	--	79	10	--	--	--	--	<.001/.001

* All samples analyzed for volatile halocarbons, but results were negative. For this run only, total metals were analyzed from HNO3-preserved samples while dissolved metals were anlayzed from non-preserved samples.

SORT	ID	LOCATION	DATE	pH lab	EC lab	Temp	hard mg/l	s.sol. mg/l	Al ppm	As(tot/dis) ppm	B ppm	Ca ppm	Cd(tot/dis) ppm
A	SD	Shasta Dam	5DEC85	--	--	--	--	--	--	--	--	--	--
M	CS	Spring Creek Dam	5DEC85	--	--	--	--	--	21.0	--	--	--	0.07
B	KD	Kewsick Dam	5DEC85	--	--	--	--	--	<.20	--	--	--	<.001/<.001
C	RB	Red Bluff	5DEC85	--	--	--	--	--	<.20	--	--	--	--
E	CO	Colusa	5DEC85	--	--	-	--	--	--	--	--	--	--
F	CB	Colusa Basin Drain	5DEC85	--	--	--	--	--	2.2	--	--	--	--
G	SS	Sacramento Slough	5DEC85	--	--	--	--	--	--	--	--	--	--
K	FR	Feather River	5DEC85	--	--	--	--	--	--	--	--	--	--
H	VM	Village Marina	5DEC85	--	--	--	58	160	--	--	--	--	--
L	AM	American River	5DEC85	--	--	--	28	5	--	--	--	--	--
I	HO	Hood	5DEC85	--	--	--	58	96	--	--	--	--	--
J	RV	Rio Vista	5DEC85	--	--	--	54	24	0.41	--	--	--	--

TABLE D.1 (continued)

LOCATION	DATE	Cr(tot/dis) ppm	Cu(tot/dis) ppm	Fe ppm	Mg ppm	Mn ppm	Na ppm	Ni(tot/dis) ppm	Zn(tot/dis) (Anlab)	Zn (CAL)
Keswick Dam	8NOV85	<.10	<.025	<.10	6.4	<.015	7.3	<.04	--	<.020
Colusa Basin Drain	8NOV85	<.01	<.025	1.2	18.0	0.086	48.0	<.04	--	<.020
Village Marina	8NOV85	.007/.002	.011/.009	--	--	--	--	<.005/<.005	.070/.060	--
American River	8NOV85	.006/.002	.046/.007	--	--	--	--	.006/<.005	.020/.010	--
Hood	8NOV85	.006/.002	.016/.011	--	--	--	--	.009/<.005	.030/.020	--
Rio Vista	8NOV85	.007/.002	.024/.009	0.26	13.0	<.015	64.0	<.005/<.005	.050/.040	<.020
Shasta Dam	20NOV85*	.008/.004	.003/.001	--	--	--	--	<.005/<.005	.010/.030	--
Spring Creek Dam	20NOV85*	.030/.019	3.32/3.30	--	--	--	--	.012/.011	25.5/25.4	--
Kewsick Dam	20NOV85*	.009/.005	.005/.002	--	--	--	--	<.005/<.005	.050/.050	--
Red Bluff	20NOV85*	.008/.004	.003/.002	--	--	--	--	<.005/<.005	.050/.030	--
Colusa	20NOV85*	.007/.005	.003/.001	--	--	--	--	<.005/<.005	.020/.010	--
Colusa Basin Drain	20NOV85*	.010/.002	.007/.009	--	--	--	--	.005/<.005	.020/.020	--
Sacramento Slough	20NOV85*	.010/.008	.008/.007	--	--	--	--	.022/<.005	.070/.070	--
Feather River	20NOV85*	.007/.002	.004/.007	--	--	--	--	<.005/<.005	.006/.050	--
Village Marina	20NOV85*	.008/.005	.006/.013	--	--	--	--	<.005/<.005	.020/.010	--
American River	20NOV85*	.007/.002	.005/.009	--	--	--	--	<.005/<.005	.020/.050	--
Hood	20NOV85*	.007/.005	.006/.008	--	--	--	--	<.005/<.005	.010/.030	--
Rio Vista	20NOV85*	.008/.007	.006/.013	--	--	--	--	<.005/<.005	.030/.030	--
Shasta Dam	5DEC85	.006/.004	.004/.004	--	--	--	--	<.005/<.005	.020/.010	--
Spring Creek Dam	5DEC85	.010/.010	2.40/2.40	69.0	--	--	--	.009/.009	8.54/8.54	8.7
Kewsick Dam	5DEC85	.006/.004	.008/.003	0.19	--	--	--	<.005/<.005	.030/.040	0.05
Red Bluff	5DEC85	.007/.005	.004/.002	0.39	--	--	--	<.005/<.005	.030/.020	0.04
Colusa	5DEC85	.023/.005	.021/.006	--	--	--	--	.016/<.005	.060/.060	--
Colusa Basin Drain	5DEC85	.021/.006	.014/.006	3.9	--	--	--	.018/.005	.050/<.001	<.05
Sacramento Slough	5DEC85	.015/.008	.008/.008	--	--	--	--	.018/.010	.040/.030	--
Feather River	5DEC85	.008/.005	.003/.003	--	--	--	--	<.005/<.005	.010/.010	--
Village Marina	5DEC85	.082/.001	.020/.002	--	--	--	--	.047/<.005	.007/.007	--
American River	5DEC85	.020/.003	.001/.001	--	--	--	--	<.005/<.005	.001/.001	--
Hood	5DEC85	.060/.004	.013/.003	--	--	--	--	.032/<.005	.006/.003	--
Rio Vista	5DEC85	.032/.002	.007/.003	0.72	--	--	--	.007/<.005	.003/.003	0.035

* All samples analyzed for volatile halocarbons, but results were negative. For this run only, total metals metals were analyzed from HNO3-preserved samples while dissolved metals were anlayzed from non-preserved samples.

APPENDIX E-1

State Of California
Resources Agency
DEPARTMENT OF FISH AND GAME

Effects of Rice Herbicides on Larval Striped Bass

1984 Laboratory Study Progress Report

Environmental Services Branch, Pesticide Investigations Unit
1701 Nimbus Road, Suite F, Rancho Cordova, California

December 1984

Effects of Rice Herbicides on Larval Striped Bass

1984 Laboratory Study Progress Report [1,2]

by

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SUMMARY

Acute (144-hr) continuous-flow toxicity tests were conducted to determine the lethal effects of rice herbicides molinate (Ordram) and thiobencarb (Bolero) seperately and in combination on striped bass embryos and larvae. Chronic (21-day) continuous flow toxicity tests were conducted to determine lethal and sublethal (growth) effects of the herbicides on larval striped bass.

Medial lethal concentrations (96-hr LC50 values) for 6 and 24-day old larvae indicated that thiobaencarb (0.35 to 0.67 mg/liter) was approximately 14 times more toxic than molinate (6.6 to 7.9 mg/liter). The acute toxicity of molinate and thiobencarb increased with increased exposure time (48 to 144 hr) and decreased with increased age (6 to 24-day old) of larvae. Mixtures of molinate and thiobencarb at equitoxic ratios had additive toxic effects. Tests on embryos and prolarvae were unsuccessful due to complete mortality in all treatment groups. The 21-day chronic test data are questionable because of low survival in the control groups. The embryo and prolarvae acute toxicity tests and the chronic toxicity tests will be repeated next year with improved culture and testing equipment and methods.

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[1] Progress report on work completed in 1984.

[2] Study funded by California Department of Fish and Game Striped Bass Stamp Fund and State Water Resources Control Interagency Agreement No. 1-161-420-2

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CONCLUSIONS

1. The 96-hr LC50 values of molinate to 6-day old and 24-day old striped bass larvae were 6.6 and 7.9 mg/liter, respectively.
2. The 96-hr LC50 values of thiobencarb to 6-day old and 24-day old striped bass larvae were 0.35 and 0.67 mg/liter, respectively.
3. The 96-hr LC50 values of molinate and thiobencarb mixture to 6-day and 24-day old striped bass larvae were 3.8 mg/liter molinate and 0.33 mg/liter thiobencarb and 3.1 mg/liter molinate and 0.24 mg/liter thiobencarb, respectively.
4. The acute toxicity of molinate and thiobencarb increased with increased exposure time (48 to 144 hr) and decreased with increased age (6 to 24-day old) of larvae.
5. Mixtures of molinate and thiobencarb had additive toxic effects.
6. A no observable effect level (based on reduced growth) for 28-day old larvae of 0.20 mg/liter molinate and 0.006 mg/liter thiobencarb was obtained from a 21-day exposure to a mixture of molinate and thiobencarb.
7. Results obtained from several tests were questionable because of high mortality (> 20%) of control groups, contamination of dilution water with volitilized molinate, and large variation in toxicant concentration.

RECOMMENDATIONS

1. The herbicide mixture acute toxicity tests should be repeated because of high toxicant concentration varation in the treatment groups. The variation can be substantially decreased by replacing the rotatmeter diluter with a proportional diluter.
2. The herbicide acute toxicity tests on striped bass embryos and prolarvae should be repeated because of high mortality in control groups. Survival in control groups can be improved with test chambers having air-lifts to provide for sufficient current to keep organisms suspended and water exchange in the aquaria.
3. The herbicide chronic toxicity tests should be repeated because of high mortality in control groups and contamination of dilution water with molinate. Contamination of molinate in the control groups can be eliminated by providing adequate ventilation in the testing room.
4. Younger life-history stages of striped bass should be exposed to the herbicides during chronic tests because they are more sensitive and growing at a faster rate than older larvae.
5. Field testing of molinate and thiobencarb to larval striped bass should be postponed to 1986 enabling laboratory culture and testing to be refined in 1985.

INTRODUCTION

Justification for Study

Rice herbicides Ordram (molinate) and Bolero (thiobencarb) have been detected in the Sacramento River from Knight's Landing downstream to Rio Vista (California Department of Food and Agriculture 1984). Since 1980, the California Department of Fish and Game (CDFG) has monitored the level of rice pesticides present in the agricultural drains which discharge into the striped bass, Morone saxatilis, spawning grounds of the Sacramento River (Finlayson and Lew 1983a; 1983b; 1984). The short-term and long-term effects of these chemicals on survival and development of embryos and larvae of striped bass are unknown. In September 1983, CDFG began a three year study to determine the toxic effects of rice pesticides from agricultural drain water on the early developmental stages of striped bass as proposed by Finlayson et al. (1982a).

The annual rice crop in California has fluctuated between a low of 180,000 acres and a high of 540,000 acres (Table 1). Over 90% of the rice acreage in California is grown in Butte, Colusa, Glenn, Sacramento, Sutter, and Yolo counties in bands bordering the west and east banks of the Sacramento River (Figure 1).

A variety of insecticides and herbicides have been used on rice in California (Table 2) for control of pests, primarily tadpole shrimp and rice leafminer and watergrass, sagetop, and arrowhead, respectively. Rice is a semi-aquatic plant, and its culture in California requires continual flooding with water movement through the inundated field.

Table 1. Ten-year trend in California rice acreage.[a]

Year	Acreage
1974	176,000
1975	332,000
1976	256,000
1977	207,000
1978	352,000
1979	374,000
1980	435,000
1981	508,000
1982	538,000
1983	348,000
1984	510,000

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[a] CDFA, Annual Pesticide Use Reports.

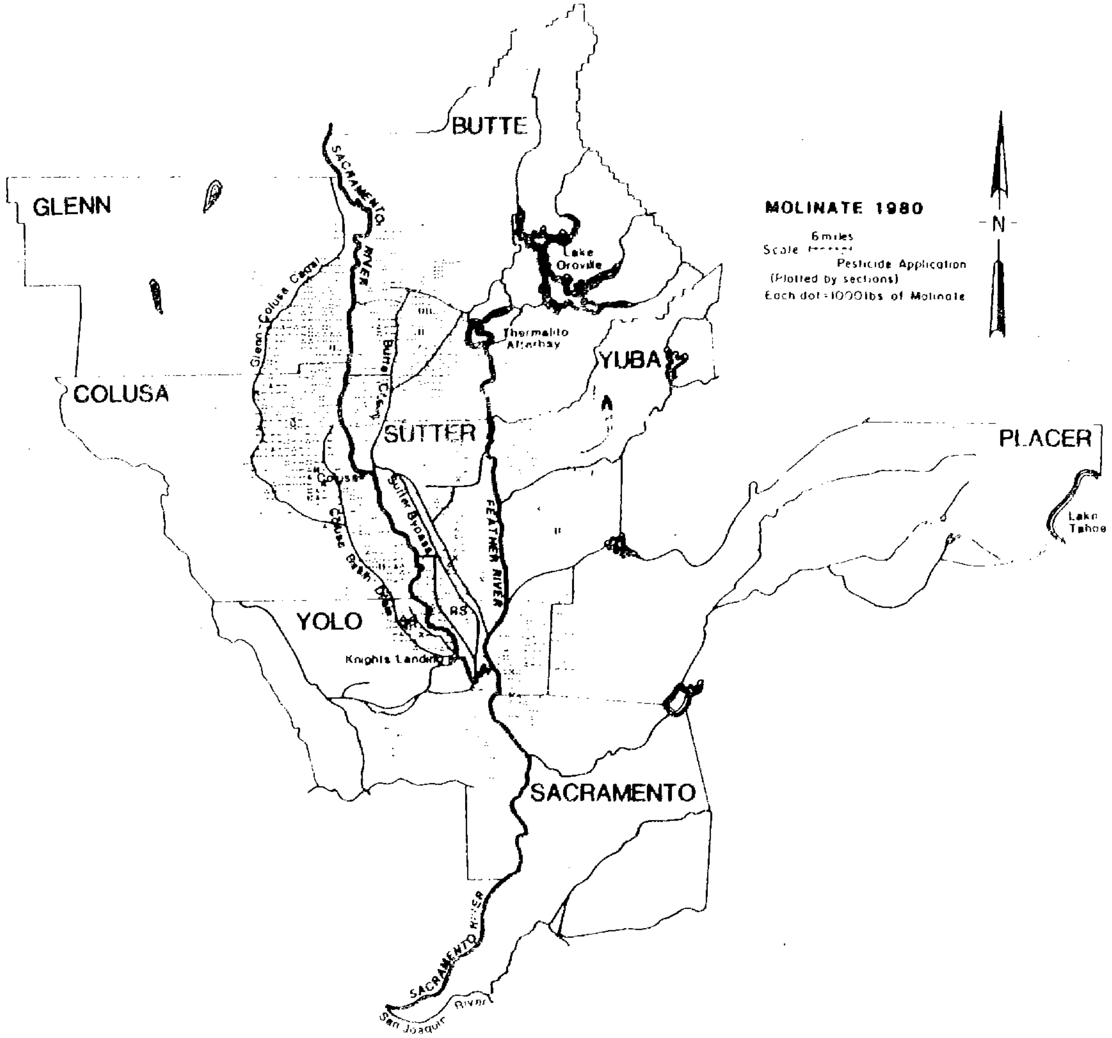

Figure 1. Rice acreage in the Sacramento Valley for 1980 based on molinate useage.

Table 2. Major pesticides used on rice in 1982.[a]

Insecticides

Chemical	Pounds (a.i.)
Furadan	115,000
Methyl parathion	101,000
Carbaryl	84,000
Parathion	15,000

Herbicides

Chemical	Pounds (a.i.)
Ordram	1,505,000
Bolero	675,000
MCPA	406,000
Bentazon	124,000
Propanil	84,000
Silvex	40,000

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[a] CDFA, 1982 Annual Pesticide Use Report.

Water runoff from rice fields into agricultural drains and, ultimately into the Sacramento River is at the present time unavoidable because of cultural requirements. Pesticides accompany this runoff which typically occurs from May through July.

The CDFG and California Regional Water Quality Control Board-Central Valley Region (CVRWQCB), and California Department of Food and Agriculture (CDFA) have monitored the off-target movement of rice pesticides into State waters since 1978 (Van de Pol 1978; Finlayson et al. 1982b; Finlayson and Lew 1983a; 1983b; 1984; CDFA 1984). These studies have identified the Colusa Basin Drain, Natomas Drain, Reclamation Slough, Reclamation District 108, Butte Slough, Sutter By-Pass, and Sacramento Slough as major sources of agricultural runoff from rice fields into the Sacramento River (Figure 2). Water samples taken during these investigations were analyzed for concentrations of ethyl parathion, methyl parathion, molinate (Ordram), thiobencarb (Bolero), and 2, methyl-4-chlorophenoxy acetic acid (MCPA). Ethyl parathion and MCPA were never detected in the water samples, and methyl parathion was only intermittently detected at concentrations up to 3.0 ug/liter, 100 times less than concentrations demonstrated to be acutely toxic to fish (Johnson and Finley 1980). High levels of molinate and thiobencarb have, however, been detected in agricultural drain water from 1981 through 1984; concentrations approaching 700 ug/liter molinate and 200

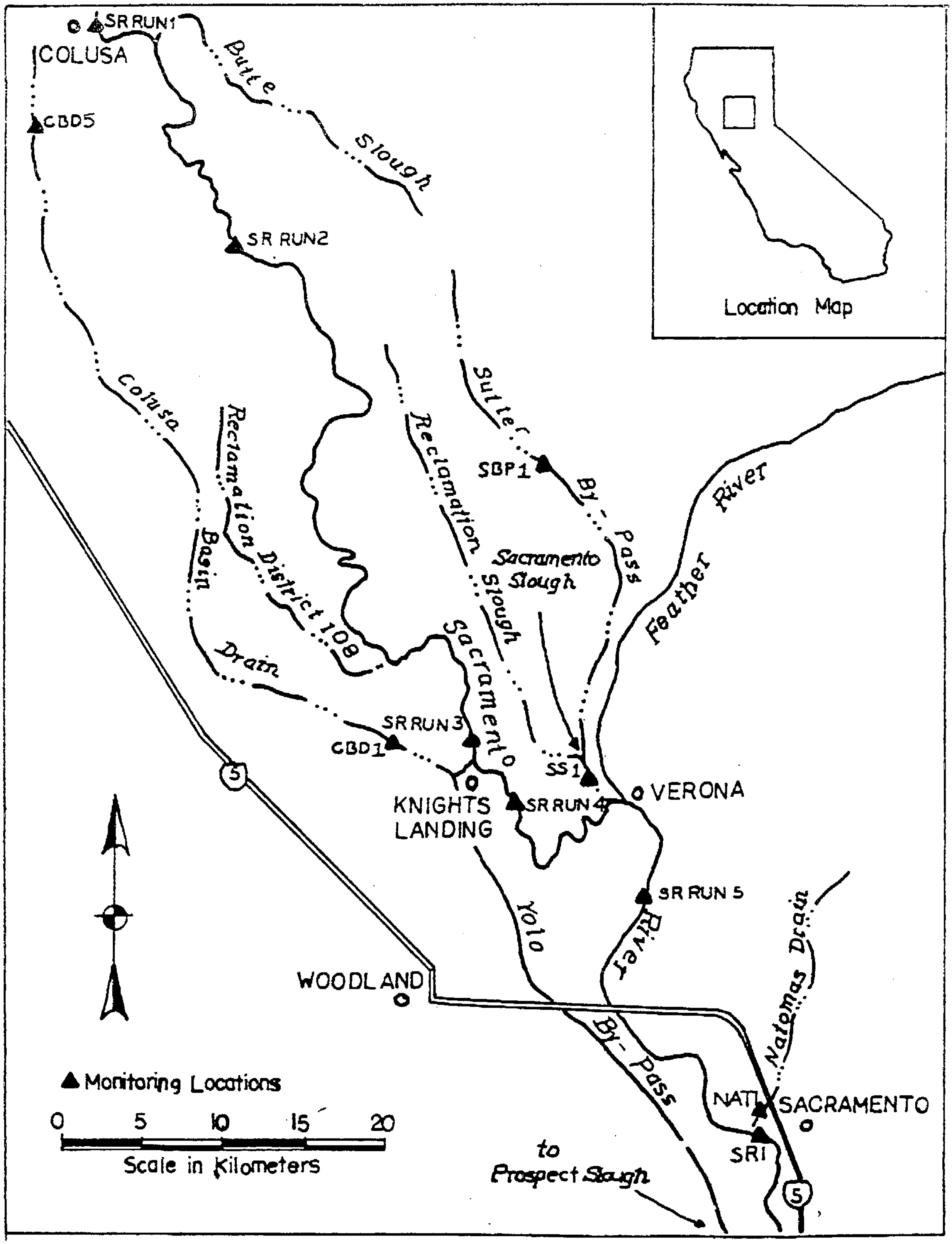

Figure 2. Monitoring locations on the Sacramento River and associated agricultural drains.

ug/liter thiobencarb have been detected in the Colusa Basin Drain (Figures 3 and 4). Detectable concentrations of rice herbicides in the agricultural drains have lasted for up to 60 days.

Residues of these herbicides in white catfish, *Ictalurus catus*, and channel catfish, *Ictalurus punctatus*, from the Colusa Basin Drain have approached 2.0 ug/g molinate and 5.0 ug/g thiobencarb (Finlayson and Lew 1983b).

The CDFG originally became involved with monitoring rice pesticides because of extensive fish losses (up to 30,000 fish) which had been occurring annually in the agricultural drains since the mid-1970's. Carp, *Cyprnus carpio*, was the primary species killed. Finlayson et al. (1982b) concluded that water temperatures and dissolved oxygen concentrations were not limiting factors for survival of channel catfish, white catfish, bullhead, *Ictalurus nebulosus*, bluegill, *Lepomis macrochirus*, crappie, *Pomoxis nigromaculatus*, largemouth bass, *Micropterus salmoides*, and carp which inhabit the agricultural drains. Ordram was highly suspected of causing the fish losses based on the toxicity data of molinate to carp presented by Kawatsu (1977). Kawatsu (1977) determined that molinate produces anemia and eventual death in carp during sub-chronic (21-day) exposure. These effects of molinate on carp were reaffirmed in a field study (Finlayson and Lew 1983b) and a laboratory study (Finlayson and Faggella MS 1984). Bolero usage on rice began in 1981. The presence of Bolero in Sacramento River water was believed responsible for imparting an off-flavor to the water supply of the City of Sacramento. Because of the

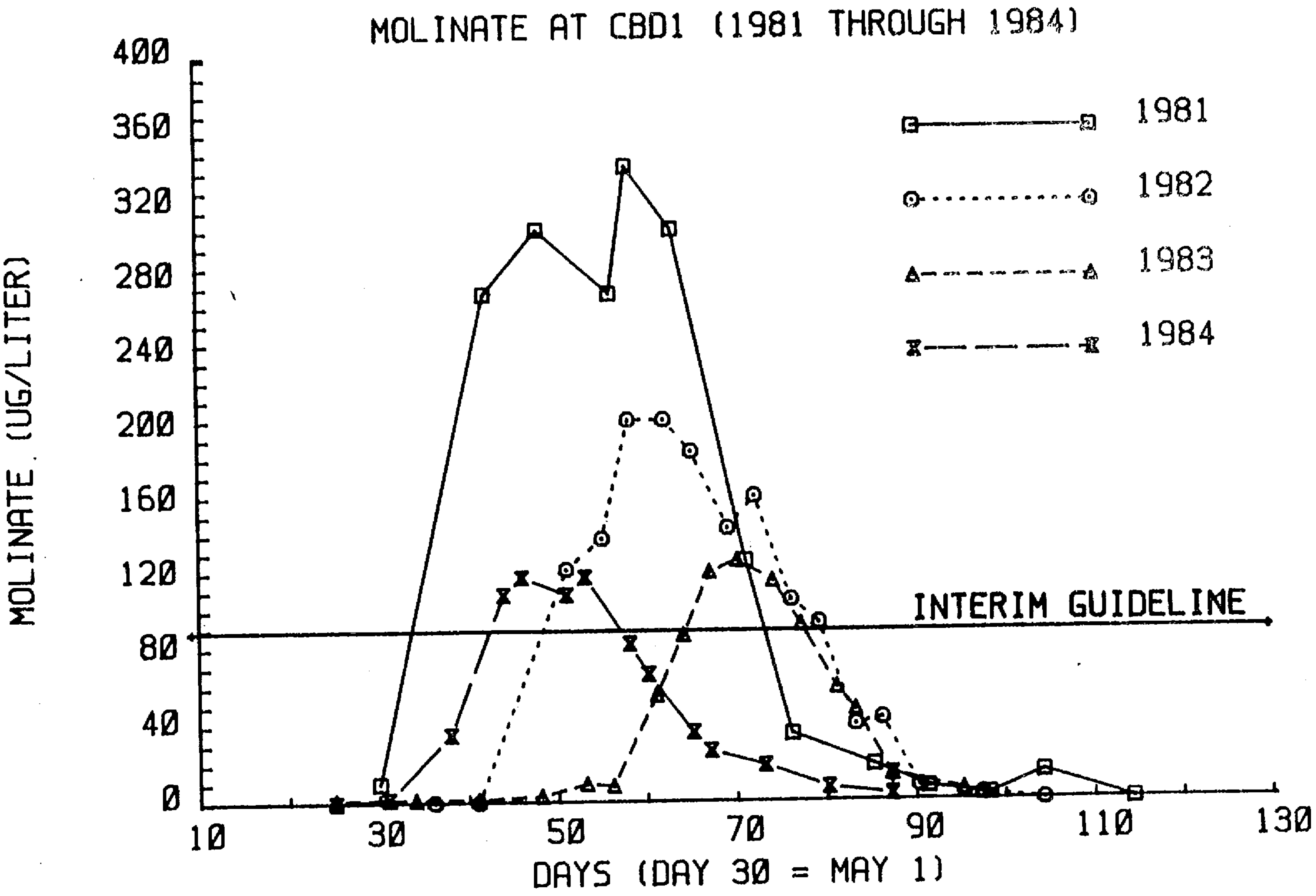

FIGURE 3. MOLINATE CONCENTRATIONS FROM COLUSA BASIN DRAIN (CBD1) IN 1981 THROUGH 1984 (DATA FROM FINLAYSON ET AL. 1982; FINLAYSON AND LEW 1983A; 1983B; 1984).

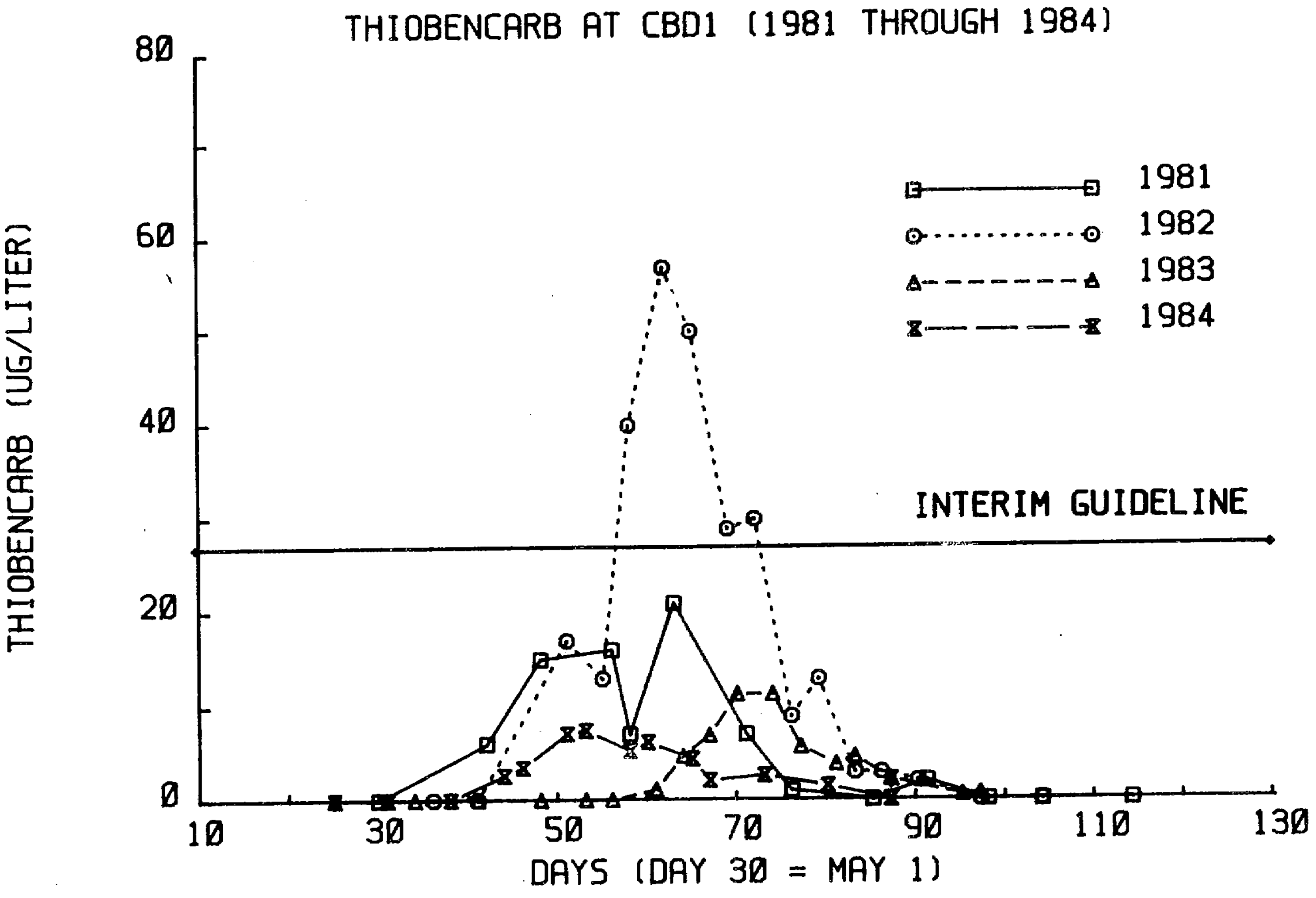

FIGURE 4. THIOBENCARB CONCENTRATIONS FROM COLUSA BASIN DRAIN (CBD1) IN 1981 THROUGH 1984 (DATA FROM FINLAYSON ET AL. 1982; FINLAYSON AND LEW 1983A; 1983B; 1984).

adverse effects of molinate and thiobencarb on beneficial uses of water, CDFA in 1982 began a series of regulatory actions aimed at curtailing the off-target movement of Ordram and Bolero. These actions have included: 1) mandatory holding times of herbicide treated waters on rice fields (allowing dissipation and breakdown of chemical on target); 2) requiring a permit for their use (providing enforceability of use restrictions); and 3) limiting sales (restricting the amounts used).

The 65-km section of the Sacramento River extending from Colusa downstream to Sacramento (Figure 2) receives large volumes of agricultural return water from rice fields. During low to normal outflow years, discharge from agricultural drains may contribute over one-third of the total river flow above the confluence with American River (Hansen 1982). Both molinate (up to 42 ug/liter) and thiobencarb (up to 12 ug/liter) have been detected in the Sacramento River in 1982 through 1984 for up to 40 days (Figures 5 and 6).

Spawning of striped bass, American shad, Alosa sapidissima, and white sturgeon, Acipenser transmontanus, occurs in the rice herbicide impacted zone of the Sacramento River around Knight's Landing during peak discharges from the agricultural drains; from April to mid-June up to 67% of spawning of striped bass occurs in the Sacramento River from Isleton to Butte City (Farley 1966; Turner 1976). Additionally, downstream migrant king salmon, Oncorhynchus tshawytscha, are present in the Sacramento River and agricultural drains (Butte Creek) during this period (Kjelson et al. 1981).

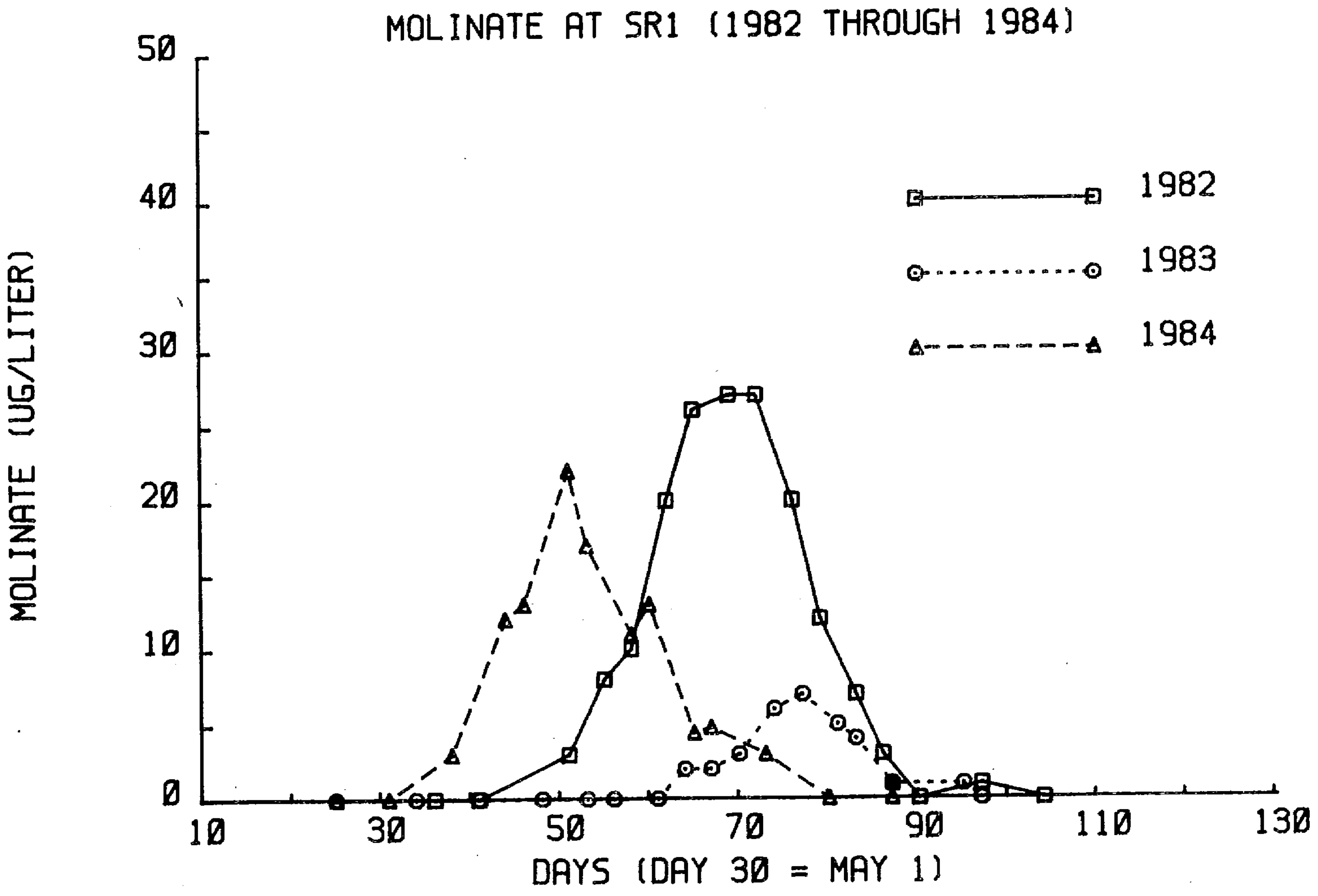

FIGURE 5. MOLINATE CONCENTRATIONS FROM SACRAMENTO RIVER (SR1) IN 1982 THROUGH 1984 (DATA FROM FINLAYSON AND LEW 1983A; 1983B; 1984).

