2018 & 2019 Nebraska Water Monitoring Programs Report

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Water Quality Division

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2018/2019 Nebraska Water Monitoring Programs Report

Nebraska Department of Environment and Energy – Water Quality Division

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Acknowledgements:

The following Nebraska Department of Environment and Energy staff have contributed to this report with their photos, maps, numbers, words, and editing. Their efforts are greatly appreciated and gratefully acknowledged here: Mike Archer, Brian Barnes, Dave Bubb, Tom Heatherly, Dan Inman, Carla McCullough, Greg Michl, Dave Miesbach, Amanda Osborn, Erik Prenosil, Dave Schumacher, Elbert Traylor.

Individual staff should be contacted with specific questions about specific programs; their contact information is provided at the end of each monitoring program description.

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Photo on Front Cover:

Nebraska Department of Environment and Energy (NDEE) staff measureing the width of the Niobrara River, Sheridan County.

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Introduction

The Nebraska Department of Environment and Energy (NDEE) is charged with monitoring, assessing, and to the extent possible, managing the state's water resources. The purpose of this work is to protect and maintain high quality water and encourage or execute activities to improve poor water quality. Monitoring is done on nearly 17,000 miles of flowing rivers and streams, more than 134,000 acres of surface water in lakes and reservoirs, as well as the vast storage of groundwater in Nebraska's aquifers.

This document brings together a short summary of many of the monitoring programs performed (or required) by the NDEE. In many cases, recent results are highlighted in the descriptions. There are also examples of how the data that are collected are used. Individual program summaries, in some cases, include descriptions or explanations of water quality trends or observations.

This document is not meant to be a comprehensive or exhaustive scientific report; rather, it is a starting place for describing the numerous monitoring programs carried out by the NDEE, its contractors, or, in some cases, the regulated community. Other NDEE reports and documents have more in-depth data and descriptions for many of the programs. The reader will be directed to these in the individual program descriptions, or can contact the author cited at the end of each program description for further information.

Partners

NDEE gathers much of the data discussed in this document; however, many partners have contributed as well. Without the contractual and voluntary assistance we receive from our many sister agencies and partners, we would not be able to detail the successes that we have accomplished. The state's Natural Resources Districts, Nebraska Public Power District, US Army Corps of Engineers, US Environmental Protection Agency, US Geological Survey, University of Nebraska-Lincoln, Lincoln-Lancaster County Health, Nebraska Game and Parks Commission, Nebraska Department of Agriculture, and others all contributed time, money, resources, and/or data to our water monitoring programs.

Many thanks.

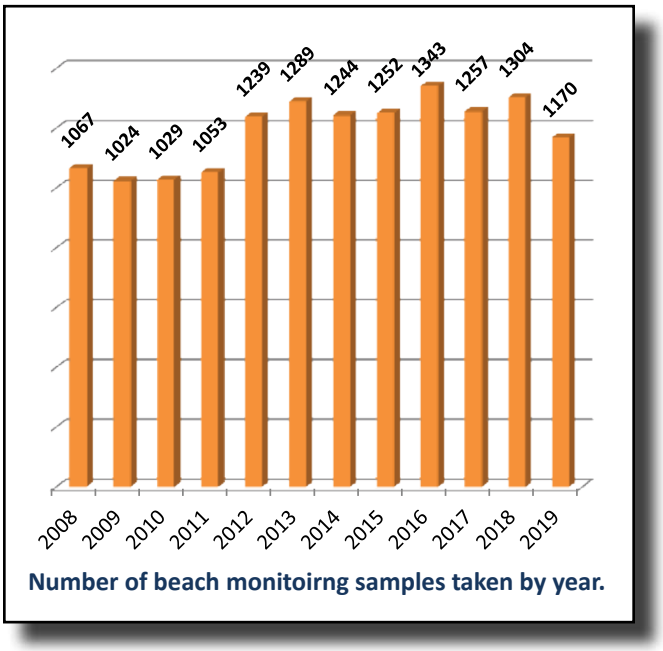
Public Beach Monitoring Program
Bacteria and Microcystin

Why Does NDEE Monitor Public Beaches?

Full contact recreation activities such as swimming, tubing, skiing, and jet skiing are popular pastimes at Nebraska's lakes and reservoirs. NDEE and its collaborators want to ensure that the users of these waters have access to the most current water quality information possible.

When and Where is the Monitoring Conducted?

Sampling for bacteria at Nebraska's beaches has been occurring for many years. Nebraska Game and Parks Commission initiated sampling at a number of locations in the 1970s. NDEE eventually took over the sampling program in the 1990s. In 2004, NDEE began sampling for the toxin, microcystin, after it was determined that high levels in some Nebraska lakes attributed to the deaths of several dogs that had ingested the water. In 2005, NDEE and its partners began a more comprehensive plan for collecting samples from publicly owned and operated lakes. Weekly sample collection of 54 sites from 51 lakes coincides with the recreation season (May 1 to September 30). Since the inception of NDEE's comprehensive beach monitoring program in 2005, nearly 15,000 samples have been analyzed for microcystin and *E. coli* bacteria. The Public Beach Monitoring Program also conducted a small pilot project evaluating five Public Water Supplies (PWS) for the microcystin toxin. These PWS were either obtaining water directing from a surface water source, e.g. a lake, or were classified as under the direct influence of a surface water source.



