Occurrence and Trends of Pesticides in Nebraska Lakes and Reservoirs 1993-2008

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February 2011

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Introduction

Non-point source pollution is a major contributor to water quality degradation in the United States and many other countries. Unlike point source pollution, which enters the water from specific locations such as pipes or discharges, non-point source pollution comes from a broader area. In most cases, non-point source pollutants are picked up and transported during rain and snowmelt events.

Nebraska is primarily an agricultural state and about 92% of the land in the state is utilized as farms and ranches (USDA, 2009). The four most prominent crops grown in the state are corn, soybeans, wheat, and sorghum (Strategic Planning, 2000). Some type of herbicide is typically applied to each of these crops through the course of a growing season. According to the United States Department of Agriculture (USDA) in 2005, herbicides were applied to 97% of the corn acreage (USDA, 2009). The five most common herbicides applied in Nebraska are atrazine, metolachlor, cyanazine, alachlor, and acetochlor (USDA, Chemical Usage, 2009).

This report will evaluate the occurrence and trends of the five major pesticides listed above in Nebraska lakes and reservoirs from 1993 through 2008.

Methods

Data Collection

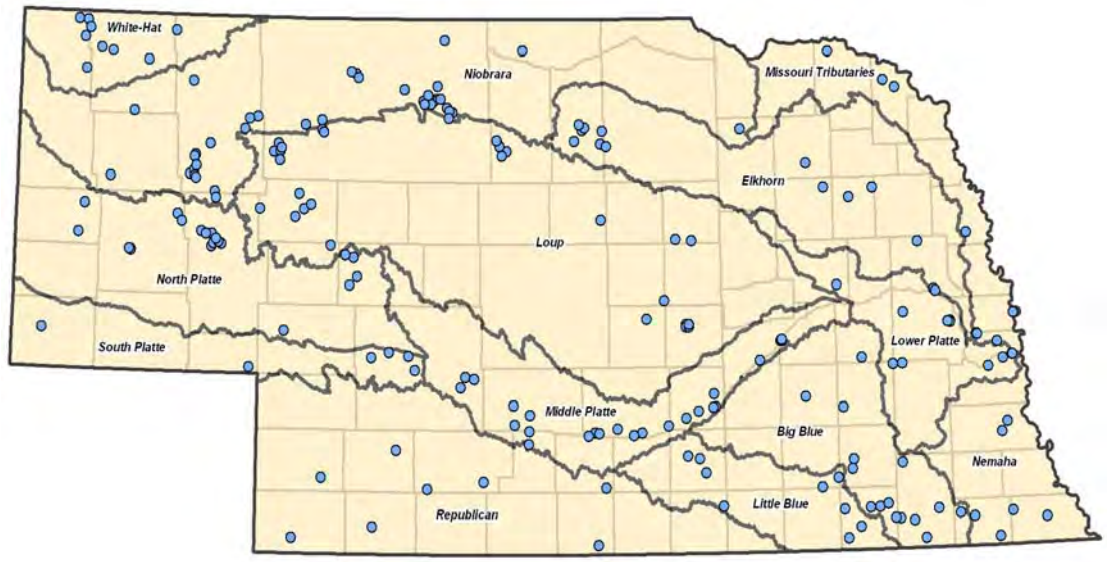
Pesticide data collections were conducted by the University of Nebraska Lincoln (UNL), Nebraska Natural Resources Districts (NRD), and Nebraska Department of Environmental Quality (NDEQ). Data collected by these entities from 1993-2008 encompassed 1,770 pesticide samples from 195 public and privately owned impoundments across Nebraska's 13 river basins (Table 1) (Figure 1).

Table 1. Nebraska Pesticide Data Coverage by River Basin from 1993 - 2008

Basin Name	# Impoundments Sampled	# Sample Sets Collected(a)
Big Blue	15	240
Elkhorn	12	168
Little Blue	9	58
Loup	26	170
Lower Platte	13	166
Middle Platte	24	164
Miss. Tributaries	8	98
Nemaha	6	106
Niobrara	38	255
North Platte	21	139
Republican	8	120
South Platte	6	35
White-Hat	9	51
Totals:	**195**	**1770**

(a) Sample set means one or more pesticide was analyzed from one sample event.

Figure 1. Location of Lakes and Reservoirs with Available Pesticide Data



Samples were typically collected in the middle of the lake on natural lakes and near the dam on reservoirs. However, when weather conditions were bad, samples were collected just off shore at an alternate site. Samples were collected from the top meter of water in all cases. Sample collection duration and frequency varied by impoundment which resulted in inconsistent sample numbers across impoundments. This should be taken into consideration when reviewing basin wide statistics such as median values. Data assessed in this report only includes samples that were collected from April through October.

All the impoundments sampled are protected for the Aquatic Life use under Title 117 - Nebraska Surface Water Quality Standards (NDEQ, 2007). While Nebraska has two impoundments designated as drinking water supplies, neither of those impoundments were included in this assessment.

Lab Procedures

All of the pesticide samples were analyzed in the NDEQ Biological Laboratory where an Immuno-Assay technique was used to quantify pesticide concentrations. This technique applies principles of enzyme linked immunosorbent assay (ELISA) to the determination of particular herbicides (QAPP, 2009). Method detection limits (MDLs) for the Immuno-Assay test are provided in Table 2.

Table 2. NDEQ Analytical Methods and Method Detection Limits for Pesticides.

Parameter	Analytical Method	Method Detection Limit (µg/L)
Atrazine	Rapid Immuno-assay	0.05
Alachlor	Rapid Immuno-assay	0.05
Metolachlor	Rapid Immuno-assay	0.05/0.07 (a)
Cyanazine	Rapid Immuno-assay	0.04
Acetochlor	Rapid Immuno-assay	0.05/0.07 (a)

(a) Method detection limit was 0.05 µg/L from 1993-2004 and 0.07 µg/L from 2005-2008.

Pesticide Background

The amounts of pesticides that are applied to crop land vary each year and can greatly influence pesticide concentrations in surface waters. Most of the herbicides that are applied in Nebraska are used in the process of corn production to control weeds (USDA, 2009). Over 8 million acres of corn are planted each year in Nebraska and some years the total acres planted approaches 9 million acres.

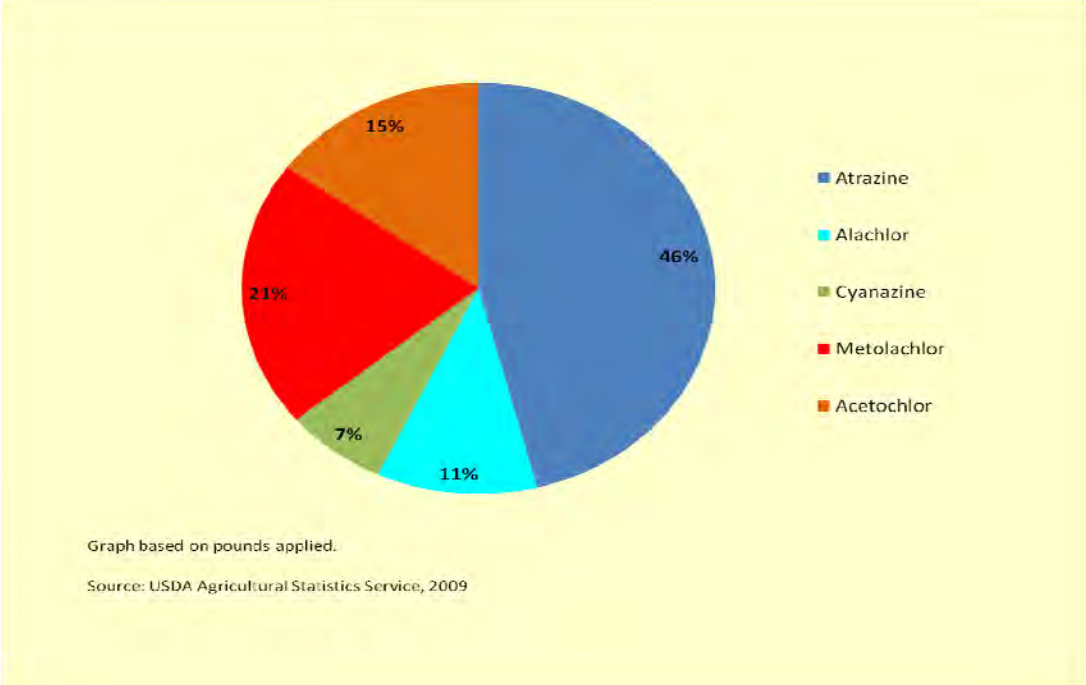
Over the years, herbicide applications in Nebraska have remained high. From 1993-2005, the lowest percentage of acres treated with herbicides in the state was in 2002, which was 83 percent (USDA, 2009). Every other year at least 93 percent of the acres were treated with herbicides (USDA, 1991-2005). This equates to herbicides being applied to over 8 million acres each year since 1993. Overall, atrazine has been the most used herbicide in the state of Nebraska (USDA, 2009) (Figure 2).

Atrazine

Atrazine is a nonselective herbicide that is widely used on corn and sorghum (Extoxnet, 1996). The widespread use of atrazine is primarily because of its low price and effective control of grasses and broad-leafs. Atrazine is applied pre-plant or pre-emergence to crop ground, which benefits farmers who have a limited application time. There are numerous products registered in Nebraska that contain atrazine.

One major problem with atrazine is that it has a relatively long half-life of 60 days, which can lead to water quality problems. Atrazine is highly water soluble, resistant to natural degradation in water, and with its long persistence in soil, is commonly detected in surface waters near where it is applied.

Figure 2. Percentage of Most Common Pesticides Applied to Corn in Nebraska (1993-2003)



Current Nebraska water quality standards list the following water quality criteria for atrazine: a Maximum Contaminant Level (MCL) of 3 μg/L for protection of public drinking water supplies, and chronic and acute criteria of 12 μg/L and 330 μg/L respectively, for the protection of aquatic life (NDEQ, 2007). The chronic criterion is based on a four day exposure while the acute criterion is based on a one hour exposure.

Alachlor

Alachlor is widely used in the United States as a herbicide for the control of annual grasses and broadleaf weeds in cropped fields. It is primarily used on corn, sorghum and soybeans. Once alachlor makes contact with the soil, it can be broken down by bacteria and sunlight within about two months.

Alachlor does not bind to most soils which increases runoff and leaching potential. Sunlight and bacterial action are also important for degrading alachlor in surface water, but evaporation generally does not occur. Once alachlor enters groundwater, its break down is very slow.

Current Nebraska water quality standards list the following water quality criteria for alachlor: a MCL of 2 μg/L for protection of public drinking water supplies, and chronic and acute criteria of 76 μg/L and 760 μg/L respectively, for the protection of aquatic life. The chronic standard is based on a four day exposure while the acute standard is based on a one hour exposure.

Metolachlor

Metolachlor is a broad spectrum herbicide used for general weed control in many crops. It is primarily applied to corn, soybeans, and sorghum. Metolachlor can also be used on lawns to control weeds. It is applied pre-emergent or post-emergent to fields and is moderately persistent in the soil (U.S. EPA, 2002).

Very little metolachlor volatilizes from the soil and the breakdown of this herbicide is dependent upon microbial activity. In soils with low organic content, extensive leaching is reported to occur and soils that have higher organic matter and clay will better adsorb this herbicide.

Current Nebraska water quality standards list the following water quality criteria for metolachlor: chronic and acute criteria of 100 μg/L and 390 μg/L respectively, for the protection of aquatic life (NDEQ, 2007). The chronic standard is based on a four day exposure while the acute standard is based on a one hour exposure. There is not a drinking standard for metolachlor.

Cyanazine

Cyanazine is a widely used herbicide to control broad-leaf weeds and grasses in crops and was first registered for use in 1971 by the U.S. EPA. It is primarily used as a pre-emergent herbicide on corn, but is also used on sorghum, wheat and other crops to control weeds.

Cyanazine quickly degrades in many soil types, primarily due to microbes and the rate of evaporation from soil which is typically very slow. Cyanazine has a half-life of 2 to 4 weeks in an air-dried sandy clay loam, 7 to 10 weeks in a sandy loam soil, 10 to 14 weeks in a clay soil, and 9 weeks in sandy clay soil. This is in contrast to atrazine and other s-triazines, where half the amount applied has been detected up to two years later. Nebraska does not have a water quality standard for cyanazine.

Acetochlor

Acetochlor is a herbicide that is used for control of most annual grasses and certain broadleaf weeds. It is used as a pre-emergence or pre-plant herbicide on corn, soybeans, and many other crops. According to the U.S. EPA, acetochlor is adsorbed by soil colloids and leaches very little from the soil. Acetochlor is also degraded in the soil by microbes. The herbicide's average persistence is 8 to 12 weeks, but may vary depending on soil type and climate.

Nebraska does not have a water quality standard for acetochlor.

Pesticide Occurrence by River Basin

Big Blue River Basin

The Big Blue River Basin is located in southeastern Nebraska (Figure 3). This basin originates in south-central Nebraska and extends southeastward, where it eventually exits the state into Kansas (NDEQ, 2005). Stream flow in the Big Blue River Basin is dependent on precipitation and can be subject to rapid increases.

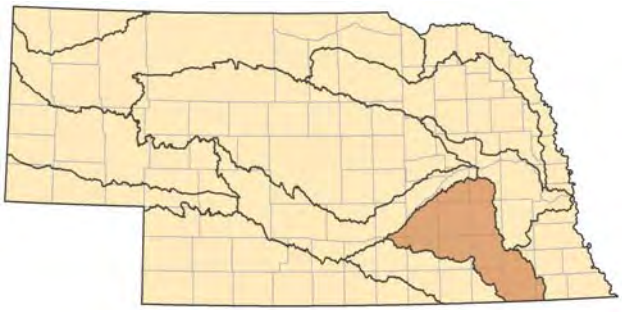


Figure 3. Big Blue River Basin Location

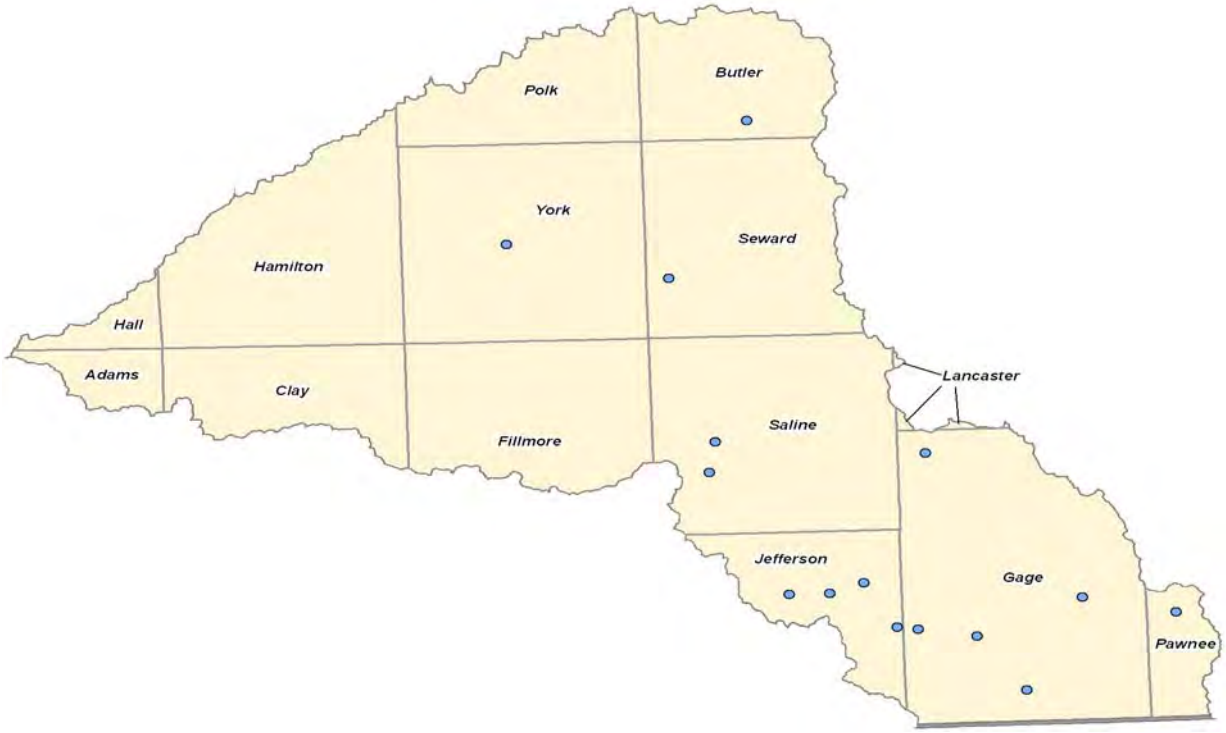
The Big Blue River Basin watershed occupies about 4,560 square miles. About two-thirds of the basin is in the Central Great Plains eco-region and the other one-third is in the Western Corn Belt Plains. The upper part of the basin lies in the loess plains over thick deposits of silt, sand, and gravel. The lower part of the basin lies in the glaciated portion of the state, with rolling hills and bedrock outcrops occurring near the Kansas-Nebraska border. Drainage in the upper part of the basin is poor and sometimes nonexistent. Due to relatively impermeable soils in the basin, stream flow is minimal, but can be significant during heavy rainfall events.