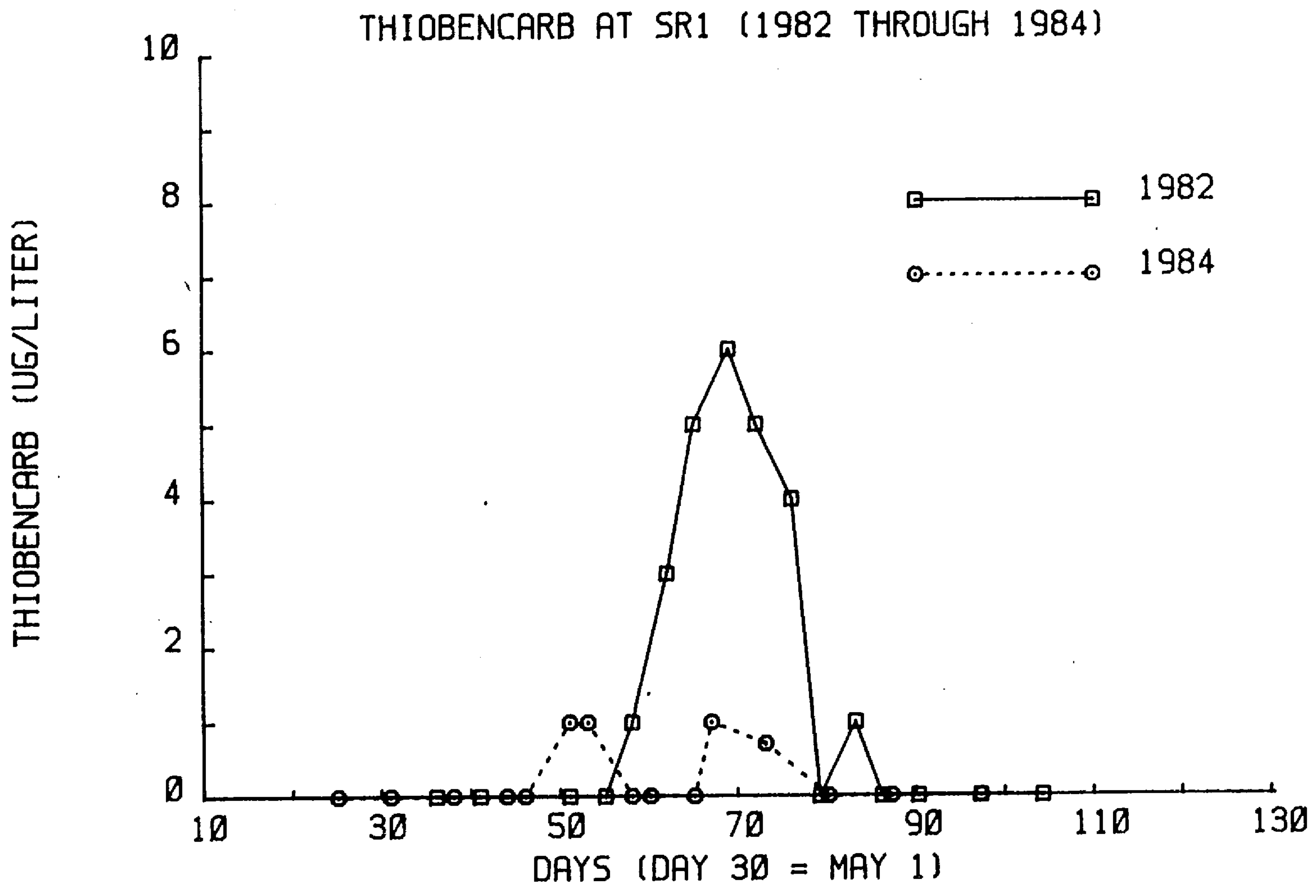

FIGURE 6. THIOBENCARB CONCENTRATIONS FROM SACRAMENTO RIVER (SR1) IN 1982 THROUGH 1984. THE 1983 CONCENTRATIONS WERE ALL LESS THAN 1 UG/LITER (DATA FROM FINLAYSON AND LEW 1983A; 1983B; 1984).

Interm Water Quality Guidelines

The data of Finlayson and Faggella (MS 1984), Kawatsu (1977), and Chevron Chemical Company and Stauffer Chemical Company pesticide registration files were used to develop interim water quality guidelines of 24 ug/liter thiobencarb and 90 ug/liter molinate for protection of aquatic organisms inhabiting the agricultural drains and the Sacramento River from Ordram and Bolero (Carper 1984).

The guidelines were considered interim because a comprehensive assessment of the hazards to resident and anadromous fisheries in the Sacramento Valley was not possible since there were few chronic exposure studies for the two herbicides. A better assessment can be made within the next few years when the present study and others have been completed.

Scope of Study

The objectives of this study are as follows:

1) Determine the acute and chronic toxicity of rice pesticides in Sacramento River and agicultural drain water to embryonic and larval striped bass;

2) Characterize the exposure of striped bass eggs and larvae to rice pesticides (Ordram and Bolero) in the Sacramento River;

3) Integrate monitoring and toxicity information into a risk assessment model for predicting the impacts of agricultural return water with varying concentrations of rice pesticides on the striped bass fishery; and

4) Recommend appropriate corrective actions to the CDFA for implementation.

Tasks Completed in 1984

Between October 1, 1983 and November 30, 1984, the following tasks were completed relative to the study's overall objectives. These are as follows:

1) Monitored rice herbicide concentrations in the Sacramento River and associated agricultural drains during 1984 rice growing season and prepared a report on the findings (Finlayson and Lew 1984);

2) Devloped testing and culturing protocols and facilities for early life history stages of striped bass; and

3) Determined the sensitivities of striped bass prolarvae and larvae to rice herbicides Ordram and Bolero.

The design and construction of culture and testing facilities were completed during the winter of 1984. The striped bass larvae were maintained in a recirculating system at the CDFG Fish Disease Laboratory and, the continuous-flow toxicity tests were conducted in the CDFG Mobile Bioassay Laboratory, both adjacent to Nimbus Hatchery on the American River. Acute and chronic tests on Ordram, Bolero, and a mixture of the two herbicides were conducted between May 1 and June 30, 1984.

This report describes the culturing and testing protocol and facilities used during the 1984 tests, the acute and chronic test results, problems encountered with the culturing and testing of larval striped bass, and recommended corrective actions for these problems.

METHODS AND MATERIALS

Study Schedule

Design and construction of the testing and rearing facilities began in September 1983 and were completed in April 1984.

Toxicity testing on embryonic and larval striped bass began on May 1, 1984 and was completed on June 29, 1984. Twenty one acute toxicity tests (7 test series) and three chronic tests (1 test series) were attempted during this two month period (Table 3). All test organisms came from three spawns (families) of striped bass.

Description of Life History Stages

Striped bass go through four life history stages: embryonic, larval, juvenile, and adult. The larval stage has been divided into prolarval and postlarval periods by Rogers et al. (1982). The period from hatching to yolk absorbtion and onset of feeding (4 to 10 days post-hatch) is known as the prolarval stage, and the period from prolarval stage to metamorphosis (22 to 76 days post-hatch) is known as the postlarval stage (Table 4). Metamorphosis of larvae to juveniles occurs at approximately 40 days post-hatch at 18 C. The juvenile stage lasts for three to four years at which time they become sexually mature.

Culture Methods

The Nimbus testing and rearing facility cultured striped bass beginning with fertilized eggs at 6 to 12 hr prior to hatch. The fertilized striped bass eggs came from the CDFG Central Valley Fish Hatchery (CVFH) located at Elk Grove, California. The CVFH is located approximately 25 miles from the

Table 3. Schedule of acute and chronic tests with molinate and thiobencarb on embronic and larval striped bass.

Begin Date	Test Series	Spawn	Developmental Stage	Test Duration	Comments
5-1-84	1	1	Embryo (12 hr pre-hatch)	-	Tests void, 100 % mortality in all chambers in 24 hr
5-4-84	2	2	Embryo (6-hr pre-hatch)	-	Tests void, 100% mortality in all chambers in 24 hr
5-5-84	3	1	Prolarvae (4-day post-hatch)	-	Tests void, 100% mortality in all chambers in 24 hr
5-11-84	4	3	Embryo (13-hr pre-hatch)	-	Tests void, 100% mortality in all chambers in 24 hr
5-11-84	5	2	Prolarvae (6-day post-hatch)	144-hr	Success
5-18-84	6	3	Pro/postlarvae (7-day post-hatch)	144-hr	Data questionable, > 20% mortality in controls
5-29-84	7	2	Postlarvae (24-day post-hatch)	144-hr	Success
6-8-84	8	3	Postlarvae (28-day post-hatch)	21-day	Data questionable, >20% mortality in controls

Table 4. Early life-history stages of striped bass raised at 18 C (after Rodgers et al. 1982).

Age	Total length (mm)	Characteristics
51.8 hr after fertilization	3.25 to 4.71	Hatching completed for eggs
3 days after hatching	5.04 to 5.77	Eye pigmented; gut differentiated ventrally pigmented; pectoral buds
6 to 7 days after hatching	5.5 to 7.5	Yolk sac absorbed
20 to 30 days after hatching	10, 12 to 16	Differentiation of rays in caudal, anal, and dorsal fins. Myotomes correlated with number of vertebrae
40 days after hatching	11.9 to 20.4	Metamorphosis

Nimbus test facility. Eggs were transported via automobile from CVFH to the Nimbus facility; travel time was approximately 30 minutes. The fertilized eggs were placed in plastic bags inside a stryofoam ice chests at CVFH prior to transportation. Upon arrival at the Nimbus facility, some of the embryos were subjected to the toxicants in tests. Those eggs not used in the toxicity tests were hatched in modified plexiglass MacDonald hatching jars (Figure 7).

One hatching jar was immersed in each quadrant of the circular tank which was supplied with water from the recirculating rearing system described below. The quantity of water flowing into the hatching jar was adjusted so that the eggs were kept suspended. As eggs hatched, the prolarvae were carried out of the hatching jar and into the quadrant of the circular tank by the overflowing water.

The rearing system consisted of a 1000-liter circular fiberglass tank with the volume adjusted to approximately 700 liters. Water in the system was recirculated through a biological filter. The tank was divided into quadrants with plexiglass frames covered with 500 um mesh polypropylene screen (Figures 8 and 9). Water was pumped from the filter into the tank through PVC pipe jets located on the bottom of the tank. The jets caused an upwelling current. Water flowed out of the tank through a central drain which was screened with 500 um mesh polypropylene screen. Water leaving the tank flowed by gravity through the biological filter and was then pumped back to the rearing tank. The filter consisted of a 66 x 61 x 47 cm box

FIGURE 7. MODIFIED MACDONALD HATCHING JARS.

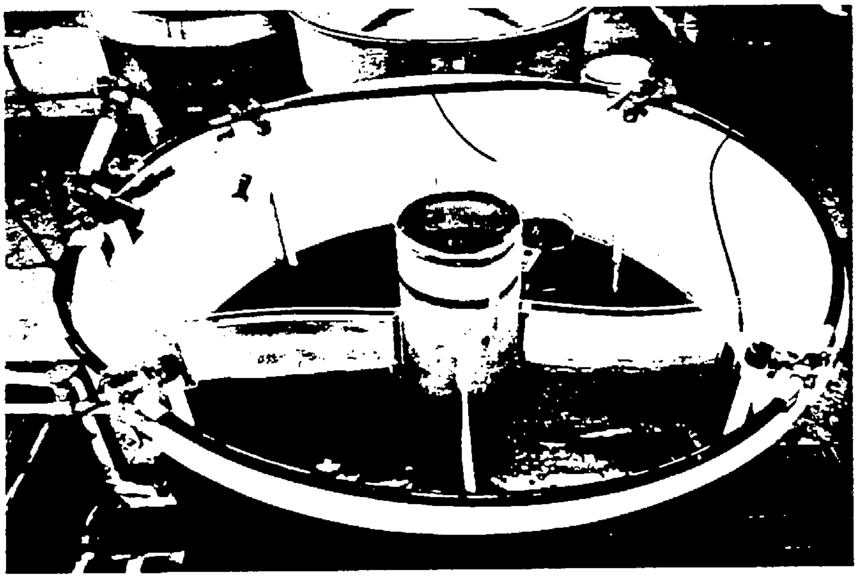

FIGURE 8. EGG AND LARVAL REARING TANK WITH SCREENED QUADRANTS.

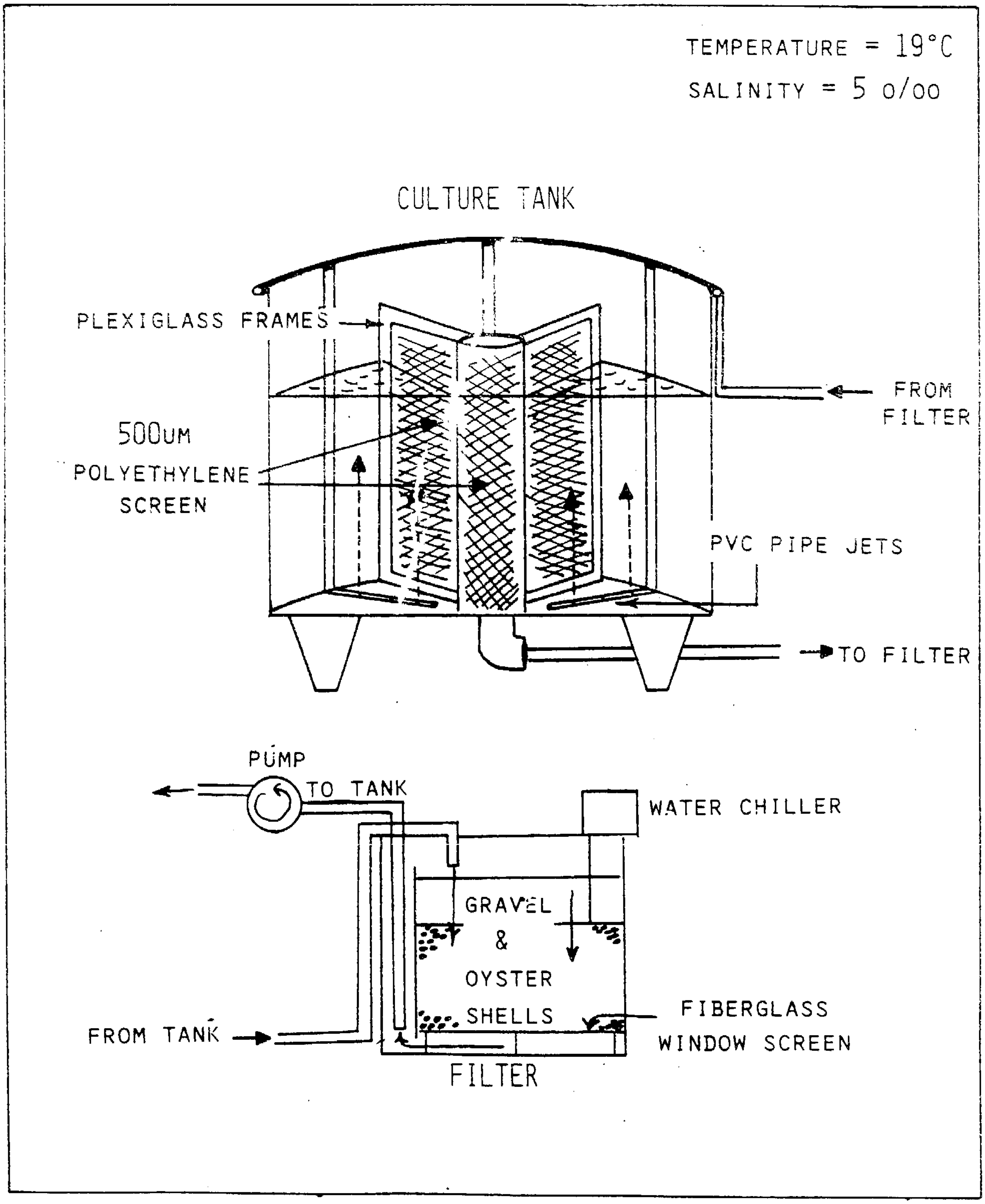

FIGURE 9. SCHEMATIC OF 1000 LITER RECIRCULATING LARVAL REARING SYSTEM.

made of fiberglassed Crezon plywood (Figure 9) filled with fine gravel and oyster shells, 11 cm deep.

Water temperature of the tank and filter was maintained at 19 C by a Frigid Model D1-33 refrigeration unit emersed in the filter bed. Water temperature was monitored twice daily.

Salinity of the water was adjusted to 5 o/oo and monitored once a week with a YSI Model 33 conductivity meter. Water was added to the system when needed to maintain the salinity at 5 o/oo. Dissolved oxygen and ammonia were not monitored. One complete water change was made approximately two weeks after the initial batch of embryos were received.

The prolarvae and postlarvae were fed San Francisco Bay brand artemia nauplii. Feeding was begun on the second day after hatching. The prolarvae generally start feeding the fourth day after hatching (Rogers et al. 1982); feeding at this earlier time allowed the larvae 2 days to imprint on the nauplii. The feeding density was approximately 5,000 nauplii per liter as suggested by Rogers et al. (1982). The larvae were fed twice daily at 0800 and 1600 hrs.

The artemia nauplii were cultured in two-liter plastic soda bottles which had the bottoms removed (Figure 10). Salinity of the culture media was adjusted to 35 o/oo sodium chloride, and 15 ml of artemia cysts were added per two liters of culture media. Each bottle was aerated for circulation. The artemia acysts were incubated for 72 hours at approximately 24 C. After-72 hours, the aeration was terminated, and the cyst shells floated to the top of the jars and were manually removed. The

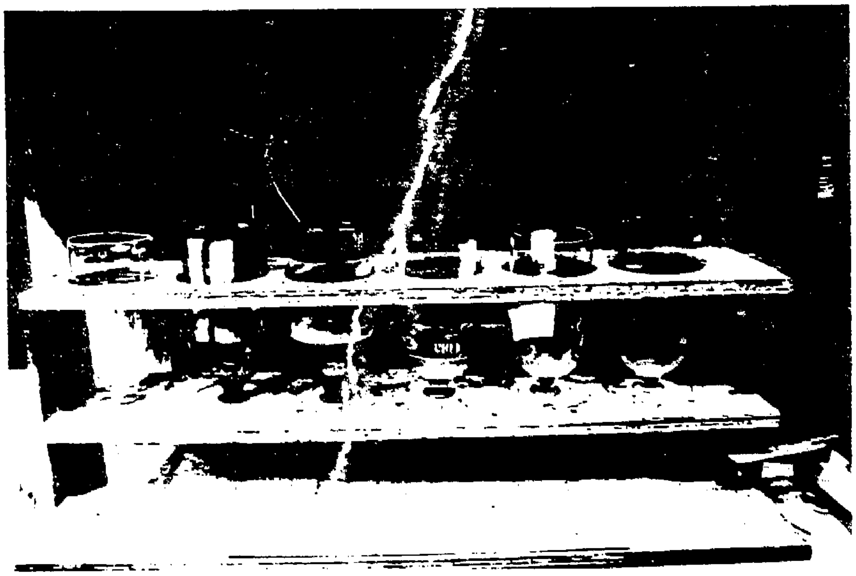

FIGURE 10. ARTEMIA REARING SYSTEM (2-LITER INVERTED PLASTIC SODA BOTTLES).

nauplii were fed to the striped bass larvae using a calibrated plastic pipette.

Samples were collected from the rearing facility for histological examination at 2 to 3-day intervals from hatch to metamorphosis to establish a record of development. Each sample consisted of five individuals which were preserved in bouin´s solution.

Testing Methods

The toxicity tests were conducted in a 7.3 x 2.4 m mobile bioassay laboratory (Figure 11) located at the Nimbus facility. The laboratory had three diluters which allowed three toxicants (molinate, thiobencarb, and the molinate and thiobencarb mixture) to be tested concurrently. Each diluter supplied twelve 81 x 15 x 21 cm aquaria, six toxicant concentrations (including controls) in duplicate. The aquaria were made of glass and silicone adhesive with water volumes adjusted to approximately 26 liters. Molinate and thiobencarb were tested individually with the solenoid valve proportional diluters, and the molinate and thiobencarb mixture was tested with a rotameter type diluter. The proportional diluters (Figure 12) were modified Mount-Brung types constructed of glass, stainless steel, teflon, and silicone. The rotameter diluter was constructed with variable area flowmeters, teflon tubing, and nylon tubing fittings (Figure 13). The 50% volume replacement time in the test aquaria was 6.5 hr.

The continuous flow tests were conducted at the nominal termperature and salinity of 19 C and 2 ̆o/oo respectively. Quality of the unmodified incomming American River water used for dilution in the tests varied in

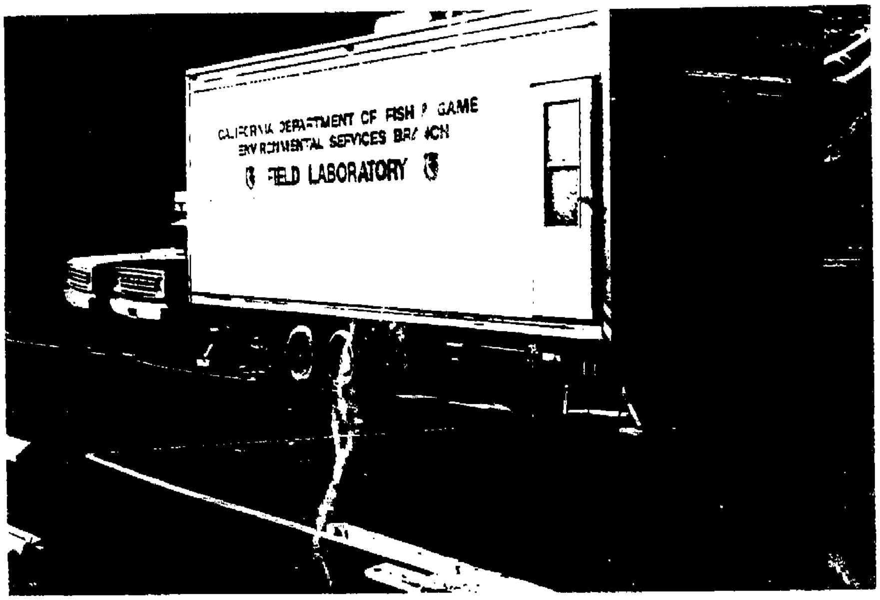

FIGURE 11. CDFG MOBILE BIOASSAY LABORATORY.

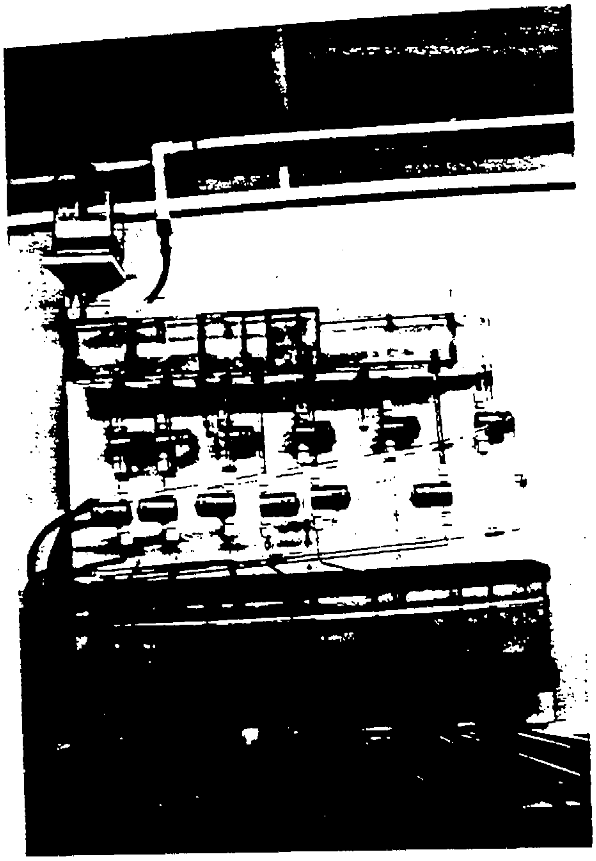

FIGURE 12. SOLENOID VALVE PROPORTIONAL DILUTER.

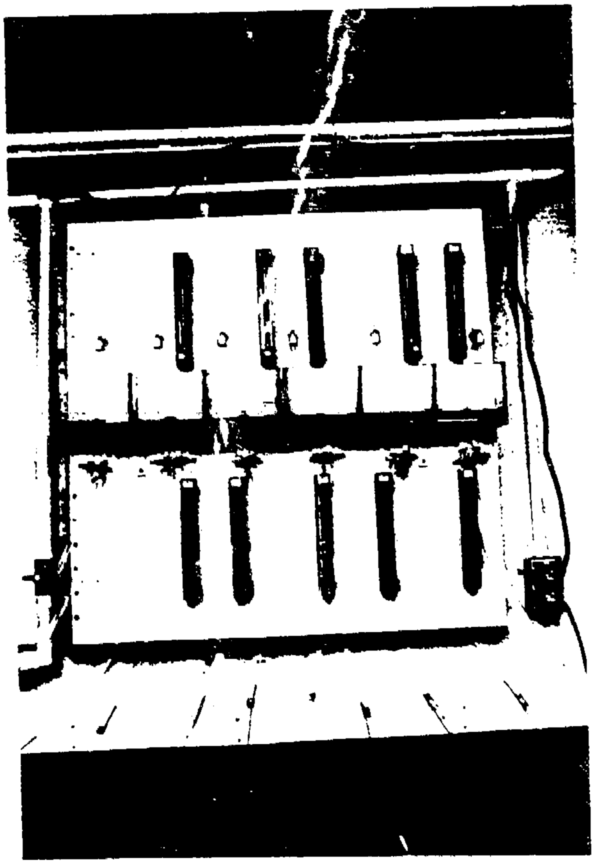

FIGURE 13. ROTAMETER TYPE DILUTER.

temperature from 14 to 17 C and in conductivity from 50 to 60 umhos/cm. The temperature and salinity of the dilution water was adjusted and monitored prior to use in the tests (Figure 14).

Temperature of the incoming dilution water was adjusted by heating a portion with a Dura Power stainless steel hotwater heater and blending it back into the dilution water line through a Gillman variable area flowmeter. Salinity of the dilution water was adjusted to 2 o/oo by injecting artificial seawater at a salinity of 35 o/oo back into the dilution water using a Cole-Parmer variable speed peristaltic pump. The seawater was stored in two 600-liter polyethylene tanks. The seawater was made by mixing 18 kg of Marine Environment sea salts with 568 liters of unmodified American River water for several hours with a Cole-Parmer 1/3 h.p. shaft-drive mixer. This quanity of seawater was sufficient for 48 hours of testing. The warmed saline dilution water was then filtered through a Teel fiberglass cartridge filter (porosity of 10 um) before passing through the Montedoro-Whitney Model WQM-1 water quality monitor (WQM). The temperature, pH, conductivity and dissolved oxygen of the dilution water were measured and recorded at 30-minute intervals by the WQM. Direct readings of the WQM were used to adjust the flows of the hot water and sea water several times daily.

Five test chamber designs were used during the testing period: 1) a modification of the flow-through egg chamber used by Burton (1982) which was manufactured from glass, silicone, and 350 um mesh polypropylene screen, used in Test Series 1 (Figure 15); 2) a 14 x 8 x 25 cm box manufactured from

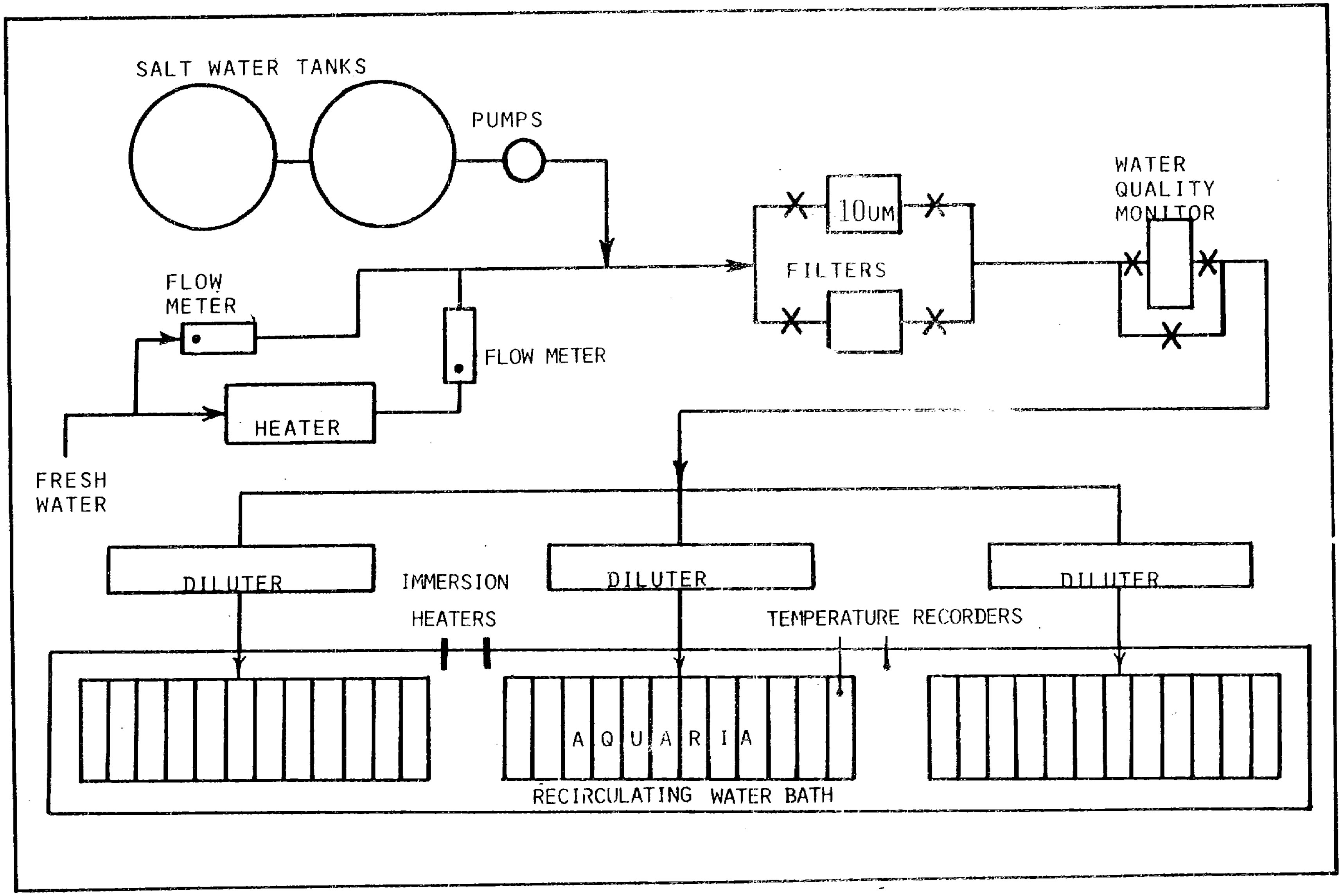

FIGURE 14. SCHEMATIC DIAGRAM OF DILUTION WATER DELIVERY SYSTEM FOR THE TOXICITY TESTING FACILITY.

500 um mesh polypropylene screen, used in Test Series 2 and 3 (Figure 16); 3) a 14 x 8 x 13 cm box manufactured from 500 um mesh polypropylene screen, used in Test Series 4; 4) a 13 x 13 x 10 cm box manufactured from 350 um mesh polypropylene screen (sides) and 500 um mesh polypropylene screen (bottom), used in Test Series 5, 6, 7, and 8 (Figure 17); and 5) a 13 x 13 x 13 cm box manufactured from 3.3 mm plate glass (sides) and 500 um mesh polypropylene screen (bottom), used in Test Series 8 (Figure 18). The flow-through egg chambers (Figure 15) were connected directly to the diluters by teflon tubing, and the flows through the chambers were controlled by pinch clamps. The boxes were suspended from the top edges of the aquaria. Glass marbles were placed in the bottoms of the all-polypropylene boxes to keep them from floating due to air bubble entrapment.