Number of beach monitoirng samples taken by year.

What is Monitored at the Beaches?

E. coli bacteria and harmful algae toxins, specifically microcystin, are monitored to give an indication of the quality of water at Nebraska swimming beaches.

E. coli bacteria are monitored to provide an "indirect" indication of potentially harmful (pathogenic) bacteria. While not all *E. coli* bacteria are considered a threat to human health, some bacteria strains are. The larger the population of *E. coli* bacteria measured, the greater are the odds of having harmful pathogenic bacteria. Using this rationale, the value of 235 colonies of *E. coli* bacteria per 100 ml of water is established as the upper limit for supporting full body contact recreation. Ingesting water with higher levels of *E. coli* bacteria may cause illness with most symptoms being exhibited within the intestinal tract. *E. coli* bacteria are primarily associated with animal and human waste. Animal sources of *E. coli* bacteria commonly enter our waters from livestock and wildlife wastes that runoff the landscape during significant rainfall events. Human sources of contamination can include improperly maintained septic systems and wastewater treatment facilities that discharge untreated wastewater.

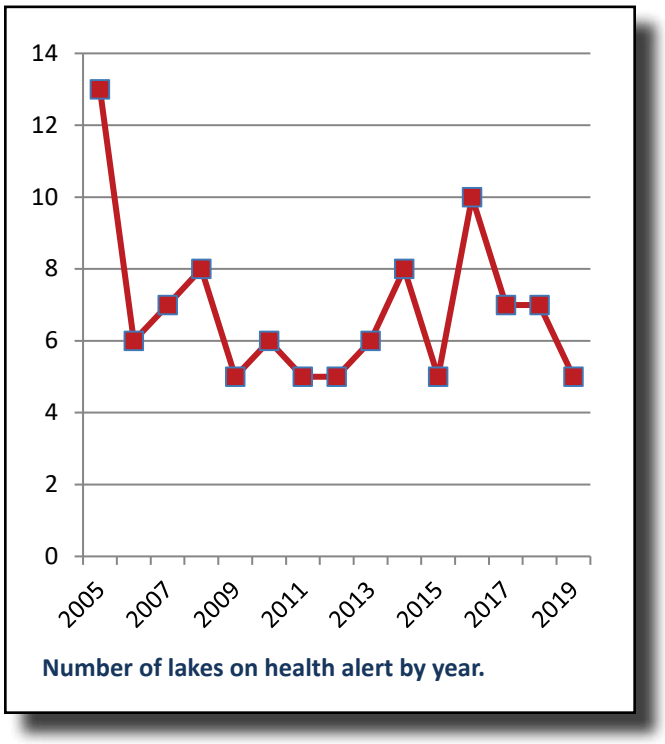
Preparing samples for microcystin analysis in NDEEs new micortiter plate format analyzer utilizing ELISA assays.

Harmful algal toxins, including microcystin, are produced by certain types of Cyanobacteria, commonly referred to as blue-green algae or harmful algal blooms (HABs). Microcystin in the water can cause skin rashes, lesions, and blisters on people who have been swimming or wading. If algal toxins are swallowed they can cause headaches, nausea, muscle or stomach pain, diarrhea, or vomiting. Though rare, severe cases can include seizures, liver or respiratory failure, or even death. A microcystin level of 20 ppb is established as the criterion for full body contact recreational activities. While not all types of cyanobacteria are toxic, the greater the population of cyanobacteria, the greater is the chance of having a harmful algal bloom. In the absence of direct microcystin toxin measurements, one should recognize a severe harmful algal bloom and treat it with caution. Blue-green algae often have a "John Deere green" or "pea green soup" color, appear as thick green paint or oil floating on the surface of the water, and usually have a strong septic odor.

How are the Data Used?

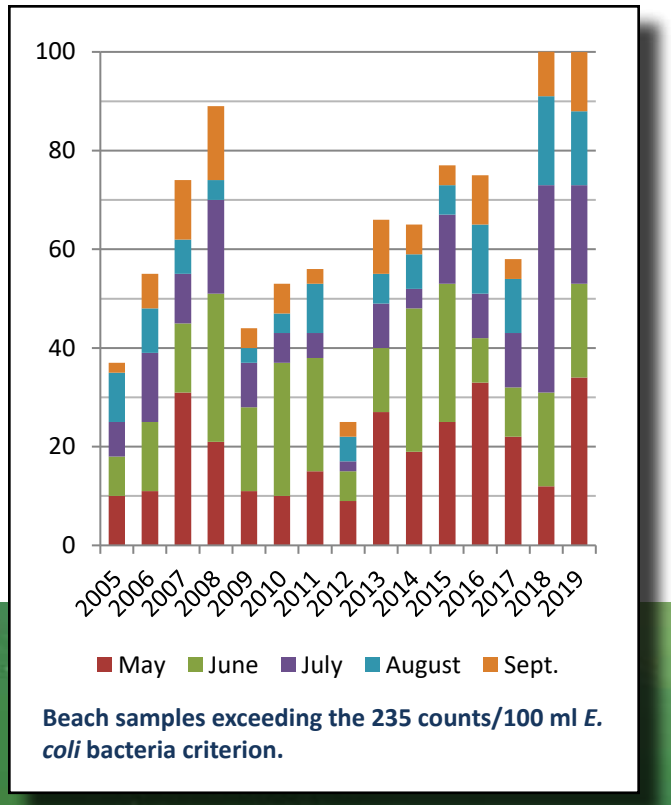
NDEE and its partners (typically local NRDs) collect the lake water sample at the beaches early each week. Because the sample collectors do their own bacteria analysis and NDEE analyzes the microcystin samples as opposed to sending them out to a contract lab, the results are quickly available and are posted on the Department's internet site by Thursday of the same week (http://dee.ne.gov). This schedule provides information to the public prior to the weekend, when they are more likely to be using the lakes.

