PESTICIDE SURFACE WATER AND SEDIMENT QUALITY REPORT

JULY 2012 SAMPLING EVENT

Richard J. Pfeuffer
South Florida Water Management District
MSC 4441
3301 Gun Club Road
West Palm Beach, FL 33406

Table of Contents

Summary

As part of the South Florida Water Management District's (SFWMD) quarterly ambient monitoring program, unfiltered water and sediment samples were collected July 23 to July 26, 2012, and analyzed for over 70 pesticides and/or products of their degradation.

The herbicides ametryn, atrazine, bromacil, and simazine were detected in one or more of these surface water samples. No harmful impacts are expected from the detected pesticides.

The insecticides/degradates DDD and DDE, along with one PCB compound, were found in the sediment at several locations. One DDE compound sediment concentration was of a magnitude considered to have a harmful effect to freshwater sediment-dwelling organisms. No harmful impacts are expected from the other detected pesticides.

The compounds and concentrations found are typical of those expected from an area of intensive historical and contemporary agricultural activity.

Background and Methods

The SFWMD pesticide monitoring network includes sites designated in the Everglades Settlement Agreement, the Lake Okeechobee Protection Act Permit, and the non-Everglades Construction Project (non-ECP) permit. The canals and marshes depicted in **Figure 1** are protected as Florida Administrative Code (F.A.C.) 62-302 Class III (fishable and swimmable) waters, while Lake Okeechobee and a segment of the Caloosahatchee River are protected as a Class I drinking water

supply. Water Conservation Area 1 (WCA-1) and the Everglades National Park are also designated as Outstanding Florida Waters, to which anti-degradation standards apply. Surface water and sediment are sampled quarterly and semiannually, respectively, upstream at each structure identified in the permit or agreement. Sediment samples are collected using a petite Ponar® dredge.

Seventy-three pesticides and degradation products were analyzed in samples from 26 of the network 27 sites (**Figure 1**). The analytes, their respective method detection limits (MDLs), and practical quantitation limits (PQLs) are listed in **Table 1**. All the analytical work is performed by the Florida Department of Environmental Protection (FDEP) Central Laboratory in Tallahassee, Florida. Analytical method details can be found at the following location: http://www.dep.state.fl.us/labs/cgi-bin/sop/chemsop.asp.

To evaluate the potential impacts on aquatic life, the observed concentration is compared to the appropriate criterion outlined in F.A.C. 62-302.530. If a pesticide compound is not specifically listed, acute and chronic toxicity criterion are calculated as one-third and one-twentieth, respectively, of the amount lethal to 50% of the test organisms in 96 hours, using the lowest technical grade effective concentration 50 (EC_{50}) or lethal concentration 50 (LC_{50}) reported in the summarized literature for the species significant to the indigenous aquatic community (F.A.C. 62-302.200). Each pesticide's description and possible uses and sites of application described herein are taken from Hartley and Kidd (1987). Sediment concentrations are compared to freshwater sediment quality assessment guidelines (MacDonald Environmental Sciences, Ltd., and United States Geological Survey, 2003). A value below the threshold effect concentration (TEC) should not have a harmful effect on sediment-dwelling organisms. Values above the probable effect concentration (PEC) demonstrate that harmful effects to sediment-dwelling organisms are likely to be frequently or always observed. This summary covers surface water and sediment samples collected from July 23 to July 26, 2012.

Results

At least one pesticide was detected in surface water at 14 of the 26 sites and in sediment at 5 of the 17 sites. The non-ECP permit requires sampling at S142 only during discharge or flow events. For this sampling event, no sample was obtained due to the lack of discharge at the time of sample collection. A minor modification of the Lake Okeechobee Water Control Structure Operations Permit (#0174552-010, dated December 18, 2011) eliminated sediment sampling at S65E, S191, and FECSR78. Additionally, sediment sampling was reduced to an annual frequency at S2, S3, and S4 for only ametryn, chlordane, DDD, DDE, and DDT analysis, which was performed during the February 2012 sampling event. Therefore no samples were collected for this event. Sediment samples are not collected at S333, S356-334, and TAMBR105, due to no requirement in the respective mandate. All of these compounds have previously been detected in this monitoring program.

