Idaho State Department of Agriculture

Evaluation of Solomon Drain, Noble Drain, and Purdum Gulch for Transport of Pesticide Residues into Mason Creek

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Introductions

In 2013, the Idaho State Department of Agriculture (ISDA) conducted a pesticide residue monitoring program on three drainages (Solomon Drain, Noble Drain, and Purdum Gulch) that transport canal spill water, stormwater, ground water and agricultural waste water into Mason Creek (Figure 1). Mason Creek has been listed in the Idaho Department of Environmental Quality's 2012 integrated report as a Category 5 (§303d) listed waterway for the pesticides chlorpyrifos and malathion. The Category 5 listing is for waters not meeting applicable water quality standards for one or more beneficial uses by one or more pollutants. Category 5 waters make up the §303(d) list of impaired waters and requires an EPA approved Total Maximum Daily Load (TMDL).

For this study, ISDA attempted to spatially evaluate the three drains by dividing each drain into two reaches and evaluating each reach, to try and determine the greatest area of impact, for pesticide residues entering each drain. Solomon Drain (SD-1 and SD-2), Noble Drain (ND-1 and ND-2), and Purdum Gulch (PG-1 and PG-2) had two stations established on each drain. The "1" station was established near the mouth of each drain and the "2" station was established approximately half-way upstream from the mouth (Figure 1). Samples were collected on a bi-weekly schedule starting on April 11, 2013 through September 25, 2013. All samples were shipped to and analyzed by the University of Idaho Analytical Science Laboratory (ASL), located in Moscow, Idaho.

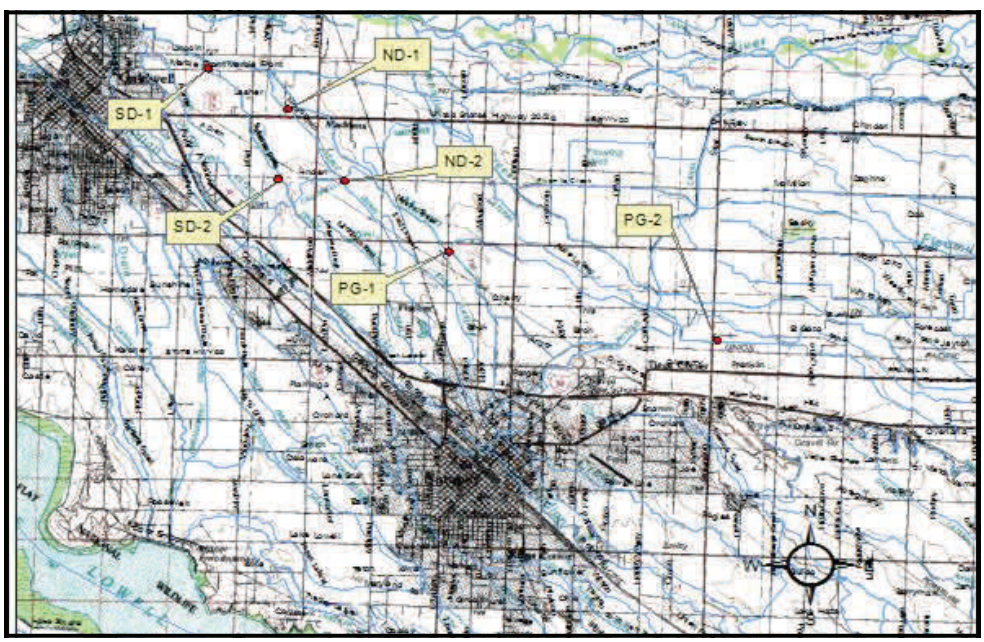

Figure 1. Monitoring sites Lower Boise River, Conway Gulch, Dixie Slough, and Mason Creek.