When levels of microcystin exceed 20 micrograms per liter (µg/l, or ppb, parts per billion), the NDEE and lake manager issue a Health Alert. During a Health Alert at a public lake, signs are posted advising the public to use caution and avoid full body recreational activities such as swimming, wading, skiing, jet skiing, sailing and particularly avoid drinking the water. Affected swimming beaches are closed. Camping, picnics, boating, fishing, and other non-contact recreational activities are allowed. The lake remains on Health Alert until levels of microcystin are measured below the 20 µg/l criterion for two consecutive weeks. If one has prolonged contact with water suspected to have high levels of the microcystin toxin, it is recommended that they shower with fresh water as soon as possible.



Number of lakes on health alert by year.

In situations where *E. coli* bacteria exceed counts of 235/100ml of water for a single sample, the water is considered at a higher risk for illness when used for full-body contact recreation. Lakes that exceed this level are specifically identified on the NDEE's website weekly, in the Environmental Alerts section. Unlike with dangerous levels of HABs, signs are not specifically posted and beaches are not closed for high bacteria levels. This is primarily because bacteria values change quickly while microcystin levels are more persistent and can remain for several weeks. This bacteria information, rather, is provided to allow the public to make their own decision on whether or not to use the lake.



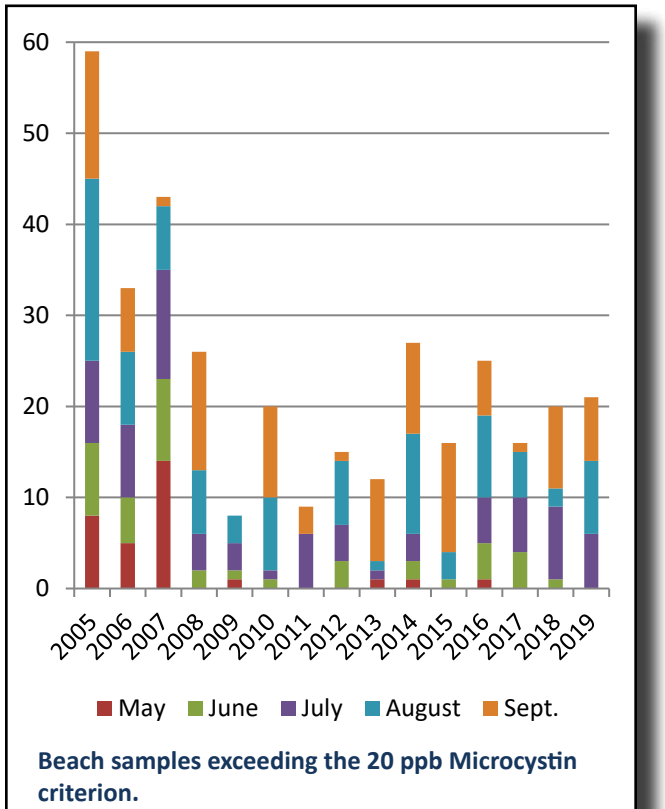
Beach samples exceeding the 235 counts/100 ml *E. coli* bacteria criterion.

Algal bloom in a Nebraska reservoir.

Guidance provided to assist the public in the decision making process includes:

- Assess the length of time from heavy rainfall to the time of use.
- Assess the condition of a lake and consider avoiding abnormally turbid waters.
- Consider chronic problems where bacteria levels are consistently high even in the absence of rainfall.
- Avoid activities which could result in a higher potential of swallowing lake water.
- When bacteria levels are high, shower after coming in contact with the water.
- Wash hands before eating if you have been in contact with lake water.

Lakes that repeatedly exceed the *E. coli* and microcystin water quality standard may be put on Nebraska's Clean Water Act 303d list of impaired waters.



Beach samples exceeding the 20 ppb Microcystin criterion.

2018 and 2019 Results

Over the two years, the Beach Monitoring program collected and analyzed almost 2500 samples for each *E. coli* and the microcystin toxin.

