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Pesticide Concentrations in Wetlands on the Lake Traverse Indian Reservation, South and North Dakota, July 2015

Data Series 984

U.S. Department of the Interior
U.S. Geological Survey

Cover. Orthoimagery (1-meter resolution) derived from digital aerial photographs for the Lake Traverse Indian Reservation from the National Agriculture Imagery Program (NAIP) using a map service from the U.S. Geological Survey Earth Resources Observation and Science (EROS) Center. Image assistance by Steve Shivers (U.S. Geological Survey).

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SALLY JEWELL, Secretary

U.S. Geological Survey
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Conversion Factors

[U.S. customary to International System of Units]

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
	Area	
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre	0.4047	square hectometer (hm^2)
acre	0.004047	square kilometer (km^2)
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Mass	
pound, avoirdupois (lb)	0.4536	kilogram (kg)

[International System of Units to U.S. customary units]

Multiply	By	To obtain
	Length	
micrometer (μm)	0.00003937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
	Volume	
liter (L)	0.2642	gallon (gal)
liter (L)	33.82	ounce, fluid (fl. oz)
milliliter (mL)	0.03382	ounce, fluid (fl. oz)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32.$$

Datum

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Supplemental Information

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Concentrations of chemical constituents in water are given in either milligrams per liter (mg/L) or micrograms per liter (µg/L).

Abbreviations

CCC	Criterion Continuous Concentration (U.S. Environmental Protection Agency)
CIAT	2-chloro-4-isopropylamino-6-amino-*s*-triazine
ELISA	enzyme-linked immunosorbent assay
EPA	U.S. Environmental Protection Agency
HBSL	Health-Based Screening Level (U.S. Geological Survey)
HHBP	Human Health Benchmark for Pesticides (U.S. Environmental Protection Agency)
LRL	laboratory reporting level
MCL	Maximum Contaminant Level (U.S. Environmental Protection Agency)
MDL	method detection limit
NWQL	National Water Quality Laboratory
USGS	U.S. Geological Survey

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Abstract

During July 2015, water samples were collected from 18 wetlands on the Lake Traverse Indian Reservation in northeastern South Dakota and southeastern North Dakota and analyzed for physical properties and 54 pesticides. This study by the U.S. Geological Survey in cooperation with the Sisseton-Wahpeton Oyate was designed to provide an update on pesticide concentrations of the same 18 wetlands that were sampled for a reconnaissance-level assessment during July 2006. The purpose of this report is to present the results of the assessment of pesticide concentrations in selected Lake Traverse Indian Reservation wetlands during July 2015 and provide a comparison of pesticide concentrations between 2006 and 2015.

Of the 54 pesticides that were analyzed for in the samples collected during July 2015, 47 pesticides were not detected in any samples. Seven pesticides—2-chloro-4-isopropylamino-6-amino-*s*-triazine (CIAT); 2,4–D; acetachlor; atrazine; glyphosate; metolachlor; and prometon—were detected in the 2015 samples with estimated concentrations or concentrations greater than the laboratory reporting level, and most pesticides were detected at low concentrations in only a few samples. Samples from all wetlands contained at least one detected pesticide. The maximum number of pesticides detected in a wetland sample was six, and the median number of pesticides detected was three.

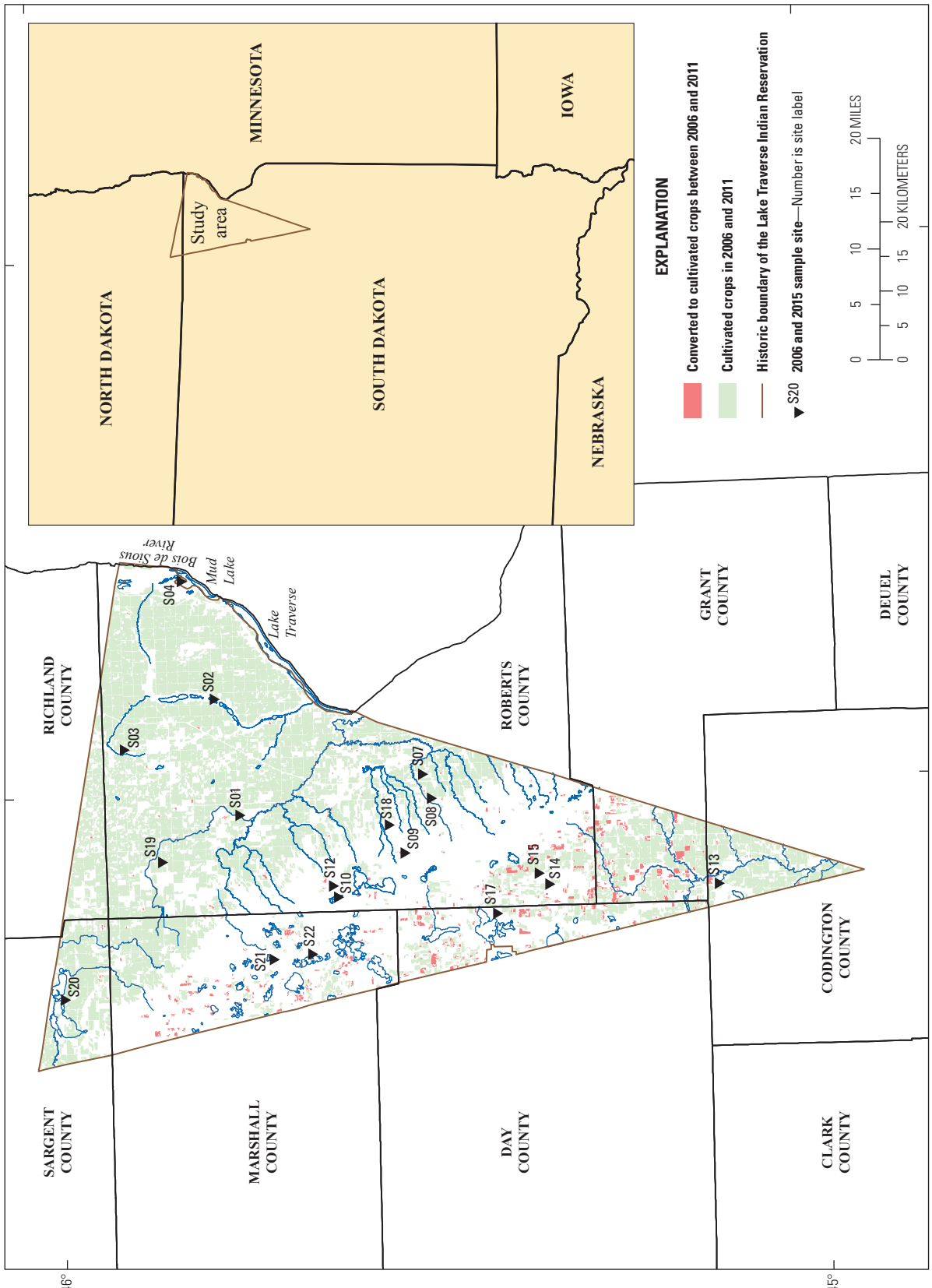
The most commonly detected pesticides in the 2015 samples were atrazine and the atrazine degradate CIAT (also known as deethylatrazine), which were detected in 14 and 13 of the wetlands sampled, respectively. Glyphosate was detected in samples from 11 wetlands, and metolachlor was detected in samples from 10 wetlands. The other detected pesticides were 2,4–D (4 wetlands), acetochlor (3 wetlands), and prometon (1 wetland).

The same pesticides that were detected in the 2006 samples were detected in the 2015 samples, with the exception of simazine, which was detected only in one sample in 2006. Atrazine and CIAT were the most commonly detected pesticides in both sampling years; however, atrazine and CIAT were detected in fewer wetlands in 2015 (14 and 13 wetlands, respectively) than in 2006 (17 wetlands for both pesticides). The pesticides 2,4–D and prometon also were detected in fewer wetlands in 2015 than 2006, and simazine was only detected in 2006. In contrast, acetochlor, glyphosate, and metolachlor were detected in samples from more wetlands in 2015 than in 2006. In samples from individual wetlands, the number of pesticides detected was similar between 2006 and 2015. At least one pesticide was detected in all wetlands in 2015, and all but one wetland had pesticide detections in 2006.

Concentrations of pesticides detected in samples from wetlands were compared to selected water-quality (human-health and aquatic-life) benchmarks. None of the concentrations in either 2006 or 2015 were greater than water-quality benchmarks, with the exception of atrazine. All detections of atrazine in the 2006 and 2015 samples were greater than the acute benchmark of 0.001 microgram per liter (µg/L) for vascular plants. In addition, some concentrations of 2,4–D and atrazine were within an order of magnitude of a water-quality benchmark. The 2,4–D concentrations in the 2015 samples from three wetlands were within an order of magnitude of the U.S. Environmental Protection Agency's Maximum Contaminant Level of 70 µg/L (that is, sample concentrations were greater than 7.0 µg/L). The maximum dissolved atrazine concentration of 0.185 µg/L in the 2015 samples along with the concentrations in 2006 samples from two wetlands were within an order of magnitude of the acute benchmark of less than 1 µg/L for nonvascular plants (that is, concentrations were greater than 0.1 µg/L).

Introduction

The boundary of the historic Lake Traverse Indian Reservation (hereafter called the Lake Traverse Reservation) encompasses parts of five counties (Roberts, Marshall, Day, Grant, and Codington Counties) in northeastern South Dakota and parts of two counties (Sargent and Richland Counties) in southeastern North Dakota (fig. 1). The Lake Traverse Reservation is within the glaciated Central Lowlands physiographic



Base from U.S. Geological Survey digital data, 1993, 1:100,000
Land cover from National Land Cover Dataset 2006 to 2011
Land Cover from to Change Index, 2014
Universal Transverse Mercator projection, zone 14

Figure 1. Location of the historic Lake Traverse Indian Reservation boundary, sample collection sites for 2006 and 2015, and land-use in cultivated crops or converted to cultivated crops.

province (Thompson, 2002) and includes parts of two physiographic divisions, the Prairie Coteau and the Minnesota River-Red River lowlands. The Prairie Coteau is a plateau of rolling morainal topography formed by deposition of glacial debris, and the Minnesota River-Red River lowlands is a somewhat flat ground moraine that consists of isolated areas of debris left by retreating glaciers (Thompson, 2002). Some areas are poorly drained and include numerous wetlands that provide a valuable wildlife production resource. Surface water and groundwater on the Lake Traverse Reservation are used for public, domestic, livestock, recreation, and irrigation purposes (Carter and Neitzert, 2008).

Pesticides are substances used to kill or control insects, weeds, fungi, rodents, bacteria, or other unwanted organisms. Pesticides provide a range of benefits, including increased food production and reduction of insect-borne disease; however, pesticide use also raises questions about possible adverse impacts on the environment, including potential effects on drinking-water sources and aquatic life (Gilliom and others, 2006). Nationally, one or more pesticides or degradates were detected in water more than 90 percent of the time during the year in streams draining watersheds with agricultural, urban, and mixed land uses (Gilliom and others, 2006). Degradates are new compounds formed by transformation of a pesticide by chemical, photochemical, or biological reactions (Gilliom and others, 2006). The pesticide compounds detected most frequently in streams and groundwater in agricultural and urban areas of the United States were generally compounds with the most extensive use (including historical use) and compounds with the greatest mobility or persistence, or both, in the hydrologic system (Gilliom and others, 2006).

More than 80 percent of the land use within the Lake Traverse Reservation is for grain production, pasture, or hay, and more than 11 percent of the area is covered by surface water in the form of wetlands, lakes, and streams (Thompson, 2002). Cultivated crops (primarily soybeans and corn) cover about 693 square miles, or about 46 percent of the Lake Traverse Reservation (Thompson, 2002). Pesticides are used mainly to control weeds (herbicides) and insects (insecticides) on crops; however, pesticides also may be used to control fungus (fungicides) and nematodes (nematocides) on some crops. For 2009, the uses of 31 herbicides were estimated in Roberts County (Stone, 2013). For 2,4–D, acetochlor, atrazine, and glyphosate, more than 10,000 pounds of each herbicide were estimated to have been used in Roberts County (table 1). In 2000, atrazine and metolachlor were the primary herbicides used in Roberts County for corn acreage, and glyphosate was the primary herbicide used for soybean acreage (Neitzert and Bartholomay, 2007). In South Dakota, glyphosate, acetochlor, and atrazine were the primary herbicides used for corn acreage in 2014, and glyphosate was the primary herbicide used for soybean acreage in 2012 (National Agricultural Statistics Service, 2015). As described by Neitzert and Bartholomay (2007), some of the pesticides that are applied on the Lake Traverse Reservation (including alachlor and atrazine) are known endocrine disruptors (Danzo, 1997; Wilson and others, 1996; Rawlings and others, 1998), and other pesticides (including glyphosate and 2,4–D) have various levels of toxicity to aquatic organisms (U.S. Forest Service, 1997, 2006).

A reconnaissance-level study of pesticide concentrations in selected wetlands on the Lake Traverse Reservation was completed in 2006 (Neitzert and Bartholomay, 2007) by the U.S. Geological Survey (USGS) in cooperation with the Sisseton-Wahpeton Oyate. For this reconnaissance-level study, samples were collected during July 2006 and analyzed for 61 widely used pesticides. Pesticides were detected in 17 of the 18 sampled wetlands. In the 17 wetlands in which pesticides were detected, the number of pesticides detected ranged from two to eight. Ten pesticides were detected in water samples from at least one of the wetlands at low concentrations. Atrazine and deethylatrazine were detected in samples from 17 of the 18 wetlands.

Because of a series of agricultural trends in recent years, many land tracts in the Lake Traverse Reservation area that formerly were used for pasture or hay production have been tilled and used to produce cultivated crops (fig. 1), which commonly have greater pesticide inputs (Gilliom and others, 2006). About 14,000 acres within the historic Lake Traverse Reservation boundary were converted to cultivated crops (with 95 percent of this conversion from grassland/herbaceous) between 2006 and 2011 (fig. 1), and about 3,400 acres were converted from cultivated crops to other land uses (64 percent were converted to open water or herbaceous wetlands and 31 percent to pasture or grasslands) between 2006 and 2011 (National Land Cover Database, 2014). To evaluate potential effects of changing land use on pesticide concentrations in wetlands, the USGS in cooperation with the Sisseton-Wahpeton Oyate resampled the 18 wetlands during July 2015. The locations of the selected Lake Traverse Reservation wetlands that were sampled for pesticides in 2006 and 2015 are shown in figure 1.

Purpose and Scope

The purpose of this report is to present the results of the assessment of pesticide concentrations in selected Lake Traverse Reservation wetlands during July 2015 and provide a comparison of pesticide concentrations for the same 18 wetlands between 2006 and 2015. Specifically, this report presents (1) a summary of sample collection and analytical methods, (2) concentrations of physical properties and pesticides for selected Lake Traverse Reservation wetlands in 2015 and a comparison to concentrations in 2006, and (3) a synopsis of the pesticide results for those pesticides detected in samples in 2015 relative to selected water-quality benchmarks. Analytical results for water samples include physical properties and pesticide concentrations for 18 wetlands. The quality of water in all Lake Traverse Reservation wetlands cannot be thoroughly characterized with such a limited sampling program; however, the results may be useful to assess the effects of

Table 1. Estimated use of 31 pesticides in Roberts County, South Dakota, in 2009.