Results

There were a total of 24 pesticide compounds identified (for all sample locations) during this study. They consisted of 16 herbicides, five insecticides, two fungicides, and one degradate of atrazine (desethyl atrazine). For all of the monitoring sites, there were a total of 489 pesticide detections which consisted of 390 herbicides, 27 insecticides, 70 degradate of atrazine (desethyl atrazine), and two fungicides. The pesticides with the highest number of detections were the herbicide atrazine degradate (desethyl atrazine) with 70, followed by the herbicides 2,4-D (59), terbacil (55), bromacil (44), and diuron (42). The organophosphate insecticides detected were chlorpyrifos at 17 detections, ethoprop had five detections, and malathion had two (Table 1).

Table 1. Pesticide name, type, trade names, and number of detections.

Pesticide	Type	*Trade Name	# Detects	Pesticide	Type	*Trade Name	# Detects
2,4-D	H	Curtail	59	hexazinone	H	Velpar	35
atrazine	H	Aatrex	14	lamda-Cyhalothrin	I	Demand	1
azoxystrobin	F	Heritage	1	malathion	I	Cythion	2
bentazon	H	Basagran	4	MCPA	H	Banlene	16
bromacil	H	Krovar	43	metalaxyl	F	Apron	1
bromoxynil	H	Buctril	21	metolachlor	H	Dual	37
chlorpyrifos	I	Lorsban	17	metribuzin	H	Sencore	5
desethyl atrazine	D	—	70	oxyfluorfen	H	Goal	4
dicamba	H	Banvel	9	pendimethalin	H	Prowl	41
diuron	H	Karmex	42	propargite	I	Omite	2
EPTC	H	Eptam	2	simazine	H	Simadex	3
ethoprop	I	Mocap	5	terbacil	H	Sinbar	55

H = herbicides, I = insecticides, D = degradate of atrazine, F = fungicide * Other Trade Names may apply

Solomon Drain showed a slight decrease in both herbicides and insecticides at the site located near the mouth (SD-1). There were two additional insecticide detections at the upstream site (SD-2) and five additional herbicide detections (Figure 2). There was no significant difference in these two sites.

Nobel Drain showed an increase of herbicides near the mouth (ND-1), but there was no difference in the number of insecticide detections (Figure 2). For these two sites (ND-1 and ND-2) there was no significant difference in detections.

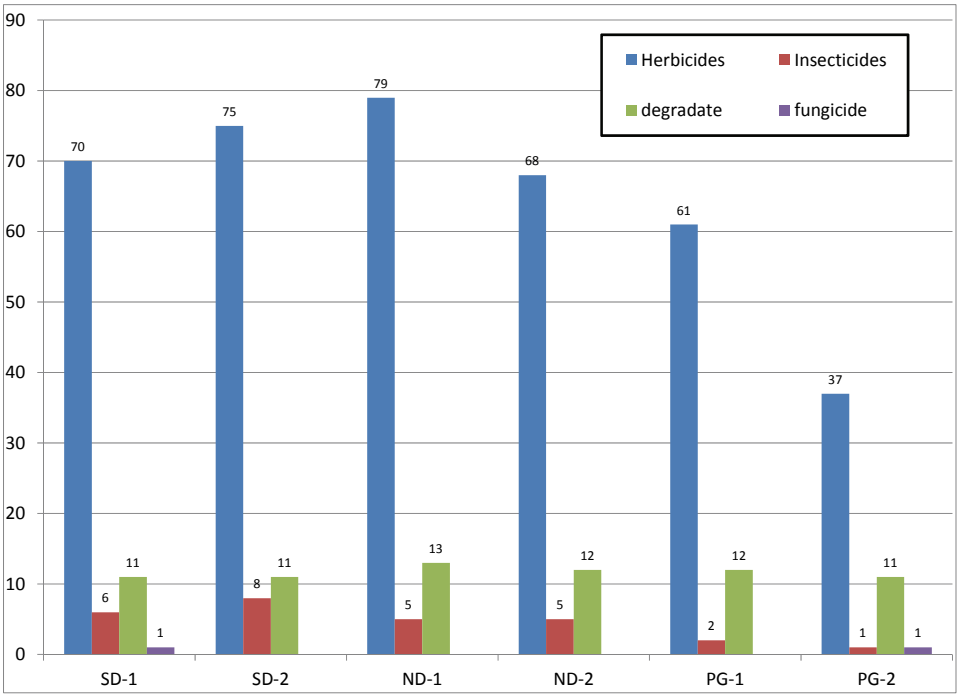

Figure 2. Sample locations and number and type of pesticides detected.