Water temperatures in the test aquaria were maintained at 19 ± 0.5 C (mean ± SD). The aquaria were immersed in constant temperature water baths. There were three water baths (12 aquaria per bath) interconnected to a central reservoir. Water in the reservoir was pumped into the three water baths, circulated between the aquaria, and returned by gravity flow to the central reservoir. The water in the reservoir was heated by submersible quartz heaters controlled by a Cole-Parmer proportional indicating electronic temperature controller. The baths were cooled by the overhead Coleman air conditioner. Temperatures in the water baths and the aquaria

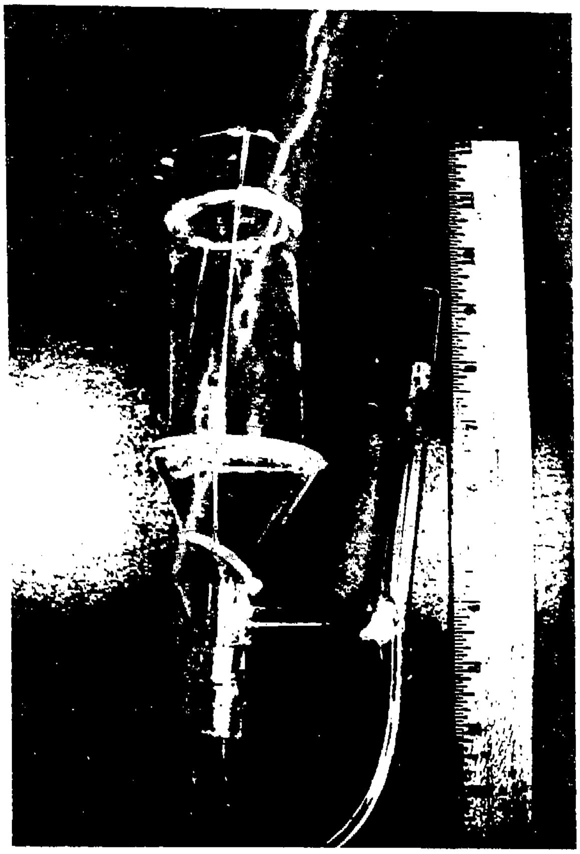

FIGURE 15. EGG TEST CHAMBER USED IN TEST SERIES No.1.

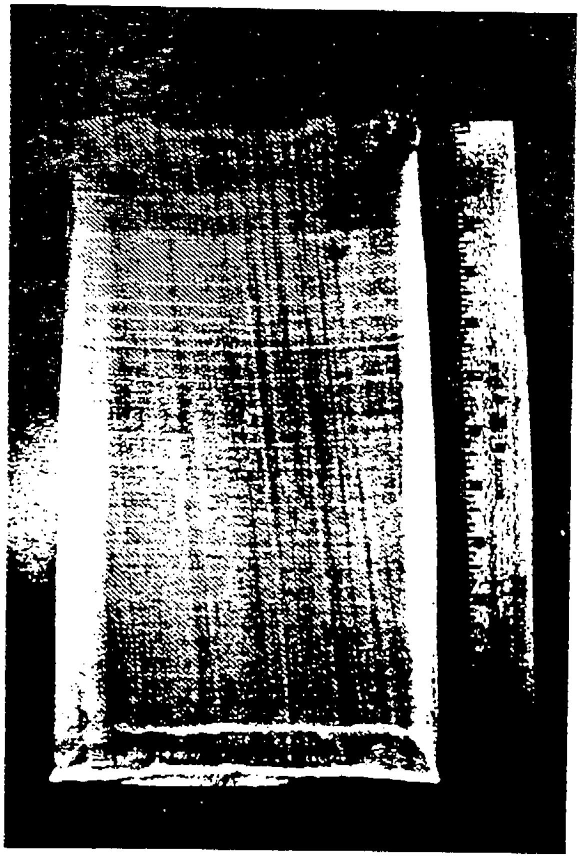

Figure 16. Larval test chamber (14 x 8 x 25 cm) made of 500 um polypropylene screen. Used fro Test Series No. 2 and 3.

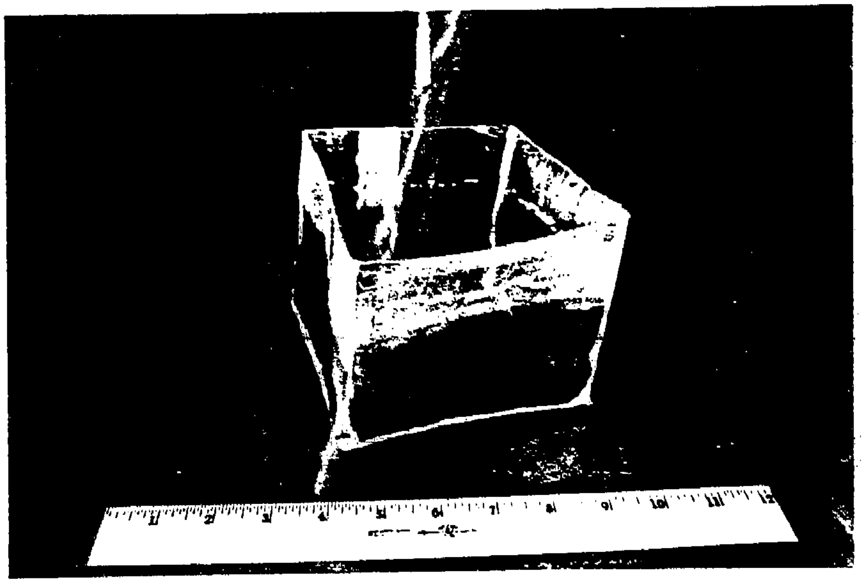

FIGURE 17. LARVAL TEST CHAMBER (13 x 13 x 10 CM) MADE OF 350 UM POLYPROPYLENE SCREEN SIDES AND A 500 UM POLYPROPYLENE SCREEN BOTTOM. USED IN TEST SERIES 5, 6, 7, AND 8.

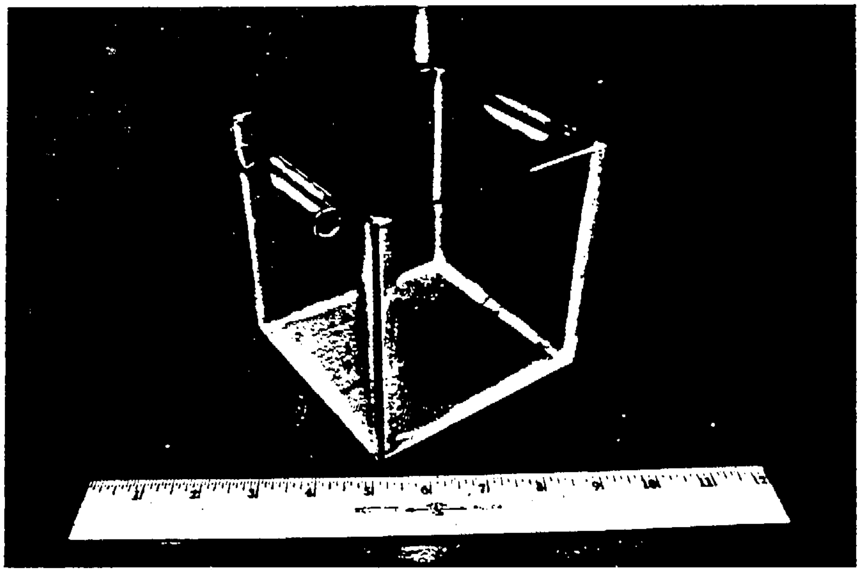

FIGURE 18. LARVAL TEST CHAMBER (13 X 13 X 13 CM) MADE WITH GLASS SIDES AND 500 UM POLYPROPYLENE SCREEN BOTTOM. USED IN TEST SERIES 8.

were continuously monitored by platinum thermometers and recorded on a Cole-Parmer two-channel strip chart recorder (Figure 14).

Acute (144-hr) toxicity tests were conducted on embryo, prolarval, and postlarval fish (Table 3). Approximately 50 embryos were placed in each test chamber, and approximately 50 larvae were placed in each test chamber at a density of 25 larvae per liter as recommended by Burton (1982). Each aquarium had one test chamber, and there were two aquaria per concentration. Thus, approximately 100 individuals per concentration were exposed in the acute toxicity tests.

Chronic (21-day) toxicity tests were conducted on 28-day old postlarvae (Table 3). Three test chambers were placed in each aquarium. Survival was monitored in two of the test chambers, and individuals in the third test chamber were collected for histological examination. Approximately 25 larvae were placed in each test chamber at a density of 12 larvae per liter. Thus, approximately 100 individuals per concentration were exposed in the chronic tests.

The larvae were fed twice daily at 0800 and 1600 hours at an optimum nauplii density of approximately 5,000 liter as recommended by Rogers et al. (1982).

Water samples for a confirmation of molinate and thiobencarb concentrations were collected with glass pipettes and deposited in borosilicate glass bottles. The samples were immediately preserved with 100 ml of petroleum ether. Samples were taken three times during the acute toxicity tests at 24, 72, 120 hours and twice weekly during the chronic tests. The samples were analyzed for molinate and thiobencarb concentrations at the CDFG Water Pollution Control Laboratory. The glass sample bottles and pipettes were chemically cleaned after use by soaking in 1N sodium hydroxide for 24 hours, rinsing with hot tapwater, washing with hot soapy water, rinsing with tapwater, rinsing three times with deionized water, and finally rinsing with a mixture (1 + 1) of petroleum ether and acetone.

Dead larvae were recorded and removed daily. A fish was considered dead if it did not respond to external stimulii or if it had turned opaque.

Length measurements of larvae were made at the termination of acute and chronic tests. Total length measurements were made on prolarvae using a calibarated ocular micrometer graduated to 0.01 mm. Total length was measured from the anterior tip of snout to the end of the notochord. Fork length measurements were made on postlarvae using a calibrated microscope slide to 0.1 mm. Total and fork length measurements were made because of damage often occuring to the tail fin.

Samples of larvae were taken for histopathological examination at the termination of the acute and chronic toxicity tests. Each sample consisted of five fish from each concentation which were preserved in bouin´s solution and fixed for later examination.

Toxicants and Delivery Systems

Molinate and thiobencarb solutions were prepared from Ordram 8 EC and Bolero 8EC commercial herbicide formulations (containing 90.3 and 85.4% active ingredient, respectively) by sonicating them in distilled water. A Heat Systems-Ultrasonics Model W-370 Cell Disrupter was used for sonication. The solutions were made up in 15 liter quantities and stored in 20 liter glass jars with lids; 15 liters was sufficient for a 6-day acute toxicity test. New solutions were prepared weekly during the 21-day chronic tests. The solutions were supplied to the toxicant mixing chambers of the diluters using Gilson peristaltic pumps and silicone tubing. The solutions were checked analytically for molinate and thiobencarb content at the beginning and end of use.

Data Analysis

All statistical calculations were computed on a 16-bit NEC APC microcomputer (11,000 K RAM, 126 K ROM) with Ashton-Tate D-Base II assembler and Digital Research CB86 Basic compiler. Survival data from the acute and chronic tests were analyzed by the binomial chi-square test for data arranged in two groups (Cochran and Cox 1968).

Median lethal concentration (LC50) values were calculated for the acute tests. The tests were considered invalid if mortality of the controls was > 20%. Abbot's correction factor was used when control mortality was > 10% and $\leq$ 20%

$$Mx(a) = 1 - Sx/Sc$$

where Mx(a) is adjusted mortality in concentration x, Sx is survival in concentration x, and Sc is survival in controls (Finley 1971).

The Mx(a) was used to calculate the adjusted number dead in concentration x

$$Dx(a) = Mx(a)*Ex$$

where Dx(a) is the adjusted number dead in concentration x and Ex is the number exposed in concentration x. The LC50 values were determined using either moving average method when $\geq$ 1 toxicant concentrations had partial mortality (between 0 and 100% mortality) or nonlinear interpolation method when no toxicant concentration had partial mortality (Stephan 1977). Angle transformation of mortality was used in the calculations:

$$V = 1/2\ [\text{Arcsin}\quad Dx/(Ex + 1) + \text{Arcsin}\quad (Dx + 1)/(Ex + 1)]$$

where V is the transformation, Ex is the number exposed and Dx (or Dx[a]) is the number dead in concentration x. Exact (95%) confidence intervals were calculated using Fullers Theorem (moving average), or conservative (> 95%) confidence intervals were calculated using binomial probabilities (nonlinear interpolation) according to methods given by Stephan (1977).

In herbicide mixture tests, molinate and thiobencarb concentrations at the LC50 level were interpolated from least squares regression (solution concentration versus herbicide concentration). To determine the type of toxic interaction of molinate and thiobencarb in mixtures, toxicities of the herbicides in mixtures were expressed as toxic units and summed (Lloyd 1961; Brown 1968):

$$(Mm/Mi) + (Tm/Ti) = S$$

where M is molinate and T is thiobencarb, i is LC50 of individual herbicide tested separately, and m is the concentration of the individual herbicide at the mixture LC50 value. Additive indexes (AI) were calculated by adjusting for asymmetry of S and substituting 95% confidence intervals for the 96-hr LC50 values and establishing a test range (Marking 1977) as follows:

$$\text{If } S \geq 1.0 \text{ then } AI = -S + 1.0;$$

$$\text{If } S \leq 1.0 \text{ then } AI = 1/S -1.0.$$

This index is symmetrical about AI = 0 (additivity); positive values indicate synergism, negative values antagonism. The theoretical range of completely (simple) additive toxicity (AI = 0) for the herbicide mixture tests were estimated by adjusting the herbicide mixture LC50 values to S = 1.0, substituting the adjusted 95% confidence intervals into the two AI equations and establishing an additive range (Finlayson and Verrue 1982). To determine the type of interaction, the two ranges were compared as follows: if the test range broadly (> 50%) overlapped the additive range then additive toxicity; if most of the test range (>50%) was below the additive range then antagonistic toxicity; and if most of the test range (>50%) was above the additive range then synergistic toxicity.

Length measurements of larvae from control and treatment groups were compared in the acute and chronic tests. Significant differences between the control and treatment groups were determined by the Kruskal-Wallis test with Dunn's multiple comparison procedure (Daniel 1978).

Chemistry

Molinate and thiobencarb concentrations in water were analyzed by the methods outlined in Finlayson et al. (1982). A quantity of test water was extracted twice with 100 ml each of petroleum ether. The extracts were combined and then analyzed with a Varian Aerograph Model 3700 gas liquid chromatograph with the following conditions:

Column: DC200, length 183 cm

ID: 2 mm

Detector temperature: 290 C

Injector temperature: 210 C

Column temperature: 192 C for thiobencarb; 180 C for moliante

Carrier gas: N_2

Carrier flow: 20 ml/min

Detector: TSD

Detection limits: 1 ug/liter for both molinate and thiobencarb.

The toxicant concentrations were averaged for the testing period, and the means were used in the calculations of LC50 values.

RESULTS

Water Quality and Toxicant Stability

The mean salinity of the dilution water for the acute toxicity tests ranged from 1.84 to 2.14 o/oo (Table 5). The mean salinity of the dilution water for the chronic toxicity tests was 1.85 o/oo. The daily means for the acute and chronic tests are summarized in Appendicies A and B, respectively.

The mean temperatures for the dilution water for the acute toxicity tests ranged from 17.4 to 17.9 C (Table 5). The mean temperature for the dilution water for the chronic tests was 18.2 C. The temperature of the water in the test aquaria averaged 19 C due to additional warming by the recirculating water bath. The daily means for the acute individual tests are summarized in Appendicies A and B.

The mean pH for the dilution water for the tests ranged from 8.5 to 9.0 (Table 5), and the dissolved oxygen ranged from 99 to 136% of saturation. The daily means for pH and dissolved oxygen for the acute and chronic tests are summarized in Appendicies A and B, respectively.

For the herbicides tested individually, the measured molinate and thiobencarb concentrations in the test aquaria averaged 94% and 87% of expected, respectively, based on analyses stock solutions and known dilution rates. For the herbicide mixture tests, measured molinate and thiobencarb concentrations in the test aquaria averaged 85 and 99% of expected, respectively.

Success of Culture and Test Methods

We did not design a protocol to monitor survival of larvae in the rearing system. Based on visual observations, it appeared that we had success comparable to that noted in the literature (Rogers et al. 1982).

Table 5. Mean quality of dilution water after heating and salt adjustment.

Test Series	N	Date	Salinity (o/oo)	Temperature (C)	pH	Dissolved Oxygen (mg/liter)
5	234	5-11 to 5-17-84	1.97 ± 0.22[a]	17.4 ± 0.9	8.98 ± 0.27	13.1 ± 0.7
6	251	5-18 to 5-24-84	2.14 ± 0.34	17.6 ± 0.8	8.95 ± 0.35	12.9 ± 1.5
7	250	5-29 to 6-4-84	1.84 ± 0.29	17.9 ± 1.1	8.84 ± 0.33	10.9 ± 0.6
8	922	6-8 to 6-29-84	1.85 ± 0.32	18.2 ± 1.2	8.52 ± 0.50	9.5 ± 0.9

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[a] Mean ± SD.

The larvae reared in our system appeared to have growth rates (Figure 19) comparable to those reported by Eldridge et al. (1981) for larvae which were fed a similar quantity of brine shrimp.

Toxicity of Thiobencarb and Molinate

The concentrations of molinate and thiobencarb tested produced dose related responses in survival of 6-day old (Table 6), 7-day old (Table 7), and 24-day old fish (Table 8). The lowest molinate and thiobencarb concentrations tested individually which significantly lowered survival during the 144-hour exposures were 7.6 and 0.19 mg/liter, respectively. For the herbicide mixture tests, the lowest molinate and thiobencarb concentrations tested which significantly lowered survival were 2.0 and 0.16 mg/liter, respectively. Growth was not measured in the test on 6-day old fish (Test Series 5) and none of the herbicide concentrations tested significantly lowered growth of the 24-day old fish (Test Series 7). Herbicide concentrations producing greater than 40% mortality significantly lowered growth of 7-day old fish (Test Series 6) during the 144-hour exposure, and this effect appeared to be dose related. The data from Test Series 6 were, however, questionable because of the high mortality of control fish (27 to 37%). Mortality of controls in Test Series 5 (6-day old larvae) and 7 (24-day old larvae) ranged from 2 to 17% with a mean of 7.5%.

Thiobencarb was on the average 14 times more toxic than molinate to larval striped bass based on 96-hr LC50 values. The toxicity of molinate and thiobencarb and the herbicide mixture increased with exposure time and decreased with age of larvae (Table 9). The 96-hr LC50 values for 6-day and 24-day old larvae exposed to the herbicides separately were 6.6 and 7.9 mg/liter molinate and 0.35 and 0.67 mg/liter thiobencarb, respectively. The

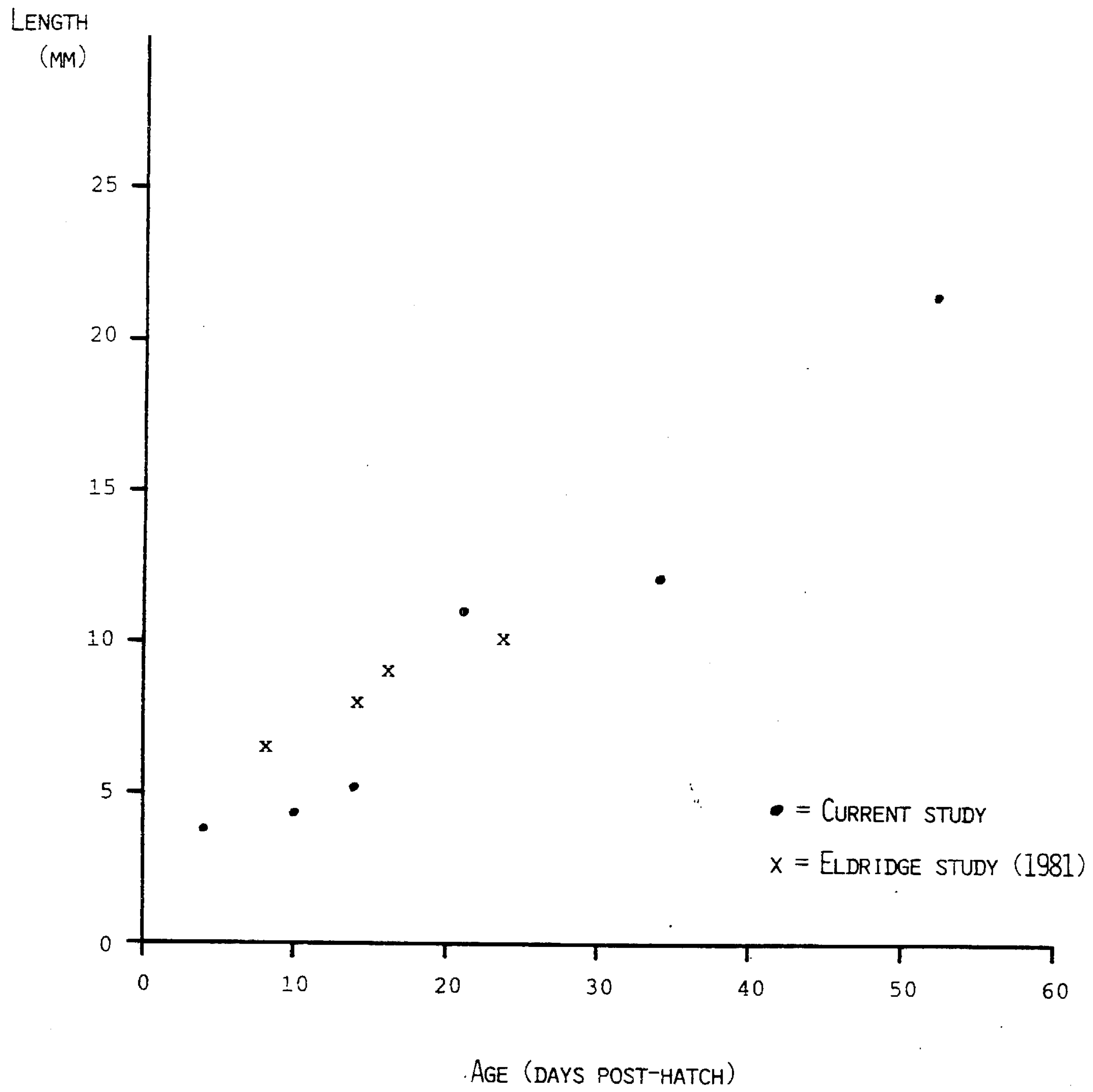

Figure 19. Larval growth in our rearing system compared to that reported by Eldridge et al. (1981).

Table 6. Acute effects (144-hr) of molinate and thiobencarb concentrations (mg/liter) on survival of 6-day old (Test Series 5) striped bass larvae (mean values with SD in parentheses).

Molinate		Thiobencarb		Molinate and Thiobencarb Mixture	
Molinate Concentration	Mortality (%)	Thiobencarb Concentration	Mortality (%)	Molinate nad Thiobencarb Concentration	Mortality (%)
Control (<0.31(0.23))	6	Control (<0.1(0))	12	Control (<0.16(0.08)) (<0.10(0))	4
2.6(0.55)	23[a]	0.12(0.01)	15	0.79(0.21) 0.07(0.03)	7
4.2(0.54)	20[a]	0.19(0.02)	31[a]	2.0(0.76) 0.16(0.05)	19[a]
6.6(0.52)	54[a]	0.37(0.04)	44[a]	3.1(1.0) 0.24(0.08)	46[a]
13.0(1.3)	100[a]	0.72(0.10)	100[a]	6.0(2.3) 0.49(0.15)	100[a]
20.0(1.8)	100[a]	1.2(0.05)	100[a]	8.6(2.9) 0.83(0.19)	100[a]

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[a] Significantly greater than controls (x^2, 0.05).

Table 7. Acute effects (144-hr) of molinate and thiobencarb concentrations (mg/liter) on growth and survival (mean values with SD in parentheses) of 7-day (Test Series 6) striped bass larvae.

Molinate				Thiobencarb				Molinate and Thiobencarb Mixture			
Molinate Concentration	Mortality (%)	Fish Length (mm)	N[a]	Thiobencarb Concentration	Mortality (%)	Fish Length (mm)	N	Molinate & Thiobencarb Concentration	Mortality (%)	Fish Length (mm)	N
Control (<0.14(0.06))	27	5.09(0.49)	25	Control (<0.1(0))	37	4.74(0.47)	24	Control (<0.12(0.04)) (<0.10(0))	37	5.08(0.55)	25
2.6(0.4)	45[b]	4.88(0.61)	10	0.13(0.03)	42	4.97(0.58)	24	0.86(0.44) 0.07(0.02)	34	4.50(0.46)[c]	25
3.8(0.4)	46[b]	4.59(0.43)[c]	25	0.23(0.08)	34	4.58(0.50)	24	3.6(0.9) 0.28(0.07)	55[b]	4.18(0.27)[c]	3
6.5(0.6)	60[b]	4.06(0.28)[c]	23	0.39(0.03)	41[b]	4.13(0.22)[c]	19	5.4(1.30) 0.40(0.12)	68[b]	3.99(0.70)[c]	12
11.0(1.1)	100[b]	-	-	0.63(0.08)	85[b]	4.06(0.22)[c]	6	10.0(3.50) 0.74(0.20)	100[b]	-	-
20.0(2.9)	100[b]	-	-	1.1(0.12)	100[b]	-	-	21.0(6.3) 1.5(0.04)	100[b]	-	-

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[a] N = number of fish measured.

[b] Significantly greater than controls (x^2, 0.05).

[c] Significantly smaller than controls (z, 0.05).

Table 8. Acute effects (144-hr) of molinate and thiobencarb concentrations (mg/liter) on growth and survival (mean values with SD in parentheses) of 24-day (Test Series 7) striped bass larvae.

Molinate				Thiobencarb				Molinate and Thiobencarb Mixture			
Molinate Concentration	Mortality (%)	Fish Length (mm)	N[a]	Thiobencarb Concentration	Mortality (%)	Fish Length (mm)	N	Molinate & Thiobencarb Concentration	Mortality (%)	Fish Length (mm)	N
Control (<0.29(0.19))	2	8.02(0.71)	25	Control (<0.1)	17	8.33(0.75)	25	Control (<0.15(0.06) (<0.10(0)	4	7.82(0.53)	25
3.6(1.3)	60[b]	8.18(1.11)	10	0.20(0.04)	33	8.48(0.31)	5	0.49(0.18) <0.1(0)	10	7.42(0.40)[c]	25
5.4(1.7)	52[b]	8.30(0.33)	18	0.27(0.05)	20	8.24(0.65)	25	2.6(1.1) 0.19(0.06)	87[b]	8.28(0.29)	3
8.9(2.5)	34[b]	7.82(0.31)	20	0.45(0.05)	57[b]	7.52(0.70)	25	3.8(0.58) 0.30(0.03)	92[b]	7.40(0.95)	2
13.0(1.3)	100[b]	-	-	0.75(0.09)	92[b]	7.93(0.07)	4	8.0(0.19) 0.60(0.05)	100[b]	-	-
20.0(1.4)	100[b]	-	-	1.3(0.12)	100[b]	-	-	14.0(0.5) 1.1(0.05)	100[b]	-	-

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[a] N = number of fish measured.

[b] Significantly greater than controls (x^2, 0.05).

[c] Significantly smaller than controls (z, 0.05).

Table 9. Mean lethal (LC50 values) and 95% confidence interval (in parentheses) concentrations (mg/liter) of molinate (Ordram 8EC) and thiobencarb (Bolero 8EC) to larval striped bass.

			LC50 Values					
			Molinate			Thiobencarb		
Fish Age (d)	Fish Length (mm)	Test Series	48-hr	96-hr	144-hr	48-hr	96-hr	144-hr
6	5.52(0.38)[a]	5	10.0 (9.6-11.0)	6.6 (6.1-7.1)	5.4 (4.9-5.9)			
						0.78 (0.72-0.84)	0.35 (0.30-0.39)	0.32 (0.29-0.35)
			5.2 (4.8-5.6)	3.8 (3.5-4.2)	2.7 (2.4-2.9)	0.46 (0.42-0.51)	0.33 (0.30-0.37)	0.22 (0.19-0.24)
24	8.06(0.66)	7	13.0 (12.0-14.0)	7.9 (71.-8.7)	-			
						-	0.67 (0.61-0.74)	0.46 (0.41-0.52)
			7.7 (6.7-8.8)	3.1 (2.6-3.6)	1.4 (1.2-1.7)	0.60 (0.52-0.68)	0.24 (0.20-0.28)	0.11 (0.09-0.13)

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[a] Mean ± SD in parentheses.

96-hr LC50 values for 6-day and 24-day old fish exposed to the herbicide mixture were 3.8 mg/liter molinate and 0.33 mg/liter thiobencarb, and 3.1 mg/liter molinate and 0.24 mg/liter thiobencarb, respectively. The toxicity of the herbicides to 6-day old fish increased with increased exposure. The LC50 values for molinate decreased from 10.0 to 5.4 mg/liter and for thiobencarb decreased from 0.78 to 0.32 mg/liter with an increase in exposure from 48 to 144 hr.

The molinate and thiobencarb mixtures produced AI ranges indicating slightly less than additive (6-day old larvae) and slightly greater than additivity (24-day old fish) toxicity (Figure 20). Collectively, the tests suggest simple additivity between molinate and thiobencarb in a mixture. The data summary sheets for the acute tests with the 6-day, 7-day, and 24-day old fish are presented in Appendix C.

None of the molinate concentrations tested seperately in the 21-day chronic test significantly lowered survival or growth of 28-day old postlarvae (Table 10). The highest thiobencarb concentration (0.074 mg/liter) tested seperately significantly lowered growth. However, high mortality (32 to 49%) in the control groups of the chronic tests with individual herbicides makes any conclusions from the data questionable. None of the molinate and thiobencarb concentrations in the herbicide mixture chronic test significantly lowered survival but concentrations $\geq$ 0.20 mg/liter molinate and $\geq$ 0.009 mg/liter thiobencarb significantly lowered growth of the postlarvae. This effect on growth appeared to be dose related. Thus, a no observable effect level (NOEL) for 28-day old fish

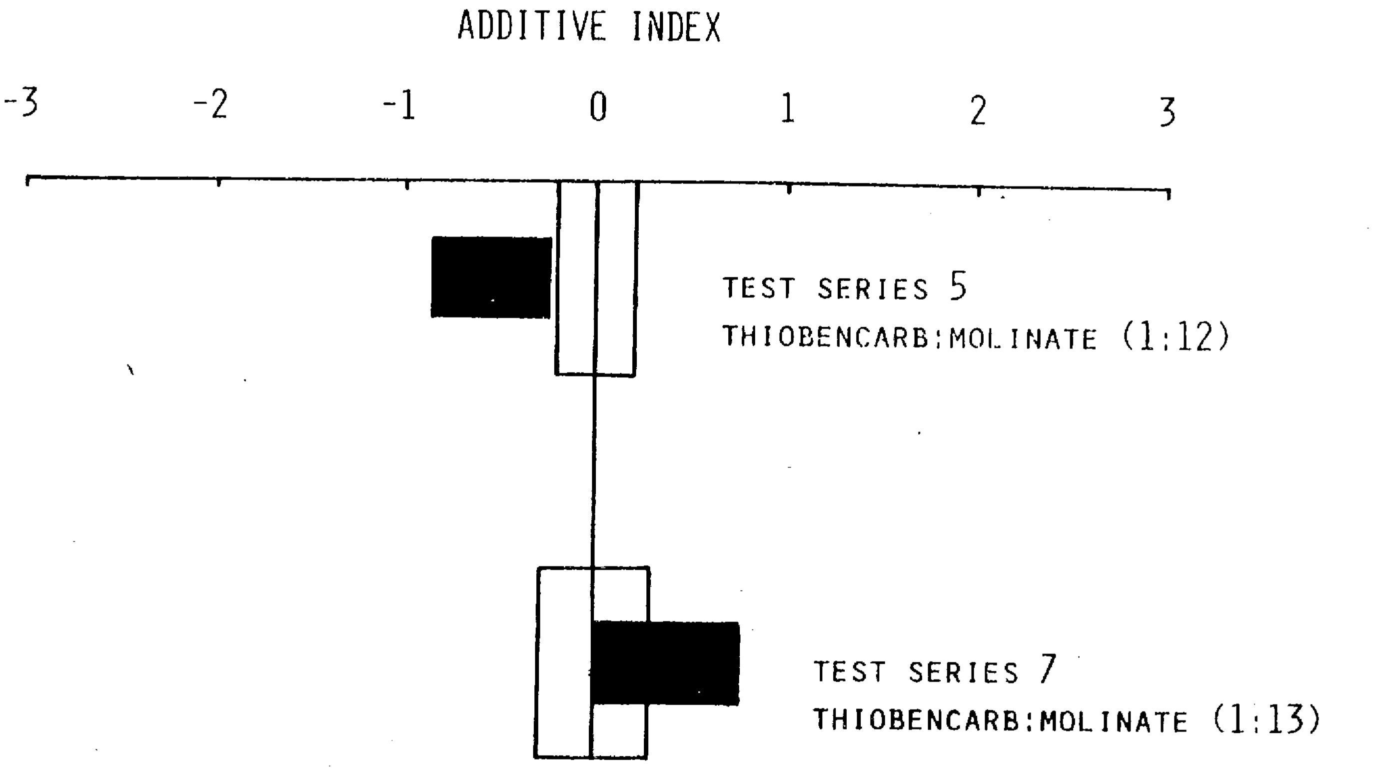

FIGURE 20.

ADDITIVE INDEX RANGES OF MOLINATE AND THIOBENCARB IN TOXICITY TESTS WITH STRIPED BASS (BASED ON 96-HR LC50 VALUES). TEST RANGE COMPARED WITH CALCULATED RANGE OF SIMPLE ADDITIVITY.

