Surface Water Pesticide Monitoring and Assessment Project 2010

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ND Department of Health
ND Department of Parks and Recreation
ND Game and Fish Department
ND Geological Survey
ND State University Extension Service
ND State Water Commission
US Department of Agriculture-NRCS
US Fish and Wildlife Service
US Geological Survey

SUMMARY

The North Dakota Department of Agriculture, working in cooperation with the North Dakota Department of Health's Division of Water Quality, coordinated a surface water monitoring survey in 2010 to assess levels of pesticides and pesticide degradates in North Dakota rivers. Thirty-three sites, representing all major river basins in North Dakota, were sampled and tested for 180 different pesticides and pesticide degradates every six weeks from April through October. There were a total of 43 detections of nine different pesticides. The most commonly detected pesticide was bentazon, with 22 detections. The next most commonly detected pesticides were 2,4-D and metolachlor with four detections each, followed by atrazine and clopyralid with three detections each. For all pesticides detections, concentrations were below levels deemed harmful by the U.S. Environmental Protection Agency (EPA). Results show that North Dakota's streams and rivers have minimal pesticide contamination. The study also supports the need for regular, comprehensive monitoring of surface water for pesticides to verify results, assess risks of pesticides to human health and the environment, and identify trends.

INTRODUCTION

The North Dakota Department of Agriculture (hereafter "Department") is the lead pesticide regulatory agency in the state through the authority provided in Chapters 4-35, 4-35.1, and 19-18 of the North Dakota Century Code. Under a cooperative agreement with the EPA, the Department is charged with regulating pesticides in the public's interest to ensure that they do not pose a risk of unreasonable adverse effects to human health or the environment.

Before 2007, the Department's Pesticide Water Quality Program (hereafter "Program") was concerned only with those pesticides that posed a risk of contaminating groundwater. The Department has had a committee in place for over a decade to advise them on groundwater issues and establish a groundwater monitoring program. Agencies represented on the committee include the ND Department of Health (NDDoH), US Department of Agriculture – Natural Resource Conservation Service, ND State University Extension Service, US Geological Survey (USGS), ND Geological Survey and the ND State Water Commission.

In the past three years, the EPA has shifted its water quality focus from groundwater to surface water. Therefore, the Program's focus has expanded to protect both groundwater and surface water from pesticide contamination. To reflect this expansion, the Groundwater Working Committee has been renamed the Water Quality Advisory Committee (WQAC) and now includes representatives from the US Fish and Wildlife Service, ND Game and Fish Department, and ND Parks and Recreation Department.

Identifying pesticide and surface water issues is a priority for the Department and the WQAC. Before the first monitoring project in 2008, no agency routinely monitored for pesticides in North Dakota's surface waters. A pilot monitoring project coordinated between the Department and the NDDoH was conducted in 2006. Eleven sites were sampled twice from late June through August and tested for 63 different pesticides. Results showed one detection of picloram at a concentration of 0.23 parts per billion (ppb), which is below any level of concern established by the EPA for human health or wildlife.

The Department, working in cooperation with the North Dakota Department of Health's Division of Water Quality, resumed a surface water monitoring survey in 2008 for pesticides and pesticide degradates. Nine sample sites in three different North Dakota basins (Sheyenne, Souris, and Yellowstone Rivers) were sampled and tested for 184 different pesticides and pesticide degradates every three weeks from April through October. A total of nine pesticides and one pesticide degradate were detected. The most commonly detected pesticides in 2008 were the herbicides 2,4-D and diuron. For all but one pesticide, concentrations were below levels deemed harmful by the EPA. Diuron was found in the Souris River in 2008 at concentrations that could be harmful to aquatic life, specifically green algae (Gray and Orr, 2009).

The pesticide water quality monitoring program received an increase in funding in 2009 through an EPA Clean Water Act Section 319 grant. Because of this grant, a later start date, and a six week sampling schedule instead of a three week schedule, the program was able to dramatically expand the number of sites sampled and make the program truly state-wide to represent every major North Dakota river basin.

In 2009, 29 sites were sampled and tested for 180 different pesticides and pesticide degradates every six weeks. Because the detections during the 2008 monitoring project were not found until June, the WQAC recommended sampling start in June of 2009 and end in November. There were a total of eleven detections of four different pesticides, inlcuding atrazine, bentazon, dimethenamid, and MCPA. The most commonly detected pesticides were the herbicides atrazine and bentazon, which were detected four and three times, respectively. MCPA and dimethenamid were each detected twice. For all pesticides, concentrations were well below levels deemed harmful by the EPA.

EPA Clean Water Act Section 319 funds continued into 2010 and we were able to expand the number of sites to 33. Sampling sites were chosen from the NDDoH's Ambient River and Stream Water Quality Monitoring Program sites to make the sampling most efficient (Figure 1, NDDoH 2009).

Project goals

The goals of the 2010 monitoring study were to:

- Determine the occurrence and concentration of pesticides in North Dakota rivers;
- Determine whether any pesticides may be present at concentrations that could adversely affect human health, aquatic life, or fish-eating wildlife; and
- Continue to evaluate the temporal and spatial frequency of sampling needed to assess contamination, thereby helping to further refine future pesticide monitoring design.

The Department will also use the monitoring data as part of its cooperative agreement with the EPA. Under that agreement, the Department has committed to evaluate a pre-defined list of national and local pesticides of interest that may pose a risk to water quality. The Department is required to demonstrate that any risks are appropriately managed. Results may also be used by the Endangered Species Program and evaluations for special pesticide registrations.

MATERIALS AND METHODS

Pesticide samples and associated field measurements were collected in 2010 at 33 sites every six weeks from early April through late October 2010. Samples were collected for the Missouri River basin during the weeks of May 10th, June 21st, August 2nd, September 13th and October 25th. Samples were collected in the eastern region of the state in the Red River, James River and Souris River basins during the weeks of April 26th, June 7th, July 19th, August 30th and October 11th. Locations of the sampling sites can be found in Table 1 and Figure 1.

Table 1. 2010 North Dakota pesticide surface water monitoring project sites

Site ID	Sampling Site	Location	Latitude	Longitude
380007	Sheyenne River - Lisbon	1.5 mi S, 0.5 Mi E Of Lisbon	46.40567	-97.673
380009	Sheyenne River - Cooperstown	4.5 mi E Of Cooperstown	47.43292	-98.0278
380012	James River - LaMoure	West Edge Of Lamoure On Hwy 13	46.35537	-98.3061
380013	James River - Jamestown	Downstream From Jamestown	46.88339	-98.6709
380021	DeLacs River - Foxholm	At Bridge In Foxholm	48.37047	-101.57
380022	Little Missouri River - Medora	1 mi W Of Medora On Bridge	46.91661	-103.532
380031	Wild Rice River - Abercrombie	3.2 mi NW Of Abercrobmie	46.47112	-96.782
380037	Turtle River - N Of Manvel	On Hwy 81 Bridge	48.08617	-97.1843
380039	Forest River - Nr Minto	0.4 mi E Of Hwy 81 Bridge	48.28598	-97.3698
38055	Bois de Sioux River	Near Doran, MN		
380059	Little Missouri River - Hwy 85	On Hwy 85 Bridge	47.59233	-103.253
380060	Spring Creek	At Zap		
380067	Cannonball River	0.5 mi S Of Breien	46.37668	-100.935
380077	Cedar Creek	At Raleigh		
380083	Red River - at Brushville, MN	6 mi N And 1 mi W Of Wahpeton	46.36948	-96.6568

Site ID	Sampling Site	Location	Latitude	Longitude
380087	Knife River - S Of Hazen	0.5 mi S Of Hazen	47.28547	-101.623
380095	Souris River - W Of Verendrye	1 mi W Of Verendrye	48.12481	-100.749
380105	Cannonball River S Of Raleigh	16 mi S Of Raleigh	46.12676	-101.333
380151	Heart River - W Of Mandan	3 mi W Of Mandan	46.83378	-100.974
380156	Goose River - AT Hillsboro	In Hillsboro	47.40701	-97.0574
380157	Park River - AT Grafton	In Grafton At Hwy 81 Bridge	48.42479	-97.4119
380158	Pembina River	Near Neche, ND		
380160	Heart River - S Of Richardton	8 mi S Of Richardton	46.74585	-102.308
380161	Souris River - W Of Minot	3.5 mi W Of Minot	48.2459	-101.372
384130	James River	At Grace City	47.55801	-98.863
384131	Knife River	At Golden Valley	47.15485	-102.06
384155	Maple River at Mapleton	@ Mapleton	46.9054	-97.0525
384156	Red River at Grand Forks	Demers Ave Bridge	47.92686	-97.0282
384157	Red River at Pembina		48.97367	-97.2378
385001	Sheyenne River Nr Kindred	On Highway 46 Nr Kindred	46.63146	-97.0003
385040	Red River Near Harwood	3 mi E Of Harwood	46.97695	-96.8203
385345	Sheyenne River Near Warwick	3.3 mi S of Warwick, ND	47.80526	-98.7172
385414	Red River	at Fargo on Main Ave Bridge	46.87364	-96.7766

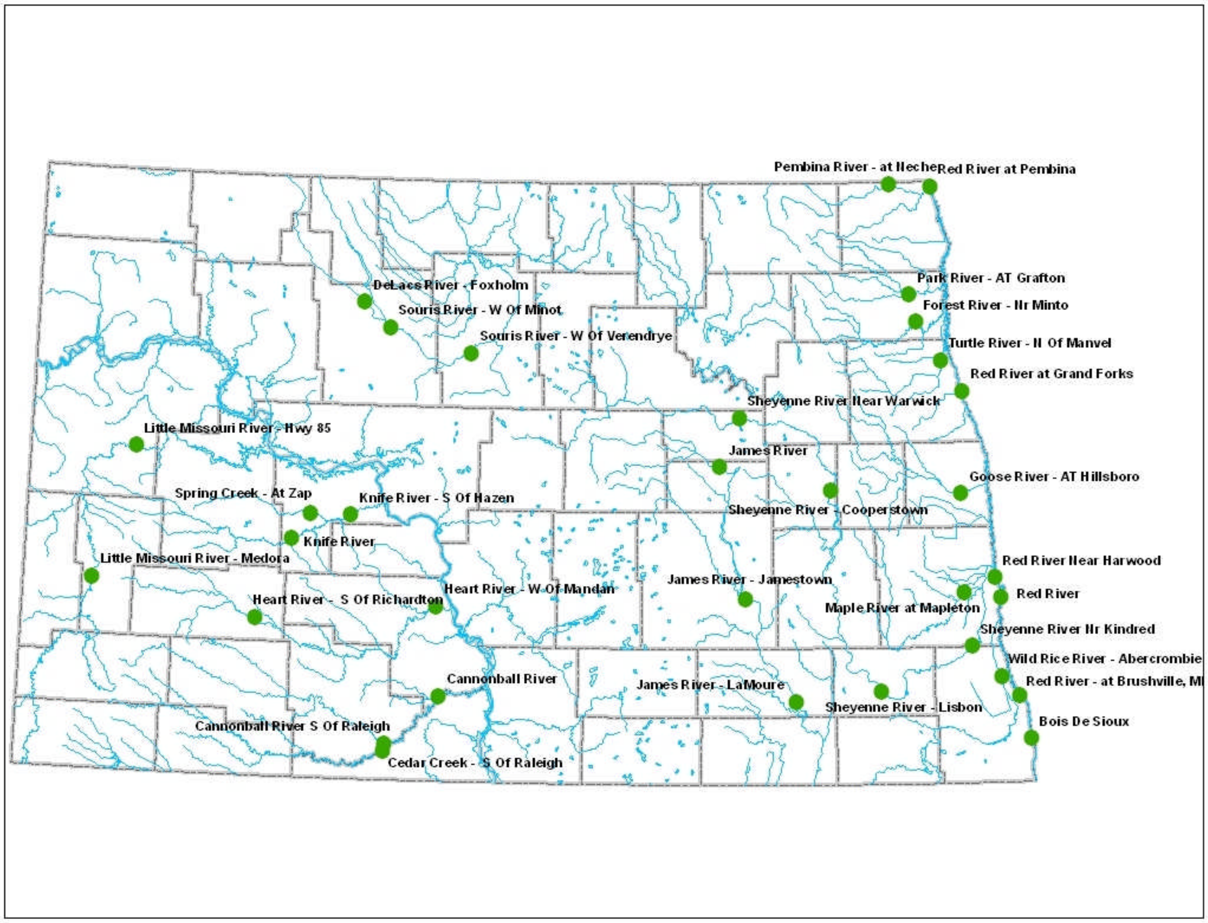

Figure 1. Sampling locations for the 2010 pesticide surface water monitoring study

Dissolved oxygen, temperature, pH, and specific conductivity were measured at the time of sampling with a YSI Model 650 MDS (YSI Incorporated, Yellow Springs OH, Multiparameter Display System) / Data Logger combined with a YSI Model 600XL 6 sensor sonde. Results were recorded in the field on a field log form (Appendix A).

