Pesticides & the Chesapeake Annual Conference,
October 17, 2011

Chesapeake Bay Watershed Pesticide Use Declines But Toxicity Increases

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Hartwell, S.I. 2011.
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But Toxicity Increases.
Environ. Toxicol. and Chem. 30 (5): 1223–1231.

http://onlinelibrary.wiley.com/doi/10.1002/etc.491/abstract

Acknowledgements - All of the pesticide use data compiled in this presentation was diligently gathered and organized by Mary Ellen Setting and/or Dennis Howard and their staff at the Maryland Department of Agriculture. Eric Durell of the Maryland Department of Natural Resources assisted in compiling toxicity data from various sources.

DATA SOURCE

From 1985 through 2004 the Maryland Department of Agriculture (MDA) estimated pesticide use in the state of Maryland every three years by farm operators, certified applicators (commercial and private), and public agencies

Response rates varied from 38 to 78% depending on sector and year so all the estimates reported are underestimates.

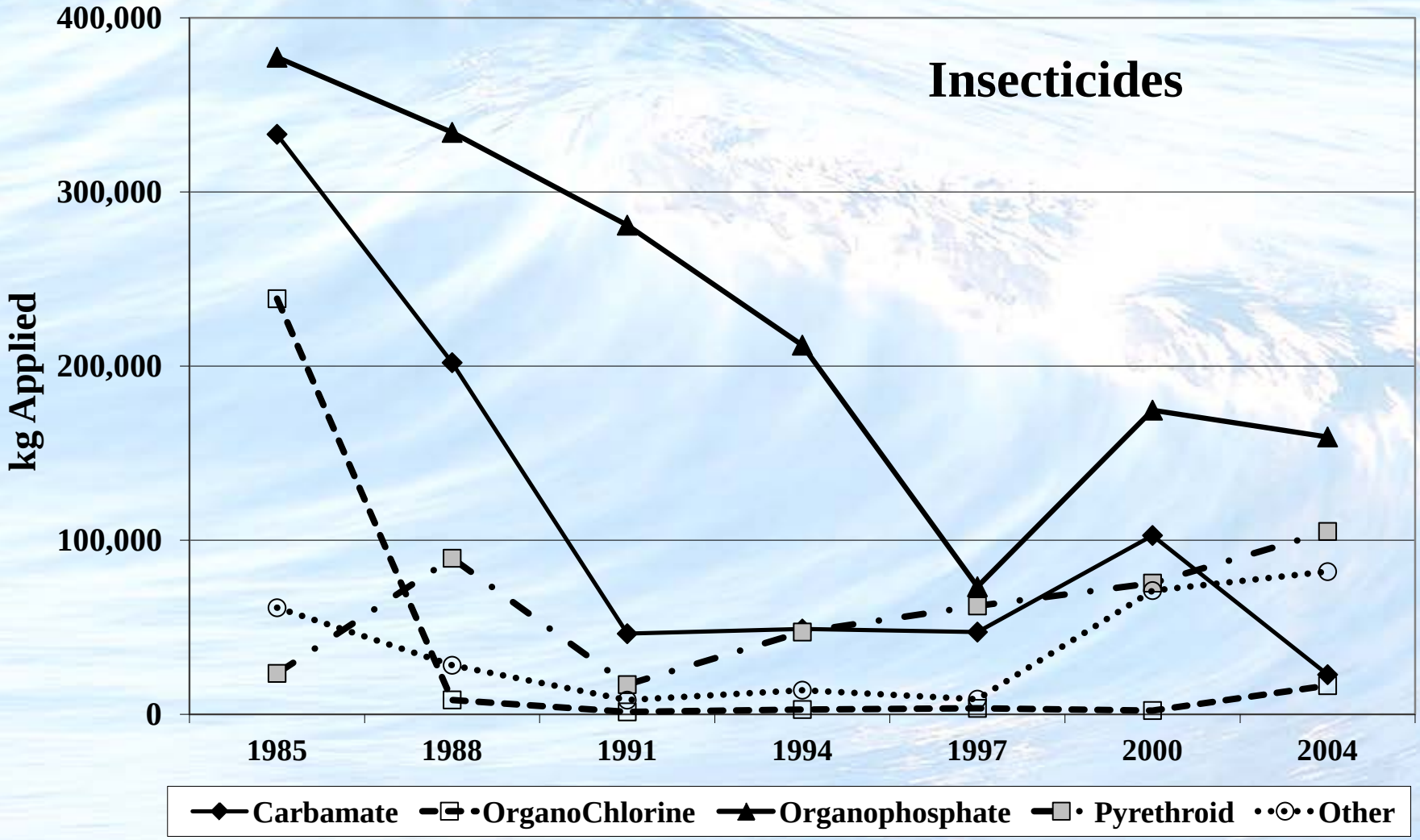
EPA estimates that approximately 75% of all pesticide usage in the US is agricultural. The other 25% is for home and garden use, industrial, commercial and government sectors.

