PESTICIDE SURFACE WATER QUALITY REPORT

MARCH 2011 SAMPLING EVENT

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Pesticide Monitoring Project Report
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Summary
As part of the South Florida Water Management District's (SFWMD) quarterly ambient monitoring program, unfiltered water samples from 33 of the 34 network sites were collected February 28 to March 3, 2011, and analyzed for over 70 pesticides and/or products of their degradation.

The herbicides ametryn, atrazine, bromacil, hexazinone, metolachlor, metribuzin, norflurazon, and simazine, along with the insecticide/degradate atrazine desethyl, alpha endosulfan, and malathion were detected in one or more of these surface water samples. The malathion concentration of 0.11 µg/L detected at S99 exceeds the Florida Administrative Code 62-302 Class III surface water quality standard of 0.1 µg/L. 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 stations 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.

Seventy-one pesticides and degradation products were analyzed in samples from 33 of the 34 network 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).

Results

In the surface water samples collected from February 28 to March 3, 2011, at least one pesticide was detected in surface water at 22 of the 33 sites. Modifications to the non-ECP permit changed the requirement for sampling at S142 to only during discharge or flow events. For this sampling event, no sample was obtained due to no discharge at the time of sample collection. The concentrations of the pesticides detected at each of the sites are summarized for the surface water in Table 2. All of these compounds have previously been detected in this monitoring program. No harmful impacts are expected from the detected pesticides.

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 long-term or chronic toxicity impacts are also 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 > 10 micrograms per liter (μg/L) (Verschueren, 1983). Environmental fate and toxicity data in Tables 3 and 4 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 0.0095 to 0.12 μg/L (Table 2). Using these criteria, these observed surface water concentrations should not have an acute, detrimental impact on fish or aquatic invertebrates.

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 3 and 4 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 18 of the 33 sampling locations, ranged from 0.011 to 1.8 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 desethyl (DEA) and atrazine desisopropyl (DIA) are biotic degradation products of atrazine. These degradation products are both persistent and mobile in water; however, DEA is more stable and the dominant initial metabolite. Since DEA and DIA are structurally and toxicologically similar to atrazine, the concentrations of total atrazine residue (atrazine + DEA + DIA) may also be a significant consideration in the surface water environment. The DEA to atrazine ratio (DAR), on a molar basis, has been suggested as an indicator of nonpoint-source pollution of groundwater (Adams and Thurman, 1991) and as a tracer of groundwater discharge into rivers (Thurman et al., 1992). Goolsby et al. (1997) determined that low DAR values, median <0.1, occur in streams during runoff shortly after application of atrazine. Higher DAR values, median about 0.4, occur later in the year after considerable degradation of atrazine to DEA has occurred in the soil. The low median DAR ratio (0.1) at the locations where both atrazine and DEA were detected, suggests minimum degradation of atrazine (Table 5). However, these general guidelines were developed based on observations in Midwest watersheds in northern temperate climates with different soil and water management regimes as well as higher atrazine water concentrations. Applications to the South Florida environment should be made with caution.

Bromacil: Bromacil is a terrestrial herbicide registered for use on pineapple, citrus, and non-crop areas. Environmental fate and toxicity data in Tables 3 and 4 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 highest 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.

Endosulfan: Endosulfan is a non-systemic insecticide and acaricide registered for use on many crops, including beans, tomatoes, corn, cabbage, citrus, and ornamental plants. Technical endosulfan is a mixture of the two stereoisomeric forms, alpha (α) and beta (β). Endosulfan is highly toxic to mammals, with an acute oral LD_{50} for rats of 70 mg/Kg (Table 3). The Soil Conservation Service (SCS) rates endosulfan with an extra small potential for loss due to leaching, a large potential for loss due to surface adsorption and a moderate potential for loss in surface solution (Table 3). Beta endosulfan's water solubility and Henry's law constant (1.91 x 10^{-5} atm – m^3/mole) (Lyman, et al., 1990) indicate volatilization may be significant in shallow waters. The bioconcentration factors indicate a low to moderate degree of accumulation in aquatic organisms (Table 3). Alpha endosulfan was detected in the surface water at S177 in the South Miami-Dade County farming area (Table 2). However, the detected concentration did not exceed the F.A.C 62-302 criterion of 0.056 µg/L.