Samples for pesticide analysis were collected in the main current below the surface at a depth of approximately 60 percent of the total water depth. This depth was chosen for sample collection as it is assumed to be representative of the entire stream. At the start of the season when there was greater water depth, a stainless steel weighted bottle sampler (WBS) was used to collect samples. The WBS is constructed of 0.25 inch thick, 4 inch inside diameter, 7 inch long stainless steel pipe which is connected to a rope by a stainless steel cable. Each pesticide sample bottle was filled by placing the sample bottle in the WBS and lowering the WBS into the water from a bridge. The WBS was lowered into the stream at a point where the stream is at its greatest depth in the cross section. The WBS was then lowered to a depth equal to 60 percent of the total stream depth. For example, if the stream were 5 feet deep at its deepest point in the streams cross section, the sample would be collected at that point at a depth 3 feet off the bottom.

When the bottle was completely filled (i.e., no bubbles observed) the WBS and bottle were retrieved. The bottle was capped, removed from the WBS, and placed in a cooler on ice until shipment. Later in the season when the river or stream was wadeable, grab samples were collected by wading into the stream. Care was taken so that the sample was not contaminated by disturbing the stream bed upstream from the collection point. When the sample was collected by wading, the stream was entered slightly down current from the sampling point and then the sampler waded to the area with the greatest current. The sample bottle was then submerged to approximately 60 percent of the stream depth; the cap removed and the bottle was allowed to fill facing towards the current, allowing it to fill naturally. Once the bottle was filled, the cap was replaced prior to removing the bottle from the stream.

Each pesticide sample consisted of two 500-mL amber glass jars with Teflon-coated caps. Sample bottles were provided by the lab and did not need to be rinsed.

The sample bottles came with appropriate labels attached. Custody reports and sample logs were immediately completed after sample collection (Appendix A). The samples were carefully packed with bubble wrap and rubber mesh and put into a cooler with ice and more packing materials shortly after collection. Coolers with the samples and ice inside were shipped to the laboratory using a next-day shipping service. The samples were usually shipped within a few hours of collection.

Selected field samples were collected in replicate to provide estimates of sample variability. The replicates consisted of two separate sets of samples collected one after another. Replicate samples were submitted blind to the laboratory. Further information on Quality Assurance/Quality Control (QA/QC) procedures can be found in the QAPP for this monitoring project (Johnson and Gray 2010).

Samples were analyzed for 180 different pesticides and degradates (Appendix C) by Pacific Agricultural Laboratory (Portland, OR) using EPA standard methods. Methods employed for analysis can be found in Table 2.

Table 2. Description of analytical methods used by Pacific Agricultural Labs.

Pesticide Class	Method Description
Organochlorine pesticides	Modified EPA method 608 (GC-ECD)
Organophosphorous pesticides	Modified EPA method 614 (GC-FPD)
Organonitrogen pesticides	Modified EPA method 625 (GC-MS)
Chlorinated pesticides	Modified EPA method 8321A (HPLC-MS)
Miscellaneous pesticides	Modified EPA method 8321A (HPLC-MS)

RESULTS AND DISCUSSION

Frequency and Timing of Pesticide Detections

Of the 180 pesticides analyzed, nine were detected in 2010. The pesticides detected were 2,4-D, atrazine, bentazon, bifenthrin, clopyralid, dicamba, diuron, MCPA and metolachlor. Bentazon was by far the most frequently detected accounting for 50 percent of 43 total pesticide detections. The next most frequently detected pesticides were 2,4-D and metolachlor with four detection each, while atrazine and clopyralid had three detections each. Dicamba, diuron and MCPA had one detection each. Metolachlor and atrazine had detections at levels that may be a concern to aquatic life (Table 3).

Table 3. Summary of pesticides detected in 2010

Pesticide	# of detections	Highest concentration (ppb)	Aquatic Life Benchmark (ppb)
2,4-D	4	1.5	N/A
Atrazine	3	0.87	1
Bentazon	22	5.2	4,500
Bifenthrin	1	0.13	N/A
Clopyralid	3	0.78	56,500
Dicamba	1	0.52	61
Diuron	1	0.19	2.4
MCPA	1	0.61	170
Metolachlor	4	0.91	1

There were no pesticide detections during the late April/early May sampling (Figure 2). Detections increased rapidly in June. The June sampling period yielded 17 detections while the late July/early August sampling period had 16 detections. Detections dropped off in late August/early September, with three detections. October sampling had seven detections.

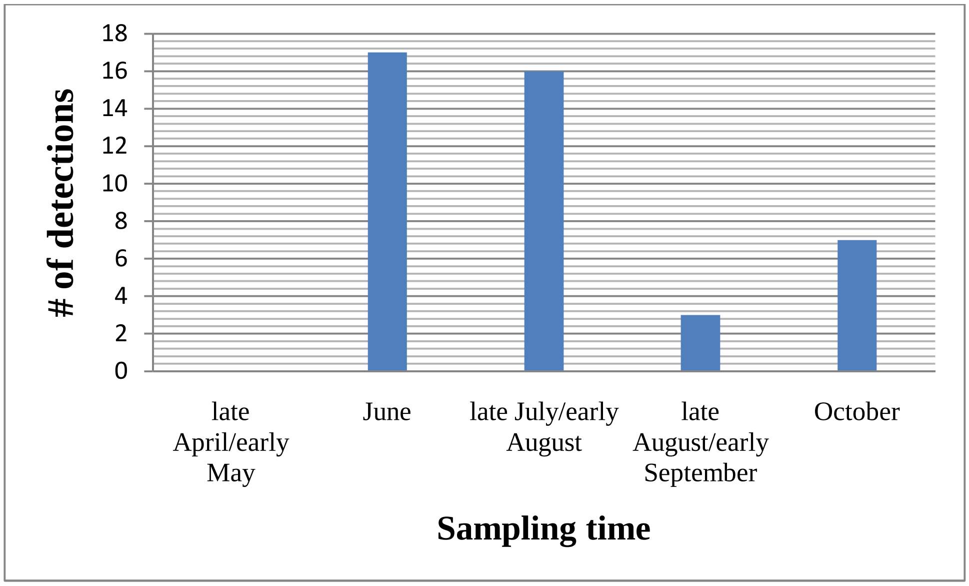

Figure 2. Frequency of pesticide detections compared by sampling period in 2010 in North Dakota

Site and Detection Locations

Twenty nine of the 43 pesticide detections were in the Red River Valley region of the Red River basin. The Missouri River basin had seven detections of five different pesticides. The Souris River had five detections, all of which were bentazon. The James River basin had two detections, both were bentazon.

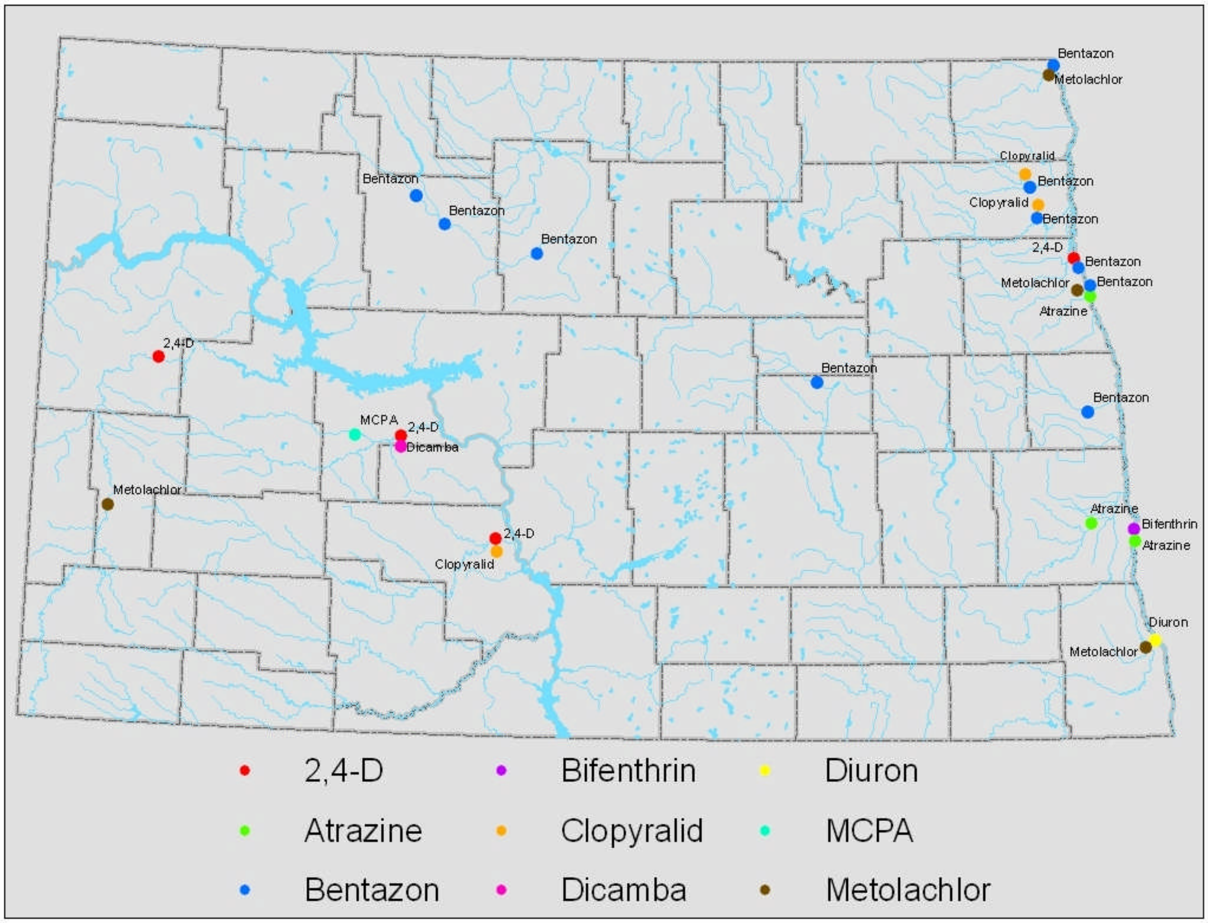

Figure 3. 2010 Pesticide detection sites

Within the Red River basin is a region known as the Red River Valley. This region for formed by the glacial Lake Agassiz. Due to the nature of the soils in this region as well as to its flat topography, this area has a higher percentage of land in high intensity agriculture. Crops that use higher amounts of pesticides such as corn, soybeans and sugar beets are common in the Red River Valley (Figure 4). The highly intensive agriculture in the Red River Valley likely contributes to the higher number of pesticide detections in the Red River Valley.

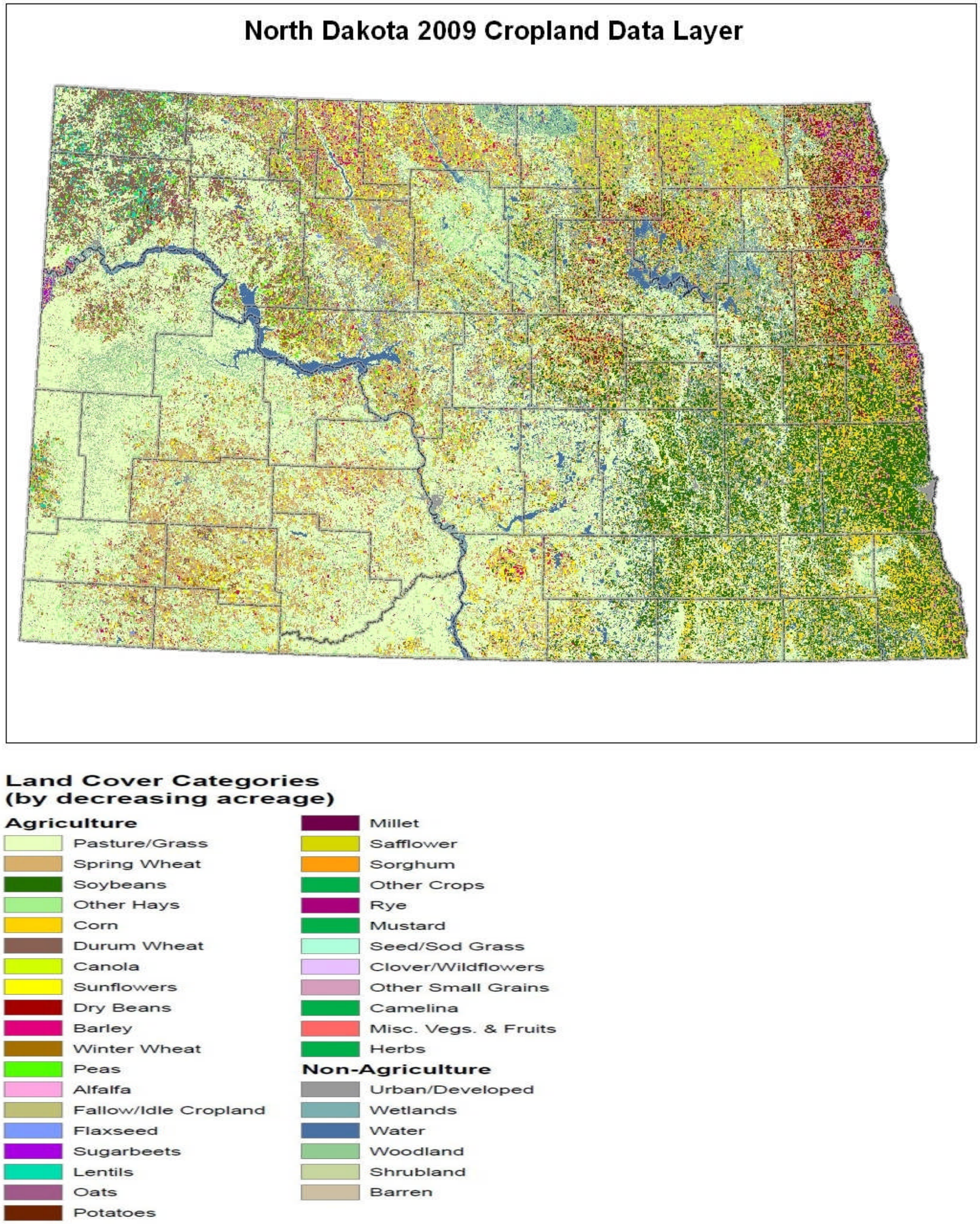

Figure 4. North Dakota Cropland Data Layer 2009. Cropping information is from the National Agriculture Statistics Service (NASS), a division of the US Department of Agriculture. The data is from remote sensing based cropland acreage indications and verified with on the ground surveys