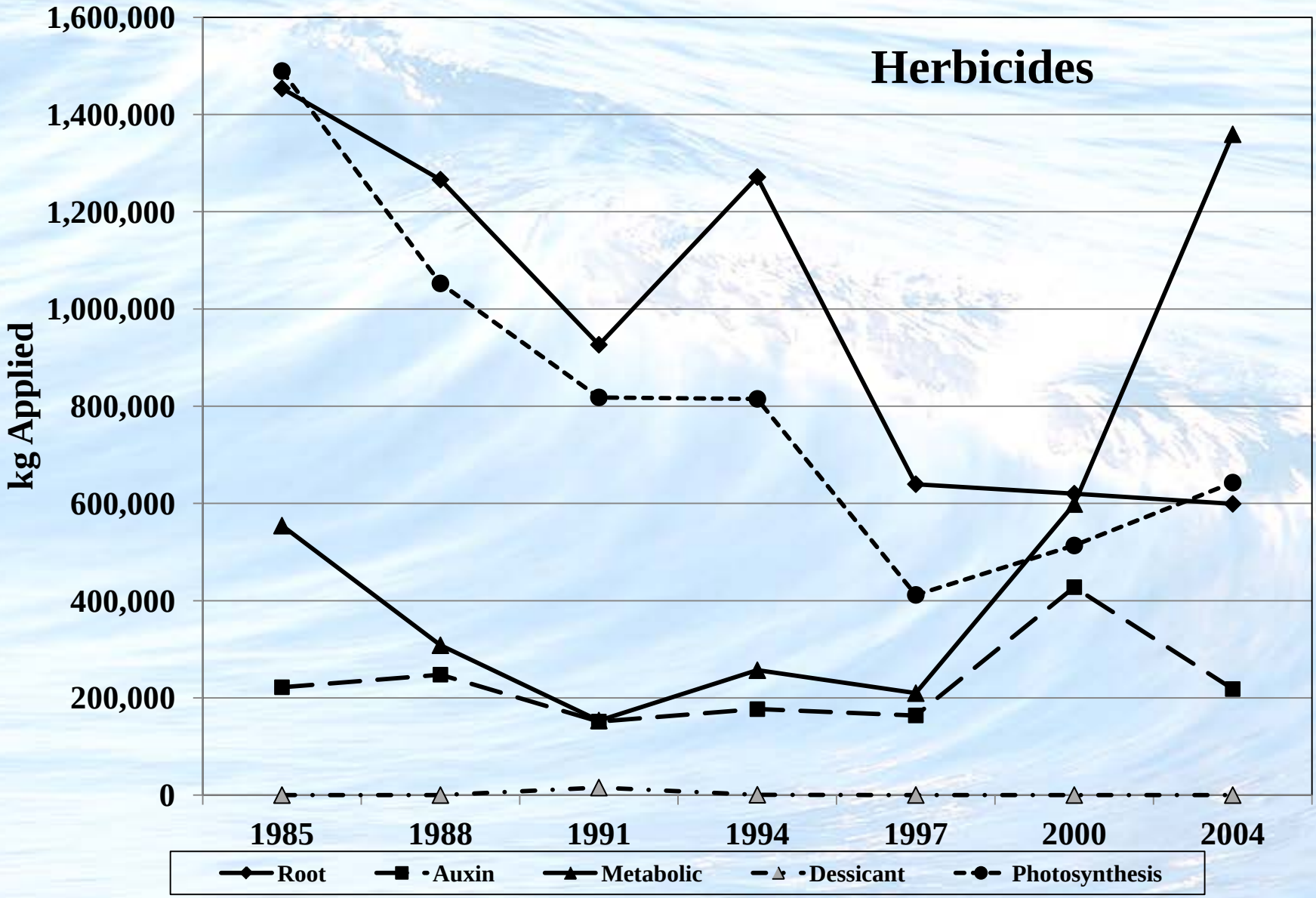
Data does not include Virginia or Pennsylvania.

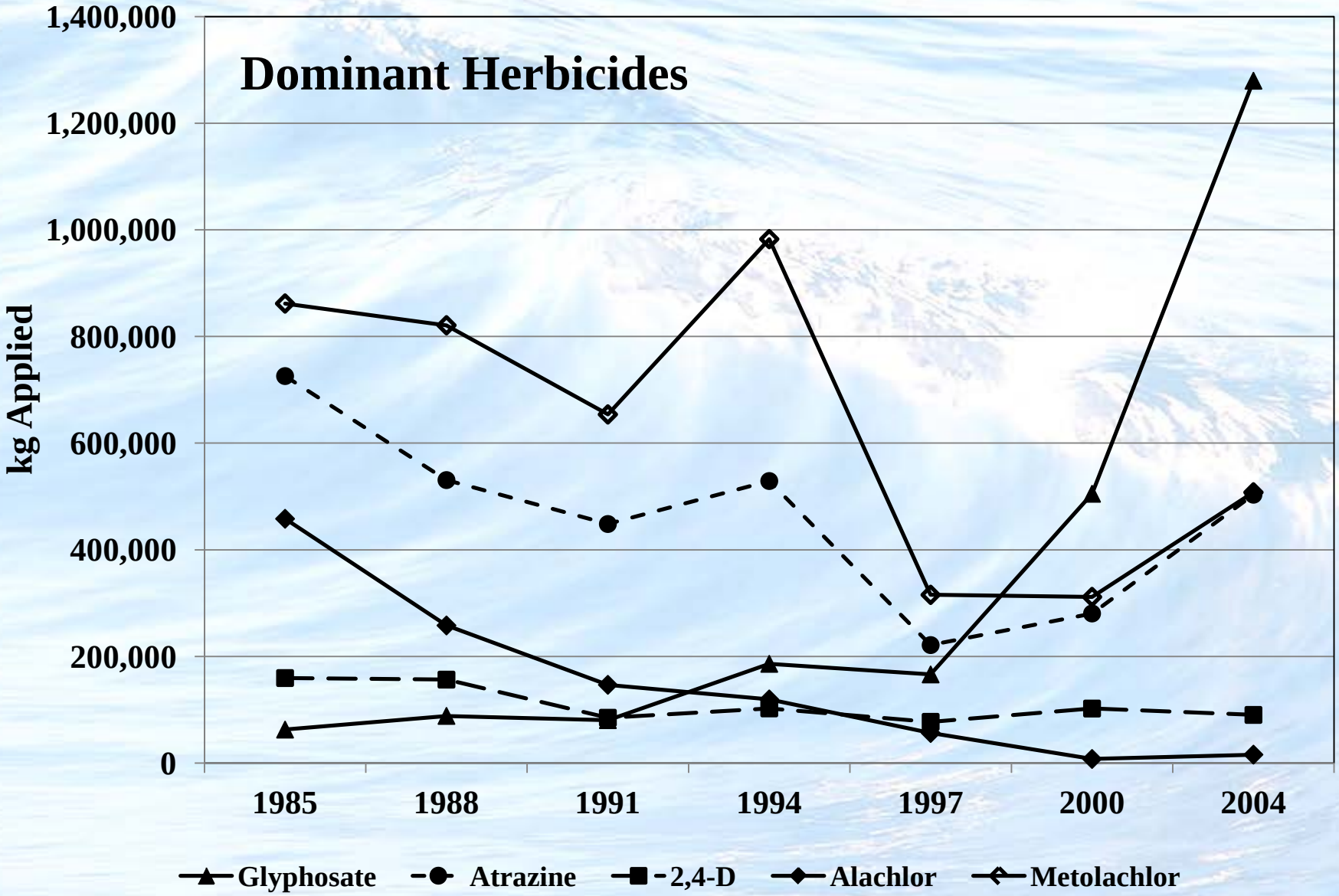
The top 20 herbicides and insecticides, in terms of total pounds applied, were compiled for each survey year. As the mix of pesticides applied changed over the years, the list of the top 20 evolved, but those that fell out of the top 20 were maintained in the data set to track changes in the use of pesticide types over time.