Bacteria

Of the bacteria samples taken and analyzed, 206 samples (8.3%) exceeded the 235 counts/100ml of water standard. In the adjacent figure, the number of samples that exceeded 235/100 ml criterion for bacteria by month for 2005 through 2019 is shown. This figure also provides the combined totals per month as well as per year. Note that most high levels occur in the spring and early summer months, in times of higher precipitation (and the associated higher run-off). Widespread heavy rain events in July 2018 and May 2019 led to higher than normal bacteria advisories in those months and a much high than normal total number of advisories for the two years.

Harmful Algal Blooms

Of the samples collected and analyzed for the microcystin toxin. 41 samples exceeded the 20 ppb threshold for issuing a Health Alert. This accounts for 1.7 % of the total samples collected. In 2018, seven lakes were placed on Health Alert. While in 2019, five lakes were placed on Health Alert. The map below shows the lakes that had samples exceed the 20 ppb health standard and the number of weeks they were under a Health Alert. The previous table illustrates the number of samples exceeding the 20 ppb microcystin criterion monthly for 2005 through 2019. It also shows the totals for each year as well as for each month through the years. Unlike with bacteria where high levels are more frequently observed in the springtime, HAB (microcystin) impacts are usually observed later in the summer, after lake water has warmed and algae growth is more significant.

In general, algae production is affected by temperature, sunlight, and the nutrients of nitrogen and phosphorus.

Why are there problems at some lakes and not others?

Biological communities such as algae are very complex systems and are affected by many variables. The HAB issue gets even more complicated as some species of blue-green algae sometimes produce toxins while other times do not. Research is being conducted worldwide to answer these questions. Additionally, NDEE is working with numerous collaborators to determine what factors are driving the growth of blue-green algae in Nebraska reservoirs and lakes. Certain conditions seem to consistently have significant effects.

The following conditions are often associated with harmful algae blooms:

- General weather of each year including the temperature, amount of sunlight and rainfall;
- Low lake water levels. During drought years, problems seem to be more frequent; and
- Increased cloud cover which implies reduced sunlight and lower water temperatures.

Harmful algal blooms during 2005 were significantly worse when compared to the other years. 2005 was characterized by lower rainfall, higher temperatures and was toward the end of a major drought. In general, lake levels were significantly lower across the state. 2018 and 2019 were “average” years when assessed for HABs.

The issue of HABs and its causes are quite complex, it is easier to understand by reducing the problem to simpler terms. In general, algae production is affected by temperature, sunlight and the nutrients of nitrogen and phosphorus. Higher temperature, sunlight, and excess nutrients result in greater blue-green algae production and therefore, a greater chance for HABs to become problematic. While temperature and sunlight are beyond our control, we can reduce the amount of nutrients reaching rivers, streams, and lakes. Any management practice that can be incorporated in a watershed that reduces these inputs into waters will reduce algae production and therefore the potential for HABs to occur.

More Information:

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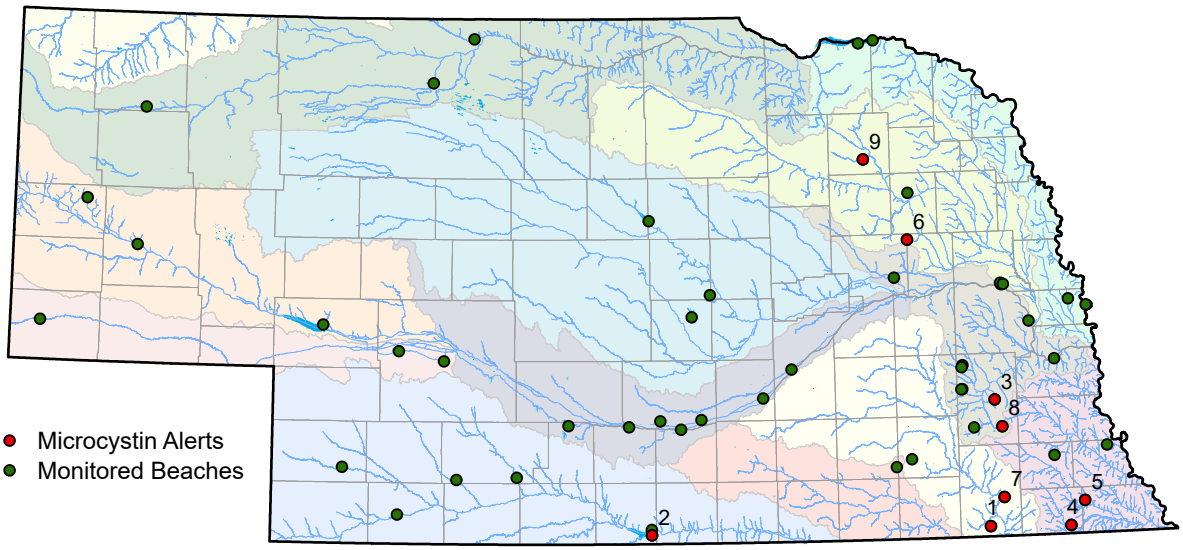


Public beaches monitored and those with microcystin alerts in 2018 and 2019. Numbers correspond to the table below.