General Information

Risk of pesticides to human health or the environment is a function of both toxicity and exposure. The EPA has established Maximum Contaminant Levels (MCLs) for pesticides in drinking water based on risk to human health. The EPA has also established Aquatic Life Benchmarks (ALBs) based on risk of pesticides to aquatic ecosystems (Appendix C). To assess risk and establish ALBs, the EPA relies on studies required under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as well as a wide range of environmental laboratory and field studies available in the public scientific literature. ALBs, which are based on the most sensitive toxicity endpoint for a given taxa, are estimates of the concentrations below which pesticides are not expected to harm aquatic life. In most cases the Department was able to compare the concentration detected in surface water to the ALB, but not an MCL, because the EPA has not established MCLs for many pesticides.

In the results, detections are compared to pesticide use throughout the state. The information is derived from a comprehensive survey of North Dakota farm operators on 2008 practices conducted by USDA's National Agricultural Statistics Service (NASS) in the spring of 2009. The survey was conducted as a phone survey. NASS selected a sample population of 7,000 farm operators to represent each crop at the district level. The target for useable surveys was 3,500 responses, stratified across NASS's reporting districts. Interviews were conducted from late January through March 2009. All percentages at the state level are weighted averages of the districts. Data were summarized by obtaining a percent of total acres treated for the general pesticide category, as well as for specific chemicals, by crop, and by crop reporting districts. These percentages of total acres treated were multiplied by the NASS estimate of total acres planted to each crop in the district. State acres were obtained by the addition of these data with state percentages derived to obtain the weighted figures (Zollinger et al. 2009).

County estimates used in Figures 5-7 and Figures 9-14 are also from the NASS survey. However, the county-level data is not a weighted average of the district, the numbers are raw data from the phone surveys.

Pesticide Specific Results

2,4-D

2,4-D is a systemic herbicide used to control of broadleaf weeds. In North Dakota, it is most commonly used on wheat, with 68 percent of its use on wheat. It is also applied to barley, oats corn, sunflowers, alfalfa, hay, CRP and pastures. 2,4-D is used on approximately 1,861,500 acres as a stand-alone product and 349,100 acres as a mixture (Zollinger et al. 2009). More acres are sprayed for lawns and other urban uses, however this amount is not known.

2,4-D was detected four times in 2010. Three of the detections were in the Missouri River basin. The Heart River west of Mandan and the Knife River south of Hazen had detections in June. The third detection in the Missouri River basin was in September on the Little Missouri River at US Highway 85. The other detection was in the Red River Valley in June on the Turtle River north of Manvel. All of the detections were downstream from areas of moderate to high 2,4-D use (Figure 5).

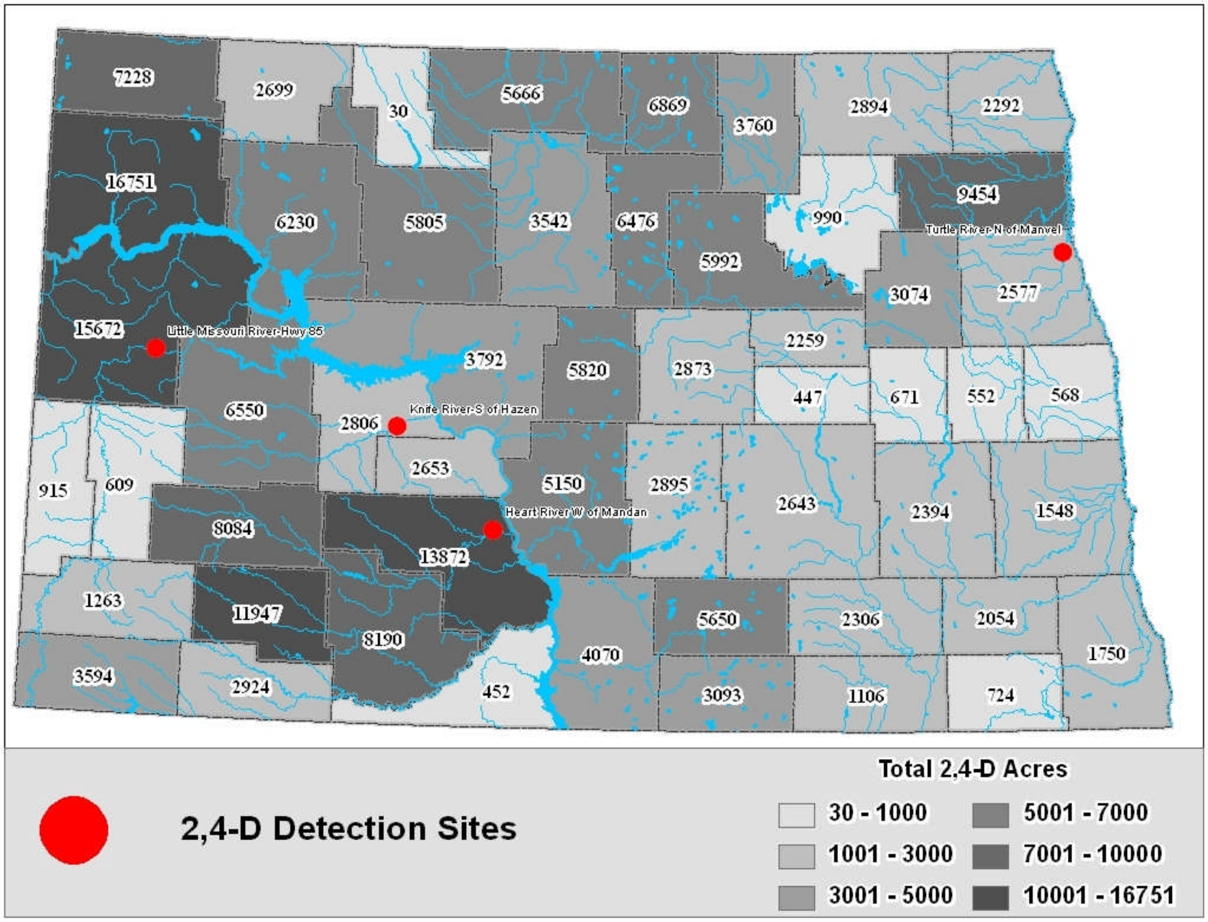

Figure 5. Locations of 2,4-D surface water detections in 2010 and 2,4-D use per county.

The 2,4-D detections ranged from 0.36 ppb-1.5 ppb. There is no ALB established for 2,4-D. The Department has notified the EPA of this deficiency and 2,4-D is now proposed to be included in the new benchmarks that will be established in 2011.

The drinking water MCL for 2,4-D is 70 ppb. The highest concentration detected is 47 times lower than the MCL, suggesting that the detected concentration does not pose a human health risk to surface water.

Atrazine

Atrazine, a broadleaf herbicide used primarily on corn, is applied to approximately 59,500 acres as a stand-alone product and to an additional 38,600 acres in mixtures in North Dakota each year (Zollinger et al. 2009).

Atrazine was detected three times in 2010 in the Red River and its tributaries. Atrazine was detected once in the Maple River at Mapleton, once in the Red River at Grand Forks and once in the Red River south of Harwood. All three detections were in late June. All of these areas are in or are downstream from areas with heavy atrazine use (Figure 6).

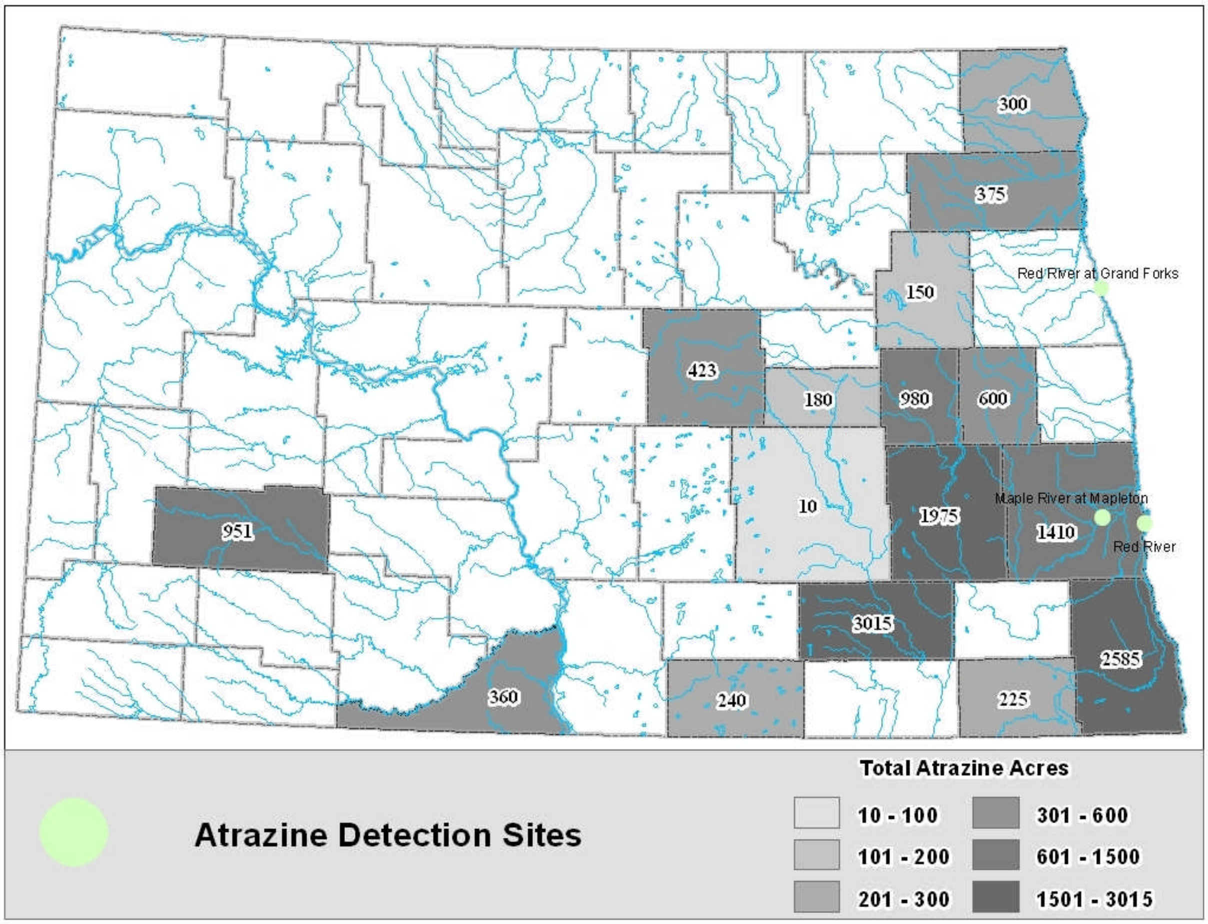

Figure 6. Locations of atrazine surface water detections in 2010 and atrazine use per county.

Atrazine was detected in the samples at a range of concentrations from 0.34 to 0.87 ppb. The EPA has recently lowered the lowest ALB for atrazine from 17.5 ppb to 1 ppb. The concentrations found in North Dakota surface water were approaching the 1 ppb benchmark established for non-vascular plants. Atrazine concentrations found were close to levels that may pose risk to non-vascular plants in the Red River basin.