Hexazinone: Hexazinone is a non-selective contact herbicide that inhibits photosynthesis. Registered uses include sugarcane, pineapple, and non-crop areas. Environmental fate and toxicity data in Tables 3 and 4 indicate that hexazinone (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. Hexazinone is practically non-toxic to freshwater invertebrates with an EC_{50} of 145 mg/L for *Daphnia magna* (U.S. EPA, 1988). The highest surface water concentration detected in this sampling event at S191 (0.34 µg/L) (Table 2) should not have an acute impact on fish or aquatic invertebrates.

Malathion: Malathion is an insecticide/acaricide used on a variety of crops including fruits, vines, ornamentals, vegetables, and field crop. Environmental fate and toxicity data in Tables 3 and 4 indicate that malathion (1) has a small potential for loss from soil by leaching, surface adsorption or surface solution; (2) is relatively non-toxic to mammals but highly toxic to fish; and (3) does not bioaccumulate significantly. The concentrations of malathion found in the surface water from this sampling event were 0.11 and 0.059 µg/L at S99 and S178, respectively. The concentration detected at S99 exceeds the F.A.C. 62-302 standard of 0.1 µg/L. At this level, impacts could occur to the fish and wildlife.

Metolachlor: Metolachlor is a selective herbicide used on potatoes, sugarcane, and some vegetables. Environmental fate and toxicity data in Tables 3 and 4 indicate that metolachlor (1) has a large potential for loss due to leaching and a medium potential for loss in surface solution and due to surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Metolachlor is non-toxic to birds (Lyman et al., 1990). The highest surface water concentration found in this sampling event (0.089 µg/L at S65E; Table 2) is over two orders of magnitude below the calculated chronic toxicity level. Using these criteria, this observed level should not have a harmful effect on fish or aquatic invertebrates.

Metribuzin: Metribuzin is a selective systemic herbicide used on a variety of crops including potatoes, tomatoes, sugarcane, and peas. Environmental fate and toxicity data in Tables 3 and 4 indicate that metribuzin (1) has a large potential for loss due to leaching, a medium potential for loss in surface solution, and a small potential for loss due to surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioaccumulate significantly. The highest concentration of metribuzin detected was 0.13 µg/L (S6). Using these criteria, this surface water concentration should not have an acute impact on fish or aquatic invertebrates.

Norflurazon: Norflurazon is a selective herbicide registered for use on many crops including citrus. Environmental fate and toxicity data in Tables 3 and 4 indicate that norflurazon (1) is easily lost from soil surface solution and a moderate potential for loss due to leaching and surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. The LC_{50} for norflurazon is > 200 mg/L for catfish and goldfish (Hartley and Kidd, 1987). The norflurazon surface water concentrations ranged from 0.11 to 0.54 µg/L (Table 2). Even at the highest concentration, this is several orders of magnitude below the calculated chronic action level. Using these criteria, these observed concentrations should not have an acute, detrimental impact on fish or aquatic invertebrates.

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 3 and 4 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 highest surface water concentration of simazine detected at S79 (0.042 μg/L; Table 2) was below any level of concern for fish or aquatic invertebrates.

Quality Assurance Evaluation

Replicate samples were collected at sites S99 and S331. All the analytes detected in the surface water had precision ≤ 30 percent relative percent difference. No pesticide analytes were detected in the field blanks performed at S99, S177, CR33.5T, S31, S80, and S7. All collected samples were shipped and all bottles were received.

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 atmospheres and S is solubility in 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.

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.