Map #	Waterbody	County	Samples Exceeding Health Limit	Weeks on Health Warning
1	Big Indian Creek Lake @ South Beach	Gage	1	2
2	Harlan County Reservoir @ SE Beach	Harlan	1	2
3	Holmes Lake @ North Shore	Lancaster	1	2
4	Iron Horse Trail Lake @ Beach	Pawnee	4	5
5	Kirkman's Cove @ North Beach	Richardson	5	9
6	Maple Creek SRA @ Beach	Colfaz	2	4
7	Rockford Lake @ SW Beach	Gage	8	14
8	Wagon Train Lake @ Swimming Beach	Lancaster	8	10
9	Willow Creek Lake @ South Beach	Pierce	10	16

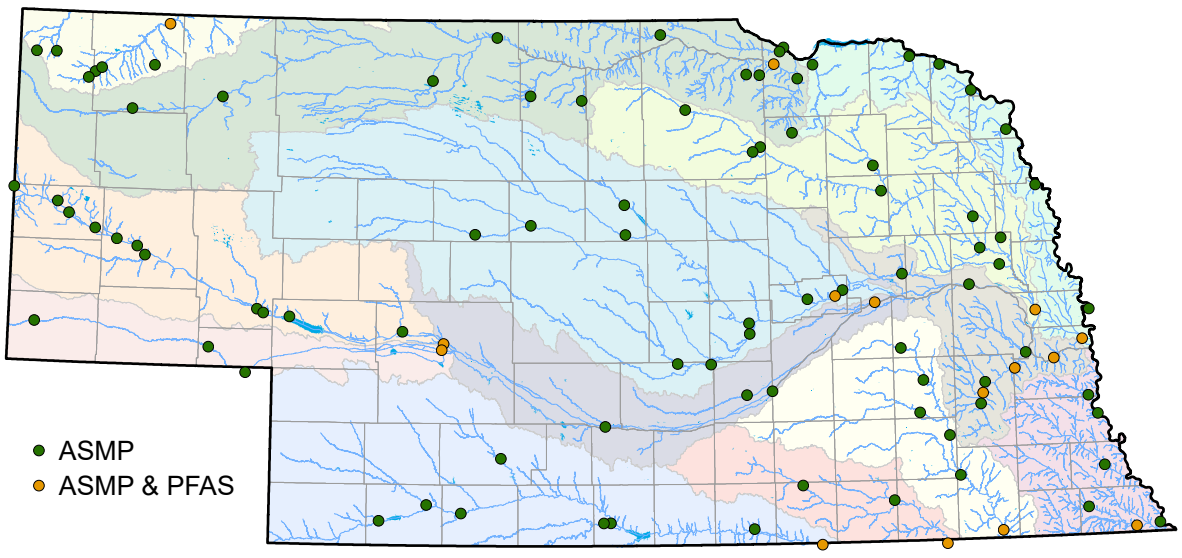
Ambient Stream Monitoring Program

Why Does NDEE Monitor Streams?

Nebraska's streams and rivers provide essential resources to the residents of our state. These streams supply irrigation and drinking water, support diverse fish and wildlife communities, offer numerous recreational opportunities, and are integral to the state's industry and electricity production. However, many of these streams also serve as conveyances to dispose of agricultural, industrial, and municipal wastewater and runoff. Assuring that Nebraska's streams can safely support these numerous, and at times, conflicting uses is the responsibility of the NDEE.

Collecting field measurements from the Platte River east of Grand Island, Merrick County.

Regular stream monitoring allows NDEE to determine if water quality conditions meet state and federal standards to safely support the assigned designated uses. If the monitoring data indicate a water quality problem, NDEE uses these data to locate potential pollutant sources and develop point and non-point source pollution control plans. Regular monitoring also allows NDEE to recognize trends in stream water quality that may lead to more efficient and effective pollution controls. Finally, NDEE uses stream monitoring data to generate a portion of the Water Quality Integrated Report to submit to the United States Environmental Protection Agency, as required by the federal Clean Water Act. This report is submitted in April of even numbered years and is used by NDEE as part of the prioritization process for the development of pollution control or watershed management plans.



Locations of Ambient Stream Monitoring Program sites and sites with PFAS sampling.

Where and When is the Monitoring Done?

The Ambient Stream Monitoring Program (ASMP) consists of 101 fixed monitoring sites designed to collect data from all 13 of Nebraska's major river basins. Samples are collected from each site on the first week of each month, year-round with monitoring assistance provided by the US Army Corps of Engineers (USACE) and South Platte and Middle Niobrara NRDs. The map on the previous page shows the locations of the 101 monitoring sites sampled as part of the 2018 and 2019 ASMP network.

How were the Monitoring Sites Selected?

Nebraska's ASMP was designed to evaluate surface water quality in each of the State's 13 major river basins. To achieve this goal, the 13 major basins were subdivided by geology, land-use, soil type, and topography. Three types of monitoring sites were then established in each basin: indicator sites, stream integrator sites, and basin integrator sites. Indicator sites are located on streams that drain areas of homogenous land-use, soil type, and geology, and provide background water quality information for the predominant ecoregions of each basin. Stream integrator sites are located at key intersections in the drainage network so that the most significant tributaries or contaminant sources in a basin are sampled by at least one of these sites. Basin integrator sites are located at the bottom of each major basin and provide insight into the water quality of the entire river basin.