Atrazine has an MCL of 3 ppb. The highest concentration detected is 3.45 times lower than the MCL, suggesting that the detected concentration does not pose a human health risk.

Bentazon

Bentazon is a postemergence herbicide used for broadleaf weed control, most commonly on dry peas, dry beans and soybeans in North Dakota. Bentazon is used as a stand-alone product on an estimated 779,200 acres in North Dakota each year. In addition, it is applied in a mixture with other pesticides on 77,300 acres (Zollinger et al. 2009).

Bentazon was detected 22 times in 2010 from June throughout October. It was detected four times in the Souris River basin, twice in the James River basin and 16 times in the Red River Valley. All of the detections were in or downstream of counties with high bentazon use (Figure 7). All bentazon detections were also near areas with a high proportion of crops commonly sprayed with bentazon (Figure 8).

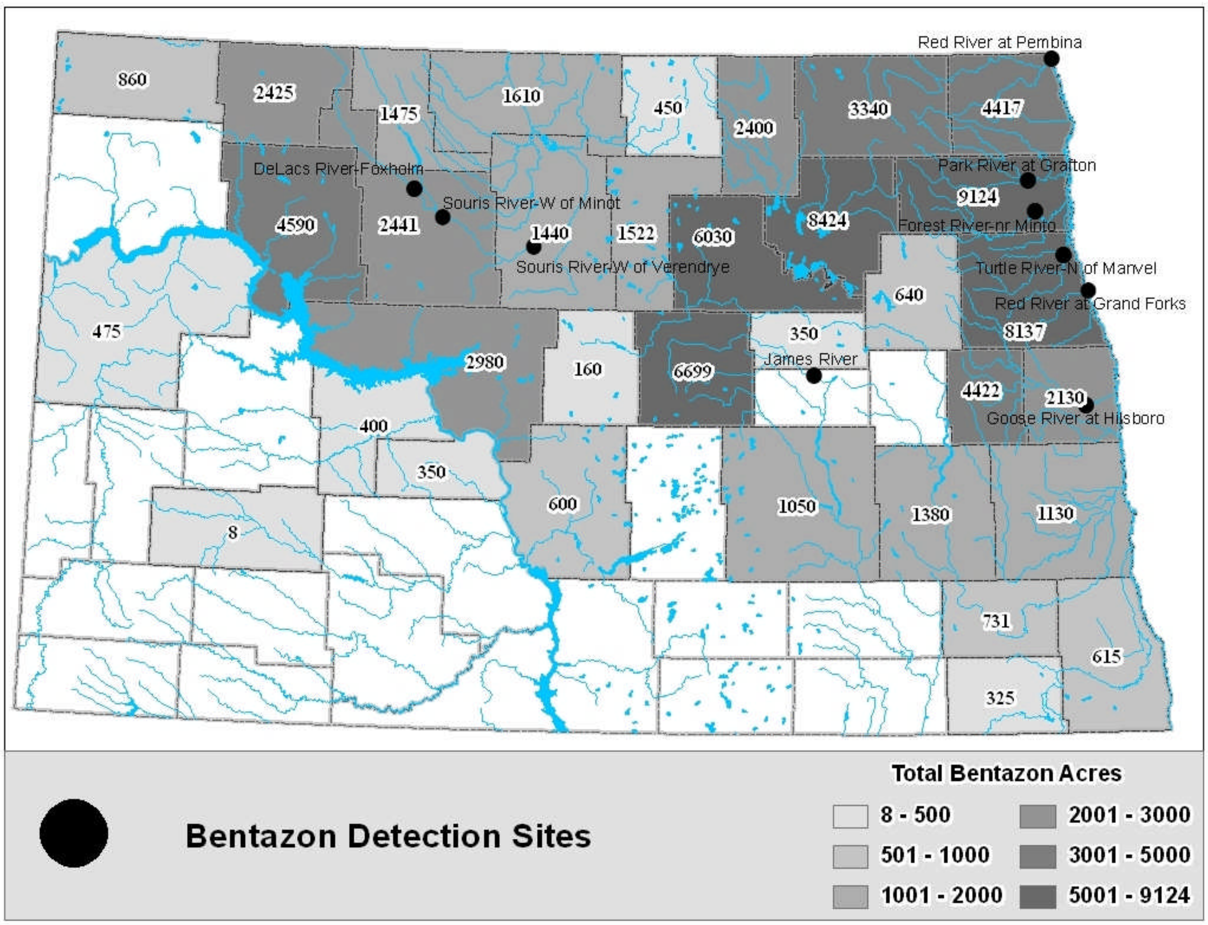

Figure 7. Locations of bentazon surface water detections in 2010 and bentazon use per count

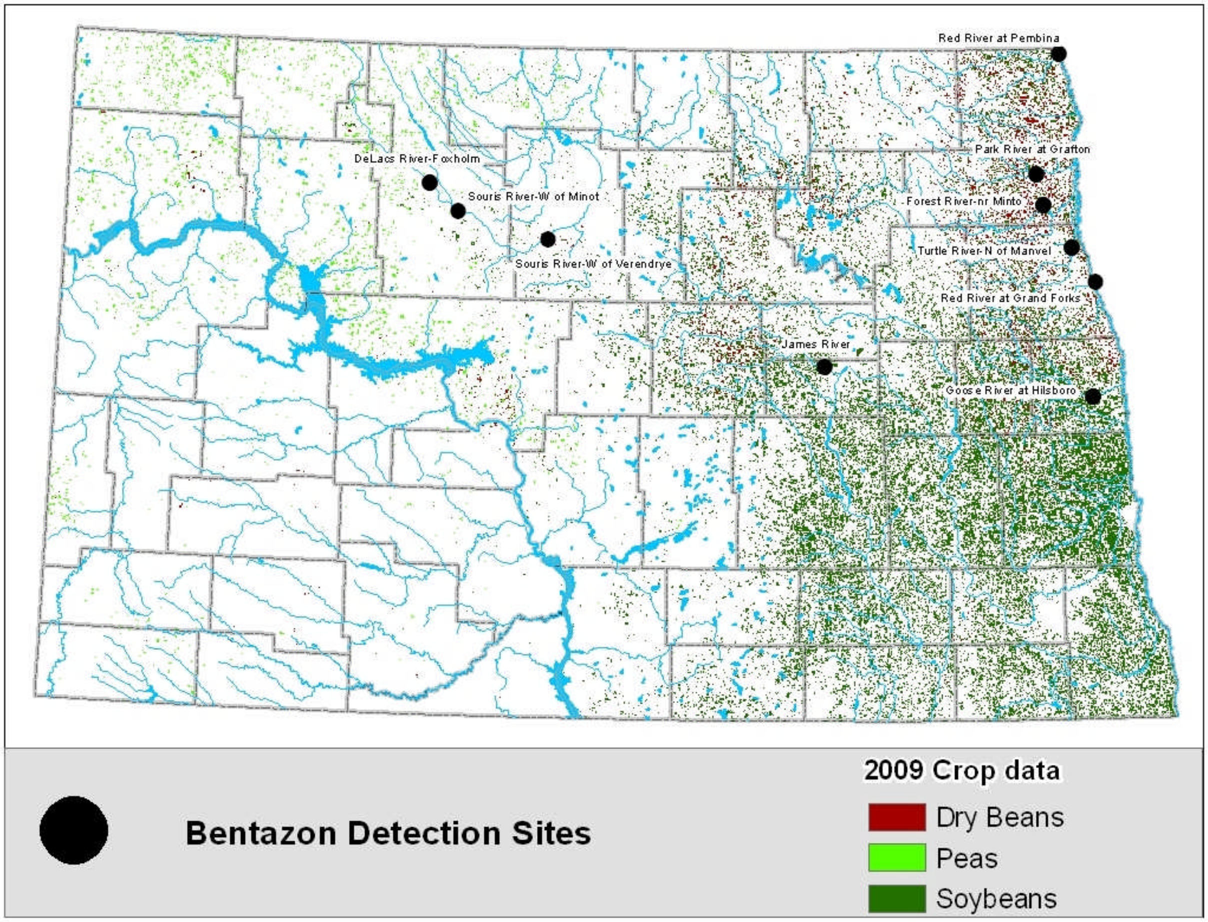

Figure 8. Bentazon detection sites overlapped with areas of dry bean, pea and soybean plantings. Cropping information is from the North Dakota Cropland Data Layer, supplied by National Ag Statistics Service.

The detections were at concentrations ranging from 0.11-5.2 ppb. The EPA ALB concentration, set for acute toxicity to nonvascular plants, is 4,500 ppb. The highest concentrations found during sampling were over 568 times less than the established benchmark, suggesting minimal risk. There are no MCLs established for bentazon.

Bifenthrin

Bifenthrin is a pyrethroid insecticide most commonly used on canola and soybeans in North Dakota. It is also registered for use on corn, peas and grapes. Bifenthrin is used as a stand-alone product on an estimated 19,200 acres in North Dakota every year. Canola is the most common crop used for stand-alone treatments, accounting for 11,200 of the 19,200 acres. Bifenthrin is also applied as a mix with zeta-cympermethrin on 30,300 acres in North Dakota. All of the 30,300 acres of bifenthrin mixture was used on soybeans (Zollinger et al. 2009). Bifenthrin is also used by homeowners on lawns and gardens, but the amounts are not quantified.

Bifenthrin was detected once in October in the Red River south of Harwood at a concentration of 0.13 ppb. The detection was at a site downstream of a county with moderate bifenthrin use (Figure 9). The Red River basin extends into Minnesota, so upstream use may be on the Minnesota side and not be reflected in Figure 9.

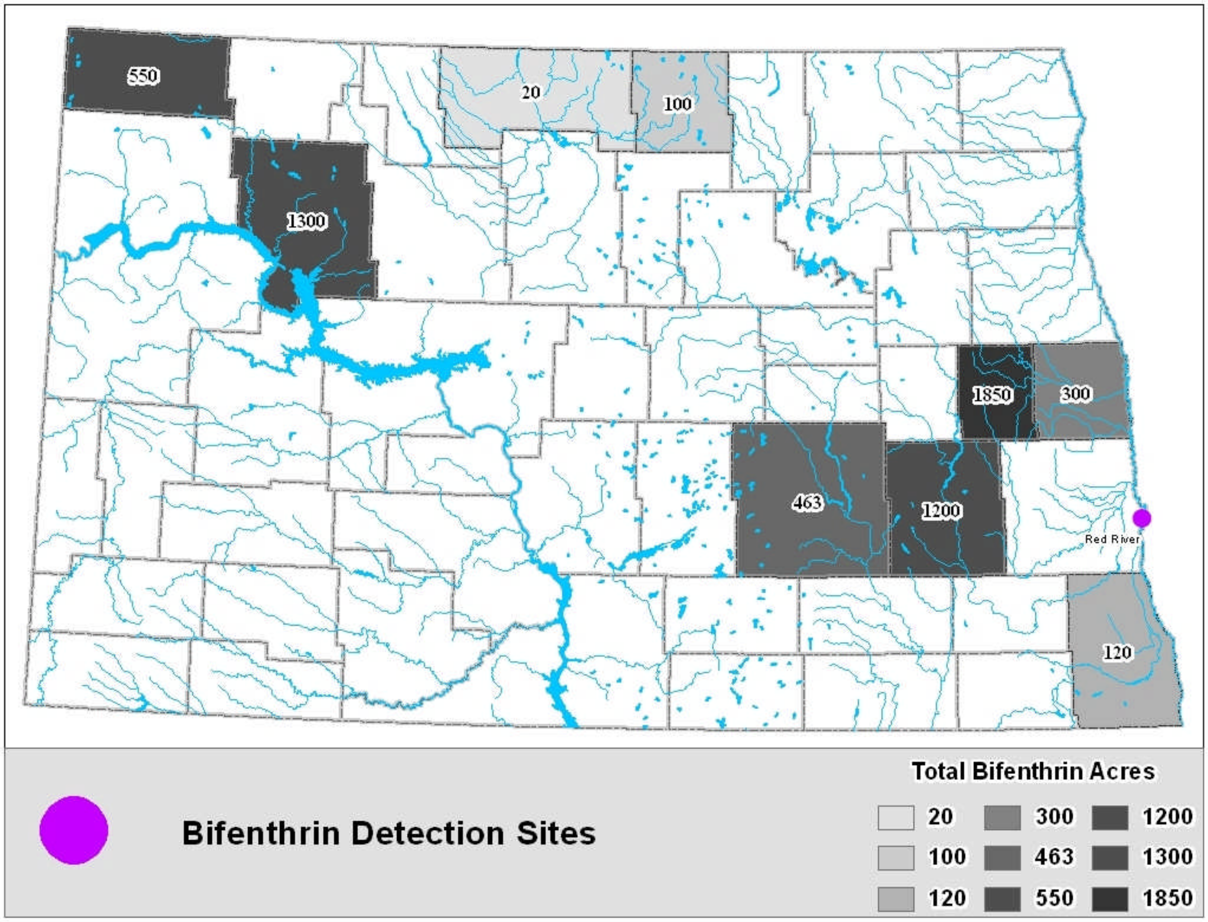

Figure 9. Locations of the bifenthrin surface water detection in 2010 and bifenthrin use per county.

