2020 Pesticide Surface Water Monitoring Report

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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 Environmental Quality's Division of Water Quality and the U.S. Geological Survey completed a surface water monitoring project in 2020 to assess levels of pesticides and pesticide degradates in North Dakota rivers and streams. Thirty-one sites were sampled approximately six times from April through October, resulting in a total of 183 river and stream samples collected. Each sample was analyzed for 102 different pesticides and pesticide degradates. The Department utilized the Montana State University Agriculture Experiment Station's Analytical Laboratory for sample analysis. Of all the river and stream analyses, there was a total of 2,175 (11.7%) detections, of which 81 (0.4%) were notable and 1,344 (7.2%) instances when an analyte was deemed present, but below the laboratory detection limit. The most commonly detected pesticide was atrazine, which was detected in 93% of samples and was found present, but below the detection limit, in the remaining samples. Other commonly detected pesticides were 2,4-D, bentazon, and metolachlor.

Based on the levels detected, results indicate that pesticides in North Dakota's rivers and streams have minimal risk to human health or the environment. Because there were detections, the survey supports the need for regular comprehensive monitoring of surface water for pesticides to monitor pesticide levels, continually assess risks of pesticides to human health and the environment and identify long-term 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 4.1-33 and 4.1-34 of the North Dakota Century Code. Under a cooperative agreement with the U.S. Environmental Protection Agency (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 focused on 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 (NDDH), 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.

The Program has since expanded its water quality focus to include surface water. To reflect this expansion, the Groundwater Working Committee has been renamed the Water Quality Advisory Committee (WQAC) and now also includes representatives from the US Fish and Wildlife Service, ND Game and Fish Department, and the ND Parks and Recreation Department.

Identifying pesticide surface water issues is a priority for the Department and the WQAC. Before the first pilot monitoring project in 2006, no agency routinely monitored North Dakota's surface waters for pesticides. The pilot monitoring project coordinated between the Department and the

NDDH 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 was below any level of concern established by the EPA for human health or aquatic life.

The Department, working in cooperation with the NDDH'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 (Orr and Gray, 2009).

The pesticide water quality monitoring program received an increase in funding in 2009 and because of this, 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. The 2009 sampling program consisted of sampling and testing 29 sites every six weeks for 180 different pesticides and pesticide degradates. Because the detections during the 2008 monitoring project were not found until June, the WQAC recommended 2009 sampling start in June and end in November. There was a total of eleven detections of four different pesticides, including 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. Concentrations of all pesticides were below levels deemed harmful by the EPA (Johnson and Gray, 2010).

The funding increase continued into 2010 and sampling sites were chosen from the NDDH's Ambient River and Stream Water Quality Monitoring Program sites to make sampling most efficient. Thirty-three sites were sampled every six weeks from April to October of 2010 and tested for 180 different pesticides and pesticide degradates. There was a total of 43 detections of 9 different pesticides, including 2,4-D, atrazine, bentazon, bifenthrin, clopyralid, dicamba, diuron, MCPA and metolachlor. The most commonly detected pesticide in 2010 was bentazon, which was detected 22 times. Metolachlor and 2,4-D were each detected four times. For all pesticides, concentrations were below levels deemed harmful by the EPA (Johnson and Gray, 2011).

In 2011, funding was directed to a wetland pesticide monitoring project. Due to staffing shortage, no monitoring was performed by the Department in 2012.

Monitoring of rivers and streams resumed in 2013. Sampling sites were chosen from the NDDH's Ambient River and Stream Water Quality Monitoring Program to make sampling most efficient. Thirty sites were sampled approximately seven times from April to October and tested for 99 pesticides and pesticide degradates. There were 30 notable detections of 6 different pesticides including 2,4-D, acetochlor, atrazine, dimethenamid, diuron and metolachlor. The most commonly detected pesticide was atrazine followed by 2,4-D (Sauter and Gray, 2014).

In 2014, river and stream monitoring continued and was similar in design to 2013. In 2014, targeted sampling was also performed in addition to monthly sampling. Targeted sampling consisted of higher frequency sampling during heaviest pesticide use times at select sites that had a history of high detections. Because of targeted sampling, there were more detections in 2014 than any previous year. There were 50 notable detections of 6 pesticides, including acetochlor, atrazine, bromoxynil, chlorpyrifos, malathion, and metolachlor. The most commonly detected pesticide was atrazine followed by 2,4-D (Sauter and Gray, 2015).

Also in 2014, the NDDH and USGS provided an opportunity to sample lakes throughout North Dakota for pesticides. This project consisted of collecting and analyzing samples from 27 lakes throughout the state, one time during mid to late summer. These samples were analyzed by Montana State University Agriculture Experiment Station's Analytical Laboratory for 96 pesticides and pesticide degradates. There were two notable detections of chlorpyrifos and one notable detection of atrazine. Similar to river and stream results, atrazine and 2,4-D were the most commonly detected pesticides (Sauter and Gray, 2015).

In 2015, river and stream monitoring continued and was similar in design to 2014. Thirty sites were sampled approximately six times from April through October, resulting in a total of 178 river and stream samples collected. Each sample was analyzed for 101 different pesticides and pesticide degradates. There were 29 notable detections of three pesticides, including acetochlor, atrazine and terbufos sulfone. The most commonly detected pesticides were atrazine; 2,4-D, bentazon and metolachlor (Sauter, 2016).

In 2016, river and stream monitoring continued and was similar in design to 2015. Thirty sites were sampled approximately six times from April through October, and four additional sites were sampled either at random or as part of follow-up sampling, resulting in a total of 196 river and stream samples collected. Each sample was analyzed for 102 different pesticides and pesticide degradates. There were 51 notable detections of seven pesticides, including 2,4-D, acetochlor, atrazine, chlorpyrifos, metolachlor, metsulfuron methyl and sulfometuron methyl. The most commonly detected pesticides were atrazine, 2,4-D, bentazon and prometon (Sauter, 2017).

In 2017, river and stream monitoring continued and was similar in design to 2016. Thirty sites were sampled approximately six times from April through October with one site being sampled additional times as part of follow-up sampling, resulting in a total of 180 river and stream samples collected. Each sample was analyzed for 102 different pesticides and pesticide degradates. There were 48 notable detections of four pesticides, including atrazine, acetochlor, malathion and metolachlor. The most commonly detected pesticides were atrazine, 2,4-D, bentazon and metolachlor. (Sauter, 2018).

In 2018, river and stream monitoring continued and was similar in design to 2017. Thirty sites were sampled approximately six times from April through October, resulting in a total of 175 river and stream samples collected. Each sample was analyzed for 102 different pesticides and pesticide degradates. There were 85 notable detections of six pesticides, including acetochlor, atrazine, clothianidin, diuron, imidacloprid and metolachlor. The most commonly detected pesticides were atrazine, 2,4-D, bentazon and metolachlor. (Sauter, 2019).

In 2019, river and stream monitoring continued and was similar in design to 2018. Thirty sites were sampled approximately six times from April through October, resulting in a total of 184 river and stream samples collected. Each sample was analyzed for 102 different pesticides and pesticide degradates. There were 119 notable detections of eight pesticides, including acetochlor, atrazine, chlorpyrifos, clothianidin, halosulfuron methyl, imidacloprid, metolachlor and phorate sulfone. The most commonly detected pesticides were atrazine, 2,4-D, bentazon and metolachlor. (Sauter, 2020).

2020 Project goals
The goals of the 2020 monitoring study were to:

- Determine the occurrence and concentration of pesticides in North Dakota rivers and streams
- Identify trends in pesticide contamination to guide regulatory activities
- Determine whether any pesticides may be present at concentrations that could adversely affect human health, aquatic life, or wildlife dependent on aquatic life
- Evaluate levels of certain neonicotinoid insecticides in North Dakota Rivers and streams

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 Protection Program and evaluations for pesticide registrations.