[Estimates of pesticide use from Stone (2013). Shaded cells indicate pesticides detected in selected Lake Traverse Indian Reservation wetlands in 2015. <, less than]

Pesticide	Analyzed for in selected wetlands for this study (tables 3 and 7)	Estimated pounds of active ingredient applied	Rank (high to low) of active ingredient applied (all pesticides)
2,4–D	Yes	20,970	3
Acetochlor	Yes	62,920	2
Acifluorfen	No	3	28
Alachlor	Yes	1,140	10
Aminopyralid	No	74	22
Atrazine	Yes	18,140	4
Azoxystrobin	No	219	18
Bentazone	No	605	15
Bifenthrin	No	308	16
Bromoxynil	No	7,054	5
Carbaryl	Yes	1,794	8
Chlorimuron	No	13	26
Chlorothalonil	No	14	25
p-dimethenamid	No	4,041	7
Dimethoate	No	18	24
Diquat	No	1	30
Glufosinate	No	741	13
Glyphosate	Yes	384,200	1
Halosulfuron	No	<1	31
Imazilil	No	2	29
Metolachlor	Yes	1,706	9
s-metolachlor	No	5,028	6
Metribuzin	Yes	215	19
Propiconazole	No	751	12
Propoxycarbazone	No	79	21
Prothioconazole	No	193	20
Pyraclostrobin	No	811	11
Pyrasulfotole	No	54	23
Pyrethrins	No	278	17
Tribenuron-methyl	No	11	27
Trifloxystrobin	No	670	14

land-management practices on the aquatic resources and to identify possible water-quality concerns that could be the focus of more comprehensive investigations in the future.

Description of Study Area

The study area was described by Neitzert and Bartholomay (2007) and is summarized here. The study area includes the area within the historic 1867 boundary of the Lake Traverse Reservation and most of Roberts County; parts of Marshall, Day, Grant, and Codington Counties in northeastern South Dakota; and parts of Sargent and Richland Counties in southeastern North Dakota (fig. 1). The Lake Traverse Reservation has an area of about 1,508 square miles. The Bois des Sioux River, Lake Traverse, and Mud Lake form most of the northeastern boundary of Roberts County.

Numerous lakes, ponds, and wetlands are on the Lake Traverse Reservation, particularly within internally drained, noncontributing areas of the basins of the Big Sioux and James Rivers. Many of the lakes are hydraulically connected to glacial-outwash aquifers, and lake levels tend to rise or fall with the water table (Lawrence, 1989). Several of the larger lakes within the study area have been developed for recreation, and many of the smaller lakes and wetlands are used for livestock watering or wildlife-production areas (Thompson, 2001).

The study area is generally sparsely populated, with a population in Roberts County of 10,149 in 2010 (U.S. Census Bureau, 2015). Municipalities and rural water systems provide most of the water used in the study area, with nearly all of the water used from groundwater sources (Carter and Neitzert, 2008). Surface-water use is limited to livestock watering (Thompson, 2001).

Previous Investigations

Previous water-quality investigations in the Lake Traverse Reservation area were described by Neitzert and Bartholomay (2007); readers are referred to that report for details on previous investigations. The 2006 reconnaissance-level pesticide assessment by Neitzert and Bartholomay (2007) is summarized in this section of the report.

During July 2006, water samples were collected from selected Lake Traverse Reservation wetlands within the Lake Traverse Reservation for a reconnaissance-level assessment. After primary pesticide application occurred on the Lake Traverse Reservation, eighteen wetlands were sampled. Samples were analyzed for 61 pesticides and for physical properties.

Pesticides were detected in 17 of the 18 sampled wetlands. In the 17 wetlands in which pesticides were detected, the number of pesticides detected ranged from two to eight, with a median of four. Of the 61 pesticides for which the samples were analyzed, 51 pesticides were not detected in any of the wetland samples. The 10 detected pesticides had low concentrations. Atrazine and deethylatrazine were detected in samples from 17 of the 18 wetlands. Concentrations of dissolved atrazine ranged from 0.007 to 0.12 microgram per liter (µg/L). Estimated concentrations of dissolved deethylatrazine ranged from 0.005 to 0.03 µg/L. Other pesticides that had concentrations that were estimated or greater than the laboratory reporting level (LRL) included 2,4–D (detected in nine samples), glyphosate (detected in five samples), aminomethylphosphonic acid (AMPA; detected in five samples), metolachlor (detected in three samples), prometon (detected in three samples), acetochlor (detected in two samples), picloram (detected in one sample), and simazine (detected in one sample). None of the pesticides detected were greater than any U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels (MCLs) for drinking water (U.S. Environmental Protection Agency, 2009).

Methods of Investigation

This study was designed to provide an update on pesticide concentrations in selected wetlands within the Lake Traverse Reservation since the 2006 reconnaissance-level assessment reported by Neitzert and Bartholomay (2007). Water-quality samples were collected during July 2015 from the same 18 wetlands that were sampled during July 2006 (table 2) and analyzed for 54 of the 61 pesticides analyzed in the 2006 samples. Site selection, sample collection, analytical methods, reporting levels, and quality assurance and quality control are described in this section.

Site Selection

The 18 wetlands sampled for the 2006 reconnaissance-level assessment on the Lake Traverse Reservation were resampled during July 2015 (fig. 1). The sites selected for the 2006 assessment were chosen to best represent the broad range of wetlands within the Lake Traverse Reservation including physical location, size, and type (as indicated by the U.S. Fish and Wildlife National Wetlands Inventory (U.S. Fish and Wildlife Service, 2014; table 2). The wetlands from which samples were collected were generally well distributed throughout the study area (fig. 1). The approximate area of the sampled wetlands ranged from less than 1 acre to 420 acres in 2014. The amount of vegetation in and surrounding the wetlands ranged from little (primarily dirt) to extreme (heavy cattails, bushes, or trees), dependent on location and type of wetland. Similar to 2006 springtime precipitation conditions noted by Neitzert and Bartholomay (2007), the study area received above-normal precipitation in May 2015 as observed at Sisseton, South Dakota (5.79 inches compared to normal of 2.94 inches; National Weather Service, 2015).

Sampled wetlands were classified using wetlands inventory codes (table 2; U.S. Fish and Wildlife Service, 2014). These alpha-numeric codes were developed to correspond to the classification nomenclature that best describes the habitat. In some cases, the sampled wetlands had been assigned multiple codes to note multiple effects on the wetlands. For these sites, the code assigned for the largest area of the wetland where the sample was collected was considered to be the primary code for this report. A primary wetlands inventory code had been assigned to 17 of the wetlands sampled in 2015. The most frequently noted code was PEMF (palustrine, emergent, semipermanently flooded). More information on the wetland codes is given in appendix 1. The wetland classification codes for the sampled wetlands were the same between 2004 and 2014 wetland inventories for all but two of the wetlands; however, the approximate wetland sizes were different between 2004 and 2014 for most of the sampled wetlands (table 2).

Table 2. Selected wetland sampling sites within the Lake Traverse Indian Reservation, 2006 and 2015, and primary wetlands inventory codes for 2004 and 2014.

Site (fig. 1)	Station number	Primary wetlands inventory code (table 1–1)	Basin land use	Approximate wetland size (in acres)	
				[1]2004	[2]2014
S01	454535097023100	PFOC	crops, grazing	36	3.6
S02	454717096493000	L2ABG	grazing	50	50
S03	455426096545100	PEMF	crops	8	11
S04	454933096361200	PEM/ABFh[3]	marsh, crops	170	420
S07	453107096583500	PEMF	marsh, crops	18	23
S08	453031097011800	PAB/EMF	crops	9	8.4
S09	453245097071800	PEMFx	crops	8	8.6
S10	453801097120100	L1UBG	crops, marsh, grazing	200	160
S12	453825097104400	PEMC	grazing	1	<1
S13	450811097114200	PEMF	crops, grazing	6	29
S14	452129097111500	PEM/SSB	crops, grazing	100	318
S15	452214097095900	PEMC[4]	crops grazing	19	<1
S17	452540097142000	L2ABG	unused	75	83
S18	453354097040800	None noted	unused, in town	8	8
S19	455145097072900	PEMF	marsh, crops	6	13
S20	455941097223800	PEM/ABF	unused, refuge	2	2.7
S21	454315097184400	PEM/ABF	tribal grazing	9	8.3
S22	454012097181700	PABF	tribal grazing	4	1.8

[1]As reported in Neitzert and Bartholomay, 2007.

[2]From U.S. Fish and Wildlife Service, 2014.

[3]Classification in 2004 was PEM/ABFh (palustrine, emergent/palustrine, aquatic bed, semipermanently flooded, diked/impounded; Neitzert and Bartholomay, 2007).

[4]Classification in 2004 was not available (Neitzert and Bartholomay, 2007).

Sample Collection

After primary pesticide application occurred on the Lake Traverse Reservation, eighteen wetlands were sampled by USGS personnel during July 2015 using the same procedures as described by Neitzert and Bartholomay (2007) for the July 2006 sampling. A difference between the 2006 and 2015 sampling was the analysis of 2,4–D and glyphosate using enzyme-linked immunosorbent assay (ELISA) techniques in 2015, as described in this section and the "Analytical Methods for 2015 Sampling" section.

Water samples were collected by wading using the hand grab method at one vertical location in the wetland. In general, sampling procedures followed guidelines described by Wilde and others (1999) using two-person, ultra-clean procedures, but these procedures were adapted to the conditions found at the different sites. For each sampled wetland, this process involved some combination of collecting water in bottles, directly or after filtering, or collecting several liters of water in a large container and later transferring the water to the appropriate bottles in a mobile laboratory.

Samples for 2,4–D and glyphosate using ELISA techniques were filtered using a 25-millimeter syringe-tip glass-fiber filter with a 0.7-micrometer pore diameter and were collected in precleaned, 20-milliliter, glass amber bottles. For determination of all other dissolved pesticides, samples were collected directly into precleaned, 1-liter, glass amber bottles and were filtered at the National Water Quality Laboratory (NWQL) using pre-cleaned, baked, glass-fiber 142-mm filters with a 0.7- µm pore diameter (Sandstrom, 1995). All samples were chilled according to sample specifications and then packed for overnight shipping to the USGS South Dakota Water Science Center laboratory in Rapid City, S. Dak., for ELISA analyses or to the USGS NWQL in Denver, Colorado, for all other pesticide analyses.

Analytical Methods for 2015 Sampling

Analytical methods used for samples collected during July 2006 are described by Neitzert and Bartholomay (2007); samples collected in 2006 were analyzed for 61 pesticides. This section of the report describes the analytical methods for the samples collected during July 2015; samples collected in 2015 were analyzed for 54 pesticides. Standard methods were used to measure physical properties in the field. The physical properties include water temperature, dissolved oxygen, pH, and specific conductance (Wilde, variously dated).

Samples for ELISA analyses for 2,4–D and glyphosate were analyzed at the USGS South Dakota Water Science Center laboratory in Rapid City, S. Dak. The ELISA analyses were completed using Abraxis (Westminster, Pennsylvania) kits for 2,4–D and glyphosate using methods described by Abraxis (2014a, 2014b). All other pesticides were analyzed at the NWQL using gas chromatography/mass spectrometry for USGS laboratory schedule 2001 as described by Zaugg and others (1995) and Madsen and others (2003).

Reporting Levels

Reporting levels for the pesticides analyzed in samples collected in July 2015 are listed in table 3. The reporting levels for 2,4–D and glyphosate by ELISA techniques (2.0 and 0.10 µg/L, respectively) are several orders of magnitude higher than reporting levels for most pesticides determined by using USGS laboratory schedule 2001. The reporting level for 2,4–D also is several orders of magnitude higher than the reporting levels for samples analyzed in 2006, which was 0.022; the reporting level for glyphosate is generally similar to the reporting level of 0.14 µg/L used in 2006 (Neitzert and Bartholomay, 2007). The different reporting levels for the 2015 samples affect comparisons of detections and concentrations of 2,4–D and glyphosate in wetlands between the 2006 and 2015 samples.

For pesticides analyzed using USGS NWQL, the method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99-percent confidence that the concentration is greater than zero (Childress and others, 1999). The LRL is the concentration at which the false negative error rate is minimized to be no more than 1 percent of the reported results. The LRL generally is equal to twice the yearly determined long-term MDL, which is a detection level derived by determining the standard deviation of a minimum of 24 MDL spike-sample measurements during an extended time. The long-term MDL controls false positive error and is the concentration at which the false positive risk is minimized to be no more than 1 percent of the reported values (Childress and others, 1999). These reporting levels may be described as preliminary for a developmental method if the levels have been based on a small number of analytical results. Also, these levels may vary from sample to sample for the same constituent and the same method if matrix effects or other factors arise that interfere with the analysis. Concentrations measured between the MDL and the LRL are described as estimated values. For most of the constituents in this report, reported concentrations are greater than the LRLs unless the concentrations are indicated as estimated. An estimated concentration should be considered a qualitatively detected constituent (Childress and others, 1999). For a few pesticides in table 3, the reporting levels are considered provisional limits of quantitation and are called interim reporting levels. The interim reporting levels are temporary reporting levels used for new or custom schedules when long-term MDL data are unavailable and an LRL has not yet been established (U.S. Geological Survey, 2004).

Quality Assurance and Quality Control

Analytical results should describe the environmental conditions at the time the samples were collected; however, certain factors such as sampling error can affect the process and ultimately lead to analytical results that are not representative of the natural conditions. Several techniques, collectively known as quality assurance and quality control, were used to evaluate the precision and accuracy of the reported analytical results for this study. Quality-assurance samples collected during July 2015 as part of this study included one field equipment blank sample and one replicate sample.

Field Equipment Blank Sample

The field equipment blank sample was used to assess the possible contamination of samples or analytical error. The blank sample was collected by passing ultra-pure water through the collection and processing equipment used for environmental samples. Procedures used were identical to those used to collect and process the environmental samples. The blank sample was collected at the same location as one of the environmental samples and just before the environmental sample was collected. If the blank sample is not contaminated during the collection, processing, transport, and if the analytical results are accurate, none of the constituents should be detected in the sample.

A field blank was collected at wetland site S13 on July 21, 2015, and was analyzed for the same pesticides that were analyzed for the environmental samples. All the pesticide concentrations in the blank sample were less than the LRLs, indicating the sampling and analytical methods did not contaminate the samples or produce false detections.

Field Replicate Sample

A field replicate sample is intended to be identical or nearly identical to the environmental sample. The field replicate sample was collected and processed sequentially after the associated primary environmental sample, and procedures used for the replicate sample were identical to procedures

Table 3. Selected information on physical properties and pesticides analyzed in samples collected in July 2015.