There are no ALBs or MCLs established for bifenthrin. Studies have shown that bifenthrin is highly toxic to aquatic life. In one study, a concentration of 0.15 ppb of bifenthrin in water for rainbow trout was established as the LC_{50}, or the dose that will kill 50% of the species studies.

Clopyralid

Clopyralid is a selective herbicide used for control of broadleaf weeds. Clopyralid is most commonly used on wheat, barley, sugarbeets, oats, corn, CRP and pasture in North Dakota. In North Dakota it was used as a stand-alone product on approximately 111,600 acres and 3,825,600 acres as a mixture in 2008. The most common mixture was clopyralid and fluroxypyr, with 3,742,400 acres treated, 80 percent of the clopyralid and fluroxypyr mixture was applied on wheat (Zollinger et al. 2009).

Clopyralid was detected three times in 2010, all on June 21st. Two detections were in the northern sections of the Red River basin, the Forest River near Minto and the Park River at Grafton. The other detection was in the Heart River west of Mandan in the Missouri River basin (Figure 3). All detections were in counties with heavy clopyralid use (Figure 10).

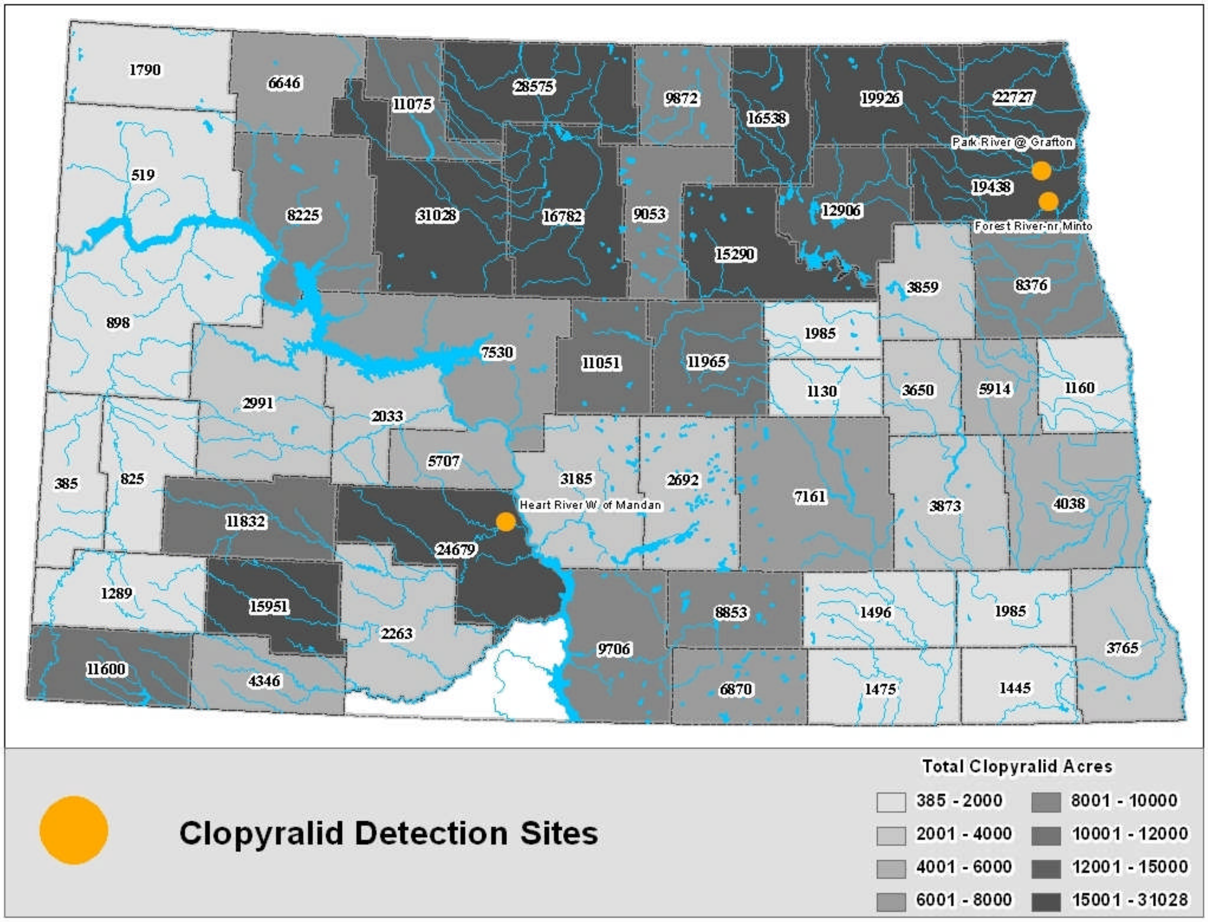

Figure 10. Locations of clopyralid surface water detections in 2010 and clopyralid use per county.

Detected concentrations of clopyralid ranged from 0.13-0.78 ppb. The lowest ALB for cloypralid is 56,600 ppb. The highest detection found during the monitoring is over 72,000 times lower than the ALB. The concentration of clopyralid detected suggests a very minimal risk to aquatic life. There are no MCLs established for clopyralid.

Dicamba

Dicamba controls annual and perennial broadleaf weeds in grain crops and grasslands, and it is used to control brush in pastures. It will control broadleaf weeds before and after they sprout. In North Dakota, an estimated 591,600 acres were sprayed with dicamba alone in 2008, with an additional 400,100 acres sprayed with mixtures that included dicamba. Dicamba is most commonly used on fallow land, pasture, CRP, hay, corn, oats and wheat in North Dakota. Wheat and corn account for 30 percent and 40 percent of dicamba use, respectively (Zollinger et al. 2009).

Dicamba was detected once on June 22nd on the Knife River south of Hazen, part of the Missouri River basin. This detection is in a county with moderate dicamba use (Figure 11).

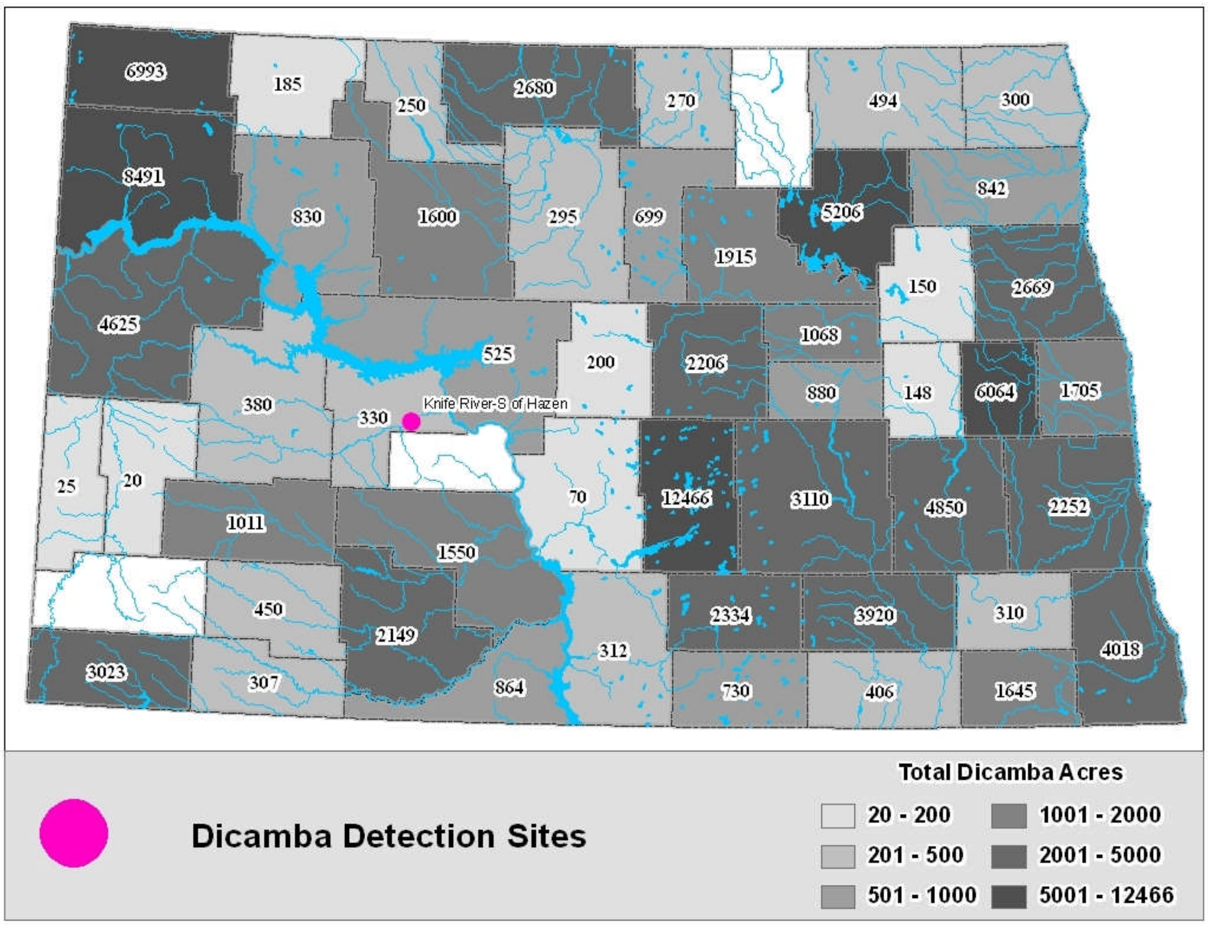

Figure 11. Locations of the dicamba surface water detection in 2010 and dicamba use per county.

The lowest ALB for dicamba is 61 ppb. The concentration of dicamba detected was 0.52 ppb. The amount of dicamba detected was 117 times lower than the ALB, suggesting minimal risk to aquatic life from dicamba exposure in the study area. There are no MCLs established for Dicamba.

Diuron

Diuron is a broad-spectrum residual herbicide registered for pre-emergence and post-emergence control of both broadleaf and annual grassy weeds. In North Dakota, it is not commonly used in agricultural fields. Diuron is believed to be used more commonly in North Dakota in rights of ways and as a soil sterilant, but this usage is not tracked.

There was one detection of diuron in June on the Red River at Brushville, MN. This location is associated with a North Dakota county which did not have reported diuron use in the NASS survey (Figure 12). The detection may be from diuron used on rights which are not reported. As mentioned previously, the Red River basin extends into Minnesota, so upstream use may be on the Minnesota side which would not be reflected in Figure 12.

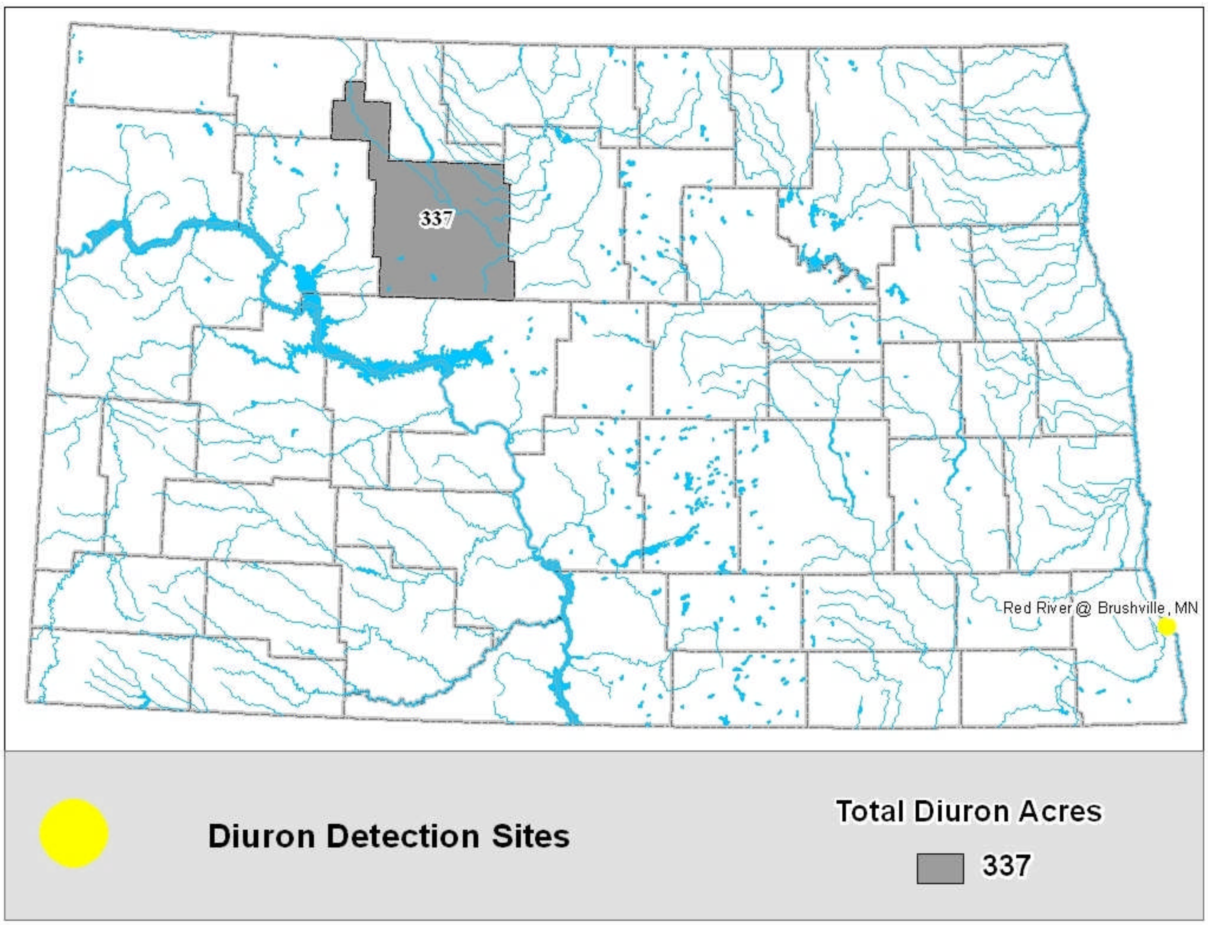

Figure 12. Locations of the diuron surface water detections in 2010 and diuron use per county.