Precipitation ranges from an annual average of 27.5 inches in the western end to 31 inches in the eastern end. Most of the precipitation in the Big Blue River Basin falls during the growing season and does not always favor crop production. Temperatures in the basin range from average highs in the upper 80s during the summer to average lows in the 10s in the winter.

Agriculture dominates the land use of this basin, with over 2 million acres being considered suitable for irrigation. Over 90% of this basin is used for crop production which leads to higher amounts of pesticide applications. Land use in the Big Blue River basin consists of dry land and irrigated crop ground, pasture, wetlands, and forest. This region is one of the most productive portions of the state, due to the fertile soils and the high annual precipitation amounts. The major crops that are grown in the basin include corn, sorghum, soybeans, and alfalfa.

Nebraska water quality standards identifies 31 publicly owned impoundments in the Big Blue River Basin all of which can be classified as reservoirs. Reservoirs in this basin range in size from one to 150 surface acres with a median size of 19 surface acres. Data was available for 15 reservoirs in this basin (Figure 4). Eleven of the reservoirs are publicly owned while four are private.

Figure 4. Location of Impoundments in the Big Blue River Basin with Pesticide Data



Detectable concentrations of all five pesticides were found at all impoundments monitored in the Big Blue River Basin (Table 3). Additionally, detectable concentrations of all five pesticides were found in more than 84 percent of the samples analyzed. The highest frequency of detectable concentrations was for acetochlor which was found in 100 percent of the 26 samples analyzed.

The drinking water standard for atrazine (3 µg/L) was exceeded in 111 of the 240 (46 %) samples and the chronic aquatic life standard (12 µg/L) was exceeded in 43 of the 240 samples (18%).

Table 3. Summary of Pesticide Data from Reservoirs in the Big Blue River Basin (1993-2008)

	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	15	15	15	4	2
# of Samples Analyzed	240	112	87	50	26
# of Samples w/Detectable Concentrations	227	109	74	46	26
% of Impoundments w/Detectable Concentrations	100	100	100	100	100
% of Samples w/Detectable Concentrations	95	97	85	92	100
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.05(a)	0.04(a)	0.07(a)
Maximum Concentration (µ/L)	42.56	6.90	136.35	9.38	6.60
Median Concentration (µ/L)	2.63	1.69	2.15	0.14	1.28
# Samples Greater Than Drinking Water Standard	111	43	NA	NA	NA
# Samples Greater Than Chronic Aquatic Life Standard	43	0	1	NA	NA
Drinking Water Standard (µg/L)	3.00	2.00	No Standard	No Standard	No Standard
Aquatic Life Chronic Standard (µg/L)	12.00	76.00	100.00	No Standard	No Standard
Aquatic Life Acute Standard (µg/L)	330.00	760.00	390.00	No Standard	No Standard

(a) Value given is the method detection limit.

The maximum concentration of atrazine detected was 42.56 µg/L, which was below the acute aquatic life criteria. The drinking water standard for alachlor (2 µg/L) was exceeded in 43 of the 112 (38%) samples. There were no samples that exceeded the chronic aquatic life standard (76 µg/L) for alachlor.

One metolachlor sample exceeded the chronic aquatic life standard. There are no drinking water standards for metolachlor. There are no drinking water or aquatic life standards for cyanazine or acetochlor.

Elkhorn River Basin

The Elkhorn River Basin is located in east-central and northeast Nebraska and heads into the Sandhills in western Nebraska (Figure 5). Flows in the basin tend to be southeasterly toward the confluence with the Lower Platte River near Omaha (NDEQ, 2008).

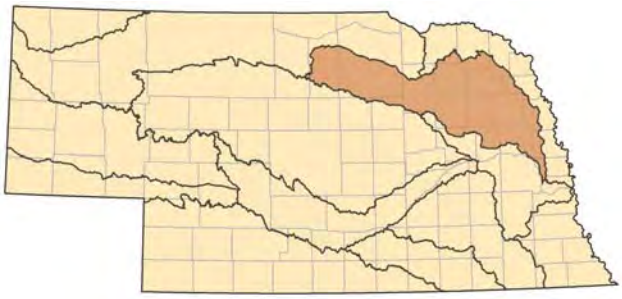


Figure 5. Elkhorn River Basin Location

The Elkhorn River Basin occupies about 6,953 square miles in the north central and northeast part of the state. This basin includes the Elkhorn River and tributaries from the headwaters starting in the Sandhills to the confluence of the Lower Platte River in eastern Nebraska.

Precipitation in the Elkhorn River Basin ranges from an annual average of 24 inches in the northwest portion to about 30 inches in the southeastern part. Generally, most of the precipitation falls during the spring and early summer. Temperatures range from average highs in the upper 80s during the summer to average lows in the lower 10s during the winter. Agriculture is the major land use in the basin, with approximately 50% of the basin being cultivated and suitable for irrigation. The grasslands of the Sandhills are generally used as pasture or harvested for hay. Most streams in the Elkhorn Basin support good base flows supplemented by groundwater.

Nebraska water quality standards identifies 30 publicly owned impoundments in the Elkhorn River Basin (NDEQ, 2007). Of these, six are reservoirs, 11 are sand/barrow pits, and 13 are natural lakes. Impoundments in this basin range in size from one to 700 surface acres with seven acres being the median size. Data was available for 12 impoundments in this basin, of which four are reservoirs and eight are natural lakes (Figure 6). Six of the impoundments are publicly owned and six are private.

Detectable concentrations of atrazine, metolachlor, cyanazine, and acetochlor were found at all impoundments monitored in the Elkhorn River Basin, while alachlor was detected in 42 percent of the impoundments sampled (Table 4). The most frequently detected pesticides were atrazine and acetochlor which were both detected in 92 percent of the samples.

The drinking water standard for atrazine (3 µg/L) was exceeded in 11 of the 168 (7 %) samples. There were no atrazine concentrations above the chronic aquatic life standard (12 µg/L). Maximum concentrations of alachlor, metolachlor, cyanazine, and acetochlor fell below aquatic life standards.

Figure 6. Location of Impoundments in the Elkhorn River Basin with Pesticide Data

Table 4. Summary of Pesticide Data from Impoundments in the Elkhorn River Basin (1993-2008)

	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	12	12	12	4	3
# of Samples Analyzed	168	116	113	54	52
# of Samples w/Detectable Concentrations	154	49	79	38	48
% of Impoundments w/Detectable Concentrations	100	42	100	100	100
% of Samples w/Detectable Concentrations	92	42	70	70	92
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.05(a)	0.04(a)	0.07(a)
Maximum Concentration (µ/L)	11.16	0.68	2.83	5.61	1.44
Median Concentration (µ/L)	0.41	0.05(a)	0.10	0.11	0.34
# Samples Greater Than Drinking Water Standard	11	0	NA	NA	NA
# Samples Greater Than Chronic Aquatic Life Standard	0	0	0	NA	NA
Drinking Water Standard (µg/L)	3.00	2.00	No Standard	No Standard	No Standard
Aquatic Life Chronic Standard (µg/L)	12.00	76.00	100.00	No Standard	No Standard
Aquatic Life Acute Standard (µg/L)	330.00	760.00	390.00	No Standard	No Standard

(a) Value given is the method detection limit.

Little Blue River Basin

The Little Blue River Basin, located in south central Nebraska, originates in central Nebraska and extends in a southeastward direction and eventually exits into the state of Kansas (NDEQ, 2005) (Figure 7). Stream flow in the basin is dependent on precipitation and is subject to rapid increases.

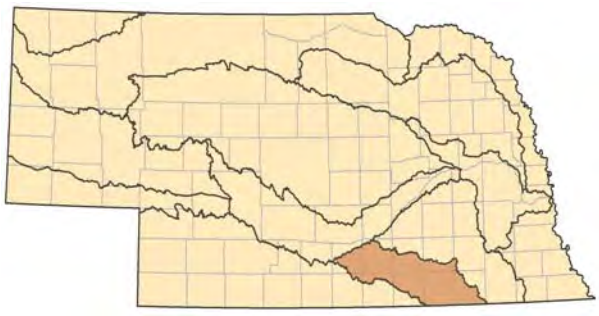


Figure 7. Little Blue River Basin Location

The Little Blue River Basin occupies about 2,691 square miles in south central Nebraska. The basin lies in the Central Great Plains eco-region. Nearly all of the soils of the basin have been developed from loess parent material, but there are some areas that have been developed from sandstone. The loess plains in the upper portion of the basin have poorly defined drainage patterns. As the plains give way to gently rolling hills, the drainage becomes more defined.

The loess soils are nearly impermeable and allow for little infiltration, and thus stream flows are generally low during periods of little to no run-off. Stream flows can undergo rapid increases during heavy precipitation events.

Precipitation in the Little Blue River Basin ranges from an annual average of 25 inches in the western portion of the basin to 29.7 inches in the eastern end. Most of the precipitation occurs during the growing season, but does not always favor crop production. Temperatures range from average highs in the upper 80s and lower 90s during the summer to average lows in the upper 10s during the winter.

Over 95% of the watershed area in the Little Blue River Basin is used for crop production which constitutes about 1.7 million acres. Other land use consists of pasture, wetlands, forest, and water. The major crops that are grown in this basin are corn, grain sorghum, soybeans, and alfalfa.

Nebraska water quality standards identifies 13 publicly owned impoundments in the Little Blue River Basin. Of these, six are reservoirs, six are sand/barrow pits, and one is a natural lake. Impoundments in this basin range in size from one to 258 surface acres with 12 acres being the median size. Pesticide data was available for nine impoundments in this basin, of which six are reservoirs, two are sandpits, and one is a natural lake (Figure 8). All of the impoundments sampled are publicly owned.

Detectable concentrations of all five pesticides were found at all impoundments monitored in the Little Blue River Basin (Table 5). Additionally, detectable concentrations of atrazine, alachlor, and metolachlor were found in more than 90 percent of the samples analyzed. The drinking water standard for atrazine (3 µg/L) was exceeded in 11 of the 58 (19 %) samples and the chronic aquatic life standard (12 µg/L) was exceeded in 1 of the 58 samples (2%). The maximum concentration of atrazine detected was 21.12 µg/L, which exceeds the chronic aquatic life criteria but falls below the acute criteria.

The drinking water standard for alachlor (2 µg/L) was exceeded in 9 of the 43 (21%) samples. There were no samples that exceeded the chronic aquatic life standard (76 µg/L) for alachlor.

There are no drinking water standards for metolachlor and all samples were below aquatic life standards. There are no drinking water standards for cyanazine or acetochlor.

Figure 8. Location of Impoundments in the Little Blue River Basin with Pesticide Data.

Table 5. Summary of Pesticide Data from Impoundments in the Little Blue River Basin (1993-2008)

	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	9	7	8	2	2
# of Samples Analyzed	58	43	41	18	13
# of Samples w/Detectable Concentrations	55	39	36	12	13
% of Impoundments w/Detectable Concentrations	100	100	100	100	100
% of Samples w/Detectable Concentrations	95	91	88	67	100
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.07(a)	0.04(a)	0.09
Maximum Concentration (µ/L)	21.12	15.08	4.16	0.37	25.08
Median Concentration (µ/L)	1.13	0.55	0.67	0.09	2.46
# Samples Greater Than Drinking Water Standard	11	9	NA	NA	NA
# Samples Greater Than Chronic Aquatic Life Standard	1	0	0	NA	NA
Drinking Water Standard (µg/L)	3.00	2.00	No Standard	No Standard	No Standard
Aquatic Life Chronic Standard (µg/L)	12.00	76.00	100.00	No Standard	No Standard
Aquatic Life Acute Standard (µg/L)	330.00	760.00	390.00	No Standard	No Standard

(a) Value given is the method detection limit.

Loop River Basin

The Loop River Basin is located in central Nebraska. This basin originates in the Sand Hills and flows to a point of confluence with the Platte River near Columbus (NDEQ, 2002) (Figure 9). The Loop River Basin watershed occupies about 15,276 square miles.

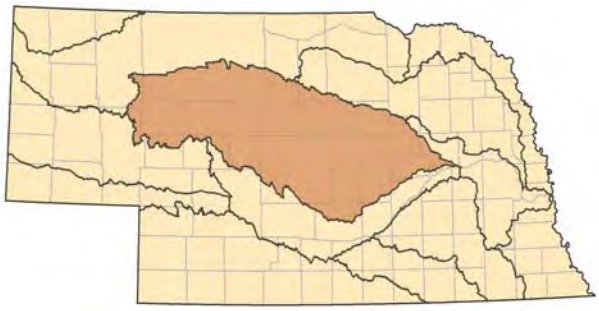


Figure 9. Loup River Basin Location

The eco-regions of this basin include the Sand Hills and the Central Great Plains. The basin is mostly made up of rolling hills, a few stream valleys, and plains remnants. In the Sand Hills, stream flow is undefined but improves in the central and lower part of the basin. Base flows in the upper part of the basin are uniform. In the lower basin, flows are less uniform due to the variability of surface run-off. Water is diverted or impounded within several reservoirs for hydroelectric generation or irrigation purposes.

Precipitation ranges from an annual average of 19 inches in the western end of the basin to 27 inches at the eastern end. Most of the precipitation in the Loup River Basin falls during the spring and early summer. Temperatures in the basin range from average highs in the upper 80s during the summer to average lows in the 10s during the winter.

A majority of the central and western portions of the basin are used for cattle ranching purposes, with areas in the east and south being used for row crop production and pastures. About one third of the agricultural lands in the Loup River Basin are suitable for cultivation. Soils in the basin range from clean sand of the Sand Hills to the loess hills that consist of deep, good quality soils. Less than 50 percent of the ground in this basin is used for crop production.