MATERIALS AND METHODS

Pesticide samples were collected approximately six times in 2020 at thirty-one sites from April through October. Locations of the sampling sites, site IDs, and GPS coordinates can be found in Table 1 and Figure 1. Sample collection dates can be found in Table 2. Samples were scheduled to be collected once per month in April, May, June, July, August, and October. Realistically, dates were variable and dependent on weather and staffing. The 2020 pesticide surface water sampling program featured good representation of North Dakota's rivers and streams and correlated well with the heaviest pesticide use period.

Site name, site ID, time and date were recorded in the field on a sample log form (Appendix A). River and stream 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. Samples were collected using weighted bottle samplers (WBSs) or by wading the site. A WBS consists of a stainless steel or fiberglass tube that is approximately seven inches long and four inches inside diameter, which is connected to a rope. 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 approximately at its greatest depth in the cross section. The WBS was then lowered to a depth equal to approximately 60 percent of the total stream depth. When the bottle was filled completely (i.e., no bubbles observed) the WBS and bottle were retrieved. The bottle was capped, removed from the WBS, labeled, and placed in a cooler on ice until shipment. When necessary, wadeable grab samples were collected by wading into the stream. 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 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. The samples were carefully packed with bubble wrap and/or rubber mesh and put into a cooler with ice and more packing materials shortly after collection. Coolers containing samples and ice were shipped to the laboratory within seven days of collection using a next-day shipping service.

Each pesticide sample consisted of one 1-L amber glass jar with a cap featuring a 1/8” PTFE-faced silicone seal. Sample bottles arrived precleaned according to EPA procedure 1 methods for extractable organic, semi-volatile, and pesticide analysis. Selected field samples were collected in replicate to provide estimates of sample variability. The replicates consisted of one separate sample collected directly after the original sample was collected. Field blank samples were also collected by each sampling entity twice during the season. Field blanks consisted of blank water received from the NDDH’s Laboratory Division. The blank water was received in 1-L amber glass bottles with Teflon lined lids. At the time of sampling, the blank water was poured into a sampling bottle, the lid was placed on the bottle, and the bottle was labeled and placed in a cooler with ice.

Each sample was analyzed for 102 different pesticides and pesticide degradates (Appendix B) by Montana State University’s Agriculture Experiment Station Analytical Laboratory. Montana’s laboratory developed a customized method titled the MTUniversal method. This method was initially developed to analyze samples for their groundwater monitoring program, but it also fit this project. The method is modeled after the successful USDA PDP Water Survey Program which uses the analytical approach to universalize one method to capture as many compounds as possible at the lowest possible levels with a broader range of acceptable performance. The method is validated according to the requirements of the MT 2008 EPA QAPP.

Table 1. 2020 North Dakota pesticide surface water monitoring project sites.

NDDoH Site ID	Site Name	Latitude	Longitude
380009	Sheyenne River near Cooperstown, ND	47.4328	-98.0276
380012	James River at Lamoure, ND	46.3555	-98.3045
380013	James River at Jamestown, ND	46.8897	-98.6817
380022	Little Missouri River at Medora, ND	46.9195	-103.5282
380031	Wild Rice River near Abercrombie, ND	46.4680	-96.7837
380037	Turtle River at Manvel, ND	48.0786	-97.1845
380039	Forest River at Minto, ND	48.2858	-97.3681
380059	Little Missouri River nr Watford City, ND	47.5958	-103.2630
380067	Cannonball River at Breien, ND	46.3761	-100.9344

Table 1. 2020 North Dakota pesticide surface water monitoring project sites (continued).

380077	Cedar Creek nr Raleigh, ND	46.0917	-101.3337
380083	Red River at Brushville, MN	46.3695	-96.6568
380087	Knife River at Hazen, ND	47.2853	-101.6221
380091	Souris River nr Sherwood	48.9900	-101.9582
380095	Souris River nr Verendrye, ND	48.1597	-100.7296
380105	Cannonball River nr Raleigh, ND	46.1269	-101.3332
380151	Heart River nr Mandan, ND	46.8339	-100.9746
380156	Goose River at Hillsboro, ND	47.4094	-97.0612
380157	Park River at Grafton, ND	48.4247	-97.4120
380158	Pembina River at Neche, ND	48.9897	-97.5570
380160	Heart River nr Richardton, ND	46.7456	-102.3083
380161	Souris River above Minot, ND	48.2458	-101.3713
384130	James River nr Grace City, ND	47.5581	-98.8629
384131	Knife River nr Golden Valley, ND	47.1545	-102.0599
384155	Maple River below Mapleton, ND	46.9052	-97.0526
384156	Red River at Grand Forks, ND	47.9275	-97.0281
384157	Red River at Pembina, ND	48.9769	-97.2376
385001	Sheyenne River near Kindred, ND	46.6316	-97.0006
385040	Red River nr Harwood, ND	46.9770	-96.8202
385055	Bois de Sioux River near Doran, MN	46.1522	-96.5789
385169	Sheyenne River at Lisbon, ND	46.4469	-97.6793
385414	Red River at Fargo, ND	46.8611	-96.7837
386013	Red River nr Georgetown, MN	47.0927	-96.8170

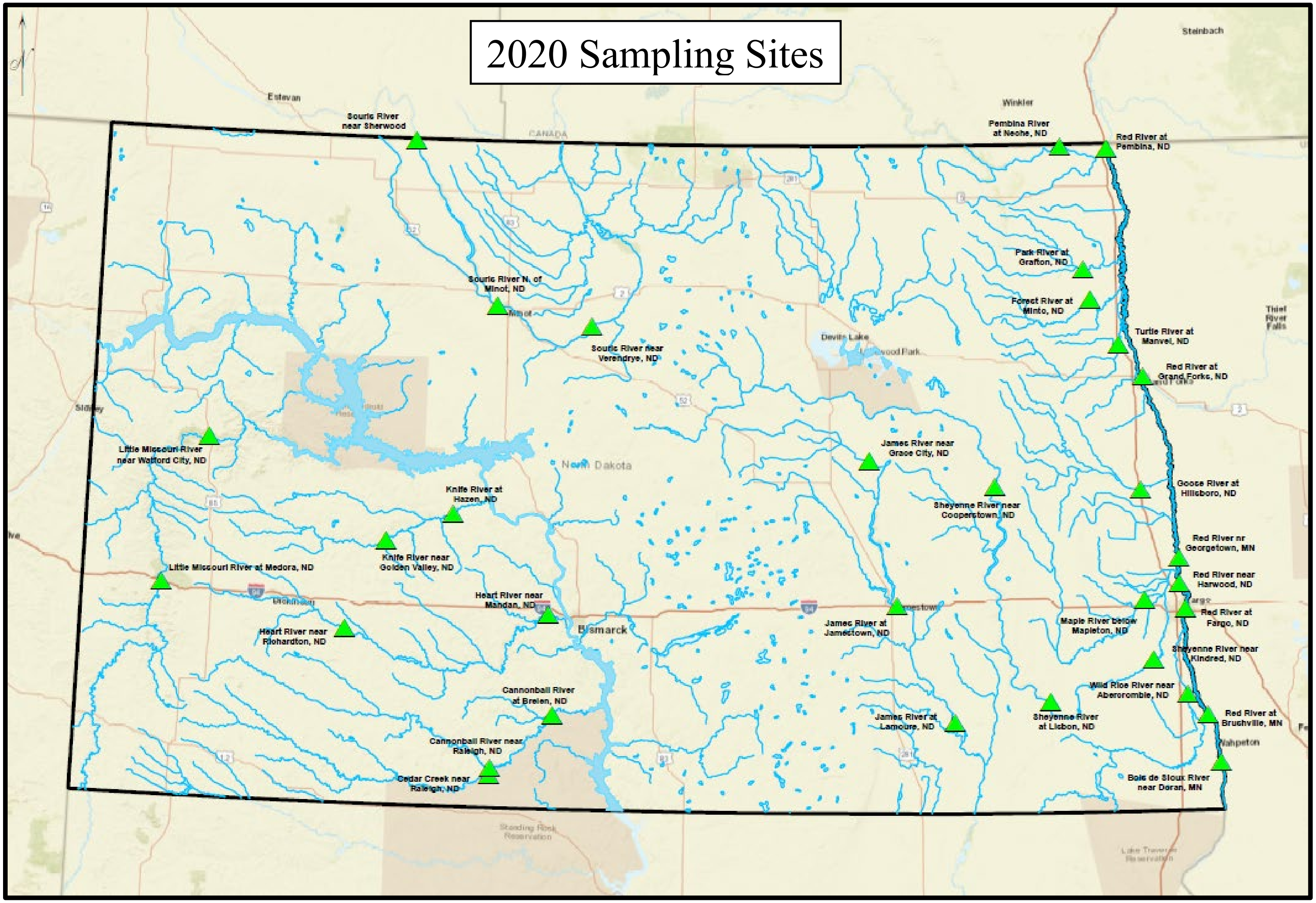
Table 2. 2020 North Dakota pesticide river and stream monitoring sample collection dates.