The sediment DDE concentration at S5A was of a magnitude considered to represent detrimental effects to sediment-dwelling organisms in freshwater sediments. All other detected concentrations in the surface water and sediment were below any effect level.

The above findings must be considered with the caveat that pesticide concentrations in surface water and sediment may vary significantly in relation to the timing and magnitude of pesticide application, rainfall events, pumping and other factors, and that this was only one sampling event. The possible acute and chronic toxicity and environmental fate impacts are reported based on the single sampling event and do not take into account previous monitoring data.

Usage and Water Quality Impacts

Ametryn: Ametryn is a selective terrestrial herbicide registered for use on sugarcane, bananas, pineapple, citrus, corn, and non-crop areas. Most algal effects occur at concentrations greater than (>) 10 micrograms per liter (µg/L) (Verschueren, 1983). Environmental fate and toxicity data in **Tables 4 and 5** indicate that ametryn (1) is lost from soil relatively easily by leaching, surface adsorption, and in surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data include a 96-hour LC_{50} of 14.1 milligrams per liter (mg/L) for goldfish (Hartley and Kidd, 1987). The ametryn surface water concentrations found in this sampling event ranged from 0.025 to 0.083 µg/L (**Table 2**). Using these criteria, these observed surface water concentrations should not have an acute, detrimental impact on fish or aquatic invertebrates. Ametryn was not detected in the sediment.

Atrazine: Atrazine is a selective systemic herbicide registered for use on pineapple, sugarcane, corn, rangelands, ornamental turf and lawn grasses, and non-crop areas. Environmental fate and toxicity data in **Tables 4 and 5** indicate that atrazine (1) is easily lost from soil by leaching and in surface solution, with moderate loss from surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data include a 96-hour LC_{50} of 76 mg/L for carp, 16 mg/L for perch, and 4.3 mg/L for guppies (Hartley and Kidd, 1987). Also, in a flow-through bioassay, the maximum acceptable toxicant concentration (MATC) of atrazine was 90 and 210 µg/L for bluegill and fathead minnow, respectively (Verschueren, 1983). The draft ambient aquatic life water quality criterion identifies a one-hour average concentration that does not exceed 1,500 µg/L more than once every three years on the average (United States Environmental Protection Agency [U.S. EPA], 2003). The atrazine surface water concentrations found in this sampling event at 13 of the 26 sampling locations, ranged from 0.024 to 0.18 µg/L (**Table 2**). Using these criteria, these observed surface water concentrations should not have an acute or chronic detrimental impact on fish or invertebrates. Atrazine was not detected in the sediment.

Bromacil: Bromacil is a terrestrial herbicide registered for use on pineapple, citrus, and non-crop areas. Environmental fate and toxicity data in **Tables 4 and 5** indicate that bromacil (1) is easily lost from soil by leaching, with moderate loss from surface adsorption or surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data include a 96-hour LC_{50} of 164 mg/L for carp (Hartley and Kidd, 1987). The only concentration of bromacil detected in the surface water during this sampling event was at S65E (0.12 µg/L) (**Table 2**). Using these criteria, this observed concentration should not have an acute or chronic detrimental impact on fish or aquatic invertebrates.

DDD, DDE: DDE is an abbreviation of **d**ichloro**d**iphenyldichloro**e**thylene [2, 2-bis (4-chlorophenyl)-1, 1-dichloroethene]. DDE is an environmental dehydrochlorination product of DDT (**d**ichloro**d**iphenyl**t**richloroethane), a popular insecticide for which the U.S. EPA cancelled all uses in 1973. The large volume of DDT used, the persistence of DDT, DDE and another metabolite, DDD (**d**ichloro**d**iphenyl**d**ichloroethane), and the high K_{oc} of these compounds account for the frequent detections in sediments. The large hydrophobicity of these compounds also results in a significant bioconcentration factor (**Table 4**). In sufficient quantities, these residues have reproductive effects in wildlife and carcinogenic effects in many mammals.