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

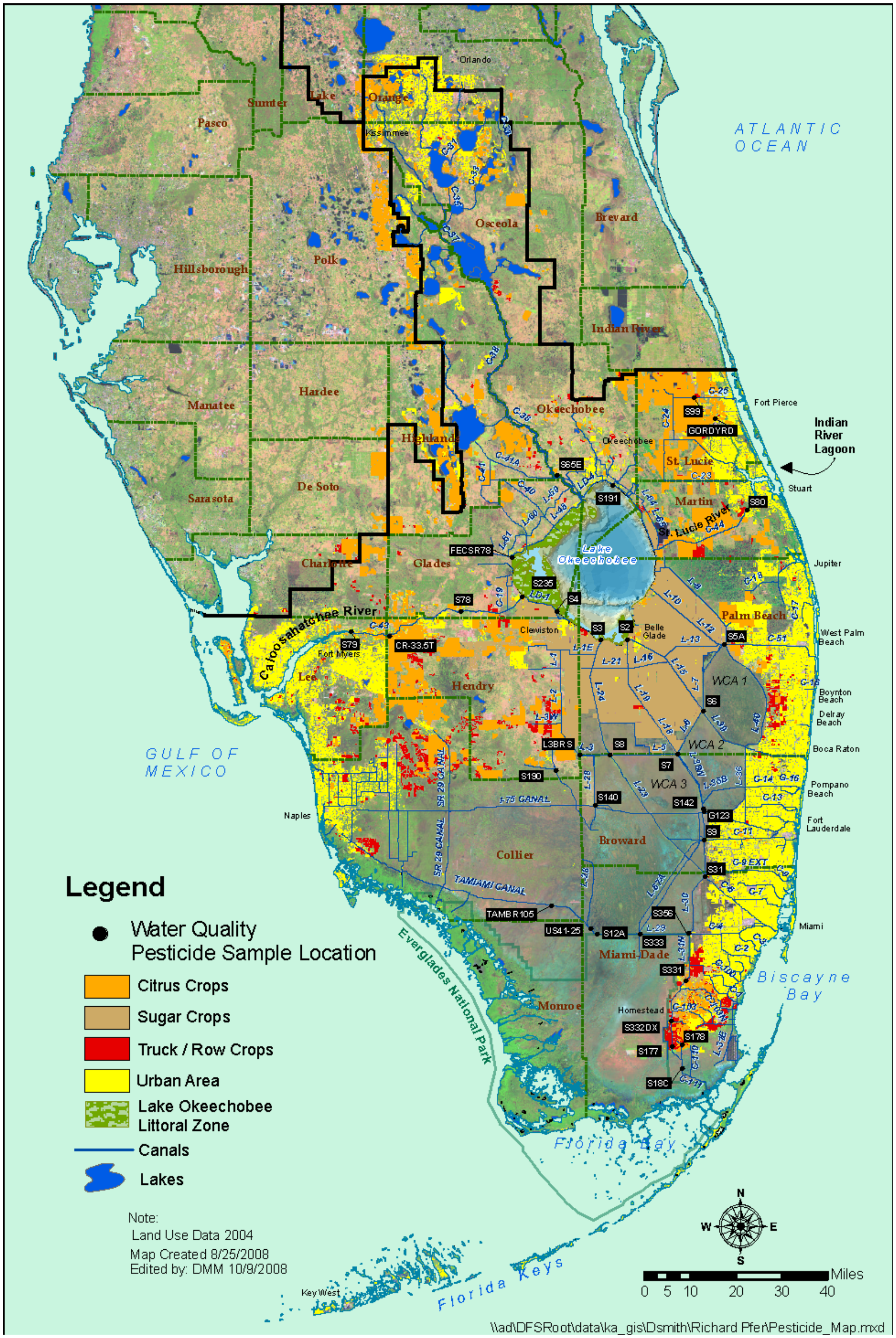

Table 1. Method detection limits (MDLs) and practical quantitation limits (PQLs) for March 2011 sampling event.