Site ID	**Sampling Date**					
380009	4/30/2020	5/20/2020	6/2/2020	7/8/2020	8/19/2020	10/20/2020
380012	4/29/2020	5/20/2020	6/2/2020	7/8/2020	8/19/2020	10/19/2020
380013	4/29/2020	5/20/2020	6/2/2020	7/8/2020	8/19/2020	10/19/2020
380022	4/22/2020	5/19/2020	6/4/2020	7/6/2020	8/18/2020	11/3/2020
380031	4/21/2020	5/4/2020	6/22/2020	7/20/2020	8/10/2020	10/21/2020
380037	4/28/2020	5/12/2020	6/8/2020	7/22/2020	8/17/2020	10/5/2020
380039	4/28/2020	5/12/2020	6/8/2020	7/22/2020	8/17/2020	10/5/2020
380059	4/22/2020	5/19/2020	6/4/2020	7/6/2020	8/18/2020	11/3/2020
380067	4/21/2020	5/18/2020	6/3/2020	7/7/2020	8/17/2020	11/4/2020
380077	4/21/2020	5/18/2020	6/3/2020	7/7/2020	8/17/2020	11/4/2020
380083	4/29/2020	5/20/2020	6/2/2020	7/8/2020	8/19/2020	10/19/2020
380087	4/21/2020	5/18/2020	6/3/2020	7/7/2020	8/17/2020	11/4/2020
380091	4/27/2020	5/20/2020	6/22/2020	7/15/2020	8/18/2020	10/6/2020

Table 2. 2020 North Dakota pesticide river and stream monitoring sample collection dates (continued).

Site ID	Sampling Date					
380095	4/28/2020	5/19/2020	6/23/2020	7/14/2020	8/19/2020	10/5/2020
380105	4/21/2020	5/18/2020	6/3/2020	7/7/2020	8/17/2020	11/4/2020
380151	4/21/2020	5/18/2020	6/3/2020	7/7/2020	8/18/2020	11/3/2020
380156	4/29/2020	5/13/2020	6/16/2020	7/22/2020	8/5/2020	10/7/2020
380157	4/28/2020	5/12/2020	6/8/2020	7/20/2020	8/17/2020	10/5/2020
380158	4/27/2020	5/12/2020	6/10/2020	7/20/2020	8/12/2020	10/6/2020
380160	4/22/2020	5/19/2020	6/4/2020	7/6/2020	8/18/2020	11/3/2020
380161	4/28/2020	5/18/2020	6/23/2020	7/15/2020	8/19/2020	10/6/2020
384130	4/30/2020	5/20/2020	6/2/2020	7/8/2020	8/19/2020	10/20/2020
384131	4/21/2020	5/18/2020	6/3/2020	7/7/2020	8/17/2020	11/4/2020
384155	4/21/2020	5/4/2020	6/24/2020	7/20/2020	8/10/2020	10/21/2020
384156	4/29/2020	5/11/2020	6/3/2020	7/27/2020	8/18/2020	
384157	4/27/2020		6/15/2020	7/14/2020	8/12/2020	10/6/2020
385001	4/20/2020	5/6/2020	6/24/2020	7/21/2020	8/11/2020	10/22/2020
385055	4/29/2020	5/20/2020	6/2/2020	7/8/2020	8/19/2020	10/19/2020
385169	4/29/2020	5/20/2020		7/8/2020	8/19/2020	10/19/2020
385414	4/21/2020	5/6/2020	6/24/2020	7/22/2020	8/12/2020	10/21/2020
386013	4/22/2020	5/5/2020	6/24/2020	7/21/2020	8/11/2020	10/22/2020

Figure 1. 2020 pesticide surface water sampling sites.



RESULTS AND DISCUSSION

River and stream sites

A total of 183 samples were analyzed for 102 different pesticides. Of the 102 pesticides analyzed, 69 different pesticides were present in at least one of the samples. Several pesticides were present in a high percentage of the samples as indicated in Table 3. Atrazine, 2,4-D, bentazon and metolachlor were present in over 70% of the samples collected. Although these pesticides were present in 70% or more of samples collected, a high percentage of the detections were well below levels that may negatively impact aquatic ecosystems or human health.

Table 3. Common pesticides detected in North Dakota surface waters in 2020.

Everything PPB unless otherwise noted	**Quantifiable Detections**		**Qs (Present below reporting limit)**		**Total**	
Analyte	Number	Percent	Number	Percent	Number	Percent
Atrazine	172	94%	11	6%	183	100%
Deethyl atrazine	171	93%	12	7%	183	100%
Hydroxy atrazine	153	84%	18	10%	171	93%
2,4-D	129	70%	37	20%	166	91%
Bentazon	134	73%	9	5%	143	78%
Metolachlor ESA	127	69%	16	9%	143	78%
Prometon	71	39%	50	27%	121	66%
Imazapyr	64	35%	54	30%	118	64%
Pyrasulfotole	42	23%	76	42%	118	64%
Acetochlor OA	101	55%	16	9%	117	64%
Propiconazole	39	21%	76	42%	115	63%
Tebuconazole	48	26%	64	35%	112	61%
Metolachlor OA	92	50%	17	9%	109	60%
Acetochlor ESA	90	49%	14	8%	104	57%
Metolachlor	65	36%	36	20%	101	55%
Dimethenamid OA	75	41%	21	11%	96	52%
Imazethapyr	68	37%	23	13%	91	50%
Saflufenacil	42	23%	49	27%	91	50%
Sulfentrazone	45	25%	39	21%	84	46%
Tebuthiuron	32	17%	51	28%	83	45%
Dimethenamid	51	28%	28	15%	79	43%
IMAM	25	14%	53	29%	78	43%
Imidacloprid	32	17%	36	20%	68	37%
MCPA	31	17%	32	17%	63	34%
Imazamox	29	16%	30	16%	59	32%
Tetraconazole	23	13%	32	17%	55	30%

Data were compared to EPA established aquatic life benchmark (ALB) values and human health maximum contaminant level (MCL) values. Detections at 20% or more of the lowest of either of these values were further reviewed. There were 81 detections of pesticides at or above these levels as detailed in Table 4.

Table 4. Detections that were 20% or more of lowest ALB or MCL.

Detections that were 20% or more of lowest ALB or MCL			
Chemical	Number of detections	Range of detections (PPB)	Lowest ALB or MCL (PPB)
Atrazine	19	0.2-2.4	1
Clothianidin	2	0.024, 0.026	0.05
Diuron	1	0.52	2.4
Imidacloprid	26	0.002-0.38	0.01
Metolachlor	33	0.23-3.30	1

There were 23 sites in which these chemicals were found at 20% or more of an ALB or MCL (Figure 2).