The DDD sediment concentrations detected were 5.7 and 22 micrograms per kilogram (µg/Kg) (**Table 3**). Any concentration which would fall below the TEC (4.9 µg/Kg) should not impact sediment dwelling organisms while concentrations above the PEC (28 µg/Kg), frequently or always have the possibility for impacting sediment-dwelling organisms. The DDD concentration detected at S5A was between the TEC and PEC. This concentration may have the possibility for harmful effects on freshwater sediment-dwelling organisms. DDD was not detected in the surface water.

The TEC is 3.2 µg/Kg and the PEC is 31 µg/Kg for DDE in freshwater sediments. The concentration of DDE detected at S5A (**Table 3**) exceeded the PEC and frequently or always have the possibility for impacting sediment-dwelling organisms. DDE was not detected in the surface water.

PCBs: Polychlorinated biphenyls (PCBs) is the generic term for a group of 209 congeners that contain a varying number of substituted chlorine atoms on one or both of the biphenyl rings. PCB-1254 is a commercial grade mixture containing 54 percent chlorine by weight. Production of PCBs was banned in 1978 and closed system uses are being phased out. In natural water systems, PCBs are found primarily absorbed to suspended sediments due to the very low solubility in water (Callahan et al., 1979). The tendency of PCBs for adsorption increases with the degree of chlorination and with the organic content of the adsorbent. While the production ban, phase out of uses, and stringent spill clean-up requirements have significantly reduced environmental loadings in recent years, the persistence and tendency to accumulate in sediment and bioaccumulate in fish, make this class of organochlorine compounds especially problematic. The TEC and PEC are 60 µg/Kg and 680 µg/Kg, respectively, for total PCBs. The sediment residue detected at S6 (**Table 3**) is greater than the TEC but less than the PEC. This concentration has a possibility for impacting freshwater sediment-dwelling organisms. None of the PCB congeners were detected in the surface water.

Simazine: Simazine is a selective systemic herbicide registered for use on many crops including sugarcane, citrus, corn, and non-crop areas. Environmental fate and toxicity data in **Tables 4 and 5** indicate that simazine (1) is easily lost from soil by leaching and has a moderate potential for loss due to surface adsorption and surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data include a 96-hour

LC_{50} of 49 mg/L for guppies (Hartley and Kidd, 1987). Most of the aquatic biological effects occur at concentrations > 500 µg/L (Verschueren, 1983). Aquatic invertebrate LC_{50} toxicity ranges from 3.2 mg/L to 100 mg/L for simazine (U.S. EPA, 1984). The only surface water concentration of simazine detected at S5A (0.13 µg/L; **Table 2**) was below any level of concern for fish or aquatic invertebrates.

Quality Assurance Evaluation

No pesticide analytes were detected in the equipment blanks or field blank performed at S18C, S191, S331, S8, US41-25, and S5A. All of the collected samples were shipped and all bottles were received.

Figure 1. South Florida Water Management District Pesticide Monitoring Network.