What is Monitored?

NDEE monitors numerous water quality parameters to establish general water quality trends and to ensure each stream is able to support its designated uses. The following parameters are collected at each site every month:

- water temperature
- dissolved oxygen
- pH
- conductivity
- total suspended solids
- ammonia
- nitrate/nitrite nitrogen
- kjeldahl nitrogen
- total phosphorus
- chloride
- *E. coli*

Collecting field measurements from the Platte River at Louisville, Cass/Sarpy County.

In addition, atrazine samples are collected at all sites from May through September. Arsenic, selenium, calcium, magnesium, and sodium are collected at all sites quarterly, as are a complete suite of metals at each basin integrator site.

In 2019, per- and polyflouroalkyl substances (PFAS) sampling was conducted in May at all basin integrator sites as well as those ASMP stream sites located in urban areas to obtain baseline data of these substances for rivers and streams in Nebraska (see map). PFAS are a group of man-made chemicals that includes PFOA, PFOS, GenX, and many other chemicals. PFAS have been manufactured and used in a variety of industries around the globe, including in the United States since the 1940s. PFOA and PFOS have been the most extensively produced and studied of these chemicals. Both chemicals are very persistent in the environment and in the human body – meaning they don't break down and they can accumulate over time. There is evidence that exposure to PFAS can lead to adverse human health effects.

Additionally, monthly sampling for sulfate began in October 2019 at all 101 sites. Prior to this, sulfate sampling only occurred at monitoring locations on the Missouri River and was conducted by the U.S. Army Corps of Engineers and the U.S. Geological Survey. NDEE's data assessments determined the Drinking Water designated use at six of those sites to be impaired for sulfate. The data also indicated that sulfate levels and the number of violations of the drinking water standard have been increasing over time with a sharp increase in violations beginning in 2014. In order to determine the source of the sulfate pollution, the Department has initiated sampling in all thirteen river basins within Nebraska.

Filtering water sample to be analyzed for various heavy metals.

History of the Ambient Stream Monitoring Program

NDEE has maintained a network of stream monitoring sites since the inception of the agency in 1971. In the early 1970s, 365 sites were monitored on a quarterly basis to gather baseline data on streams where there was limited information. In 1978, the program was reorganized to consist of 90 sites that were monitored monthly. The program was again restructured in 2001 to a network of 97 sites and sampling has been conducted monthly at each of these sites ever since. Additional changes to the ASMP network were made in 2016 when four sites were added to the network, bringing the total number of sites sampled to 101. During 2019, approximately 1,212 water quality samples were analyzed for the 32 monthly parameters collected for this program.

More information about all surface water impairments is available in the 2016 Water Quality Integrated Report. This report combines the Clean Water Act 303(d) impaired waters list with the 305(b) summary of the health of Nebraska's surface waters. This report is available on NDEE's website at http://dee.ne.gov or directly at http://dee.ne.gov/publica.nsf/pages/WAT234

Sample container for *E. coli* bacteria.

More Information:

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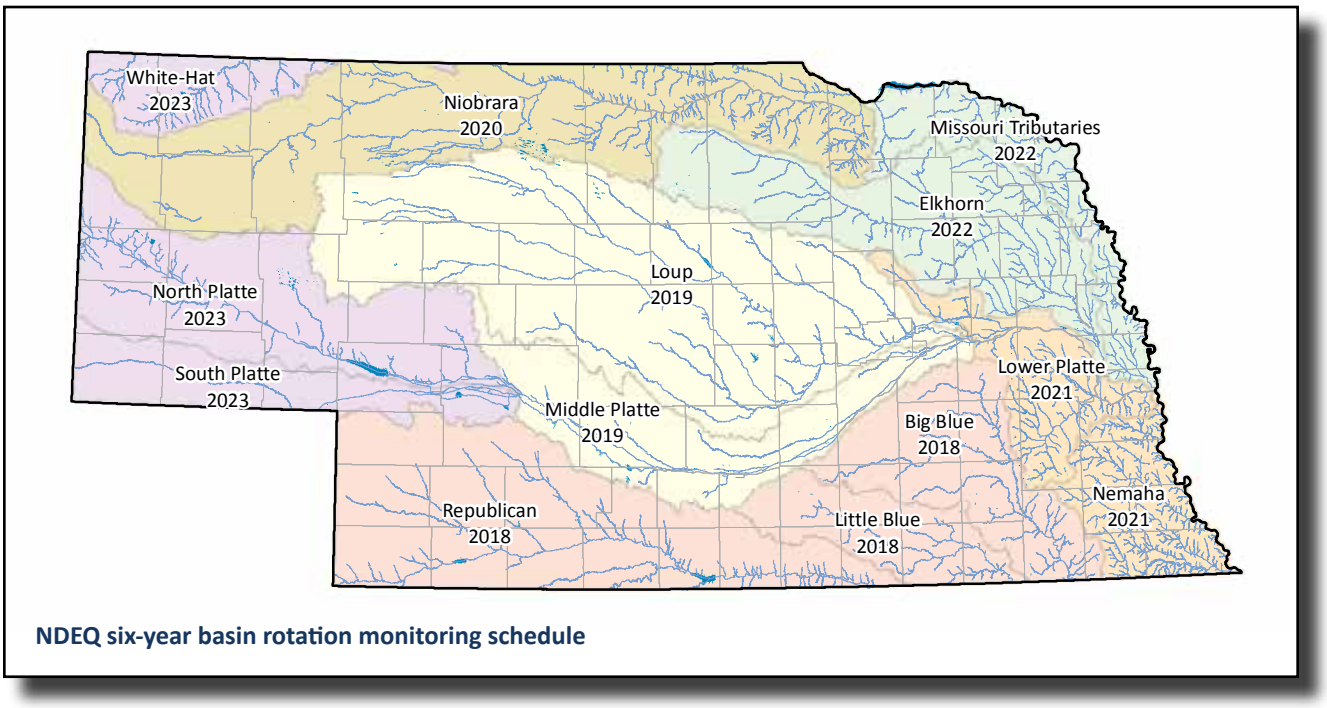
Basin Rotation Monitoring Program