Purdum Gulch showed the greatest difference in herbicide detections with almost a two-fold increase at the downstream site (PG-1) but only a slight difference in insecticides and the degradate of atrazine (Figure 2). Visually, Purdum Gulch appears to show a major difference from the upstream site to the downstream site, but statistically, there was no significant difference.

Figures 3, 4, and 5 show each station, both upstream and downstream, and compares the total number of pesticide detections. Data for the upstream and downstream sites for both Solomon Drain (R^2 = 0.853) and Noble Drain (R^2 = 0.795) showed a strong correlation (degree of relationship).

Purdum Gulch showed a moderate correlation (R^2 = 0.640) and the largest increase of herbicide detections from the upstream to the downstream site (Figure 2 and Figure 5). It appears that the majority of herbicide detections occur downstream of where Phyllis Canal crosses Purdum Gulch. The other two sites, Noble and Solomon Drains, did not show any clear delineation of where increases in pesticide detections occur.

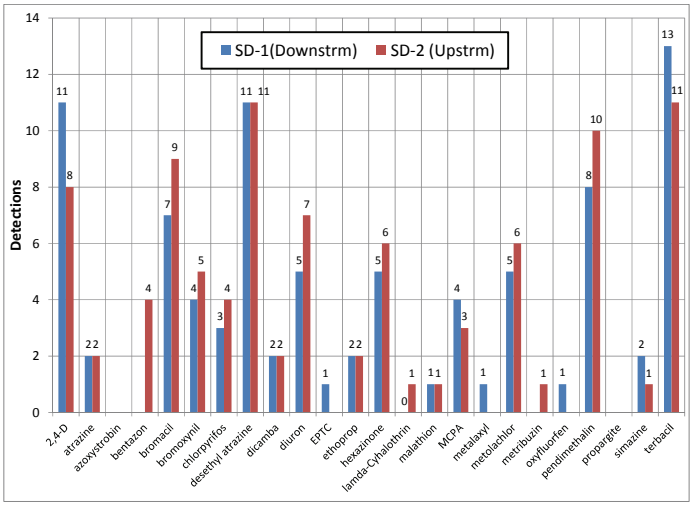

Figure 3. Solomon Drain pesticide detections.

Pesticides of Concern

ISDA defines a pesticide of concern (POC) as any pesticide that is detected at a concentration that is greater than or equal to fifty percent (≥50%) of an established Environmental Protection Agency (EPA) Aquatic Life Benchmark. These benchmarks are developed for acute and chronic effects on fish, aquatic invertebrates, and acute effects on vascular and nonvascular plants. Acute toxicity of a pesticide refers to the effects from a single dose or repeated exposure over a short period of time (i.e. a few hours or a day). Chronic toxicity is the ability of a substance to cause adverse health effects resulting from long-term or repeated low levels of exposure.

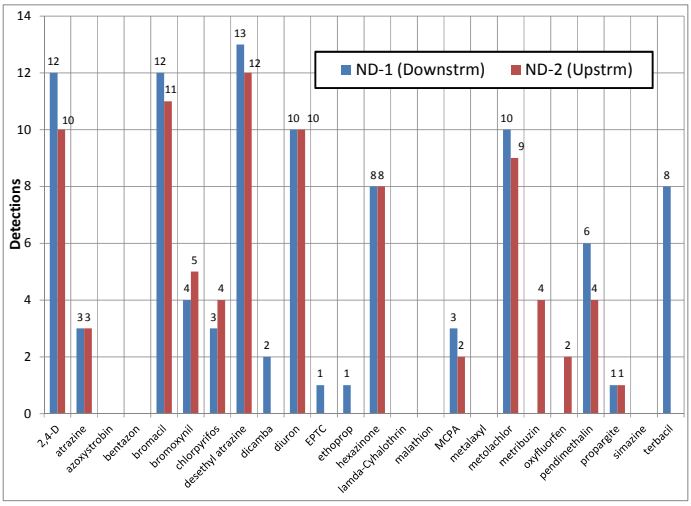

Figure 4. Noble Drain pesticide detections.