Pesticide or metabolite	Water: range of MDLs - PQLs (µg/L)	Pesticide or metabolite	Water: range of MDLs - PQLs (µg/L)
2,4-D	0.2 - 0.6	endrin aldehyde	0.0042 - 0.017
2,4,5-T	0.2 - 0.6	ethion	0.0094 - 0.041
2,4,5-TP (silvex)	0.2 - 0.6	ethoprop	0.0094 - 0.041
acifluorfen	0.2 - 0.6	fenamiphos (nemacur)	0.038 - 0.16
alachlor	0.057 - 0.24	fonofos (dyfonate)	0.0094 - 0.041
aldrin	0.0019 - 0.0082	heptachlor	0.0023 - 0.0098
ametryn	0.0094 - 0.041	heptachlor epoxide	0.0019 - 0.0082
atrazine	0.0094 - 0.19	hexazinone	0.019 - 0.082
atrazine desethyl	0.0094 - 0.041	imidacloprid	0.2 - 0.68
atrazine desisopropyl	0.0094 - 0.041	linuron	0.2 - 0.68
azinphos methyl (guthion)	0.028 - 0.12	malathion	0.028 - 0.12
α-BHC (alpha)	0.0021 - 0.024	metalaxyl	0.047 - 0.2
β-BHC (beta)	0.0032 - 0.014	methoxychlor	0.0094 - 0.041
δ-BHC (delta)	0.0019 - 0.0082	metolachlor	0.057 - 0.24
γ-BHC (gamma) (lindane)	0.0019 - 0.0082	metribuzin	0.019 - 0.082
bromacil	0.047 - 0.2	mevinphos	0.057 - 0.24
butylate	0.019 - 0.082	mirex	0.011 - 0.049
carbophenothion (trithion)	0.015 - 0.065	naled	0.075 - 0.33
chlordane	0.019 - 0.082	norflurazon	0.019 - 0.082
chlorothalonil	0.015 - 0.065	parathion ethyl	0.019 - 0.082
chlorpyrifos ethyl	0.0094 - 0.041	parathion methyl	0.019 - 0.082
chlorpyrifos methyl	0.019 - 0.082	PCB-1016	0.019 - 0.082
cypermethrin	0.019 - 0.082	PCB-1221	0.019 - 0.082
DDD-p,p'	0.0045 - 0.02	PCB-1232	0.019 - 0.082
DDE-p,p'	0.0038 - 0.016	PCB-1242	0.019 - 0.082
DDT-p,p'	0.0057 - 0.024	PCB-1248	0.019 - 0.082
demeton	0.028 - 0.12	PCB-1254	0.019 - 0.082
diazinon	0.019 - 0.082	PCB-1260	0.019 - 0.082
dicofol (kelthane)	0.042 - 0.18	permethrin	0.015 - 0.065
dieldrin	0.0019 - 0.0082	phorate	0.0094 - 0.041
disulfoton	0.019 - 0.082	prometryn	0.019 - 0.082
diuron	0.2 - 0.68	prometon	0.019 - 0.082
α-endosulfan (alpha)	0.0038 - 0.016	simazine	0.0094 - 0.041
β-endosulfan (beta)	0.0038 - 0.016	toxaphene	0.094 - 0.41
endosulfan sulfate	0.0045 - 0.023	trifluralin	0.0075 - 0.033
endrin	0.0094 - 0.041		

Table 2. Summary of pesticide residues (µg/L) detected above the method detection limit in surface water samples collected by SFWMD in March 2011.

Date	Location	Flow	ametryn	atrazine	atrazine desethyl	bromacil	alpha endosulfan	hexazinone	malathion	metolachlor	metribuzin	norflurazon	simazine	Number of compounds detected at
2/28/2011	S99	N	-	-	-	-	-	-	***0.11 I****	-	-	0.54 *	-	2
	GORDYRD	Y	-	-	-	-	-	-	-	-	-	0.17	-	1
	S177	N	-	-	-	-	0.024	-	-	-	-	-	-	1
	S178	N	-	0.011 I	-	-	-	-	0.059 I	-	-	-	-	2
	S18C	N	-	-	-	-	-	-	-	-	-	-	-	0
	S2	N	0.0095 I	0.20	0.026 I	-	-	-	-	-	-	-	-	3
	S3	N	-	0.22	0.028 I	-	-	-	-	-	-	-	-	2
	S331	N	-	-	-	-	-	-	-	-	-	-	-	0
	S332DX	N	-	-	-	-	-	-	-	-	-	-	-	0
	S4	N	-	0.26	0.031 I	-	-	-	-	-	-	-	-	2
	S80	N	-	-	0.021 I	-	-	-	-	-	-	0.17	-	2
3/1/2011	CR33.5T	Y	-	0.26	0.020 I	0.054 I	-	-	-	-	-	0.11	0.014 I	5
	FECSR78	N	-	0.029 I	-	-	-	0.033 I	-	-	-	-	-	2
	S12A	N	-	0.013 I	-	-	-	-	-	-	-	-	-	1
	S191	N	-	0.015 I	-	-	-	0.34	-	-	-	-	-	2
	S235	N	0.017 I	0.43	0.023 I	-	-	-	-	-	-	-	-	3
	S31	N	-	-	-	-	-	-	-	-	-	-	-	0
	S333	Y	-	-	-	-	-	-	-	-	-	-	-	0
	S356-334	Y	-	-	-	-	-	-	-	-	-	-	-	0
	S65E	Y	-	0.033 I	-	0.12 I	-	-	-	0.089 I	0.026 I	-	-	4
	S78	N	0.013 I	0.24	0.021 I	-	-	-	-	-	-	-	-	3
	S79	N	-	0.12	0.015 I	0.083 I	-	-	-	-	-	0.12	0.042	5
	TAMBR105	Y	-	-	-	-	-	-	-	-	-	-	-	0
	US41-25	N	-	-	-	-	-	-	-	-	-	-	-	0
3/2/2011	G123	N	-	-	-	-	-	-	-	-	-	-	-	0
	L3BRS	Y	-	0.054	-	-	-	-	-	-	-	-	-	1
	S140	N	-	-	-	-	-	-	-	-	-	-	-	0
	S190	N	-	0.023 I	-	-	-	-	-	-	-	-	-	1
	S80	N	-	0.081	-	-	-	-	-	-	-	-	-	1
	S9	Y	-	-	-	-	-	-	-	-	-	-	-	0
3/3/2011	S5A	N	0.10	1.8	0.052	-	-	-	-	0.066 I	0.021 I	-	-	5
	S6	N	0.12	1.3	0.021 I	-	-	-	-	-	0.13	-	-	4
	S7	N	0.033 I	0.14	-	-	-	-	-	-	-	-	-	2
Total number of compound detections			6	18	10	3	1	2	2	2	3	5	2	54