The Wild Rice River sampled near Abercrombie, ND had ten detections; the pesticides detected were atrazine (three detections), imidacloprid (three detections) and metolachlor (four detections). The Red River at Pembina, ND had eight detections; the pesticides detected were atrazine (two detections), imidacloprid (three detections) and metolachlor (three detections). The Maple River below Mapleton, ND had eight detections; the pesticides detected were atrazine (two detections), imidacloprid (three detections) and metolachlor (three detections). The Red River at Grand Forks, ND had seven detections; the pesticides detected were atrazine, clothianidin (two detections), imidacloprid (two detections) and metolachlor (two detections). The Red River sampled near Georgetown, MN had seven detections; the pesticides detected were atrazine (two detections), imidacloprid (two detections) and metolachlor (three detections). Within the Red River basin, the Park River sampled at Grafton, ND had six detections; the pesticides detected were imidacloprid (two detections) and metolachlor (four detections). The Red River sampled at Fargo, ND had six detections; the pesticides detected were atrazine (two detections), imidacloprid and metolachlor (three detections). The Sheyenne River near Kindred, ND had four detections; the pesticides detected were imidacloprid (two detections) and metolachlor (two detections). The Forest River sampled at Minto, ND had one imidacloprid detection and three metolachlor detections. The Bois de Sioux River sampled near Doran, MN had three detections; the pesticides detected were atrazine and metolachlor (two detections). The Goose River sampled at Hillsboro, ND had two detections; the pesticides detected were imidacloprid and metolachlor. The Sheyenne River at Lisbon, ND had two pesticide detections; the pesticides detected were imidacloprid and metolachlor. The Red River at Brushvale, MN had two detections; the pesticides detected were imidacloprid and metolachlor. The Sheyenne River near Cooperstown, ND had one atrazine detection and one metolachlor detection.

Within the James River Basin, the James River at Lamoure, ND had one imidacloprid detection; The James River at Jamestown, ND had one diuron detection. The James River near Grace City, ND had one atrazine detection.

Within the other river basins in North Dakota, the Souris River above Minot, ND had three pesticide detections; the pesticides detected were atrazine, imidacloprid and thiamethoxam. The Souris River near Verendrye, ND had one atrazine detection and one imidacloprid detection. The Cannonball River near Raleigh, ND had one imidacloprid detection. The Knife River near Golden Valley, ND had one atrazine detection. The Knife River at Hazen, ND had one atrazine detection.

The 81 pesticide detections at concentrations of 20% or more of the lowest ALB were spread throughout the growing season with most detections occurring in July (Figure 3). In April and May, there were two detections of imidacloprid and one metolachlor detection. In June, atrazine, imidacloprid and metolachlor were detected multiple times at levels 20% or more of the lowest ALB. July had detections of atrazine, clothianidin, diuron, imidacloprid and metolachlor. There were multiple detections of imidacloprid and metolachlor and one detection of atrazine and clothianidin in August. In October, metolachlor was detected twice, and imidacloprid was detected once above 20% of an ALB.

Figure 3. Detections at 20% or more of the lowest ALB or MCL by month samples were collected.

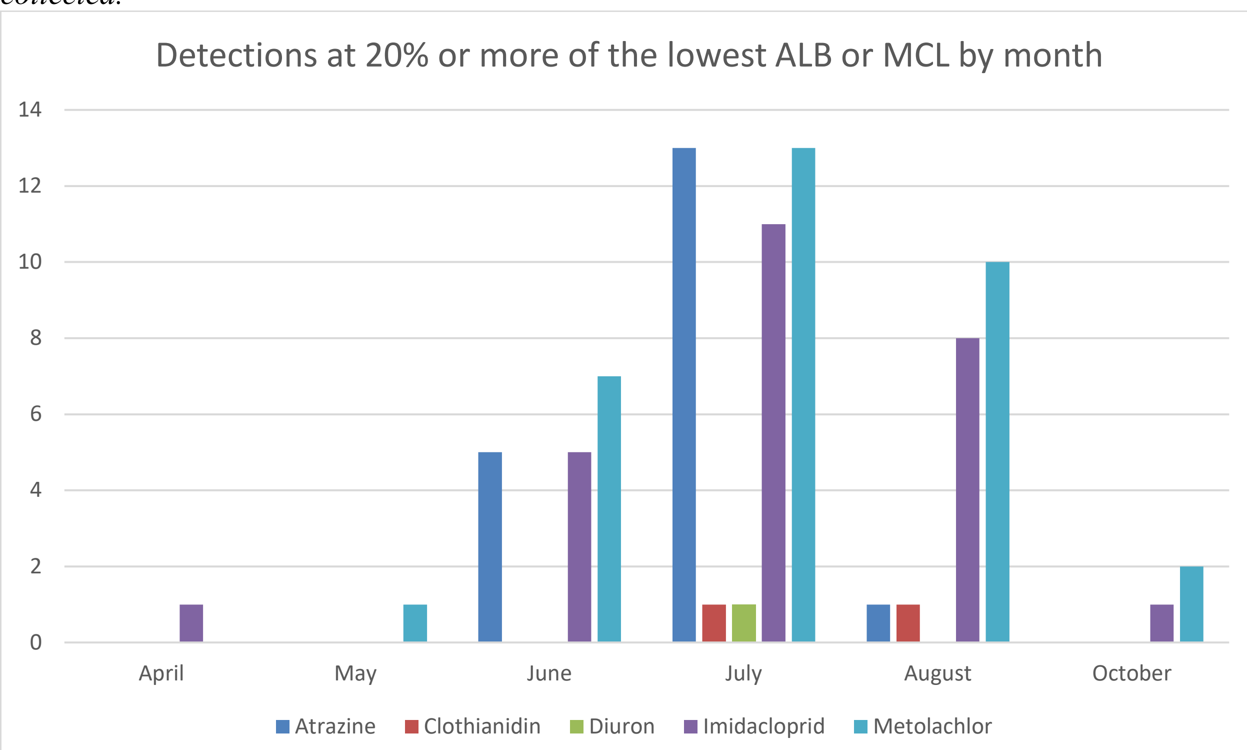
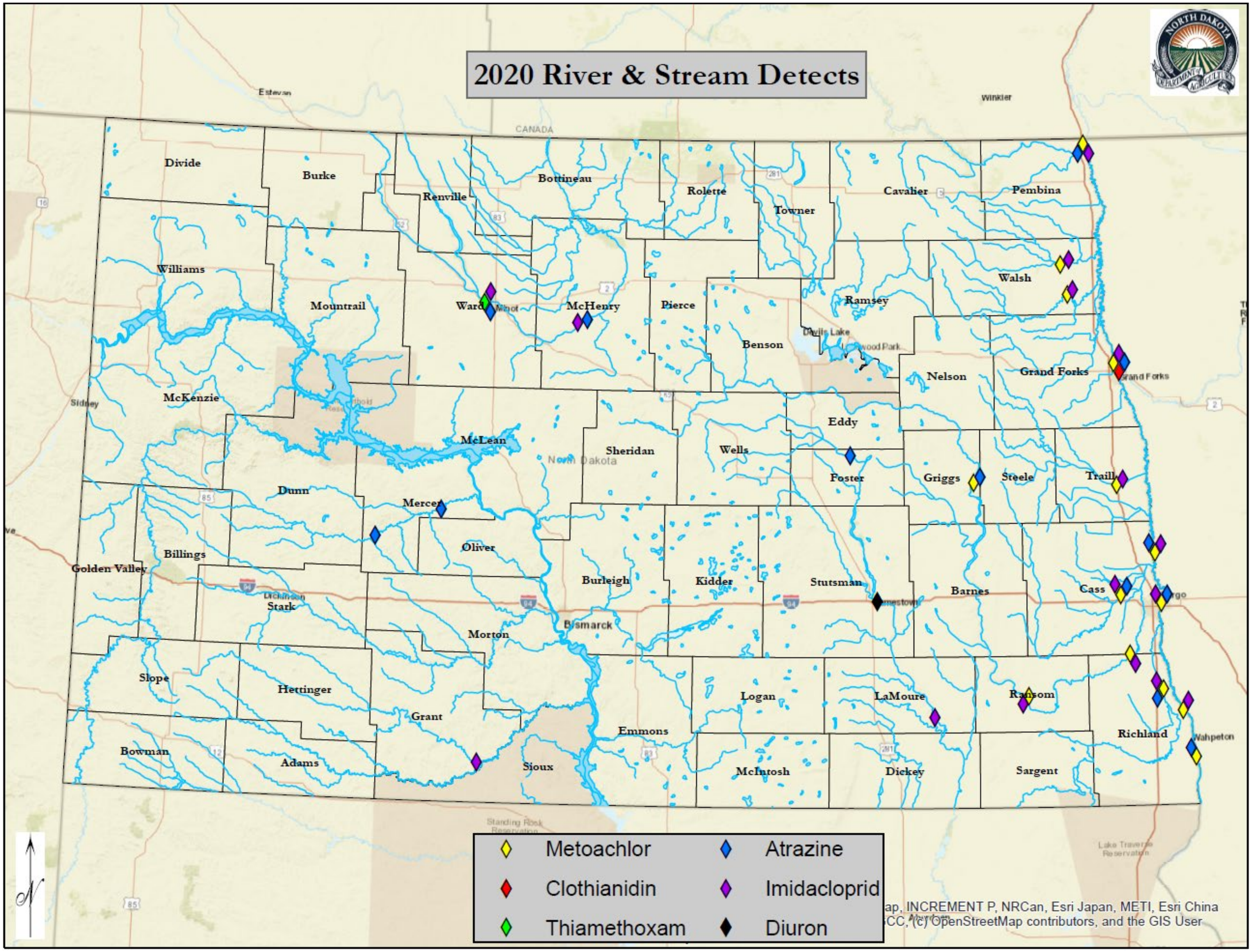