Nebraska water quality standards identify 48 publicly owned impoundments in the Loup River Basin. Of these, 17 are reservoirs, 10 are sand/barrow pits, and 21 are natural lakes. Impoundments in this basin range in size from one to 5,127 surface acres with 24 acres being the median size. Pesticide data was available for 26 impoundments in this basin, of which five are reservoirs and 21 are natural lakes. Nine of the impoundments sampled are publicly owned and 17 are private (Figure 10).

Detectable concentrations of atrazine and acetochlor were found at all impoundments monitored in the Loup River Basin (Table 6). Metolachlor was detected in more than 88 percent of the impoundments while alachlor and cyanazine were detected in 64 percent and 33 percent of the impoundments, respectively. The most frequently detected pesticides were atrazine and acetochlor which were both found 73 percent of the samples.

The drinking water standard for atrazine (3 µg/L) was exceeded in 3 of the 170 (2%) samples but the chronic aquatic life standard (12 µg/L) was not exceeded. The maximum concentration of atrazine detected was 7.92 µg/L, which was below the aquatic life criteria. Neither the drinking water nor the aquatic life standards for alachlor were exceeded. There are no drinking water standards for metolachlor and all samples were below aquatic life standards. There are no drinking water standards for cyanazine or acetochlor.

Figure 10. Location of Impoundments in the Loup River Basin with Pesticide Data

Table 6. Summary of Pesticide Data from Impoundments in the Loup River Basin (1993-2008)

	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	26	25	24	3	4
# of Samples Analyzed	170	121	154	12	51
# of Samples w/Detectable Concentrations	124	24	68	1	37
% of Impoundments w/Detectable Concentrations	100	64	88	33	100
% of Samples w/Detectable Concentrations	73	20	44	8	73
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.05(a)	0.04(a)	0.07(a)
Maximum Concentration (µ/L)	7.92	0.96	1.19	0.09	2.36
Median Concentration (µ/L)	0.12	0.05(a)	0.07	0.04(a)	0.09
# Samples Greater Than Drinking Water Standard	3	0	NA	NA	NA
# Samples Greater Than Chronic Aquatic Life Standard	0	0	0	NA	NA
Drinking Water Standard (µg/L)	3.00	2.00	No Standard	No Standard	No Standard
Aquatic Life Chronic Standard (µg/L)	12.00	76.00	100.00	No Standard	No Standard
Aquatic Life Acute Standard (µg/L)	330.00	760.00	390.00	No Standard	No Standard

(a) Value given is the method detection limit.

Lower Platte River Basin

The Lower Platte River Basin is located in eastern and southeastern Nebraska (Figure 11). The basin originates at the confluence of the Loup and Middle Platte River Basins to a point of confluence with the Missouri River near Plattsmouth (NDEQ, 2007).

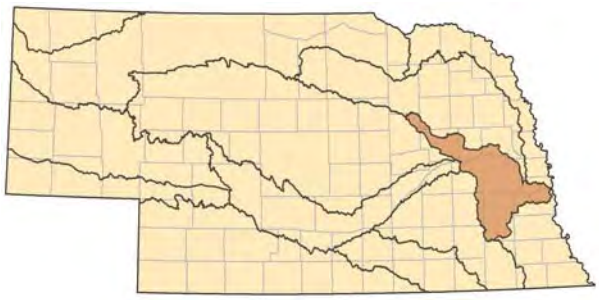


Figure 11. Lower Platte River Basin Location

The Lower Platte River Basin occupies about 3,110 square miles in the east and southeast

portion of the state. The eco-regions of this basin include the Western Corn Belt and the Central Great Plains. The topography of the Lower Platte River Basin ranges from steep bluffs to flat valley plains.

Precipitation ranges from an annual average of 23 inches in the northwestern portion to about 30 inches near the mouth of the Platte River. Most of the precipitation falls in the spring and early summer. Temperatures range from average highs in the upper 80's during the summer to average lows in the 10's during the winter.

Agriculture is the major land use in the basin. The upland areas are generally used for cultivated cropland. The steep rolling hills consist of grasslands and woodlands. In the lower basin, non-irrigated agriculture is quite extensive. The Lower Platte River Basin has over 80% of its watershed being used for crop production.

Nebraska water quality standards identifies 73 publicly owned impoundments in the Lower Platte River Basin. Of these, 29 are reservoirs, 42 are sand/barrow pits, and two are natural lakes. Impoundments in this basin range in size from one to 1,800 surface acres with 14 acres being the median size. Pesticide data was available for 13 impoundments in this basin, of which four are reservoirs and 9 are sandpits (Figure 12). Six of the impoundments sampled are publicly owned and seven are private.

Figure 12. Location of Impoundments in the Lower Platte River Basin with Pesticide Data

Detectable concentrations of atrazine, metolachlor, cyanazine, and acetochlor were found at all impoundments monitored in the Lower Platte River Basin while alachlor was detected in 50 percent of the 12 impoundments sampled (Table 7). The most frequently detected pesticide was atrazine which was found in 98 percent of the samples.

The drinking water standard for atrazine (3 µg/L) was exceeded in 45 of the 166 (27 %) samples and the chronic aquatic life standard (12 µg/L) was exceeded in 8 of the 166 samples (5%). The maximum concentration of atrazine detected was 25.96 µg/L, which exceeds the chronic aquatic life criteria but falls below the acute criteria.

The drinking water standard for alachlor (2 µg/L) was exceeded in 8 of the 123 (7%) samples. There were no samples that exceeded the chronic aquatic life standard (76 µg/L) for alachlor.

There are no drinking water standards for metolachlor and all samples were below aquatic life standards. There are no drinking water standards for cyanazine or acetochlor.

Table 7. Summary of Pesticide Data from Impoundments in the Lower Platte River Basin (1993-2008)

	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	13	12	13	3	4
# of Samples Analyzed	166	123	110	34	24
# of Samples w/Detectable Concentrations	162	82	87	25	23
% of Impoundments w/Detectable Concentrations	100	50	100	100	100
% of Samples w/Detectable Concentrations	98	67	79	74	96
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.05(a)	0.04(a)	0.07(a)
Maximum Concentration (µ/L)	25.96	33.00	3.35	5.08	7.81
Median Concentration (µ/L)	1.46	0.18	0.19	0.24	0.62
# Samples Greater Than Drinking Water Standard	45	8	NA	NA	NA
# Samples Greater Than Chronic Aquatic Life Standard	8	0	0	NA	NA
Drinking Water Standard (µg/L)	3.00	2.00	No Standard	No Standard	No Standard
Aquatic Life Chronic Standard (µg/L)	12.00	76.00	100.00	No Standard	No Standard
Aquatic Life Acute Standard (µg/L)	330.00	760.00	390.00	No Standard	No Standard

(a) Value given is the method detection limit.

Middle Platte River Basin

The Middle Platte River Basin is located in central Nebraska (Figure 13). The basin extends from the confluence of the North and South Platte Rivers on the western end, to the Loup Power Canal on the eastern end (NDEQ, 2003).

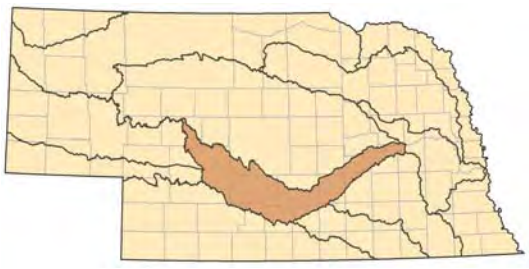


Figure 13. Middle Platte River Basin Location

The Middle Platte River Basin occupies approximately 5,130 square miles in south central Nebraska. The majority of the basin lies in the Central Great Plains eco-region. The northwestern portion of the basin lies in the Sand Hills eco-region.

Soils vary from sands of the valley alluvium in the Sandhills to fertile loess of the plains. The plains and loess hills have a well developed drainage pattern that discharges into poorly drained flat valleys.

Precipitation ranges from an annual average of 20 inches in the western end to 27 inches in the eastern end of the basin. A majority of the precipitation falls during spring and early summer. Temperatures in the basin range from average highs in the upper 80s during the summer to average lows in the 10s during the winter.

Agriculture dominates the land use with upland areas and the Sand Hills being mostly rangeland and pasture. The major crops that are grown in the Middle Platte River Basin are corn, soybeans, and alfalfa.

Nebraska water quality standards identifies 94 publicly owned impoundments in the Middle Platte River Basin. Of these, 79 are sand/barrow pits, 14 are reservoirs, and one is a natural lake. Impoundments in this basin range in size from one to 2,800 surface acres with 11 acres being the median size. Pesticide data was available for 24 impoundments in this basin, of which 19 are sandpits and five are reservoirs. Nineteen of the impoundments sampled are publicly owned and five are private (Figure 14).

Detectable concentrations of atrazine, cyanazine, and acetochlor were found at all impoundments monitored in the Middle Platte River Basin while metolachlor and alachlor were found in 95 and 78 percent of the impoundments sampled respectively (Table 8). The most frequently detected pesticide was atrazine which was found in 95 percent of the samples.

Neither the drinking water nor aquatic life standards for atrazine or alachlor were exceeded. There are no drinking water standards for metolachlor and all samples were below aquatic life standards. There are no drinking water standards for cyanazine or acetochlor.

Figure 14. Location of Impoundments in the Middle Platte River Basin with Pesticide Data

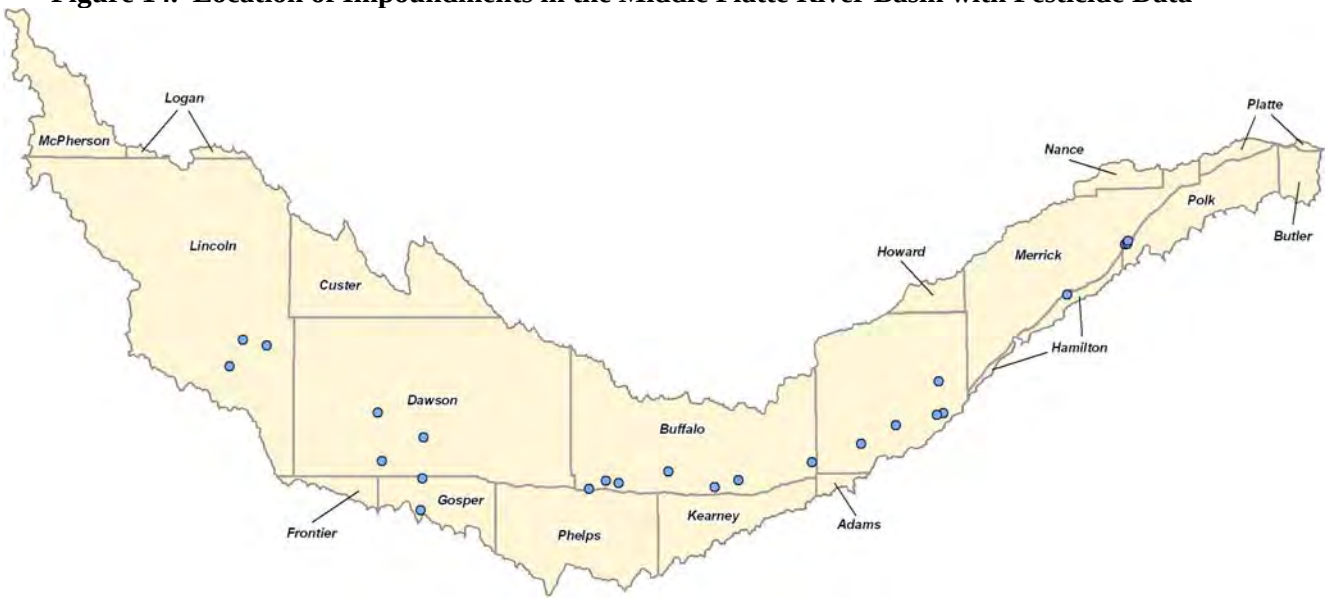


Table 8. Summary of Pesticide Data from Impoundments in the Middle Platte River Basin (1993-2008)

	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	24	23	22	4	4
# of Samples Analyzed	164	104	129	19	42
# of Samples w/Detectable Concentrations	155	57	63	13	34
% of Impoundments w/Detectable Concentrations	100	78	95	100	100
% of Samples w/Detectable Concentrations	95	55	51	68	81
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.05(a)	0.04(a)	0.07(a)
Maximum Concentration (µ/L)	2.88	0.48	0.82	0.84	0.85
Median Concentration (µ/L)	0.27	0.05(a)	0.07	0.12	0.12
# Samples Greater Than Drinking Water Standard	0	0	NA	NA	NA
# Samples Greater Than Chronic Aquatic Life Standard	0	0	0	NA	NA
Drinking Water Standard (µg/L)	3.00	2.00	No Standard	No Standard	No Standard
Aquatic Life Chronic Standard (µg/L)	12.00	76.00	100.00	No Standard	No Standard
Aquatic Life Acute Standard (µg/L)	330.00	760.00	390.00	No Standard	No Standard

(a) Value given is the method detection limit.

Missouri River Tributaries Basin

The Missouri River Basin is located in eastern and northeastern Nebraska (Figure 15). This basin is defined as the area of Nebraska that drains into the Missouri River between its confluence with the Niobrara River and its confluence with the Platte River and includes the Missouri River (NDNR, 2009).

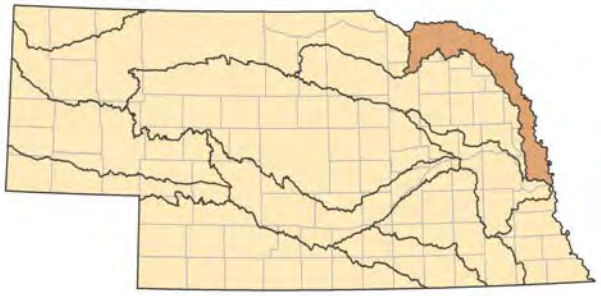


Figure 15. Missouri River Basin Location

Precipitation ranges from an annual average of 23 inches in the northwestern end of the basin to 30 inches in the southeastern corner. A majority of the precipitation falls during the spring and early summer. Temperatures in the basin range from average highs in the upper 80s during the summer to average lows in the 10s during the winter.

Agriculture is the major land use in the Missouri River Basin with corn and beans being the major crops. Most of the surface water in this basin is used for storage and irrigation and the water tends to be drawn from the major streams.

Nebraska water quality standards identifies 29 publicly owned impoundments in the Missouri River Tributaries Basin. Of these, 14 are reservoirs, 11 are sand/barrow pits, and four are natural lakes. Impoundments in this basin range in size from one to 30,000 surface acres with 59 acres being the median size. Pesticide data was available for eight impoundments in this basin, of which five are reservoirs, one is a natural lake, and two are sandpits. Six of the impoundments sampled are publicly owned while two are private (Figure 16).

Detectable concentrations of all five pesticides were found at all impoundments monitored in the Missouri River Tributaries Basin (Table 9). The most frequently detected pesticide was atrazine which was found in 84 percent of the samples.

The drinking water standard for atrazine (3 µg/L) was exceeded in 10 of the 98 (10%) samples. The maximum concentration of atrazine detected was 4.87 µg/L, which was below the chronic and acute aquatic life criteria. Neither the drinking water nor the aquatic life standards for

alachlor were exceeded in the 68 samples collected. There are no drinking water standards for metolachlor and all samples were below aquatic life standards. There are no drinking water standards for cyanazine or acetochlor.