Why Does NDEE Conduct Basin Rotation Monitoring?

A goal of the federal Clean Water Act is that each state assess the water quality of "all navigable waters of the State". In Nebraska, this means assessing nearly 17,000 miles of perennial streams and rivers, and more than 134,000 acres of lakes and reservoirs. These water quality assessments are used to determine if the sampled waterbodies are safe for recreation and if they can support aquatic life and industrial or agricultural uses. If the data shows that a waterbody cannot support all of its designated uses due to pollution, NDEE begins a process to determine the source of the pollution and develop a pollution control strategy. This process can be both time consuming and costly, so it is imperative that NDEE has sufficient data about a waterbody before it makes a determination on the water quality. The Basin Rotation Monitoring Program (BRMP) was developed so that NDEE can work towards the goal of assessing all waterbodies within the state, while at the same time, insuring sufficient data is collected to determine if a waterbody is impaired by pollution. By focusing sampling efforts in 1-3 river basins each year for intensive monitoring, NDEE can collect enough water quality samples to perform accurate assessments, while at the same time, collect data from many waterbodies because of the reduced size of the sampling area.

Where and When is the Monitoring Done?

Monitoring is done on a six-year rotation in the 13 major river basins in the state. Monitoring in each basin, during its rotation year, is conducted on a weekly basis from May 1 through September 30. In 2018, a total of 39 streams were sampled in the Big Blue, Little Blue and Republican River basins with monitoring assistance provided by the South Platte NRD. In 2019, 37 streams were sampled in the Middle Platte and Loup basins with monitoring assistance provided by the Lower Loup and Upper Loup NRDs. This sampling resulted in 858 water quality samples being collected in 2018 and 814 samples collected in 2019 of which all samples were analyzed for 15 parameters. The map below shows the basins and their rotation schedule.



NDEQ six-year basin rotation monitoring schedule

Collecting water samples from the West Fork Maple Creek, Colfax County.

How are the Monitoring Sites Chosen?

One of the primary objectives for the BRMP is the protection of public health. To meet this objective, NDEE aims to assess 100% of the stream segments and public lakes that support primary contact recreation (swimming and wading). For this reason, the majority of monitoring sites in this program have been designated for recreation.

What is Monitored?

NDEE monitors a suite of water quality parameters to establish general water quality trends and to ensure each stream is able to support its designated uses. The following parameters are collected at each stream site: ammonia, nitrate-nitrite, kjeldahl nitrogen, total phosphorus, chloride, total suspended solids, stream discharge and atrazine. Water temperature, pH, conductivity, dissolved oxygen, turbidity and *E. coli* bacteria are collected at both stream and lake sites.

Impairments and Sources

According to the 2018 integrated report, *E. coli* is the most common water quality impairment. *E. coli* samples are collected from water bodies used for recreational uses such as swimming and boating. *E. coli* in surface water can cause gastrointestinal problems if swallowed. *E. coli* exists naturally in the environment and can become elevated in lakes and rivers from runoff following a rainfall event. A few sources of *E. coli* include wildlife and livestock feces and failing septic systems. The herbicide atrazine is the second most common impairment detected. Atrazine is a widely used herbicide that is commonly applied in the spring when rain events can cause cropland runoff to enter nearby streams and rivers.

Data from the BRMP are combined with the Ambient Stream, Ambient Lake and other surface water monitoring programs to make up the data package used for all assessments of the status of Nebraska's waters.

More Information

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Obtaining field measurements with a multi-parameter meter in the Elkhorn River, Holt County.

Stream Biological Monitoring Program

Why Biological Monitoring?