Figure 2. Sampling sites where pesticides were detected at 20% or more of lowest ALB.



Looking at values at or above 20% of an ALB is a very conservative means of filtering data and does not automatically indicate significant risk to aquatic ecosystems or human health. In looking for levels that may pose risk, results were further reviewed to identify instances in which an ALB or MCL had been exceeded (Tables 4 & 5). The most conservative ALBs and MCLs which are displayed below, are based on long-term exposure to a pesticide and are discussed in detail below.

ALB discussion

The EPA has established ALBs for several chemicals, relying on studies required under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as well as a wide range of environmental, laboratory, field studies, and modeling available in published 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. ALBs are typically based on continuous exposure over a window of time, such as 96 hours or more depending on the study. EPA-established ALBs are guidance for states to use and are not regulatory thresholds. NDDA sampling consists of one grab sample, so essentially it is one point in time and is difficult to correlate with a true ALB. In most cases, the Department could compare the concentration detected in surface water to the EPA-established ALB as a reference. Any value that exceeded an ALB constitutes an indication of exceedance and does not constitute a true exceedance, as sample collection methods are variable for each ALB.

Table 4. Detections indicating an aquatic life benchmark (ALB) was met or exceeded.

Site Name	Sample Date	Analyte	Level (ppb)	ALB
Bois de Sioux River near Doran, MN	5/20/2020	Metolachlor	1.9	1
Bois de Sioux River near Doran, MN	7/8/2020	Metolachlor	1.1	1
Cannonball River nr Raleigh, ND	8/17/2020	Imidacloprid	0.38	0.01
Forest River at Minto, ND	6/8/2020	Metolachlor	1.2	1
Maple River below Mapleton, ND	6/22/2020	Atrazine	1.8*	1
Maple River below Mapleton, ND	6/22/2020	Metolachlor	2.5*	1
Maple River below Mapleton, ND	7/20/2020	Metolachlor	3.3	1
Park River at Grafton, ND	7/20/2020	Imidacloprid	0.04	0.01
Red River at Fargo, ND	7/22/2020	Metolachlor	1.2	1
Red River at Grand Forks, ND	7/27/2020	Metolachlor	2.7	1
Red River at Pembina, ND	6/15/2020	Metolachlor	1.4	1
Red River nr Georgetown, MN	7/21/2020	Metolachlor	1.1	1
Souris River above Minot, ND	7/15/2020	Imidacloprid	0.027	0.01
Souris River nr Verendrye, ND	7/14/2020	Imidacloprid	0.021	0.01
Wild Rice near Abercrombie, ND	6/22/2020	Atrazine	2.4	1
Wild Rice near Abercrombie, ND	6/22/2020	Metolachlor	1.5	1
Wild Rice near Abercrombie, ND	7/20/2020	Metolachlor	3.3	1
Wild Rice near Abercrombie, ND	8/10/2020	Metolachlor	1.5	1

*For starred detections, relative percent difference for the replicate check was not acceptable. Results are still being reported as both original and replicate samples indicated ALB had been exceeded.

Risk from ALB and MCL Exceedance

Atrazine

Atrazine, a broadleaf herbicide used primarily on corn, was quantifiably detected in 94% (172) of samples and present in 6% (11) of samples. Of those detections, 19 were at 20% or more of an MCL or ALB. Atrazine detections indicated an MCL was met or exceeded twice with values of 1.8 and 2.4 ppb. The Refined Ecological Risk Assessment for Atrazine (Environmental Protection Agency 2016) discusses risk from atrazine to the environment. This document lists the most sensitive aquatic endpoint for atrazine at less than 1.0 ppb. This value is based on a study performed in 1976 that demonstrated a 67% reduction in chlorophyll production in green algae over a seven-day exposure period (Torres and O'Flaherty 1976). The EPA risk assessment states average atrazine concentrations in water at or above 5.0 ppb for several weeks are predicted to lead to reproductive effects in fish, while a 60-day average of 3.4 ppb has a high probability of impacting aquatic plant community primary productivity, structure, and function. The highest concentrations detected were 1.8 ppb and 2.4 ppb at different sites. In both instances, the samples collected before and after the exceedances were below 1.0 ppb indicating minimal, short-term risk. No aquatic impacts were noted by samplers or were reported to the NDDA by any other entities. Although there was ALB exceedance it is important to note that out of 183 samples, atrazine was only found above an ALB twice. Notable atrazine detections were similar to those found in 2019 (2 notable detections) and were lower compared to 2018 (9) however, it is still one of the most commonly detected pesticides in rivers and streams. These sites will continue to be monitored closely and if funding allows, targeted sampling will be performed.

Imidacloprid

Imidacloprid is primarily used as a seed treatment on corn, soybeans, small grains and some oilseed crops in North Dakota. Other products containing imidacloprid allow for various uses on ornamental and turf, golf courses, select agricultural commodities and on pets. Imidacloprid was detected at 20% or more of an ALB 26 times, four of which exceeded an ALB in 2020. The Preliminary Aquatic Risk Assessment to Support the Registration Review of Imidacloprid discusses risk from imidacloprid to aquatic ecosystems (Environmental Protection Agency 2017). This document lists the most sensitive aquatic endpoint for imidacloprid at 0.01 ppb for the no observed adverse effect concentration (NOAEC) and 0.03 ppb for the lowest observed affect concentration (LOAEC) for mayfly (*C. horaria*) for chronic effects (28-day study). The highest concentration detected was 0.38. Samples collected before and after the four ALB exceedances were all under the ALB indicating risk was short in duration. EPA updated the ALB for imidacloprid in 2018. In previous years, the lowest ALB for imidacloprid was 1.05 ppb, which is significantly higher than the highest detection in 2020.

Metolachlor

Metolachlor is used primarily on corn in North Dakota for grass and broadleaf weed control. Metolachlor and metolachlor degradates were detected or present in as high as 75% of samples. Metolachlor was detected at or above an ALB twelve times in 2020. The Registration Review Problem Formulation for Metolachlor and S-Metolachlor (Environmental Protection Agency 2014) discusses risk from metolachlor to aquatic ecosystems. The lowest EPA established ALB is 1 ppb for chronic risk to invertebrates and is based on the lowest NOAEC from a life-cycle test with water flea (*Daphnia magna*). The LOAEC for water flea is 10 ppb. The highest concentration detected was 3.3 ppb which is over the NOAEC but below the LOAEC. This indicates minimal risk to aquatic ecosystems. There is no EPA MCL for metolachlor.