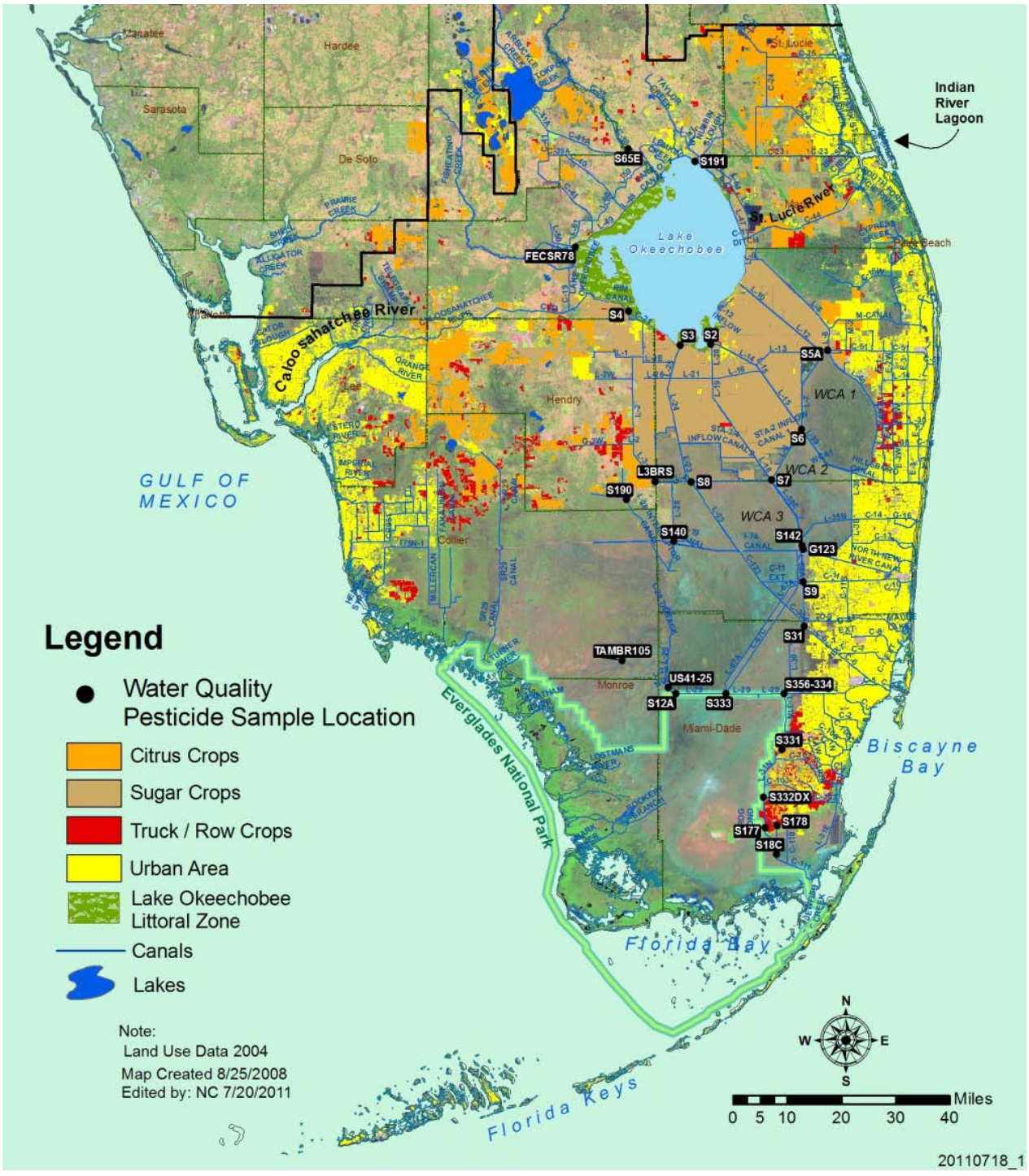

Table 1. Method detection limits (MDLs) and practical quantitation limits (PQLs) for July 2012 sampling event.