Wood preservatives (e.g. chromium-copper-arsenic, CCA), boat bottom-paint anti-foulants (cuperous oxide), and pesticides that are not generally released by broadcast application (boric acid) were excluded. Applications of *Bacillus thuringiensis* in the early 90s were not included.

Insecticides were grouped by chemical structure. Herbicides were grouped by toxic mode of action.


Insecticides
400,000
300,000
200,000
100,000
0
kg Applied
1985
1988
1991
1994
1997
2000
2004
Carbamate
OrganoChlorine
Organophosphate
Pyrethroid
Other


Herbicides
kg Applied
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1985
1988
1991
1994
1997
2000
2004
Root
Auxin
Metabolic
Dessicant
Photosynthesis


Dominant Herbicides
kg Applied
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1985
1988
1991
1994
1997
2000
2004
Glyphosate
Atrazine
2,4-D
Alachlor
Metolachlor

Bioassay lethal/effective concentration (LC50/EC50) data was gathered from the U.S. EPA

Animal species included rainbow trout (*Oncorhynchus mykiss*), bluegill sunfish (*Lepomis macrochirus*), the waterflea (*Daphnia magna*), and a marine mysid shrimp (*Mysidopsis bahia*).

Plant species included a freshwater algae, *Selenastrum capricornutum,* a marine algae, *Skeletonema costatum,* and duckweed, a freshwater vascular plant, *Lemna gibba*.

Toxicity Units (TU) were calculated for each year for each chemical, based on the application rate and the LC/EC50 for each species (TU=kg/LC50). The total TU of herbicides and insecticides was summed for each species by year.

The total kg applied vs total applied in terms of TU were plotted over time to assess trends in application rates and potential toxic impact.

Chemical	Type	Trout ppb	Bluegill ppb	Daphnia ppb	Mysid ppb	geometric m
aldicarb	CB	560.0	83.4	553.0	13	flow
bendiocarb	CB	1,375.0	1,062.5	29.2	6.7	LOEC
carbaryl	CB	7,600.0	9,523.5	5.6	5.7	
carbofuran	CB	400.0	88.0	29.0	0.98	
metam-sodium	CB	34,100.0	510.0	2,360.0		
methomyl	CB	2,065.0		16.0	230	
chlordane	OC	69.5	74.0	240.0		
endosulfan	OC	0.97	2.1	166.0		
heptachlor	OC	7.0	13.0		3.4	
lindane	OC	18.0	25.0	110.0	6.3	
toxaphene	OC	6.4	2.4	10.0		
acephate	OP	110,000.0	2,000,000.0	16,400.0	3800	
azinphos-methyl	OP	8.8	4.5	1.1	0.21	
bromchlophos	OP	270.0	2,200.0	0.3	8.8	
chlorpyrifos	OP	7.1	2.0	1.7	0.04	
diazinon	OP	90.0	168.0	1.0	4.2	
dichlorvos	OP	100.0	1,109.5	1.0	19	
dimethoate	OP	6,850.0	6,000.0	275.0	15000	
disulfoton	OP	1,850.0	132.7	13.0	100	
isofenphos	OP	1,800.0	1,400.0	3.9	1.7	
malathion	OP	17.1	54.0	1.0	2.2	
parathion	OP	1,430.0	73.5	2.0	0.55	
phorate	OP	13.0	1.5	37.0	1.1	
phosmet	OP	167.5	72.0	5.6	16	
temephos	OP	8,956.6	32,400.0	0.011		
terbufose	OP	7.6	1.9	1.07	0.22	
trichlorfon	OP	1,052.5	230.0	5.60	6.7	
cyfluthrin	PY	0.16	1.5	0.141	0.0023	
cypermethrin	PY	1.01	2.8	56.2	0.0055	
esfenvalerate	PY	0.07	0.2	0.15		
fenvalerate	PY	0.7	0.3	0.33	0.008	
lamda-cyhalothrin	PY	0.17	0.2	0.14	0.0041	
permethrin	PY	6.0	8.1	1.76	0.033	
tefluthrin	PY	0.1	4.5	0.07	0.053	
bifenazate	X	760.0	580.0	500.0	58	
captan	X	73.0	310.0	445.0	8400	
chinomethionate	X					
diflubenzuron	X	140,000.0	182,500.0	3.2	2.1	
fipronil	X	142.5	54.0	106.3	0.14	
halofenozide	X			3,600.0	3500	
imidacloprid	X	229,100.0		85200	38	
vorlex	X					
		39	37	39	34	
%Wdata		0.93	0.88	0.93	0.81	
Median LC50s						
CB		1,720.0	510.0	29.1	6.7	
OC		7.0	13.0	138.0	4.9	
OP		218.8	150.4	1.9	4.2	
PY		0.17	1.50	0.15	0.01	
X		760.0	445.0	472.5	48.0	