As mentioned previously, Mason Creek is listed on the State's 303(d) list for the insecticides chlorpyrifos and malathion. Solomon drain (SD-1 and SD-2) contributed organophosphate insecticides chlorpyrifos, malathion, and the pyrethroid lamda-Cyhalothrin. Noble Drain (ND-1 and ND-2) also contributed chlorpyrifos, along with the carbamate insecticide methomyl and the acaricide propargite (mite control). Purdum Gulch (PG-1 and PG-2) had a few detections of chlorpyrifos but at a much lesser degree than the other two drains. There was an herbicide detection of 2,4-D at PG-2 that exceeded the vascular acute benchmark (Table 2).

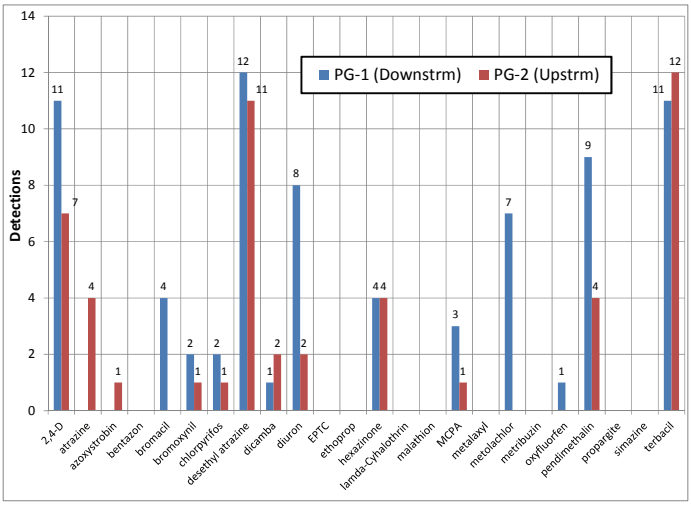

Figure 5. Purdum Gulch pesticide detections.

Chlorpyrifos attaches very strongly to soil and migrates off-site during irrigation or storm events that cause excessive erosion. Chlorpyrifos is a restricted use pesticide (RUP) and is very toxic to aquatic species. Methomyl is also an RUP, but has a low affinity for soil binding and is primarily transported in the water column. Methomyl is moderately toxic to aquatic species. Malathion is a general use pesticide (GUP), is highly soluble in water and can move quickly through the soil. Malathion can be moderately toxic to fish, but can be highly toxic to aquatic invertebrates. Both lamda-Cyhalothrin and propargite bind tightly to soil and move off-target during erosional events. The pyrethroid lamda-Cyhalothrin is highly toxic to both fish and aquatic invertebrates. Propargite can be toxic to fish and invertebrates, but at much higher concentrations than the other insecticides detected during this study (Table 2).

Table 2. Pesticides of Concern, numbers in red, under the concentration column, are considered a POC by ISDA. Other red values are the EPA Aquatic Benchmarks that are of concern.