Additional Neonicotinoid discussion

As neonicotinoid insecticides continue to gain attention and discussions about prevalence in the environment become more common, it is important to discuss them as part of river and stream sampling. In 2008 and 2009, samples were analyzed for imidacloprid, and analysis for clothianidin was added in 2010. Since 2013, ND river and stream samples have been analyzed for the neonicotinoid insecticides clothianidin, imidacloprid, and thiamethoxam. Compared to herbicides such as atrazine and 2,4-D, neonicotinoids are not as frequently detected. When detections do occur, they are at low levels. In 2020, clothianidin was detected twice and present below the reporting limit in 29 samples; the highest detection was 0.026 ppb. Imidacloprid was detected in 32 samples and present below the reporting limit in 36 samples; the highest detection was 0.38 ppb. Thiamethoxam was detected twice and present below the reporting limit 21 times with the highest detection being 0.22 ppb; the lowest ALB for thiamethoxam is 0.74 ppb. Out of the 184 samples collected, only twice was a neonicotinoid detected above the lowest aquatic LOAEC. In 2020, there were less neonicotinoid detections compared to 2019 and almost all detections were below levels that may affect the most sensitive aquatic invertebrate test species. River and stream sampling indicate neonicotinoid insecticides under current uses do not pose significant risk to river and stream ecosystems in North Dakota.

Conclusion

Results of the 2020 monitoring study indicate that pesticides were found at similar levels to those found in 2019. Trends over the last few years show certain pesticides are consistently found in North Dakota rivers and streams. In 2020 there were 18 detections that indicated MCL and/or ALB had been exceeded, this is a very small percentage of samples. Overall, detections ranged widely in level and frequency based on the pesticide, with a very large percentage being below the laboratory’s reporting limits.

The need for continued sampling is of utmost importance not only to continue to ensure rivers and streams in ND are safe, but also to identify trends and build on the existing data set. Levels of atrazine, acetochlor, 2,4-D, metolachlor, prometon, tebuconazole, and bentazon need to continue to be monitored. These pesticides are present in a high percentage of samples and occasionally approach levels that may begin to impact aquatic ecosystems. Detections of imidacloprid have increased over the last few years, and 2018 research indicated it is toxic at lower levels than previously thought. It is imperative to monitor, and if necessary, implement risk mitigation before significant impacts to human health or the environment happen. Mitigation measures could include increased use inspections focused on specific pesticides, increased user education and compliance assistance, and site-specific or chemical-specific use restrictions.

Comparisons of river and stream data from 2008-2020 showed a few potential trends. Atrazine continues to be found in a high percentage of samples, which is not surprising given the large-scale use and its chemical properties. Atrazine is also the most common pesticide found at higher levels, especially in the eastern third of the state. This is also not surprising since atrazine is predominantly used on corn, which was planted on a large number of acres in the Red River Valley. In addition, use of atrazine and other herbicides has likely increased due to the expansion in acres infested with glyphosate-resistant weeds. Another trend across all years of data reveals the highest number of detections comes from samples collected in June through August. This is to be expected, as most of the pesticides detected are pre-emergence herbicides which are typically applied around planting and can take several weeks to move into surface water. In 2020, there were fewer notable neonicotinoid detections compared to 2019 but still more than in previous years. Neonicotinoid use patterns have likely been the same for many years, so it is important to monitor and see if detections increase for these chemicals.

This project is the only state-wide comprehensive surface water monitoring project for pesticides in North Dakota. As laboratory testing capabilities improve, more data will be available leading to a better understanding of pesticide movement and aquatic ecosystem health in North Dakota. Resources permitting, the Department will continue to work with its state and federal partners to monitor surface water for pesticides to ensure that pesticides are not negatively impacting water resources. These data are also effective in demonstrating the effectiveness of current approaches and to improve risk assessment quality. If impairments of rivers are found, these can be addressed through education and if necessary, regulation. This mix of compliance assistance and regulatory oversight has been shown to be highly effective, especially when supported by sound data.

REFERENCES

Environmental Protection Agency. (2008). *Registration Review-Preliminary Problem Formulation for Ecological Risk and Environmental Fate, Endangered species and Drinking Water Assessments for Chlorpyrifos.* https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0850-0007

Environmental Protection Agency. (2014). *Registration Review Problem Formulation for Metolachlor and S-Metolachlor.* https://www.regulations.gov/document?D=EPA-HQ-OPP-2014-0772-0002

Environmental Protection Agency. (2017). *Transmittal of the Preliminary Aquatic and Non-Pollinator Terrestrial Risk Assessment to Support Registration Review for Clothianidin.* https://www.regulations.gov/document?D=EPA-HQ-OPP-2011-0865-0242

Environmental Protection Agency. (2017). *Preliminary Aquatic Risk Assessment to Support the Registration Review of Imidacloprid discusses risk from imidacloprid to aquatic ecosystems.* https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0844-1086

Johnson, J.N., Gray, J.A. 2010. Surface Water Pesticide Monitoring and Assessment Project, 2009. North Dakota Department of Agriculture, http://www.nd.gov/ndda/program/pesticide-water-quality-program

Johnson, J.N., Gray, J.A. 2011. Surface Water Pesticide Monitoring and Assessment Project, 2010. North Dakota Department of Agriculture, http://www.nd.gov/ndda/program/pesticide-water-quality-program

NDDH. 2009. Quality Assurance Project Plan for the Ambient River and Stream Water Quality Monitoring Program. North Dakota Department of Health, Division of Water Quality, Bismarck, North Dakota.

Orr, J.N., Gray, J.A. 2009. Surface Water Pesticide Monitoring and Assessment Project, 2008. North Dakota Department of Agriculture, http://www.nd.gov/ndda/program/pesticide-water-quality-program

Sauter J. D., Gray, J.A. 2014. Surface Water Pesticide Monitoring and Assessment Project, 2013. North Dakota Department of Agriculture, http://www.nd.gov/ndda/program/pesticide-water-quality-program

Sauter J. D., Gray, J.A. 2015. Surface Water Pesticide Monitoring and Assessment Project, 2014. North Dakota Department of Agriculture, http://www.nd.gov/ndda/program/pesticide-water-quality-program

Sauter J. D. 2016. Surface Water Pesticide Monitoring and Assessment Project, 2015. North Dakota Department of Agriculture, http://www.nd.gov/ndda/program/pesticide-water-quality-program

Sauter J. D. 2017. Surface Water Pesticide Monitoring and Assessment Project, 2016. North Dakota Department of Agriculture, http://www.nd.gov/ndda/program/pesticide-water-quality-program

Sauter J. D. 2018. Surface Water Pesticide Monitoring and Assessment Project, 2017. North Dakota Department of Agriculture, http://www.nd.gov/ndda/program/pesticide-water-quality-program

Sauter J. D. 2019. Surface Water Pesticide Monitoring and Assessment Project, 2018. North Dakota Department of Agriculture, http://www.nd.gov/ndda/program/pesticide-water-quality-program

Sauter J. D. 2020. Surface Water Pesticide Monitoring and Assessment Project, 2019. North Dakota Department of Agriculture, http://www.nd.gov/ndda/program/pesticide-water-quality-program

Sauter, J.D., 2017. Quality Assurance Plan for the Pesticide Water Quality Monitoring Program. North Dakota Department of Agriculture, unpublished.

Torres, A.M.R. and L.M. O'Flaherty. 1976. Influence of pesticides on *Chlorella*, *Chlorococcum*, *Stigeoclonium* (Chlorophyceae), *Tribonema*, *Vaucheria* (Xanthophyceae) and *Oscillatoria* (Cyanophyceae). Phycologia 15(1):25-36.

Appendix A. Sample identification record.