CHEMICAL	Action	Trout	Bgill	Daphnia	Selenastrum	Skeletonema	DuckWeed	Type
acetochlor	root inhib.	667	1467	9800	1.43	5.1	3.4	amide
alachlor	root inhib.	17333	42000	21000	1.64			amide
benefin	root inhib.							dinitrotoluidine
CDAA	root inhib.							amide
dimethenamid	root inhib.	61578	8200	14000	16	70	14.5	amide
metolachlor	root inhib.	7900	3200	22500	9	85.5	351	amide
naptalam	root inhib.	76100	354400	118500				amide
oryzalin	root inhib.	3355	2880	1500	42	41	15.4	dinitroaniline
pendimethalin	root inhib.	138	199	280	5.4	5.2	12.5	dinitroaniline
prodiamine	root inhib.		3180.00	10325.00				dinitroaniline
sulfometuron methyl	root inhib.			24000	4.6		0.48	urea
trifluralin	root inhib.	22	8.4	560		28	43.5	dinitroaniline
2,4-D	auxin mimic	239333	221500	25000	42200	2020	695	phenoxy
2,4-DP	auxin mimic							phenoxy
chloramben	auxin mimic							aromatic acid
clopyralid	auxin mimic	103500	125400	225000	6900			pyridine
DCPA (Chlorthal)	auxin mimic	30000		82500				aromatic acid
dicamba	auxin mimic	81700	135300	110700		490		aromatic acid
dithiopyr	auxin mimic	460	470	17000	20			pyridine
MCPA	auxin mimic	90000	97000	27000	106450	6928	1875	phenoxy
MCPP	auxin mimic	124800			9964	17	1900	phenoxy
triclopyr	auxin mimic	334500	360	39355	17700	8035	8200	pyridine
aciflourfen	metabolic	35500	31000	52550			378	diphenyl ether
bensulide	metabolic	910	1105	580	1800		150	organophosphate
butylate	metabolic	8625	4870	11900			4100	thiocarbamate
chlormequat	metabolic							ammonium chloride
dinoseb	metabolic							dinitrophenol
EPTC	metabolic	20480	19566	11260	1380	6100	5600	thiocarbamate
glyphosate	metabolic	14000	92500	78862	13270	3370	24000	organophosphate
imazapyr	metabolic	92000		750000	1000	92000	22.7	imidazolinone
imazaquin	metabolic	280000	420000	280000				imidazolinone
Maleic-Hydrazide	metabolic			107500			114000	pyridazinone
mesotrione	metabolic			840000	1900	20000	17700	benzoylcyclohexanedione
metam-sodium	metabolic							dithiocarbamate
vorlex	metabolic							methyl isothiocyanate mixture
sodium chlorate	dessicant			919300	133000			inorganic
atrazine	photo. inihib.	4500	28400	27950	74	38.5	80	triazine
clomazone	photo. inihib.	19000	34000	5200	3500	1000	35000	other
cyanazine	photo. inihib.	9000	22500	45500	5.5	17.8	64	triazine
diquat dibromide	photo. inihib.		124600	1856	9.4			quaternary ammonium
diuron	photo. inihib.	1950	3000	8400	2.4			urea
linuron	photo. inihib.	3000	9600	767	67	35.9	273	urea
metribuzin	photo. inihib.	60923	83980	14562	14.4	8.8	160	triazinone
paraquat	photo. inihib.	33840	84500		320	2840	98	quaternary ammonium
simazine	photo. inihib.	48366	58000		100	600	140	triazine
Median LC/EC50s								
root inhib.		5627.5	3180	10062.5	5.4	34.5	14.5	
auxin mimic		96750	111200	26000	13832	2020	1887.5	
metabolic		20480	25283	11900	1800	13050	4850	
photo. inhib.		14000	34000	5200	67	38.5	140	
%W data			66.7	75.6	62.2	48.9	57.8	