Figure 16. Location of Impoundments in the Missouri River Tributaries Basin with Pesticide Data

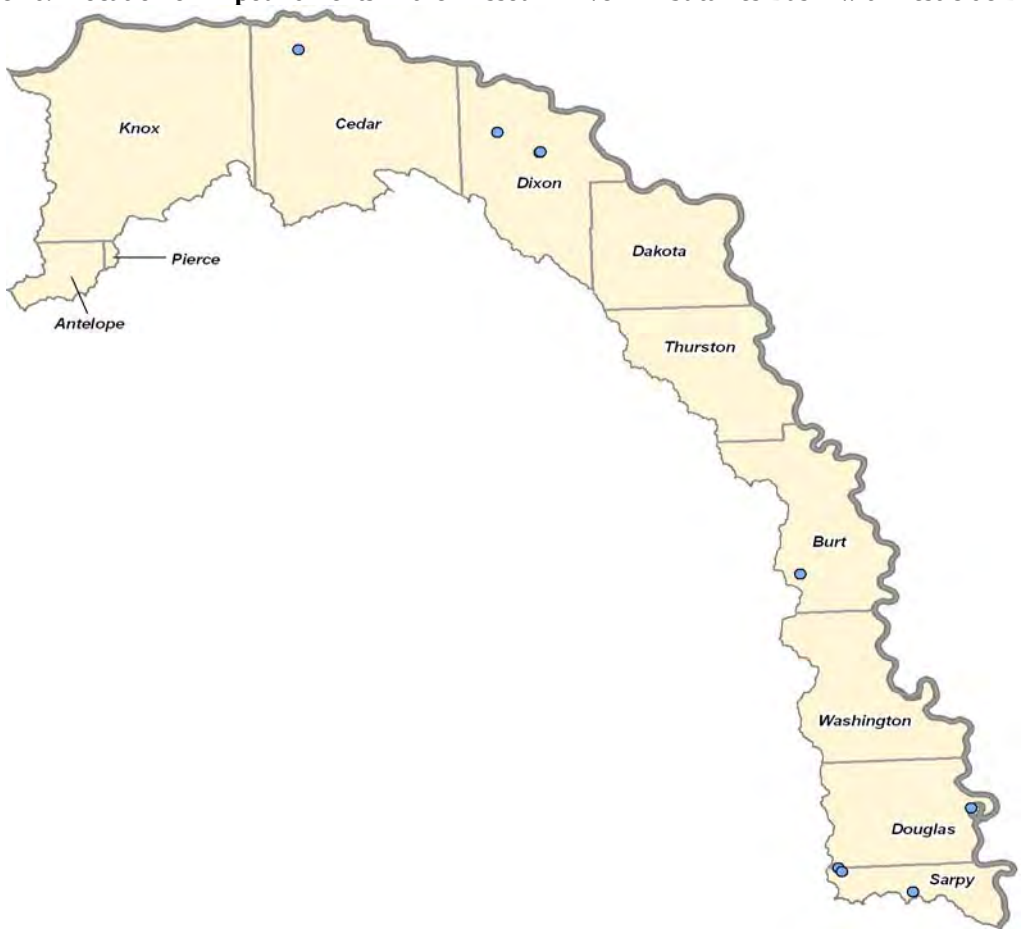


Table 9. Summary of Pesticide Data from Impoundments in the Missouri River Tributaries Basin (1993-2008)

	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	8	7	7	4	3
# of Samples Analyzed	98	68	60	37	30
# of Samples w/Detectable Concentrations	82	34	41	27	25
% of Impoundments w/Detectable Concentrations	100	100	100	100	100
% of Samples w/Detectable Concentrations	84	50	68	73	83
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.05(a)	0.04(a)	0.07(a)
Maximum Concentration (µ/L)	4.87	0.31	1.18	5.95	0.60
Median Concentration (µ/L)	0.45	0.05	0.13	0.33	0.18
# Samples Greater Than Drinking Water Standard	10	0	NA	NA	NA
# Samples Greater Than Chronic Aquatic Life Standard	0	0	0	NA	NA
Drinking Water Standard (µg/L)	3.00	2.00	No Standard	No Standard	No Standard
Aquatic Life Chronic Standard (µg/L)	12.00	76.00	100.00	No Standard	No Standard
Aquatic Life Acute Standard (µg/L)	330.00	760.00	390.00	No Standard	No Standard

(a) Value given is the method detection limit.

Nemaha River Basin

The Nemaha River Basin is located in southeast Nebraska. The basin consists of a segment of the Missouri River and the confluence of the Platte River to the state line (NDEQ, 2007) (Figure 17). The Nemaha River Basin occupies about 2,770 square miles in the southeast portion of the state.

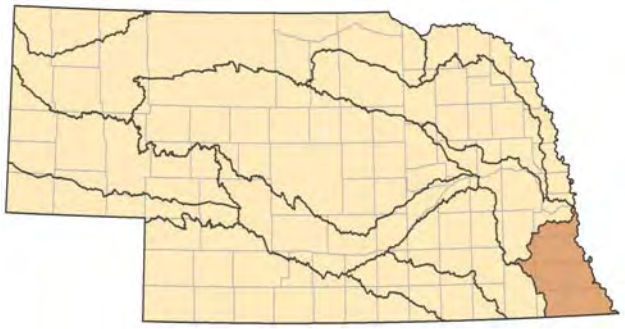


Figure 17. Nemaha River Basin Location

The entire basin is included in the Western Corn Belt Plains eco-region. Drainage in the basin is generally flows to the east and southeast. The topography consists of rolling hills, steep bluffs, and flat valleys.

Precipitation ranges from an annual average of 32 inches in the northwestern portion to 35 inches in the southeastern part of the basin. A majority of the precipitation falls in the spring and early summer months. Temperatures range from average highs in the upper 80s during the summer to lows in the 10s during the winter.

Agriculture is the major land use with over 95% of the acres being classified as agricultural lands. Only 15% of the land is considered to be well suited for irrigation. Tall grass prairie and eastern deciduous forest are the native vegetation types found in the Nemaha River Basin.

Nebraska water quality standards identifies 33 publicly owned impoundments in the Nemaha River Basin. Of these, 22 are sand/barrow pits, 10 are reservoirs, and one is a natural lake. Impoundments in this basin range in size from one to 160 surface acres with three acres being the median size. Pesticide data was available for six impoundments in this basin, which consisted of five reservoirs and one sandpit (Figure 18). Five of the six impoundments sampled are publicly owned.

Detectable concentrations of all five pesticides were found at all impoundments monitored in the Nemaha River Basin (Table 10). Additionally, detectable concentrations of all five pesticides were found in more than 85 percent of the samples. The highest frequency of detectable concentrations was for atrazine which was detected in 98 percent of the samples.

The drinking water standard for atrazine (3 µg/L) was exceeded in 34 of the 106 (32%) samples and the chronic aquatic life standard (12 µg/L) was exceeded in 3 of the 106 samples (3%). The maximum concentration of atrazine detected was 17.34 µg/L, which exceeds the chronic aquatic life criteria but falls below the acute criteria.

The drinking water standard for alachlor (2 µg/L) was exceeded in 16 of the 74 (22%) samples. There were no samples that exceeded the chronic aquatic life standard (76 µg/L) for alachlor.

There are no drinking water standards for metolachlor and all samples were below aquatic life standards. There are no drinking water standards for cyanazine or acetochlor.

Figure 18. Location of Impoundments in the Nemaha River Basin with Pesticide Data

Table 10. Summary of Pesticide Data from Impoundments in the Nemaha River Basin (1993-2008)

	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	6	6	6	2	3
# of Samples Analyzed	106	74	74	27	29
# of Samples w/Detectable Concentrations	104	64	66	25	28
% of Impoundments w/Detectable Concentrations	100	100	100	100	100
% of Samples w/Detectable Concentrations	98	86	89	93	97
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.05(a)	0.04(a)	0.07(a)
Maximum Concentration (µ/L)	17.34	13.65	7.20	8.44	6.00
Median Concentration (µ/L)	1.52	0.43	0.59	0.26	0.86
# Samples Greater Than Drinking Water Standard	34	16	NA	NA	NA
# Samples Greater Than Chronic Aquatic Life Standard	3	0	0	NA	NA
Drinking Water Standard (µg/L)	3.00	2.00	No Standard	No Standard	No Standard
Aquatic Life Chronic Standard (µg/L)	12.00	76.00	100.00	No Standard	No Standard
Aquatic Life Acute Standard (µg/L)	330.00	760.00	390.00	No Standard	No Standard

(a) Value given is the method detection limit.

Niobrara River Basin

The Niobrara River Basin is located in northwestern and north-central Nebraska. This basin originates in Wyoming and extends into Nebraska to a point of confluence with the Missouri River near the town of Niobrara (NDEQ, 2005) (Figure 19). Stream flow in the basin is from surface run-off and groundwater contributions.

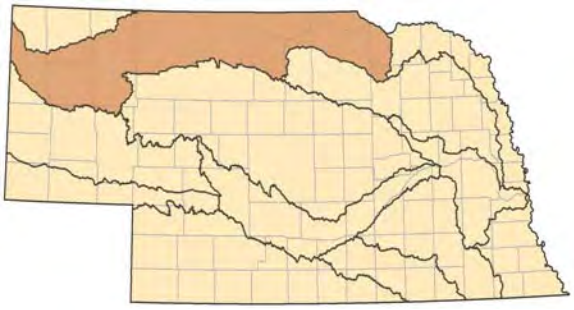


Figure 19. Niobrara River Basin Location

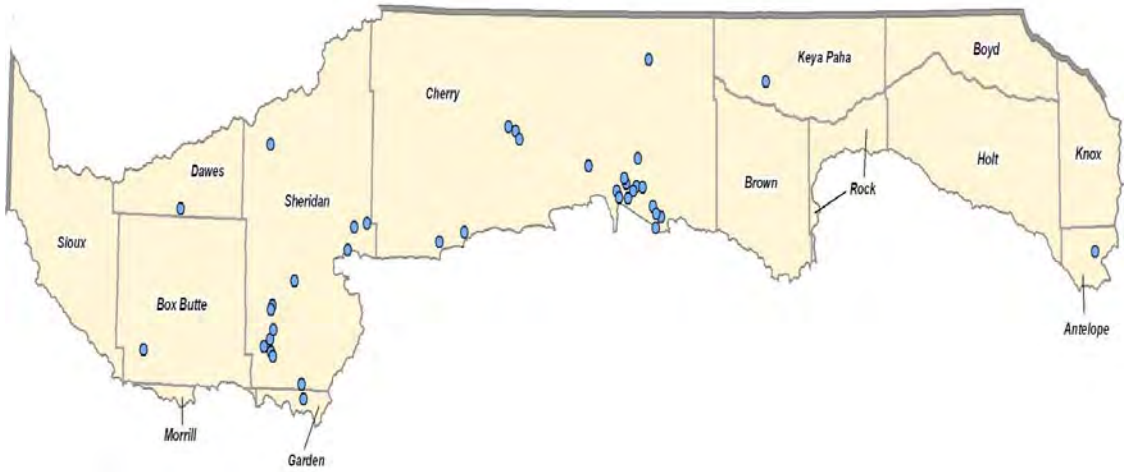
The Niobrara River Basin occupies about 11,870 square miles. The eco-regions of the basin include the Western High Plains, Sand Hills, and the Northwestern Glaciated Plains.

Precipitation ranges from an annual average of 18 inches in the western end to 23 inches at the eastern end (NDEQ, 2005). A majority of the precipitation falls during the spring and early summer. Temperatures range from average highs in the upper 80s during the summer to average lows in the 10s during the winter.

Approximately three million of the acres in the basin are considered arable, of which about 2.2 million acres are considered suitable for irrigation. The major crops grown in the Niobrara River Basin are corn, wheat, alfalfa, and soybeans.

Nebraska water quality standards identifies 66 publicly owned impoundments in the Niobrara River Basin. Of these, 44 are natural lakes, 13 are sand/barrow pits, and nine are reservoirs. Impoundments in this basin range in size from one to 2,905 surface acres with 54 acres being the median size. Pesticide data was available for 38 impoundments in this basin, which consists of 32 natural lakes and six reservoirs (Figure 20). Nineteen of the thirty eight impoundments sampled are publicly owned.

Figure 20. Location of Impoundments in the Niobrara River Basin with Pesticide Data



Acetochlor was detected in all three impoundments sampled while atrazine was detected in 95 percent of the 38 impoundments sampled (Table 11). Neither the drinking water nor aquatic life standards for atrazine or alachlor were exceeded. There are no drinking water standards for metolachlor and all samples were below aquatic life standards. There are no drinking water standards for cyanazine or acetochlor.

Table 11. Summary of Pesticide Data from Impoundments in the Niobrara River Basin (1993-2008)

	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	38	37	35	8	3
# of Samples Analyzed	255	176	209	38	55
# of Samples w/Detectable Concentrations	157	21	112	11	28
% of Impoundments w/Detectable Concentrations	95	24	86	67	100
% of Samples w/Detectable Concentrations	62	12	54	29	51
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.05(a)	0.04(a)	0.07(a)
Maximum Concentration (µ/L)	2.48	0.37	2.63	0.25	1.59
Median Concentration (µ/L)	0.08	0.05(a)	0.07	0.04(a)	0.08
# Samples Greater Than Drinking Water Standard	0	0	NA	NA	NA
# Samples Greater Than Chronic Aquatic Life Standard	0	0	0	NA	NA
Drinking Water Standard (µg/L)	3.00	2.00	No Standard	No Standard	No Standard
Aquatic Life Chronic Standard (µg/L)	12.00	76.00	100.00	No Standard	No Standard
Aquatic Life Acute Standard (µg/L)	330.00	760.00	390.00	No Standard	No Standard

(a) Value given is the method detection limit.

North Platte River Basin

The North Platte River Basin is located in western Nebraska (Figure 21). The basin extends from the Nebraska-Wyoming border to the confluence of the North and South Platte Rivers (NDEQ, 2003). Stream flow in the basin is heavily controlled by irrigation withdrawals/returns and reservoirs.

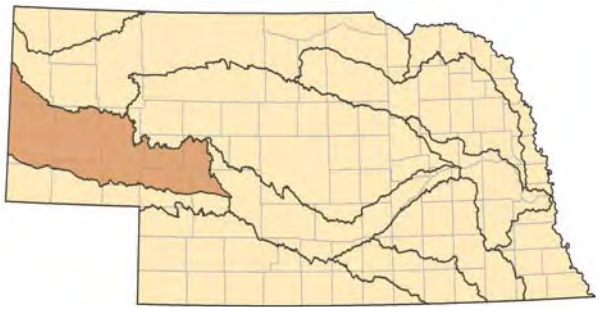


Figure 21. North Platte River Basin Location

The North Platte River Basin occupies about 7,117 square miles and is in the central portion of Nebraska's panhandle. The Western High Plains, Sandhills, and the Central Great Plains eco-regions are spread throughout the basin. The topography of the basin varies from bluffs, buttes, sandhills, and flat valley plains. The seasonal flow of the North Platte River varies and is based on snowmelt from the Rocky Mountains, reservoirs, and irrigation needs. Precipitation ranges from an annual average of 15 inches in the western end of the basin to 20 inches in the eastern end. A majority of the precipitation falls in the spring and early summer.