Diuron was detected at a concentration of 0.19 ppb. The lowest ALB is 2.4 ppb. The detection found in 2010 is twelve times lower than the lowest ALB, which has been established for algae. The risk of aquatic life from the diuron detection in 2010 is therefore considered low by the Department.

MCPA

MCPA is a systemic herbicide used to control annual and perennial weeds in cereal grains and grasslands. MCPA use in North Dakota is primarily on wheat, barley, oats, flax, CRP and pasture. An estimated 933,600 acres of MCPA are applied in North Dakota annually as a stand-alone product, while an additional 2,651,000 acres are treated with a mixture that includes MCPA (Zollinger et al. 2009).

There was one detection of MCPA in Spring Creek near Zap, part of the Missouri River basin. (Figure 13). The detection was in June and at a concentration of 0.61 ppb. The detection of MCPA was in a county with low reported MCPA use. Other areas of the state with more intensive MCPA use did not have any MCPA detections (Figure 13).

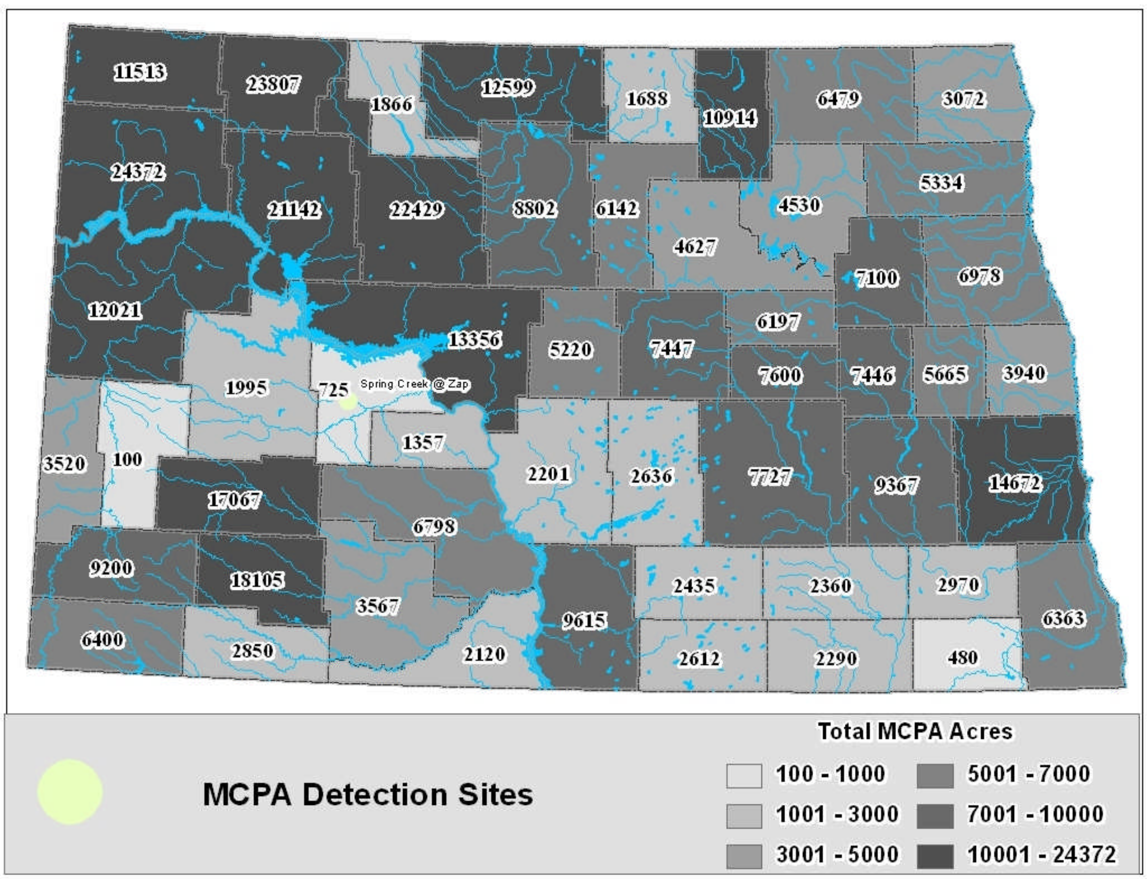

Figure 13. Locations of the MCPA surface water detections in 2010 and MCPA use per county.

The ALB for MCPA is 170 ppb for the most sensitive species, aquatic vascular plants. The highest concentration found during sampling was over 278 times lower than the established benchmark, suggesting minimal risk. There are no MCLs established for MCPA.

Metolachlor

Metolachlor is used primarily on corn in North Dakota for grass and broadleaf weed control. Metolachlor's primary use was as a mix with atrazine and mesotrione on an estimated 21,800 acres in North Dakota in 2008 (Zollinger et al. 2009).

Metolachlor was detected four times in North Dakota with three of the detections in the Red River Valley and one in the Missouri River basin. Two of the detections were in June, one in July and one was in October. Metolachlor was detected once in the Red River at Pembina, a county with relatively heavy use; once in the Red river at Brushville, in a county with moderate use; and once in the Red river at Grand Forks, in a county with no use but downstream from counties with moderate use. Metolachlor was also detected in the Little Missouri River at Medora, in a county with no use and downstream from a counties with no reported use patterns in 2008 (Figure 14). This detection could reflect an expansion of areas that grow corn since the 2008 survey.

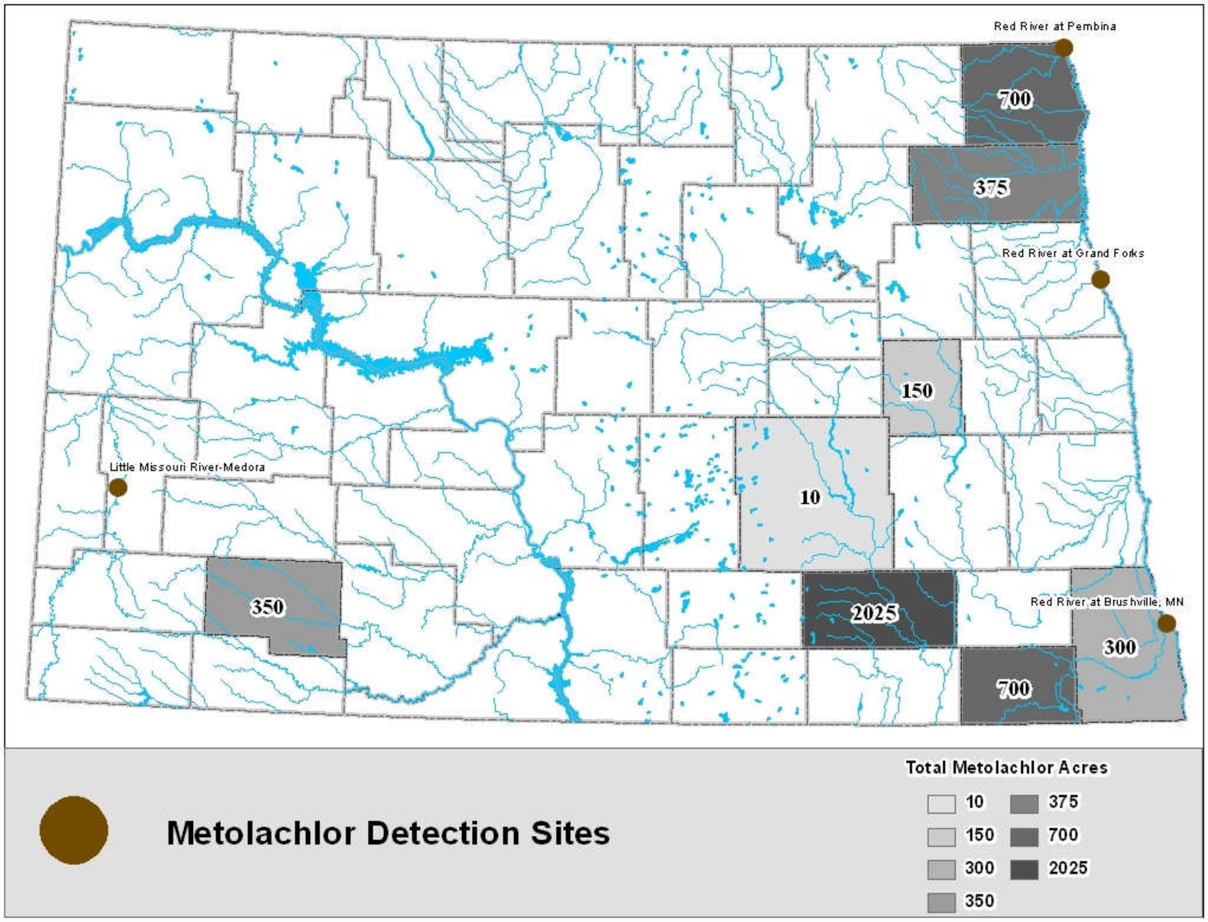

Figure 14. Locations of metolachlor surface water detections in 2010 and metolachlor use per county.

Metolachlor detections ranged from 0.39-0.91 ppb. The ALB for metolachlor is 1 ppb. These concentrations were approaching the 1 ppb benchmark established for chronic invertebrate exposure. This could indicate a risk to aquatic life due to metolachlor use in North Dakota.

CONCLUSIONS

Based on pesticide surface water quality monitoring conducted since 2006, the 2010 monitoring study had the second highest number of detections. The same pesticides were analyzed in 2009 as 2010, and used 29 of the 33 sites used in 2010. However the sampling did not start until June, so the total number of sampling events was less in 2009 than 2010. There were a total of eleven detections of four different pesticides (atrazine, bentazon, dimethenamid, and MCPA) in 2009. The most commonly detected pesticides in 2009 were the herbicides atrazine and bentazon, detected four and three times, respectively. MCPA and dimethenamid were each detected twice. In 2009, all pesticide concentrations were significantly below levels deemed harmful by the EPA. Overall there were fewer detections in 2009 than 2010. The biggest difference between 2009 and 2010 was the high number of bentazon detection in 2010.

The 2008 monitoring season was more similar to the 2010 season in that there were higher numbers of pesticide detections. The 2008 season had 184 pesticides monitored, a major difference is that there were only nine sampling sites in 2008. Another difference is that the sites were monitored every three weeks from April to October in 2008, while sites were only sampled every six weeks in 2009 and 2010. The 2008 season had 52 detections, with the most common being diuron with 14 and 2,4-D with 13. Diuron was found at levels over the ALB in 2008. In comparison the 2010 season had 43 detections and no pesticides over ALBs.

The 2006 pilot project had just one detection. However the 2006 project only had eleven sites. These eleven sites were sampled just twice and tested for only 63 pesticides. Even with fewer sites and pesticides analyzed for, 2006 showed relatively fewer detections than 2010.

We now have three years of ambient surface water sampling for pesticides in North Dakota. Results from these studies show that North Dakota rivers and streams have minimal pesticide contamination. This is a good sign for the environment, agricultural producers and others who rely on pesticides. All 2010 detections were below EPA's ALBS and MCLs. According to these criteria, the concentrations of pesticides found in North Dakota rivers and streams do not pose a significant risk to human health and the environment. The concentrations of pesticides found in 2010 are not expected to harm aquatic life, including acute and chronic exposures to fish and invertebrates, vascular plants, non-vascular plants and aquatic communities.

However, there were two pesticides at levels approaching their respective ALBs, atrazine and metolachlor. There was one pesticide, bifenthrin that did not have an ALB but concentrations found are close to its LC_{50}.