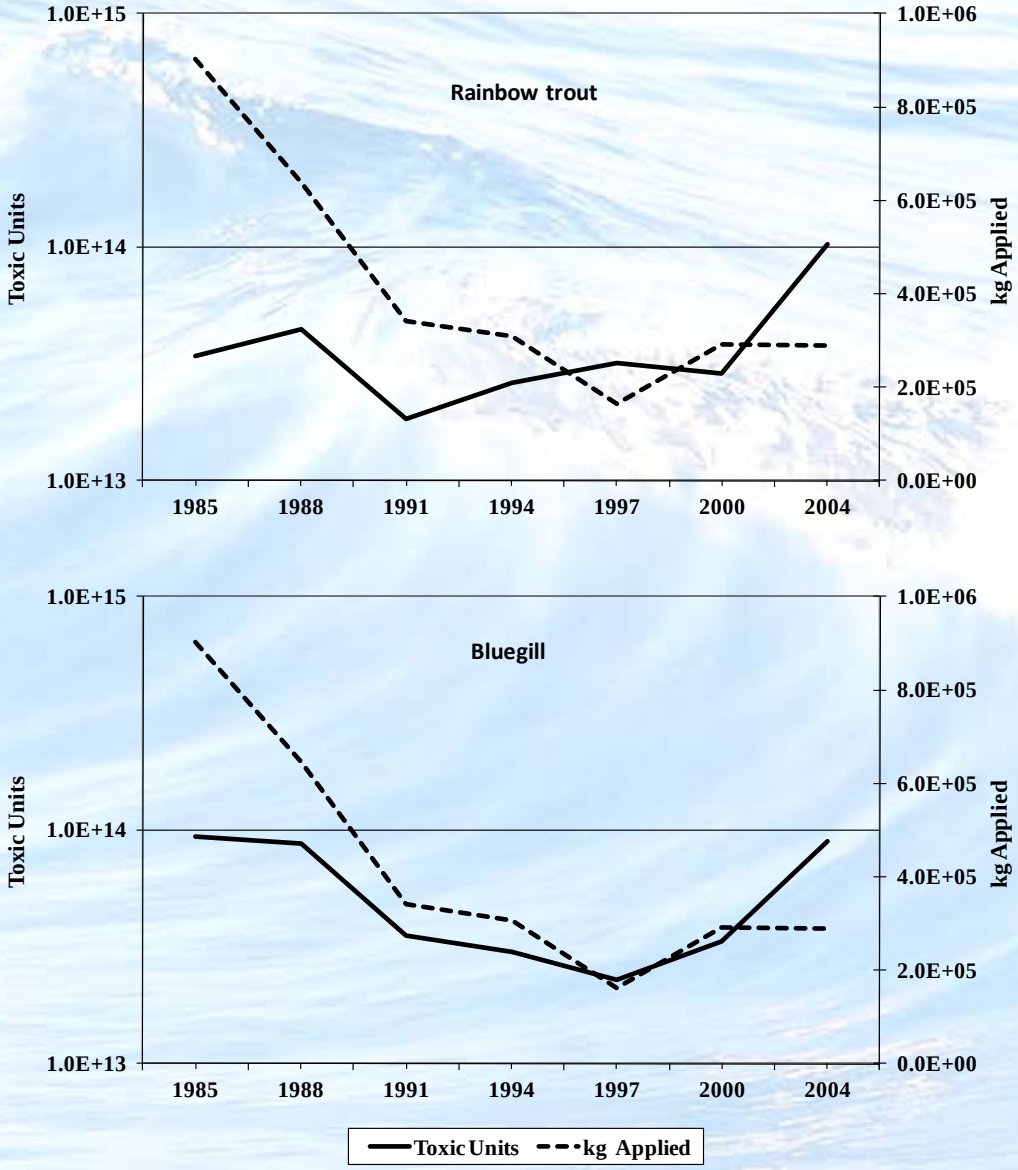


Figure 2. Total kg of insecticide applied in Maryland vs toxic units for Rainbow trout *(Oncorhynchus mykiss*) and bluegill sunfish, (*Lepomis macrochirus*).

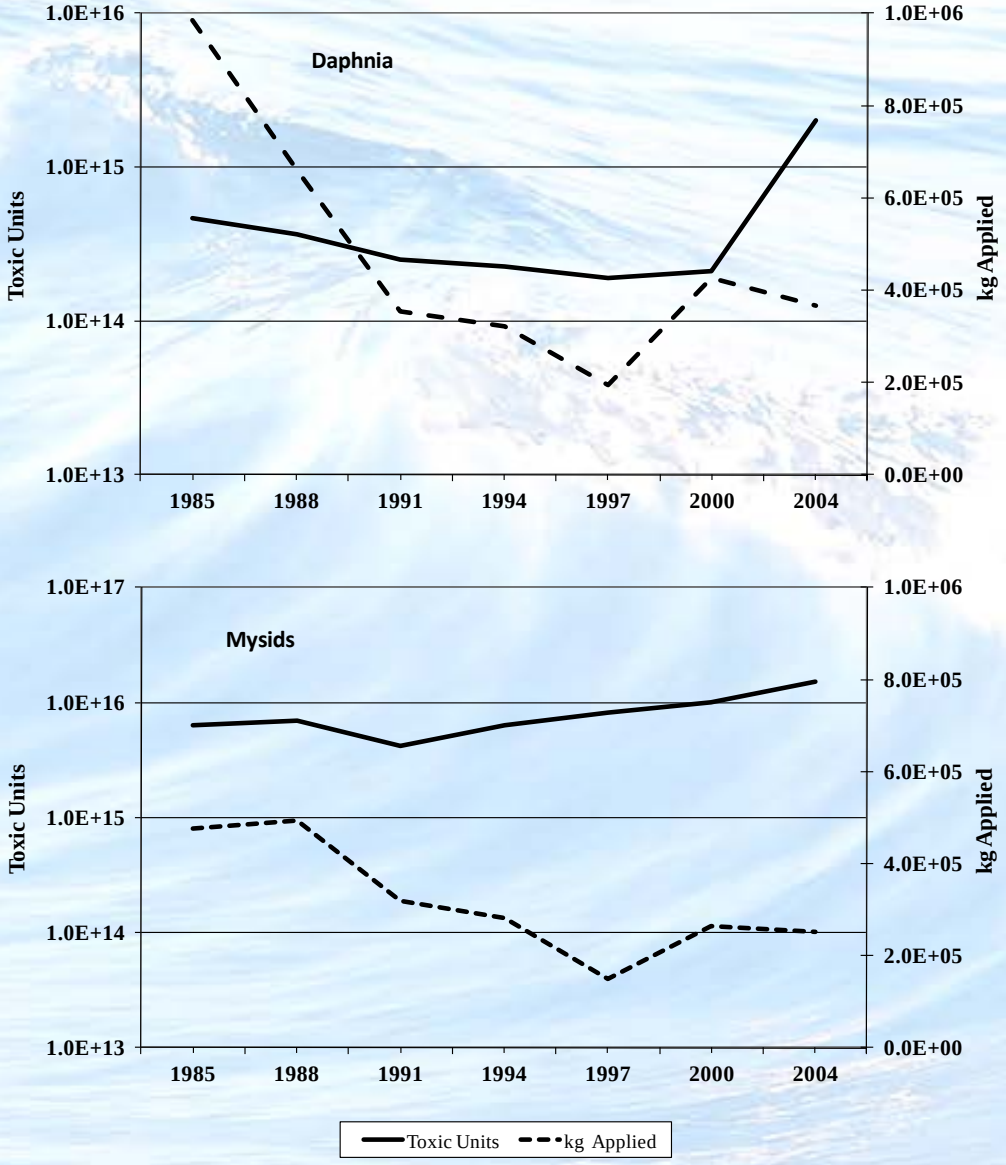


Figure 3. Total kg of insecticide applied in Maryland vs toxic units for the Cladoceran *Daphnia magna* and the shrimp *Mysidopsis bahia*.