[All pesticide concentrations are dissolved. USGS, U.S. Geological Survey; CASRN; Chemical Abstracts Services Registry Number; --, not applicable; mm Hg, millimeters of mercury; FNU, formazin nephelometric turbidity units; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; ELISA, enzyme-linked immunosorbent assay; µg/L, micrograms per liter; LRL, laboratory reporting level; IRL, interim reporting level]

Property or pesticide	USGS parameter code	CASRN[1]	Reporting level	Units	Reporting level type
Physical properties measured in the field					
Barometric pressure	00025	--	--	mm Hg	--
Turbidity	63680	--	--	FNU	--
Air temperature	00020	--	--	°C	--
Water temperature	00010	--	--	°C	--
Dissolved oxygen	00300	--	--	mg/L	--
pH	00400	--	--	standard units	--
Specific conductance	00095	--	--	µS/cm	--
Pesticides analyzed by using ELISA techniques at USGS South Dakota Water Science Center, Rapid City, S. Dak.					
2,4–D	82697	94–75–7	[2]2.0	µg/L	--
Glyphosate	99960	1071–83–6	[3]0.10	µg/L	--
Pesticides analyzed by using laboratory schedule 2001 at USGS National Water Quality Laboratory[4]					
2-chloro-4-isopropylamino-6-amino-*s*-triazine (CIAT; deethylatrazine)	04040	6190–65–4	0.010	µg/L	LRL
2,6-diethylaniline	82660	579–66–8	0.0060	µg/L	IRL
Acetochlor	49260	34256–82–1	0.010	µg/L	LRL
Alachlor	46342	15972–60–8	0.008	µg/L	LRL
Atrazine	39632	1912–24–9	0.008	µg/L	LRL
Azinphos-methyl	82686	86–50–0	0.12	µg/L	LRL
Benfluralin	82673	1861–40–1	0.014	µg/L	LRL
Butylate	04028	2008–41–5	0.0040	µg/L	LRL
Carbaryl	82680	63–25–2	0.06	µg/L	LRL
Carbofuran	82674	1563–66–2	0.060	µg/L	LRL
Chlorpyrifos	38933	2921–88–2	0.010	µg/L	IRL
Cyanazine	04041	21725–46–2	0.022	µg/L	LRL
Dacthal	82682	1861–32–1	0.0076	µg/L	LRL
Desulfinylfipronil amide	62169	--	0.029	µg/L	IRL
Desulfinylfipronil	62170	--	0.012	µg/L	IRL
Diazinon	39572	333–41–5	0.0060	µg/L	LRL
Dieldrin	39381	60–57–1	0.008	µg/L	LRL
Disulfoton	82677	298–04–4	0.040	µg/L	LRL
s-ethyl dipropylcarbomothiate (EPTC)	82668	759–94–4	0.0056	µg/L	LRL
Ethalfluralin	82663	55283–68–6	0.006	µg/L	LRL
Ethoprophos	82672	13194–48–4	0.016	µg/L	LRL
Fipronil	62166	120068–37–3	0.018	µg/L	LRL
Fipronil sulfide	62167	120067–83–6	0.016	µg/L	LRL
Fipronil sulfone	62168	120068–36–2	0.024	µg/L	LRL
Fonofos	04095	944–22–9	0.0048	µg/L	LRL
alpha-HCH	34253	319–84–6	0.0040	µg/L	LRL
Lindane	39341	58–89–9	0.0040	µg/L	LRL

Table 3. Selected information on physical properties and pesticides analyzed in samples collected in July 2015.—Continued

[All pesticide concentrations are dissolved. USGS, U.S. Geological Survey; CASRN; Chemical Abstracts Services Registry Number; --, not applicable; mm Hg, millimeters of mercury; FNU, formazin nephelometric turbidity units; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; ELISA, enzyme-linked immunosorbent assay; µg/L, micrograms per liter; LRL, laboratory reporting level; IRL, interim reporting level]

Property or pesticide	USGS parameter code	CASRN[1]	Reporting level	Units	Reporting level type
Linuron	82666	330–55–2	0.06	µg/L	LRL
Malathion	39532	121–75–5	0.016	µg/L	LRL
Methyl parathion	82667	298–00–0	0.008	µg/L	LRL
Metolachlor	39415	51218–45–2	0.012	µg/L	LRL
Metribuzin	82630	21087–64–9	0.012	µg/L	LRL
Molinate	82671	2212–67–1	0.008	µg/L	LRL
Napropamide	82684	15299–99–7	0.010	µg/L	LRL
p,p'-DDE	34653	72–55–9	0.0048	µg/L	LRL
Parathion	39542	56–38–2	0.020	µg/L	LRL
Pebulate	82669	1114–71–2	0.016	µg/L	LRL
Pendimethalin	82683	40487–42–1	0.012	µg/L	LRL
cis-permethrin	82687	61949–76–6	0.010	µg/L	LRL
Phorate	82664	298–02–2	0.020	µg/L	LRL
Prometon	04037	1610–18–0	0.012	µg/L	LRL
Propachlor	04024	1918–16–7	0.006	µg/L	LRL
Propanil	82679	709–98–8	0.010	µg/L	LRL
Propargite	82685	2312–35–8	0.020	µg/L	LRL
Propyzamide	82676	23950–58–5	0.008	µg/L	LRL
Simazine	04035	122–34–9	0.006	µg/L	LRL
Tebuthiuron	82670	34014–18–1	0.028	µg/L	LRL
Terbacil	82665	5902–51–2	0.024	µg/L	LRL
Terbufos	82675	13071–79–9	0.018	µg/L	LRL
Thiobencarb	82681	28249–77–6	0.016	µg/L	LRL
Triallate	82678	2303–17–5	0.0046	µg/L	LRL
Trifluralin	82661	1582–09–8	0.018	µg/L	LRL
alpha-HCH-d_6 (surrogate)	91065	86194–41–4	--	percent	--
Diazinon-d_{10} (surrogate)	91063	100155–47–3	--	percent	--

[1]This report contains Chemical Abstracts Services Registry Numbers (CASRN)®, which is a registered trademark of the American Chemical Society. The CASRN online database provides the latest registry number information at http://www.cas.org/. Chemical Abstracts Services recommends the verification of the CASRNs through CAS Client ServicesSM.

[2]Abraxis, 2014a.

[3]Abraxis, 2014b.

[4]Zaugg and others, 1995; Madsen and others, 2003.

used for the primary sample. Any differences in the analytical results between the environmental sample and the replicate sample may indicate some combination of inconsistency of sample collection, the natural variability in the sampled water, and the variability of the analytical method.

A field replicate was collected at wetland site S13 on July 21, 2015. Precision of analytical results for the field replicate sample was determined by calculating the relative percent difference (RPD) for the primary/replicate sample pair as indicated in the following equation:

$$RPD = \left(\frac{d}{\bar{x}}\right) \times 100, \quad (1)$$

where

RPD is the relative percent difference for the primary/replicate sample pair

d is the difference in concentration between the primary environmental sample and the field replicate sample for a given primary/replicate sample pair, and

$\bar{x}$ is the mean concentration of the primary environmental sample and the field replicate sample for a given primary/replicate pair.

All the primary/replicate sample pairs either had concentrations less than the LRL for both pairs or had the given constituent detected in both sample pairs. Three pesticides were detected in the primary and replicate samples from wetland site 13 (table 4). All the RPDs were within the acceptable level of precision, which generally is 20 percent or less (Taylor, 1987).

Pesticide Concentrations in Wetlands

This section of the report summarizes the pesticide concentrations in water samples collected from 18 wetlands within the Lake Traverse Reservation during July 2015. This section also provides a comparison of the detections and concentrations of pesticides in samples collected during July 2015 to the detections and concentrations of pesticides in samples collected during July 2006 by Neitzert and Bartholomay (2007). In addition to presenting analytical results for pesticides, results for physical properties are included. The samples collected for this study were analyzed for the physical properties of barometric pressure, turbidity, water temperature, dissolved oxygen, pH, and specific conductance; 54 pesticides; and 2 pesticide surrogate compounds (table 3). All water-quality data can be obtained from the USGS National Water Information System (U.S. Geological Survey, 2015) by using the station numbers in table 2.

Water-Quality Benchmarks

Various water-quality benchmarks are available for pesticide concentrations in water with regards to human health and aquatic life. Not all pesticides analyzed for this study had human-health or aquatic-life benchmarks. Selected available water-quality benchmarks for pesticides analyzed during July 2015 are listed in table 5. All benchmarks referenced in this study are used as a basis of comparison.

For the human-health benchmarks, the EPA's MCLs are legally enforceable drinking-water standards for the highest level of a contaminant that is allowed in drinking water (U.S. Environmental Protection Agency, 2009). Because MCLs apply only to drinking water from public supplies, the MCLs do not apply to any of the wetlands in this study but are used as a basis of comparison. The EPA's Secondary Maximum Contaminant Levels are nonenforceable guidelines regarding contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water (U.S. Environmental Protection Agency, 2009). The EPA's chronic noncancer Human Health Benchmarks for Pesticides (HHBPs) are nonenforceable advisory values protective of chronic noncancer effects (U.S. Environmental Protection Agency, 2015a). The EPA's carcinogenic HHBPs are nonenforceable advisory values protective of cancer effects (U.S. Environmental Protection Agency, 2015a). The HHBP range represents a one-in-one million (10^{-6}) to one-in-ten thousand (10^{-4}) cancer risk range. The USGS noncancer Health-Based Screening Levels (HBSLs) are nonenforceable benchmarks protective of chronic noncancer effects (Toccalino and others, 2014). The USGS cancer HBSLs are nonenforceable benchmarks protective of cancer effects (Toccalino and others, 2014). The HBSL range represents a one-in-one million (10^{-6}) to one-in-ten thousand (10^{-4}) cancer risk range.

For the aquatic-life benchmarks, the EPA's Criteria Maximum Concentration is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect (U.S. Environmental Protection Agency, 2015b). The EPA's Criterion Continuous Concentration (CCC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed

Table 4. Concentrations of pesticides and recoveries of pesticide surrogates detected in the primary and replicate samples from wetland site 13.

[RPD, relative percent difference; µg/L, micrograms per liter; E, estimated; NA, not applicable]

Pesticide	Units	Primary environmental sample	Replicate sample	RPD (percent)
2-chloro-4-isopropylamino-6-amino-*s*-triazine (CIAT; deethylatrazine)	µg/L	E0.026	E0.025	0.98
Atrazine	µg/L	0.058	0.058	0.00
Glyphosate	µg/L	E0.11	E0.11	0.00
alpha-HCH-d_6 (surrogate)	percent	98.2	95.8	NA
Diazinon-d_{10} (surrogate)	percent	106	104	NA

Table 5. Selected water-quality benchmarks for pesticides analyzed in samples collected in July 2015.

[All benchmark concentrations are in units of micrograms per liter. USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency; CMC, criterion maximum concentration; CCC, criterion continuous concentration; --, not available; MCL, U.S. Environmental Protection Agency Maximum Contaminant Level; HHBP, U.S. Environmental Protection Agency Human Health Benchmark for Pesticides; HBSL, U.S. Geological Survey Health-Based Screening Level; <, less than; >, greater than; LOC, level of concern; LC_{50}, 50-percent lethal concentration; NOEAC, no-observed-adverse-effects concentration; EC_{50}, 50-percent effect concentration]

Property or pesticide	USGS parameter code	Human-health benchmarks			Aquatic-life benchmarks[2]							
		Drinking water			EPA Office of Water Aquatic Life Criteria		Fish		Invertebrates		Nonvascular plants	Vascular plants
		Regulation (type)[1]	Noncancer benchmark (type)	Cancer benchmark (type)	CMC	CCC	Acute[3]	Chronic[4]	Acute[5]	Chronic[6]	Acute[7]	Acute[8]
2-chloro-4-isopropylamino-6-amino-*s*-triazine (CIAT; deethylatrazine)	04040	--	--	--	--	--	--	--	--	--	--	--
2,4–D	82697	70 (MCL)	--	--	--	--	--	--	12,500	--	--	--
2,6-diethylaniline	82660	--	--	--	--	--	--	--	--	--	--	--
Acetochlor	49260	--	140 (HHBP)[9]	--	--	--	191	130	4,100	22.1	1.43	3.4
Alachlor	46342	2 (MCL)	--	--	--	--	900	187	1,250	110	1.64	2.3
Atrazine	39632	3 (MCL)	--	--	--	--	2,650	--	360	60	<1	0.001
Azinphos-methyl	82686	--	11 (HHBP)[9]	--	--	--	0.18	0.055	0.08	0.036	--	--
Benfluralin	82673	--	35 (HHBP)[9]	--	--	--	34.85	1.9	1,090	15.5	>100	--
Butylate	04028	--	400 (HBSL)[10]	--	--	--	105	--	5,950	--	--	--
Carbaryl	82680	--	--	40–4,000 (HBSL)[10]	2.1	2.1	110	6	0.85	0.5	660	1,500
Carbofuran	82674	40 (MCL)	--	--	--	--	44	5.7	1.115	0.75	--	--
Chlorpyrifos	38933	--	2 (HBSL)[10]	--	0.083	0.041	0.9	0.57	0.05	0.04	140	--
Cyanazine	04041	--	10 (HBSL)[10]	0.03–3 (HBSL)[10]	--	--	--	--	--	--	--	--
Dacthal	82682	--	70 (HBSL)[10]	20–2,000 (HBSL)[10]	--	--	15,000	--	13,500	--	>11,000	>11,000
Desulfinylfipronil amide	62169	--	--	--	--	--	--	--	--	--	--	--
Desulfinylfipronil	62170	--	1 (HBSL)[10]	--	--	--	--	--	--	--	--	--
Diazinon	39572	--	1 (HBSL)[10]	--	0.17	0.17	45	<0.55	0.105	0.17	3,700	--
Dieldrin	39381	--	0.4 (HBSL)[10]	0.002–0.2 (HBSL)[10]	--	--	--	--	--	--	--	--
Disulfoton	82677	--	0.9 (HBSL)[10]	--	--	--	19.5	4	1.95	0.01	--	--
s-ethyl dipropylcarbomothiate (EPTC)	82668	--	350 (HHBP)[9]	--	--	--	7,000	--	3,250	800	1,400	5,600
Ethalfluralin	82663	--	280 (HHBP)[9]	0.4–40 (HHBP)[9]	--	--	16	0.4	30	24	25	--

Table 5. Selected water-quality benchmarks for pesticides analyzed in samples collected in July 2015.—Continued

[All benchmark concentrations are in units of micrograms per liter. USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency; CMC, criterion maximum concentration; CCC, criterion continuous concentration; --, not available; MCL, U.S. Environmental Protection Agency Maximum Contaminant Level; HHBP, U.S. Environmental Protection Agency Human Health Benchmark for Pesticides; HBSL, U.S. Geological Survey Health-Based Screening Level; <, less than; >, greater than; LOC, level of concern; LC_{50}, 50-percent lethal concentration; NOEAC, no-observed-adverse-effects concentration; EC_{50}, 50-percent effect concentration]

Property or pesticide	USGS parameter code	Human-health benchmarks			Aquatic-life benchmarks[2]							
		Drinking water			EPA Office of Water Aquatic Life Criteria		Fish		Invertebrates		Nonvascular plants	Vascular plants
		Regulation (type)[1]	Noncancer benchmark (type)	Cancer benchmark (type)	CMC	CCC	Acute[3]	Chronic[4]	Acute[5]	Chronic[6]	Acute[7]	Acute[8]
Ethoprophos	82672	--	10 (HHBP)[9]	1–100 (HHBP)[9]	--	--	150	24	22	0.8	8,400	--
Fipronil	62166	--	1 (HHBP)[9]	--	--	--	41.5	6.6	0.11	0.011	140	>100
Fipronil sulfide	62167	--	--	--	--	--	--	--	--	--	--	--
Fipronil sulfone	62168	--	--	--	--	--	--	--	--	--	--	--
Fonofos	04095	--	10 (HBSL)[10]	--	--	--	--	--	--	--	--	--
Glyphosate	99960	700 (MCL)	--	--	--	--	21,500	1,800	26,600	49,900	12,100	11,900
alpha-HCH	34253	--	7 (HBSL)[10]	0.006–0.6 (cancer HBSL)[10]	--	--	--	--	--	--	--	--
Lindane	39341	0.2 (MCL)	--	--	0.95	--	0.85	2.9	0.5	54	--	--
Linuron	82666	--	54 (HHBP)[9]	--	--	--	1,500	5.58	60	0.09	13.7	2.5
Malathion	39532	--	500 (HBSL)[10]	--	--	0.1	16.5	8.6	0.295	0.035	2,400	>9,630
Methyl parathion	82667	--	1 (HBSL)[10]	--	--	--	925	<10	0.485	0.25	15,000	18,000
Metolachlor	39415	--	700 (HBSL)[10]	--	--	--	1,600	30	550	1	8	21
Metribuzin	82630	--	90 (HBSL)[10]	--	--	--	21,000	3,000	2,100	1,290	8.7	130
Molinate	82671	--	7 (HBSL)[10]	--	--	--	>42,500	--	38,500	--	5,630	10,400
Napropamide	82684	--	840 (HHBP)[9]	--	--	--	3,200	1,100	7,150	1,100	3,400	--
p,p'-DDE	34653	--	--	0.1–10 (HBSL)[10]	--	--	--	--	--	--	--	--
Parathion	39542	--	0.2 (HHBP)[9]	--	--	--	--	--	--	--	--	--
Pebulate	82669	--	49 (HHBP)[9]	--	--	--	3,150	--	3,315	--	230	1,800
Pendimethalin	82683	--	210 (HHBP)[9]	--	--	--	69	6.3	140	14.5	5.2	12.5
cis-permethrin	82687	--	1,750 (HHBP)[9]	4–400 (HHBP)[9]	--	--	--	--	--	--	--	--
Phorate	82664	--	4 (HHBP)[9]	--	--	--	1.175	0.34	0.3	0.21	>1,300	--
Prometon	04037	--	400 (HBSL)[10]	--	--	--	6,000	19,700	12,850	3,450	98	--
Propachlor	04024	--	400 (HBSL)10	1–100 (HBSL)[10]	--	--	85	--	395	--	13.5	--