In 2010, metolachlor was found once in the Missouri River Watershed and three times in the Red River Watershed. Concentrations detected were approaching the 1 ppb ALB for metolachlor. The benchmark of 1 ppb was established by EPA after a thorough review of the literature on the effects of metolachlor on aquatic life. A study by Liu et al. (2006) was used to establish the ALB for metolachlor. This study found that at a concentration of 10 ppb of metolachlor, the reproductive rate of cladocerans (i.e.number of young produced by water fleas) was reduced by 10 percent. At a concentration of 1 ppb of metolachlor, there was no effect to water fleas including reproductive effects. Because the detections of metolachlor found in North Dakota were less than the concentration that had no effect on the water fleas, the Department has concluded that metolachlor is currently only a minor concern. Metolachlor will continue to be monitored, although no risk mitigation measures will be evaluated for metolachlor at this time.

In 2010, atrazine was detected four times in the Red River Valley watershed, with concentrations approaching the revised atrazine ALB of 1 ppb. This benchmark was revised by EPA after a thorough review of the literature on effects of atrazine to aquatic life. A 1976 study by Torres and O'Flaherty found atrazine had a detrimental effect to freshwater algae at these levels. The algae had a 41-98 percent reduction in chlorophyll production when exposed to atrazine concentrations of 1 ppb for one week. Thereforth, the concentration of 1 ppb was used to establish the ALB. The results of this study show that the detections of atrazine found in North Dakota may be a concern for freshwater algae in the Red River.

Bifenthrin was found once in 2010, however there are no ALBs to compare with the concentrion detected. From available toxicity data, the Department determined that bifenthrin concentrations were near a level that could endanger freshwater fish.

Atrazine and bifenthrin should continue to be carefully monitored by the Department. Possible risk mitigations measures need to be considered by the Department and the WQAC. Mitigation measures could include increased use inspections focused on atrazine, increased user education and compliance assistance, and voluntary or non-voluntary use restrictions. Use restrictions could include mandatory buffer distances from water, reducing use rates or number of allowed applications, or cancelling product registration to no longer allow sales or use in the state.

The Department has addressed problem pesticides before, for example, diuron was found in the Souris River in 2008 at a concentration above the ALB. This was a problem that could have gone undetected for many years if not for this program. The Department conducted investigations and outreach to the area following the 2008 detections. In 2009 and 2010, there were no detections of diuron in the Souris River. Despite the inherent uncertainty of the cause of the diuron decrease, this is an excellent example of how a monitoring system can be useful in finding and mitigating a previously unnoticed problem.

As seen by the above example, the project serves important purposes. If there are no impairments, it shows that current regulations are effective in mitigating the risk of pesticide contamination to surface water. If impairments of rivers are found, these can be addressed through regulation and education. This is especially important because this project is the only state-wide comprehensive surface water monitoring project for pesticides in North Dakota.

Another important reason for monitoring is because without surface water data, federal agencies such as the EPA often use conservative models that tend to overestimate the concentrations of pesticides in surface water and the risk that pesticides pose to human and environmental health. Due to a lack of surface water monitoring data, these models are often used for decision making for policies such as set back areas from surface water on labels, potential National Pollutant Discharge Eliminations Systems (NPDES) permits, and Endangered Species Bulletins. With more data from projects such as this one, EPA could rely on real world data instead of models for policy decisions.

Surface water data is very useful for state programs. Data from this monitoring has allowed the Department to evaluate pesticides risks for many of the pesticide regulatory programs. Quality data on pesticide occurrence and their concentration in surface water allows the Department to better protect surface water resources from pesticides, while at the same time ensuring that unnecessary regulatory and management burdens are not place on pesticide users. Continuing and expanding this comprehensive, multi-year, state-wide pesticide monitoring program is invaluable to the Department as a tool to evaluate the potential risks of pesticide use on the state's surface water resources.

One area recommended for expansion of this program would be to monitor surface waters beside rivers and streams. The Department has limited data on levels of pesticides in lakes and wetlands. This lack of data has limited our ability to evaluate pesticide risks for many of pesticide regulatory programs. As a result, the Department has been forced to use models developed by the EPA to assess risk to lakes and wetlands. These models are derived from data from other states, and the accuracy of these models is questionable.

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Appendix A. Chain of Custody Form and Field Log Form

PAL
Pacific Agricultural Laboratory

Analytical Request/Chain of Custody

Pacific Agricultural Laboratory
12505 N.W. Cornell Rd. • Portland, OR 97229
Tel 503.626.7943 • Fax 503.641.0644 • www.pacaglab.com

Page ____ of ______

PAL Project # ______________

CLIENT INFO

Name ____
Contact ____
Address ______________________________________
City ____________________ State ______ Zip ______________
Telephone ____________________ Fax______________
Email ____________________
Project # ______________ Purchase Order # ______________
Method of Shipment ______________________________

Requested Turnaround Time
❑ Standard (10 working days)
❑ Rush ______________ please specify

PAL ID	Client Sample ID	Sample Date	Sample Time	Sample Type	Container Type	No. of Containers	Requested Analysis						Comments

	DATE	TIME		DATE	TIME
Relinquished by: ______________ SIGNATURE	_____	_____	Received by ______________ SIGNATURE	_____	_____
Relinquished by: ______________ SIGNATURE	_____	_____	Received by ______________ SIGNATURE	_____	_____

Lab Comments: ____

Stream and River Field log used by the North Dakota Department of Health

North Dakota Department of Health
Division of Water Quality
Stream and River Field Log
Telephone: 701.328.5210

Fax: 701.328.5200

Sample #:		Site ID:	Site Description:	Date:___/___/____	Spec. Conduct	Temperature
Dup	Blk	Comments:		Time: :	pH	D.O.
Sample #:		Site ID:	Site Description:	Date:___/___/____	Spec. Conduct	Temperature
Dup	Blk	Comments:		Time: :	pH	D.O.
Sample #:		Site ID:	Site Description:	Date:___/___/____	Spec. Conduct	Temperature
Dup	Blk	Comments:		Time: :	pH	D.O.
Sample #:		Site ID:	Site Description:	Date:___/___/____	Spec. Conduct	Temperature
Dup	Blk	Comments:		Time: :	pH	D.O.
Sample #:		Site ID:	Site Description:	Date:___/___/____	Spec. Conduct	Temperature
Dup	Blk	Comments:		Time: :	pH	D.O.
Sample #:		Site ID:	Site Description:	Date:___/___/____	Spec. Conduct	Temperature
Dup	Blk	Comments:			pH	D.O.

				Time: :		
Sample #:		Site ID:	Site Description:	Date:___/___/____	Spec. Conduct	Temperature
Dup	Blk	Comments:		Time: :	pH	D.O.

Stream and River Field log used by the North Dakota Department of Health

Appendix B. Full list of pesticides detected in 2010

Pesticide	Concentration (ppb)	ALB	Date	Location	Site
2,4-D	0.84	N/A	6/21/2010	Turtle River-N of Manvel	5083000
2,4-D	0.19	N/A	6/21/2010	Heart River W of Mandan	380151
2,4-D	1.5	N/A	6/22/2010	Knife River-S of Hazen	380087
2,4-D	0.36	N/A	9/13/2010	Little Missouri River-Hwy 85	380059
Atrazine	0.34	1	6/23/2010	Red River	50540000
Atrazine	0.87	1	6/14/2010	Maple River at Mapleton	384155
Atrazine	0.42	1	6/21/2010	Red River at Grand Forks	5082500
Bentazon	0.11	4,500	6/21/2010	Turtle River-N of Manvel	5083000
Bentazon	0.57	4,500	6/21/2010	Forest River-nr Minto	5085000
Bentazon	0.19	4,500	6/21/2010	Park River @ Grafton	5090000
bentazon	0.28	4,500	7/20/2010	Souris River-W of Verendrye	380095
Bentazon	2.2	4,500	7/20/2010	DeLacs River-Foxholm	380021
Bentazon	0.23	4,500	7/20/2010	Souris River-W of Minot	380161
Bentazon	0.3	4,500	7/21/2010	James River	384130
Bentazon	0.19	4,500	7/26/2010	Red River @ Grand Forks	5082500
Bentazon	0.41	4,500	7/26/2010	Goose River @ Hilsboro	5066500
Bentazon	0.96	4,500	7/27/2010	Turtle River-N of Manvel	5083000
Bentazon	5.2	4,500	7/27/2010	Forest River-nr Minto	5085000
Bentazon	3.2	4,500	7/27/2010	Park River @ Grafton	5090000
Bentazon	0.39	4,500	7/28/2010	Red River at Pembina	5102490
Bentazon	0.5	4,500	8/9/2010	Park River @ Grafton	5090000
Bentazon	0.15	4,500	8/10/2010	Red River at Pembina	5102490
Bentazon	0.13	4,500	8/10/2010	Goose River @ Hilsboro	5066500
Bentazon	0.71	4,500	8/10/2010	Turtle River-N of Manvel	5083000
Bentazon	3.1	4,500	8/10/2010	Forest River-nr Minto	5085000
Bentazon	0.18	4,500	8/31/2010	James River	384130
Bentazon	0.42	4,500	8/31/2010	DeLacs River-Foxholm	380021
Bentazon	0.13	4,500	10/4/2010	Park River @ Grafton	509000
Bentazon	0.98	4,500	10/4/2010	Forest River-nr Minto	5085000
Bentazon	0.23	4,500	10/5/2010	Goose River @ Hilsboro	5066500
Bentazon	0.21	4,500	10/4/2010	Turtle River-N of Manvel	5083000
Bentazon	0.11	4,500	10/11/2010	DeLacs River-Foxholm	380021
Bifenthrin	0.13	N/A	10/5/2010	Red River	505400
Clopyralid	0.78	56,500	6/21/2010	Forest River-nr Minto	5085000
Clopyralid	0.41	56,500	6/21/2010	Park River @ Grafton	5090000
Clopyralid	0.13	56,500	6/21/2010	Heart River W of Mandan	380151
Dicamba	0.52	61	6/22/2010	Knife River-S of Hazen	380087

Pesticide	Concentration (ppb)	ALB	Date	Location	Site
Diuron	0.19	2.4	6/15/2010	Red River @ Brushville, MN	380083
MCPA	0.61	170	6/22/2010	Spring Creek @ Zap	380060
Metaolachlor	0.8	1	6/21/2010	Red River at Grand Forks	5082500
Metaolachlor	0.91	1	6/22/2010	Little Missouri River-Medora	380022
Metaolachlor	0.39	1	10/12/2010	Red River @ Brushville, MN	380083
Metaolachlor	0.7	1	7/28/2010	Red River @Pembina	5102490

Appendix C. List of all analytes tested for in 2010

Analyte	Trade name	Type	Reporting limit
2,4,5-T	N/A	H	0.080 ug/liter (ppb)
2,4,5-TP (fenoprop)	Silvex	H	0.080 ug/liter (ppb)
2,4-D	2,4-D, Weed-B-Gon	H	0.20 ug/liter (ppb)
2,4-DB	Butryac, Butoxone	H	0.20 ug/liter (ppb)
3-Hydroxycarbofuran	degradate	D	0.12 ug/liter (ppb)
Acetochlor	Surpass, harnass	H	0.30 ug/liter (ppb)
Acifluorfen	Blazer, Tackle	H	0.080 ug/liter (ppb)
Alachlor	Intrro, Lariat, Lasso	H	0.12 ug/liter (ppb)
Aldicarb	Temik	I	0.12 ug/liter (ppb)
Aldicarb sulfone	degradate	D	0.12 ug/liter (ppb)
Aldicarb sulfoxide	degradate	D	0.12 ug/liter (ppb)
Aldrin	Aldrex	I	0.12 ug/liter (ppb)
Ametryn	Evik, Gesapax	H	0.30 ug/liter (ppb)
Amitraz	Avartan, Triatox, Mitac	I	0.60 ug/liter (ppb)
Aspon	N/A	I	0.30 ug/liter (ppb)
Atrazine	Aatrex,	H	0.30 ug/liter (ppb)
Azinphos-methyl	Guthion, Bay	I	0.30 ug/liter (ppb)
Azoxystrobin	Quadris	F	0.30 ug/liter (ppb)
Bendiocarb	Dycarb, Niomil	I	0.12 ug/liter (ppb)
Benfluralin	Balan	H	0.12 ug/liter (ppb)
Bensulide	Pre-San, Betamec	H	0.12 ug/liter (ppb)
Bentazon	Basagran	H	0.080 ug/liter (ppb)
Bifenthrin	Talstar, Capture, Brigade	I	0.12 ug/liter (ppb)
Bolstar	Sulprofos	I	0.30 ug/liter (ppb)
Boscalid	Emerald, Endura	F	0.12 ug/liter (ppb)
Bromacil	Hyvar, Bromax	H	0.30 ug/liter (ppb)
Bromopropylate	Acarol, Folbex	I	0.60 ug/liter (ppb)
Captafol	Captafol, Sanspor	F	0.12 ug/liter (ppb)
Captan	Captanex, Orthocide	F	0.30 ug/liter (ppb)
Carbaryl	Sevin, Savit	I	0.12 ug/liter (ppb)
Carbophenothion	Trithion, Garrathion	I	0.30 ug/liter (ppb)
Carbofuran	Furadan, Carbodan	I	0.12 ug/liter (ppb)
Carfentrazone-ethyl	Aim	H	0.30 ug/liter (ppb)
Chlordane	Belt, Chlortox	I	1.2 ug/liter (ppb)
Chlorfenvinphos	N/A	I	0.30 ug/liter (ppb)
Chlorobenzilate	Akar, Acaraben	I	0.30 ug/liter (ppb)
Chloroneb	Terraneb	F	0.30 ug/liter (ppb)
Chlorothalonil	Bravo, Ole, Farben	F	0.12 ug/liter (ppb)
Chlorpyrifos	Lorsban, Dursban	I	0.30 ug/liter (ppb)