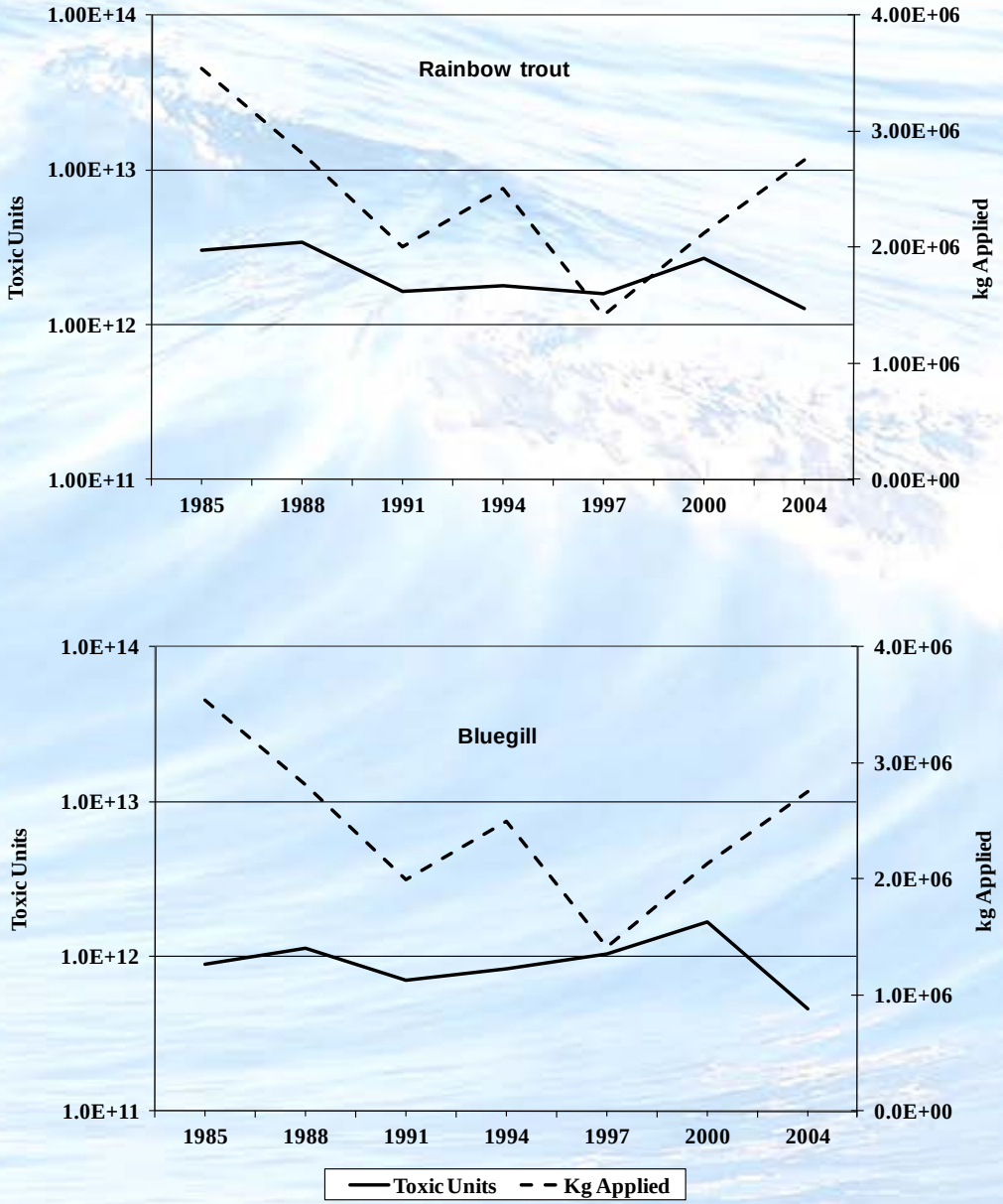


Figure 4. Total kg of herbicide applied in Maryland vs toxic units for Rainbow trout (*Oncorhynchus mykiss*) and bluegill sunfish (*Lepomis macrochirus*).

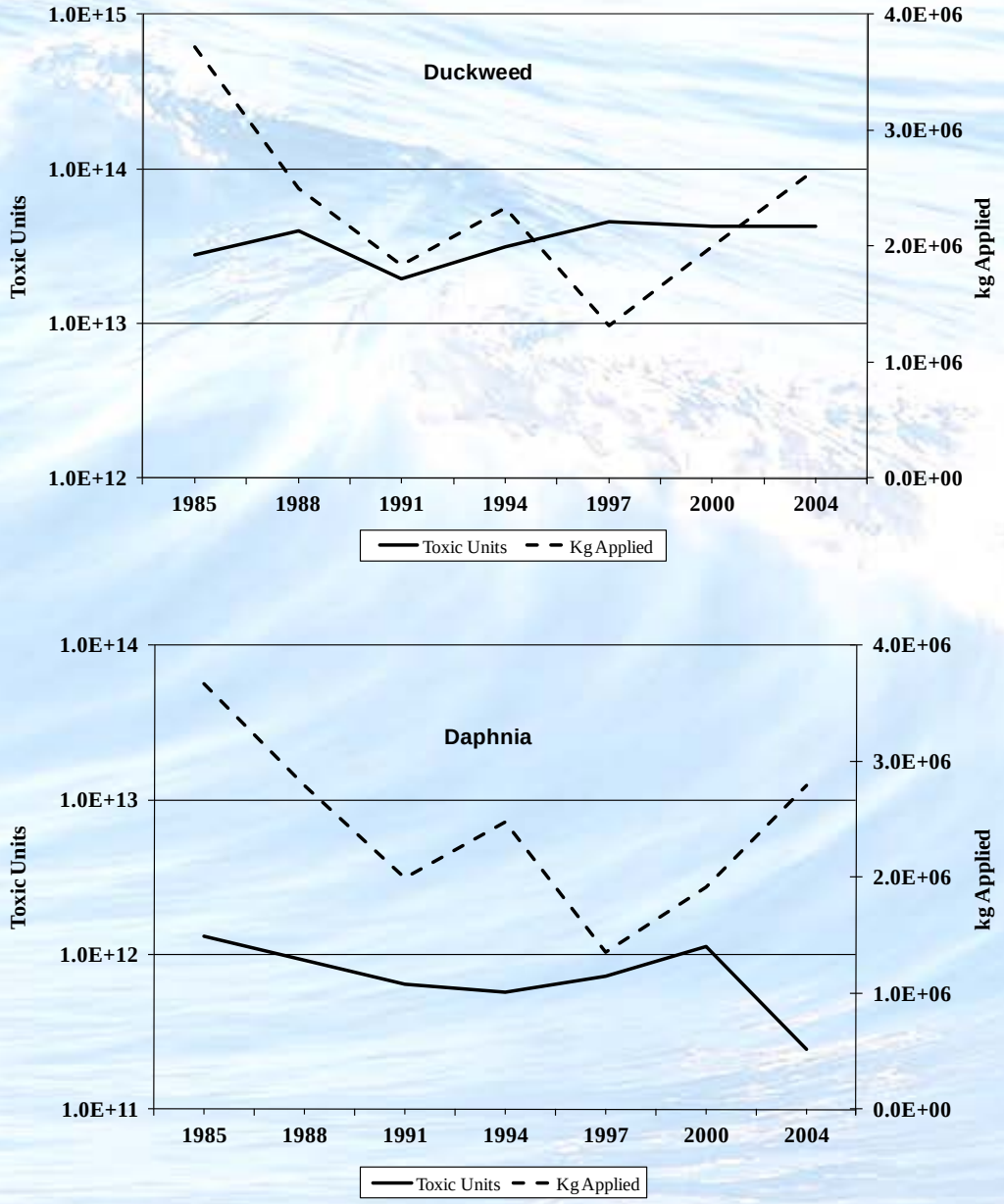


Figure 5. Total kg of herbicide applied in Maryland vs toxic units for duckweed (*Lemna gibba*) and the cladoceran (*Daphnia magna*).