N - no Y - yes R - reverse; - denotes that the result is below the method detection limit; * results are 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
Values in bold, italicized font are at a concentration that potential harmful effects to organisms may be observed.

Table 3. Selected properties of pesticides detected during the March 2011 sampling event.

Common Name	Surface Water Standards F.A.C. 62-302 (µg/L)	Acute Oral LD_{50} For Rats (mg/kg) (1)	U.S. EPA Carcinogenic Potential	Water Solubility (WS) (mg/L) (2, 3)	K_{oc} (mL/g) (2, 3)	Soil Half-life (days) (2, 3)	Soil Conservation Service (SCS) rating (2)			Volatility from Water	Bioconcentration Factor (BCF)
							LE	SA	SS		
ametryn	-	1,110	D	185	300	60	M	M	M	I	33
atrazine	-	3,080	C	33	100	60	L	M	L	I	86
bromacil	-	5,200	C	700	32	60	L	M	M	I	15
alpha endosulfan	0.056	70	-	0.53	12,400	50	XS	L	M	S	884
hexazinone	-	1,690	D	33,000	54	90	L	M	M	I	2
malathion	0.1	2,800	D	145	1,800	1	S	S	S	I	37
metolachlor	-	2,780	C	530	200	90	L	M	M	I	18
metribuzin	-	2,200	D	1,220	41	30	L	S	M	I	11
norflurazon	-	9,400	C	28	700	90	M	M	L	I	94
simazine	-	>5,000	C	6.2	130	60	L	M	M	I	221

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)
Volatility from water: R = rapid, I = insignificant, S = significant
Bioconcentration Factor (BCF) calculated as $BCF = 10^{\wedge(2.791 - 0.564 \log WS)}$ (4)
B2: probable human carcinogen; C: possible human carcinogen; D: not classified; E: evidence of non-carcinogen for humans (5)
FDEP F.A.C. 62-302 surface water quality standards (4/2008) for Class III waters except Class I in ( ) Note: endosulfan usually considered the sum of alpha and beta isomers