Table 5. Selected water-quality benchmarks for pesticides analyzed in samples collected in July 2015.—Continued

[All benchmark concentrations are in units of micrograms per liter. USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency; CMC, criterion maximum concentration; CCC, criterion continuous concentration; --, not available; MCL, U.S. Environmental Protection Agency Maximum Contaminant Level; HHBP, U.S. Environmental Protection Agency Human Health Benchmark for Pesticides; HBSL, U.S. Geological Survey Health-Based Screening Level; <, less than; >, greater than; LOC, level of concern; LC_{50}, 50-percent lethal concentration; NOEAC, no-observed-adverse-effects concentration; EC_{50}, 50-percent effect concentration]

Property or pesticide	USGS parameter code	Human-health benchmarks			Aquatic-life benchmarks[2]							
		Drinking water			EPA Office of Water Aquatic Life Criteria		Fish		Invertebrates		Nonvascular plants	Vascular plants
		Regulation (type)[1]	Noncancer benchmark (type)	Cancer benchmark (type)	CMC	CCC	Acute[3]	Chronic[4]	Acute[5]	Chronic[6]	Acute[7]	Acute[8]
Propanil	82679	--	63 (HHBP)[9]	--	--	--	1,150	9.1	600	86	16	110
Propargite	82685	--	280 (HHBP)[9]	1–100 (HHBP)[9]	--	--	59	16	37	9	66.2	75,000
Propyzamide	82676	--	600 (HBSL)[10]	1–100 (HBSL)[10]	--	--	36,000	7,700	>2,800	600	>4,000	1,180
Simazine	04035	4 (MCL)	--	--	--	--	3,200	--	500	--	2.24	140
Tebuthiuron	82670	--	1,000 (HBSL)[10]	--	--	--	53,000	9,300	148,500	21,800	50	135
Terbacil	82665	--	100 (HBSL)[10]	--	--	--	23,100	1,200	32,500	640	11	140
Terbufos	82675	--	0.4 (HBSL)[10]	--	--	--	0.385	0.64	0.1	0.03	--	--
Thiobencarb	82681	--	70 (HHBP)[10]	--	--	--	280	--	50	1	17	770
Triallate	82678	--	175 (HHBP)[9]	0.5–50 (HHBP)[9]	--	--	600	38	45.5	13	120	2,400
Trifluralin	82661	--	200 (HBSL)[10]	10–1,000 (HBSL)[10]	--	--	20.5	1.14	280	2.4	7.52	43.5

[1]From U.S. Environmental Protection Agency, 2009.

[2]From U.S. Environmental Protection Agency (2015b).

[3]Benchmark equals the toxicity value multiplied by the LOC. For acute fish, the toxicity value is generally the lowest 96-hour LC50 in a standardized test (usually with rainbow trout, fathead minnow, or bluegill), and the LOC is 0.5.

[4]Benchmark equals the toxicity value multiplied by the LOC. For chronic fish, toxicity value is usually the lowest NOEAC from a life-cycle or early life stage test (usually with rainbow trout or fathead minnow), and the LOC is 1.

[5]Benchmark equals the toxicity value multiplied by the LOC. For acute invertebrate, toxicity value is usually the lowest 48- or 96-hour EC50 or LC50 in a standardized test (usually with midge, scud, or daphnids), and the LOC is 0.5.

[6]Benchmark equals the toxicity value multiplied by the LOC. For chronic invertebrates, toxicity value is usually the lowest NOEAC from a life-cycle test with invertebrates (usually with midge, scud, or daphnids), and the LOC is 1.

[7]Benchmark equals the toxicity value multiplied by the LOC. For acute nonvascular plants, toxicity value is usually a short-term (less than 10 days) EC50 (usually with green algae or diatoms), and the LOC is 1.

[8]Benchmark equals the toxicity value multiplied by the LOC. For acute vascular plants, toxicity value is usually a short-term (less than 10 days) EC50 (usually with duckweed), and the LOC is 1.

[9]The noncancer benchmark, which is a chronic noncancer HHBP, and the cancer benchmark, which is a carcinogenic HHBP, are from U.S. Environmental Protection Agency (2015a).

[10]From Toccalino and others (2014).

indefinitely without resulting in an unacceptable effect. The Criteria Maximum Concentration and CCC are just two of the six parts of an aquatic-life criterion; the other four parts are the acute averaging period, chronic averaging period, acute frequency of allowed exceedance, and chronic frequency of allowed exceedance. Because these aquatic-life criteria are national guidance, the criteria are intended to be protective of most aquatic communities in the United States (U.S. Environmental Protection Agency, 2015b). The other aquatic-life benchmarks (fish, invertebrates, nonvascular plants, and vascular plants) are based on toxicity values and levels of concern (U.S. Environmental Protection Agency, 2015b) as indicated in associated footnotes in table 5.

In addition to the pesticide benchmarks in table 5, several human-health and aquatic-life benchmarks are available for physical properties measured during the 2015 sampling. The physical property of pH has a human-health benchmark (Secondary Maximum Contaminant Level) of 6.5–8.5 units (U.S. Environmental Protection Agency, 2009) and an aquatic-life benchmark (CCC) of 6.5–9.0 units (U.S. Environmental Protection Agency, 2015c). Aquatic-life benchmarks for dissolved oxygen are complex and generally are applicable to 7-day and 30-day means; therefore, the daily minimum criterion of 5.0 milligrams per liter (mg/L) for coldwater and warmwater fish (U.S. Environmental Protection Agency, 1986) is used in this report as a guide. Additional benchmarks exist from the State of South Dakota (South Dakota Legislature, 2015) and State of North Dakota (North Dakota Department of Health, 2001) for various beneficial uses; however, the benchmarks are beyond the scope of this study.

Physical Properties

Water samples collected during July 2015 for this study were analyzed for the physical properties presented in table 6. Physical properties for the July 2006 samples also are included in table 6 for comparison to the 2015 results.

Turbidity is a measure of the cloudiness of water caused by the presence of suspended material (U.S. Environmental Protection Agency, 2012). From a human-health perspective, turbidity has no health effects, but can interfere with disinfection and provide a medium for microbial growth (U.S. Environmental Protection Agency, 2009). From an aquatic-life perspective, higher turbidity increases water temperatures because suspended particles absorb more heat (U.S. Environmental Protection Agency, 2012). These warmer temperatures, in turn, reduce the dissolved oxygen concentration because warm water holds less dissolved oxygen than cold water. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis and the production of dissolved oxygen. Suspended materials can clog fish gills reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As the particles settle, they can blanket the stream bottom, especially in slower waters, and smother fish eggs and benthic macroinvertebrates. For the 2015 samples, turbidity ranged from 1.2 to 80 formazin nephelometric turbidity units (wetland sites S22 and S12, respectively), with a median value of 7.8 formazin nephelometric turbidity units (table 6).

Dissolved oxygen is required by higher forms of aquatic life for survival (Hem, 1992). Dissolved-oxygen concentrations ranged from 0.7 mg/L (wetland site S21) to 17.3 mg/L (wetland site S10), with a median concentration of 6.4 mg/L (table 6). The dissolved-oxygen concentrations for 2015 samples from sites S01, S09, S12, S15, S19, S21, and S22 were less than the daily minimum criterion of 5.0 mg/L for coldwater and warmwater fish (U.S. Environmental Protection Agency, 1986).

The physical property of pH is a measure of the hydrogen ion concentration; pH values of 7.0 indicate a neutral solution, pH values less than 7.0 indicate acidity, and pH values greater than 7.0 indicate alkalinity (Hem, 1992). The pH values in the 2015 samples ranged from 7.3 to 9.1 (wetland sites S09 and S02, respectively), with a median value of 8.3 (table 6). The pH values for 2015 samples from sites S02, S03, S07, S08, S10, S17, and S20 were greater than the upper range of the Secondary Maximum Contaminant Level of 6.5–8.5 units (U.S. Environmental Protection Agency, 2009). The pH values for 2015 samples from sites S02 and S10 were greater than the upper range of the CCC of 6.5–9.0 units (U.S. Environmental Protection Agency, 2015c).

Specific conductance is a measure of the ability of water to conduct an electrical current (Hem, 1992). Specific conductance provides an indication of the amount of dissolved constituents in water. As dissolved ion concentrations increase, specific conductance increases. For the 2015 samples, specific conductance ranged from 348 microsiemens to 5,280 microsiemens per centimeter at 25 degrees Celsius (wetland sites S17 and S07, respectively), with a median value of 866 microsiemens per centimeter at 25 degrees Celsius.

The effects of water temperature on aquatic organisms are numerous (U.S. Environmental Protection Agency, 1986). Fish, insects, zooplankton, phytoplankton, and other aquatic species all have a preferred temperature range (Michaud, 1991). Warm water retains less dissolved oxygen than cool water and may not contain enough dissolved oxygen for the survival of different species of aquatic life. Water temperature measured in the 2015 samples ranged from 16.3 to 28.9 degrees Celsius (wetland sites S15 and S07, respectively), with a median temperature of 22.6 degrees Celsius.

The percent increase in selected physical properties (turbidity, dissolved oxygen, and specific conductance) from 2006 to 2015 was calculating using the following equation:

$$Percent\ increase = \left(\frac{\text{Value}_{2015} - Value_{2006}}{\text{Value}_{2006}} \right) \times 100, \quad (2)$$

Table 6. Physical properties of water in selected Lake Traverse Indian Reservation wetlands, July 2006 and July 2015.

[mm of Hg, millimeters of mercury; FNU, formazin nephelometric turbidity units; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; --, no data. Number in parentheses below property is U.S. Geological Survey National Water Information System parameter code. Shaded cells denote percent increases for turbidity, dissolved oxygen, and specific conductance of greater than 100 percent]

Site (fig. 1)	Station number	Date	Time	Barometric pressure, (mm of Hg) (00025)	Turbidity, (FNU) (63680)	Dissolved oxygen, (mg/L) (00300)	pH (standard units) (00400)	Specific conductance (µS/cm) (00095)	Water temperature, (°C) (00020)
S01	454535097023100	7/11/2006	910	729	--	[1]2.0	7.8	897	19.9
S01	454535097023100	7/22/2015	840	715	3.2	[1]0.8	7.7	1,890	22.6
S02	454717096493000	7/12/2006	930	733	6.1	8.3	8.5	1,490	24.8
S02	454717096493000	7/22/2015	1130	728	27	14.2	[2,3]9.1	1,280	25.8
S03	455426096545100	7/11/2006	1355	732	16	7.0	8.2	995	26.0
S03	455426096545100	7/22/2015	1100	730	25	6.9	[2]9.0	747	25.0
S04	454933096361200	7/12/2006	1130	736	6.1	8.4	[2]8.7	1,400	27.3
S04	454933096361200	7/22/2015	1210	728	18	6.2	8.3	1,720	24.3
S07	453107096583500	7/20/2006	950	736	65	[1]3.5	8.1	5,040	18.8
S07	453107096583500	7/21/2015	1320	729	80	8.1	[2]8.8	5,280	28.9
S08	453031097011800	7/20/2006	910	730	66	9.2	[2]8.8	1,360	24.1
S08	453031097011800	7/21/2015	1250	726	9.7	7.3	8.7	1,280	25.6
S09	453245097071800	7/13/2006	1030	703	1.0	[1]3.0	7.4	320	20.5
S09	453245097071800	7/21/2015	1210	710	2.8	[1]1.0	7.3	386	18.8
S10	453801097120100	7/12/2006	1440	709	3.5	9.2	[2]8.8	681	24.5
S10	453801097120100	7/21/2015	1530	709	2.5	17.3	[2,3]9.1	489	26.1
S12	453825097104400	7/12/2006	1540	712	230	18.5	8.7	409	32.7
S12	453825097104400	7/21/2015	1500	712	4.6	[1]4.7	7.6	724	22.6
S13	450811097114200	7/20/2006	1255	720	160	[1]4.0	6.7	775	19.3
S13	450811097114200	7/21/2015	915	716	8.3	6.6	8.3	500	21.7
S14	452129097111500	7/20/2006	1135	719	1.5	[1]4.6	7.4	552	18.1
S14	452129097111500	7/21/2015	1030	714	3.3	9.2	7.8	545	16.7
S15	452214097095900	7/20/2006	1105	718	5.3	5.0	7.4	502	20.2
S15	452214097095900	7/21/2015	1100	714	8.1	[1]4.1	7.4	514	16.3
S17	452540097142000	7/20/2006	1040	718	0.5	11.9	[2,3]9.5	823	24.8
S17	452540097142000	7/21/2015	1130	713	25	11.5	[2]8.7	348	24.0
S18	453354097040800	7/13/2006	1120	717	3.2	10.3	8.5	1,240	25.7
S18	453354097040800	7/21/2015	1420	723	1.7	10.6	8.2	985	26.3
S19	455145097072900	7/11/2006	1025	729	34	[1]1.4	7.0	885	20.0
S19	455145097072900	7/22/2015	910	727	4.1	[1]3.1	8.1	1,070	23.9
S20	455941097223800	7/11/2006	1240	728	20	[1]2.2	7.7	1,360	19.4
S20	455941097223800	7/22/2015	1000	727	12	5.8	[2]9.0	2,560	24.3
S21	454315097184400	7/13/2006	850	706	3.8	[1]4.8	8.2	1,230	23.3
S21	454315097184400	7/22/2015	800	712	7.4	[1]0.7	7.4	1,100	23.3

Table 6. Physical properties of water in selected Lake Traverse Indian Reservation wetlands, July 2006 and July 2015.—Continued

[mm of Hg, millimeters of mercury; FNU, formazin nephelometric turbidity units; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; --, no data. Number in parentheses below property is U.S. Geological Survey National Water Information System parameter code. Shaded cells denote percent increases for turbidity, dissolved oxygen, and specific conductance of greater than 100 percent]

Site (fig. 1)	Station number	Date	Time	Barometric pressure, (mm of Hg) (00025)	Turbidity, (FNU) (63680)	Dissolved oxygen, (mg/L) (00300)	pH (standard units) (00400)	Specific conductance (µS/cm) (00095)	Water temperature, (°C) (00020)
S22	454012097181700	7/13/2006	930	707	1	7.2	[2]9.0	272	23.7
S22	454012097181700	7/22/2015	720	710	1.2	[1]1.7	8.5	402	23.3

[1]Value less than daily minimum criterion of 5.0 for coldwater and warmwater fish (U.S. Environmental Protection Agency, 1986).