☐ ADDITIVE RANGE

■ TEST RANGE

Table 10. Chronic effects (21-day) of molinate and thiobencarb concentrations (mg/liter) on growth and survival (mean values with SD in parentheses) of 28-day old (Test Series 5) striped bass larvae.

Molinate				Thiobencarb				Molinate and Thiobencarb Mixture			
Molinate Concentration	Mortality (%)	Fish Length (mm)	N[a]	Thiobencarb Concentration	Mortality (%)	Fish Length (mm)	N	Molinate & Thiobencarb Concentration	Mortality (%)	Fish Length (mm)	N
Control (<0.13(0.05))	49	17.2(1.4)	25	Control (<0.001(0.001))	32	20.1(1.5)	14	Control (<0.08(0.04)) (<0.002(0.002))	16	19.4(1.6)	25
0.16(0.07)	18	18.6(1.3)	25	0.010(0.004)	8	18.9(1.4)	25	0.18(0.17) 0.003(0.001)	21	18.6(1.3)	25
0.20(0.04)	3	18.3(1.3)	25	0.015(0.003)	28	19.4(1.5)	25	0.20(0.08) 0.006(0.002)	19	18.7(1.7)	25
0.28(0.09)	16	17.7(1.3)	25	0.022(0.006)	9	19.0(1.4)	25	0.20(0.09) 0.009(0.002)	18	18.7(1.6)[b]	25
0.45(0.07)	20	17.6(1.1)	25	0.041(0.018)	2	19.5(1.8)	25	0.43(0.10) 0.020(0.005)	13	17.5(1.3)[b]	25
0.79(0.10)	35	18.3(1.6)	25	0.074(0.013)	20	17.8(1.4)[b]	25	0.68(0.12) 0.046(0.014)	17	17.1(1.2)[b]	25

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[a] N = number of fish measured.

[b] Significantly smaller than controls (x, 0.05).

exposed to the herbicide mixture for 21 days was 0.20 mg/liter molinate and 0.006 mg/liter thiobencarb.

The specimens collected from the acute and chronic tests for histological examination have not been processed at the time of writing this report. Results of their examination will be presented in an addendum to this progress report.

DISCUSSION

Water Quality and Toxicant Stability

The raw water from the American River used for dilution in the tests was adjusted to a desired salinity of 2 o/oo and a temperature of 19 C. Water was warmed from ambient (14 to 16 C) to 17 to 18 C with the hotwater heater and further warmed to 19 C by heat transfer from the recirculating water bath. The recirculating water bath was kept at 20 C with the use of overhead air conditioning and heating probes. Excellent temperature control of dilution water was obtained with this two stage temperature system. Mean water temperature during the tests was 19.0 ± 0.5 C (± SD).

Because we used overhead air conditioning for cooling the recirculating water bath, the testing room had no ventilation. Volatilization of molinate is a well known phenomenon and is believed to be the major mode of Ordram dissipation from rice fields (Cornacchia et al., 1984). Molinate volitized off the test aquaria and because of a lack of room ventillation, was deposited into the control aquaria in significant amounts (up to 0.3 mg/liter). To prevent this from reoccuring, ventilation fans will be installed in the test room, and the water bath will be cooled by a recirculating water chiller.

Mean salinities of dilution water for the tests ranged from 1.8 to 2.1 o/oo. Although Rogers et al. (1982) suggests increasing salinities (5 to 15 o/oo) with increasing age of striped bass larvae for optimum survival. We obtained, however, as low as 2% mortality in control groups at 2 o/oo. Salinities of 1 to 3 o/oo can be expected in the "salt wedge" of the Sacramento River estuary (Knutson and Orsi 1982) and thus, a salinity of approximately 2 o/oo more closely mimics environmental conditions of

Sacramento River spawned striped bass larvae. We suspect that the higher mortality of some control groups was due to poor water circulation in the test chambers leading to low dissolved oxygen and high ammonia concentrations, rather than due to low salinities. The salinity of 2 o/oo will be used in future tests. Little variation in salinity occured during the tests and no changes are expected in this system next year.

Variation of toxicant concentrations in test aquaria was dependent on the type of diluter used. For the solenoid valve proportional diluters (single herbicide tests), the standard deviation of the mean toxicant concentration was within ± 10% for acute and ± 17% for the chronic tests. For the rotameter diluter (herbicide mixture tests), the standard deviation of the mean toxicant concentration was within ± 45% for both the acute and chronic tests. The toxicant variation (± 10%) in the acute tests with the proportional diluters is acceptable. The higher variation (± 17%) with the proportional diluters was probably due to the use of three toxicant stock solutions during the 21-day tests and therefore, not reflective of diluter performance. The large variation (± 45%) in the tests with the rotameter diluter can be attributed to the blocking of the rotameters by air bubbles and solid matter, and changes in pressure of dilution water and toxicant. The rotamenter diluter will be replaced by a solenoid valve proportional diluter in future tests to bring toxicant variation in the herbicide mixture tests in line with that of the individual herbicide tests.

Success of Culture and Test Methods

We did not design a protocol to monitor survival of larvae in the rearing system. Based on visual observations, it appeared that we had success comparable to that noted in the literature (Rogers et al. 1982).

The larvae reared in our system appeared to have a growth rate comparable to that reported by Eldridge et al. (1981) who fed larvae a similar quantity of brine shrimp nauplii. We will be feeding the larvae in the rearing and testing systems three times per day at the same nauplii density in the future.

The larvae in our system had problems inflating their gas bladders which is common in all hatchery operations (Lewis and Heidinger 1981). We will be modifying our culturing system next year by switching from an upwelling current to a circular current when the larvae are able to swim. There is some indication that larvae kept in an upwelling current have more problems inflating their gas bladders than those kept in a circular current (Lewis and Heidinger 1981).

We encountered difficulty confining larvae in the test chambers without causing high mortality. The egg test chambers described by Burton (1982) did not work well in our test system. We experienced difficulty in regulating water flows through the chamber at a constant rate. The hatching prolarvae are positive rheotaxic and positive phototrophic which caused them to swim to the top of the chamber and impinge themselves against the screen, producing death.

The all-polypropylene screen test chambers were difficult to work with and produced high mortality of larvae. They were difficult to work with because of their tendency to float and produced high mortality because of inadequate water exchange and current and the tendency of larvae to swim into the side screens. The test chambers with glass sides did not float but still lacked sufficient water exchange and current; however, the larvae did not impinge themselves in the screen mesh which produced higher survival.

Airlifts will be added to the glass chambers in the future to create water currents and an exchange of water between the test aquaria and the test chambers.

Toxicicty of Molinate and Thiobencarb

The acute 96-hour LC50 value of molinate for 6-day old fish (6.6 mg/liter) was 19% less than that of the 24-day old fish (7.9 mg/liter). The toxicity of molinate to larval striped bass (LC50 values of 6.6 to 7.9 mg/liter) is slightly less than that to juvenile striped bass (LC50 value of 8.1 mg/liter) as determined by Finlayson and Faggella (MS 1984).

The acute 96-hour LC50 value of thiobencarb for the 6-day old fish (0.35 mg/liter) was 48% less than that of the 24-day old fish (0.67 mg/liter). The 24-day old fish appear to have approximately the same sensitivity (96-hr LC50 values in parentheses) as juvenile striped bass (0.76 mg/liter), chinook salmon (0.76 mg/liter), and rainbow trout (0.79 mg/liter) as determined by Finlayson and Faggella (MS 1984).

Thiobencarb was 16 times more acutely toxic than molinate to larval striped bass. The difference in toxicity between thiobencarb and molinate, based on 96-hr LC50 values, ranged from 19 times to 12 times for 24-day and 6-day old fish, respectively. The differences in acute toxicity between thiobencarb and molinate for juvenile fishes are 11 times for striped bass, 18 times for steelhead trout, 17 times for chinook salmon, and 19 times for channel catfish (Finlayson and Faggella MS 1984).

Test ranges, based on 96-hr LC50 values, indicated that the molinate and thiobencarb in a mixture produce slightly less than simple additivity (antagonism) to 6-day old fish but slightly greater than simple additivity (synergism) to 24-day old fish. Collectively, the data suggests that the toxicity of molinate and thiobencarb in an equitoxic mixture is additive to larval striped bass. Likewise, thiobencarb and molinate in equitoxic mixtures produce additive toxic effects to junvenile steelhead trout, channel catfish, and chinook salmon (Finlayson and Faggella MS 1984).

Growth was measured in acute tests conducted on 7-day old fish (Test Series 6) and 24-day old fish (Test Series 7). Thiobencarb and molinate individually and in a mixture significantly lowered the growth of the 7-day old fish in a dose related fashion but the same effects did not occur in the test on the 24-day old fish. The 7-day old fish are growing at a faster rate relative to their body size than the 24-day old fish (Eldridge et al. 1981). Thus, effects on growth caused by toxicant stress would be more noticeable with the 7-day rather than 24-day old fish. The data from the tests with the 7-day old fish were, however, questionable becuase of the low survival in the control groups, suggesting that the larvae were under extreneous stress. Thus, these data cannot be accepted as unequivocal evidence that molinate and thiobencarb affected growth of larval striped bass under these test conditions.

None of the molinate and thiobencarb concentrations either singly or in combination significantly reduced survival of 28-day old larvae during the 21-day chronic tests. None of the molinate concentrationions tested individually and only the highest thiobencarb concentration tested individually significantly reduced growth. Additionally, the control groups from both tests on the individual herbicides had high mortality. A NOEL of 0.20 mg/liter molinate and 0.06 mg/liter thiobencarb was observed in the herbicide mixture test based on reduced growth. It is believed that chronic tests with younger larvae will yield lower NOEL values because the younger larvae were more sensitive to both herbicides and are growing at a faster rate.

Additional Studies

The laboratory tests will be repeated in 1985 and the field tests will be done in 1986. Recommended culture and testing protocols for larval striped bass which will be used in 1985 are presented in Appendix E.

The larval acute tests will be repeated next year because of high (>20%) mortality of control groups in Test Series 6, the large variation of toxicant concentrations in the herbicide mixture tests, and significant molinate contamination of the dilution water in the control group aquaria. The chronic tests as well will be repeated next year because of the same biological and systematic problems.

The high mortality of control groups in Test Series 6 may be due to this family originating from a bad batch of eggs or may be due to low dissolved oxygen or high ammonia concentrations in the test chambers. Low dissolved oxygen in the test chambers could have been caused by poor water circulation in the chamber resulting from brine shrimp clogging the screens.

The changes which will be made in the testing protocol for next year are as follows:

1) The glass and net test chambers will have air lifts to continuously replenish the test chamber water and assure sufficient dissolved oxygen concentrations. The air lift will also produce a small current in the test chamber which will keep the embryos and larvae suspended and divorced from escape behavior;

2) The rotameter diluter will be replaced by a solenoid valve proportional diluter which will decrease the variability of toxicant concentrations;

3) Ventilation fans will be installed in the test room to expell volatilized molinate and prevent its introduction into other test troughs;

4) A one-ton water chiller will be used to cool the recirculating water bath to 19 C;

5) The larvae will be fed brine shrimp nauplii once every eight hours (3 times daily) to insure maximum growth;

6) The brine shrimp nauplii will be better seperated from the cysts to keep clogging of the test chambers and build-up in the rearing tanks to a minimum; and

7) The larvae in the rearing facility will be exposed to both upwelling and circular currents to improve air bladder inflation.

In addition to the above changes in testing and rearing protocol, analysis of macromolecular content (RNA, DNA, and protein) will be used in addition to growth measurements to assess effects of the herbicides on larval striped bass. This procedure has successfully been used to detect biochemical changes during toxicosis that precede reductions in growth of larval fish exposed to various toxicants (Barion and Adelman 1984).

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Appendix A-1. Water quality of dilution water used for 6-day (Test Series 5) acute tests on molinate and thiobencarb.

Daily Water Quality Statistics

Date	Conductivity (umhos/cm)	Dissolved Oxygen (mg/liter)	Temperature (C)	pH
5/11/84[a] (31)	3,502 ± 34[b] (3,249 - 3,800)	13.17 ± .12 (11.8 - 14.14)	17.86 ± .17 (15.67 - 19.86)	9.37 ± .01 (9.32 - 9.67)
5/12/84 (19)	3,139 ± 25 (2,965 - 3,298)	13.38 ± .11 (12.45 - 13.98)	16.74 ± .09 (16.25 - 17.39)	9.3 ± .01 (9.26 - 9.33)
5/13/84 (17)	3,923 ± 93 (2,904 - 4,313)	13.04 ± .15 (12.13 - 14.08)	18.82 ± .08 (18.35 - 19.39)	8.83 ± .05 (8.72 - 9.24)
5/14/84 (32)	3,672 ± 54 (3,340 - 4,221)	13.13 ± .1 (11.8 - 14.47)	17.4 ± .06 (16.81 - 13)	8.77 ± .05 (8.5 - 9.21)
5/15/84 (48)	3,927 ± 22 (3,482 - 4,274)	12.95 ± .14 (8 - 14.82)	17.23 ± .15 (13.63 - 18.75)	9.10 ± .01 (8.99 - 9.22)
5/16/84 (49)	3,536 ± 46 (3,064 - 4,011)	13.20 ± .10 (11.55 - 14.47)	17.21 ± .14 (13.51 - 18.28)	8.91 ± .01 (8.8 - 9.01)
5/17/84 (38)	3,052 ± 26 (2,760 - 3,376)	13.12 ± .10 (12.06 - 14.45)	17.44 ± .12 (16.56 - 18.56)	8.67 ± .01 (8.54 - 8.78)

Appendix A-1. (Cont'd)

Test Water Quality Statistics

Date(s)	Conductivity (umhos/cm)	Dissolved Oxygen (mg/liter)	Temperature (C)	pH
5/11/84 to 5/17/84 (234)	3,547 ± 26 (2,760 - 4,313)	13.12 ± .05 (8 - 14.82)	17.44 ± .06 (13.51 - 19.86)	8.98 ± .02 (8.5 - 9.67)

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a/ Date(s) followed by number of measurements in parentheses.

b/ Mean ± SE; range in parentheses.

Appendix A-2. Water quality of dilution water used for 6-day (Test Series 6) acute tests on molinate and thiobencarb.

Daily Water Quality Statistics

Date	Conductivity (umhos/cm)	Dissolved Oxygen (mg/liter)	Temperature (C)	pH
5/18/84[a] (14)	3,935 ± 7[b] (3,905 – 3,992)	13.20 ± .16 (11.97 – 14.42)	18.17 ± .19 (17.4 – 19.63)	9.33 ± .00 (9.32 – 9.36)
5/19/84 (42)	3,808 ± 33 (3,468 – 4,247)	12.91 ± .11 (11.78 – 14.63)	17.84 ± .12 (16.84 – 19.04)	9.31 ± .01 (9.07 – 9.37)
5/20/84 (43)	3,573 ± 165 (70 – 5,424)	13.83 ± .51 (10.59 – 23.65)	17.61 ± .14 (14.3 – 18.85)	9.05 ± .05 (7.83 – 9.27)
5/21/84 (47)	3,793 ± 81 (227 – 4,073)	12.49 ± .09 (11.3 – 13.84)	17.53 ± .06 (16.71 – 18.28)	8.86 ± .04 (8.42 – 9.12)
5/22/84 (40)	3,699 ± 16 (3,547 – 3,871)	12.71 ± .09 (11.53 – 13.77)	17.47 ± .17 (15.96 – 18.84)	8.56 ± .01 (8.43 – 8.71)
5/23/84 (47)	4,008 ± 83 (3,364 – 4,776)	12.48 ± .10 (11.16 – 13.91)	17.87 ± .14 (16.61 – 19.62)	8.73 ± .05 (8.37 – 9.26)
5/24/84 (18)	4,603 ± 59 (4,013 – 4,757)	12.69 ± .15 (11.59 – 14.05)	16.89 ± .08 (16.15 – 17.31)	9.22 ± .01 (9.14 – 9.24)

Appendix A-2. (Cont'd)

Test Water Quality Statistics

Date(s)	Conductivity (umhos/cm)	Dissolved Oxygen (mg/liter)	Temperature (C)	pH
5/18/84 to 5/24/84 (251)	3,849 ± 39 (70 - 5,424)	12.87 ± .10 (10.59 - 23.65)	17.64 ± .05 (14.3 - 19.63)	8.95 ± .02 (7.83 - 9.37)

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a/ Date(s) followed by number of measurements in parentheses.

b/ Mean ± SE; range in parentheses.

Appendix A-3. Water quality of dilution water used for 6-day (Test Series 7) acute tests on molinate and thiobencarb.

Daily Water Quality Statistics

Date	Conductivity (umhos/cm)	Dissolved Oxygen (mg/liter)	Temperature (C)	pH
5/29/84 [a] (47)	3,710 ± 40 [b] (2,428 - 4,091)	11.04 ± .1 (9.83 - 12.65)	18.83 ± .12 (17.39 - 20.12)	8.5 ± .06 (8.14 - 9.17)
5/30/84 (47)	3,744 ± 41 (3,328 - 4,258)	11.18 ± .09 (10.02 - 12.37)	18.52 ± .07 (17.7 - 19.4)	9.07 ± .01 (8.95 - 9.15)
5/31/84 (48)	3,427 ± 28 (3,181 - 3,855)	11.15 ± .09 (9.97 - 12.38)	17.64 ± .10 (15.72 - 18.75)	8.92 ± .05 (8.42 - 9.46)
6/1/84 (47)	2,783 ± 64 (38 - 3,110)	11.05 ± .09 (9.6 - 12.02)	17.55 ± .12 (16.41 - 19.14)	9.06 ± .03 (8.8 - 9.38)
6/2/84 (46)	2,839 ± 68 (2,404 - 4,627)	10.79 ± .08 (9.59 - 11.69)	17.08 ± .11 (14.63 - 18.08)	8.76 ± .01 (8.55 - 8.92)
6/3/84 (47)	3,135 ± 77 (377 - 3,657)	10.59 ± .08 (9.45 - 11.56)	17.34 ± .11 (16.32 - 18.49)	8.94 ± .01 (8.69 - 9.09)
6/4/84 (23)	3,219 ± 14 (3,134 - 3,335)	10.35 ± .11 (9.48 - 11.25)	16.75 ± .12 (15.99 - 17.68)	8.9 ± 0 (8.89 - 8.95)

Appendix A-3. (Cont'd)

Test Water Quality Statistics

Date(s)	Conductivity (umhos/cm)	Dissolved Oxygen (mg/liter)	Temperature (C)	pH
5/18/84 to 6/4/84 (330)	3,318 ± 29 (38 - 4,627)	10.95 ± .03 (9.45 - 12.65)	17.87 ± .06 (14.63 - 20.6)	8.84 ± .02 (8.14 - 9.46)

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a/ Date(s) followed by number of measurements in parentheses.

b/ Mean ± SE; range in parentheses.

Appendix B-1. Water quality of dilution water used for 21-day (Test Series 8) chronic tests on molinate and thiobencarb.

Daily Water Quality Statistics

Date	Conductivity (umhos/cm)	Dissolved Oxygen (mg/liter)	Temperature (C)	pH
6/8/84[a/] (30)	3,412 ± 47[b/] (3,011 - 4,322)	9.39 ± .11 (8.62 - 10.73)	16.7 ± .15 (14.07 - 17.35)	8.08 ± .02 (7.89 - 8.24)
6/9/84 (47)	3,149 ± 47 (2,576 - 3,558)	9.00 ± .06 (8.36 - 10.51)	16.69 ± .11 (15.47 - 17.85)	8.35 ± .08 (7.7 - 8.93)
6/10/84 (47)	3,586 ± 37 (3,237 - 3,969)	8.99 ± .08 (7.97 - 10.15)	17.15 ± .15 (14.48 - 18.74)	8.91 ± .01 (8.82 - 8.97)
6/11/84 (43)	3,614 ± 27 (3,247 - 3,918)	10.16 ± .34 (8.18 - 15.85)	17.2 ± .13 (16.15 - 18.66)	8.82 ± .01 (8.7 - 8.88)
6/12/84 (45)	3,631 ± 14 (3,216 - 3,718)	10.60 ± .27 (8.23 - 12.75)	17.2 ± .1 (14.9 - 18.23)	8.54 ± .05 (8.02 - 8.77)
6/13/84 (41)	3,534 ± 57 (2,620 - 4,333)	9.21 ± .06 (8.5 - 9.9)	17.52 ± .17 (16.17 - 19.22)	8.11 ± .03 (7.78 - 8.4)
6/14/84 (45)	3,694 ± 20 (3,486 - 4,376)	9.75 ± .05 (9.06 - 10.53)	17.3 ± .13 (15.25 - 18.66)	8.64 ± .06 (8.29 - 9.28)
6/15/84 (47)	3,655 ± 25 (3,245 - 3,888)	9.78 ± .07 (8.74 - 10.97)	17.9 ± .13 (16.73 - 19.37)	9.16 ± .01 (9.05 - 9.23)
6/16/84 (46)	3,426 ± 38 (3,070 - 3,835)	9.46 ± .07 (8.52 - 10.43)	18.57 ± .1 (17.54 - 19.57)	8.77 ± .04 (8.31 - 9.04)

Appendix B-1. (Cont'd)

Daily Water Quality Statistics

Date	Conductivity (umhos/cm)	Dissolved Oxygen (mg/liter)	Temperature (C)	pH
6/17/84 (47)	3,523 ± 48 (2,433 - 3,828)	9.22 ± .05 (8.5 - 10.11)	18.65 ± .1 (17.75 - 20.07)	8.36 ± .02 (8.16 - 8.56)
6/18/84 (31)	3,461 ± 81 (2,248 - 3,874)	9.12 ± .08 (8.57 - 10.13)	18.4 ± .07 (17.01 - 19.26)	8.39 ± .02 (8.08 - 8.51)
6/19/84 (14)	4,022 ± 49 (3,860 - 4,487)	9.21 ± .09 (8.87 - 9.95)	18.74 ± .08 (18.3 - 19.33)	9.24 ± .01 (9.21 - 9.28)
6/20/84 (47)	3,587 ± 37 (2,999 - 3,855)	9.56 ± .05 (8.81 - 10.34)	17.90 ± .12 (16.58 - 19.29)	9.12 ± .01 (8.95 - 9.2)
6/21/84 (47)	3,467 ± 37 (3,127 - 4,006)	9.90 ± .19 (8.2 - 13.43)	17.88 ± .1 (15.77 - 19.07)	9.05 ± .01 (8.91 - 9.15)
6/22/84 (48)	3,396 ± 31 (3,116 - 3,707)	9.85 ± .06 (8.92 - 10.77)	18.21 ± .15 (16.89 - 19.67)	8.91 ± .01 (8.84 - 9.04)
6/23/84 (47)	3,681 ± 17 (3,510 - 3,886)	9.51 ± .06 (8.32 - 10.36)	19.33 ± .17 (17.87 - 21.07)	8.82 ± .01 (8.69 - 8.89)
6/24/84 (47)	3,488 ± 155 (245 - 5,418)	9.56 ± .05 (8.73 - 10.27)	19.06 ± .14 (15.58 - 20.76)	8.43 ± .05 (7.71 - 8.76)
6/25/84 (47)	2,068 ± 34 (1,850 - 2,952)	9.35 ± .04 (8.81 - 9.9)	18.47 ± .11 (17.38 - 19.84)	7.59 ± .01 (7.51 - 7.72)

Appendix B-1. (Cont'd)

Daily Water Quality Statistics

Date	Conductivity (umhos/cm)	Dissolved Oxygen (mg/liter)	Temperature (C)	pH
6/26/84 (47)	2,280 ± 81 (1,180 - 3,283)	9.14 ± .06 (8.22 - 10.24)	18.96 ± .19 (16.63 - 21.43)	7.72 ± .04 (7.49 - 8.36)
6/27/84 (45)	2,934 ± 56 (941 - 3,257)	9.13 ± .08 (8.03 - 11.59)	19.51 ± .09 (17.92 - 20.33)	8.12 ± .02 (7.94 - 8.3)
6/28/84 (46)	3,123 ± 29 (2,926 - 3,784)	8.68 ± .05 (7.78 - 9.83)	19.56 ± .18 (16.64 - 21.36)	8.17 ± .01 (8.02 - 8.39)
6/29/84 (18)	3,046 ± 6 (3,016 - 3,104)	8.87 ± .10 (8.17 - 9.59)	18.8 ± .07 (18.46 - 19.28)	8.18 ± .01 (8.1 - 8.21)

Test Water Quality Statistics

Date(s)	Conductivity (umhos/cm)	Dissolved Oxygen (mg/liter)	Temperature (C)	pH
6/8/84 to 6/29/84 (922)	3,334 ± 19 (245 - 5,418)	9.46 ± .03 (7.78 - 15.85)	18.16 ± .04 (14.07 - 21.43)	8.52 ± .02 (7.49 - 9.28)

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a/ Date(s) followed by number of measurements in parentheses.

b/ Mean ± SE; range in parentheses.

Appendix C-1. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 5 - Molinate (48-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 12,000, 11,000

STOCK SOLUTION FINAL CONC (MG/LITER) 11,000

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 5.52 (.38)

FISH WEIGHT (G) ______

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	79	79	20	
56	72	33	13	
32	74	4	6.5	
18	86	2	4.2	
10	70	0	2.6	
CONTROL	84	1	.31	

LC50 (%) ______

LC50 MOLINATE (MG/LITER) 10

LC50 THIOBENCARB (MG/LITER) ______

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-1.

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 5 - Molinate (96-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 12,000, 11,000

STOCK SOLUTION FINAL CONC (MG/LITER) 11,000

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 5.52 (.38)

FISH WEIGHT (G) ____

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	79	79	20	
56	72	72	13	
32	74	20	6.5	
18	86	10	4.2	
10	70	7	2.6	
CONTROL	84	1	.31	

LC50 (%) ____

LC50 MOLINATE (MG/LITER) 6.6

LC50 THIOBENCARB (MG/LITER) ____

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-1. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 5 - Molinate (144-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 12,000, 11,000

STOCK SOLUTION FINAL CONC (MG/LITER) 11,000

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 5.52 (.38)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	79	79	20	
56	72	72	13	
32	74	40	6.5	
18	86	17	4.2	
10	70	16	2.6	
CONTROL	84	5	.31	

LC50 (%)

LC50 MOLINATE (MG/LITER) 5.4 (4.9 -5.9)

LC50 THIOBENCARB (MG/LITER)

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-1.

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 5 - Thiobencarb (48-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 800, 700

STOCK SOLUTION FINAL CONC (MG/LITER) 650

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 5.52 (.38)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	84	79		1.2
56	90	30		.72
32	86	5		.37
18	77	14		.19
10	73	2		.12
CONTROL	77	2		< .10

LC50 (%)

LC50 MOLINATE (MG/LITER)

LC50 THIOBENCARB (MG/LITER) .78

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-1. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 5 - Thiobencarb (96 hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 800, 700

STOCK SOLUTION FINAL CONC (MG/LITER) 950

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 5.52 (.38)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	84	84		1.2
56	90	90		.72
32	86	10		.37
18	77	19		.19
10	73	4		.12
CONTROL	77	6		< .10

LC50 (%)

LC50 MOLINATE (MG/LITER)

LC50 THIOBENCARB (MG/LITER) .35

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-1. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 5 - Thiobencarb (144-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 800, 700

STOCK SOLUTION FINAL CONC (MG/LITER) 950

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 5.52 (.38)

FISH WEIGHT (G) ____________

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	84	84		1.2
56	90	90		.72
32	86	38		.37
18	77	24		.19
10	73	11		.12
CONTROL	77	9		<.10

LC50 (%) ____________

LC50 MOLINATE (MG/LITER) ____________

LC50 THIOBENCARB (MG/LITER) .32 (.29-.35)

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-1. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 5 - Molinate and Thiobencarb Mixture (48-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 9,000, 750,600

STOCK SOLUTION FINAL CONC (MG/LITER) 8,900, 540

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 5.52 (.38)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	65	64	8.6	.83
56	46	17	6.0	.49
32	78	5	3.1	.24
18	67	1	2.0	.16
10	92	1	.79	.07
CONTROL	98	3	<.16	<.10

LC50 (%) 55.65

LC50 MOLINATE (MG/LITER) 5.2

LC50 THIOBENCARB (MG/LITER) .46

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-1. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 5 - Molinate and Thiobencarb Mixture (96-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 9,000, 750,600

STOCK SOLUTION FINAL CONC (MG/LITER) 8,900, 540

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 5.52 (.38)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	65	65	8.6	.83
56	46	46	6.0	.49
32	78	7	3.1	.24
18	67	1	2.0	.16
10	92	2	.79	.07
CONTROL	98	3	< .16	<.10

LC50 (%) 39.84

LC50 MOLINATE (MG/LITER) 3.8

LC50 THIOBENCARB (MG/LITER) .33

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-1. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 5 - Molinate and Thiobencarb Mixture (144-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 9,000, 750,600

STOCK SOLUTION FINAL CONC (MG/LITER) 8,900, 540

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 5.52 (.38)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	65	65	8.6	.83
56	46	46	6.0	.49
32	78	36	3.1	.24
18	67	13	2.0	.16
10	92	6	.79	.07
CONTROL	98	4	< .16	< .10

LC50 (%) 26.6

LC50 MOLINATE (MG/LITER) 2.7 (2.4 -2.9)

LC50 THIOBENCARB (MG/LITER) .22 (.19-.24)

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-2. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 6 - Molinate (48-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 14,000, 13,000

STOCK SOLUTION FINAL CONC (MG/LITER) 9,600

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 4.95 (.50)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	100	100	20	
56	95	33	11	
32	96	30	6.5	
18	100	19	3.8	
10	96	25	2.6	
CONTROL	88	6	< .14	

LC50 (%)

LC50 MOLINATE (MG/LITER) 9.8

LC50 THIOBENCARB (MG/LITER)

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-2. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 6 - Molinate (96-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 14,000, 13,000

STOCK SOLUTION FINAL CONC (MG/LITER) 9,600

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 4.95 (.50)

FISH WEIGHT (G) ____

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	100	100	20	
56	95	90	11	
32	96	46	6.5	
18	100	35	3.8	
10	96	35	2.6	
CONTROL	88	19	<.14	

LC50 (%) ____

LC50 MOLINATE (MG/LITER) 6.1

LC50 THIOBENCARB (MG/LITER) ____

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-2. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 6 - Molinate (144-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 14,000, 13,000

STOCK SOLUTION FINAL CONC (MG/LITER) 9,600

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 4.95 (.50)

FISH WEIGHT (G) ______

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	100	100	20	
56	95	95	11	
32	96	58	6.5	
18	100	46	3.8	
10	96	43	2.6	
CONTROL	88	24	<.14	

LC50 (%) ______

LC50 MOLINATE (MG/LITER) 5.2 (4.8 -5.6)

LC50 THIOBENCARB (MG/LITER) ______

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-2. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 6 - Thiobencarb (48-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 850, 830

STOCK SOLUTION FINAL CONC (MG/LITER) 350

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 4.95 (.50)

FISH WEIGHT (G) ____

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	100	16		1.1
56	96	18		.63
32	93	18		.39
18	85	16		.23
10	100	26		.13
CONTROL	90	17		< .1

LC50 (%) ____

LC50 MOLINATE (MG/LITER) ____

LC50 THIOBENCARB (MG/LITER) ____

LC50 METHOD - PROBIT - MOVING AVERAGE - NONLINEAR INTERPOLATION

Appendix C-2.

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 6 - Thiobencarb (96-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 850, 830

STOCK SOLUTION FINAL CONC (MG/LITER) 350

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 4.95 (.50)

FISH WEIGHT (G) ____

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	100	87		1.1
56	96	41		.63
32	93	27		.39
18	85	19		.23
10	100	40		.13
CONTROL	90	23		< .1

LC50 (%) ____

LC50 MOLINATE (MG/LITER) ____

LC50 THIOBENCARB (MG/LITER) .8

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-2. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 6- Thiobencarb (144-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 850, 830

STOCK SOLUTION FINAL CONC (MG/LITER) 350

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 4.95 (.50)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	100	100		1.1
56	96	82		.63
32	93	38		.39
18	85	29		.23
10	100	42		.13
CONTROL	90	33		<.10

LC50 (%)

LC50 MOLINATE (MG/LITER)

LC50 THIOBENCARB (MG/LITER) .55 (.52-.58)

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-2. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 6 - Molinate and Thiobencarb Mixture (48-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) (10,500, 10,400)(710, 760)

STOCK SOLUTION FINAL CONC (MG/LITER) 7,100, 500

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 4.95 (.50)

FISH WEIGHT (G) ______

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	100	23	21	1.5
56	96	12	10	.74
32	98	19	5.4	.40
18	102	20	3.6	.28
10	90	14	.86	.07
CONTROL	83	11	< .1	< .1

LC50 (%) ______

LC50 MOLINATE (MG/LITER) ______

LC50 THIOBENCARB (MG/LITER) ______

LC50 METHOD - PROBIT - MOVING AVERAGE - NONLINEAR INTERPOLATION

Appendix C-2. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 6 - Molinate and Thiobencarb Mixture (96-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) (10,500, 10,400) (710, 760)

STOCK SOLUTION FINAL CONC (MG/LITER) 7,100, 500

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 4.95 (.50)

FISH WEIGHT (G) ____

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	100	100	21	1.5
56	96	65	10	.74
32	98	45	5.4	.40
18	102	45	3.6	.28
10	90	29	.86	.07
CONTROL	83	26		< .1

LC50 (%) 40.34

LC50 MOLINATE (MG/LITER) 7.6

LC50 THIOBENCARB (MG/LITER) .56

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-2. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 6 - Molinate and Thiobencarb Mixture (144-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) (10,500, 10,400) (710,760)

STOCK SOLUTION FINAL CONC (MG/LITER) 7,100, 500

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 4.95 (.50)

FISH WEIGHT (G) ____

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	100	100	21	1.5
56	96	96	10	.74
32	98	67	5.4	.40
18	102	56	3.6	.28
10	90	31	.86	.07
CONTROL	83	31	< .12	< .1

LC50 (%) 25.8

LC50 MOLINATE (MG/LITER) 4.4 (4.0 -4.8)

LC50 THIOBENCARB (MG/LITER) .33 (.31-.37)

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-3.