Temperatures range from average highs in the upper 80's during the summer and average lows in the 10's during the winter. Agriculture is the major land use in the basin with livestock being the dominant agricultural product. About 75% of the basin is in rangeland and pastures, and 20% in cropland. Most crops require irrigation due to the low annual precipitation average in this basin.

Nebraska water quality standards identifies 48 publicly owned impoundments in the North Platte River Basin. Of these, 31 are natural lakes, 12 are sand/barrow pits, and five are reservoirs. Impoundments in this basin range in size from one to 35,000 surface acres with 24 acres being the median size. Pesticide data was available for 21 impoundments, of which 15 were natural lakes, four were sandpits, and two were reservoirs (Figure 22). Thirteen of the impoundments sampled are publicly owned while 8 are private.

The percentage of impoundments that pesticides were detected in the North Platte River Basin ranged from 33 percent for alachlor to 100 percent for cyanazine and acetochlor (Table 12). The most frequently detected pesticide was atrazine which was found in 61 percent of the samples analyzed. Neither the drinking water nor aquatic life standards for atrazine or alachlor were exceeded. There are no drinking water standards for metolachlor and all samples were below aquatic life standards. There are no drinking water standards for cyanazine or acetochlor.

Figure 22. Location of Impoundments in the North Platte River Basin with Pesticide Data

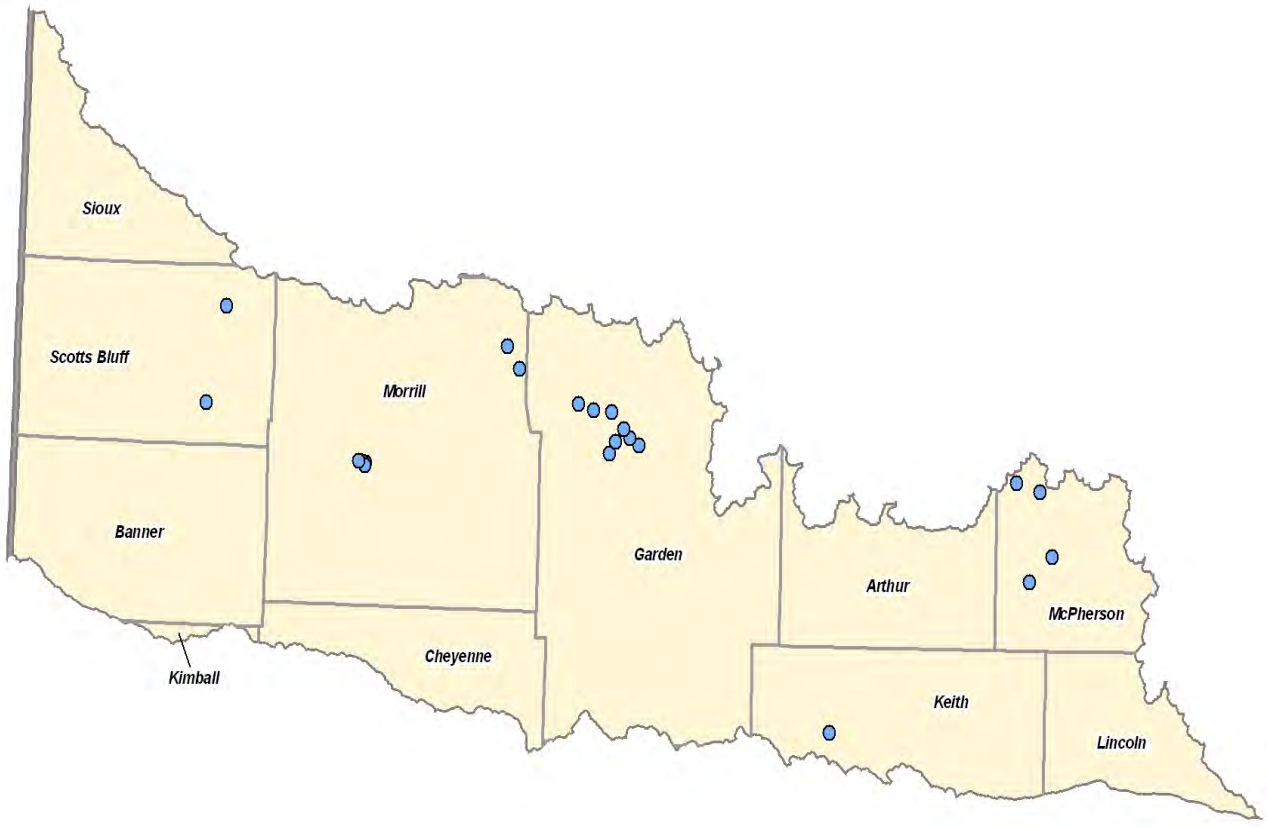


Table 12. Summary of Pesticide Data from Impoundments in the North Platte River Basin (1993-2008)

	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	21	15	19	1	5
# of Samples Analyzed	139	74	128	5	47
# of Samples w/Detectable Concentrations	85	8	53	1	19
% of Impoundments w/Detectable Concentrations	86	33	84	100	100
% of Samples w/Detectable Concentrations	61	11	41	20	40
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.05(a)	0.04(a)	0.07(a)
Maximum Concentration (µ/L)	2.74	2.38	1.42	0.12	2.26
Median Concentration (µ/L)	0.08	0.05(a)	0.07	0.04(a)	0.07(a)
# Samples Greater Than Drinking Water Standard	0	0	NA	NA	NA
# Samples Greater Than Chronic Aquatic Life Standard	0	0	0	NA	NA
Drinking Water Standard (µg/L)	3.00	2.00	No Standard	No Standard	No Standard
Aquatic Life Chronic Standard (µg/L)	12.00	76.00	100.00	No Standard	No Standard
Aquatic Life Acute Standard (µg/L)	330.00	760.00	390.00	No Standard	No Standard

(a) Value given is the method detection limit.

Republican River Basin

The Republican River Basin is located in southwestern Nebraska (Figure 23). The basin extends from the Nebraska-Colorado border and runs across the lower portion of the state before exiting into the state of Kansas (NDEQ, 2005). Stream flow in the basin is controlled by irrigation withdrawals, returns, and reservoirs.

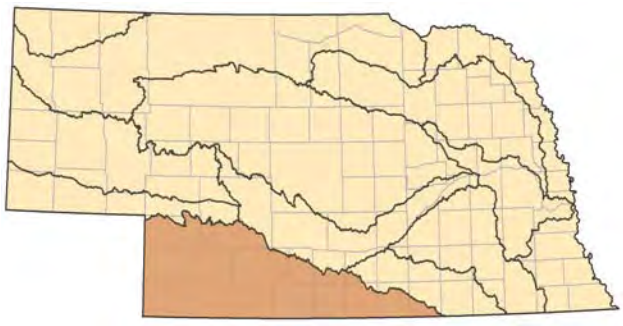


Figure 23. Republican River Basin Location

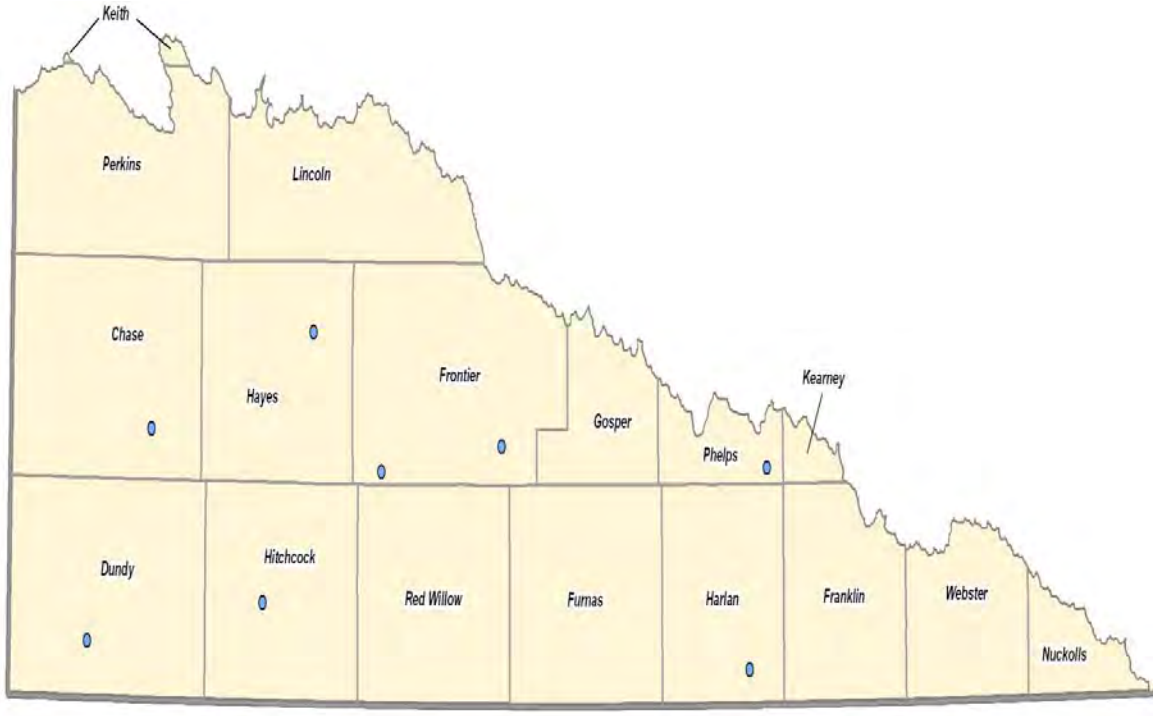
The Republican River Basin occupies about 9,712 square miles and is in the southwestern portion of Nebraska. The eco-regions of the basins include the Central Great Plains, Western High Plains, and the Sandhills.

Precipitation ranges from an annual average of 20 inches in the western portion to 27.5 inches in the eastern part of the basin. A majority of the precipitation occurs during the spring and early summer. Temperatures in the basin range from average highs in the upper 80s during the summer to average lows in the 10s during the winter.

Agriculture is the major land use in the basin with about 45% in rangeland and pastures and 50% in cultivated cropland. Crop production varies in the basin due to soil conditions, topography and the availability of water. Distribution of rainfall is not always favorable for crop production in this basin. Wheat, corn, and sorghum are the major crops that are grown in the basin.

Nebraska water quality standards identifies 18 publicly owned impoundments in the Republican River Basin. Of these, 11 are reservoirs and seven are sand/barrow pits. Impoundments in this basin range in size from one to 13,500 surface acres with 11 acres being the median size. Pesticide data was available for 8 impoundments, which consisted of seven reservoirs and one barrow pit (Figure 24). All the impoundments sampled are publicly owned.

Figure 24. Location of Impoundments in the Republican River Basin with Pesticide Data



Atrazine, metolachlor, and acetochlor were found at all impoundments sampled in the Republican River Basin while alachlor and cyanazine were found in 83 and 67 percent of the impoundments sampled respectively (Table 13). The most frequently detected pesticide was atrazine which was found in 81 percent of the samples.

The drinking water standard for atrazine (3 µg/L) was exceeded in 3 of the 120 (3%) samples but all samples had concentrations below the chronic aquatic life standard. Neither the drinking water standard nor aquatic life standards for alachlor were exceeded. There are no drinking water standards for metolachlor and all samples were below aquatic life standards. There are no drinking water standards for cyanazine or acetochlor.

Table 13. Summary of Pesticide Data from Impoundments in the Republican River Basin (1993-2008)

	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	8	6	8	6	6
# of Samples Analyzed	120	48	87	32	65
# of Samples w/Detectable Concentrations	97	10	45	12	42
% of Impoundments w/Detectable Concentrations	100	83	100	67	100
% of Samples w/Detectable Concentrations	81	21	52	38	65
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.05(a)	0.04(a)	0.07(a)
Maximum Concentration (µ/L)	4.89	0.97	2.26	0.30	2.29
Median Concentration (µ/L)	0.29	0.05(a)	0.07	0.04(a)	0.12
# Samples Greater Than Drinking Water Standard	3	0	NA	NA	NA
# Samples Greater Than Chronic Aquatic Life Standard	0	0	0	NA	NA
Drinking Water Standard (µg/L)	3.00	2.00	No Standard	No Standard	No Standard
Aquatic Life Chronic Standard (µg/L)	12.00	76.00	100.00	No Standard	No Standard
Aquatic Life Acute Standard (µg/L)	330.00	760.00	390.00	No Standard	No Standard

(a) Value given is the method detection limit.

South Platte River Basin

The South Platte River Basin is located in the southern part of the Nebraska Panhandle (Figure 25). The basin extends from the Nebraska-Wyoming border and runs across the southern part of the panhandle and extends east until it comes into contact with the Middle Platte River Basin in central Nebraska.

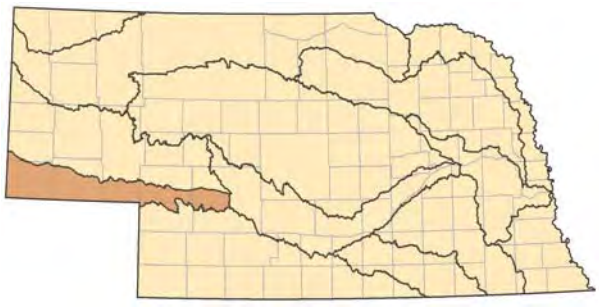


Figure 25. South Platte River Basin Location

The South Platte River Basin occupies about 3645 square miles. The eco-regions in this basin include the Western High Plains and the Sandhills.

Precipitation in the South Platte River Basin averages 16 inches annually. Most of the precipitation falls during the spring and early summer. Temperatures in the basin range from average highs in the upper 80s during the summer to average lows in the 10s during the winter.

Agriculture is the major land use in the South Platte River Basin. Rangeland makes up the largest percentage of the agriculture in the basin, mainly because of the erratic precipitation and limited opportunities for irrigation.

Nebraska water quality standards identifies 13 publicly owned impoundments in the South Platte River Basin. Of these, nine are sand/barrow pits and four are reservoirs. Impoundments in this basin range in size from four to 3,000 surface acres with 27 acres being the median size. Pesticide data was available for six impoundments in this basin, of which three are reservoirs and three are sandpits (Figure 26). All the impoundments sampled are publicly owned.

Figure 26. Location of Impoundments in the South Platte River Basin with Pesticide Data

Acetochlor was detected in the only impoundment sampled while atrazine was found in five of six impoundments sampled. Alachlor and metolachlor were both found in four of six lakes sampled (Table 14). The most frequently detected pesticide was atrazine which was found in 69 percent of the samples analyzed.

Neither atrazine nor alachlor exceeded drinking water or aquatic life standards. There are no drinking water standards for metolachlor and all samples were below aquatic life standards. There are no drinking water standards for cyanazine or acetochlor.

Table 14. Summary of Pesticide Data from Impoundments in the South Platte River Basin (1993-2008)

	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	6	6	6	No Data	1
# of Samples Analyzed	35	30	34		5
# of Samples w/Detectable Concentrations	24	6	10		1
% of Impoundments w/Detectable Concentrations	83	67	67		100
% of Samples w/Detectable Concentrations	69	20	29		20
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.05(a)		0.07(a)
Maximum Concentration (µ/L)	0.43	0.47	0.70		0.70
Median Concentration (µ/L)	0.09	0.05(a)	0.05(a)		0.07(a)
# Samples Greater Than Drinking Water Standard	0	0	NA	NA	NA
# Samples Greater Than Chronic Aquatic Life Standard	0	0	0	NA	NA
Drinking Water Standard (µg/L)	3.00	2.00	No Standard	No Standard	No Standard
Aquatic Life Chronic Standard (µg/L)	12.00	76.00	100.00	No Standard	No Standard
Aquatic Life Acute Standard (µg/L)	330.00	760.00	390.00	No Standard	No Standard

(a) Value given is the method detection limit.