[2]Value greater than the upper range of the U.S. Environmental Protection Agency's Secondary Maximum Contaminant Level of 6.5–8.5 units (U.S. Environmental Protection Agency, 2009).

[3]Value greater than the upper range of the U.S. Environmental Protection Agency's Criterion Continuous Concentration of 6.5–9.0 units (U.S. Environmental Protection Agency, 2015c).

where

$Value_{2015}$ is the physical property value from the 2015 sample and

$Value_{2006}$ is the physical property value from the 2006 sample; a resulting negative value would be a percent decrease.

Increases of greater than 100 percent (which indicate a value double or more than double of the 2006 value) for the physical properties of turbidity, dissolved oxygen, and specific conductance are indicated in table 6. None of these physical properties had a decrease of greater than 100 percent. Samples from five wetlands (sites S02, S04, S09, S14, and S17) had an increase in turbidity of more than 100 percent between the 2006 and 2015 samples. Samples from three wetlands (sites S07, S19, and S20) had an increase in dissolved oxygen of more than 100 percent, and the sample from one wetland (site 01) had an increase in specific conductance of more than 100 percent; however, these parameters can change substantially over the course of a day. Turbidity can be affected by wave action, and dissolved oxygen can undergo large diurnal variations if aquatic vegetation is present.

Pesticides

Water samples collected during July 2015 for this study were analyzed for dissolved concentrations of 54 pesticides and 2 pesticide surrogates (table 7). Results of pesticides analyzed in the 2006 samples (Neitzert and Bartholomay, 2007) also are included in table 7 for comparison but only for those 54 pesticides that were analyzed in the 2015 samples; 61 pesticides were analyzed in the 2006 samples.

2015 Samples

Of the 54 pesticides that were analyzed for in the 2015 samples, 47 were not detected in any samples. Seven pesticides—2-chloro-4-isopropylamino-6-amino-*s*-triazine (CIAT); 2,4–D; acetachlor; atrazine; glyphosate, metolachlor, and prometon—were detected in the 2015 samples with estimated concentrations or concentrations greater than the LRL (fig 2), and most pesticides were detected at low concentrations in only a few samples (table 7). Samples from all wetlands contained at least one pesticide (fig. 3). The maximum number of pesticides detected in a wetland sample was six (site S04), and the median number of pesticides detected was three.

The most commonly detected pesticides in the 2015 samples were atrazine and the atrazine degradate CIAT (also known as deethylatrazine), which were detected in 14 and 13 of the wetlands sampled, respectively (fig. 2). Detected concentrations of dissolved atrazine ranged from 0.017 to 0.185 µg/L, with a median detected concentration of 0.047 µg/L. Detected concentrations of dissolved CIAT ranged from an estimated 0.005 to 0.045 µg/L, with a median detected concentration of 0.02 µg/L (table 7).

Glyphosate was detected in samples from 11 wetlands, and metolachlor was detected in samples from 10 wetlands. Detected concentrations of dissolved glyphosate ranged from an estimated 0.11 to 1.2 µg/L, with a median detected concentration of 0.20 µg/L (table 7). Detected concentrations of dissolved metolachlor ranged from 0.005 to 0.083 µg/L, with a median detected concentration of 0.014 µg/L (table 7).

Other pesticides that had concentrations that were estimated or greater than the LRL were 2,4–D (4 wetlands), acetochlor (3 wetlands), and prometon (1 wetland). Detected concentrations of dissolved 2,4–D ranged from an estimated 3.6 to 9.5 µg/L, with a median detected concentration of 8.3 µg/L. Detected concentrations of dissolved acetochlor ranged from an estimated 0.017 to 0.035 µg/L, with a median estimated concentration of 0.025 µg/L. The detected concentration of dissolved prometon was estimated as 0.011 µg/L (table 7).

Table 7. Pesticide concentrations in water samples from selected Lake Traverse Indian Reservation wetlands, July 2006 and July 2015.

[All concentrations in micrograms per liter, unless otherwise noted. Shading represents samples with detected pesticide concentrations or estimated concentrations greater than the reporting level. Gray shading represents 2006 sample, and tan shading represents 2015 sample. Number in parentheses below constituent is U.S. Geological Survey National Water Information System parameter code. CIAT, 2-chloro-4-isopropylamino-6-amino-*s*-triazine (deethylatrazine); EPTC, *s*-ethyl dipropylcarbomothiate; E, estimated; <, less than; --, not analyzed]

Site (fig. 1)	Station number	Date	Time	CIAT (04040)	2,4–D ([1]82697/ [2]39730)	2,6-diethyl-aniline (82660)	Acetochlor (49260)	Alachlor (46342)	Atrazine (39632)	Azinphos-methyl (82686)
S01	454535097023100	7/11/2006	0910	E0.029	0.112	<0.0060	<0.006	<0.005	0.110	<0.050
S01	454535097023100	7/22/2015	0840	E0.026	<2.0	<0.0060	<0.010	<0.008	0.053	<0.120
S02	454717096493000	7/12/2006	0930	E0.011	<0.022	<0.0060	<0.006	<0.005	0.033	<0.050
S02	454717096493000	7/22/2015	1130	<0.014	<2.0	<0.0060	<0.010	<0.008	0.037	<0.120
S03	455426096545100	7/11/2006	1355	E0.014	<0.022	<0.0060	<0.006	<0.005	0.052	<0.050
S03	455426096545100	7/22/2015	1100	E0.020	9.5	<0.0060	<0.010	<0.008	0.057	<0.120
S04	454933096361200	7/12/2006	1130	E0.028	0.027	<0.0060	<0.006	<0.005	0.120	<0.050
S04	454933096361200	7/22/2015	1210	E0.045	<2.0	<0.0060	E0.035	<0.008	0.185	<0.120
S07	453107096583500	7/20/2006	0950	E0.010	<0.022	<0.0060	<0.006	<0.005	0.025	<0.050
S07	453107096583500	7/21/2015	1320	<0.010	<2.0	<0.0060	<0.010	<0.019	<0.017	<0.120
S08	453031097011800	7/20/2006	0910	E0.017	E0.107	<0.0060	<0.006	<0.005	0.094	<0.050
S08	453031097011800	7/21/2015	1250	E0.017	<2.0	<0.0060	<0.010	<0.008	0.045	<0.120
S09	453245097071800	7/13/2006	1030	E0.023	0.1	<0.0060	<0.006	<0.005	0.076	<0.050
S09	453245097071800	7/21/2015	1210	E0.014	<2.0	<0.0060	<0.010	<0.008	0.021	<0.120
S10	453801097120100	7/12/2006	1440	E0.017	0.099	<0.0060	E0.007	<0.005	0.050	<0.050
S10	453801097120100	7/21/2015	1530	E0.027	<2.0	<0.0060	E0.025	<0.008	0.058	<0.120
S12	453825097104400	7/12/2006	1540	E0.030	<0.022	<0.0060	<0.006	<0.005	0.068	<0.050
S12	453825097104400	7/21/2015	1500	<0.010	<2.0	<0.0060	<0.010	<0.008	<0.010	<0.120
S13	450811097114200	7/20/2006	1255	E0.007	E0.106	<0.0060	<0.006	<0.005	0.021	<0.050
S13	450811097114200	7/21/2015	0915	E0.026	<2.0	<0.0060	<0.010	<0.008	0.058	<0.120
S14	452129097111500	7/20/2006	1135	<0.014	<0.022	<0.0060	<0.006	<0.005	<0.007	<0.050
S14	452129097111500	7/21/2015	1030	E0.005	<2.0	<0.0060	<0.010	<0.008	<0.008	<0.120
S15	452214097095900	7/20/2006	1105	E0.005	<0.022	<0.0060	<0.006	<0.005	0.007	<0.050
S15	452214097095900	7/21/2015	1100	E0.009	<2.0	<0.0060	<0.010	<0.008	<0.008	<0.120
S17	452540097142000	7/20/2006	1040	E0.026	E0.051	<0.0060	<0.006	<0.005	0.079	<0.050
S17	452540097142000	7/21/2015	1130	<0.011	<2.0	<0.0060	<0.010	<0.008	0.021	<0.120
S18	453354097040800	7/13/2006	1120	E0.011	0.025	<0.0060	E0.008	<0.005	0.037	<0.050
S18	453354097040800	7/21/2015	1420	E0.021	<2.0	<0.0060	E0.017	<0.008	0.045	<0.120
S19	455145097072900	7/11/2006	1025	E0.007	<0.022	<0.0060	<0.006	<0.005	0.013	<0.050
S19	455145097072900	7/22/2015	0910	E0.024	9.0	<0.0060	<0.010	<0.008	0.067	<0.120
S20	455941097223800	7/11/2006	1240	E0.028	<0.022	<0.0060	<0.006	<0.005	0.096	<0.050
S20	455941097223800	7/22/2015	1000	<0.019	<2.0	<0.0060	<0.010	<0.008	0.049	<0.120
S21	454315097184400	7/13/2006	0850	E0.022	<0.022	<0.0060	<0.006	<0.005	0.064	<0.050
S21	454315097184400	7/22/2015	0800	E0.011	E3.6	<0.0060	<0.010	<0.008	0.017	<0.120
S22	454012097181700	7/13/2006	0930	E0.021	0.083	<0.0060	<0.006	<0.005	0.064	<0.050
S22	454012097181700	7/22/2015	0720	E0.018	7.5	<0.0060	<0.010	<0.008	0.040	<0.120

Table 7. Pesticide concentrations in water samples from selected Lake Traverse Indian Reservation wetlands, July 2006 and July 2015.—Continued

[All concentrations in micrograms per liter, unless otherwise noted. Shading represents samples with detected pesticide concentrations or estimated concentrations greater than the reporting level. Gray shading represents 2006 sample, and tan shading represents 2015 sample. Number in parentheses below constituent is U.S. Geological Survey National Water Information System parameter code. CIAT, 2-chloro-4-isopropylamino-6-amino-*s*-triazine (deethylatrazine); EPTC, *s*-ethyl dipropylcarbomothiate; E, estimated; <, less than; --, not analyzed]

Site (fig. 1)	Station number	Date	Time	Benfluralin (82673)	Butylate (04028)	Carbaryl (82680)	Carbofuran (82674)	Chlorpyrifos (38933)	Cyanazine (04041)	Dacthal (82682)
S01	454535097023100	7/11/2006	0910	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S01	454535097023100	7/22/2015	0840	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S02	454717096493000	7/12/2006	0930	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S02	454717096493000	7/22/2015	1130	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S03	455426096545100	7/11/2006	1355	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S03	455426096545100	7/22/2015	1100	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S04	454933096361200	7/12/2006	1130	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S04	454933096361200	7/22/2015	1210	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S07	453107096583500	7/20/2006	0950	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S07	453107096583500	7/21/2015	1320	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S08	453031097011800	7/20/2006	0910	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S08	453031097011800	7/21/2015	1250	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S09	453245097071800	7/13/2006	1030	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S09	453245097071800	7/21/2015	1210	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S10	453801097120100	7/12/2006	1440	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S10	453801097120100	7/21/2015	1530	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S12	453825097104400	7/12/2006	1540	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S12	453825097104400	7/21/2015	1500	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S13	450811097114200	7/20/2006	1255	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S13	450811097114200	7/21/2015	0915	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S14	452129097111500	7/20/2006	1135	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S14	452129097111500	7/21/2015	1030	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S15	452214097095900	7/20/2006	1105	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S15	452214097095900	7/21/2015	1100	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S17	452540097142000	7/20/2006	1040	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S17	452540097142000	7/21/2015	1130	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S18	453354097040800	7/13/2006	1120	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S18	453354097040800	7/21/2015	1420	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S19	455145097072900	7/11/2006	1025	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S19	455145097072900	7/22/2015	0910	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S20	455941097223800	7/11/2006	1240	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S20	455941097223800	7/22/2015	1000	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S21	454315097184400	7/13/2006	0850	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S21	454315097184400	7/22/2015	0800	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076
S22	454012097181700	7/13/2006	0930	<0.010	<0.0040	<0.041	<0.020	<0.0050	<0.018	<0.0030
S22	454012097181700	7/22/2015	0720	<0.014	<0.0040	<0.060	<0.060	<0.0100	<0.022	<0.0076

Table 7. Pesticide concentrations in water samples from selected Lake Traverse Indian Reservation wetlands, July 2006 and July 2015.—Continued

[All concentrations in micrograms per liter, unless otherwise noted. Shading represents samples with detected pesticide concentrations or estimated concentrations greater than the reporting level. Gray shading represents 2006 sample, and tan shading represents 2015 sample. Number in parentheses below constituent is U.S. Geological Survey National Water Information System parameter code. CIAT, 2-chloro-4-isopropylamino-6-amino-*s*-triazine (deethylatrazine); EPTC, *s*-ethyl dipropylcarbomothiate; E, estimated; <, less than; --, not analyzed]

Site (fig. 1)	Station number	Date	Time	Desulfinyl-fipronil amide (62169)	Desulfinyl-fipronil (62170)	Diazinon (39572)	Dieldrin (39381)	Disulfoton[3] (82677)	EPTC (82668)	Ethalfluralin (82663)
S01	454535097023100	7/11/2006	0910	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S01	454535097023100	7/22/2015	0840	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S02	454717096493000	7/12/2006	0930	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S02	454717096493000	7/22/2015	1130	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S03	455426096545100	7/11/2006	1355	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S03	455426096545100	7/22/2015	1100	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S04	454933096361200	7/12/2006	1130	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S04	454933096361200	7/22/2015	1210	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S07	453107096583500	7/20/2006	0950	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S07	453107096583500	7/21/2015	1320	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S08	453031097011800	7/20/2006	0910	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S08	453031097011800	7/21/2015	1250	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S09	453245097071800	7/13/2006	1030	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S09	453245097071800	7/21/2015	1210	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S10	453801097120100	7/12/2006	1440	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S10	453801097120100	7/21/2015	1530	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S12	453825097104400	7/12/2006	1540	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S12	453825097104400	7/21/2015	1500	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S13	450811097114200	7/20/2006	1255	<0.029	<0.012	<0.0128	<0.009	<0.021	<0.0040	<0.009
S13	450811097114200	7/21/2015	0915	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S14	452129097111500	7/20/2006	1135	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S14	452129097111500	7/21/2015	1030	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S15	452214097095900	7/20/2006	1105	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S15	452214097095900	7/21/2015	1100	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S17	452540097142000	7/20/2006	1040	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S17	452540097142000	7/21/2015	1130	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S18	453354097040800	7/13/2006	1120	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S18	453354097040800	7/21/2015	1420	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S19	455145097072900	7/11/2006	1025	<0.029	<0.012	<0.0051	<0.009	<0.021	<0.0040	<0.009
S19	455145097072900	7/22/2015	0910	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S20	455941097223800	7/11/2006	1240	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S20	455941097223800	7/22/2015	1000	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S21	454315097184400	7/13/2006	0850	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S21	454315097184400	7/22/2015	0800	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006
S22	454012097181700	7/13/2006	0930	<0.029	<0.012	<0.0050	<0.009	<0.021	<0.0040	<0.009
S22	454012097181700	7/22/2015	0720	<0.029	<0.012	<0.0060	<0.008	--	<0.0056	<0.006

Table 7. Pesticide concentrations in water samples from selected Lake Traverse Indian Reservation wetlands, July 2006 and July 2015.—Continued