Pesticide or metabolite	Water: range of MDLs - PQLs (µg/L)	Sediment: range of MDLs - PQLs (µg/Kg)	Pesticide or metabolite	Water: range of MDLs - PQLs (µg/L)	Sediment: range of MDLs - PQLs (µg/Kg)
2,4-D	0.2 - 0.62	9.6 - 140	endrin aldehyde	0.0037 - 0.016	1 - 19
2,4,5-T	0.2 - 0.62	9.6 - 140	ethion	0.0093 - 0.04	2.5 - 47
2,4,5-TP (silvex)	0.2 - 0.62	9.6 - 140	ethoprop	0.0046 - 0.02	1.2 - 23
acifluorfen	0.2 - 0.62	9.6 - 140	fenamiphos	0.028 - 0.12	5 - 93
alachlor	0.057 - 0.24	18 - 330	fonofos	0.0093 - 0.04	1.2 - 23
aldrin	0.0019 - 0.008	0.5 - 9.3	heptachlor	0.0019 - 0.008	0.64 - 15
ametryn	0.0093 - 0.04	2.5 - 61	heptachlor epoxide	0.0019 - 0.008	0.5 - 9.3
atrazine	0.0093 - 0.04	2.5 - 47	hexazinone	0.028 - 0.12	7.5 - 140
atrazine desethyl	0.0093 - 0.04	N/A	imidacloprid	0.21 - 0.68	N/A
atrazine desisopropyl	0.0093 - 0.04	N/A	linuron	0.21 - 0.68	8.8 - 130
azinphos methyl (guthion)	0.019 - 0.08	7.5 - 140	malathion	0.0093 - 0.04	2.5 - 47
α-BHC (alpha)	0.0019 - 0.008	0.5 - 9.3	metalaxyl	0.037 - 0.16	N/A
β-BHC (beta)	0.0019 - 0.008	0.5 - 9.3	methamidophos	N/A	10 - 190
δ-BHC (delta)	0.0019 - 0.008	0.5 - 9.3	methoxychlor	0.0093 - 0.04	3.5 - 65
γ-BHC (gamma) (lindane)	0.0019 - 0.008	0.5 - 9.3	metolachlor	0.056 - 0.24	15 - 280
bromacil	0.037 - 0.16	15 - 280	metribuzin	0.019 - 0.08	5 - 93
butylate	0.019 - 0.08	N/A	mevinphos	0.0093 - 0.04	2.5 - 47
carbophenothion (trithion)	0.0056 - 0.024	1.5 - 28	mirex	0.0037 - 0.016	1 - 19
chlordane	0.019 - 0.08	5 - 93	monocrotophos	N/A	3 - 56
chlorothalonil	0.0074 - 0.032	1.5 - 28	naled	0.037 - 0.16	10 - 190
chlorpyrifos ethyl	0.0093 - 0.04	2.5 - 47	norflurazon	0.028 - 0.12	7.5 - 140
chlorpyrifos methyl	0.0093 - 0.04	2.5 - 47	parathion ethyl	0.019 - 0.08	2.5 - 47
cypermethrin	0.011 - 0.048	2.5 - 47	parathion methyl	0.0093 - 0.04	2.5 - 47
DDD-P,P'	0.0037 - 0.016	1 - 19	PCB-1016	0.019 - 0.08	5 - 93
DDE-P,P'	0.0037 - 0.016	1 - 19	PCB-1221	0.019 - 0.08	10 - 190
DDT-P,P'	0.0037 - 0.016	1.5 - 28	PCB-1232	0.019 - 0.08	5 - 93
demeton	0.022 - 0.096	3 - 56	PCB-1242	0.019 - 0.08	5 - 93
diazinon	0.0093 - 0.04	2.5 - 47	PCB-1248	0.019 - 0.08	5 - 93
dicofol (kelthane)	0.022 - 0.096	6 - 110	PCB-1254	0.019 - 0.08	7.5 - 140
dieldrin	0.0019 - 0.008	0.5 - 9.3	PCB-1260	0.019 - 0.08	5 - 93
disulfoton	0.0046 - 0.02	1.2 - 23	permethrin	0.0093 - 0.04	2.5 - 47
diuron	0.21 - 0.68	8.8 - 130	phorate	0.0046 - 0.02	1.2 - 47
α-endosulfan (alpha)	0.0019 - 0.008	0.5 - 9.3	prometryn	0.019 - 0.08	5 - 93
β-endosulfan (beta)	0.0019 - 0.008	0.5 - 9.3	prometon	0.019 - 0.08	N/A
endosulfan sulfate	0.0037 - 0.016	1 - 19	simazine	0.0093 - 0.04	2.5 - 47
endrin	0.0037 - 0.016	1.6 - 30	toxaphene	0.093 - 0.4	30 - 560
			trifluralin	0.0074 - 0.032	2 - 37

N/A – not analyzed

Table 2. Summary of pesticide residues (µg/L) detected above the method detection limit in surface water samples collected by SFWMD in July 2012.