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. ~~Test Series 7 - Molinate~~ (48-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 14,000, 11,000

STOCK SOLUTION FINAL CONC (MG/LITER) 11,000

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 8.06 (.66)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	51	50	20	
56	54	25	13.2	
32	50	3	8.94	
18	50	3	5.4	
10	50	3	3.6	
CONTROL	49	0	< .29	

LC50 (%)

LC50 MOLINATE (MG/LITER) 13

LC50 THIOBENCARB (MG/LITER)

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-3. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 7 - Molinate (96-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 14,000, 11,000

STOCK SOLUTION FINAL CONC (MG/LITER) 11,000

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 8.06 (.66)

FISH WEIGHT (G) ______

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	51	51	20	
56	54	44	13	
32	50	15	8.9	
18	50	20	5.4	
10	50	9	3.6	
CONTROL	49	0	<.29	

LC50 (%) ______

LC50 MOLINATE (MG/LITER) 7.9

LC50 THIOBENCARB (MG/LITER) ______

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-3. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. ~~Test Series 7 - Mo~~linate (144-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 14,000, 11,000

STOCK SOLUTION FINAL CONC (MG/LITER) 11,000

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 8.06 (.66)

FISH WEIGHT (G) __________

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	51	51	20	
56	54	54	13	
32	50	17	8.9	
18	50	26	5.4	
10	50	30	3.6	
CONTROL	49	1	<.29	

LC50 (%) __________

LC50 MOLINATE (MG/LITER) __________

LC50 THIOBENCARB (MG/LITER) __________

LC50 METHOD - PROBIT - MOVING AVERAGE - NONLINEAR INTERPOLATION

Appendix C-3. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 7 - Thionencarb (48-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 590, 690

STOCK SOLUTION FINAL CONC (MG/LITER) 530

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 8.06 (.66)

FISH WEIGHT (G) ____________

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	50	15		1.3
56	50	3		.75
32	46	3		.45
18	51	0		.27
10	49	1		.20
CONTROL	52	2		< .10

LC50 (%) ____________

LC50 MOLINATE (MG/LITER) ____________

LC50 THIOBENCARB (MG/LITER) ____________

LC50 METHOD - PROBIT - MOVING AVERAGE - NONLINEAR INTERPOLATION

Appendix C-3. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 7 - Thiobencarb (96-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 790, 690

STOCK SOLUTION FINAL CONC (MG/LITER) 530

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 8.06 (.66)

FISH WEIGHT (G) ______

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	50	50		1.3
56	50	22		.75
32	46	8		.45
18	51	3		.27
10	49	5		.20
CONTROL	52	4		<.10

LC50 (%) ______

LC50 MOLINATE (MG/LITER) ______

LC50 THIOBENCARB (MG/LITER) .67

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-3. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TestSeries 7 - Thiobencarb (144-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) 790, 690

STOCK SOLUTION FINAL CONC (MG/LITER) 530

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 8.06 (.66)

FISH WEIGHT (G) ____

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	50	50		1.3
56	50	46		.75
32	46	26		.45
18	51	10		.27
10	49	16		.20
CONTROL	52	9		< .10

LC50 (%) ____

LC50 MOLINATE (MG/LITER) ____

LC50 THIOBENCARB (MG/LITER) .46 (.41-.52)

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-3. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 7 - Molinate and Thiobencarb Mixture (48-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) (11,000, 8,700) (530,630)

STOCK SOLUTION FINAL CONC (MG/LITER) 8,000, 520

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 8.06 (.66)

FISH WEIGHT (G) ______

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	50	42	14	1.1
56	50	28	8.0	.60
32	49	5	3.8	.30
18	47	1	2.6	.19
10	50	2	.49	<.10
CONTROL	49	0	<.15	<.10

LC50 (%) 55.6

LC50 MOLINATE (MG/LITER) 7.7

LC50 THIOBENCARB (MG/LITER) .6

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-3. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 7 - Molinate and Thiobencarb Mixture (96-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) (11,000, 8,700) (530, 630)

STOCK SOLUTION FINAL CONC (MG/LITER) 8,000, 520

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 8.06 (.66)

FISH WEIGHT (G) ______

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	50	50	14	1.1
56	50	50	8.0	.6
32	49	26	3.8	.3
18	47	10	2.6	.19
10	50	2	.49	<.1
CONTROL	49	2	<.15	<.1

LC50 (%) 24.94

LC50 MOLINATE (MG/LITER) 3.1

LC50 THIOBENCARB (MG/LITER) .24

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix C-3. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 7 - Molinate and Thiobencarb Mixture (144-hr)

STOCK SOLUTION INITIAL CONC (MG/LITER) (11,000, 8,700) (530, 630)

STOCK SOLUTION FINAL CONC (MG/LITER) 8,000, 520

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 8.06 (.66)

FISH WEIGHT (G) ____________

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	50	50	14	1.1
56	50	50	8.0	.60
32	49	45	3.8	.30
18	47	41	2.6	.19
10	50	5	.49	<.1
CONTROL	49	2	<.15	<.1

LC50 (%) 13.9

LC50 MOLINATE (MG/LITER) 1.4 (1.2 -1.7)

LC50 THIOBENCARB (MG/LITER) .11 (.09-.13)

LC50 METHOD - PROBIT -[✓ MOVING AVERAGE]- NONLINEAR INTERPOLATION

Appendix D-1. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 8 - Molinate (21-day)

STOCK SOLUTION INITIAL CONC (MG/LITER) 530, 510, 510, 540, 540

STOCK SOLUTION FINAL CONC (MG/LITER) 570

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 17.24 (1.35)

FISH WEIGHT (G) ________

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	94	33	.80	
56	93	19	.45	
32	102	16	.28	
18	98	3	.20	
10	95	17	.16	
CONTROL	99	47	<.13	

LC50 (%) ________

LC50 MOLINATE (MG/LITER) ________

LC50 THIOBENCARB (MG/LITER) ________

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix D-1. ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. Test Series 8 -Thiobencarb (21-day)

STOCK SOLUTION INITIAL CONC (MG/LITER) 36, 33, 39, 33, 32

STOCK SOLUTION FINAL CONC (MG/LITER) 31

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 20.07 (1.50)

FISH WEIGHT (G) ____

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	50	10		.074
56	41	1		.041
32	46	4		.022
18	53	15		.015
10	50	4		.010
CONTROL	22	7		<.001

LC50 (%) ____

LC50 MOLINATE (MG/LITER) ____

LC50 THIOBENCARB (MG/LITER) ____

LC50 METHOD - PROBIT - MOVING AVERAGE - NONLINEAR INTERPOLATION

Appendix D-1. **ACUTE TOXICITY TEST DATA SUMMARY**

TEST NO. Test Series 8 - Molinate and Thiobencarb Mixture (21-day)

STOCK SOLUTION INITIAL CONC (MG/LITER)

STOCK SOLUTION FINAL CONC (MG/LITER) 400, 23

DILUTION OF TOXICANT 500

TEST SPECIES Striped bass

FISH LENGTH (MM) 19.38 (1.6)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	90	15	.68	.046
56	87	11	.43	.020
32	91	16	.20	.009
18	91	17	.20	.006
10	63	13	.18	.003
CONTROL	43	6	.08	<.002

LC50 (%)

LC50 MOLINATE (MG/LITER)

LC50 THIOBENCARB (MG/LITER)

LC50 METHOD - PROBIT - [✓ MOVING AVERAGE] - NONLINEAR INTERPOLATION

Appendix E. Recommended Culture and Testing Protocols

Larval Culture

The rearing system will consist of three (320 liter) circular tanks with biological filters. The tanks will be equipped with moveable jets so that the water returning from the biological filters can be directed in either an upwelling or a circular current. The larvae will be kept in an upwelling current until they are 12 days old. The current will then be redirected to a circular motion.

The temperature and salinity will be the same as last year (19 C and 5 o/oo respectively). Temperature, pH, salinity, ammonia, and dissolved oxygen will be monitored daily. The biological filters will be activated (at 25 C) two weeks prior to larval indroductions. Ammonia (NH_4CL) will be added at a concentration of 1 to 3 mg/liter along with an inoculation of pure culture bacteria (<u>Nitrosomonas</u> and <u>Nitrobacter</u>) to activate the biological filters.

Each tank will contain larvae from one family (spawn). Hatching and rearing success will be monitored by determining the number of embryos (volumetrically) put into the McDonald jar and counting the number of larvae used in testing and surviving to metamorphosis.

The larvae will be fed brine shrimp nauplii at a density of 5,000 per liter three times daily for the first eleven days after hatch. The larvae will be trained to eat commercial feed according to the feeding schedule (Table E-1). The feeding density can be reduced when the fish are capable of searching out food at 12 days after hatch. Larvae from each family will be measured and the RNA/DNA (macronuclear) content determined at 4, 7, 12, 24, 48, and 60 days after hatch.

Toxicity Tests

Acute (6-day) toxicity tests will be conducted on the following life-history stages: 1) Pre-hatch (embryo), 2) 7-day old larvae, and 3) 24-day old larvae. Chronic toxicity tests (50 to 60 days) will be conducted starting with embryos and continuing through to metamorphosis. The toxicants molinate, thiobencarb, and a mixture of the two herbicides will be exposed to the striped bass using proportional diluters.

Embryos (16 to 12 hr pre-hatch) will be obtained from the Central Valley hatchery and transported to the Nimbus facility by automobile. Embryos to be used in toxicity tests will be transfered to test vessels using small plastic cups. Embryos not being used in toxicity tests will be placed in MacDonald hatching jars in the rearing system. These embryos will be hatched and reared for testing later life-history stages.

Toxicity tests will be conducted in test chambers with glass sides, a 500 um polypropylene screen bottom, and air lifts. There will be one or two test chambers placed in each aquarium with larvae density of 25 per liter (embryos and prolarvae) or 12 per liter (postlarvae). The test temperature will be maintained at 19 C by the constant temperature water baths. The water bath temperature will be maintained to within ± 0.5 C by a water chiller and submersible heaters, and the temperature will be continuously recorded on a strip chart recorder. Salinity of the dilution water will be maintained at 2o/oo by monitoring conductivity and adjusting salt injection daily. Dissolved oxygen will be monitored daily and ammonia will be monitored at least twice weekly in the test chambers. Toxicant concentrations will be checked analytically twice during the acute toxicity tests and once a week during the chronic toxicity tests in each test aquarium.

The test fish will be fed brine shrimp nauplii when they are two days old. Each test chamber will be fed at a rate of 5,000 nauplii/liter three to four times per day. The larvae will be fed by hand, using a calibrated cup. The test chambers will be cleaned of cysts and other debris daily.

Mortality will be recorded twice daily during the acute and chronic toxicity tests. Median lethal concentrations (LC50 valves) will be calculated using the mortality data. Length measurements will be made at the termination of each acute and chronic toxicity test on twenty fish or all living fish remaining in each concentration. Test fish samples will also be taken and analyzed for RNA/DNA content as another method of assessing growth. No observable effect levels will be determined using survival and sublethal (growth) data derived from the chronic toxicity tests.

able E-1. Feeding schedule for larval striped bass.

Age of Fish (days)	Food Type[a]
3 - 11	live brine shrimp nauplii
12 - 17	pulverized Tetramin and brine shrimp nauplii
18 - 22	pulverized Tetramin, pulverized trout starter and live brine shrimp nauplii
23 - 30	pulverized trout starter, trout starter and live brine shrimp nauplii
31 - 35	trout starter
36 - 40	trout starter and 2/64 salmon feed
41 - 45	2/64 salmon feed

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[a] Combination diets mixed in equal proportions.

APPENDIX E-2

State of California
Resources Agency
DEPARTMENT OF FISH AND GAME

Effects of Rice Herbicides on

Larval Striped Bass

1985 Laboratory Study Progress Report

Environmental Services Branch, Pesticide Investigations Unit

1701 Nimbus Road, Suite F, Rancho Cordova, California

December 1985

Effects of Rice Herbicides on Larval Striped Bass

1985 Laboratory Study Progress Report[1,2]

by

G. A. Faggella and B. J. Finlayson

California Department of Fish and Game Pesticide Investigations Unit
1701 Nimbus Road, Suite F, Rancho Cordova, California

SUMMARY

Acute (144-hr) and chronic (31-day) continuous-flow laboratory toxicity tests were conducted to determine the lethal and sublethal effects of rice herbicides molinate (Ordram) and thiobencarb (Bolero) separately and in combination on striped bass (*Morone saxatilis*) embryos, larvae, and fry. These tests were conducted to evaluate effects on striped bass inhabiting the Sacramento River which receives discharges of these herbicides.

Median lethal concentrations ([illegible] LC50 values) for 6 and 13-day old bass indicated that thiobencarb ([illegible] and [illegible] mg/liter) was approximately 10 times more toxic than molinate ([illegible] and 10.7 mg/liter). A mixture of molinate and thiobencarb at a [illegible] ratio had additive toxic effects on 13-day old larvae. [illegible] larvae during the 144-hr acute tests was as sensitive an indicator of [illegible] stress as was growth. Generally, the acute toxicity of the [illegible] to striped bass increased with increased exposure time ([illegible]) and decreased with increased age (6 to 45-day old) of fish. Although there was a prominent decrease in the sensitivity to rice herbicides between larval (6 to 24-day old) and juvenile (>45-day old) fish, there were no distinct differences among the 6, 13, and 24-day old larvae. Early life-history stage chronic toxicity tests will be conducted in 1986 with improved culture and testing equipment and methods.

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[1] Progress report on work completed in 1985.

[2] Study funded by California Department of Fish and Game Striped Bass Stamp Act, State Water Resources Control Board Interagency Ageement No. 1-161-420-2, and Rice Research Board Standard Agreement No. C-1053.

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CONCLUSIONS

1. The 144-hr LC50 values of molinate for 6-day and 13-day old striped bass were 2.1 and 8.8, respectively.
2. The 96-hr LC50 values of thiobencarb for 6-day and 13-day old striped bass were 0.28 and 0.51 mg/liter, respectively.
3. The 144-hr LC50 values of molinate and thiobencarb in mixtures for 6-day and 45-day old striped bass were 2.6 mg/liter molinate and 0.16 mg/liter thiobencarb and 6.6 mg/liter molinate and 0.58 mg/liter thiobencarb, respectively.
4. Generally, the acute toxicity of the rice herbicides to striped bass increased with increased exposure time (48 to 144 hr) and decreased with increased age (6 to 45-day old) of fish.
5. An equitoxic mixture of molinate and thiobencarb had additive toxic effects on 13-day old striped bass larvae.
6. The chronic (31-day) tests on molinate and thiobencarb with 45-day old fish failed to show effects at levels below those causing effects with 6-day old fish.
7. Stress on larvae caused by handling and water supersaturated with gas probably contributed to the relatively poor survival of control groups.
8. In acute tests with rice herbicides, survival of larvae was as sensitive an indicator of toxic stress as was growth .

RECOMMENDATIONS

1. Early life-history stage (6-day old larvae) chronic tests (40-day) on rice herbicides should be conducted in 1986.
2. As a quality control measure for rice herbicide test concentrations, 5 to 10% of the water samples should be taken in duplicate and analyzed for molinate and thiobencarb concentrations.
3. As a quality assurance measure for rice herbicide test concentrations, 5 to 10% of the water samples should be taken in duplicate and analyzed for molinate and thiobencarb concentrations by a cooperating laboratory.
4. Survival of larvae in the rearing system can be improved by using upwelling currents for the first 6 to 8 days after hatch and keeping the gas content of the water below saturation.
5. Handling stress and subsequent mortality of control groups can be reduced by anesthetizing the larvae with NaCl or MS-222 prior to moving them from the rearing system to the test tanks.
6. Stripping the dilution water of supersaturated gas, aerating the larvae to keep them suspended in the test chambers, and darkening the test chambers to reduce positive phototaxis of larvae should be investigated for decreasing stress and improving survival of larvae in the test system.
7. Contamination of control group aquaria with volatile molinate should be reduced further by covering the aquaria.

INTRODUCTION

Identification of Problem

The purpose of this study is to develop toxicological data which will facilitate the development of water quality criteria that will protect fish and other aquatic organisms from the adverse effects of the herbicides Ordram (molinate) and Bolero (thiobencarb). Ordram and Bolero have been detected in the Sacramento River from Knight's Landing downstream to Rio Vista (Cornacchia et al. 1984; California Department of Food and Agriculture [CDFA] 1984;1985). The herbicides are discharged from rice fields into agricultural drains, and subsequently, into the striped bass, Morone saxatilis, spawning and nursery areas of the Sacramento River (Farley 1966; Turner 1976). The herbicides are present annually in the Sacramento River from May through June (Finlayson and Lew 1983a; 1983b; 1984; 1985).

Previous studies have defined the acute and chronic toxicities of molinate and thiobencarb to juvenile resident and anadromous fishes (Finlayson and Faggella 1984a). Ordram use has been responsible for large fish kills in agricultural drains (Finlayson and Lew 1983b), and Bolero use is believed responsible for other adverse effects on water quality (Cornacchia et al. 1984). The acute effects of herbicides on survival and development of striped bass embryos and larvae in the Sacramento River were unknown until recently. In September 1983, California Department of Fish and Game (CDFG) began a three-year study to determine the toxic effects of rice pesticides from agricultural drain water on striped bass. The studies which were completed in 1984 have been previously reported (Finlayson and Faggella 1984b). This report summarizes the studies completed in 1985.

Scope of Study

The objectives of this study are as follows:

1) Determine the acute and chronic toxicities of rice pesticides in Sacramento River and agricultural drain water to embryonic and larval striped bass;
2) Characterize the exposure of striped bass eggs and larvae to rice pesticides in the Sacramento River;
3) Integrate monitoring and toxicity information into a risk assessment model for predicting the impacts of agricultural return water with varying concentrations of rice pesticides on the striped bass fishery; and
4) Recommend appropriate corrective actions to the CDFA for implementation.

Tasks Completed in 1984

Between October 1983 and December 1984, the following tasks were completed relative to the study's overall objectives:

1) Monitored herbicide concentrations in the Sacramento River and associated agricultural drains during 1984 rice growing season and prepared a report on the findings (Finlayson and Lew 1984);
2) Developed prototype testing and culturing protocols and facilities for early life-history stages of striped bass; and

3) Determined the sensitivities of striped bass prolarvae and larvae to the rice herbicides by conducting 24 acute and chronic tests and prepared a progress report on the findings (Finlayson and Faggella 1984b).

The design and construction of prototype culture and testing facilities were completed during the winter of 1984. The striped bass larvae were maintained in a recirculating system at the CDFG Fish Disease Laboratory and, the continuous-flow toxicity tests were conducted in the CDFG Mobile Bioassay Laboratory, both adjacent to Nimbus Hatchery on the American River. Acute and chronic tests on molinate, thiobencarb, and a mixture of the two herbicides with striped bass embryos and larvae were conducted between May 1 and June 30, 1984.

Tasks Completed in 1985

Between January and December 1985 the following tasks were completed relative to the study's overall objectives:

1) Constructed a glass and solenoid valve type diluter to replace the flow meter type diluter used in 1984 tests for better toxicant delivery;

2) Installed airlifts in the test chambers for aeration and water circulation and exchange;

3) Installed an oil-less air compressor, two-stage regulator, and PVC pipe delivery system for the test chamber airlifts;

4) Constructed 36 new glass and polypropylene screen test chambers for increased testing capacity;

5) Installed a water chiller in the recirculating water bath system for better temperature control;

6) Modified the saltwater injection system for better control of dilution water salinity;

7) Installed ventilation fans to remove volatilized herbicides from the bioassay room before contaminating test aquaria;

8) Modified the striped bass rearing system to allow for using either circular or up-welling currents, and increased the holding capacity to allow for keeping up to three families concurrently;

9) Enlarged brine shrimp rearing capacity for increased food supply of larval fish;

10) Conducted 27 acute and chronic toxicity tests on molinate, thiobencarb, and a mixture of the two herbicides with striped bass embryos, larvae, and fry; and

11) Monitored rice herbicide concentrations in the Sacramento River and associated agricultural drains during 1985 rice growing season and prepared a report on the findings (Finlayson and Lew 1985).

METHODS AND MATERIALS

Study Schedule

The modifications of the testing and rearing facilities began in January and were completed by April 1985.

Toxicity tests with embryonic and larval striped bass began on April 27 and were completed by July 22, 1985. Twenty-four acute toxicity tests (8 tests series) and three chronic toxicity tests (1 test series) were attempted during this three month period (Table 1). All test organisms came from four spawns (families) of striped bass.

Culture System

Striped bass embryos (12 to 16 hours prehatch) were obtained from the CDFG Central Valley Fish Hatchery (CVFH) located near Elk Grove, California. The embryos were placed in plastic bags and transported inside a styrofoam ice chest to the Nimbus testing and rearing facility. Upon arrival at the Nimbus facility, some of the embryos were subjected to the herbicides in tests. Those embryos not used in the toxicity tests were hatched in modified plexiglass MacDonald hatching jars described by Finlayson and Faggella (1984b).

The hatching jars were placed in rearing tanks with one striped bass family per tank. The rearing system consisted of three 400-liter circular fiberglass tanks with the water volumes adjusted to approximately 200 liters. Initial loading of striped bass in tanks did not exceed 30 prolarvae per liter of water. The tanks were interconnected to biological filters made of two 114-liter plastic garbage cans (Figure 1). Aquarium

Table 1. Schedule of acute and chronic tests with molinate (M) and thiobencarb (T) on striped bass embryos, larvae, and fry.

Begin Date	Test Series	Spawn	Developmental Stage	Test Duration	Comments
4-27-85	1	1	Embryonic (12-hr pre-hatch)	--	Void, >50% mortality in controls
5-9-85	2	2	Embryonic (12-hr pre-hatch)	--	Void, >50% mortality in controls
5-10-85	3	3	Embryonic (12-hr pre-hatch)	--	Void, >50% mortality in controls
5-23-85	4	3	Postlarval (13-day post-hatch)	144 hr	Success with M & T tests, <50% mortality in highest MT treatment
5-31-85	5	4	Postlarval (6-day post-hatch)	144 hr	Success with M test, >25% mortality in T test controls, < 75% mortality in highest MT test treatment
6-7-85	6	4	Postlarval (13-day post-hatch)	144 hr	Success with single MT test
6-7-85	7	3	Postlarval (28-day post-hatch)	144 hr	Data questionable, <50% mortality in all tests
6-21-85	8	3	Fry (45-day post-hatch)	144 hr	>25% mortality in M & T tests, MT test success
6-21-85	9	3	Fry (45-day post-hatch)	31 day	MT mix test void, >50% mortality in controls, success with M & T tests

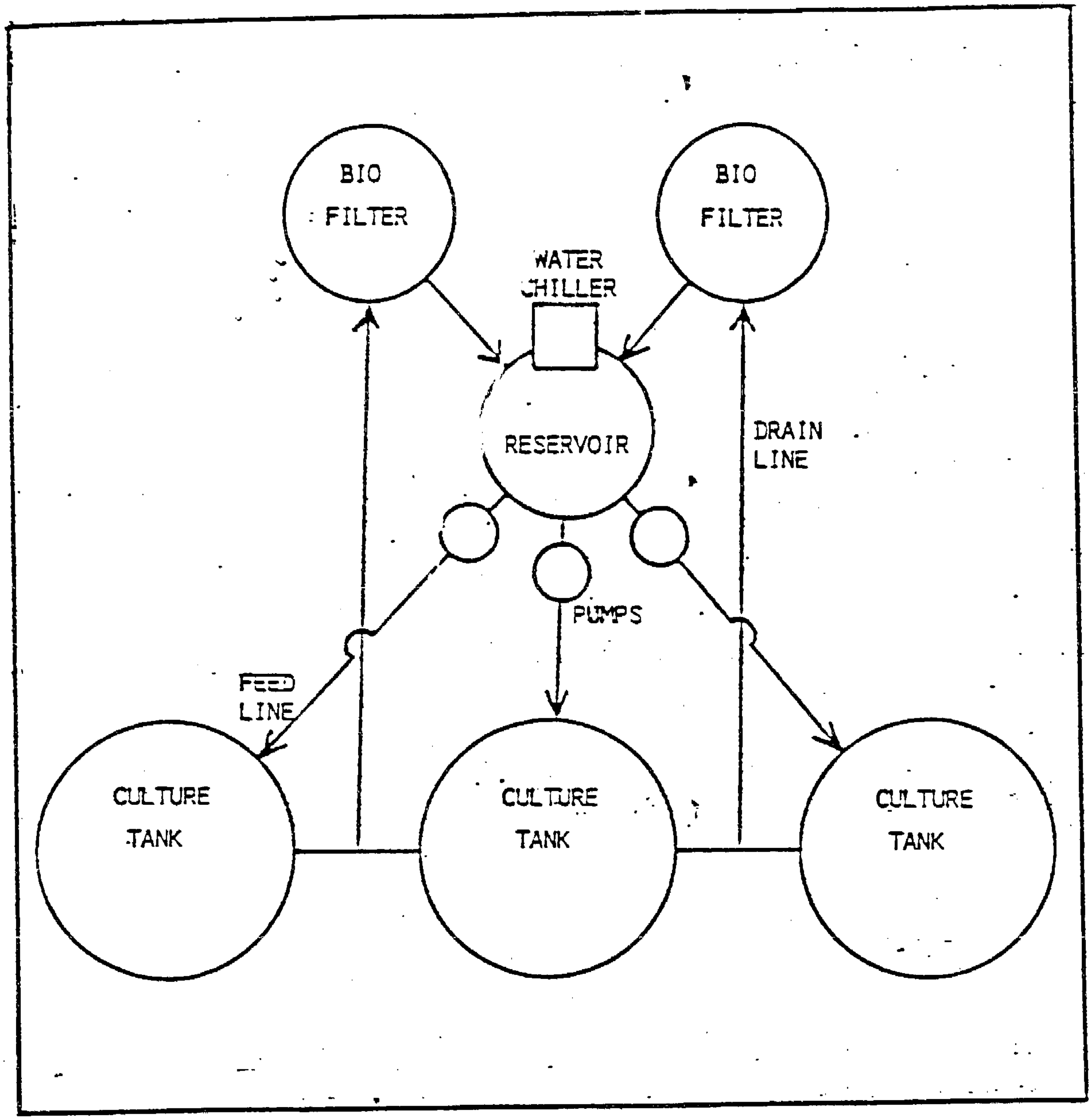


FIGURE 1. SCHEMATIC DIAGRAM OF THE RECIRCULATING REARING SYSTEM.

gravel (30 to 35 cm deep) was used as a substrate for bacterial growth in the filters. Water flowed by gravity out of each rearing tank through a 500-um mesh polypropylene screen into a central drain, through the biological filters, and then into a central reservoir. The water in the reservoir was maintained at 20° C using a Frigid Unit® model D1-100 1/2-ton refrigeration unit. The cooled water was then recirculated to the circular rearing tanks with March® model AC3CMD impellor pumps. Water flowed into the tanks as either upwelling or circular currents.

Water temperature, salinity, dissolved oxygen, and ammonia in the rearing system were measured daily. The biological filters were backflushed and approximately 10% of the water was replaced daily. Salinity of the water was maintained at 2 to 5 o/oo using Marine Environment® artificial sea salts.

Beginning at 4 days after hatch, the striped bass larvae were fed brine shrimp nauplii. Automatic feeders (Figure 2) suspended over the rearing tanks dispensed live brine shrimp nauplii to the larval striped bass every three hours. The feeders were controlled by solenoid valves operated by repeat-cycle timers. Each feeder was calibrated to dispense approximately 400 ml of nauplii to the rearing tank which resulted in a density of approximately 200 nauplii per liter of tank water, eight times per day.

The nauplii were cultured in bottomless inverted one-gallon plastic bottles. Salinity of the culture media was adjusted to 35 o/oo with sodium chloride, and 30 ml of Argent® artemia cysts (from China) were added per

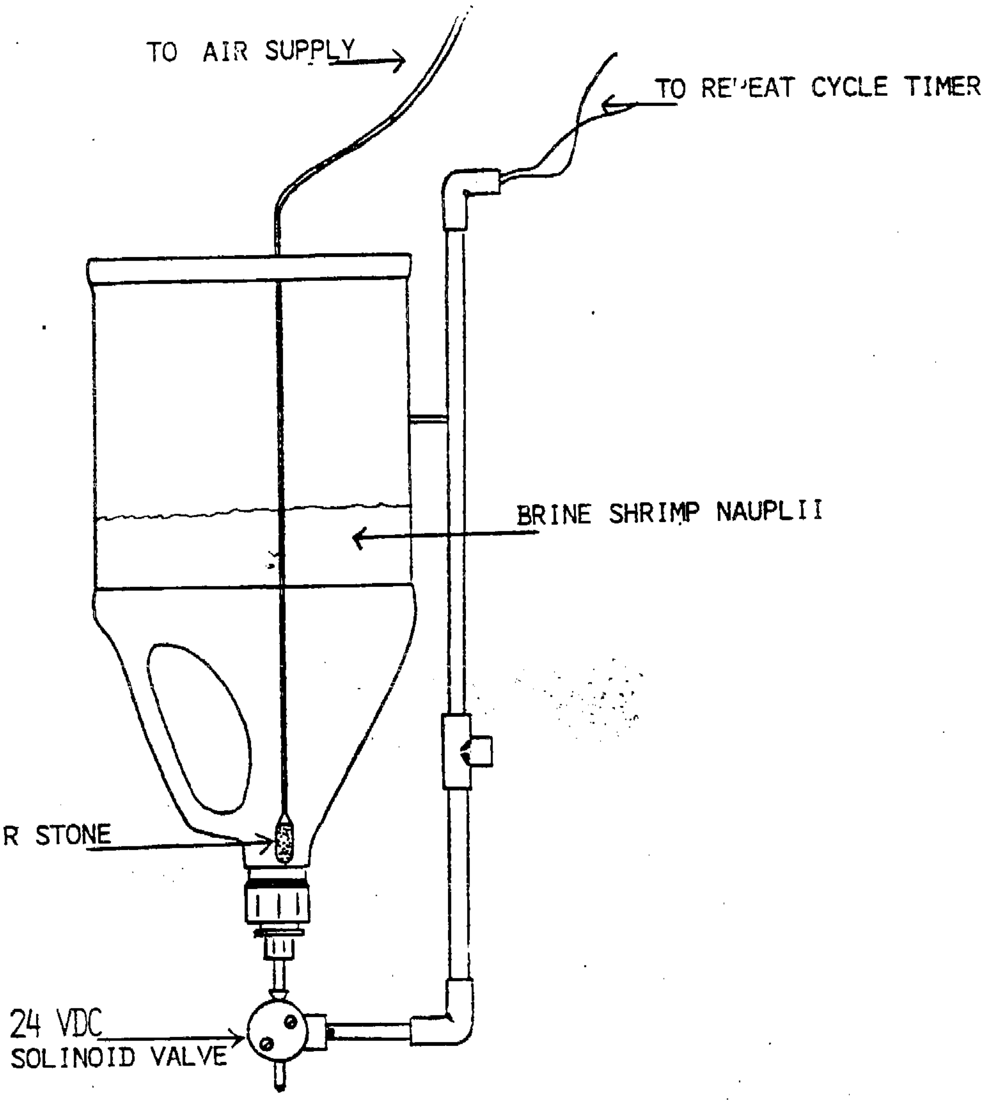


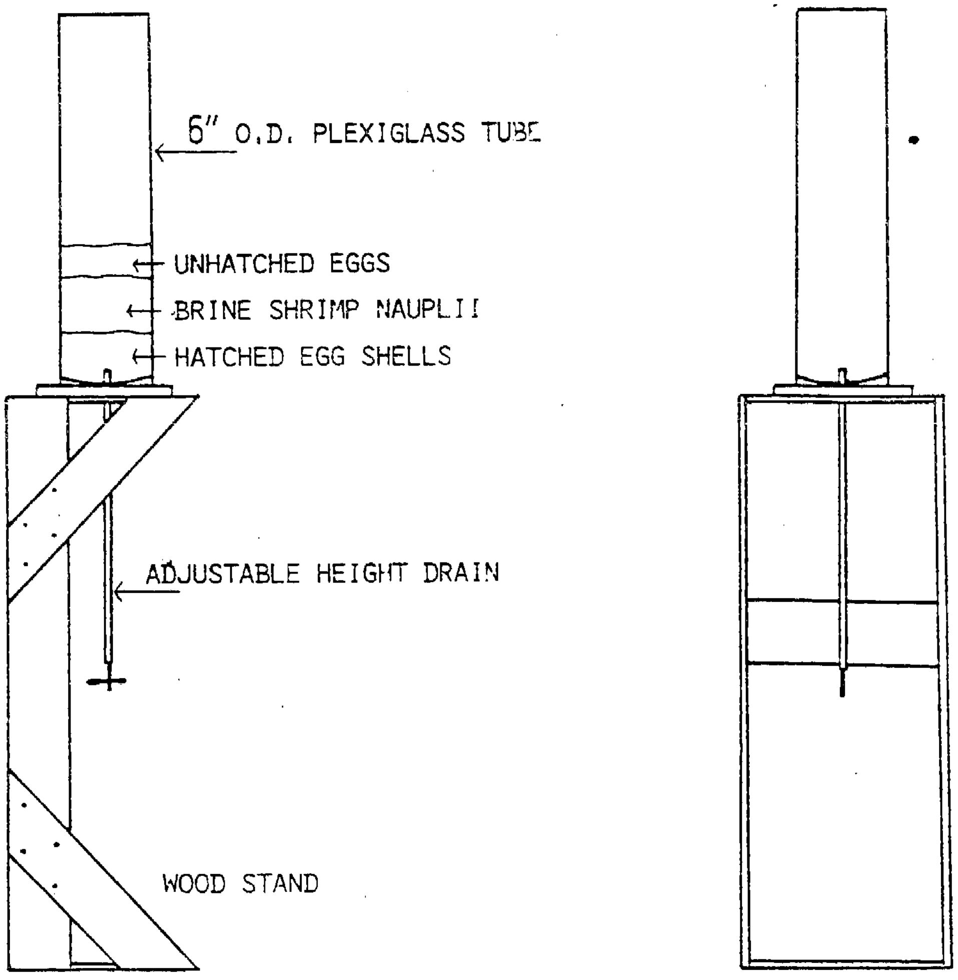
FIGURE 2. AUTOMATIC FEEDER FOR REARING SYSTEM.

gallon of culture media; this resulted in a density of 500,000 nauplii per liter. The nauplii were separated from the shells and unhatched cysts using a device (Figure 3) similar to that described by Lewis and Heidinger (1981). At about three weeks after hatch, the diets of larvae were supplemented with salmon and trout starter feed at 5% of their estimated weight per day.