White River – Hat Creek Basin

The White River-Hat Creek Basin is located in extreme northwestern Nebraska (Figure 27). The basin originates in Nebraska and heads in a northeastern pattern to confluence with the Missouri River and the Cheyenne River (NDEQ, 2005). Stream flow in the basin is from surface run-off and groundwater contributions.

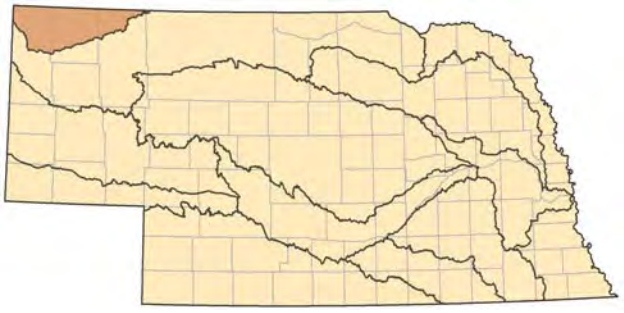


Figure 27. White River-Hat Creek Basin Location

The White River-Hat Creek Basin occupies about 2,130 square miles and is located in the northwestern part of the state. The eco-regions in the basin include the Western High Plains and the Northwestern Great Plains.

Average annual precipitation throughout the basin is about 16 inches. A majority of the precipitation occurs during the spring and early summer. Temperatures in the basin range from average highs in the upper 80s during the summer to average lows in the 10s during the winter.

Agriculture is the major land use in the White River-Hat Creek Basin with about 55% of the basin used for rangeland or pastures and 15% in cropland. The native vegetation in the basin includes Dakota prairie, short grass prairie and Rocky Mountain forest.

Nebraska water quality standards identifies 26 publicly owned impoundments in the White River – Hat Creek Basin. Of these, 18 are sand/barrow pits, six are reservoirs, and two are natural lakes. Impoundments in this basin range in size from one to 900 surface acres with 4 acres being the median size. Pesticide data was available for nine impoundments in this basin, all of which are reservoirs (Figure 28). Eight of the impoundments sampled are publicly owned and one was private.

Atrazine and acetochlor were found in all impoundments sampled, however, acetochlor was only sampled in one impoundment. Metolachlor was detected in eight of nine impoundments sampled while alachlor was detected in six of nine impoundments sampled (Table 15). The most frequently detected pesticide was atrazine which was found in 55 percent of the samples analyzed.

Neither atrazine nor alachlor exceeded drinking water or aquatic life standards. There are no drinking water standards for metolachlor and all samples were below aquatic life standards. There are no drinking water standards for cyanazine or acetochlor.

Figure 28. Location of Impoundments in the White-Hat River Basins with Pesticide Data

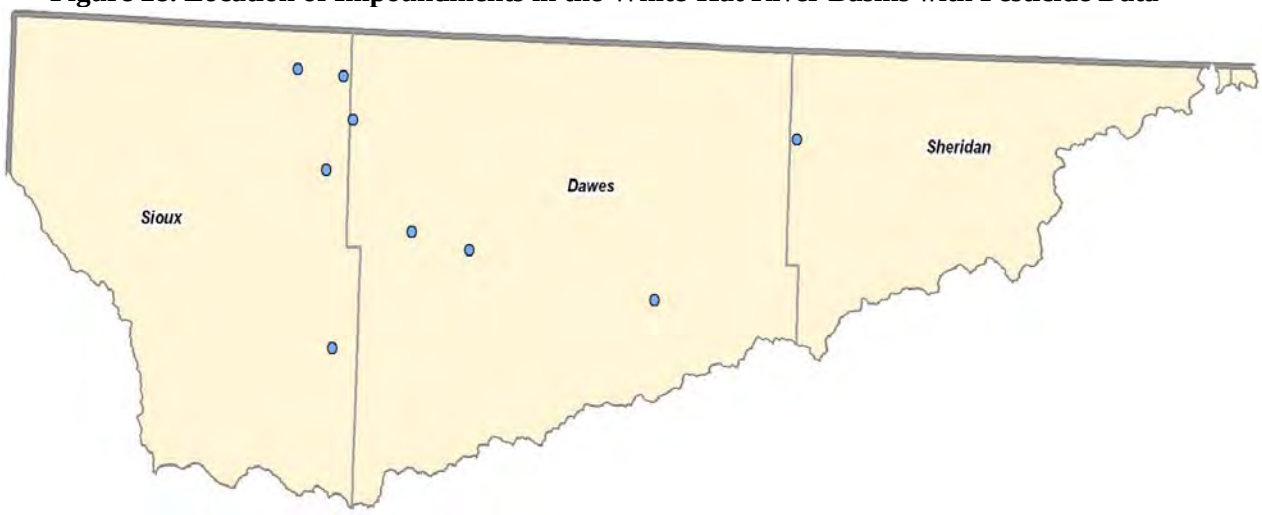


Table 15. Summary of Pesticide Data from Impoundments in the White River-Hat Creek Basin (1993-2008)

	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	9	9	9	1	1
# of Samples Analyzed	51	30	39	5	13
# of Samples w/Detectable Concentrations	28	5	17	0	7
% of Impoundments w/Detectable Concentrations	100	67	89	0	100
% of Samples w/Detectable Concentrations	55	17	44	0	54
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.05(a)	0.04(a)	0.07(a)
Maximum Concentration (µ/L)	2.47	0.35	0.78	0.04(a)	2.47
Median Concentration (µ/L)	0.06	0.05(a)	0.07	0.04(a)	0.08
# Samples Greater Than Drinking Water Standard	0	0	NA	NA	NA
# Samples Greater Than Chronic Aquatic Life Standard	0	0	0	NA	NA
Drinking Water Standard (µg/L)	3.00	2.00	No Standard	No Standard	No Standard
Aquatic Life Chronic Standard (µg/L)	12.00	76.00	100.00	No Standard	No Standard
Aquatic Life Acute Standard (µg/L)	330.00	760.00	390.00	No Standard	No Standard

(a) Value given is the method detection limit.

Factors Influencing Pesticide Runoff

Pesticides are applied to the land in different amounts and at different times of the year. Given the wide application of pesticides, there are many factors that could affect their delivery to surface waters. One factor is climate, which includes the amount and timing of rainfall with respect to pesticide application. Average annual precipitation ranges from 16 inches in panhandle in western Nebraska to 33.5 inches in southeastern Nebraska (NeRAIN, 2009). Precipitation differences can have a great affect on the land usage and will influence the amount of runoff. Average atrazine concentrations in impoundments in Nebraska does correlate well with average annual precipitation and the percentage of cropped ground (Figures 29 and 30).

Soil types play an important role in the time it takes pesticides to reach surface water. The percentage of sand, silt, and clay in a soil determines its texture and will influence how fast water can move through the soil (USGS, 2009). The greater the percentage of sand, the easier it is for water and any contaminants to migrate. Soil pH can also play a role in pesticide transport. As soil pH decreases, pesticides bind more to the clay and are less soluble in water (Soil Facts, 1997).

Agriculture management practices also play an important role in herbicides reaching surface water. Application method and rate can vary between different individual farmers, their crop type, and soil type in their area. Tillage practices, land treatment, and irrigation practices all can have an affect on how quickly herbicides reach surface water.

Figure 29. Average Rainfall and Atrazine Concentrations in Impoundments (1993-2008)

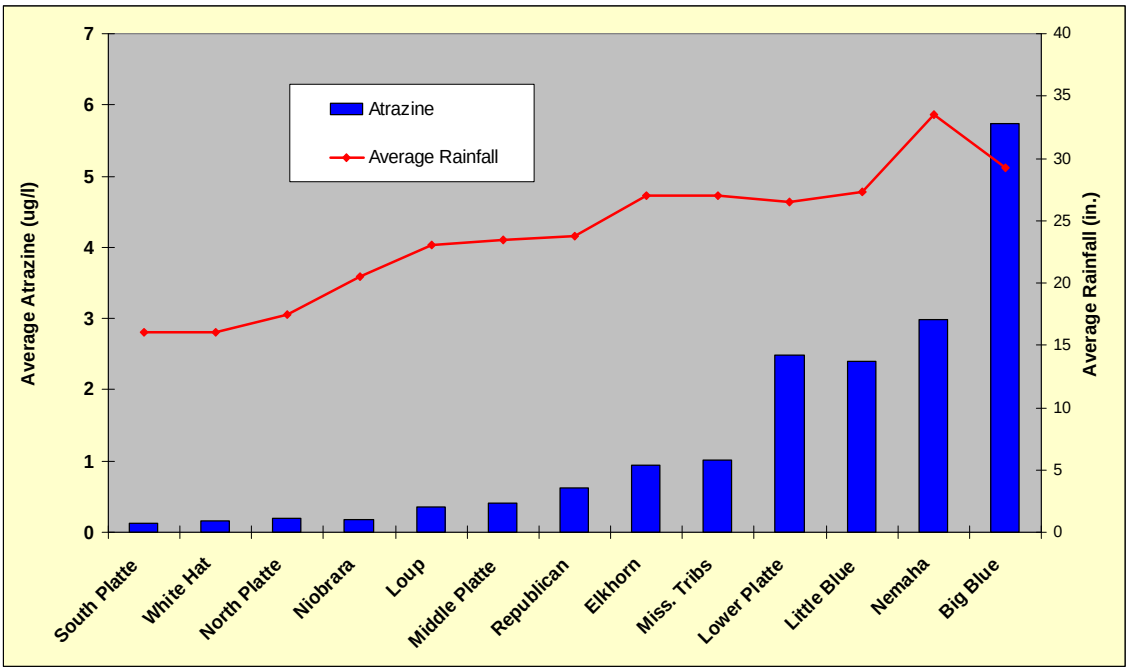
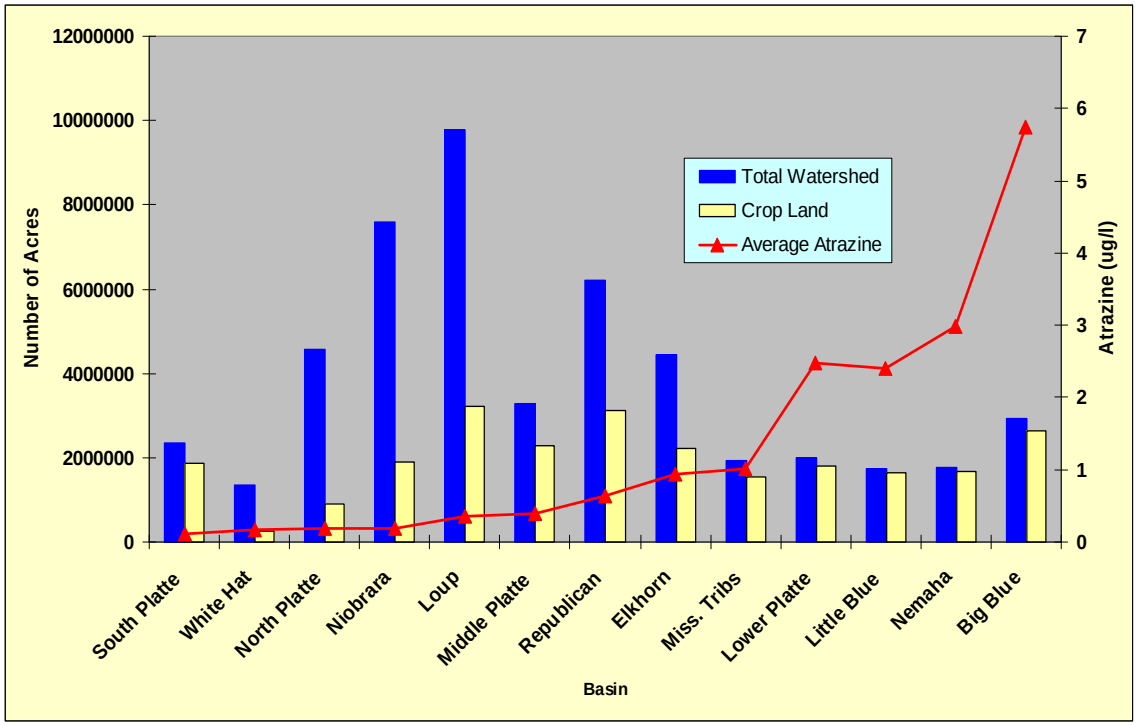


Figure 30. Watershed Area and Total Land in Crop Production vs. Average Atrazine Concentrations in Nebraska Impoundments (1993-2008)



While rainfall and runoff are the focus of pesticide transport to surface water, the movement of herbicides through the environment occurs in different ways, such as volatilization during or after application (The Nature Conservancy, 2001). Volatilization occurs as the herbicide passes into the gaseous stage and moves with the breeze. Generally, volatilization occurs during application, but can also occur after the herbicide has been deposited on the plants or on the soil surface. Volatility increases with temperature, soil moisture, and with decreasing clay and organic matter content. Once airborne, the herbicides can be transported variable distances before being deposited to the earth's surface. There are widespread observations of herbicides in wet deposition samples collected in the midwest and northeast, which provides further evidence for their ability to undergo long-range atmospheric transport (Roach *et al.*, 1997). Evidence of volatilization can also be seen in the Sandhills region of Nebraska where minimal amounts of herbicides are utilized. Data from six natural lakes in the Valentine Wildlife Refuge indicated all lakes exhibited detectable concentrations of atrazine and metolachlor (Table 16). Two of the six lakes exhibited detectable concentrations of alachlor and the one lake monitored for cyanazine exhibited a detectable concentration. The most frequently detected pesticide in these natural lakes was atrazine which was detected in 30 of 39 (77 percent) samples analyzed (Table 16). Metolachlor was detected in 26 of 35 (74 percent) of the samples analyzed while alachlor was detected in only two of 35 (6 percent) samples analyzed. The maximum concentration of atrazine reported from the six lakes monitored was 1.71 µg/L, which is well below criteria for the protection of aquatic life.

Table 16. Summary of Pesticide Data from Natural Lakes in the Valentine Wildlife Refuge

Data Period: 1993-1998	Atrazine	Alachlor	Metolachlor	Cyanazine	Acetochlor
# Impoundments Sampled	6	6	6	1	0
# of Samples Analyzed	39	35	35	4	0
# of Samples w/Detectable Concentrations	30	2	26	1	NA
% of Impoundments w/Detectable Concentrations	100	33	100	100	NA
% of Samples w/Detectable Concentrations	77	6	74	25	NA
Minimum Concentration (µ/L)	0.05(a)	0.05(a)	0.05(a)	0.04(a)	NA
Maximum Concentration (µ/L)	1.71	0.08	1.49	0.06	NA
Median Concentration (µ/L)	0.07	0.05(a)	0.08	0.04(a)	NA

(a) Concentration reported is the Detection Limit

Statewide Pesticide Trends

Atrazine, alachlor, and metolachlor data for all impoundments across the state from 1993 through 2008 was pooled, divided into four year periods, and then assessed by month. The month that showed the highest average atrazine concentrations varied by assessment period. From 1993-2000 average atrazine concentrations peaked in July while from 1997 to 2000 the highest average concentration occurred in June and from 2001 to 2008 concentrations peaked in May (Figure 31). From the assessment periods of 1993-1996 to 1997-2000 statewide average atrazine concentrations dropped from 4.95 µg/L to 1.32 µg/L representing a 73 percent decrease. From the assessment periods of 1997-2000 to 2001-2004 average concentrations decreased by another 18 percent. There was no reduction from the assessment periods of 2001-2004 to 2005-2008. From 1993 to 2005, atrazine use in Nebraska has ranged from 5.3 million pounds in 2002 to over 8.2 million pounds in 1999 (Figure 32), (USDA, 2009).