Date	Site	Flow	ametryn	atrazine	bromacil	simazine	Number of compounds detected at site
7/23/2012	S18C	Y	-	-	-	-	0
	S178	Y	-	-	-	-	0
	S177	Y	-	-	-	-	0
	S331	Y	-	-	-	-	0
	S332DX	Y	-	-	-	-	0
7/24/2012	FECSR78	Y	-	-	-	-	0
	S12A	R	-	-	-	-	0
	S191	N	-	0.059	-	-	1
	S2	N	0.048	0.18	-	-	2
	S3	Y	0.052	0.14	-	-	2
	S31	Y	-	0.049	-	-	1
	S333	N	-	0.028 I	-	-	1
	S356-334	N	-	-	-	-	0
	S4	N	0.025 I	0.064	-	-	2
	S65E	N	-	-	0.12 I *	-	1
	TAMBR105	Y	-	-	-	-	0
	US41-25	Y	-	-	-	-	0
7/25/2012	G123	N	-	-	-	-	0
	L3BRS	N	-	0.024 I	-	-	1
	S140	N	-	-	-	-	0
	S190	N	-	0.026 I	-	-	1
	S8	N	-	0.050	-	-	1
7/26/2012	S6	Y	0.083	0.11	-	-	2
	S5A	N	0.044	0.072	-	0.13	3
	S7	Y	0.032 I	0.076	-	-	2
	S9	Y	-	0.097	-	-	1
Total number of compound detections			6	13	1	1	21

N – no, Y – yes, R – reverse; - denotes that the result is below the method detection limit; * value is the average of replicate samples; I – value reported is less than the practical quantitation limit, and greater than or equal to the method detection limit

Table 3. Summary of pesticides residues (µg/Kg) detected above the method detection limit in sediment samples collected by SFWMD in July 2012.

Date	Site	Flow	DDD-P,P'	DDE-P,P'	PCB-1254	Number of compounds detected at site
7/23/2012	S177	Y	-	6.2 I	-	1
	S178	Y	-	6.2 I	-	1
7/25/2012	G123	N	-	3.0 I	-	1
7/26/2012	S5A	N	22	***140***	-	2
	S6	Y	5.7 I	28	92	3
Total number of compound detections			2	5	1	8

N – no, Y – yes, R – reverse; - denotes that the result is below the method detection limit
I – value reported is less than the practical quantitation limit, and greater than or equal to the method detection limit
Values in bold, italicized font are at a concentration that harmful effects to sediment-dwelling organisms are likely to be frequently or always observed.

Table 4. Selected properties of pesticides detected during the July 2012 sampling event.

Common Name	Surface Water Standards F.A.C. 62-302 (µg/L)	Acute Oral LD_{50} For Rats (mg/kg) (1)	Bioconcentration Factor (2)	Volatility from Water (2)	Soil Conservation Service (SCS) rating (3)			K_{oc} (mL/g) (3, 4)	Soil Half-life (days) (3, 4)	Water Solubility (WS) (mg/L) (3, 4)	U.S. EPA Carcinogenic Potential (5)
					LE	SA	SS				
ametryn	-	1,110	33	I	M	M	M	300	60	185	D
atrazine	-	3,080	86	I	L	M	L	100	60	33	C
bromacil	-	5,200	15	I	L	M	M	32	60	700	C
DDD-p,p'	-	3,400	3,173	I	-	-	-	239,900	-	0.055	-
DDE-p,p'	-	880	2,887	S	-	-	-	243,220	-	0.065	-
PCB's	0.014	-	-	-	-	-	-	-	-	-	B2
simazine	-	>5000	221	I	L	M	M	130	60	0.3	C

- No data available
FDEP F.A.C. 62-302 surface water standards (7/2012) for Class III waters except Class I noted in ( )
Bioconcentration Factor (BCF) calculated as $BCF = 10^{\wedge(2.71 - 0.564 \log WS)}$ (2)
Volatility from water: R = rapid, I = insignificant, S = significant
SCS ratings are pesticide loss due to leaching (LE), surface adsorption (SA) or surface solution (SS) and grouped as large (L), medium (M), small (S), or extra small (XS)
B2: probable human carcinogen; C: possible human carcinogen; D: not classified; E: evidence of non-carcinogen for humans (5)

(1) Hartley and Kidd (1987)
(2) Lyman, et al. (1990)
(3) Goss and Wauchope (1992)
(4) Montgomery (1993)
(5) U.S. EPA (1996)

Table 5. Toxicity of pesticides detected during the July 2012 sampling event to freshwater aquatic invertebrates and fishes (µg/L).