Sample Identification Record
North Dakota Department of Health **Telephone: 701.328.6140**
Division of Laboratory Services–Chemistry **Fax: 701.328.6280**

Preservation: Yes ☐	Temperature:
Initials:	

Sample Collection/Billing Information						
Account #	**Project Code:**	**Project Description:**				
Collected By:						
Analyte Groups:		**Collection Method:**			**Matrix:** Water	
For Laboratory Use Only Lab ID:	Site ID:	Site Description:			Temp.	DO
	Date Collected:	Time Collected:	Depth (m):	Comments:	SC	pH
	Site ID:	Site Description:			Temp.	DO
	Date Collected:	Time Collected:	Depth (m):	Comments:	SC	pH
	Site ID:	Site Description:			Temp.	DO
	Date Collected:	Time Collected:	Depth (m):	Comments:	SC	pH
	Site ID:	Site Description:			Temp.	DO
	Date Collected:	Time Collected:	Depth (m):	Comments:	SC	pH
	Site ID:	Site Description:			Temp.	DO
	Date Collected:	Time Collected:	Depth (m):	Comments:	SC	pH
	Site ID:	Site Description:			Temp.	DO
	Date Collected:	Time Collected:	Depth (m):	Comments:	SC	pH
	Site ID:	Site Description:			Temp.	DO
	Date Collected:	Time Collected:	Depth (m):	Comments:	SC	pH

Appendix B. List of analytes and reporting limits.

List of analytes and reporting limits in 2020			
Analyte	Common Trade Names*	Type	Reporting Limit (ppb)
2,4-D	2,4-D, Curtail	H	0.009
Acetochlor	Surpass, Harness	H	0.14
Acetochlor ESA	degradate	D	0.02
Acetochlor OA	degradate	D	0.0084
Alachlor	Intrro, Lariat, Lasso	H	0.11
Alachlor ESA	degradate	D	0.044
Alachlor OA	degradate	D	0.0068
AMBA (mesotrione metabolite)	degradate	D	0.021
Aminocyclopyrachlor	Method, Perspective	H	0.025
Aminopyralid	Cleanwave	H	0.03
Atrazine	Aatrex	H	0.0022
Azoxystrobin	Quadris	F	0.0052
Bentazon	Basagran	H	0.0022
Bromacil	Hyvar, Bromax	H	0.0041
Bromoxynil	Huskie, Buctril	H	0.012
Carbaryl	Sevin, Savit	I	0.014
Chlorpyrifos	Lorsban, Dursban	I	0.06
Chlorsulfuron	Finesse, Glean	H	0.0056
Clodinafop acid	Discover NG	H	0.013
Clopyralid	Stinger, Curtail	H	0.088
Clothiandin	Poncho	I	0.016
Deethyl atrazine	degradate	D	0.0017
Deethyl Deisopropyl Atrazine (DEDIA)	degradate	D	0.1
Deisopropyl atrazine	degradate	D	0.04
Dicamba	Banvel	H	0.88
Difenoconazole	CruiserMaxx, InspireF	H	0.011
Dimethenamid	Outlook	H	0.006
Dimethenamid OA	degradate	D	0.0072
Dimethoate	Cygon, Roxion	I	0.0022
Disulfoton sulfone	degradate	D	0.0066
Diuron	Direx, Karmex	H	0.0053
Fluoroethyldiaminotriazine (FDAT)	degradate	D	0.0051
Fipronil	Regent	I	0.0024
Fipronil desulfinyl	degradate	D	0.14
Fipronil sulfide	degradate	D	0.08
Fipronil sulfone	degradate	D	0.04
Flucarbazone	Everst, Prepare	H	0.0024
Flucarbazone sulfonamide (FSA)	degradate	D	0.0039
Flumetsulam	Python	H	0.029

Appendix B. List of analytes and reporting limits (continued).

List of analytes and reporting limits in 2020			
Analyte	Common Trade Names*	Type	Reporting Limit (ppb)
Flupyradifurone	Sivanto	I	0.045
Fluroxypyr	Starane	H	0.035
Glutaric Acid	degradate	D	0.03
Hydroxy atrazine	degradate	D	0.004
Halosulfuron methyl	Permit	H	0.01
Hexazinone	Velpar	H	0.0015
Imazamethabenz methyl acid metabolite (IMAM)	degradate	D	0.0025
Imazamethabenz methyl ester (IME)	degradate	D	0.001
Imazamox	Raptor, Beyond	H	0.0057
Imazapic	Plateau	H	0.003
Imazapyr	Imazapyr, Lineage	H	0.0035
Imazethapyr	Authority Assist, Pursuit	H	0.004
Imidacloprid	Touchstone PF	I	0.0018
Indaziflam	Alion, Specticle	H	0.002
Isoxaben	Gallery, Snapshot	H	0.003
Isoxaflutole	Corvus, Balance Flexx	H	0.13
Malathion	Malathion, Cythion	I	0.028
Malathion oxon	degradate	D	0.0024
MCPA	MCP	H	0.0046
MCPP	Encore, Trimec	H	0.0044
Metalaxyl	Hi-Yield, Ridomil	F	0.0035
Methomyl	Lannate	I	0.012
Methoxyfenozide	Intrepid	I	0.01
Metolachlor	Dual Magnum	H	0.024
Metolachlor ESA	degradate	D	0.005
Metolachlor OA	degradate	D	0.042
Metsulfuron methyl	Ally, Cimarron	H	0.01
Nicosulfuron	Accent, Steadfast	H	0.011
NOA 407854 (Pinoxaden metablolite)	degradate	D	0.0052
NOA 447204 (Pinoxaden metablolite)	degradate	D	0.02
Norflurazon	Solicam	H	0.02
Norflurazon desmethyl	degradate	D	0.02
Oxamyl	Vydate	I	0.01
Parathion methyl oxon	degradate	D	0.012
Phorate sulfone	degradate	D	0.024
Phorate sulfoxide	degradate	D	0.003
Picloram	Tordon	H	0.28
Picoxystrobin	Approach	F	0.0075
Prometon	Pramitol	H	0.001

Appendix B. List of analytes and reporting limits (continued).

List of analytes and reporting limits in 2020			
Analyte	Common Trade Names*	Type	Reporting Limit (ppb)
Propiconazole	Banner, Tilt, Radar	F	0.01
Prosulfuron	Peak, Spirit	H	0.005
Pyrasulfatole	Huskie, Wolverine	H	0.02
Pyroxsulam	GR1, Powerflex	H	0.013
Saflufenacil	Sharpen	H	0.01
Simazine	Princep	H	0.0026
Sulfentrazone	Spartan	H	0.035
Sulfometuron methyl	Lineage, Oust	H	0.0025
Sulfosulfuron	Maverick, Outrider	H	0.0054
Tebuconazole	Folicur	F	0.014
Tebuthiuron	Spike	H	0.0011
Tembotrione	Capreno, Laudis	H	0.073
Terbacil	Sinbar	H	0.0048
Terbufos sulfone	degradate	D	0.011
Tetraconazole	Domarck, Eminent	F	0.0039
Thiamethoxam	CruiserMaxx, Meridian	I	0.02
Thiencarbazone methyl	Corvus, Huskie Complete	H	0.04
Thifensulfuron	Supremacy Harmony	H	0.022
Tralkoxydim	Achieve	H	0.0051
Tralkoxydim acid	degradate	D	0.005
Triallate	Far-Go	H	0.3
Triasulfuron	Dally, Rave	H	0.0055
Tricolpyr	Garlon	H	0.022
Trifloxystrobin	Compass, Stratego	F	0.02

*Common trade names do not represent all trade names containing an active ingredient. Trade names chosen are for example purposes only and this list is not endorsing or making any recommendations.

H=Herbicide; I=Insecticide; F=Fungicide; D=Degradate (breakdown product)

Appendix C. List of detections that were 20% or more of an aquatic life benchmark.