Testing System

The toxicity tests were conducted in the bioassay trailer (Figure 4) previously described by Finlayson and Faggella (1984b). Three tests were run concurrently; molinate, thiobencarb, and an equitoxic mixture of the two herbicides. Five concentrations of herbicides and a control were supplied to replicate aquaria (12 aquaria total) in each test using solenoid valve proportional diluters. The flow rate through the 15-liter aquaria was 4 liters per hour. The photoperiod was 14-hour light (0500 to 1900 hrs) and 10-hour dark and was provided by automatically controlled overhead fluorescent lights. Two overhead ventilation fans with a total discharge capacity of 2,000 cfm kept molinate and thiobencarb vapors in the 1,200-cf bioassay room to a minimum.

Dilution water used for the tests came from the American River. Native quality of the American River water during the tests was pH of 7.1, alkalinity of 20 mg/liter $CaCO_3$, temperature of 14 to 17° C, conductivity of 50 uS, and dissolved oxygen at 90% or greater of saturation. The dilution water was heated to 18 ± 1° C with a stainless steel water heater. Salinity of the dilution water was adjusted to 2 ± 1 o/oo by injecting



SIDE VIEW

FRONT VIEW

FIGURE 3. BRINE SHRIMP SEPARATER.

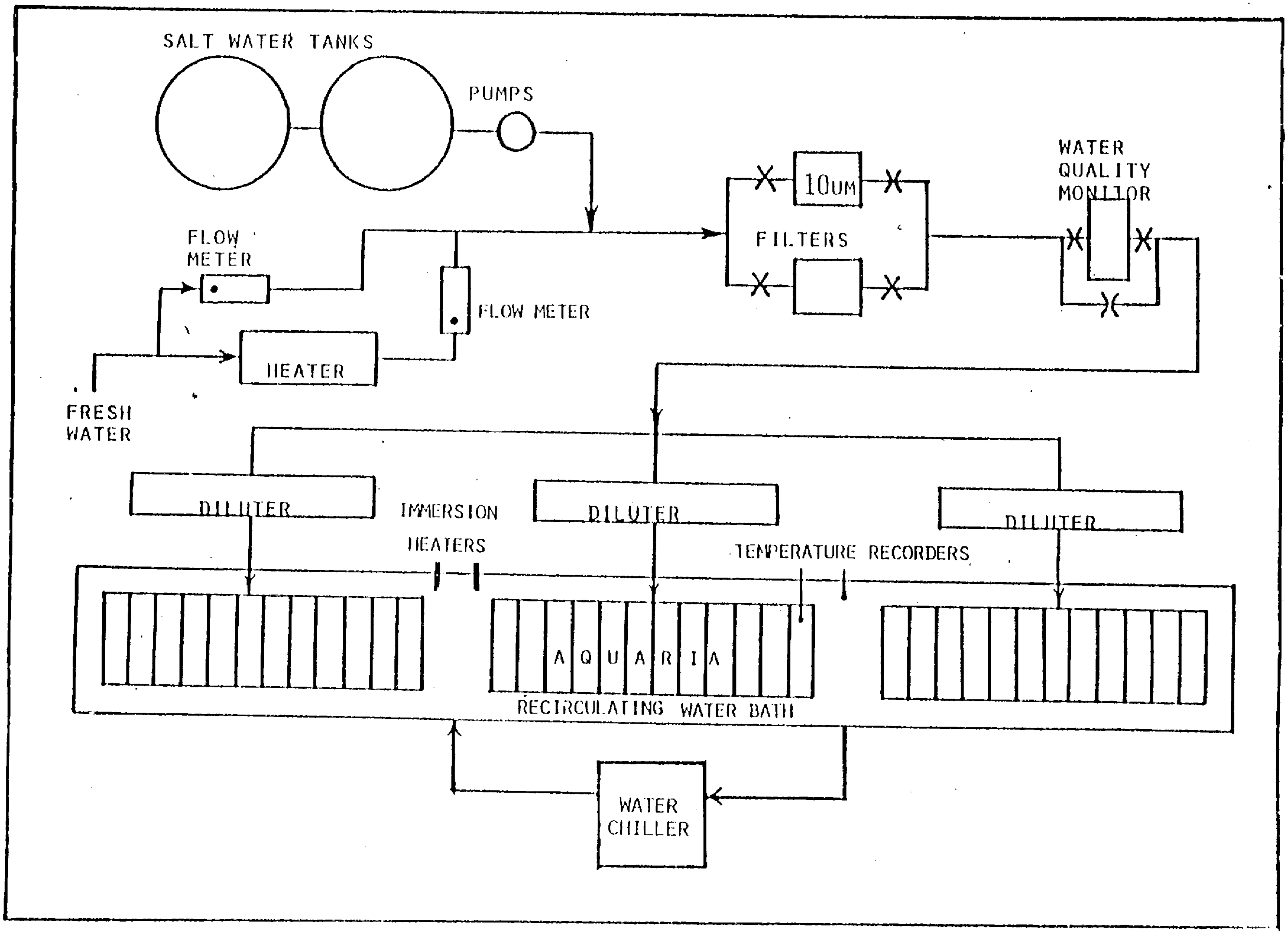


FIGURE 4. SCHEMATIC DIAGRAM OF DILUTION WATER DELIVERY SYSTEM FOR THE BIOASSAY TRAILER.

artificial sea water (35 o/oo) with a March® model AC3CMD impellor pump (Figure 5). The quality of the heated saline dilution water was automatically measured hourly for temperature, conductivity, dissolved oxygen, and pH using a Montedoro-Whitney® model WQM-1 water quality monitor. Additional water temperature control in the aquaria was provided by a recirculating water bath. The temperature of the recirculating water bath was maintained at 20° C by either heating with Cole-Parmer® quartz imersion heaters or cooling with an Edwards® model CC1 one-ton water chiller. Water temperatures in the water bath and aquaria were continually measured on a Cole-Parmer® two-channel script chart recorder.

The embryonic and larval striped bass were exposed in 600-ml glass beakers (Figure 6) and one-liter (13 x 13 x 13-cm) plate glass and polypropylene screen test chambers (Figure 7), respectively. For the tests with embryonic striped bass, the toxicant delivery tubes from the diluters were placed in the bottom of the beakers to provide an upwelling current, and the water flow from the diluters was adjusted so that the embryos were kept suspended but not washed out of the beakers. The newly hatched prolarvae flowed out of the beakers into the test chambers. For the tests with larvae, test chambers had airlifts which provided for an exchange of test water between chambers and aquaria and helped keep the larvae suspended. A Dayton® model 42706 oil-less air compressor with a 76-liter storage tank supplied air to the test chambers through two-stage regulators, PVC manifolds, and valves.

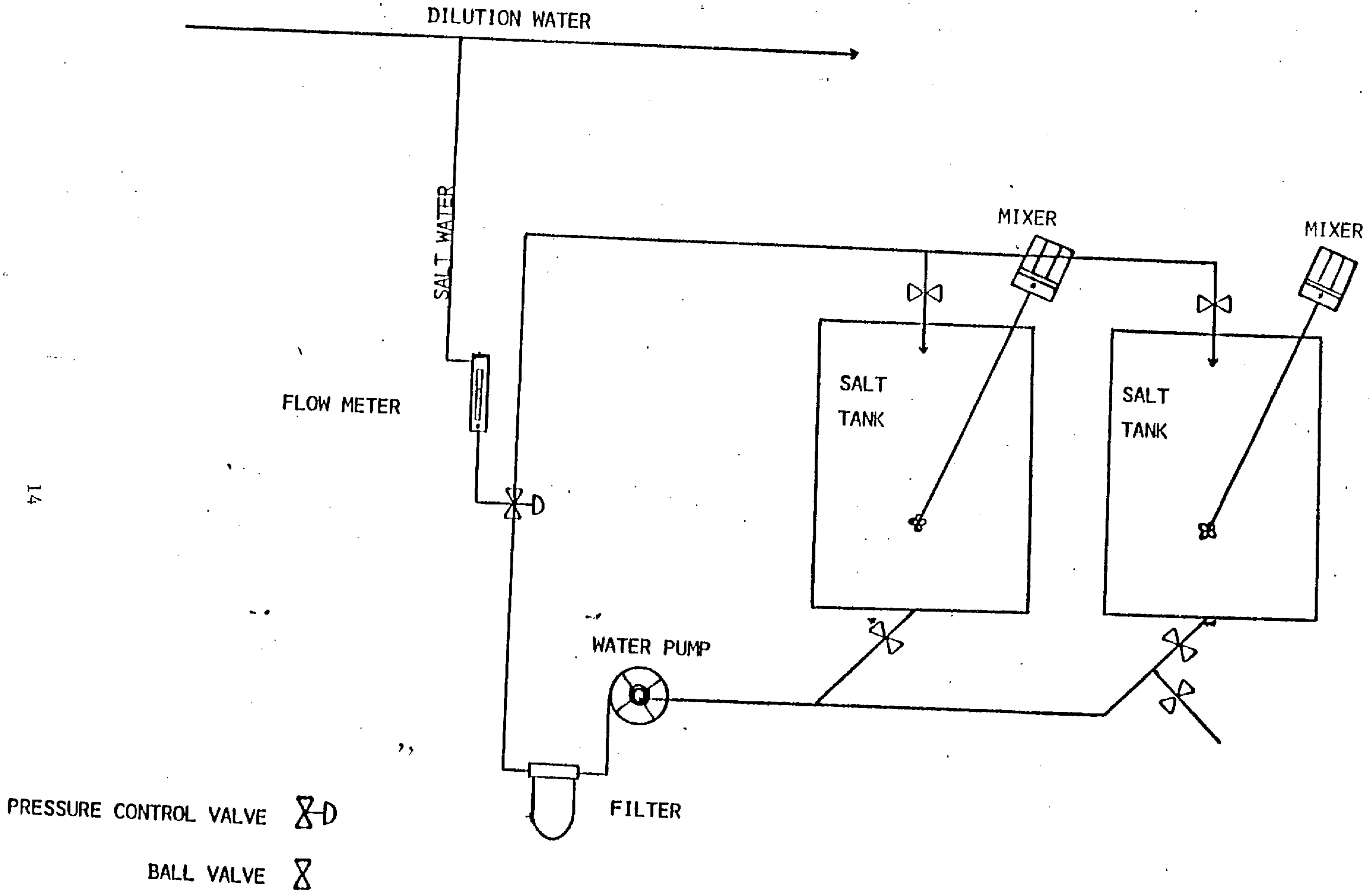


FIGURE 5. SCHEMATIC DIAGRAM OF SALT WATER INJE ON SYSTEM.

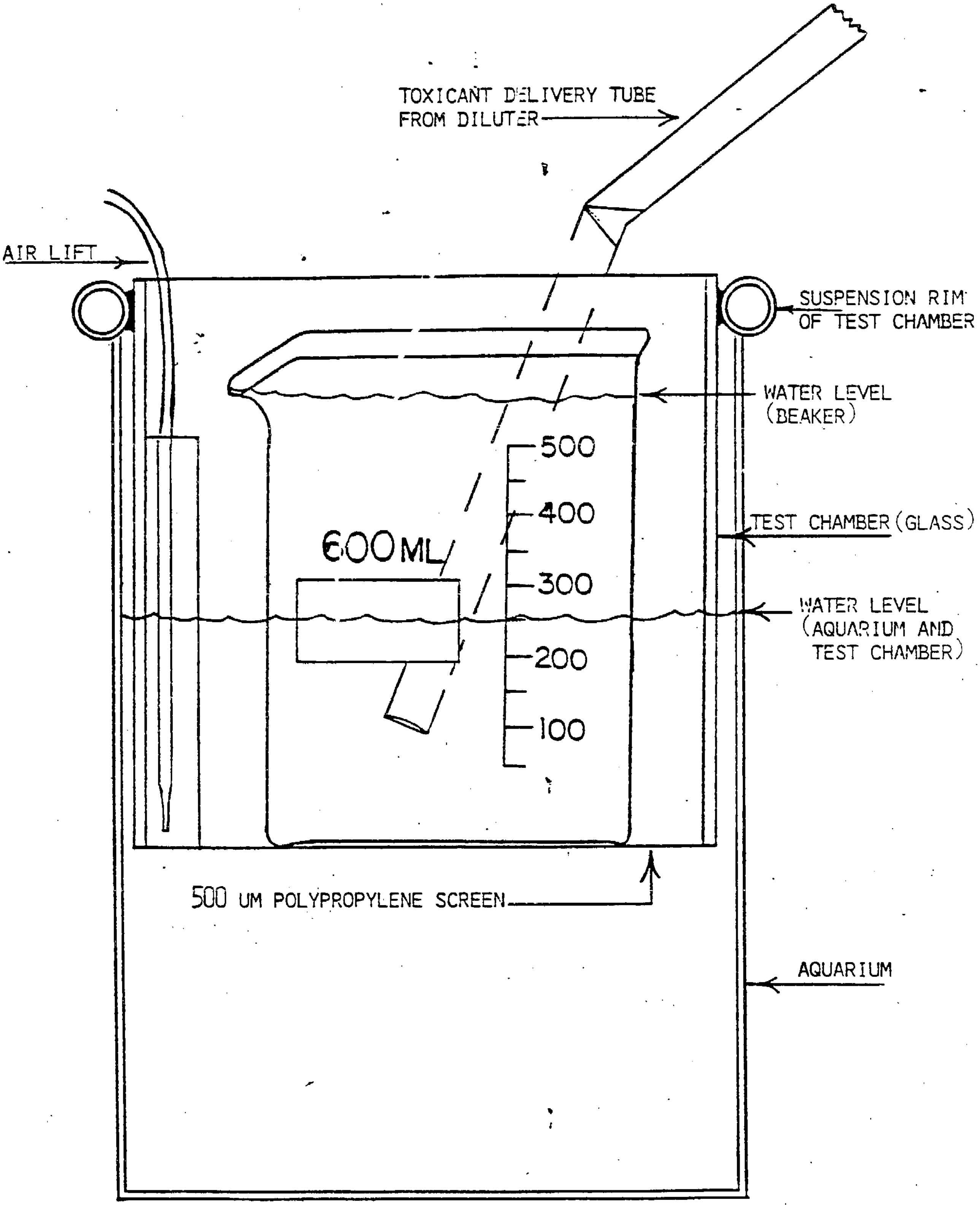


FIGURE 6. EMBRYONIC AND LARVAL TEST VESSEL.

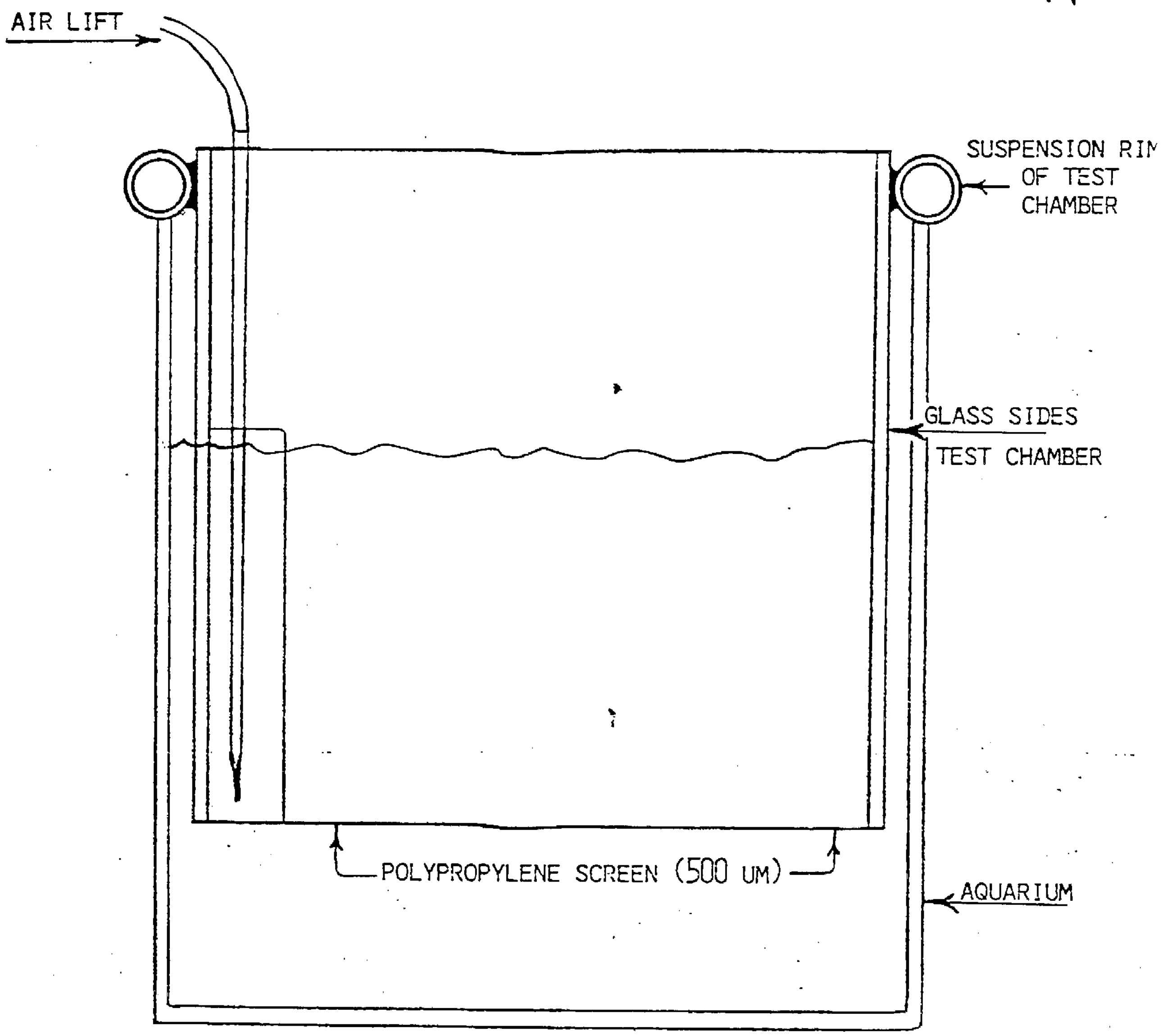


FIGURE 7. GLASS AND POLYPROPYLENE TEST VESSEL.

Testing Methods

Six-day (144-hr) continuous-flow acute tests were conducted on embryonic and larval striped bass and 31-day continuous-flow chronic tests were conducted on striped bass fry using standard practices (American Society for Testing and Materials 1980). The stocking density was 25 striped bass embryos per beaker with one beaker per aquaria (50 embryos per concentration). The stocking density was 20 striped bass larvae or fry per test chamber with one chamber per aquaria (40 fish per concentration).

The fish were fed brine shrimp nauplii at a density of 5,000 nauplii per liter, three times daily during the tests. Dead larvae were recorded and removed daily. A fish was considered dead if it did not respond to external stimuli or had turned opaque. At the termination of the acute and chronic tests, all remaining fish were measured (standard length) using methods previously described by Finlayson and Faggella (1984b). Some of the fish were fixed in Bouin's solution for later histological examination. Other fish (5 per aquaria) were immediately frozen in deionized water for later RNA and DNA analyses using the methods of Barron and Adelman (1984).

Toxicants and Delivery Systems

Molinate and thiobencarb stock solutions were prepared from Ordram 8EC and Bolero 8EC commercial herbicide formulations (containing 90.3 and 85.4% active ingredient, respectively) by sonicating them in deionized water. A Heat Systems-Ultrasonics® model W-370 Cell Disrupter was used for sonication. The solutions were made up in 12-liter quantities and stored in 20-liter glass jars with lids; 12 liters was sufficient quantity for a

6-day acute toxicity test. New solutions were prepared weekly during the 31-day chronic tests. The solutions were delivered to the proportional diluters through silicone tubing using Gilson® model HP1 Minipuls peristaltic pumps. The solutions were checked analytically for molinate and thiobencarb content at the beginning and end of use.

Toxicant Monitoring

Water samples for confirmation of molinate and thiobencarb test concentrations were collected by dipping chemically clean 250-ml amber glass bottles into the aquaria. The bottles were filled to the top and sealed with teflon-lined caps. The samples were stored in a refrigerator at 4° C until analyzed. Water samples were taken from all the aquaria two times during the 6-day acute tests at 24 and 120-hour intervals and twice a week during the 31-day chronic tests. The samples were analyzed at the CDFG Water Pollution Control Laboratory.

Chemistry

Water samples were extracted with the Baker®-10 Solid Phase Extraction C-8 disposable columns. The Baker®-10 columns were pre-conditioned with 2 ml of methanol followed by 2 ml of deionized water. Water samples were passed through the columns at a rate of 5 ml per minute. The herbicides were eluted from the columns with two 2-ml aliquots of ethyl acetate. The extracts were transferred to a 10-ml graduated tube and adjusted to a desirable volume for analysis by gas chromatography. The instrumental conditions of the Varian-Aerograph® model 3700 gas chromatograph used for the analysis were follows:

Column: DC-200, Length: 183 cm, I.D.: 2 mm

Detector Temperature: 290° C

Injector Temperature: 210° C

Column Temperature: 192° C for thiobencarb

180° C for molinate

Carrier Flow: 30 ml/min

Carrier Gas: N_2

Detector: TSD

Detection Limits: 1 ug/liter for both molinate and thiobencarb

Data Analysis

Survival data of striped bass from the acute and chronic tests were analyzed by the binomial chi-square test for data arranged in two groups (Cochran and Cox 1968). Median lethal concentration (LC50) values were not calculated if mortality of the control group was >25%. Abbot's correction factor was used to adjust for mortality in treatment groups in the LC50 value calculations when control group mortality was >10% and $\leq$25%

$$Mx(a) = 1 - Sx/Sc$$

where Mx(a) is adjusted mortality in concentration x, Sx is survival in concentration x, and Sc is survival in controls (Finley 1971). The Mx(a) was used to calculate the adjusted number dead in concentration x

$$Dx(a) = Mx(a)*Ex$$

where Dx(a) is the adjusted number dead in concentration x and Ex is the number exposed in concentration x.

The LC50 values were determined using either moving average method when ≥1 toxicant concentrations had partial mortality (between 0 and 100% mortality) or nonlinear interpolation method when no toxicant concentration had partial mortality (Stephan 1977). Exact (95%) confidence intervals were calculated using Fullers Theorem (moving average), or conservative (>95%) confidence intervals were calculated using binomial probabilities (nonlinear interpolation) according to methods given by Stephan (1977).

In herbicide mixture tests, molinate and thiobencarb concentrations at the LC50 level were interpolated from least squares regression (solution concentration versus herbicide concentration). To determine the type of toxic interaction of molinate and thiobencarb in mixtures, toxicities of the herbicides in mixtures were expressed as toxic units and summed (Lloyd 1961; Brown 1968):

$$(Mm/Mi) + (Tm/Ti) = S$$

where M is molinate, T is thiobencarb, i is LC50 of individual herbicide tested separately, and m is the concentration of the individual herbicide at the mixture LC50 value. Additive indexes (AI) were calculated by adjusting for asymmetry of S and substituting 95% confidence intervals for the LC50 values and establishing a test range (Marking 1977) as follows:

$$\text{If } S \geq 1.0 \text{ then } AI = -S + 1.0;$$

$$\text{If } S \leq 1.0 \text{ then } AI = 1/S - 1.0.$$

This index is symmetrical about AI = 0 (additivity); positive values indicate synergism, negative values antagonism. The theoretical range of completely (simple) additive toxicity (AI = 0) for the herbicide mixture tests were estimated by adjusting the herbicide mixture LC50 values to S = 1.0, substituting the adjusted 95% confidence intervals into the two AI equations and establishing an additive range (Finlayson and Verrue 1982). To determine the type of interaction, the two ranges were compared as follows: if the test range broadly (>50%) overlapped the additive range then additive toxicity; if most of the test range (>50%) was below the additive range then antagonistic toxicity; and if most of the test range (>50%) was above the additive range then synergistic toxicity.

Length measurements of larvae from control and treatment groups were compared in the acute and chronic tests. Significant differences between the control and treatment groups were determined by the Kruskal-Wallis test with Dunn's multiple comparison procedure (Daniel 1978).

RESULTS

Culture System

There was poor survival in the rearing system this year. Only one family (Spawn 3) lived for longer than 14 days after hatch. The poor survival in the rearing system was attributed, in part, to over-inflated gas bladders (gas bubble disease) caused by water supersaturated with gas. The circulation impellor of the refrigeration unit was forcing air into solution. The gas bubble disease disappeared once the impellor was detached. Growth of families from Spawns 3 and 4 were comparable to that reported by Finlayson and Faggella (1984b) and by Eldridge et al. (1981) (Figure 8).

Water Quality and Toxicant Stability

The culture system had a mean water temperature of 18.7° C, salinity of 3.7 o/oo, dissolved oxygen of 8.2 mg/liter, and total ammonia of 0.08 mg/liter. The means were based on daily measurements which are summarized in Appendix A.

The mean salinities of the dilution water for the acute toxicity tests were 1.6 o/oo (Test Series 6 & 7) and 2.5 o/oo (Test Series 8). The mean salinity of the dilution water for the chronic toxicity tests was 2.7 o/oo (Table 2). The daily means for the acute and chronic tests are summarized in Appendices B and C, respectively.

The mean temperatures of the dilution water for the acute toxicity tests ranged from 18.9 to 19.9° C, and the mean temperature of the dilution water for the chronic toxicity test was 20.1° C (Table 2). The mean

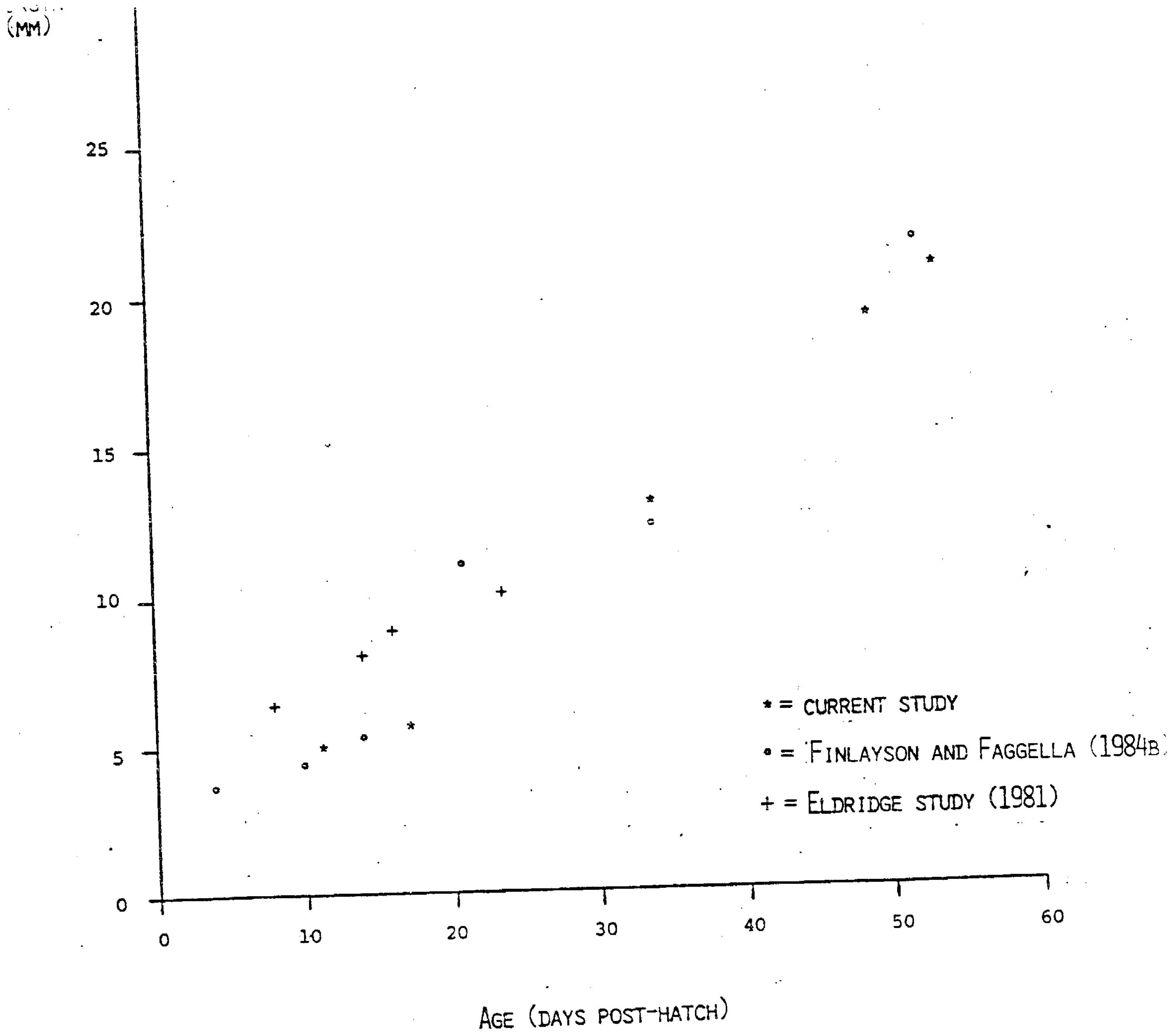


Figure 8 Larval growth during the 1985 study compared to that reported by Finlayson and Faggella (1984b) and Eldridge et al. (1981).

Table 2. Mean quality of dilution water by test series after heating and salt adjustment.

Test Series	N	Date	Salinity (o/oo)	Temperature (° C)	pH
6 & 7	162	6-7-85 6-13-85	1.6±0.9[a]	18.9±0.9	6.98±0.34
8	192	6-26-85 7-2-85	2.5±1.4	19.9±1.6	7.09±0.43
9	567	6-26-85 7-19-85	2.7±0.7	20.1±0.5	7.08±0.25

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[a] Mean ± standard error

temperature in the test aquaria for both acute and chronic tests was 20.2° C ± 0.86 (mean ± S.E.). The daily mean temperatures for the dilution water of the individual acute and chronic toxicity tests are summarized in Appendices B and C, respectively. The daily mean temperatures in the test aquaria are summarized in Appendix D.

The mean pH for the dilution water by test ranged from 6.98 to 7.09 (Table 2). The daily mean pH for the acute and chronic tests are summarized in Appendicies B and C, respectively. Dissolved oxygen in the test aquaria was at saturation levels throughout all testing. Total ammonia concentrations in the test aquaria were <0.01 mg/liter throughout all the tests.

Molinate contamination of the control test aquaria was reduced with the use of exhaust fans. Molinate concentrations in the control aquaria were 0.4% (0.15 mg/liter) of the highest molinate concentration (40.3 mg/liter) tested.

There were considerable differences between the expected and measured herbicide concentrations in the thiobencarb and the herbicide mixture tests. Measured herbicide concentrations averaged 55% ± 32% (mean ± S.E.) of the expected concentrations in thiobencarb tests. Measured molinate and thiobencarb concentrations averaged 64% ± 35% and 51% ± 47%, respectively, of the expected herbicide concentrations in the herbicide mixture tests. Measured herbicide concentrations averaged 90% ± 37% of the expected concentrations in the molinate tests.

Toxicity of Molinate and Thiobencarb

Survival of fish in control groups during the 144-hr tests varied between 65 and 84% for 6-day old, 77 and 92% for 13-day old, 91 and 93% for 28-day old, and 68 and 85% for 45-day old fish. Molinate and thiobencarb concentrations caused dose related responses in survival of the 6-day old (Table 3 and Appendix E-1), 13-day old (Tables 4 and 5 and Apendices E-2 and E-3), 28-day old (Table 6 and Appendix E-4), and 45-day old (Table 7 and Appendix E-5) fish.

The lowest herbicide test concentrations during the 144-hour exposures that significantly ($p \leq 0.05$) lowered survival compared to control groups for 6-day to 45-day old fish ranged from 1.5 to 21.5 mg/liter for molinate tests, 0.11 to 0.77 mg/liter for thiobencarb tests, and 0.88 to 5.9 mg/liter molinate and 0.05 to 0.49 mg/liter thiobencarb for the herbicide mixture tests (Table 8). The lowest herbicide test concentrations during the 144-hour exposures that significantly ($p \leq 0.05$) reduced growth compared to control groups for the same age fish ranged from 1.5 to >21.5 mg/liter for molinate tests, 0.07 to >0.77 mg/liter for thiobencarb tests, and >1.1 to >7.7 mg/liter molinate and 0.07 to >0.74 mg/liter thiobencarb for the herbicide mixture tests (Table 9).