[All concentrations in micrograms per liter, unless otherwise noted. Shading represents samples with detected pesticide concentrations or estimated concentrations greater than the reporting level. Gray shading represents 2006 sample, and tan shading represents 2015 sample. Number in parentheses below constituent is U.S. Geological Survey National Water Information System parameter code. CIAT, 2-chloro-4-isopropylamino-6-amino-*s*-triazine (deethylatrazine); EPTC, *s*-ethyl dipropylcarbomothiate; E, estimated; <, less than; --, not analyzed]

Site (fig. 1)	Station number	Date	Time	Ethoprophos (82672)	Fipronil (62166)	Fipronil sulfide (62167)	Fipronil sulfone (62168)	Fonofos (04095)	Glyphosate ([1]99960/ [2]62722)	*alpha*-HCH (34253)
S01	454535097023100	7/11/2006	0910	<0.012	<0.016	<0.013	<0.024	<0.0053	<0.150	<0.0050
S01	454535097023100	7/22/2015	0840	<0.016	<0.018	<0.016	<0.024	<0.0048	E0.21	<0.0040
S02	454717096493000	7/12/2006	0930	<0.012	<0.016	<0.013	<0.024	<0.0053	E0.060	<0.0050
S02	454717096493000	7/22/2015	1130	<0.016	<0.018	<0.016	<0.024	<0.0048	<0.10	<0.0040
S03	455426096545100	7/11/2006	1355	<0.012	<0.016	<0.013	<0.024	<0.0053	<0.150	<0.0050
S03	455426096545100	7/22/2015	1100	<0.016	<0.018	<0.016	<0.024	<0.0048	<0.10	<0.0040
S04	454933096361200	7/12/2006	1130	<0.012	<0.016	<0.013	<0.024	<0.0053	E0.070	<0.0050
S04	454933096361200	7/22/2015	1210	<0.016	<0.018	<0.016	<0.024	<0.0048	E0.25	<0.0040
S07	453107096583500	7/20/2006	0950	<0.012	<0.016	<0.013	<0.024	<0.0053	<0.150	<0.0050
S07	453107096583500	7/21/2015	1320	<0.016	<0.018	<0.016	<0.024	<0.0048	1.2	<0.0040
S08	453031097011800	7/20/2006	0910	<0.012	<0.016	<0.013	<0.024	<0.0053	<0.150	<0.0050
S08	453031097011800	7/21/2015	1250	<0.016	<0.018	<0.016	<0.024	<0.0048	E0.15	<0.0040
S09	453245097071800	7/13/2006	1030	<0.012	<0.016	<0.013	<0.024	<0.0053	E0.050	<0.0050
S09	453245097071800	7/21/2015	1210	<0.016	<0.018	<0.016	<0.024	<0.0048	E0.12	<0.0040
S10	453801097120100	7/12/2006	1440	<0.012	<0.016	<0.013	<0.024	<0.0053	<0.150	<0.0050
S10	453801097120100	7/21/2015	1530	<0.016	<0.018	<0.016	<0.024	<0.0048	<0.10	<0.0040
S12	453825097104400	7/12/2006	1540	<0.012	<0.016	<0.013	<0.024	<0.0053	<0.150	<0.0050
S12	453825097104400	7/21/2015	1500	<0.016	<0.018	<0.016	<0.024	<0.0048	E0.11	<0.0040
S13	450811097114200	7/20/2006	1255	<0.012	<0.016	<0.013	<0.024	<0.0053	E0.110	<0.0050
S13	450811097114200	7/21/2015	0915	<0.016	<0.018	<0.016	<0.024	<0.0048	E0.11	<0.0040
S14	452129097111500	7/20/2006	1135	<0.012	<0.016	<0.013	<0.024	<0.0053	<0.150	<0.0050
S14	452129097111500	7/21/2015	1030	<0.016	<0.018	<0.016	<0.024	<0.0048	<0.10	<0.0040
S15	452214097095900	7/20/2006	1105	<0.012	<0.016	<0.013	<0.024	<0.0053	<0.150	<0.0050
S15	452214097095900	7/21/2015	1100	<0.016	<0.018	<0.016	<0.024	<0.0048	E0.11	<0.0040
S17	452540097142000	7/20/2006	1040	<0.012	<0.016	<0.013	<0.024	<0.0053	<0.150	<0.0050
S17	452540097142000	7/21/2015	1130	<0.016	<0.018	<0.016	<0.024	<0.0048	<0.10	<0.0040
S18	453354097040800	7/13/2006	1120	<0.012	<0.016	<0.013	<0.024	<0.0053	<0.150	<0.0050
S18	453354097040800	7/21/2015	1420	<0.016	<0.018	<0.016	<0.024	<0.0048	0.34	<0.0040
S19	455145097072900	7/11/2006	1025	<0.012	<0.016	<0.013	<0.024	<0.0053	<0.150	<0.0050
S19	455145097072900	7/22/2015	0910	<0.016	<0.018	<0.016	<0.024	<0.0048	E0.20	<0.0040
S20	455941097223800	7/11/2006	1240	<0.012	<0.016	<0.013	<0.024	<0.0053	0.3	<0.0050
S20	455941097223800	7/22/2015	1000	<0.016	<0.018	<0.016	<0.024	<0.0048	0.44	<0.0040
S21	454315097184400	7/13/2006	0850	<0.012	<0.016	<0.013	<0.024	<0.0053	<0.150	<0.0054
S21	454315097184400	7/22/2015	0800	<0.016	<0.018	<0.016	<0.024	<0.0048	<0.10	<0.0040
S22	454012097181700	7/13/2006	0930	<0.012	<0.016	<0.013	<0.024	<0.0053	<0.150	<0.0050
S22	454012097181700	7/22/2015	0720	<0.016	<0.018	<0.016	<0.024	<0.0048	<0.10	<0.0040

Table 7. Pesticide concentrations in water samples from selected Lake Traverse Indian Reservation wetlands, July 2006 and July 2015.—Continued

[All concentrations in micrograms per liter, unless otherwise noted. Shading represents samples with detected pesticide concentrations or estimated concentrations greater than the reporting level. Gray shading represents 2006 sample, and tan shading represents 2015 sample. Number in parentheses below constituent is U.S. Geological Survey National Water Information System parameter code. CIAT, 2-chloro-4-isopropylamino-6-amino-*s*-triazine (deethylatrazine); EPTC, *s*-ethyl dipropylcarbomothiate; E, estimated; <, less than; --, not analyzed]

Site (fig. 1)	Station number	Date	Time	Lindane (39341)	Linuron (82666)	Malathion (39532)	Methyl parathion (82667)	Metolachlor (39415)	Metribuzin (82630)	Molinate (82671)
S01	454535097023100	7/11/2006	0910	<0.0040	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S01	454535097023100	7/22/2015	0840	<0.0040	<0.060	<0.016	<0.008	0.006	<0.012	<0.0080
S02	454717096493000	7/12/2006	0930	<0.0040	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S02	454717096493000	7/22/2015	1130	<0.0040	<0.060	<0.016	<0.008	0.017	<0.012	<0.0080
S03	455426096545100	7/11/2006	1355	<0.0040	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S03	455426096545100	7/22/2015	1100	<0.0040	<0.060	<0.016	<0.008	0.017	<0.012	<0.0080
S04	454933096361200	7/12/2006	1130	<0.0040	<0.035	<0.027	<0.015	0.027	<0.028	<0.0030
S04	454933096361200	7/22/2015	1210	<0.0040	<0.060	<0.016	<0.008	0.083	<0.012	<0.0080
S07	453107096583500	7/20/2006	0950	<0.0040	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S07	453107096583500	7/21/2015	1320	<0.0040	<0.060	<0.016	<0.008	<0.012	<0.012	<0.0080
S08	453031097011800	7/20/2006	0910	<0.0040	<0.035	<0.027	<0.015	0.008	<0.028	<0.0030
S08	453031097011800	7/21/2015	1250	<0.0040	<0.060	<0.016	<0.008	0.013	<0.012	<0.0080
S09	453245097071800	7/13/2006	1030	<0.0040	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S09	453245097071800	7/21/2015	1210	<0.0040	<0.060	<0.016	<0.008	0.006	<0.012	<0.0080
S10	453801097120100	7/12/2006	1440	<0.0040	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S10	453801097120100	7/21/2015	1530	<0.0040	<0.060	<0.016	<0.008	0.015	<0.012	<0.0080
S12	453825097104400	7/12/2006	1540	<0.0040	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S12	453825097104400	7/21/2015	1500	<0.0040	<0.060	<0.058	<0.008	<0.012	<0.012	<0.0080
S13	450811097114200	7/20/2006	1255	<0.0040	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S13	450811097114200	7/21/2015	0915	<0.0040	<0.060	<0.016	<0.008	<0.012	<0.012	<0.0080
S14	452129097111500	7/20/2006	1135	<0.0040	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S14	452129097111500	7/21/2015	1030	<0.0040	<0.060	<0.016	<0.008	<0.012	<0.012	<0.0080
S15	452214097095900	7/20/2006	1105	<0.0040	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S15	452214097095900	7/21/2015	1100	<0.0040	<0.060	<0.016	<0.008	<0.012	<0.012	<0.0080
S17	452540097142000	7/20/2006	1040	<0.0040	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S17	452540097142000	7/21/2015	1130	<0.0040	<0.060	<0.016	<0.008	0.008	<0.012	<0.0080
S18	453354097040800	7/13/2006	1120	<0.0040	<0.035	<0.027	<0.015	E0.004	<0.028	<0.0030
S18	453354097040800	7/21/2015	1420	<0.0040	<0.060	<0.016	<0.008	0.02	<0.012	<0.0080
S19	455145097072900	7/11/2006	1025	<0.0040	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S19	455145097072900	7/22/2015	0910	<0.0040	<0.060	<0.016	<0.008	<0.012	<0.012	<0.0080
S20	455941097223800	7/11/2006	1240	<0.0147	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S20	455941097223800	7/22/2015	1000	<0.0040	<0.060	<0.016	<0.008	0.005	<0.012	<0.0080
S21	454315097184400	7/13/2006	0850	<0.0083	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S21	454315097184400	7/22/2015	0800	<0.0040	<0.060	<0.016	<0.008	<0.012	<0.012	<0.0080
S22	454012097181700	7/13/2006	0930	<0.0040	<0.035	<0.027	<0.015	<0.006	<0.028	<0.0030
S22	454012097181700	7/22/2015	0720	<0.0040	<0.060	<0.016	<0.008	<0.012	<0.012	<0.0080

Table 7. Pesticide concentrations in water samples from selected Lake Traverse Indian Reservation wetlands, July 2006 and July 2015.—Continued

[All concentrations in micrograms per liter, unless otherwise noted. Shading represents samples with detected pesticide concentrations or estimated concentrations greater than the reporting level. Gray shading represents 2006 sample, and tan shading represents 2015 sample. Number in parentheses below constituent is U.S. Geological Survey National Water Information System parameter code. CIAT, 2-chloro-4-isopropylamino-6-amino-*s*-triazine (deethylatrazine); EPTC, *s*-ethyl dipropylcarbomothiate; E, estimated; <, less than; --, not analyzed]

Site (fig. 1)	Station number	Date	Time	Napropamide (82684)	p,p'-DDE (34653)	Parathion (39542)	Pebulate (82669)	Pendimethalin (82683)	*cis*-Permethrin (82687)	Phorate (82664)
S01	454535097023100	7/11/2006	0910	<0.007	<0.003	<0.010	<0.0045	<0.022	<0.006	<0.055
S01	454535097023100	7/22/2015	0840	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S02	454717096493000	7/12/2006	0930	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S02	454717096493000	7/22/2015	1130	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S03	455426096545100	7/11/2006	1355	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S03	455426096545100	7/22/2015	1100	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S04	454933096361200	7/12/2006	1130	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S04	454933096361200	7/22/2015	1210	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S07	453107096583500	7/20/2006	0950	<0.007	<0.003	<0.010	<0.0083	<0.022	<0.006	<0.055
S07	453107096583500	7/21/2015	1320	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S08	453031097011800	7/20/2006	0910	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S08	453031097011800	7/21/2015	1250	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S09	453245097071800	7/13/2006	1030	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S09	453245097071800	7/21/2015	1210	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S10	453801097120100	7/12/2006	1440	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S10	453801097120100	7/21/2015	1530	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S12	453825097104400	7/12/2006	1540	<0.007	<0.003	<0.010	<0.0342	<0.022	<0.006	<0.055
S12	453825097104400	7/21/2015	1500	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S13	450811097114200	7/20/2006	1255	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S13	450811097114200	7/21/2015	0915	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S14	452129097111500	7/20/2006	1135	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S14	452129097111500	7/21/2015	1030	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S15	452214097095900	7/20/2006	1105	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S15	452214097095900	7/21/2015	1100	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S17	452540097142000	7/20/2006	1040	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S17	452540097142000	7/21/2015	1130	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S18	453354097040800	7/13/2006	1120	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S18	453354097040800	7/21/2015	1420	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S19	455145097072900	7/11/2006	1025	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S19	455145097072900	7/22/2015	0910	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S20	455941097223800	7/11/2006	1240	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S20	455941097223800	7/22/2015	1000	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S21	454315097184400	7/13/2006	0850	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S21	454315097184400	7/22/2015	0800	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020
S22	454012097181700	7/13/2006	0930	<0.007	<0.003	<0.010	<0.0040	<0.022	<0.006	<0.055
S22	454012097181700	7/22/2015	0720	<0.010	<0.005	<0.020	<0.0160	<0.012	<0.010	<0.020

Table 7. Pesticide concentrations in water samples from selected Lake Traverse Indian Reservation wetlands, July 2006 and July 2015.—Continued

[All concentrations in micrograms per liter, unless otherwise noted. Shading represents samples with detected pesticide concentrations or estimated concentrations greater than the reporting level. Gray shading represents 2006 sample, and tan shading represents 2015 sample. Number in parentheses below constituent is U.S. Geological Survey National Water Information System parameter code. CIAT, 2-chloro-4-isopropylamino-6-amino-*s*-triazine (deethylatrazine); EPTC, *s*-ethyl dipropylcarbomothiate; E, estimated; <, less than; --, not analyzed]