Figure 31. Four Year Average Atrazine Concentrations in Impoundments for the Months of May-September (1993-2008)

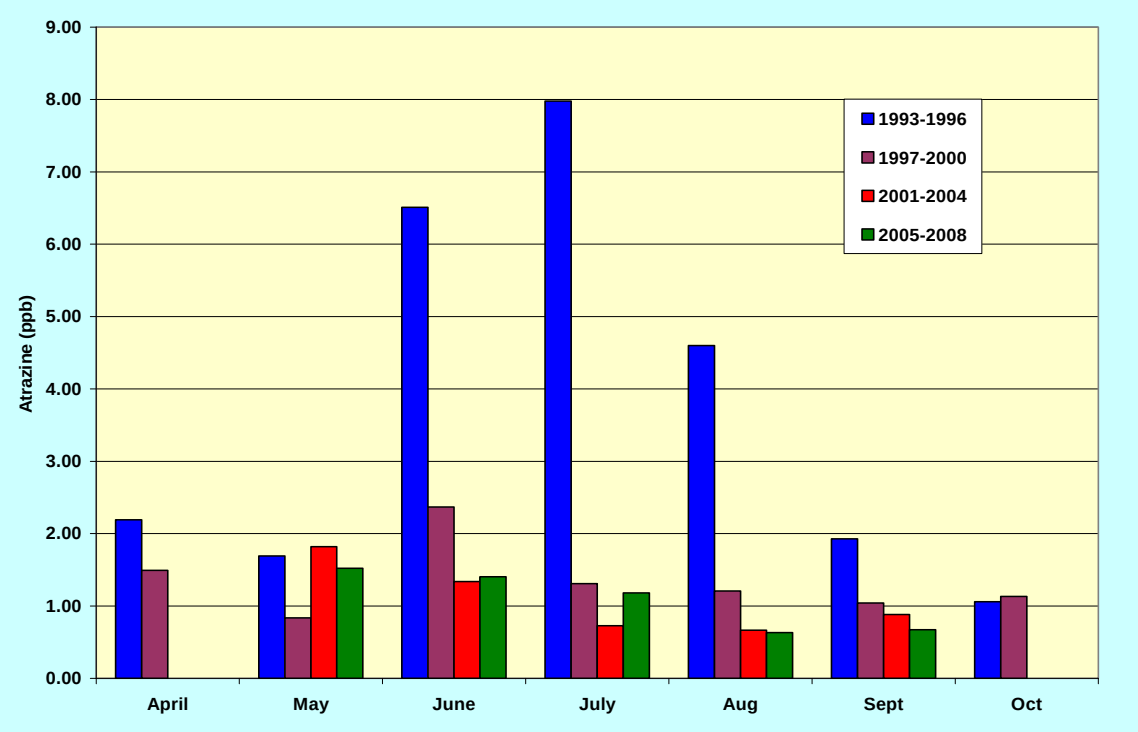
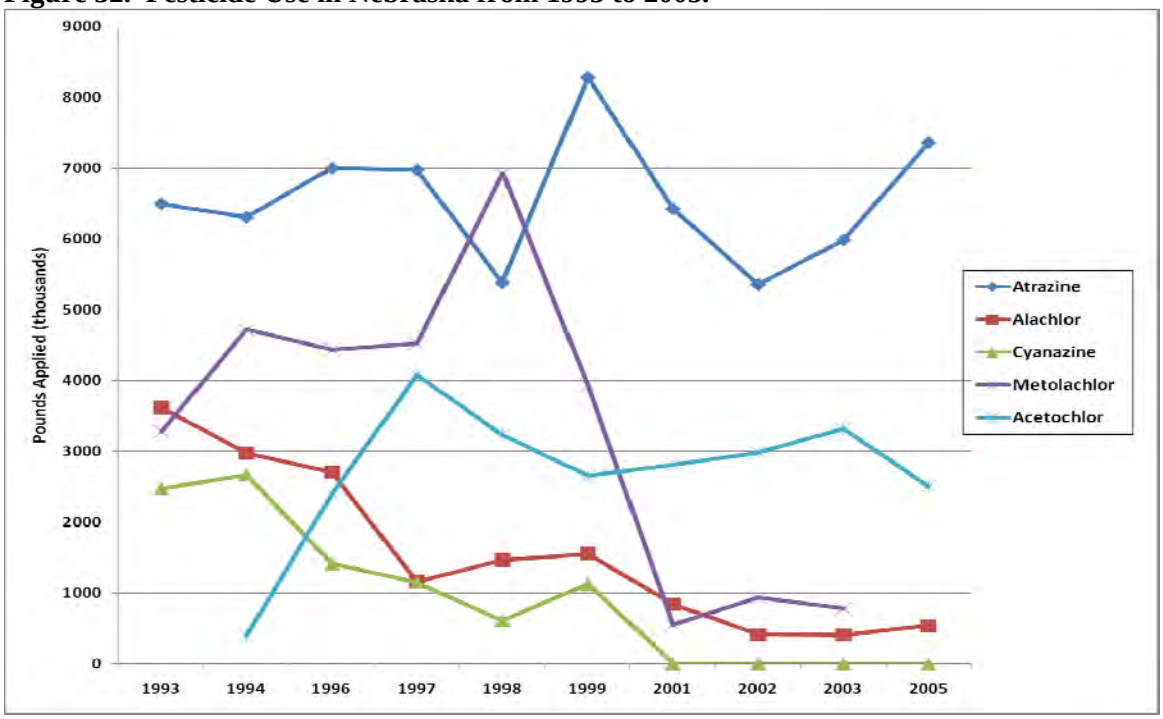


Figure 32. Pesticide Use in Nebraska from 1993 to 2005.



As with atrazine, the month that showed the highest average alachlor concentrations varied by assessment period. During the periods of 1993-1996 and 2001-2004 statewide average concentrations peaked in May while periods 1997-2000 and 2005-2008 exhibited peak concentrations in June (Figure 33). Average alachlor concentrations increased by 54 percent from the assessment periods of 1993-1996 to 1997-2000 then exhibited a 52 percent decrease from the periods of 1997-2000 to 2001-2004, then again increased by 44 percent from the periods of 2001-2004 to 2005-2008. Alachlor usage in Nebraska exhibited a steady decrease from over 6.3 million pounds in 1993 to 0.5 million pounds in 2005 (Figure 32).

Metolachlor was not monitored prior to 1997. For the periods of 1997-2000 and 2005-2008 peak metolachlor concentrations occurred in the month of June while peak concentrations for the period of 2001-2004 were in the month of May (Figure 34). From the periods of 1997-2000 to 2001-2004 average metolachlor concentrations increased from 0.25 µg/L to 0.93 µg/L representing a 73 percent increase. Average concentrations then dropped by 65 percent from the periods of 2001-2004 to 2005-2008. Metolachlor usage in Nebraska exhibited an increase from 3.2 million pounds in 1993 to over 6.9 million pounds in 1998. Usage then dropped to 0.7 million pounds by 2003 (Figure 32).

Figure 33. Four Year Average Alachlor Concentrations in Impoundments from May through September (1993-2008)

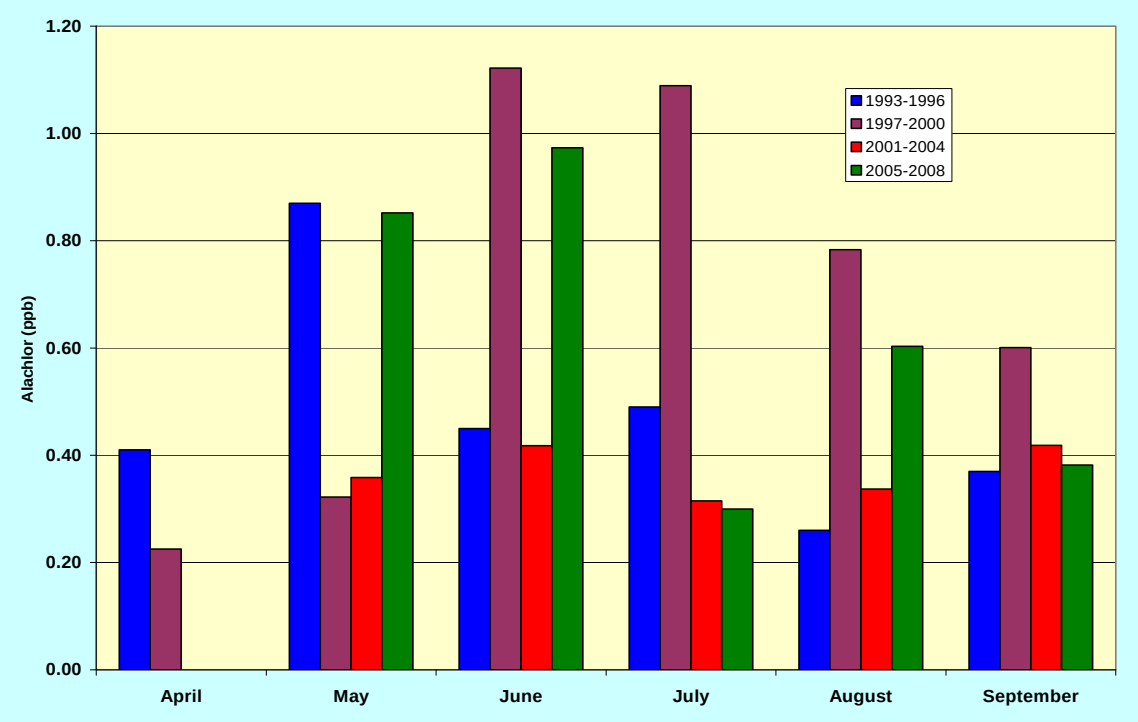
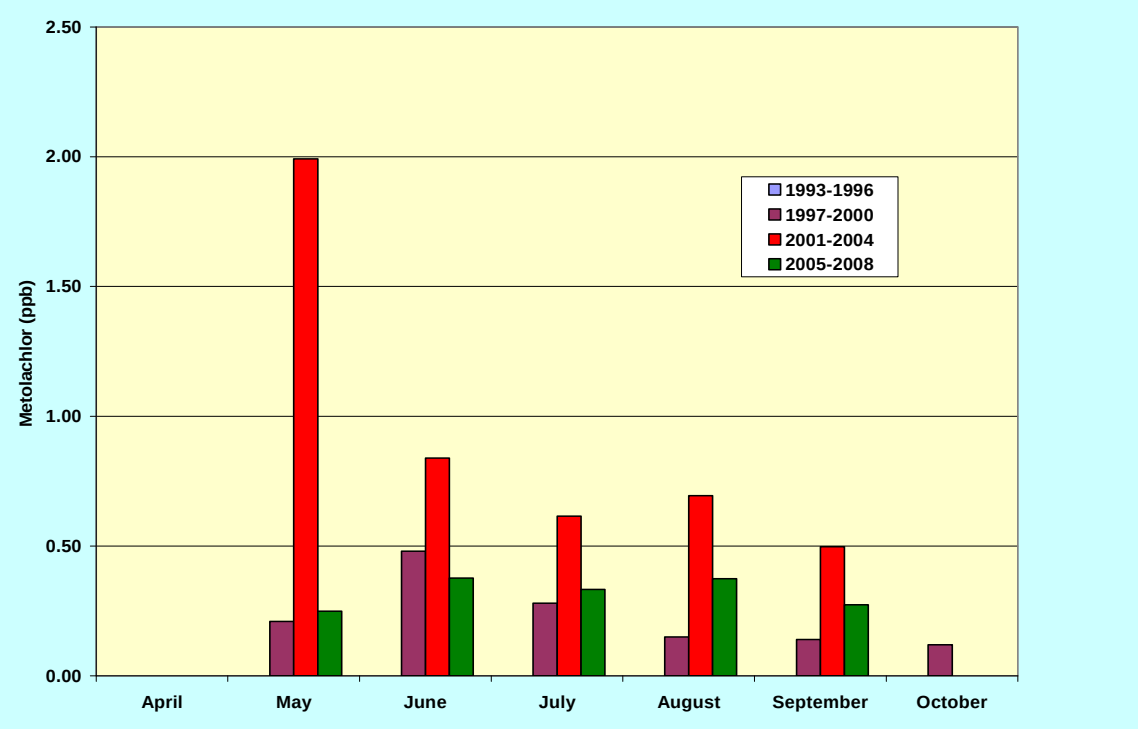


Figure 34. Four Year Average Metolachlor Concentrations in Impoundments from May through September (1993-2008)



The greatest average cyanazine concentration was observed in the months of June and July during the 1993-1996 period and June for the 1997-2000 period (Figure 35). Average concentrations were all at the reporting limit for all months during the 2005-2008 period. Statewide average concentrations of cyanazine decreased from 0.71 µg/L to 0.45 µg/L from the periods of 1993-1996 to 1997-2000 representing a 36 percent decrease. While there were no samples from 2001-2004, average concentrations decreased from 0.45 µg/L to the laboratory reporting limit (0.07 µg/L) from the periods of 1997-2000 to 2005-2008 representing an 85 percent decrease. Cyanazine use in Nebraska peaked in 1994 at 2.6 million pounds. Limitations on cyanazine use were implemented in 1997 and by 2002 the sale of cyanazine at the distributor and retail levels were discontinued (U.S.EPA, 1999).

Decreases in atrazine concentrations have been documented at several reservoirs. A sufficient amount of data was available to assess atrazine trends on 16 reservoirs across the state (Table 17). Of the 16 reservoirs assessed, ten exhibited a significantly decreasing trend, three exhibited a decreasing trend that was not significant, one exhibited an increasing trend that was significant, and two exhibited increasing trends that were not significant. Individual trend assessments may not be reflective of statewide conditions as 10 of 16 reservoirs assessed for trends were targets of watershed improvement projects that involved an extensive amount of land treatment and education. Eight of the ten reservoirs with significant decreasing trends were watershed project sites.

Recharge Reservoir in York, County was the only impoundment on the 2008 Section 303(d) list of impaired waters for atrazine. Concentrations of atrazine in the reservoir have decreased enough to remove this pollutant as an impairment (Figure 36). There are no proposed lake or reservoir listings for atrazine on the 2010 Section 303(d) list.