Analyte	Trade name	Type	Reporting limit
Chlorpyrifos-methyl	Reldan, Storcide	I	0.30 ug/liter (ppb)
Clopyralid	Stinger, Curtail	H	0.080 ug/liter (ppb)
Clothianidin	Poncho	I	0.12 ug/liter (ppb)
Coumaphos	Resistox, Asuntol	I	0.30 ug/liter (ppb)
Cyanazine	Bladex	H	0.60 ug/liter (ppb)
Cyfluthrin	Tempo, Baythroid	I	1.2 ug/liter (ppb)
Cyhalothrin	Grenade, Karate	I	1.2 ug/liter (ppb)
Cypermethrin	Ammo	I	1.2 ug/liter (ppb)
Dacthal	Dacthal	H	0.12 ug/liter (ppb)
DCPA	Dacthal	H	0.20 ug/liter (ppb)
DCPMU	degradate	D	0.12 ug/liter (ppb)
Deltamethrin	Butox, K-Othrin	I	1.2 ug/liter (ppb)
Diazinon	Knox Out, Diazol	I	0.30 ug/liter (ppb)
Dicamba	Banvel	H	0.080 ug/liter (ppb)
Dichlobenil	Casoron, Image	H	0.12 ug/liter (ppb)
Dichlorofenthion	Mobilawn, Gro13	I	0.30 ug/liter (ppb)
Dichlorprop	Weedone, Strike, Envert	H	0.20 ug/liter (ppb)
Dichlorvos	Vapona, DDVP	I	0.30 ug/liter (ppb)
Diclofop-methyl	Hoelon	H	0.60 ug/liter (ppb)
Dicloran	Botran	F	0.12 ug/liter (ppb)
Dicofol	Kelthane	I	0.30 ug/liter (ppb)
Dicrotophos	Bidrin	I	0.30 ug/liter (ppb)
Dieldrin	Dieldrex	I	0.12 ug/liter (ppb)
Dimethenamid	Outlook	H	0.30 ug/liter (ppb)
Dimethoate	Cygon, Roxion	I	0.30 ug/liter (ppb)
Dinoseb	Aretit, Dinitro	H	0.20 ug/liter (ppb)
Diphenylamine	N/A	F	0.12 ug/liter (ppb)
Disulfoton	Disyston, Dithiosystox	I	0.30 ug/liter (ppb)
Dithiopyr	Dimension	H	0.12 ug/liter (ppb)
Diuron	Direx, Karmex	H	0.12 ug/liter (ppb)
Endosulfan I	Thionex, Thiodan	I	0.12 ug/liter (ppb)
Endosulfan II	Thionex	I	0.12 ug/liter (ppb)
Endosulfan sulfate	degradate	D	0.12 ug/liter (ppb)
Endrin	Endrex	I	0.12 ug/liter (ppb)
Endrin aldehyde	degradate	D	0.12 ug/liter (ppb)
Endrin Ketone	Mendrin, Endrex	I	
EPN	N/A	I	0.30 ug/liter (ppb)
Esfenvalerate	Asana, Pydrin	I	0.12 ug/liter (ppb)
Ethalfluralin	Sonalan	H	0.12 ug/liter (ppb)
Ethion	Ethiol, Cethion	I	0.30 ug/liter (ppb)
Ethofumesate	Progress, Tramat	H	0.30 ug/liter (ppb)
Ethoprop	Mocap	I	0.30 ug/liter (ppb)
Etridiazole	Banrot, Terrazole	F	0.12 ug/liter (ppb)
Famphur	N/A	I	0.30 ug/liter (ppb)
Fenamiphos	Nemacur	I	0.30 ug/liter (ppb)

Analyte	Trade name	Type	Reporting limit
Fenarimol	Rubigan	F	0.12 ug/liter (ppb)
Fenbuconazole	Indar	F	0.60 ug/liter (ppb)
Fenitrothion	Cyfen, Folithion	I	0.30 ug/liter (ppb)
Fenobucarb	Folistar, Prostar, Moncut	F	0.12 ug/liter (ppb)
Fenoxaprop-ethyl	Puma, Option, Whip	H	0.60 ug/liter (ppb)
Fensulfothion	Terracur, Dasanit	I	0.30 ug/liter (ppb)
Fenthion	Baytex	I	0.30 ug/liter (ppb)
Fenuron	Dybar, PDU	H	0.30 ug/liter (ppb)
Fenvalerate	Pydrin	I	0.12 ug/liter (ppb)
Fipronil	Regent	I	0.60 ug/liter (ppb)
Fluazifop-P-butyl	Fusilade	H	0.60 ug/liter (ppb)
Fludioxanil	Maxim, Celest	F	0.30 ug/liter (ppb)
Flumioxazin	Sumisoya, Valor	H	0.30 ug/liter (ppb)
Fluometuron	Cortoran, Lanex	H	0.30 ug/liter (ppb)
Fluroxypyr-meptyl	Starane	H	0.30 ug/liter (ppb)
Flutolanil	Moncoat	F	1.2 ug/liter (ppb)
Folpet	Cosan, Fungitrol	F	0.30 ug/liter (ppb)
Heptachlor	Heptamule	I	0.12 ug/liter (ppb)
Heptachlor epoxide	degradate	D	0.12 ug/liter (ppb)
Hexachlorobenzene	HCB	F	0.12 ug/liter (ppb)
Hexazinone	Velpar	H	0.30 ug/liter (ppb)
Imazamethabenz	Assert	H	0.02 ug/liter (ppb)
Imidacloprid	Touchstone PF	I	0.30 ug/liter (ppb)
Iprodione	Rovral	F	0.12 ug/liter (ppb)
Isoxaben	Cent 7, Gallery	H	0.30 ug/liter (ppb)
Linuron	Linex, Lorox	H	0.30 ug/liter (ppb)
Malathion	Malathion, Cythion	I	0.30 ug/liter (ppb)
MCPA	MCP	H	20 ug/liter (ppb)
MCPP	Encore, Trimec	H	20 ug/liter (ppb)
Mefenoxam	Apron, Dividend,Dynasty	F	0.30 ug/liter (ppb)
Merphos	Folex	H	0.30 ug/liter (ppb)
Metalaxyl	Hi-Yield, Ridomil	F	0.30 ug/liter (ppb)
Methidathion	Somonic, suprathion	I	0.30 ug/liter (ppb)
Methiocarb	Mesurol	I	0.12 ug/liter (ppb)
Methomyl	Lannate	I	0.12 ug/liter (ppb)
Methoxychlor	Methoxychlor	I	0.12 ug/liter (ppb)
Metolachlor	Dual, Magnum	H	0.30 ug/liter (ppb)
Metribuzin	Sencor, Lexone	H	0.60 ug/liter (ppb)
Mevinphos	Phosdrin	I	0.30 ug/liter (ppb)
Mirex	Ferriamicide, Dechlorane	I	0.12 ug/liter (ppb)
Monocrotophos	N/A	I	0.30 ug/liter (ppb)
Monuron	CMU, Telvar	I	0.12 ug/liter (ppb)
Myclobutanil	Rally	F	0.60 ug/liter (ppb)

Analyte	Trade name	Type	Reporting limit
Neburon	Kloben	H	0.12 ug/liter (ppb)
Norflurazon	Solicam	H	0.12 ug/liter (ppb)
Ovex	Ovochlor, Ovotran	I	0.12 ug/liter (ppb)
Oxadiazon	Ronstar	H	0.12 ug/liter (ppb)
Oxamyl	Vydate	I	0.12 ug/liter (ppb)
Oxyfluorfen	Goal	H	0.12 ug/liter (ppb)
p,p'-DDD	N/A	I	0.12 ug/liter (ppb)
p,p'-DDE	degradate	D	0.12 ug/liter (ppb)
p,p'-DDT	N/A	I	0.12 ug/liter (ppb)
Parathion	Parathion, Thiophos	I	0.30 ug/liter (ppb)
Parathion-methyl	Penncap-M, Folidol-M	I	0.30 ug/liter (ppb)
PCNB (quintozene)	Terraclor, Tritisan	F	0.12 ug/liter (ppb)
Pendimethalin	Prowl	H	0.30 ug/liter (ppb)
Permethrin	Ambush, Pounce	I	1.2 ug/liter (ppb)
Phorate	Thimet	I	0.30 ug/liter (ppb)
Phosmet	Imidan	I	0.30 ug/liter (ppb)
Phosphamidon	Phosphamidon	I	0.30 ug/liter (ppb)
Picloram	Tordon	H	0.20 ug/liter (ppb)
Pirimicarb	Pirimor	I	0.30 ug/liter (ppb)
Pirimiphos-methyl	Tomahawk,Silosan	I	0.30 ug/liter (ppb)
Prodiamine	Barricade	H	0.12 ug/liter (ppb)
Prometon	Pramitol	H	0.60 ug/liter (ppb)
Prometryn	Caparol	H	0.30 ug/liter (ppb)
Pronamide	Kerb	H	0.12 ug/liter (ppb)
Propachlor	Ramrod	H	0.30 ug/liter (ppb)
Propanil	Stampede, Prop-Job	H	0.12 ug/liter (ppb)
Propargite	Comite, Omite	I	0.60 ug/liter (ppb)
Propazine	Milogard	F	0.30 ug/liter (ppb)
Propiconazole	Banner, Tilt, Radar	F	0.30 ug/liter (ppb)
Propoxur	Baygon	I	0.12 ug/liter (ppb)
Pyraclostrobin	Cabrio, Headline	F	0.30 ug/liter (ppb)
Pyridaben	Pyromite, Dynomite	I	0.60 ug/liter (ppb)
Pyrimethanil	Distinguish	F	0.12 ug/liter (ppb)
Quinclorac	Paramount	H	0.20 ug/liter (ppb)
Ronnel	Ectoral, Korlan	I	0.30 ug/liter (ppb)
Sethoxydim	Poast	H	6.0 ug/liter (ppb)
Siduron	Tupersan	H	0.12 ug/liter (ppb)
Simazine	Princep	H	0.60 ug/liter (ppb)
Simetryn	Gybon	H	0.30 ug/liter (ppb)
Sulfentrazone	Spartan	H	0.30 ug/liter (ppb)
Sulprofos	Sinbar	H	0.30 ug/liter (ppb)
Tebuconazole	Folicur	F	0.60 ug/liter (ppb)
Tebuthiuron	Spike	H	0.60 ug/liter (ppb)
Terbacil	Sinbar	H	0.12 ug/liter (ppb)
Terbufos	Counter	I	0.30 ug/liter (ppb)
Tetrachlorvinphos	Disvap	I	0.30 ug/liter (ppb)

Analyte	Trade name	Type	Reporting limit
Thiabendazole	Arbotect	F	0.30 ug/liter (ppb)
Thiobencarb	Bolero, Saturn, Abolish	H	0.30 ug/liter (ppb)
Tokuthion	Prothiofos	I	0.30 ug/liter (ppb)
Toxaphene	Phenatox,Toxakil	I	6.0 ug/liter (ppb)
Triadimefon	Bayleton	F	0.60 ug/liter (ppb)
Trichloronate	N/A	I	0.30 ug/liter (ppb)
Triclopyr	Garlon	H	0.080 ug/liter (ppb)
Trifloxystrobin	Ronilan	F	0.12 ug/liter (ppb)
Triflumazole	Terraguard, Procure	F	0.12 ug/liter (ppb)
Trifluralin	Treflan, Trilin	H	0.12 ug/liter (ppb)
Vinclozalin	Ronilan	F	0.12 ug/liter (ppb)
α-BHC	degradate	D	0.12 ug/liter (ppb)
β-BHC	degradate	D	0.12 ug/liter (ppb)
γ-BHC (Lindane)	Gamma BHC	I	0.12 ug/liter (ppb)
δ-BHC	degradate	D	0.12 ug/liter (ppb)

* H=Herbicide, F=Fungicide, I=Insecticide, D=Degradate