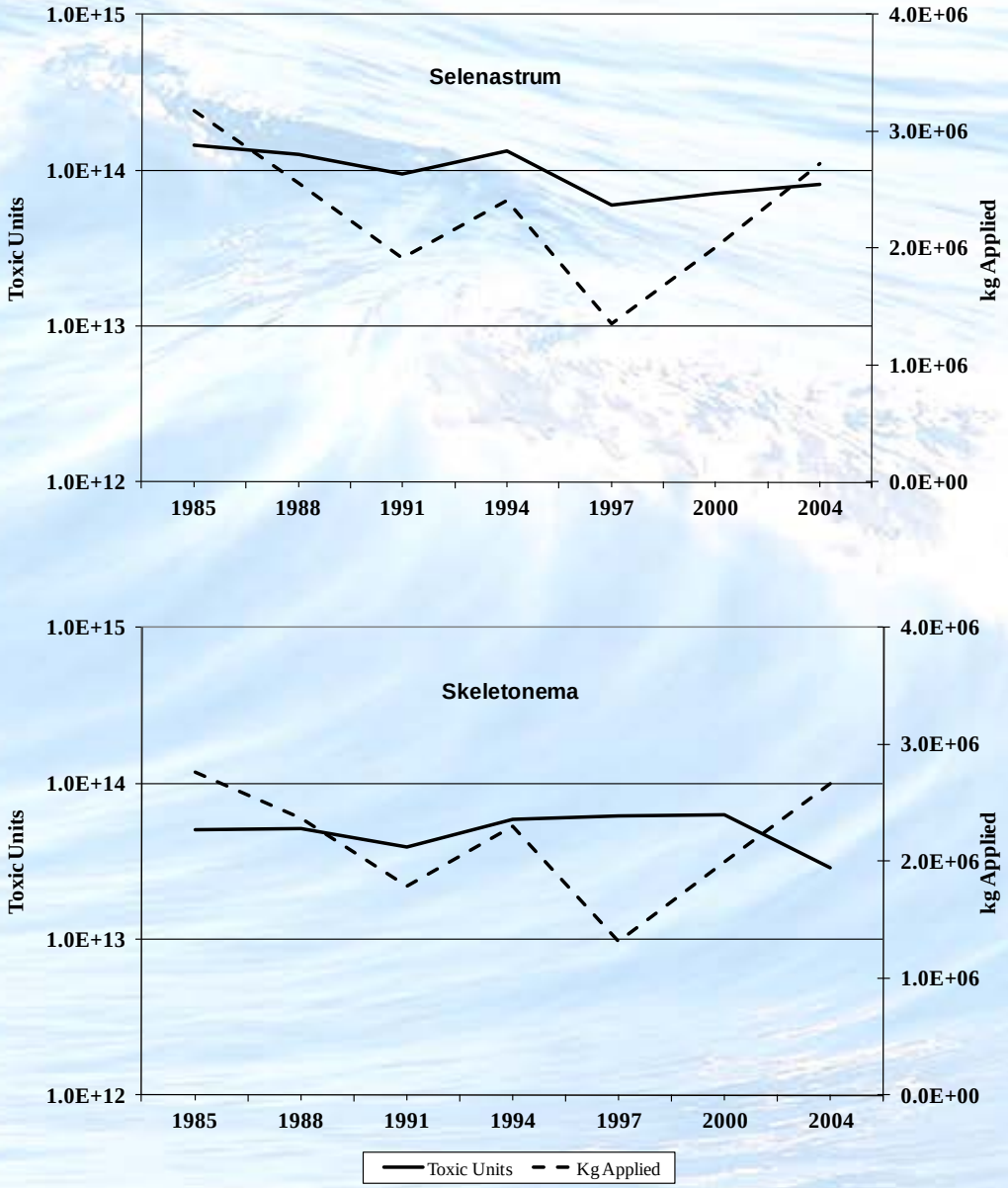
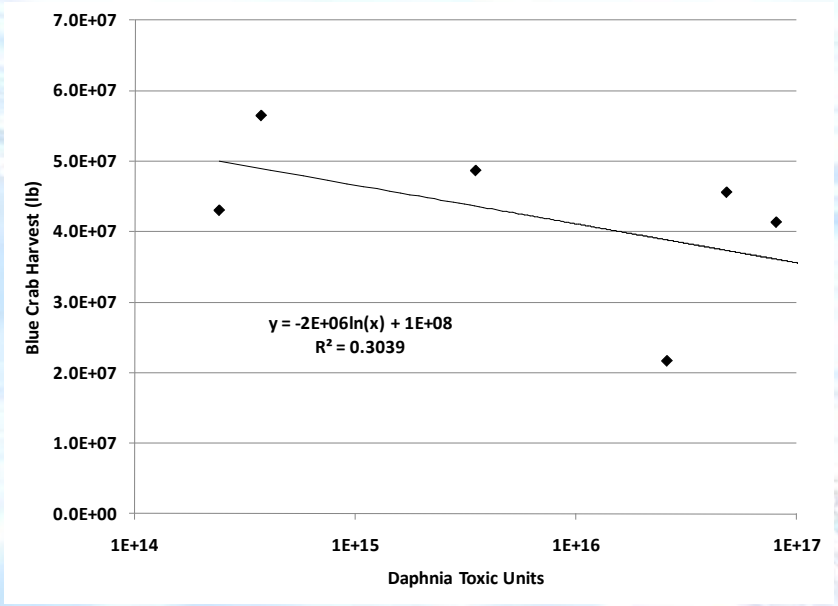


Figure 6. Total kg of herbicide applied in Maryland vs toxic units for a freshwater algae (*Selenastrum capricornutum*) and a marine algae (*Skeletonema costatum*).