Site	Date	POC	Concentration ug/L	Fish Acute ug/L	Fish Chronic ug/L	Inverts Acute ug/L	Inverts Chronic ug/L	Nonvascular Acute ug/L	Vascular Acute ug/L
SD-1	7/31/2013	chlorpyrifos	0.040	0.9	0.57	0.05	0.04	140	—
	8/14/2013	chlorpyrifos	0.041	0.9	0.57	0.05	0.04	140	—
	8/28/2013	chlorpyrifos	0.059	0.9	0.57	0.05	0.04	140	—
	6/19/2013	malathion	0.16	16.4	8.6	0.3	0.035	2,400	—
SD-2	4/24/2013	chlorpyrifos	0.035	0.9	0.57	0.05	0.04	140	—
	7/17/2013	chlorpyrifos	0.027	0.9	0.57	0.05	0.04	140	—
	8/14/2013	chlorpyrifos	0.034	0.9	0.57	0.05	0.04	140	—
	8/28/2013	chlorpyrifos	0.027	0.9	0.57	0.05	0.04	140	—
	6/19/2013	lamda-Cyhalothrin	0.059	0.105	0.031	0.0035	0.002	>310	—
	6/19/2013	malathion	0.26	16.4	8.6	0.3	0.035	2,400	—
ND-1	4/24/2013	chlorpyrifos	0.066	0.9	0.57	0.05	0.04	140	—
	8/14/2013	chlorpyrifos	0.036	0.9	0.57	0.05	0.04	140	—
	8/28/2013	chlorpyrifos	0.055	0.9	0.57	0.05	0.04	140	—
	7/31/2013	methomyl	0.42	160	12	2.5	0.7	—	—
	5/22/2013	propargite	15	59	16	37	9	66.2	75,000
ND-2	4/24/2013	chlorpyrifos	0.028	0.9	0.57	0.05	0.04	140	—
	6/19/2013	chlorpyrifos	0.044	0.9	0.57	0.05	0.04	140	—
	7/17/2013	chlorpyrifos	0.030	0.9	0.57	0.05	0.04	140	—
	8/14/2013	chlorpyrifos	0.038	0.9	0.57	0.05	0.04	140	—
	5/22/2013	propargite	16	59	16	37	9	66.2	75,000
PG-1	7/31/2013	chlorpyrifos	0.097	0.9	0.57	0.05	0.04	140	—
	8/14/2013	chlorpyrifos	0.075	0.9	0.57	0.05	0.04	140	—
PG-2	4/11/2013	chlorpyrifos	0.026	0.9	0.57	0.05	0.04	140	—
	6/19/2013	2,4-D	15	12,075	14,200	12,500	16,050	3,880	13.1

Conclusions

There were a total of 24 pesticide compounds identified during this study. They consisted of 16 herbicides, five insecticides, two fungicides and one degradate of atrazine (desethyl atrazine). Overall there were 489 pesticide detections with 390 herbicide detections, 27 insecticide detections, 70 detections of the degradate of atrazine (desethyl atrazine), and two fungicide detections.

This program was designed to try and spatially determine areas, within each subwatershed, where there may be an increase of pesticide residues entering each drainage. For the two smaller subwatersheds (Solomon and Noble) there was no apparent delineation between upstream and downstream sampling stations. Both drainages contribute POC insecticides, on a regular basis, into Mason Creek. Data derived from Purdum Gulch indicates that perhaps acreage that is downstream of Phyllis Canal may result in the increase of herbicide detections.

The overall data indicates that these three drainages continue to discharge pesticides of concern into Mason Creek. ISDA's pesticide inspectors should focus on these three subwatersheds that drain to Mason Creek. The two smaller subwatersheds (Solomon 2,573 acres and Noble 2,285 acres) should be the main focus of these ISDA pesticide use inspections and additional focus should be on the overall management of chlorpyrifos (Lorsban).

Recommendations

The following items are several precautions that can be taken when applying pesticides:

⇒ Read and follow Label Directions-Always follow label directions for water quality protection.

⇒ Conduct maintenance and calibration of application equipment, match application rates to pest problem.

⇒ Implementation of management strategies-Field scouting, evaluation of pest control needs, selection of proper pesticide, irrigation management, etc.

⇒ Implement BMPs, including conservation buffers, vegetative filter strips, sediment basins, and pump back systems.

⇒ Avoid runoff due to weather events, excessive irrigation and check the forecast prior to pesticide applications.