Common Name	48 hr EC_{50} Water flea *Daphnia magna*	Acute Toxicity (*)	Chronic Toxicity (*)	96 hr LC_{50} Fathead Minnow (#) *Pimephales promelas*	Acute Toxicity (*)	Chronic Toxicity (*)	96 hr LC_{50} Bluegill *Lepomis macrochirus*	Acute Toxicity (*)	Chronic Toxicity (*)	96 hr LC_{50} Largemouth Bass *Micropterus salmoides*	Acute Toxicity (*)	Chronic Toxicity (*)	96 hr LC_{50} Rainbow Trout (#) *Oncorhynchus mykiss*	Acute Toxicity (*)	Chronic Toxicity (*)	96 hr LC_{50} Channel Catfish *Ictalurus punctatus*	Acute Toxicity (*)	Chronic Toxicity (*)
ametryn	28,000 (4)	9,333	1,400	16,000 (5)	5,333	800	4,100 (2)	1,367	205	-	-	-	8,800 (2)	2,933	440	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	3,600 (5)	1,200	180	-	-	-
atrazine	6,900 (4)	2,300	345	15,000 (4)	5,000	750	16,000 (2)	5,333	800	-	-	-	8,800 (2)	2,933	440	7,600 (2)	2,533	380
	-	-	-	-	-	-	-	-	-	-	-	-	5,300 (6)	1,767	265	-	-	-
bromacil	-	-	-	-	-	-	127,000 (4)	42,333	6,350	-	-	-	36,000 (4)	12,000	1,800	-	-	-
	121,000 (7)	40,333	6,050	-	-	-	127,000 (7)	42,333	6,350	-	-	-	36,000 (7)	12,000	1,800	-	-	-
DDD-p,p'	3,200 (3)	1,067	160	4,400 (1)	1,467	220	42 (1)	14	2.1	42 (1)	14	2.1	70 (1)	23.3	4	1,500 (1)	500	75
DDE-p,p'	-	-	-	-	-	-	240 (1)	80	12	-	-	-	32 (1)	10.7	2	-	-	-
simazine	1,100 (4)	367	55	100,000 (4)	33,333	5,000	90,000 (2)	30,000	4,500	-	-	-	100,000 (4)	33,333	5,000	-	-	-

- No data available

(*) Florida Administrative Code (F.A.C.) 62-302.200, for compounds not specifically listed, acute and chronic toxicity standards are calculated as one-third and one-twentieth, respectively, of the amount lethal to 50% of the test organisms in 96 hours, where the 96 hour LC_{50} is the lowest value which has been determined for a species significant to the indigenous aquatic community.

(#) Species is not indigenous. Information is given for comparison purposes only.

(1) Johnson and Finley (1980)
(2) Hartley and Kidd (1987)
(3) Verschueren (1983)
(4) U.S. EPA (1991)
(5) U.S. EPA (2005)
(6) U.S. EPA (2006)
(7) U.S. EPA (1996)

Glossary

Bioconcentration Factor: The ratio of the concentration of a contaminant in an aquatic organism to the concentration in water, after a specified period of exposure via water only. The duration of exposure should be sufficient to achieve a near steady-state condition.

EC_{50}: A concentration necessary for 50 percent of the aquatic species tested to exhibit a toxic effect short of mortality (e.g., swimming on side or upside down, cessation of swimming) within a short (acute) exposure period, usually 24 to 96 hours.