Figure 35. Four Year Average Cyanazine Concentrations in Impoundments from May through September (1993-2008)

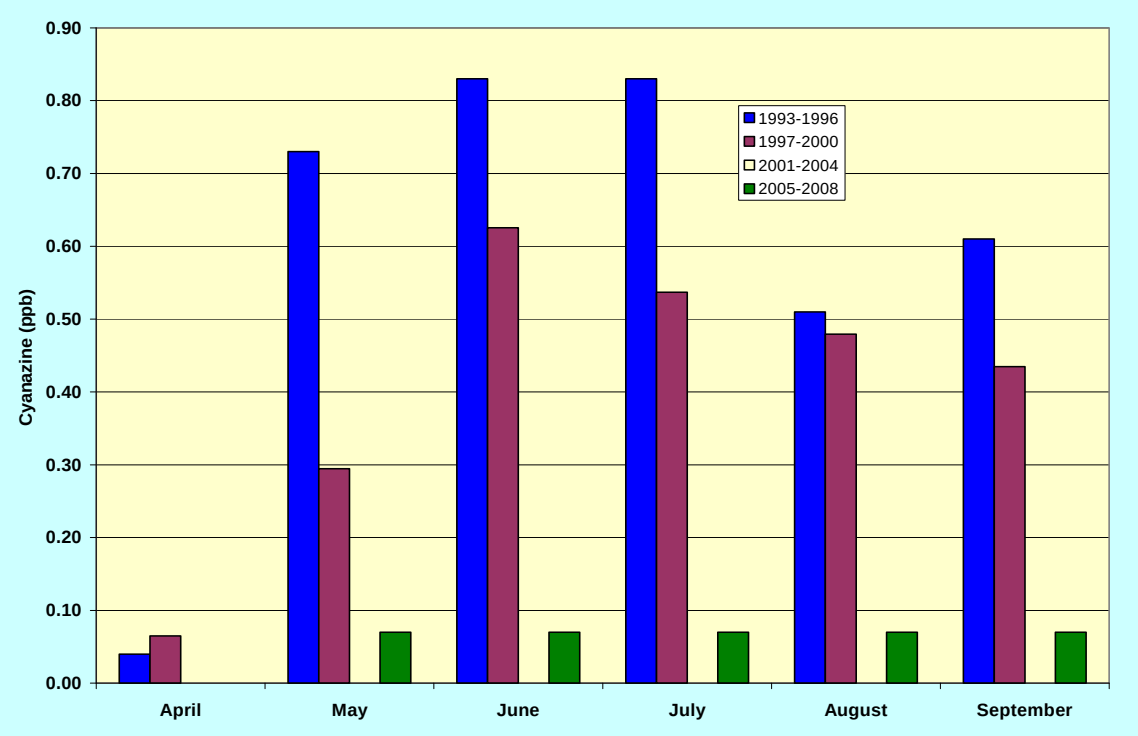
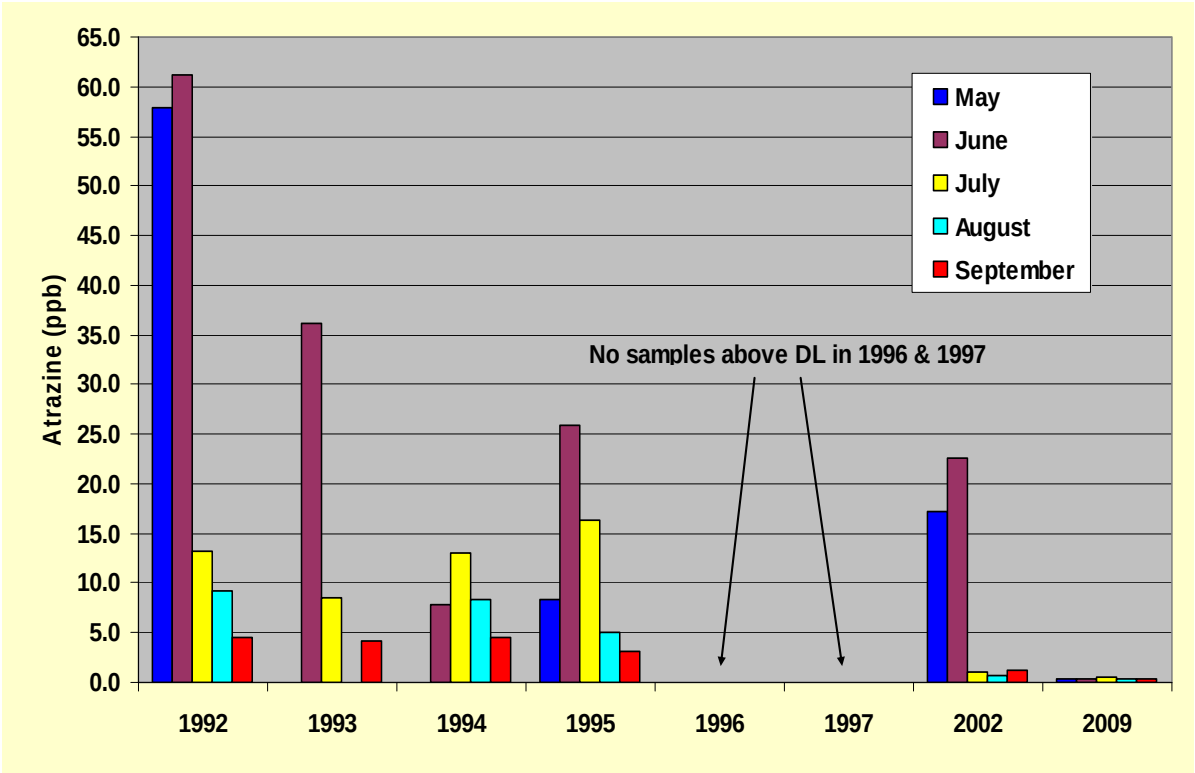


Table 17. Atrazine Trend Assessments on Nebraska Reservoirs

Reservoir Name	River Basin	Trend Result	Significant ($\alpha = 0.05$)	Watershed Project Completed
Swan 5A	Big Blue	Decreasing	Yes	Yes
Recharge	Big Blue	Decreasing	Yes	Yes
Maskenthine	Elkhorn	Decreasing	Yes	Yes
Willow Creek	Elkhorn	Decreasing	Yes	No
Wildwood	Lower Platte	Decreasing	No	Yes
Stagecoach	Lower Platte	Decreasing	No	No
Wagon Train	Lower Platte	Increasing	Yes	Yes
Bluestem	Lower Platte	Decreasing	Yes	No
Branched Oak	Lower Platte	Increasing	No	No
Conestoga	Lower Platte	Decreasing	Yes	No
Sherman	Loup	Increasing	No	No
Walnut Creek	Missouri Tributaries	Decreasing	Yes	Yes
Wehrspann	Missouri Tributaries	Decreasing	Yes	Yes
Zorinsky	Missouri Tributaries	Decreasing	Yes	Yes
Kirkmans Cove	Nemaha	Decreasing	Yes	Yes
Iron Horse Trail	Nemaha	Decreasing	No	Yes

Figure 36. Monthly Average Atrazine Concentrations in Recharge Lake, York County, NE



Summary and Conclusions

Nebraska is a state dominated by agricultural land uses and the application of pesticides is widespread. Detectable concentrations of at least one pesticide have been found in most all impoundments sampled including those that do not receive a significant amount of overland flow. In general, pesticide concentrations tend to increase as you move from west to east across the state. This also coincides with the percentage of land that is used for crop production and the amount of average annual rainfall.

The Big Blue River Basin exhibited the highest median concentration of atrazine, alachlor, and metolachlor. The Little Blue River Basin exhibited the highest median concentration of acetochlor while the Missouri Tributaries Basin exhibited the highest median concentration of cyanazine.

Atrazine is the only pesticide found in high enough concentrations to exceed water quality standards for aquatic life. Fifty five of the 1770 samples (3%) collected statewide exceeded the chronic criteria for aquatic life and there were no samples that exceeded the acute standard. Forty three of the 55 samples that exceeded the chronic criteria were collected from impoundments in the Big Blue River Basin. Drinking water criteria were exceeded on 228 (13%) of the 1770 samples of which 111 samples were from impoundments in the Big Blue River Basin. None of the impoundments monitored are designated as a drinking water supply.

Statewide average concentrations of atrazine and cyanazine have dropped significantly since the early 1990's while average concentrations of alachlor and metolachlor have varied through the years. Atrazine decreases have been documented in several eastern Nebraska watersheds which may or may not have been related to watershed projects that have resulted in a significant amount of land treatment.

While surface water contamination from pesticides occurs primarily through rainfall and runoff events, there is evidence that air deposition also plays a role. Measurable concentrations of atrazine, alachlor, metolachlor, and cyanazine were detected in samples from natural lakes located in a National Wildlife Refuge.

Several factors should be taken into account when reviewing results in this report. This assessment did not take into account rainfall patterns across the state. Many parts of the state experienced wet years during the early 1990s and dry years in the early 2000s. These weather patterns are closely tied to runoff and pesticide contributions to surface water. Data collection locations on reservoirs were typically near the dam which may not be representative of the entire reservoir. Additionally, data from all impoundments types were pooled for this assessment. Reservoirs will typically exhibit higher concentrations of atrazine than sandpits and natural lakes due to runoff influences.

The NDEQ will continue to monitor pesticide concentrations across the state to evaluate the potential for water quality problems. Watershed programs that target land treatment and education will continue to play a critical role in minimizing pesticides runoff and transport to surface waters.

References

Chatterjee *et al*. 2006. Simple Linear Regression. Regression Analysis by Example, Fourth Edition. http://biocomp.cnb.uam.es/~coss/Docencia/ADAM/.../Simple%20Regression.pdf

EXTOXNET. 1996. Extension Toxicology Network. Pesticide Information Profile. http://extoxnet.orst.edu

EXTOXNET. 1996. Extension Toxicology Network. Cyanazine Pesticide Information Profile. http://extoxnet.orst.edu/pips/cyanazin.htm

EXTOXNET. 1996. Extension Toxicology Network. Metolachlor Pesticide Information Profile. http://extoxnet.orst.edu/pips/metolach.htm

EXTOXNET. 1996. Extension Toxicology Network. Acetochlor Pesticide Information Profile. http://extoxnet.orst.edu/pips/acetochl.htm

Hartzler. 2002. Absorption of Soil-Applied Herbicides. Weed Science Journal. Hartzler, Bob. www.weeds.iastate.edu.mgmt/2002/soilabsorption.htm

NDEQ. 2002. Total Maximum Daily Loads for the Loup River Basin. Nebraska Dept. of Environmental Quality Planning Unit, Water Quality Division, Lincoln, NE.

NDEQ. 2003. Total Maximum Daily Loads for the Middle Platte River Basin. Nebraska Dept. of Environmental Quality Planning Unit, Water Quality Division, Lincoln, NE.

NDEQ. 2003. Total Maximum Daily Loads for the North Platte River Basin. Nebraska Dept. of Environmental Quality Planning Unit, Water Quality Division, Lincoln, NE.

NDEQ. 2005. Total Maximum Daily Loads for the Big Blue River Basin. Nebraska Dept. of Environmental Quality Planning Unit, Water Quality Division, Lincoln, NE.

NDEQ. 2005. Total Maximum Daily Loads for the Republican River Basin. Nebraska Dept. of Environmental Quality Planning Unit, Water Quality Division, Lincoln, NE.

NDEQ. 2005. Total Maximum Daily Loads for the White River-Hat Creek Basin. Nebraska Dept. of Environmental Quality Planning Unit, Water Quality Division, Lincoln, NE.

NDEQ. 2005. Total Maximum Daily Loads for the Republican Basin. Nebraska Dept. of Environmental Quality Planning Unit, Water Quality Division, Lincoln, NE.

NDEQ. 2005. Total Maximum Daily Loads for the Little Blue River Basin. Nebraska Dept. of Environmental Quality Planning Unit, Water Quality Division, Lincoln, NE.

NDEQ. 2005. Total Maximum Daily Loads for the Niobrara River Basin. Nebraska Dept. of Environmental Quality Planning Unit, Water Quality Division, Lincoln, NE.

NDEQ. 2007. Total Maximum Daily Loads for the Nemaha River Basin. Nebraska Dept. of Environmental Quality Planning Unit, Water Quality Division, Lincoln, NE.

References Continued

NDEQ, 2007. Title 117 – Nebraska Surface Water Quality Standards. Nebraska Department of Environmental Quality. Water Quality Planning Unit. Lincoln, NE.

NDEQ. 2008. Total Maximum Daily Loads for the Elkhorn River Basin. Nebraska Dept. of Environmental Quality Planning Unit, Water Quality Division, Lincoln, NE. Draft.

NDNR. 2009. Missouri Tributary Basins. Annual Report. Nebraska Department of Natural Resources, Lincoln, NE. http://www.dnr.state.ne.us/LB962/AnnualReport_2009/MissouriTributaryBasins.pdf

NeRAIN. 2009. Rainfall Totals. January 2004-Present. Nebraska Rainfall Assessment and Information Network. http://dnrdata.dnr.ne.gov/NeRAIN/index.asp

Roach *et al*. 1997. Determination of Atmospheric Atrazine and Alachlor Concentrations By Reverse Phase Liquid Chromatography and Gas Chromatography Mass Spectrometry. http://carbon.cudenver.edu/~landerso/97ra12203.htm

The Nature Conservancy. April 2001. Weed Control Methods Handbook. The Properties of Herbicides. Tu *et al*. http://wilderness.net/toolboxes/documents/invasive/Chapter 6 HerbicideProperties.pdf

USDA. 1991-2005. Corn Herbicides- All Pounds Applied. United States Department of Agriculture.

USDA. 2009. National Agricultural Statistics Service. Nebraska Data-Chemical Usage, Field Crops. United States Department of Agriculture. http://www.nass.usda.gov/Statistics_by_State/Nebraska/index.asp

U.S. EPA. 1997. Cyanazine Risk Characterization. California Environmental Protection Agency. http://www.cdpr.ca.gov/docs/risk/rcd/cyanazine.pdf

U.S. EPA. 1999. Federal Register Notice: Cyanazine; Notice of Amendment to Terms and Conditions of Registration. Federal Register, January 22, 1999, Volume 64, Number 14, Pages 3511-3513.

U.S. EPA. 2000. Level III Eco-regions of Nebraska. U.S. Environmental Protection Agency. http://www.hort.purdue.edu/newcrop/cropmap/nebraska/maps/NEeco3.html

U.S. EPA. 2002. Metolachlor Analysis of Risks. United States Environmental Protection Agency. http://www.epa.gov/espp/litstatus/effects/metolachlor-analysis.pdf

U.S. EPA. 2004. Acetochlor Fact Sheet. June 2004. United States Environmental Protection Agency.

U.S. EPA. 2006. EPA Consumer Fact Sheet on: Atrazine. United States Environmental Protection Agency. http://www.epa.gov/safewater/contaminants/dw_contamfs/atrazine.html

References Continued

U.S. EPA. 2006. EPA Consumer Fact Sheet on: Alachlor. United States Environmental Protection Agency. http://www.epa.gov/safewater/contaminants/dw_contamfs/atrazine.html

U.S. EPA. 2007. Cyanazine Fact Sheet. May 2007. United States Environmental Protection Agency.

U.S. EPA. 2008. Atrazine Life Criteria. June 2008. United States Environmental Protection Agency. http://www.epa.gov/waterscience/criteria/atrazine/index.htm

U.S. EPA. 2008. EPA Stream Corridor Structure. United States Environmental Protection Agency. http://www.epa.gov/watertrain/stream/stream6.html

USGS. 2009. Real-Time Water Data for Nebraska. June 2009. United States Geological Survey. http://waterdata.usgs.gov/ne/nwis/rt

USGS. 2009. The Water Cycle. Water Science Basics. U.S. Geological Survey. http://ga.water.usgs.gov/edu/watercyclesummary.html