Thiobencarb averaged for 6-day and 13-day old larvae 16 times more toxic than molinate, based on 96-hour LC50 values (Table 10). Generally, the toxicity of the rice herbicides decreased with increased age of larvae. The 96-hour LC50 values for 6-day old and 13-day old larvae exposed to the herbicides separately were 2.1 and 10.7 mg/liter molinate and 0.28 mg/liter

Table 3. Acute effects (6-day) of molinate and thiobencarb concentrations (mg/liter) on growth and survival (mean values with S.E. in parentheses) of 6-day old (Test Series 5) striped bass larvae.

Molinate Concentration	Mortality (%)	Fish Length (mm)	N a/	Thiobencarb Concentration	Mortality (%)	Fish Length (mm)	N	Molinate & Thiobencarb Concentrations	Mortality (%)	Fish Length (mm)	N
Control 0.02(0.02)	16	5.55(0.12)	36	Control 0.002(0.00)	35	5.3(0.10)	26	Control 0.03(0.01) 0.001(0.00)	25	4.52(0.13)	37
1.5(0.1)	37 b/	4.70(0.39) c/	6	0.03(0.02)	28	5.02(0.05)	28	0.7(0.3) 0.05(0.02)	30	3.56(0.03) c/	28
0.9(0.5)	52 b/	4.71(0.24) c/	10	0.07(0.06)	31	3.45(0.03) c/	31	1.0(0.3) 0.06(0.03)	27	4.23(0.18)	20
4.6(0.6)	100 b/	--	--	0.14(0.11)	44	4.01(0.16) c/	24	1.7(0.3) 0.09(0.06)	28	4.88(0.03)	31
8.4(3.5)	100 b/	--	--	0.31(0.12)	85 b/	3.46(0.03) c/	8	2.7(0.7) 0.17(0.06)	63 b/	4.27(0.17)	19
13.3(2.1)	100 b/	--	--	0.48(0.33)	100 b/	--	–	4.4(0.9) 0.26(0.10)	68 b/	5.03(0.07)	21

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a/ N = Number of fish measured

b/ Significantly greater than control (x^2, 0.05)

c/ Significantly greater than control (z, 0.05)

Table 4. Acute effects (6-day) of molinate and thiobencarb concentrations (mg/liter) on growth and survival (mean values with S.E. in parentheses) of 13-day old (Test Series 4) striped bass larvae.

Molinate Concentration	Mortality (%)	Fish Length (mm)	N[a]	Thiobencarb Concentration	Mortality (%)	Fish Length (mm)	N	Molinate and Thiobencarb Mixture			
								Molinate & Thiobencarb Concentrations	Mortality (%)	Fish Length (mm)	N
Control 0.21(0.24)	18	5.62(0.05)	59	Control 0.001(0.00)	23	5.80(0.09)	20	Control 0.04(0.05 <0.001(0.00)	15	5.50(0.06)	39
2.0(0.3)	17	5.72(0.09)	23	0.07(0.04)	13	5.52(0.07)	23	1.0(0.4) 0.07(0.01)	25	5.39(0.08)	28
3.1(0.7)	21	5.55(0.10)	27	0.11(0.08)	57[b]	5.12(0.14)[c]	13	1.1(0.2) 0.07(0.00)	23	5.13(0.10)[c]	20
4.9(1.0)	23	5.34(0.08)[c]	23	0.22(0.14)	37	4.96(0.12)[c]	14	1.6(0.3) 0.12(0.02)	20	5.16(0.09)[c]	22
8.0(1.7)	49[b]	5.06(0.10)[c]	17	0.44(0.060	82[b]	4.80(0.03)[c]	6	2.7(0.5) 0.20(0.02)	10	4.87(0.09)[c]	25
15.5(3.7)	100[b]	--	--	0.86(0.23)	100[b]	--	--	4.4 .22	28	4.67(0.08)[c]	17

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[a] N = Number of fish measured

[b] Significantly greater than control (x^2, 0.05)

[c] Significantly greater than control (z, 0.05)

Table 5. Acute effects (6-day) of molinate and thiobencarb concentrations (mg/liter) on survival (mean values with S.E. in parentheses) of 13-day old (Test Series 6) striped bass larvae.

Molinate and Thiobencarb Mixture		
Molinate Concentration	Thiobencarb Concentration	Mortality (%)
Control	Control	
0.04(0.02)	<0.01(0.01)	8
0.88(0.2)	0.05(0.05)	23 [a]
1.3(0.3)	0.09(0.04)	28 [a]
2.0(0.5)	0.15(0.06)	45 [a]
3.2(0.5)	0.27(0.15)	53 [a]
5.9(0.1)	0.48(0.06)	100 [a]

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[a] Significantly greater than control (x^2, 0.05)

Table 6. Acute effects (6-day) of molinate and thiobencarb concentrations (mg/liter) on growth and survival (mean values with S.E. in parantheses) of 28-day old (Test Series 7) striped bass larvae.

								Molinate and Thiobencarb Mixture			
Molinate Concentration	Mortality (%)	Fish Length (mm)	N a/	Thiobencarb Concentration	Mortality (%)	Fish Length (mm)	N	Molinate & Thiobencarb Concentrations	Mortality (%)	Fish Length (mm)	N
Control 0.03(0.02)	7	12.5(0.3)	23	Control <0.01(0.00)	8	12.6(0.5)	14	Control 0.04(0.02 <0.01(0.01)	9	12.9(0.3)	10
1.9(0.2)	15	12.1(0.2)	24	0.04(0.02)	14	12.8(0.3)	20	0.9(0.2) 0.05(0.05)	0	12.4(0.3)	19
0.02(0.02)	8	12.0(0.3)	20	0.10(0.06)	6	12.0(0.3)	15	1.3(0.3) 0.09(0.04)	4	12.2(0.4)	12
5.0(0.6)	10	11.8(0.3)	17	0.18(0.11)	0	12.5(0.2)	25	2.0(0.5) 0.15(0.06)	8	11.9(0.2)	18
7.0(1.8)	17	12.1(0.2)	14	0.35(0.17)	33 b/	12.2(0.3)	10	3.2(0.5) 0.27(0.15)	0.5	11.8(0.2)	23
15.5(3.0)	55 b/	11.8(0.2)	6	0.44(0.26)	41 b/	10.9(0.4) c/	10	5.9(0.1) 0.48(0.06)	39 b/	10.8(0.2) c/	7

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a/ N = Number of fish measured

b/ Significantly different than control (x^2, 0.05)

c/ Significantly different than control (z, 0.05)

Table 7. Acute effects (6-day) of molinate and thiobencarb concentrations (mg/liter) on growth and survival (mean values with S.E. in parentheses) of 45-day old (Test Series 8) striped bass fry.

								Molinate and Thiobencarb Mixture			
Molinate Concentration	Mortality (%)	Fish Length (mm)	N[a]	Thiobencarb Concentration	Mortality (%)	Fish Length (mm)	N	Molinate & Thiobencarb Concentrations	Mortality (%)	Fish Length (mm)	N
Control 0.13(0.08)	32	19.0(0.4)	18	Control <0.01(0.00)	25	20.0(0.3)	20	Control 0.02(0.02) <0.01(0.00)	15	18.9(0.3)	25
5.8(0.8)	26	19.1(0.4)	19	0.20(0.18)	5	24.4(0.6)	13	3.5(1.2) 0.35(0.11)	3	18.8(0.3)	28
7.5(0.4)	31	18.7(0.4)	18	0.27(0.08)	0	24.0(0.4)	15	4.9(1.4) 0.49(0.16)	33[b]	18.2(0.3)	13
12.8(2.4)	32	18.3(0.4)	16	0.40(0.25)	37	23.5(0.4)	6	7.7(2.1) 0.74(0.25)	69[b]	18.1(0.5)	7
21.5(3.0)	95[b]	19.0(0.5)	2	0.77(0.23)	90[b]	19.5(3.5)	2	13.1(4.0) 1.1(0.4)	100[b]	--	--
38.8(6.2)	100[b]	--	--	1.3(0.35)	--	--	--	20.8(4.9) 1.7(0.7)	100[b]	--	--

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[a] N = Number of fish measured

[b] Significantly different than control (x^2, 0.05)

Table 8. Lowest herbicide concentrations (mg/liter) that significantly lowered survival of striped bass larvae and fry during 6-day exposures.

Fish Age (days)	Molinate	Thiobencarb	Molinate and Thiobencarb Mixture	
			Molinate	Thiobencarb
6	1.5	.31	2.7	0.17
13	8.0	.11	.88	.05
28	15.5	0.35	5.9	0.48
45	21.5	0.77	4.9	0.49

Table 9. Lowest herbicide concentrations (mg/liter) that significantly reduced growth of striped bass larvae and fry during 6-day exposures.

Fish Age (days)	Molinate	Thiobencarb	Molinate and Thiobencarb Mixture	
			Molinate	Thiobencarb
6	1.5	0.07	>4.4	>0.26
13	4.9	0.11	1.1	0.07
28	>15.5	>0.44	5.9	0.48
45	>21.5	>0.77	>7.7	>0.74

Table 10. Median lethal (LC50 values) and 95% confidence interval (in parentheses) concentrations (mg/liter) of molinate and thiobencarb to striped bass.

Fish Age	Fish Length (mm)	Test Series	Toxicant	Molinate 48-hr	Molinate 96-hr	Molinate 144-hr	Thiobencarb 48-hr	Thiobencarb 96-hr	Thiobencarb 144-hr
6	5.30(0.10)	5	Thiobencarb				--	0.28 (.25-.31)	--
6	5.55(0.12)	5	Molinate	3.8 (2.6-5.1)	2.1 (1.8-2.4)	2.1 (1.7-2.4)			
6	4.52(0.13)	5	Mixture	--	--	2.6 (1.6-2.6)	--	--	0.16 (.10-.16)
13	5.80(0.09)	4	Thiobencarb				--	0.51 (.44-.86)	0.24 (.21-.27)
13	5.62(0.05)	4	Molinate	11.3 (8-15.5)	10.7 (8-15.5)	8.8 (8-15.5)			
13	--	6	Mixture	--	3.0 (2.7-3.3)	2.0 (1.7-2.4)	--	0.24 (.21-.26)	0.16 (.13-.19)
45	20.0(0.3)	8	Thiobencarb				--	--	0.57 (.40-.77)
45	19.0(0.4)	8[a/]	Molinate	--	--	--			
45	18.9(0.3)	8	Mixture	--	7.5 (6.7-8.3)	6.6 (4.7-7.50	--	0.65 (.60-.72)	0.58 (.43-.66)
45	34.0(1.5)	9[b/]	Thiobencarb					.21 (.18-.24)	
45	34.0(1.0)	9[b/]	Molinate		< 5.6				

[a/] Mortality in control $> 25\%$

[b/] Chronic toxicity test (31-day) LC50 value and 0.51 mg/liter thiobencarb, respectively. The 96-hour LC50 values for 13-day and 45-day old larvae exposed to the herbicide mixture were 3.0 mg/liter molinate and 0.24 mg/liter thiobencarb and 7.5 mg/liter molinate and 0.65 mg/liter thiobencarb, respectively. The toxicity of the herbicides to the 13-day old fish increased with increased exposure time. The LC50 values for molinate decreased from 11.3 (48-hour) to 8.8 (144-hour) mg/liter and for thiobencarb decreased from 0.51 (96-hour) to 0.24 (144-hour) mg/liter. The 31-day LC50 values for 45-day old fry exposed to the herbicides individually were <5.6 mg/liter molinate and 0.21 mg/liter thiobencarb.

The molinate and thiobencarb mixture produce an AI range for 13-day old larvae that suggest simple additive toxicity (Figure 9). Additive index ranges were not calculated for 6-day and 45-day old fish because of high mortality (>25%) occuring in some of the test control groups.

Molinate concentrations ≥5.6 mg/liter during the 31-day chronic test significantly lowered survival and growth compared to the control group of 45-day old fish (Table 11 and Appendix E-6). Thiobencarb concentrations ≥0.24 mg/liter significantly reduced survival compared to the control group . The data from the chronic toxicity test on the herbicide mixture are not presented because of the high mortality in that control group.

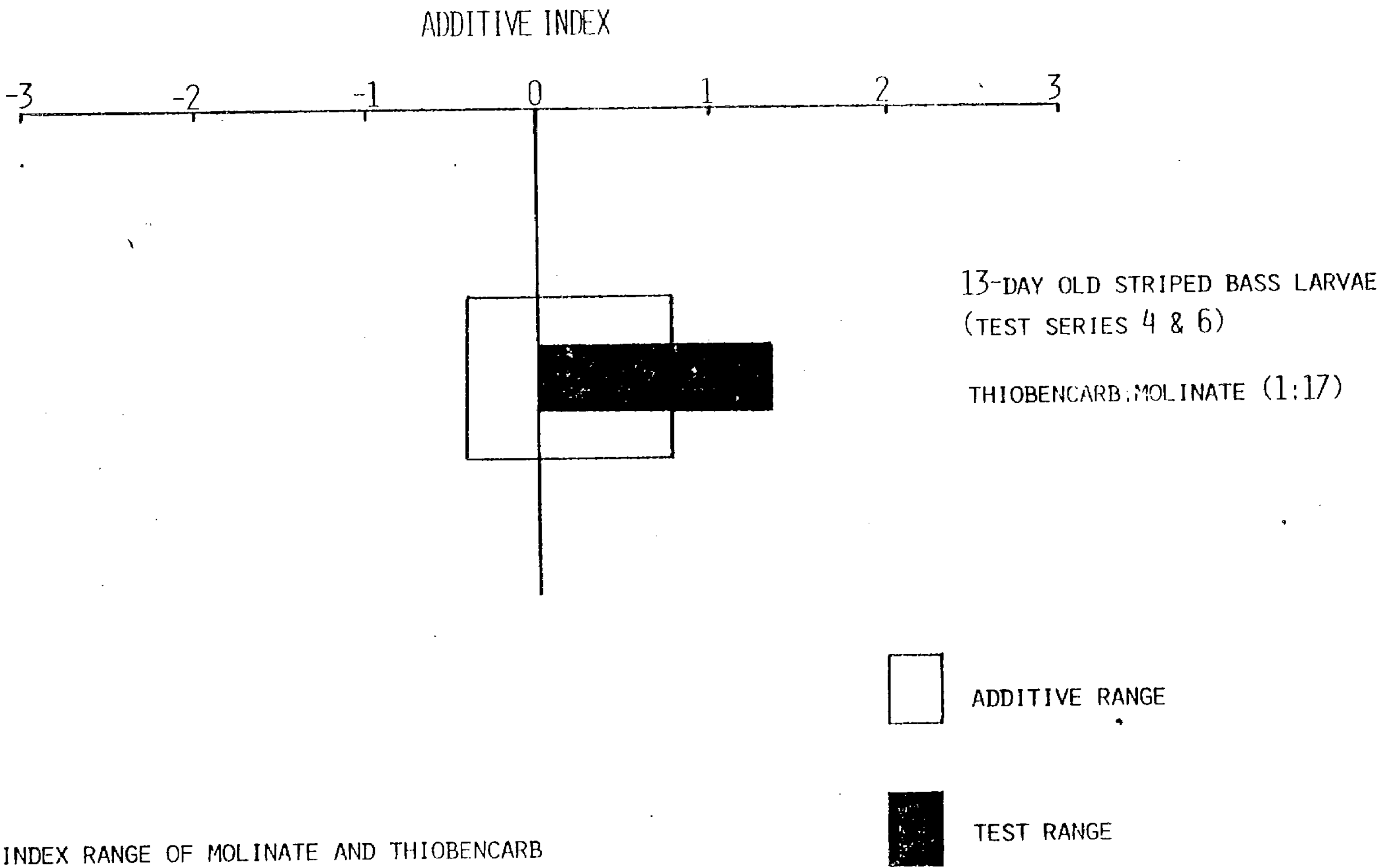

FIGURE 9.
ADDITIVE INDEX RANGE OF MOLINATE AND THIOBENCARB IN TOXICITY TEST WITH STRIPED BASS (BASED ON 96-HR LC50 VALUES). TEST RANGE COMPARED WITH CALCULATED RANGE OF SIMPLE ADDITIVITY.

Table 11. Chronic effects (31-day) of molinate and thiobencarb concentrations (mg/liter) on growth and survival (mean values with S.E. in parentheses) of 45-day old (Test Series 9) striped bass fry.

Molinate Concentrations	Mortality (%)	Fish Length (cm)	N[a]	Thiobencarb Concentrations	Mortality (%)	Fish Length (cm)	N
Control 0.15(0.22)	13	3.4(0.1)	45	Control 0.01(0.00)	17	3.4(0.1)	37
5.6(1.0)	85 [b]	2.4(0.1) [c]	6	0.18(0.10)	15	3.7(0.1)	15
6.3(2.9)	34 [b]	2.8(0.1) [c]	28	0.24(0.17)	100 [b]	- -	--
12.8(2.1)	100 [b]	- -	--	0.51(0.25)	100 [b]	- -	--

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[a] N = Number of fish measured

[b] Significantly different than control (x^2, 0.05)

[c] Significantly different than control (z, 0.05)

DISCUSSION

Water Quality and Toxicant Stability

Excellent temperature control of the dilution water was obtained with the use of hot water heater, water chiller, and heating rods. Water temperatures in the test aquaria during a single test varied from ±0.5 to ±0.9° C.

Mean salinities of dilution water in the tests varied from 1.6 to 2.6 o/oo. The control system did not produce consistent salinities. This was because the pump used for injecting the brine solution developed insufficient pressure (7 psi) which was incapable of overcoming the line pressure of raw river water (12 psi) without manual flow adjustments to balance the entire system. Thus, an increase in line pressure resulted in a reduced salinity of the dilution water. A centrifugal pump producing sufficient pressure (25 psi) will be used for injecting brine in the future.

With the use of exhaust fans in the bioassay room, contamination of control aquaria with molinate was reduced in 1985 by 250% compared to 1984 levels. In 1984, molinate concentrations in control aquaria (0.31 mg/liter) were up to 1.4% of the highest Ordram test concentration (20.0 mg/liter). In 1985, molinate concentrations in the control aquaria (0.15 mg/liter) were only up to 0.4% of the highest molinate test concentration (40.3 mg/liter). Covers will be placed on the aquaria in future tests which should further reduce Ordram contamination.

The differences between measured and expected herbicide concentrations were probably caused by inconsistent toxicant delivery from the peristaltic pumps. The measured concentrations were generally less than the expected concentrations. Placing the pumps at the same level as the herbicide stock solutions increased the measured concentrations up to the expected herbicide concentrations. Additionally, quality control and quality assurance programs for rice herbicide test concentrations will be conducted in future tests. For quality control, approximately 5 to 10% of the water samples will be collected in replicate and analyzed by CDFG for rice herbicides. For quality assurance, approximately 5 to 10% of the water samples will be collected in replicate and analyzed by a cooperating laboratory for rice herbicides.

Culture and Test Methods

There was poor survival of the newly hatched prolarvae in the rearing system this year. Good survival was obtained from only one striped bass family. The gas supersaturated water appeared to adversely affect survival by producing larvae with over-inflated air bladders. These larvae floated immobilized on the surface of the water. This problem was corrected by disconnecting the refrigeration unit's impellor. After the gas content of the water fell below saturation, the over-inflated air bladder condition appeared to be reversible because the bladders deflated to normal size and the larvae swam freely within the water column.

An upwelling current was used for the first six days after hatch with the last striped bass family. The upwelling current kept the larvae suspended and away from the central drain of the rearing tank. After six days, the upwelling current was changed to a circular current. Despite using both upwelling and circular currents, this family suffered high mortality. These eggs were taken late in the season and may have been weaker than those from earlier spawns. Eggs of striped bass taken early in the spawning season have been reported to be characteristically stronger than those taken later. Thus, the high mortality of the last striped bass family could have been due to weaker eggs and not the culture techniques. In the future, an upwelling current will be used in the rearing system for the first 6 to 8 days after hatch with a circular current utilized after the prolarval stage.

The tests with embryonic striped bass were not successful in 1985. Tests with embryonic striped bass were also not successful in 1984 (Finlayson and Faggella 1984b). The prolarvae died soon after hatching in the test chambers. The airlift arrangement improved water exchange between the aquaria and the test chambers but was insufficient to keep the larvae suspended. The high mortalities in the larval control groups may have been due to, in part, previous stressful conditions in the rearing system caused by gas supersaturation and handling. Anesthetizing the larvae in the rearing system with MS-222 prior to handling appeared to substantially improve the survival of control groups in the test system.

In future tests, automatic siphons will be used for exchanging water between test chambers and the aquaria. To help overcome the stress caused by positive phototaxis, aeration will be used in the test chambers to keep the larvae suspended, and the test chambers will be darkened. As an additional stress reducing measure, the larvae will be anesthetized in the rearing system prior to handling.

Toxicity of Molinate and Thiobencarb

The LC50 values derived from the 1985 tests indicated that the toxicity of Ordram and Bolero either singly or in combination decreased with increased age of larvae. The 6-day old larvae were two to five times more sensitive to the herbicides than 13-day old fish; respective 96-hr LC50 values were 2.1 and 10.7 mg/liter for molinate tests and 0.28 and 0.51 mg/liter for thiobencarb tests. However, 6-day and 13-day old larvae appeared to be equally sensitive to the herbicide mixture. The 45-day old fry were less sensitive to the herbicides than either the 6-day or 13-day old larvae.

The striped bass larvae used in the 1985 tests appeared to be more sensitive to molinate and thiobencarb than those used in the 1984 tests (Finlayson and Faggella 1984b). For example, the 96-hr LC50 values for 6-day old larvae to the herbicides separately were 2.1 mg/liter molinate and 0.28 mg/liter thiobencarb in 1985 compared to 6.6 mg/liter molinate and 0.35 mg/liter thiobencarb in 1984 (Figure 10). Similar results were obtained from tests on the herbicide mixtures (Figure 11). However, the 24-day old larvae tested in 1984 appeared to be more sensitive to a herbicide mixture than the 13-day old fish tested in 1985. It is not known if the larvae tested in 1985 were more sensitive or weaker (stressed) than the fish tested in 1984 or if the differences can be attributed to

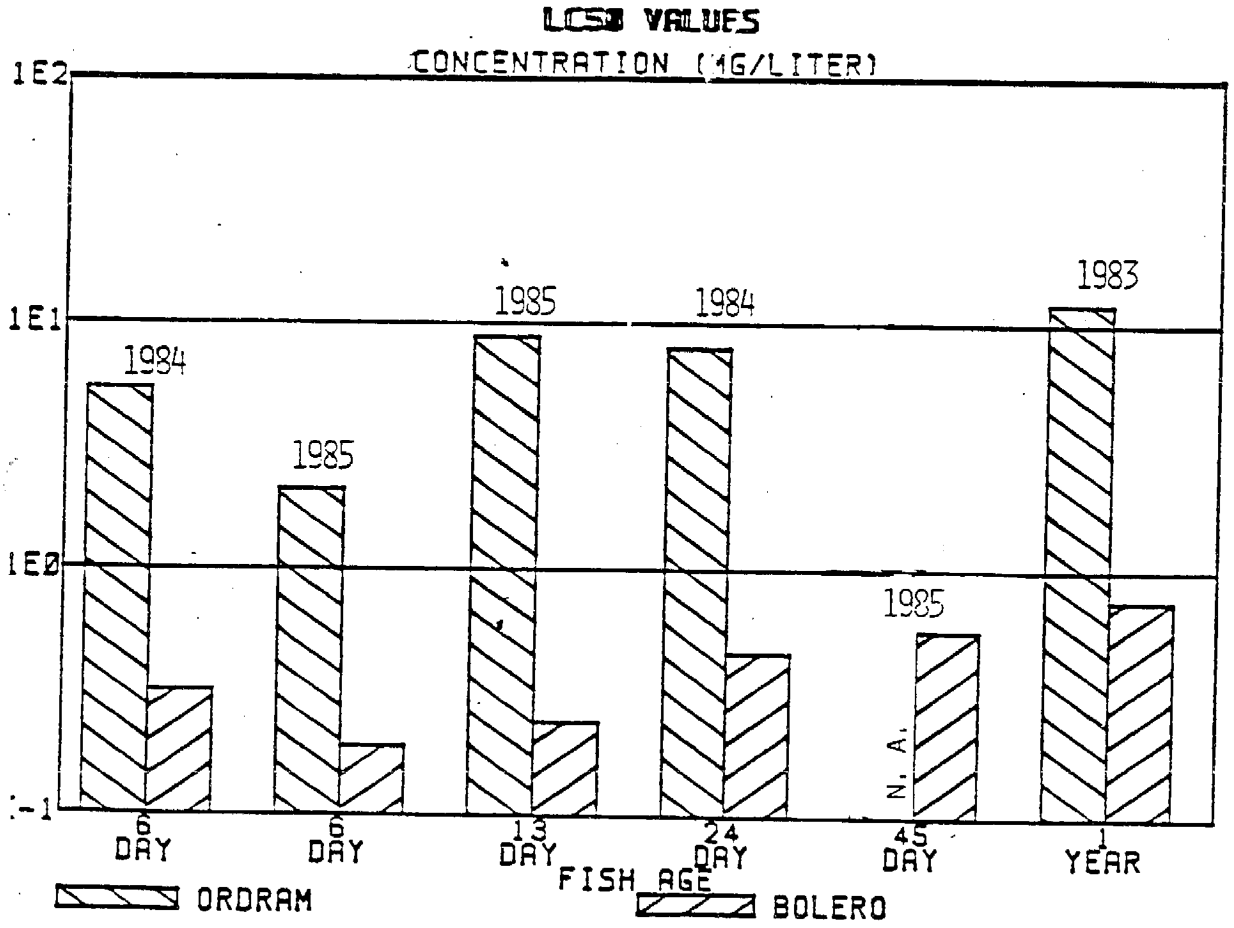

Figure 10. 96-hr and 144-hr LC50 values for striped bass larvae and juveniles exposed to molinate (Ordram) and thiobencarb (Bolero) separately (1983 data from Finlayson and Faggella 1984a; 1984 data from Finlayson and Faggella 1984b).

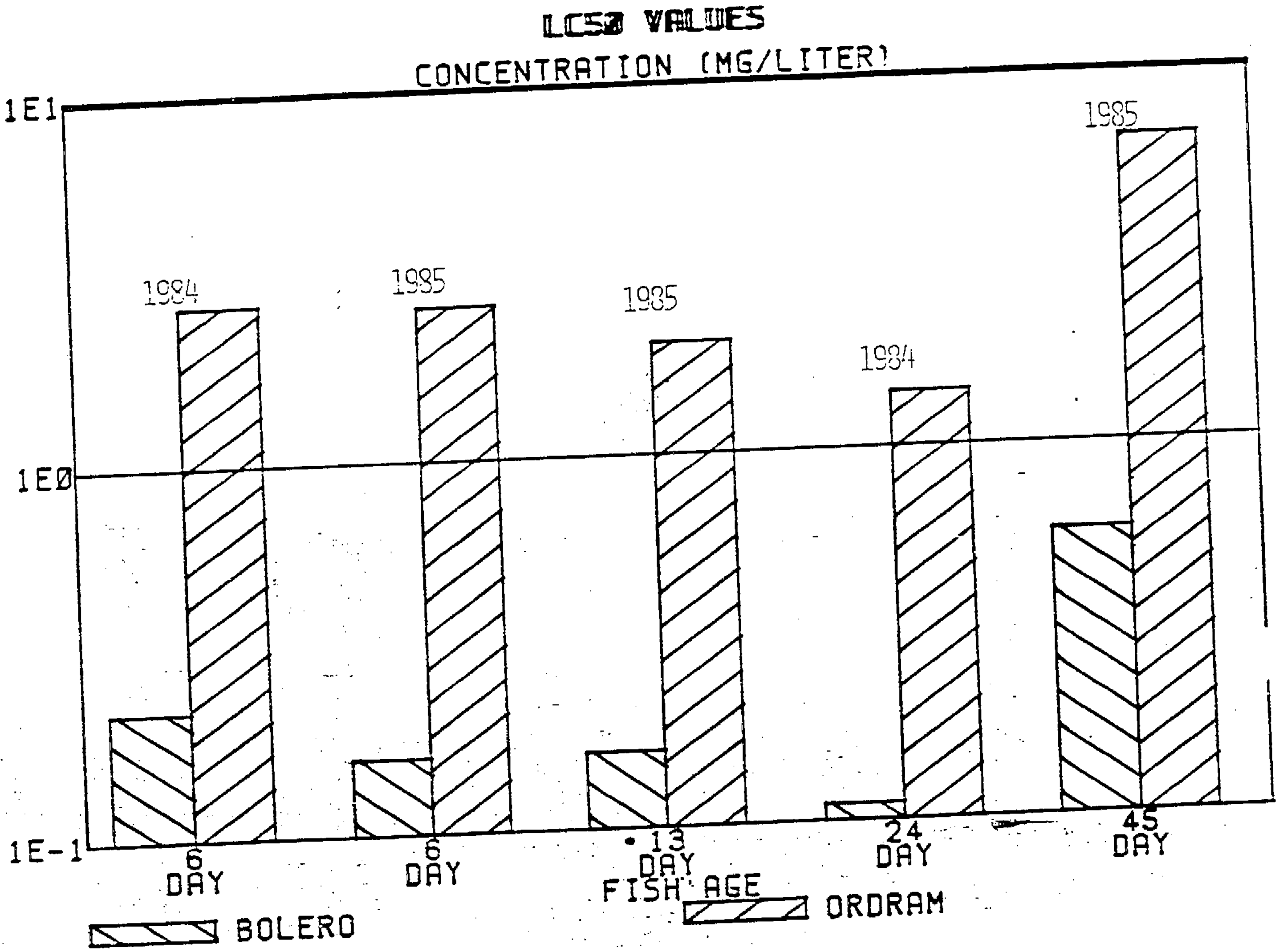

Figure 11. 96-hr and 144-hr LC50 values for striped bass larvae and juveniles exposed to molinate (Ordram) and thiobencarb (Bolero) mixtures (1984 data from Finlayson and Faggella 1984b).

biological variability. Collectively, the data suggests that 45-day and 1-year old fish have similar sensitivities to rice herbicides, and they are less sensitive than 6-day, 13-day, and 24-day old larvae. We were unable, however, to detect distinct differences in the sensitivities to rice herbicides among the different age (6 to 24-day old) larvae.

Test ranges based on 96-hr LC50 values for 13-day old larvae tested in 1985 indicated simple additive toxicity for molinate and thiobencarb in a mixture. Simple additive toxicity between molinate and thiobencarb was also determined for 6-day and 24-day old striped bass larvae by Finlayson and Faggella (1984b) and for juvenile catfish, Ictalurus punctatus, trout, Salmo gairdneri, and salmon, Oncorhynchus tshwytscha, by Finlayson and Faggella (1984a).

Growth (standard length) was measured on survivors from the acute and chronic tests conducted in 1985. A reduction in survival appeared to be as sensitive an indicator of toxic effects (test endpoints) as was a reduction in growth. This was particularly true of older larvae and fry. In a critical review of growth responses in fish during chronic and early life-history stage toxicity tests, Woltering (1984) noted that a reduction in survival was as sensitive a test endpoint as was a reduction in growth, and our data on larval growth and survival support this. The RNA and DNA content of larval striped bass from the 1985 tests may prove to be a more sensitive indicator of toxic effects than survival and growth. We are waiting for the results of these analyses.

The no observable effect levels (NOEL) for 45-day old fish exposed for

31-days to molinate and thiobencarb separately were <5.6 mg/liter and 0.18 mg/liter, respectively. The NOEL values for the herbicides tested separately were higher than those shown to reduce growth of 6-day old larvae in 144-hr, 1.5 mg/liter molinate and 0.07 mg/liter thiobencarb. Thus, chronic tests (30 to 40-day duration) on younger and more sensitive larvae (6-day old) are warranted.

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Appendix A. Monthly mean water quality of the rearing system based on daily measurements.

Date	Temperature (°C)	Salinity (o/oo)	D.O. (mg/liter)	$NH_3+NH_4^+$ (mg/liter)
4-19-85 to 4-30-85	17.5±0.6 [a/]	3.3±0.6	0.1±0.6	0.13±0.10
5-1-85 to 5-29-85	18.5±0.8	2.6±0.9	8.3±1.0	0.06±0.06
6-1-85 to 6-11-85	20.1±0.7	5.3±1.3	7.2±1.6	0.04±0.05

[a/] Mean ± S.E.

Appendix B. Daily mean quality of dilution water for the acute toxicity Test Series 6 and 7 based on hourly measurements.

Date	Salinity (o/oo)	Temperature (°C)	pH
6-7-85	2.37 ± 0.31[a] (2.68-2.06)	18.29 ± 0.78 (17.33-19.80)	7.36 ± 0.07 (7.02-7.45)
6-8-85	1.96 ± 0.11 (2.07-2.06)	18.46 ± 0.96 (16.26-19.94)	7.33 ± 0.11 (7.02-7.45)
6-9-85	1.95 ± 0.27 (2.22-1.68)	18.60 ± 0.73 (17.62-19.71)	7.06 ± 0.09 (6.91-7.19)
6-10-85	2.26 ± 0.24 (2.50-2.02)	18.92 ± 0.90 (17.70-20.50)	7.01 ± 0.06 6.93-7.15)
6-11-85	2.18 ± 0.49 (2.67-1.69)	19.09 ± 1.10 (16.46-21.16)	7.09 ± 0.24 (6.73-7.70)
6-12-85	1.79 ± 0.01 (1.80-1.78)	19.16 ± 0.70 (18.27-20.68)	6.98 ± 0.31 (6.43-7.28)
6-13-85	1.05 ± 0.0 (1.05-1.05)	19.24 ± 0.74 (18.26-20.30)	6.47 ± 0.01 (6.44-6.49)

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[a] Mean ± S.E. with range in parentheses.