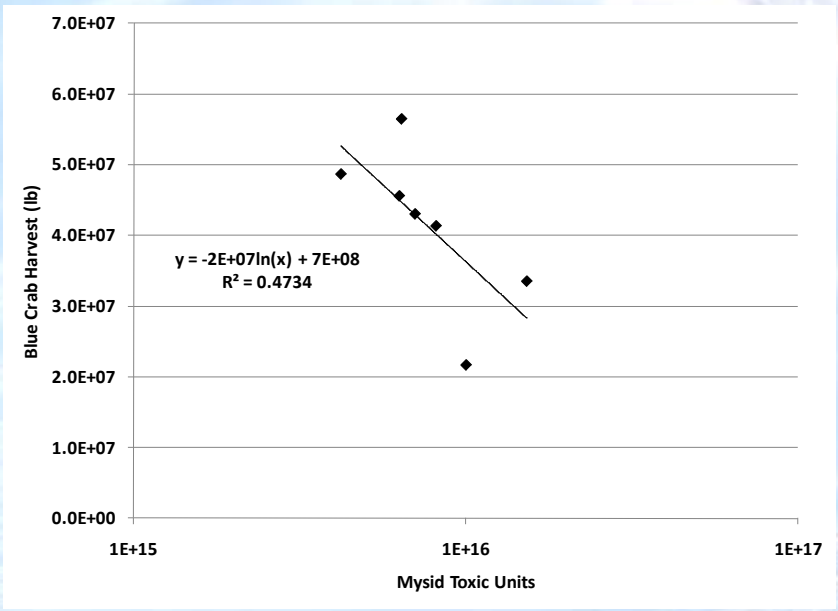
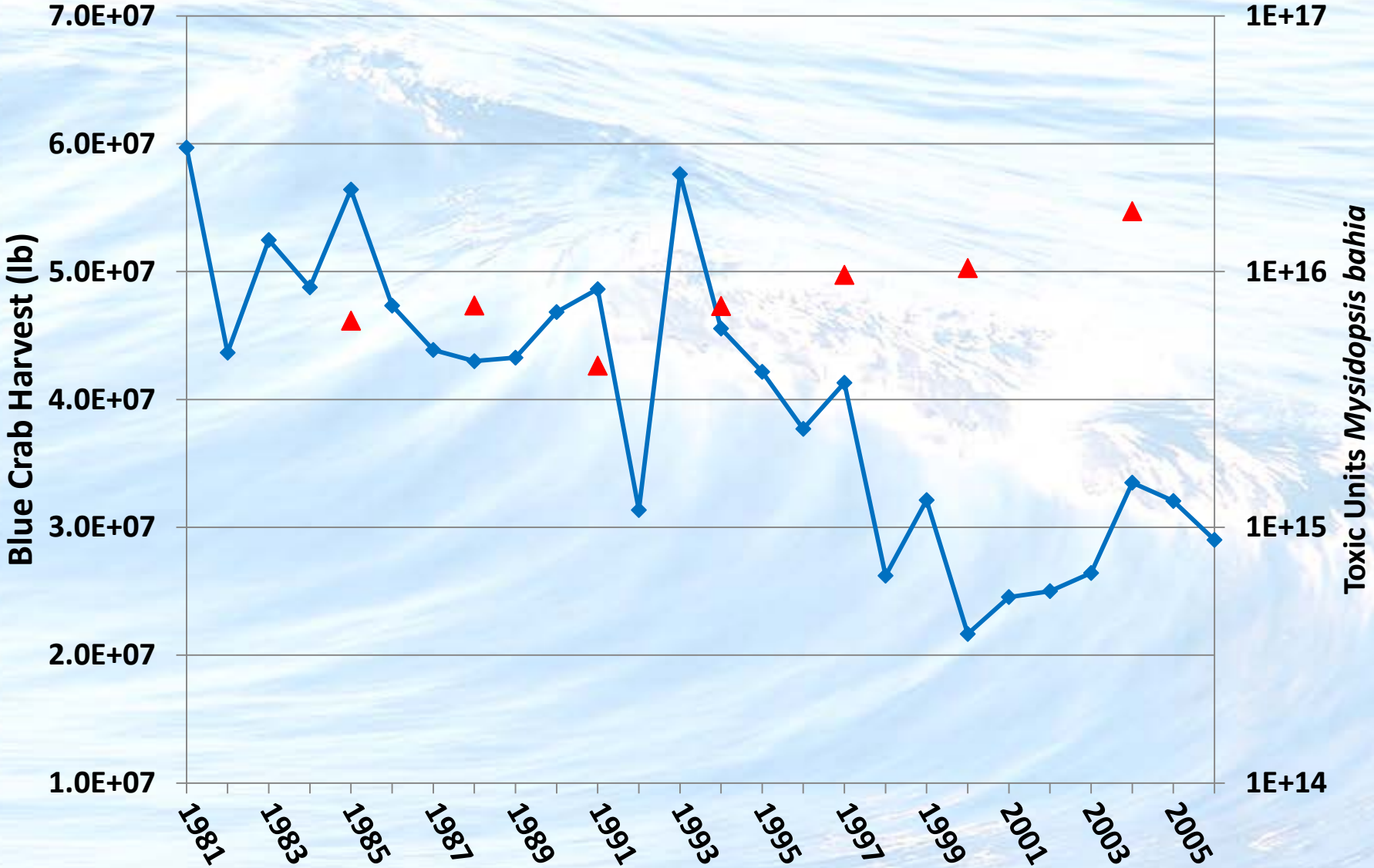


Figure 7. Plots of Blue Crab (*Callinectes sapidus*) harvest in Maryland vs toxic units of insecticides calculated for *Daphnia magna* and *Mysidopsis bahia* applied between 1985 and 2004.


7.0E+07
6.0E+07
5.0E+07
4.0E+07
3.0E+07
2.0E+07
1.0E+07
Blue Crab Harvest (lb)
1E+17
1E+16
1E+15
1E+14
Toxic Units Mysidopsis bahia
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005