Site Name	Site ID	Sample Date	Analyte	Detection	Lowest ALB
Sheyenne River near Cooperstown, ND	380009	7/8/2020	Atrazine	0.64	1
Sheyenne River near Cooperstown, ND	380009	7/8/2020	Metolachlor	0.53	1
James River at Lamoure, ND	380012	6/2/2020	Imidacloprid	0.0031	0.01
James River at Jamestown, ND	380013	7/8/2020	Diuron	0.52	2.4
Wild Rice River near Abercrombie, ND	380031	6/22/2020	Atrazine	2.4	1
Wild Rice River near Abercrombie, ND	380031	7/20/2020	Atrazine	0.71	1
Wild Rice River near Abercrombie, ND	380031	8/10/2020	Atrazine	0.21	1
Wild Rice River near Abercrombie, ND	380031	6/22/2020	Imidacloprid	0.0021	0.01
Wild Rice River near Abercrombie, ND	380031	7/20/2020	Imidacloprid	0.0045	0.01
Wild Rice River near Abercrombie, ND	380031	8/10/2020	Imidacloprid	0.0031	0.01
Wild Rice River near Abercrombie, ND	380031	6/22/2020	Metolachlor	1.5	1
Wild Rice River near Abercrombie, ND	380031	7/20/2020	Metolachlor	3.3	1
Wild Rice River near Abercrombie, ND	380031	8/10/2020	Metolachlor	1.5	1
Wild Rice River near Abercrombie, ND	380031	10/22/2020	Metolachlor	0.23	1
Turtle River at Manvel, ND	380039	6/8/2020	Imidacloprid	0.0031	0.01
Turtle River at Manvel, ND	380039	6/8/2020	Metolachlor	1.2	1
Turtle River at Manvel, ND	380039	7/22/2020	Metolachlor	0.72	1
Turtle River at Manvel, ND	380039	8/17/2020	Metolachlor	0.26	1
Red River at Brushville, MN	380083	7/8/2020	Imidacloprid	0.0051	0.01
Red River at Brushville, MN	380083	7/8/2020	Metolachlor	0.29	1
Knife River at Hazen, ND	380087	7/7/2020	Atrazine	0.53	1
Souris River nr Verendrye, ND	380095	7/14/2020	Atrazine	0.76	1
Souris River nr Verendrye, ND	380095	7/14/2020	Imidacloprid	0.021	0.01
Cannonball River nr Raleigh, ND	380105	8/17/2020	Imidacloprid	0.38	0.01
Goose River at Hillsboro, ND	380156	7/22/2020	Imidacloprid	0.0055	0.01
Goose River at Hillsboro, ND	380156	7/22/2020	Metolachlor	0.26	1
Park River at Grafton, ND	380157	6/8/2020	Imidacloprid	0.0054	0.01
Park River at Grafton, ND	380157	7/20/2020	Imidacloprid	0.04	0.01
Park River at Grafton, ND	380157	6/8/2020	Metolachlor	0.33	1
Park River at Grafton, ND	380157	7/20/2020	Metolachlor	0.29	1
Park River at Grafton, ND	380157	8/17/2020	Metolachlor	0.47	1
Park River at Grafton, ND	380157	10/5/2020	Metolachlor	0.31	1
Souris River above Minot, ND	380161	7/15/2020	Atrazine	0.29	1
Souris River above Minot, ND	380161	7/15/2020	Imidacloprid	0.027	0.01
James River nr Grace City, ND	384130	7/8/2020	Atrazine	0.2	1
Knife River nr Golden Valley, ND	384131	7/7/2020	Atrazine	0.55	1

Appendix C. List of detections that were 20% or more of an aquatic life benchmark (continued).

Site Name	Site ID	Sample Date	Analyte	Detection	Lowest ALB
Maple River below Mapleton, ND	384155	6/22/2020	Atrazine	1.8*	1
Maple River below Mapleton, ND	384155	7/20/2020	Atrazine	0.89	1
Maple River below Mapleton, ND	384155	6/22/2020	Imidacloprid	0.0059	0.01
Maple River below Mapleton, ND	384155	7/20/2020	Imidacloprid	0.0038	0.01
Maple River below Mapleton, ND	384155	8/10/2020	Imidacloprid	0.0034	0.01
Maple River below Mapleton, ND	384155	6/22/2020	Metolachlor	2.5*	1
Maple River below Mapleton, ND	384155	7/20/2020	Metolachlor	3.3	1
Maple River below Mapleton, ND	384155	8/10/2020	Metolachlor	0.64	1
Red River at Grand Forks, ND	384156	7/27/2020	Atrazine	0.21	1
Red River at Grand Forks, ND	384156	7/27/2020	Clothianidin	0.024	0.05
Red River at Grand Forks, ND	384156	8/18/2020	Clothianidin	0.026	0.05
Red River at Grand Forks, ND	384156	7/27/2020	Imidacloprid	0.0068	0.01
Red River at Grand Forks, ND	384156	8/18/2020	Imidacloprid	0.0067	0.01
Red River at Grand Forks, ND	384156	7/27/2020	Metolachlor	2.7	1
Red River at Grand Forks, ND	384156	8/18/2020	Metolachlor	0.7	1
Red River at Pembina, ND	384157	6/15/2020	Atrazine	0.22	1
Red River at Pembina, ND	384157	7/14/2020	Atrazine	0.22	1
Red River at Pembina, ND	384157	4/27/2020	Imidacloprid	0.0024	0.01
Red River at Pembina, ND	384157	7/14/2020	Imidacloprid	0.0043	0.01
Red River at Pembina, ND	384157	8/12/2020	Imidacloprid	0.0022	0.01
Red River at Pembina, ND	384157	6/15/2020	Metolachlor	1.4	1
Red River at Pembina, ND	384157	7/14/2020	Metolachlor	0.74	1
Red River at Pembina, ND	384157	8/12/2020	Metolachlor	0.63	1
Sheyenne River near Kindred, ND	385001	8/11/2020	Imidacloprid	0.0027	0.01
Sheyenne River near Kindred, ND	385001	10/22/2020	Imidacloprid	0.0027	0.01
Sheyenne River near Kindred, ND	385001	7/21/2020	Metolachlor	0.53	1
Sheyenne River near Kindred, ND	385001	8/11/2020	Metolachlor	0.46	1
Bois de Sioux River near Doran, MN	385055	7/8/2020	Atrazine	0.5	1
Bois de Sioux River near Doran, MN	385055	5/20/2020	Metolachlor	1.9	1
Bois de Sioux River near Doran, MN	385055	7/8/2020	Metolachlor	1.1	1
Sheyenne River at Lisbon, ND	385169	8/19/2020	Imidacloprid	0.0047	0.01
Sheyenne River at Lisbon, ND	385169	8/19/2020	Metolachlor	0.41	1
Red River at Fargo, ND	385414	6/24/2020	Atrazine	0.44	1
Red River at Fargo, ND	385414	7/22/2020	Atrazine	0.23	1

*For starred detections, relative percent difference for the replicate check was not acceptable. Results are still being reported as both original and replicate samples indicated ALB had been exceeded.

Appendix C. List of detections that were 20% or more of an aquatic life benchmark (continued).

Site Name	Site ID	Sample Date	Analyte	Detection	Lowest ALB
Red River at Fargo, ND	385414	7/22/2020	Imidacloprid	0.002	0.01
Red River at Fargo, ND	385414	6/24/2020	Metolachlor	0.48	1
Red River at Fargo, ND	385414	7/22/2020	Metolachlor	1.2	1
Red River at Fargo, ND	385414	8/12/2020	Metolachlor	0.56	1
Red River nr Georgetown, MN	386013	6/24/2020	Atrazine	0.49	1
Red River nr Georgetown, MN	386013	7/21/2020	Atrazine	0.36	1
Red River nr Georgetown, MN	386013	7/21/2020	Imidacloprid	0.0025	0.01
Red River nr Georgetown, MN	386013	8/11/2020	Imidacloprid	0.0023	0.01
Red River nr Georgetown, MN	386013	6/24/2020	Metolachlor	0.58	1
Red River nr Georgetown, MN	386013	7/21/2020	Metolachlor	1.1	1
Red River nr Georgetown, MN	386013	8/11/2020	Metolachlor	0.55	1