Site (fig. 1)	Station number	Date	Time	Prometon (04037)	Propachlor (04024)	Propanil (82679)	Propargite (82685)	Propyzamide (82676)	Simazine (04035)	Tebuthiuron (82670)
S01	454535097023100	7/11/2006	0910	<0.010	<0.010	<0.011	<0.023	<0.0040	<0.005	<0.016
S01	454535097023100	7/22/2015	0840	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S02	454717096493000	7/12/2006	0930	<0.010	<0.010	<0.011	<0.023	<0.0040	<0.005	<0.016
S02	454717096493000	7/22/2015	1130	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S03	455426096545100	7/11/2006	1355	<0.010	<0.010	<0.011	<0.023	<0.0040	<0.005	<0.016
S03	455426096545100	7/22/2015	1100	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S04	454933096361200	7/12/2006	1130	E0.005	<0.010	<0.011	<0.023	<0.0040	E0.002	<0.016
S04	454933096361200	7/22/2015	1210	E0.011	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S07	453107096583500	7/20/2006	0950	<0.010	<0.010	<0.021	<0.023	<0.0040	<0.005	<0.016
S07	453107096583500	7/21/2015	1320	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S08	453031097011800	7/20/2006	0910	<0.010	<0.010	<0.011	<0.023	<0.0040	<0.005	<0.016
S08	453031097011800	7/21/2015	1250	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S09	453245097071800	7/13/2006	1030	<0.010	<0.010	<0.011	<0.044	<0.0040	<0.005	<0.016
S09	453245097071800	7/21/2015	1210	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S10	453801097120100	7/12/2006	1440	<0.010	<0.010	<0.011	<0.023	<0.0040	<0.005	<0.016
S10	453801097120100	7/21/2015	1530	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S12	453825097104400	7/12/2006	1540	<0.010	<0.010	<0.011	<0.023	<0.0040	<0.005	<0.016
S12	453825097104400	7/21/2015	1500	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S13	450811097114200	7/20/2006	1255	<0.010	<0.010	<0.011	<0.043	<0.0040	<0.005	<0.016
S13	450811097114200	7/21/2015	0915	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S14	452129097111500	7/20/2006	1135	<0.010	<0.010	<0.011	<0.023	<0.0040	<0.005	<0.016
S14	452129097111500	7/21/2015	1030	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S15	452214097095900	7/20/2006	1105	<0.010	<0.010	<0.011	<0.023	<0.0040	<0.005	<0.016
S15	452214097095900	7/21/2015	1100	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S17	452540097142000	7/20/2006	1040	<0.010	<0.010	<0.015	<0.023	<0.0040	<0.005	<0.016
S17	452540097142000	7/21/2015	1130	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S18	453354097040800	7/13/2006	1120	E0.008	<0.010	<0.011	<0.023	<0.0040	<0.005	<0.016
S18	453354097040800	7/21/2015	1420	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S19	455145097072900	7/11/2006	1025	0.028	<0.010	<0.011	<0.023	<0.0040	<0.005	<0.016
S19	455145097072900	7/22/2015	0910	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S20	455941097223800	7/11/2006	1240	<0.010	<0.010	<0.011	<0.023	<0.0040	<0.005	<0.016
S20	455941097223800	7/22/2015	1000	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S21	454315097184400	7/13/2006	0850	<0.010	<0.010	<0.011	<0.023	<0.0040	<0.005	<0.016
S21	454315097184400	7/22/2015	0800	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028
S22	454012097181700	7/13/2006	0930	<0.010	<0.010	<0.011	<0.035	<0.0040	<0.005	<0.016
S22	454012097181700	7/22/2015	0720	<0.012	<0.006	<0.010	<0.020	<0.0080	<0.006	<0.028

Table 7. Pesticide concentrations in water samples from selected Lake Traverse Indian Reservation wetlands, July 2006 and July 2015.—Continued

[All concentrations in micrograms per liter, unless otherwise noted. Shading represents samples with detected pesticide concentrations or estimated concentrations greater than the reporting level. Gray shading represents 2006 sample, and tan shading represents 2015 sample. Number in parentheses below constituent is U.S. Geological Survey National Water Information System parameter code. CIAT, 2-chloro-4-isopropylamino-6-amino-*s*-triazine (deethylatrazine); EPTC, *s*-ethyl dipropylcarbomothiate; E, estimated; <, less than; --, not analyzed]

Site (fig. 1)	Station number	Date	Time	Terbacil (82665)	Terbufos[3] (82675)	Thiobencarb (82681)	Triallate (82678)	Trifluralin (82661)	*alpha*-HCH-d_6, (surrogate) (91065) (percent recovery)	Diazinon-d_{10} (surrogate) (91063) (percent recovery)
S01	454535097023100	7/11/2006	0910	<0.034	<0.017	<0.010	<0.0060	<0.009	112	116
S01	454535097023100	7/22/2015	0840	<0.024	--	<0.016	<0.0046	<0.018	93.1	105
S02	454717096493000	7/12/2006	0930	<0.034	<0.017	<0.010	<0.0060	<0.009	109	116
S02	454717096493000	7/22/2015	1130	<0.024	--	<0.016	<0.0046	<0.018	91.3	99.5
S03	455426096545100	7/11/2006	1355	<0.034	<0.017	<0.010	<0.0060	<0.009	102	112
S03	455426096545100	7/22/2015	1100	<0.024	--	<0.016	<0.0046	<0.018	93.6	102
S04	454933096361200	7/12/2006	1130	<0.034	<0.017	<0.010	<0.0060	<0.009	111	114
S04	454933096361200	7/22/2015	1210	<0.024	--	<0.016	<0.0046	<0.018	91.8	101
S07	453107096583500	7/20/2006	0950	<0.034	<0.017	<0.010	<0.0060	<0.009	97	108
S07	453107096583500	7/21/2015	1320	<0.024	--	<0.016	<0.0046	<0.018	95.9	111
S08	453031097011800	7/20/2006	0910	<0.034	<0.017	<0.010	<0.0060	<0.009	112	117
S08	453031097011800	7/21/2015	1250	<0.024	--	<0.016	<0.0046	<0.018	92	102
S09	453245097071800	7/13/2006	1030	<0.034	<0.017	<0.010	<0.0060	<0.009	110	113
S09	453245097071800	7/21/2015	1210	<0.024	--	<0.016	<0.0046	<0.018	96.6	106
S10	453801097120100	7/12/2006	1440	<0.034	<0.017	<0.010	<0.0060	<0.009	105	107
S10	453801097120100	7/21/2015	1530	<0.024	--	<0.016	<0.0046	<0.018	98.4	106
S12	453825097104400	7/12/2006	1540	<0.034	<0.017	<0.010	<0.0060	<0.009	102	117
S12	453825097104400	7/21/2015	1500	<0.024	--	<0.016	<0.0046	<0.018	94.4	104
S13	450811097114200	7/20/2006	1255	<0.034	<0.017	<0.010	<0.0060	<0.009	117	125
S13	450811097114200	7/21/2015	0915	<0.024	--	<0.016	<0.0046	<0.018	98.2	106
S14	452129097111500	7/20/2006	1135	<0.034	<0.017	<0.010	<0.0060	<0.009	106	108
S14	452129097111500	7/21/2015	1030	<0.024	--	<0.016	<0.0046	<0.018	93.9	87.3
S15	452214097095900	7/20/2006	1105	<0.034	<0.017	<0.010	<0.0060	<0.009	111	117
S15	452214097095900	7/21/2015	1100	<0.024	--	<0.016	<0.0046	<0.018	90.3	97.3
S17	452540097142000	7/20/2006	1040	<0.034	<0.017	<0.010	<0.0060	<0.009	111	116
S17	452540097142000	7/21/2015	1130	<0.024	--	<0.016	<0.0046	<0.018	90.2	95.5
S18	453354097040800	7/13/2006	1120	<0.034	<0.017	<0.010	<0.0060	<0.009	114	122
S18	453354097040800	7/21/2015	1420	<0.024	--	<0.016	<0.0046	<0.018	84.5	87.6
S19	455145097072900	7/11/2006	1025	<0.034	<0.017	<0.010	<0.0060	<0.009	101	114
S19	455145097072900	7/22/2015	0910	<0.024	--	<0.016	<0.0046	<0.018	94.6	112
S20	455941097223800	7/11/2006	1240	<0.034	<0.017	<0.010	<0.0060	<0.009	102	116
S20	455941097223800	7/22/2015	1000	<0.024	--	<0.016	<0.0046	<0.018	95.1	105
S21	454315097184400	7/13/2006	0850	<0.034	<0.017	<0.010	<0.0060	<0.009	117	125
S21	454315097184400	7/22/2015	0800	<0.024	--	<0.016	<0.0046	<0.018	89	100
S22	454012097181700	7/13/2006	0930	<0.034	<0.017	<0.010	<0.0060	<0.009	112	117
S22	454012097181700	7/22/2015	0720	<0.024	--	<0.016	<0.0046	<0.018	93.7	100

[1]Parameter code in 2015.

[2]Parameter code in 2006.

[3]Disulfoton and terbufos were not analyzed in the 2015 samples because samples for these pesticides were ruined during laboratory preparation.

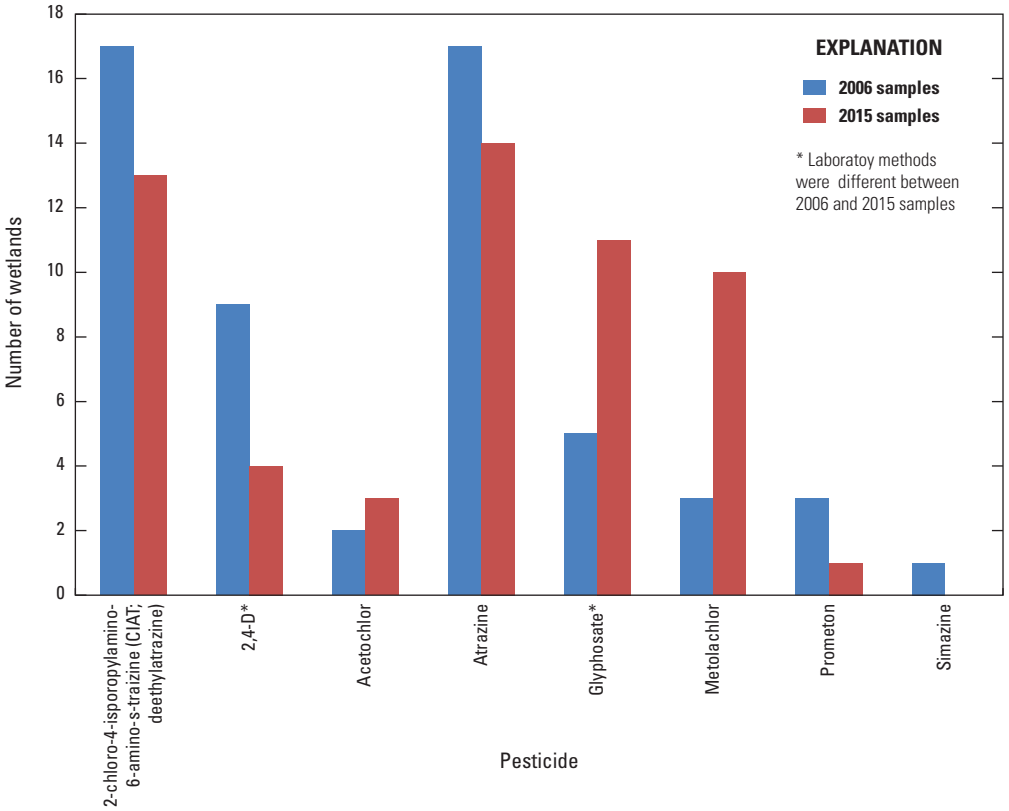


Figure 2. Number of wetlands at which selected pesticides were detected, July 2006 and July 2015.

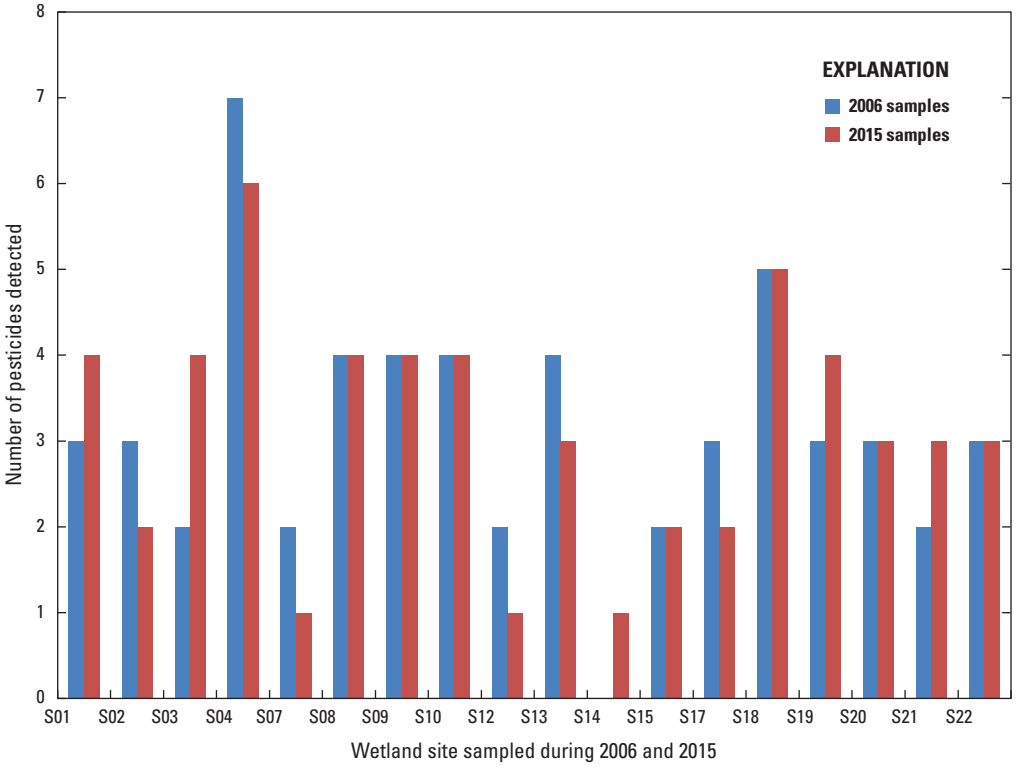


Figure 3. Number of pesticides detected in water samples for selected Lake Traverse Indian Reservation wetlands, July 2006 and July 2015.

Comparison of Pesticide Detections and Concentrations between 2006 and 2015 Sampling

Samples collected during July 2006 were analyzed for 61 pesticides (Neitzert and Bartholomay, 2007), and samples collected during July 2015 were analyzed for 54 pesticides. Only those pesticides that are common between the two sampling periods are included in table 7 and in figures 2 and 3. Also, as described in the "Reporting Levels" section, the different reporting levels for 2,4–D and glyphosate for the 2015 samples affected comparisons of detections and concentrations of those two pesticides between the 2006 and 2015 samples.

The same pesticides that were detected in the 2006 samples were detected in the 2015 samples, with the exception of simazine, which was detected only in one sample in 2006 (fig. 2). Atrazine and CIAT were the most commonly detected pesticides in both sampling years; however, atrazine and CIAT were detected in fewer wetlands in 2015 (14 and 13 wetlands, respectively) than in 2006 (17 wetlands for both pesticides). In addition to atrazine and CIAT, 2,4–D and prometon were detected in fewer wetlands in 2015 than in 2006, and simazine was only detected in 2006. In contrast, acetochlor, glyphosate, and metolachlor were detected in more wetlands in 2015 than in 2006 (fig. 2).

In samples from individual wetlands, the number of pesticides detected was similar between 2006 and 2015 (fig. 3). At least one pesticide was detected in all wetlands in 2015, and all but one wetland (site S14) had pesticide detections in 2006. Concentrations of detected pesticides were generally similar between 2006 and 2015. Exceptions were 2,4–D concentrations in samples from wetland sites S3, S19, S21, and S22 and glyphosate concentrations in samples from wetland site S07 (table 7); however, the large concentration differences may be associated with the different analytical methods and reporting levels between 2006 and 2015 for these pesticides.

Synopsis of Pesticide Results

The analytical results from this study indicate that some pesticides were present in selected Lake Traverse Reservation wetlands in 2015. Comparing these results to the 2006 results and established water-quality benchmarks may provide useful information relative to the quality of the water in the wetlands. This synopsis will focus on the seven pesticides detected in samples collected in 2015 for this study—CIAT; 2,4–D; acetachlor; atrazine; glyphosate, metolachlor, and prometon. The atrazine degradate CIAT is described in the "Atrazine" section.