Appendix B. (Cont'd) Daily mean quality of dilution water for the acute toxicity Test Series 8.

Date	Salinity (o/oo)	Temperature (°C)	pH
6-25-85	2.02 ± 0.45 [a/] (2.47-1.57)	19.43 ± 0.76 (18.42-20.84)	7.37 ± 0.27 (7.05-7.89)
6-26-85	4.12 ± 0.23 (4.35-3.89)	19.73 ± 0.72 (18.77-21.02)	7.74 ± 7.89 (7.53-7.86)
6-27-85	2.84 ± 1.57 (4.41-1.27)	19.70 ± 1.07 (17.22-21.68)	7.27 ± 0.40 (6.42-7.59)
6-28-85	1.54 ± 1.51 (3.05-0.03)	19.80 ± 0.47 (19.21-20.59)	6.81 ± 0.39 (6.43-7.46)
6-29-85	1.97 ± 0.73 (2.70-1.97)	19.39 ± 0.77 (17.38-20.79)	6.81 ± 0.21 (6.55-7.13)
6-30-85	2.65 ± 1.23 (3.88-1.42)	19.70 ± 0.85 (18.56-21.47)	6.86 ± 0.16 (6.66-7.07)
7-1-85	2.68 ± 1.28 (3.96-1.40)	20.25 ± 0.82 (18.92-21.77)	7.01 ± 0.31 (6.52-7.51)
7-2-85	1.77 ± 1.09 (2.83-0.68)	20.66 ± 0.91 (18.25-22.07)	6.83 ± 0.32 (6.43-7.36)

[a/] Mean ± S.E. with range in parentheses.

Appendix C. Daily mean quality of dilution water for the chronic Test Series 9.

Date	Salinity (o/oo)	Temperature (°C)	pH
6-26-85	4.12 ± 0.23 [a] (4.35-3.89)	19.73 ± 0.72 (18.77-21.02)	7.74 ± 0.12 (7.53-7.86)
6-27-85	2.84 ± 1.57 (4.41-1.27)	19.70 ± 1.07 (17.22-21.68)	7.27 ± 0.40 (6.42-7.59)
6-28-85	1.54 ± 1.51 (3.05-0.03)	19.80 ± 0.47 (19.21-20.59)	6.81 ± 0.39 (6.43-7.46)
6-29-85	1.97 ± 0.73 (2.70-1.24)	19.39 ± 0.77 (17.38-20.79)	6.81 ± 0.21 (6.55-7.13)
6-30-85	2.65 ± 1.23 (3.88-1.42)	19.70 ± 0.85 (18.56-21.47)	6.86 ± 0.16 (6.66-7.07)
7-1-85	2.68 ± 1.28 (3.96-1.40)	20.25 ± 0.82 (18.92-21.77)	7.01 ± 0.31 (6.52-7.51)
7-2-85	1.77 ± 1.09 (2.86-0.68)	20.66 ± 0.91 (18.25-22.07)	6.83 ± 0.16 (6.43-7.36)
7-3-85	3.27 ± 0.29 (3.56-2.98)	20.42 ± 0.81 (18.02-21.54)	7.28 ± 0.14 (7.15-7.69)
7-4-85	1.75 ± 0.71 (2.46-1.04)	20.06 ± 0.84 (17.89-21.19)	7.11 ± 0.31 6.52-7.63)
7-5-85	2.74 ± 1.69 (4.43-1.05)	20.51 ± 0.94 (19.09-21.97)	7.11 ± 0.49 (6.35-7.62)
7-6-85	3.39 ± 0.95 (4.34-2.44)	20.32 ± 0.58 (18.51-20.95)	7.35 ± 0.19 (6.87-7.51)
7-7-85	2.44 ± 1.38 (3.82-1.06)	19.85 ± 0.70 (19.02-21.09)	7.25 ± 0.24 (6.90-7.62)
7-8-85	2.45 ± 1.50 (3.95-0.95)	20.40 ± 0.89 (19.21-21.79)	6.96 ± 0.90 (6.22-7.57)

---

[a] Mean ± S.E. with range in parentheses.

Appendix C. (Cont'd).

Date	Salinity (o/oo)	Temperature (°C)	pH
6-9-85	2.48 ± 0.45 [a] (2.93-2.03)	20.41 ± 0.84 (18.17-21.63)	7.15 ± 0.10 (7.02-7.28)
7-10-85	3.31 ± 0.51 (3.82-2.80)	19.97 ± 0.31 (19.33-20.74)	7.12 ± 0.12 (6.97-7.45)
7-11-85	2.42 ± 0.62 (3.04-1.80)	19.14 ± 0.25 (18.69-19.60)	7.04 ± 0.08 (6.92-7.16)
7-12-85	2.81 ± 1.18 (3.99-1.63)	19.23 ± 0.77 (18.34-20.53)	7.12 ± 0.23 (6.70-7.70)
7-13-85	2.61 ± 1.26 (3.87-1.35)	20.07 ± 1.01 (18.82-21.80)	7.20 ± 0.42 (6.29-7.73)
7-14-85	1.85 ± 1.07 (2.92-0.78)	20.37 ± 0.64 (19.53-21.48)	7.00 ± 0.37 (6.22-7.37)
7-15-85	2.83 ± 1.66 (4.49-1.17)	20.61 ± 1.02 (18.48-21.87)	6.96 ± 0.43 (6.16-7.45)
7-16-85	4.02 ± 0.51 (4.53-3.51)	20.61 ± 0.66 (19.69-21.64)	7.31 ± 0.12 (7.18-7.53)
7-17-85	3.11 ± 0.91 (4.02-2.20)	20.43 ± 0.57 (19.64-21.36)	7.26 ± 0.24 (6.40-7.44)
7-18-85	3.20 ± 1.27 (4.47-1.93)	20.46 ± 1.00 (18.13-21.89)	6.99 ± 0.28 (6.35-7.30)
7-19-85	2.53 ± 0.18 (2.61-2.35)	20.46 ± 0.63 (19.71-21.70)	6.43 ± 0.15 (6.21-6.64)

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[a] Mean ± S.E. with range in parentheses.

Appendix D. Daily mean water temperature in the test aquaria for the acute toxicity tests based on measurements taken every four hours.

Test Series	Date	Mean Temperature (°C)	Standard Error
Series 1	4-27-85	20.50	.41
	4-28-85	20.50	.58
	4-29-85	20.00	.96
	4-30-85	20.25	.27
	5-1-85	19.93	.67
	5-2-85	19.29	.49
	5-3-85	19.92	.74
	5-4-85	20.36	.38
	5-5-85	20.57	1.21
	5-6-85	20.64	.69
	5-7-85	20.00	.71
	5-8-85	19.64	.56
Series 2	5-9-85	19.29	.49
Series 3	5-10-85	19.36	.99
	5-11-85	19.79	.81
	5-12-85	20.93	1.10
	5-13-85	20.93	.73
	5-14-85	21.29	1.80
	5-15-85	19.57	.45

Appendix D. (Cont'd).

Test Series	Date	Mean Temperature (°C)	Standard Error
	5-16-85	19.50	.85
	5-17-85	19.14	.24
	5-18-85	19.64	.48
	5-19-85	19.93	.53
	5-20-85	21.21	1.55
	5-21-85	20.25	1.08
	5-22-85	20.50	.50
Series 4	5-23-85	20.21	.49
	5-24-85	20.00	.58
	5-25-85	20.29	.57
	5-26-85	19.93	.53
	5-27-85	19.36	1.25
	5-28-85	19.50	.58
	5-29-85	20.07	.53
	5-30-85	19.29	.91
Series 5	5-31-85	18.64	.69
	6-1-85	19.14	.38
	6-2-85	19.29	.57
	6-3-85	19.43	.45

Appendix D. (Cont'd).

Test Series	Date	Mean Temperature (°C)	Standard Error
	6-4-85	19.21	.39
	6-5-85	19.86	.24
	6-6-85	20.64	1.14
Series 6 & 7	6-7-85	19.86	.80
	6-8-85	20.50	1.87
	6-9-85	22.21	.81
	6-10-85	21.93	1.43
	6-11-85	22.00	1.08
	6.12-85	20.29	.86
	6-13-85	19.93	.84
	6-14-85	20.07	.93
	6-15-85	21.36	1.07
	6-16-85	20.64	1.18
	6-17-85	18.93	.89
	6-18-85	19.86	1.14
	6-19-85	20.43	1.21
	6-20-85	18.64	.75
Series 9	6-21-85	19.00	1.04
	6-22-85	18.64	1.21
	6-23-85	18.71	.86

Appendix D. (Cont'd).

Test Series	Date	Mean Temperature (°C)	Standard Error
	6-24-85	19.57	1.13
Series 8	6-25-85	20.48	1.34
	6-26-85	21.00	.96
	6-27-85	20.79	.70
	6-28-85	20.14	1.14
	6-29-85	19.00	.71
	6-30-85	20.07	.89
	7-1-85	20.29	1.11
	7-2-85	20.93	.93
	7-3-85	20.86	.90
	7-4-85	20.07	.67
	7-5-85	21.79	.86
	7-6-85	21.07	.93
	7-7-85	20.57	.35
	7-8-85	21.86	1.28
	7-9-85	20.00	1.71
	7-10-85	19.64	1.03
	7-11-85	19.71	.70
	7-12-85	20.93	1.72

Appendix D. (Cont'd).

Test Series	Date	Mean Temperature (°C)	Standard Error
	7-13-85	21.43	1.30
	7-14-85	22.50	1.19
	7-15-85	22.00	1.22
	7-16-85	20.54	1.14
	7-17-85	19.71	1.29
	7-18-85	19.71	.99
	7-19-85	20.50	.71
	7-20-85	19.93	.45
	7-21-85	20.64	.75

Appendix E-1

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 5 - Molinate (48-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 9100

STOCK SOLUTION FINAL CONC (MG/LITER) 10,000

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.55 (0.12)

FISH WEIGHT (G) ________

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	51	36	13.3	
56	47	37	8.4	
32	44	28	4.6	
18[a/]	25	1	0.95	
10	27	4	1.5	
CONTROL	50	2	0.02	

LC50 (%) ________

LC50 MOLINATE (MG/LITER) 3.5 (2.5-4.5)

LC50 THIOBENCARB (MG/LITER) ________

LC50 METHOD -PROBIT-[✓ MOVING AVERAGE]-NONLINEAR INTERPOLATION-

[a/] Data from 18% concentration not used in the LC50 analysis

Appendix E- 1

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 5 - Molinate (96-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 9,100

STOCK SOLUTION FINAL CONC (MG/LITER) 10,000

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.55 (0.12)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	51	51	13.3	
56	47	47	8.4	
32	44	44	4.6	
18 a/	25	13	0.95	
10	27	9	1.5	
CONTROL	50	8	0.02	

LC50 (%)

LC50 MOLINATE (MG/LITER) 2.1 (1.8-2.4)

LC50 THIOBENCARB (MG/LITER)

LC50 METHOD -PROBIT-[✓ MOVING AVERAGE]-NONLINEAR INTERPOLATION-

a/ Data from the 18% concentration not used in the LC50 analysis

Appendix E-1

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 5 - Molinate (144-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 9,100

STOCK SOLUTION FINAL CONC (MG/LITER) 10,000

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.55 (0.12)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	51	51	13.3	
56	47	47	8.4	
32	44	44	4.6	
18[a/]	25	13	0.95	
10	27	10	1.5	
CONTROL	50	8	0.02	

LC50 (%)

LC50 MOLINATE (MG/LITER) 2.1 (1.7-2.4)

LC50 THIOBENCARB (MG/LITER)

LC50 METHOD -PROBIT-[✓ MOVING AVERAGE]-NONLINEAR INTERPOLATION-

[a/] Data from the 18% concentration not used in the LC50 analysis

Appendix E - 1

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 5 - Thiobencarb (48-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 810

STOCK SOLUTION FINAL CONC (MG/LITER) 790

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.30 (0.10)

FISH WEIGHT (G) ______

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	45	12		0.48
56	54	7		0.39
32	43	7		0.14
18	49	8		0.07
10	50	7		0.03
CONTROL	43	9		0.002

LC50 (%) >100

LC50 MOLINATE (MG/LITER) ______

LC50 THIOBENCARB (MG/LITER) >0.48

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-1

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 5 - Thiobencarb (96-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 810

STOCK SOLUTION FINAL CONC (MG/LITER) 790

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.30 (0.10)

FISH WEIGHT (G) ______

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	45	45		0.48
56	54	30		0.31
32	43	11		0.14
18	49	12		0.07
10	50	12		0.03
CONTROL	43	11		0.002

LC50 (%) ______

LC50 MOLINATE (MG/LITER) ______

LC50 THIOBENCARB (MG/LITER) 0.28 (0.25-0.31)

LC50 METHOD -PROBIT-[✓ MOVING AVERAGE]-NONLINEAR INTERPOLATION-

Appendix E - 1

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 5 - Thiobencarb (144-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 810

STOCK SOLUTION FINAL CONC (MG/LITER) 790

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.30 (0.10)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	45	45		0.48
56	54	46		0.31
32	43	19		0.14
18	49	15		0.07
10	50	14		0.03
CONTROL	43	15		0.002

LC50 (%)

LC50 MOLINATE (MG/LITER)

LC50 THIOBENCARB (MG/LITER) 0.19 (0.17-0.22)

LC50 METHOD -PROBIT-[✓ MOVING AVERAGE]-NONLINEAR INTERPOLATION-

Appendix E-1

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 5 - Molinate and Thiobencarb Mixture (48-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 3600, 270

STOCK SOLUTION FINAL CONC (MG/LITER) 3800, 600

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 4.52 (0.13)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	72	3	4.4	0.26
56	54	4	2.7	0.17
32	47	1	1.7	0.09
18	30	1	1.0	0.06
10	53	6	0.70	0.05
CONTROL	51	7	0.03	0.001

LC50 (%) >100

LC50 MOLINATE (MG/LITER) >4.4

LC50 THIOBENCARB (MG/LITER) >0.26

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-1

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 5 - Molinate and Thiobencarb Mixture (96-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 3600 270

STOCK SOLUTION FINAL CONC (MG/LITER) 3800, 600

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 4.52 (0.13)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	72	13	4.4	0.26
56	54	10	2.7	0.17
32	47	8	1.7	0.09
18	30	4	1.0	0.06
10	53	12	0.70	0.05
CONTROL	51	10	0.03	0.001

LC50 (%) >100

LC50 MOLINATE (MG/LITER) >4.4

LC50 THIOBENCARB (MG/LITER) >0.26

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-1

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 5 - Molinate and Thiobencarb Mixture (144-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 3,600, 270

STOCK SOLUTION FINAL CONC (MG/LITER) 3,800, 600

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 4.52 (0.13)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	72	46	4.4	0.26
56	54	32	2.7	0.17
32	47	13	1.7	0.09
18	30	8	1.0	0.06
10	53	16	0.70	0.05
CONTROL	51	13	0.03	0.001

LC50 (%) >56

LC50 MOLINATE (MG/LITER) >2.7

LC50 THIOBENCARB (MG/LITER) >0.17

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-2

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 4 - Molinate (48-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 8500

STOCK SOLUTION FINAL CONC (MG/LITER) 10,000

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.62 (0.05)

FISH WEIGHT (G) ________

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	44	39	15.5	
56	35	3	8.0	
32	31	1	4.9	
18	39	1	3.1	
10	36	1	2.0	
CONTROL	99	10	0.21	

LC50 (%) ________

LC50 MOLINATE (MG/LITER) 11.3 (8.0-15.5)

LC50 THIOBENCARB (MG/LITER) ________

LC50 METHOD -PROBIT-MOVING AVERAGE-[✓ NONLINEAR INTERPOLATION-]

Appendix E-2

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 4 - Molinate (96-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 8,500

STOCK SOLUTION FINAL CONC (MG/LITER) 10,000

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.62 (0.05)

FISH WEIGHT (G) __________

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	44	43	15.5	
56	35	8	8.0	
32	31	4	4.9	
18	39	2	3.1	
10	36	3	2.0	
CONTROL	99	11	0.21	

LC50 (%) __________

LC50 MOLINATE (MG/LITER) 10.7 (8.0-15.5)

LC50 THIOBENCARB (MG/LITER) __________

LC50 METHOD -PROBIT-MOVING AVERAGE-[✓ NONLINEAR INTERPOLATION-]

Appendix E-2

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 4 - Molinate (144-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 8500

STOCK SOLUTION FINAL CONC (MG/LITER) 10,000

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.62 (0.05)

FISH WEIGHT (G) ________

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	44	44	15.5	
56	35	17	8.0	
32	31	7	4.9	
18	39	8	3.1	
10	36	6	2.0	
CONTROL	99	18	0.21	

LC50 (%) ________

LC50 MOLINATE (MG/LITER) 8.8 (8.0-15.5)

LC50 THIOBENCARB (MG/LITER) ________

LC50 METHOD -PROBIT-MOVING AVERAGE-[✓ NONLINEAR INTERPOLATION]-

Appendix E-2

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 4 - Thiobencarb (48-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 730

STOCK SOLUTION FINAL CONC (MG/LITER) 680

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.80 (0.09)

FISH WEIGHT (G) ____

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	40	25		0.86
56	34	2		0.44
32	38	2		0.22
18	37	9		0.11
10	32	2		0.07
CONTROL	40	5		0.001

LC50 (%) > 56

LC50 MOLINATE (MG/LITER) ____

LC50 THIOBENCARB (MG/LITER) > .44

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-2

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 4 - Thiobencarb (96-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 730

STOCK SOLUTION FINAL CONC (MG/LITER) 680

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.80 (0.09)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	40	38		0.86
56	34	16		0.44
32	38	4		0.22
18	37	9		0.11
10	32	2		0.07
CONTROL	40	6		0.001

LC50 (%)

LC50 MOLINATE (MG/LITER)

LC50 THIOBENCARB (MG/LITER) 0.50 (0.45-0.56)

LC50 METHOD -PROBIT-[✓ MOVING AVERAGE]-NONLINEAR INTERPOLATION-

Appendix E-2

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 4 - Thiobencarb (144-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 730

STOCK SOLUTION FINAL CONC (MG/LITER) 680

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.80 (0.09)

FISH WEIGHT (G) __________

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	40	40		0.86
56	34	28		0.44
32	38	14		0.22
18	37	21		0.11
10	32	4		0.07
CONTROL	40	9		0.001

LC50 (%) __________

LC50 MOLINATE (MG/LITER) __________

LC50 THIOBENCARB (MG/LITER) 0.24 (0.21-0.27)

LC50 METHOD -PROBIT-[✓ MOVING AVERAGE]-NONLINEAR INTERPOLATION-

Appendix E-2

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 4 - Molinate and Thiobencarb Mixture (48-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 3500 250

STOCK SOLUTION FINAL CONC (MG/LITER) 4100, 290

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.50 (0.06)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	36	0	4.4	0.22
56	40	1	2.7	0.20
32	34	1	1.6	0.12
18	35	0	1.1	0.07
10	52	2	1.0	0.07
CONTROL	59	5	0.04	<0.001

LC50 (%) > 100

LC50 MOLINATE (MG/LITER) >4.4

LC50 THIOBENCARB (MG/LITER) >0.22

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-2

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 4 - Molinate and Thiobencarb Mixture (96-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 3500, 250

STOCK SOLUTION FINAL CONC (MG/LITER) 4100, 290

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.50 (0.06)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	36	3	4.4	0.22
56	40	2	2.7	0.20
32	34	1	1.6	0.12
18	35	3	1.1	0.07
10	52	5	1.0	0.07
CONTROL	59	5	0.04	<0.001

LC50 (%) >100

LC50 MOLINATE (MG/LITER) >4.4

LC50 THIOBENCARB (MG/LITER) >0.22

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-2

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 4 - Molinate and Thiobencarb Mixture (144-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 3500, 250

STOCK SOLUTION FINAL CONC (MG/LITER) 4100, 290

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 5.50 (0.06)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	36	10	4.4	0.22
56	40	4	2.7	0.20
32	34	6	1.6	0.12
18	35	8	1.1	0.07
10	52	13	1.0	0.07
CONTROL	59	9	0.04	<0.001

LC50 (%) >100

LC50 MOLINATE (MG/LITER) >4.4

LC50 THIOBENCARB (MG/LITER) >0.22

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-3

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 6 - Molinate and Thiobencarb Mixture (48-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 6000, 560

STOCK SOLUTION FINAL CONC (MG/LITER) 6200, 460

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 4.52 (0.13)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	37	2	5.9	0.48
56	40	0	3.2	0.27
32	40	2	2.0	0.15
18	40	0	1.3	0.09
10	41	3	0.88	0.05
CONTROL	40	0	0.04	<0.01

LC50 (%) >100

LC50 MOLINATE (MG/LITER) >5.9

LC50 THIOBENCARB (MG/LITER) >0.48

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-3

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 6 - Moliante and Thiobencarb Mixture (96-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 6000, 560

STOCK SOLUTION FINAL CONC (MG/LITER) 6200, 460

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 4.52 (0.13)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	37	37	5.9	0.48
56	40	18	3.2	0.27
32	40	8	2.0	0.15
18	40	0	1.3	0.09
10	41	3	0.88	0.05
CONTROL	40	1	0.04	<0.01

LC50 (%) 49.2 (44.5-54.9)

LC50 MOLINATE (MG/LITER) 3.0 (2.7-3.3)

LC50 THIOBENCARB (MG/LITER) 0.24 (0.21-0.26)

LC50 METHOD -PROBIT-[✓ MOVING AVERAGE]-NONLINEAR INTERPOLATION-

Appendix E-3

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 6 - Molinate and Thiobencarb Mixture (144-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 6000, 560

STOCK SOLUTION FINAL CONC (MG/LITER) 6200, 460

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 4.52 (0.13)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	37	37	5.9	0.48
56	40	21	3.2	0.27
32	40	18	2.0	0.15
18	40	11	1.3	0.09
10	41	10	0.8	0.05
CONTROL	40	3	0.04	< 0.01

LC50 (%) 32.6 (27.3-39.1)

LC50 MOLINATE (MG/LITER) 2.0 (1.7-2.4)

LC50 THIOBENCARB (MG/LITER) 0.16 (0.13-0.19)

LC50 METHOD -PROBIT- [✓ MOVING AVERAGE] -NONLINEAR INTERPOLATION-

Appendix E-4

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 7 - Molinate (48-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 9300

STOCK SOLUTION FINAL CONC (MG/LITER) 9400

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 12.5 (0.3)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	38	3	15.5	
56	35	1	7.0	
32	39	1	5.0	
18	39	0	0.02	
10	40	4	1.9	
CONTROL	42	2	0.03	

LC50 (%) > 100

LC50 MOLINATE (MG/LITER) >15.5

LC50 THIOBENCARB (MG/LITER)

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-4

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 7 - Molinate (96-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 9900

STOCK SOLUTION FINAL CONC (MG/LITER) 9400

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 12.5 (0.3)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	38	6	15.5	
56	35	2	7.0	
32	39	2	5.0	
18	39	2	0.02	
10	40	5	1.9	
CONTROL	42	3	0.03	

LC50 (%) > 100

LC50 MOLINATE (MG/LITER) >15.5

LC50 THIOBENCARB (MG/LITER)

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-4

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 7 - Molinate (144-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 9,900

STOCK SOLUTION FINAL CONC (MG/LITER) 9,400

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 12.5

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	38	21	15.5	
56	35	6	7.0	
32	39	4	5.0	
18	39	3	0.02	
10	40	6	1.9	
CONTROL	42	3	0.03	

LC50 (%) >56

LC50 MOLINATE (MG/LITER) >7.0

LC50 THIOBENCARB (MG/LITER) --

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-4

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 7 - Thiobencarb (48-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 740

STOCK SOLUTION FINAL CONC (MG/LITER) 560

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 12.6 (0.5)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	37	3		0.44
56	30	1		0.35
32	38	0		0.18
18	36	2		0.10
10	42	5		0.04
CONTROL	38	2		<0.01

LC50 (%) >100

LC50 MOLINATE (MG/LITER)

LC50 THIOBENCARB (MG/LITER) >0.44

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-4

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 7 - Thiobencarb (96-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 740

STOCK SOLUTION FINAL CONC (MG/LITER) 560

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 12.6 (0.5)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	37	10		0.44
56	30	4		0.35
32	38	0		0.18
18	36	2		0.10
10	42	5		0.04
CONTROL	38	3		<0.01

LC50 (%) >100

LC50 MOLINATE (MG/LITER)

LC50 THIOBENCARB (MG/LITER) >0.44

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-4

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 7 - Thiobencarb (144-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 740

STOCK SOLUTION FINAL CONC (MG/LITER) 560

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 12.6 (0.5)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	37	15		0.44
56	30	10		0.35
32	38	0		0.18
18	36	2		0.10
10	40	6		0.04
CONTROL	38	3		< 0.01

LC50 (%) >100

LC50 MOLINATE (MG/LITER)

LC50 THIOBENCARB (MG/LITER) >0.44

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-4

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 7 - Molinate and Thiobencarb Mixture (48-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 6000, 560

STOCK SOLUTION FINAL CONC (MG/LITER) 6200, 460

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 12.9 (0.3)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	28	1	5.9	0.48
56	40	1	3.2	0.27
32	39	0	2.0	0.15
18	25	0	1.3	0.09
10	40	0	0.88	0.05
CONTROL	44	4	0.04	<0.01

LC50 (%) >100

LC50 MOLINATE (MG/LITER) >5.9

LC50 THIOBENCARB (MG/LITER) >0.48

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-4

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 7 - Molinate and Thiobencarb Mixture (96-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 6,000, 650

STOCK SOLUTION FINAL CONC (MG/LITER) 6,200, 460

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 12.9 (0.3)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	28	4	5.9	0.48
56	40	1	3.2	0.27
32	39	0	2.0	0.15
18	25	0	1.3	0.09
10	40	0	0.88	0.05
CONTROL	44	4	0.04	<0.01

LC50 (%) >100

LC50 MOLINATE (MG/LITER) >5.9

LC50 THIOBENCARB (MG/LITER) >0.48

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 7 - Molinate and Thiobencarb Mixture (144-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 6000, 560

STOCK SOLUTION FINAL CONC (MG/LITER) 6200, 460

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 12.9 (0.3)

FISH WEIGHT (G) ________

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	28	11	5.9	0.48
56	40	2	3.2	0.27
32	39	3	2.0	0.15
18	25	1	1.3	0.09
10	40	0	088	0.05
CONTROL	44	4	0.04	<0.01

LC50 (%) >100

LC50 MOLINATE (MG/LITER) >5.9

LC50 THIOBENCARB (MG/LITER) >0.48

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-5

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 8 - Molinate (48-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 23,000

STOCK SOLUTION FINAL CONC (MG/LITER) 22,000

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 19.0 (0.4)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	39	11	38.8	
56	40	2	21.5	
32	38	0	12.8	
18	39	1	7.5	
10	38	0	5.8	
CONTROL	38	1	0.13	

LC50 (%) >100

LC50 MOLINATE (MG/LITER) >38.8

LC50 THIOBENCARB (MG/LITER)

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-5

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 8 - Molinate (96-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 23,000

STOCK SOLUTION FINAL CONC (MG/LITER) 22,000

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 19.0 (0.4)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	39	11	38.8	
56	40	2	21.5	
32	38	0	12.8	
18	39	1	7.5	
10	38	0	5.8	
CONTROL	38	1	0.13	

LC50 (%) >100

LC50 MOLINATE (MG/LITER) >38.8

LC50 THIOBENCARB (MG/LITER)

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-5

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 8 - Molinate (144-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 23,000

STOCK SOLUTION FINAL CONC (MG/LITER) 22,000

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 19.0 (0.4)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	39	39	38.8	
56	40	38	21.5	
32	38	12	12.8	
18	39	12	7.5	
10	38	10	5.8	
CONTROL	38	12	0.13	

LC50 (%)

LC50 MOLINATE (MG/LITER) 18.2 (16.5- 20.2)

LC50 THIOBENCARB (MG/LITER)

LC50 METHOD -PROBIT- [✓ MOVING AVERAGE] -NONLINEAR INTERPOLATION-

Appendix E-5

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 8 - Thiobencarb (48-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 1,030

STOCK SOLUTION FINAL CONC (MG/LITER) 1,000

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 20.0 (0.3)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	—	--		1.3
56	20	1		0.77
32	19	0		0.40
18	20	0		0.27
10	19	1		0.20
CONTROL	36	3		<0.01

LC50 (%) >56

LC50 MOLINATE (MG/LITER)

LC50 THIOBENCARB (MG/LITER) > 0.77

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-5

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 8 - Thiobencarb (96-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 1,030

STOCK SOLUTION FINAL CONC (MG/LITER) 1,000

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 20.0 (0.3)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	--	--		1.3
56	20	15		0.77
32	19	1		0.40
18	20	0		0.27
10	19	1		0.20
CONTROL	36	7		<0.01

LC50 (%) >32

LC50 MOLINATE (MG/LITER)

LC50 THIOBENCARB (MG/LITER) >.40

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-5

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 8 - Thiobencarb (144-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 1,030

STOCK SOLUTION FINAL CONC (MG/LITER) 1,000

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 20.0 (0.3)

FISH WEIGHT (G) __________

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	--	--		1.3
56	20	18		0.77
32	19	7		0.40
18	20	0		0.27
10	19	1		0.20
CONTROL	36	9		<0.01

LC50 (%) __________

LC50 MOLINATE (MG/LITER) __________

LC50 THIOBENCARB (MG/LITER) 0.57 (0.4-0.77)

LC50 METHOD -PROBIT-MOVING AVERAGE-[✓ **NONLINEAR INTERPOLATION**]**-**

Appendix E-5

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 8 - Molinate and Thiobencarb Mixture (48-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 14,000, 1,200

STOCK SOLUTION FINAL CONC (MG/LITER) 15,000, 1,300

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 18.9 (0.3)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	41	21	20.8	1.7
56	39	0	13.1	1.1
32	39	2	7.7	0.74
18	39	0	4.9	0.46
10	39	0	3.5	0.35
CONTROL	41	0	0.02	<0.01

LC50 (%) >50

LC50 MOLINATE (MG/LITER) >13.1

LC50 THIOBENCARB (MG/LITER) >1.1

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-5

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 8 - Molinate and Thiobencarb Mixture (96-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 14,000 1,200

STOCK SOLUTION FINAL CONC (MG/LITER) 15,000, 1,300

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 18.9 (0.3)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	41	41	20.8	1.7
56	39	31	13.1	1.1
32	39	17	7.7	0.74
18	39	8	4.9	0.46
10	39	0	3.5	0.35
CONTROL	41	4	0.02	<0.01

LC50 (%) 31.7 (28.1-35.8)

LC50 MOLINATE (MG/LITER) 7.5 (6.7-8.3)

LC50 THIOBENCARB (MG/LITER) 0.65 (0.60-0.72)

LC50 METHOD -PROBIT-[✓ MOVING AVERAGE]-NONLINEAR INTERPOLATION-

Appendix E-5

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 8 - Molinate and Thiobencarb Mixture (144-hr)

STOCK SOLUTION INITAL CONC (MG/LITER) 14,000, 1,200

STOCK SOLUTION FINAL CONC (MG/LITER) 15,000, 1,300

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 18.9 (0.3)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	41	41	20.8	1.7
56	39	39	13.1	1.1
32	39	27	7.7	0.74
18	39	13	4.9	0.46
10	39	1	3.5	0.35
CONTROL	41	6	0.02	< 0.01

LC50 (%) 27.4 (18-32)

LC50 MOLINATE (MG/LITER) 6.6 (4.7-7.5)

LC50 THIOBENCARB (MG/LITER) 0.58 (0.43-0.66)

LC50 METHOD -PROBIT-MOVING AVERAGE-[✓ NONLINEAR INTERPOLATION]-

Appendix E-6

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 9 - Molinate (31-day)

STOCK SOLUTION INITAL CONC (MG/LITER) 21,833 (Mean Conc.)

STOCK SOLUTION FINAL CONC (MG/LITER) __________

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 3.4 (0.07)

FISH WEIGHT (G) __________

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	--	--	40.3	
56	--	--	21.1	
32	59	59	12.8	
18	59	20	6.3	
10	60	51	5.6	
CONTROL	60	7	0.15	

LC50 (%) <10

LC50 MOLINATE (MG/LITER) <5.6

LC50 THIOBENCARB (MG/LITER) ---

LC50 METHOD -PROBIT-MOVING AVERAGE-NONLINEAR INTERPOLATION-

Appendix E-6

ACUTE TOXICITY TEST DATA SUMMARY

TEST NO. TEST SERIES 9 - Thiobencarb (31-day)

STOCK SOLUTION INITAL CONC (MG/LITER) 1,052 (Mean Conc.)

STOCK SOLUTION FINAL CONC (MG/LITER)

DILUTION OF TOXICANT 500

TEST SPECIES STRIPED BASS

FISH LENGTH (MM) 3.4 (0.07)

FISH WEIGHT (G)

TEMPERATURE (C) 19

RESPONSE SUMMARY

CONCENTRATION (%)	EXPOSED (NO)	RESPONDED (NO)	MOLINATE (MG/LITER)	THIOBENCARB (MG/LITER)
100	--	--		1.3
56	--	--		0.86
32	31	31		0.51
18	29	29		0.24
10	27	4		0.18
CONTROL	54	9		0.0

LC50 (%)

LC50 MOLINATE (MG/LITER)

LC50 THIOBENCARB (MG/LITER) 0.21 (0.18-0.24)

LC50 METHOD -PROBIT-MOVING AVERAGE-[✓ NONLINEAR INTERPOLATION]-