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

Table 4. Toxicity of pesticides detected during the March 2011 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 (8)	9,333	1,400	16,000 (9)	5,333	800	4,100 (6)	1,367	205	-	-	-	8,800 (6)	2,933	440	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	3,600 (9)	1,200	180	-	-	-
atrazine	6,900 (8)	2,300	345	15,000 (8)	5,000	750	16,000 (6)	5,333	800	-	-	-	8,800 (6)	2,933	440	7,600 (6)	2,533	380
	-	-	-	-	-	-	-	-	-	-	-	-	5,300 (10)	1,767	265	-	-	-
bromacil	-	-	-	-	-	-	127,000 (8)	42,333	6,350	-	-	-	36,000 (8)	12,000	1,800	-	-	-
	121,000 (16)	40,333	6,050	-	-	-	127,000 (16)	42,333	6,350	-	-	-	36,000 (16)	12,000	1,800	-	-	-
endosulfan	166 (8)	55	8	1 (1)	0.3	0.05	1 (1)	0.3	0.05	-	-	-	1 (1)	0.3	0.05	1 (1)	0.3	0.05
	-	-	-	-	-	-	2 (4)	0.67	0.10	-	-	-	3 (2)	1	0.15	1.5 (8)	0.5	0.08
	-	-	-	-	-	-	-	-	-	-	-	-	1 (4)	0.3	0.05	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	0.3 (7)	0.10	0.02	-	-	-
	166 (11)	55	8	1.5 (11)	0.5	0.08	1.7 (11)	0.57	0.09	-	-	-	0.8 (11)	0.27	0.04	-	-	-
hexazinone	151,600 (8)	50,533	7,580	274,000 (6)	91,333	13,700	100,000 (8)	33,333	5,000	-	-	-	180,000 (8)	60,000	9,000	-	-	-
	151,600 (12)	50,533	7,580	274,000 (12)	91,333	13,700	505,000 (12)	168,333	25,250	-	-	-	>320,000 (12)	>106,667	>16,000	-	-	-
malathion	1 (1)	0.3	0.05	8,650 (1)	2,883	433	103 (1)	34	5.2	285 (1)	95	14	200 (1)	67	10	8,970 (1)	2,990	449
	1.8 (5)	0.6	0.09	9,000 (2)	3,000	450	110 (2)	37	5.5	-	-	-	170 (2)	57	9	7,620 (8)	2,540	381
	-	-	-	-	-	-	12 (3)	4	0.6	-	-	-	100 (3)	33	5	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	29 (4)	10	1	-	-	-
	1.0 (13)	0.33	0.05	-	-	-	30 (13)	10	1.5	-	-	-	4 (13)	1.3	0.2	-	-	-
metolachlor	23,500 (8)	7,833	1,175	-	-	-	15,000 (6)	5,000	750	-	-	-	2,000 (6)	667	100	4,900 (7)	1,633	245
metribuzin	4,200 (8)	1,400	210	-	-	-	80,000 (6)	26,667	4,000	-	-	-	64,000 (6)	21,333	3,200	100,000 (8)	33,333	5,000
	4,200 (14)	1,400	210	-	-	-	75,900 (14)	25,300	3,795	-	-	-	76,770 (14)	25,590	3,839	-	-	-
norflurazon	15,000 (8)	5,000	750	-	-	-	16,300 (8)	5,433	815	-	-	-	8,100 (8)	2,700	405	>200,000 (6)	>67,000	>10,000
	>15,000 (15)	>5,000	>750	-	-	-	16,300 (15)	5,433	815	-	-	-	8,100 (15)	2,700	405	-	-	-
simazine	1,100 (8)	367	55	100,000 (8)	33,333	5,000	90,000 (6)	30,000	4,500	-	-	-	100,000 (8)	33,333	5,000	-	-	-

(*) 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) U.S. EPA (1977)
(3) Davis (1970)
(4) Schneider (1979)
(5) U.S. EPA (1972)
(6) Hartley and Kidd (1987)
(7) Montgomery (1993)
(8) U.S. EPA (1991)
(9) U.S. EPA (2005)
(10) U.S. EPA (2006a)
(11) U.S. EPA (2002)
(12) U.S. EPA (1994)
(13) U.S. EPA (2006b)
(14) U.S. EPA (1998)
(15) U.S. EPA (1996b)
(16) U.S. EPA (1996c)

Table 5. Atrazine Desethyl/Atrazine ratio (DAR) data for March 2011 sampling event.

Date	Location	Flow*	atrazine		atrazine desethyl		DAR
			µg/l	moles/l	µg/l	moles/l	
2/28/2011	S2	N	0.2	9.27278E-10	0.026	1.38569E-10	0.1
	S3	N	0.22	1.02001E-09	0.028	1.49229E-10	0.1
	S4	N	0.26	1.20546E-09	0.031	1.65217E-10	0.1
3/1/2011	CR33.5T	Y	0.26	1.20546E-09	0.02	1.06592E-10	0.1
	S235	N	0.43	1.99365E-09	0.023	1.22581E-10	0.1
	S78	N	0.24	1.11273E-09	0.021	1.11922E-10	0.1
	S79	N	0.12	5.56367E-10	0.015	7.99439E-11	0.1
3/3/2011	S5A	N	1.8	8.34550E-09	0.052	2.77139E-10	0.03
	S6	N	1.3	6.02731E-09	0.021	1.11922E-10	0.02

DAR	All sites	Flow only sites	No flow sites
average	0.1	0.1	0.1
median	0.1	0.1	0.1
minimum	0.0	0.1	0.02
maximum	0.2	0.1	0.1

* N - no; Y - yes; R - reverse