2,4–D

The pesticide 2,4–D is used as a herbicide for the control of broad-leaf weeds in agriculture and for control of woody plants along roadsides, railways, and utility rights of way (U.S. Environmental Protection Agency, 2013a). The pesticide 2,4–D is one of the most widely used pesticides in the study area (Stone, 2013). Of the 31 pesticides for which Stone (2013) estimated use in Roberts County in 2009, the pesticide 2,4–D ranked third in pounds of active ingredient applied (table 1). This pesticide was detected in four of the sampled wetlands in 2015 and in nine of the wetlands in 2006 (table 7).

Water-quality benchmarks available for 2,4–D include a human-health benchmark (MCL) of 70 µg/L and an aquatic-life benchmark (acute invertebrates) of 12,500 µg/L (table 5). Some people who drink water containing 2,4–D well in excess of MCL for many years could experience problems with their kidneys, liver, or adrenal glands (U.S. Environmental Protection Agency, 2013a). The maximum dissolved 2,4–D concentration detected in 2015 samples was 9.5 µg/L (table 7), which is less than these benchmarks. The 2,4–D concentrations in the 2015 samples from three wetlands are within an order of magnitude of the MCL (that is, greater than 7.0 µg/L; table 7).

Acetochlor

Acetochlor is a pre-emergent herbicide widely used on corn (Extoxnet, 1996). Acetochlor is one of the most widely used pesticides in the study area (Stone, 2013). Of the 31 pesticides for which Stone (2013) estimated use in Roberts County in 2009, acetochlor ranked second in pounds of active ingredient applied (table 1). Acetochlor was detected in three wetlands in 2015 and in two wetlands in 2006 (table 7).

A human-health benchmark (chronic noncancer HHBP) of 140 µg/L is available for acetochlor (table 5). Aquatic-life benchmarks for acetochlor include fish (acute, 191 µg/L; chronic, 130 µg/L), invertebrates (acute, 4,100 µg/L; chronic, 22.1 µg/L), nonvascular plants (acute, 1.43 µg/L), and vascular plants (acute, 3.4 µg/L; table 5). All dissolved concentrations of acetochlor detected in 2006 and 2015 were estimated concentrations. The maximum dissolved concentration detected in wetlands in the 2015 samples was estimated as 0.035 µg/L (table 7), which is several orders of magnitude less than any human-health and aquatic-life benchmarks.

Atrazine

Atrazine is a widely used herbicide for control of broadleaf and grassy weeds in corn, sorghum, and other crops (U.S. Environmental Protection Agency, 2013b; Gidding and others, 2005) and has been commonly detected in groundwater and surface water in agricultural areas of the United States (Gilliom and others, 2006). Atrazine has been widely used in the study area (Battaglin and Goolsby, 1994; Neitzert and Bartholomay, 2007) and has the physical and chemical properties that allow atrazine to move readily in the environment (Capel, 1989). Of the 31 pesticides for which Stone (2013) estimated use in Roberts County in 2009, atrazine ranked fourth in pounds of active ingredient applied (table 1). Atrazine and its degradate CIAT were the most frequently detected pesticides in the wetland samples in 2015; atrazine was detected

in 14 wetlands and CIAT was detected in 13 wetlands (fig. 2). In the 2006 samples, atrazine and CIAT were detected in 17 wetlands (table 7) and were the most frequently detected pesticides for the 2006 sampling.

A human-health benchmark (MCL) of 3 µg/L is available for atrazine (table 5). Some people who drink water containing atrazine well in excess of the MCL for many years could experience problems with their cardiovascular system or reproductive difficulties (U.S. Environmental Protection Agency, 2013b). Aquatic-life benchmarks for atrazine include 2,650 µg/L for fish (acute), 360 and 60 µg/L for invertebrates (acute and chronic, respectively), less than 1 µg/L for nonvascular plants (acute), and 0.001 µg/L for vascular plants (acute; table 5). Atrazine is a known endocrine disruptor (Danzo, 1997) and can have numerous adverse effects on aquatic ecosystems, including reproductive effects on fish such as reduced reproduction and spawning (Tillitt and others, 2010); however, atrazine is much more toxic to plants (for example, algae, phytoplankton, and macrophytes) than to animals (Gidding and others, 2005). The maximum dissolved atrazine concentration in the 2015 samples was 0.185 µg/L (table 7). This maximum concentration is much less than the MCL for atrazine and several of the aquatic-life benchmarks; however, this 2015 maximum concentration along with the concentrations in 2006 samples from two wetlands are within an order of magnitude of the acute benchmark for nonvascular plants (that is, concentrations greater than 0.1 µg/L). All detections of atrazine in the 2006 and 2015 samples were greater than the acute benchmark for vascular plants.

Little is known about the toxicity of the atrazine degradate CIAT; however, acute and chronic toxicity for CIAT are less than those of atrazine (Ralston-Hooper and others, 2009). Water-quality benchmarks are not available for CIAT.

Glyphosate

Glyphosate is a broad-spectrum nonselective herbicide that is among the most widely used herbicides in the world (Battaglin and others, 2003). Glyphosate is one of the most widely used pesticides in the study area (Stone, 2013). Of the 31 pesticides for which Stone (2013) estimated use in Roberts County in 2009, glyphosate ranked first in pounds of active ingredient applied (table 1). Glyphosate was detected in 5 wetlands in 2006 and in 11 wetlands in 2015 (table 7); however, different analytical methods were used for glyphosate between 2006 and 2015.

A human-health benchmark (MCL) of 700 µg/L is available for glyphosate (table 5). Aquatic-life benchmarks for glyphosate include fish (acute, 21,500 µg/L; chronic, 1,800 µg/L), invertebrates (acute, 26,600 µg/L; chronic, 49,900 µg/L), nonvascular plants (acute, 12,100 µg/L), and vascular plants (acute, 11,900 µg/L; table 5). The maximum detected concentration of dissolved glyphosate was 1.2 µg/L in the 2015 samples and 0.3 µg/L in the 2006 samples; most detections of glyphosate were estimated concentrations in 2006 and 2015 (table 7). All concentrations of glyphosate were several to many orders of magnitude less than water-quality benchmarks.

Metolachlor

Metolachlor is a pre-emergent herbicide widely used on corn, sorghum, soybeans, and other crops (Extoxnet, 1993). Of the 31 pesticides for which Stone (2013) estimated use in Roberts County in 2009, metolachlor ranked ninth in pounds of active ingredient applied (table 1). Metolachlor was detected in samples from 3 wetlands in 2006 and in 10 wetlands in 2015 (fig. 2).

A human-health benchmark (noncancer HBSL) of 700 µg/L is available for metolachlor (table 5). Aquatic-life benchmarks for metolachlor include fish (acute, 1,600 µg/L; chronic, 30 µg/L), invertebrates (acute: 550 µg/L; chronic: 1 µg/L), nonvascular plants (acute: 8 µg/L), and vascular plants (acute: 21 µg/L; table 5). The maximum concentration for dissolved metolachlor was 0.083 µg/L in the 2015 samples and 0.027 µg/L in the 2006 samples (table 7), which are one or more orders of magnitude less than water-quality benchmarks.

Prometon

Prometon is an herbicide commonly used to control the emergence of broadleaf weeds and grasses (U.S. Environmental Protection Agency, 1990). Prometon was not one of 34 pesticides for which Battaglin and Goolsby (1994) estimated use in Roberts County in 1987, and prometon was not one of 31 pesticides for which Stone (2013) estimated use in Roberts County in 2009. Prometon was detected in samples from three wetlands in 2006 and from one wetland in 2015 (table 7).

A human-health benchmark (noncancer HBSL) of 400 µg/L is available for prometon (table 5). Aquatic-life benchmarks for prometon include fish (acute, 6,000 µg/L; chronic, 19,700 µg/L), invertebrates (acute, 12,850 µg/L; chronic, 3,450 µg/L), and nonvascular plants (acute, 98 µg/L; table 5). In the one sample with a detection of prometon in 2015, the dissolved concentration was estimated as 0.011 µg/L, and the maximum dissolved concentration in the 2006 samples was 0.028 µg/L (table 7), which are several orders of magnitude less than water-quality benchmarks.

Summary

During July 2015, water samples were collected from 18 wetlands on the Lake Traverse Indian Reservation in northeastern South Dakota and southeastern North Dakota and analyzed for physical properties and 54 pesticides. This study by the U.S. Geological Survey in cooperation with the Sisseton-Wahpeton Oyate was designed to provide an update on pesticide concentrations of the same 18 wetlands that were

sampled for a reconnaissance-level assessment during July 2006. The purpose of this report is to present the results of the assessment of pesticide concentrations in selected Lake Traverse Indian Reservation wetlands during July 2015 and provide a comparison of pesticide concentrations between 2006 and 2015.

For the 2015 samples, turbidity ranged from 1.2 to 80 formazin nephelometric turbidity units. Dissolved-oxygen concentrations ranged from 0.7 to 17.3 milligrams per liter. The dissolved-oxygen concentrations for 2015 samples from seven wetlands were less than the U.S. Environmental Protection Agency's daily minimum criterion of 5.0 milligrams per liter for coldwater and warmwater fish. The pH values in the 2015 samples ranged from 7.3 to 9.1. The pH values for seven wetlands were greater than the upper range of the U.S. Environmental Protection Agency's Secondary Maximum Contaminant Level of 6.5–8.5 units, and samples from two wetlands were greater than the upper range of the U.S. Environmental Protection Agency's Criterion Continuous Concentration of 6.5–9.0 units. Specific conductance ranged from 348 to 5,280 microsiemens per centimeter at 25 degrees Celsius. Water temperature measured in the 2015 samples ranged from 16.3 to 28.9 degrees Celsius.

Of the 54 pesticides that were analyzed for in the samples collected during July 2015, 47 pesticides were not detected in any samples. Seven pesticides—2-chloro-4-isopropylamino-6-amino-*s*-triazine (CIAT); 2,4–D; acetachlor; atrazine; glyphosate, metolachlor, and prometon—were detected in the 2015 samples with estimated concentrations or concentrations greater than the laboratory reporting level and most pesticides were detected at low concentrations in only a few samples. Samples from all wetlands contained at least one pesticide. The maximum number of pesticides detected in a wetland sample was six, and the median number of pesticides detected was three.

The most commonly detected pesticides in the 2015 samples were atrazine and the atrazine degradate CIAT (also known as deethylatrazine), which were detected in 14 and 13 of the wetlands sampled, respectively. Detected concentrations of dissolved atrazine ranged from 0.017 to 0.185 micrograms per liter (µg/L).. Detected concentrations of dissolved CIAT ranged from an estimated 0.005 to 0.045 µg/L.

Glyphosate was detected in samples from 11 wetlands, and metolachlor was detected in samples from 10 wetlands. Detected concentrations of dissolved glyphosate ranged from an estimated 0.11 to 1.2 µg/L. Detected concentrations of dissolved metolachlor ranged from 0.005 to 0.083 µg/L.

The other detected pesticides were 2,4–D (4 wetlands), acetochlor (3 wetlands), and prometon (1 wetland). Detected concentrations of dissolved 2,4–D ranged from an estimated 3.6 to 9.5 µg/L. Detected concentrations of dissolved acetochlor ranged from an estimated 0.017 to 0.035 µg/L. The detected concentration of dissolved prometon was an estimated 0.011 µg/L.

The same pesticides that were detected in the 2006 samples were detected in the 2015 samples, with the exception of simazine, which was detected only in one sample in 2006. Atrazine and CIAT were the most commonly detected pesticides in both sampling years; however, atrazine and CIAT were detected in fewer wetlands in 2015 (14 and 13 wetlands, respectively) than in 2006 (17 wetlands for both pesticides). The pesticides 2,4–D and prometon also were detected in fewer wetlands in 2015 than 2006, and simazine was only detected in 2006. In contrast, acetochlor, glyphosate, and metolachlor were detected in more wetlands in 2015 than in 2006. In samples from individual wetlands, the number of pesticides detected was similar between 2006 and 2015. All wetlands had at least one pesticide detection in 2015, and all but one wetland had pesticide detections in 2006.

Concentrations of pesticides detected in samples from wetlands were compared to selected water-quality (human-health and aquatic-life) benchmarks. None of the concentrations in either 2006 or 2015 were greater than water-quality benchmarks, with the exception of atrazine. All detections of atrazine in the 2006 and 2015 samples were greater than the acute benchmark of 0.001 µg/L for vascular plants. In addition, some concentrations of 2,4–D and atrazine were within an order of magnitude of a water-quality benchmark. The 2,4–D concentrations in the 2015 samples from three wetlands were within an order of magnitude of the U.S. Environmental Protection Agency's Maximum Contaminant Level of 70 µg/L (that is, sample concentrations were greater than 7.0 µg/L). The maximum dissolved atrazine concentration of 0.185 µg/L in the 2015 samples along with the concentrations in 2006 samples from two wetlands were within an order of magnitude of the acute benchmark of less than 1 µg/L for nonvascular plants (that is, concentrations were greater than 0.1 µg/L).

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Appendix 1. U.S. Fish and Wildlife Service Wetlands Inventory Codes and Definitions

This appendix provides information about U.S. Fish and Wildlife Service wetlands inventory codes and definitions for the selected Lake Traverse Indian Reservation wetlands at which water samples were collected during July 2006 and July 2015 (table 1–1). The U.S. Fish and Wildlife Service wetlands inventory for South Dakota was last accessed September 11, 2015, at http://www.fws.gov/wetlands/Data/Mapper.html. The inventory is in the form of a mapping application for individual U.S. Geological Survey quadrangles consisting of delineated wetlands and attributes of the wetlands. An attribute for each wetland is a code that indicates how the wetland had been classified in terms of various factors including geomorphology, water quality, vegetation, and the duration of the presence of standing water.

Of the 18 wetlands at which water samples were collected in 2006 and 2015, one site (site S18) did not have an associated primary wetland inventory code based on the 2014 wetland inventory (U.S. Fish and Wildlife Service, 2014) compared to two sites (sites S15 and S18) based on the 2004 wetland inventory (reported by Neitzert and Bartholomay, 2007). The wetland sites, S02, S10, and S17, have been assigned to the lacustrine system; and the remaining 13 sites have been assigned to the palustrine system.

Table 1–1. U.S. Fish and Wildlife Service wetlands inventory codes for selected Lake Traverse Indian Reservation wetlands at which water-quality samples were collected during 2006 and 2015.

Wetland code[1]	Definition	Sampling sites[2] (fig. 1)	Number of sites
L1UBG	Lacustrine, limnetic, unconsolidated bottom, intermittently exposed	S10	1
L2ABG	Lacustrine, littoral, aquatic bed, intermittently exposed	S02, S17	2
PABF	Palustrine, aquatic bed, semipermanently flooded	S22	1
PAB/EMF	Palustrine, aquatic bed/emergent, semipermanently flooded	S08	1
PEMC	Palustrine, emergent, seasonally flooded	S12, [3]S15	1
PEMF	Palustrine, emergent, semipermanently flooded	S03, S07, S13, S19	4
PEMFx	Palustrine, emergent, semipermanently flooded, excavated	S09	1
PEM/ABF	Palustrine, emergent/aquatic bed, semipermanently flooded	S20, S21	2
PEMFh	Palustrine, emergent/unconsolidated bottom, demipermanently flooded, diked/impounded	[4]S04	1
PEM/SSB	Palustrine, emergent/scrub-shrub, saturated	S14	1
PFOC	Palustrine, forested, seasonally flooded	S01	1

[1]From U.S. Fish and Wildlife Service, 2014.

[2]No wetland inventory code was assigned for sampling site S18.

[3]Wetland code was not available when reported in Neitzert and Bartholomay (2007).

[4]Wetland code was reported as PEM/ABFh (palustrine, emergent/aquatic bed, simipermanently flooded, diked/impounded) in Neitzert and Bartholomay (2007).

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