Henry's law constant (H): Relates the concentration of a compound in the gas phase to its concentration in the liquid phase. The constant is calculated from the formula: $H = P_{vp}/S$ where P_{vp} is pressure in units of atmospheres and S is solubility in units of moles/meter^3 for a compound.

K_{oc}: The soil/sediment partition or sorption coefficient normalized to the fraction of organic carbon in the soil. This value provides an indication of the chemical's tendency to partition between soil organic carbon and water.

LC_{50}: A concentration which is lethal to 50 percent of the aquatic animals tested within a short (acute) exposure period, usually 24 to 96 hours.

LD_{50}: The dosage which is lethal to 50 percent of the terrestrial animals tested within a short (acute) exposure period, usually 24 to 96 hours.

Method Detection Limits (MDLs): The minimum concentration of an analyte that can be detected with 99 percent confidence of its presence in the sample matrix.

Practical Quantitation Limits (PQLs): The lowest level of quantitation that can be reliably achieved within specified limit of precision and accuracy during routine laboratory operating conditions. The PQLs are further verified by analyzing spike concentrations whose relative standard deviation in 20 fortified water samples is < 15 percent. In general, PQLs are 2 to 5 times larger than the MDLs.

Probable Effect Concentration (PEC): The probable effect concentration is intended to identify concentrations above which harmful effects to sediment-dwelling organisms are likely to be frequently or always observed.

Soil or water half-life: The time required for one-half the concentration of the compound to be lost from the water or soil under the conditions of the test.

Threshold Effect Concentration (TEC): The threshold effect concentration is intended to identify concentrations below which harmful effects to freshwater sediment-dwelling organisms are unlikely to be observed.

References

Callahan, M.A., M.W. Slimak, N.W. Gabel, I.P. May, C.F. Fowler, J.R. Freed, P. Jennings, R.L. Durfee, F.C. Witmore, B. Maestri, W.R. Mabey, B.R. Holt, and C. Gould. (1979). *Water-Related Environmental Fate of 129 Priority Pollutants, Volume I.* USEPA 440/4-79-029a.

Goss, D. and R. Wauchope. (Eds.) 1992. *The SCS/ARS/CES Pesticide Properties Database: II Using It With Soils Data In A Screening Procedure*. Soil Conservation Service. Fort Worth, TX.

Hartley, D. and H. Kidd. (Eds.) 1987. *The Agrochemicals Handbook.* Second Edition, The Royal Society of Chemistry. Nottingham, England.

Johnson, W.W. and M.T. Finley. 1980. *Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates*. U.S. Department of the Interior, Fish and Wildlife Service Resource Publication 137. Washington, DC.

Lyman, W.J., W.F. Reehl, and D.H. Rosenblatt. 1990. *Handbook of Chemical Property Estimation Methods*. American Chemical Society, Washington, DC.

MacDonald Environmental Sciences, Ltd. and United States Geological Survey. 2003. Development and Evaluation of Numerical Sediment Quality Assessment Guidelines for Florida Inland Waters. Report to Florida Department of Environmental Protection. Tallahassee, FL.

Montgomery, J.H. 1993. *Agrochemicals Desk Reference: Environmental Data*. Lewis Publishers. Chelsea, MI.

United States Environmental Protection Agency. 1984. Chemical Fact Sheet for Simazine. March, 1984.

_____ 1991. Pesticide Ecological Effects Database. Ecological Effects Branch, Office of Pesticide Programs, Washington, DC.

_____ 1996. *Drinking Water Regulations and Health Advisories*. Office of Water. EPA 822-B-96-002.

_____ 2003. Ambient Aquatic Life Water Criteria for Atra++zine. Revised Draft EPA-822-R-03-023. October 2003.

_____ 2005. Reregistration Eligibility Decision (RED) for Ametryn; EPA 738-R-05-006 September 2005.

_____ 2006. Decisions Document for Atrazine.

Verschueren, K. 1983. *Handbook of Environmental Data on Organic Chemicals*. Second Edition, Van Nostrand Reinhold Co. Inc. New York, NY.