Nebraska has over 81,000 miles of streams of which nearly 17,000 miles flow continuously. Streams in Nebraska are capable of containing a rich diversity of aquatic life including aquatic macroinvertebrates (i.e. small animals living in water that can be seen with a naked eye), fish, amphibians, and mammals. Nitrogen, phosphorus, pesticides, sediment, and other pollutants are stressors that can degrade stream conditions for aquatic life, and can be potentially harmful to people. The aim of the Stream Biological Monitoring Program (SBMP) is to provide accurate statewide assessments of the biological conditions of Nebraska's streams so that sound decisions in management, planning, and regulation can be made.

Collecting field parameters at Dane Creek, Valley County.

History of the Stream Biological Monitoring Program

NDEE began biological monitoring in 1983 with a targeted approach for classifying stream segments for Title 117 (Nebraska Surface Water Quality Standards). These sites were typically located at stream bridge crossings. Over 900 stream sites were sampled for fish and macroinvertebrates over a 14 year period. In 1997, the Department added a probabilistic monitoring design that involved the sampling of randomly selected sites in order to address statewide and regional questions about water quality. Data to answer such questions as "How good is the water quality in Nebraska?" are best obtained such that all streams have an equal chance of being sampled.

Where is the Monitoring Conducted?

Each year, 33-40 randomly selected wadeable stream sites (i.e. streams that are shallow enough to sample without boats) are chosen for study in one to three river basins throughout Nebraska. During a six-year cycle, all 13 major river basins in the state are intensively monitored (see previous map on page 9).

What is Monitored?

The "health" of a stream depends not only on the contaminants present or absent, but the quality of the habitat and the creatures living there. NDEE's SBMP assesses the health of streams by evaluating the composition and numbers of resident aquatic macroinvertebrate and fish communities. Assessments are made by comparing the macroinvertebrate and fish communities at "reference condition" streams where there are no significant disturbances, to the communities collected from the randomly selected stream sites.

Aquatic Macroinvertebrates

Aquatic macroinvertebrates are small creatures that live in streams attached to rocks, vegetation, woody debris, or burrowed into the stream bottom. They include aquatic larval stages of insects such as mayflies and dragonflies; crustaceans such as crayfish, as well as worms, clams, and snails. Because they may be extremely sensitive to pollutants, macroinvertebrate populations often respond to changes in water quality caused by the introduction of various contaminants into the stream. Department personnel have collected nearly 600 different species of macroinvertebrates since 1997 through the sampling effort associated with the SBMP. In addition, numerous new species not previously found in Nebraska have been recorded.

Collecting macroinvertebrates from Larabee Creek, Sheridan County.

Fish

From small coldwater trout streams to large warm rivers, Nebraska streams support more than 80 species of fish. As with macroinvertebrates, fish display varying habitat requirements and water quality tolerances making them excellent indicators of stream health. The majority of Nebraska's species are small, with adults generally less than five inches long. The Department's fish surveys have also provided information on changing abundances and ranges of fish in the state. Some species occur in many more places than previously thought, while others have shown dramatic declines over the last 30 years.

Fish collected from the South Platte River, Deuel County.

How are the Data Used?

The biological data collected through the SBMP are used to inform a variety of management activities, such as:

- Documenting current statewide biological conditions in Nebraska's streams to track water quality status and trends.
- Identifying streams that do not attain their assigned environmental goals and are in need of restoration or remedial action. Where significant problems were found (i.e. streams were assessed as having poor biological conditions), these stream segments are placed on the 303(d) List of Impaired Water Bodies (as required by the federal Clean Water Act) with regard to aquatic life.
- Identifying exceptional stream segments (reference conditions).
- Providing accurate biological distribution information.
- Serves as a benchmark to measure best management practice success.

Results

Biological data from 459 random sites were used to characterize the condition of wadeable streams in the 13 major river basins in Nebraska (see bar graph). The results of the survey show the North Platte and Niobrara Basins are in the best condition of the basins evaluated with 59% and 47% of the streams in good condition, respectively. The streams in the Lower Platte Basin present the most concerns with only 14% of the streams in good condition and 42% of the streams in poor condition.

The Wadeable Streams Assessment done in 2004-2005 by EPA reported that increases in nutrients (e.g., nitrogen and phosphorus) and streambed sediments have the highest negative impact on biological condition. These contaminants are commonly introduced into the streams by non-point source pollution from agricultural practices such as crop production and livestock operations and by point source pollution such as discharge from sewage treatment facilities. Analyses within Nebraska have shown that the loss of quality habitat is a very strong stressor on aquatic communities, as is excess sedimentation that accompanies human activities in watersheds.

2018 & 2019 Update

Although NDEE targets ~34 sites for biological sampling per year, the Department only able to collect from 26 sites in 2018 and 10 sites in 2019 due to conflicts with the National Rivers and Streams Assessment sampling and record statewide flooding. NDEE sampled nine sites from the Big Blue basin, five sites from the Little Blue basin, 12 sites from the Republican basin, six sites from the Loup basin, and four sites from the Middle Platte basin. The macroinvertebrate data is still be assessed. The fish assemblages were dominated by sand shiners, red shiners, fathead minnows, creek chubs, and white suckers, as is typical for Nebraska streams. In addition, NDEE added a new species record for the state: bullhead minnows were collected from the Little Blue River in 2018.

More Information:

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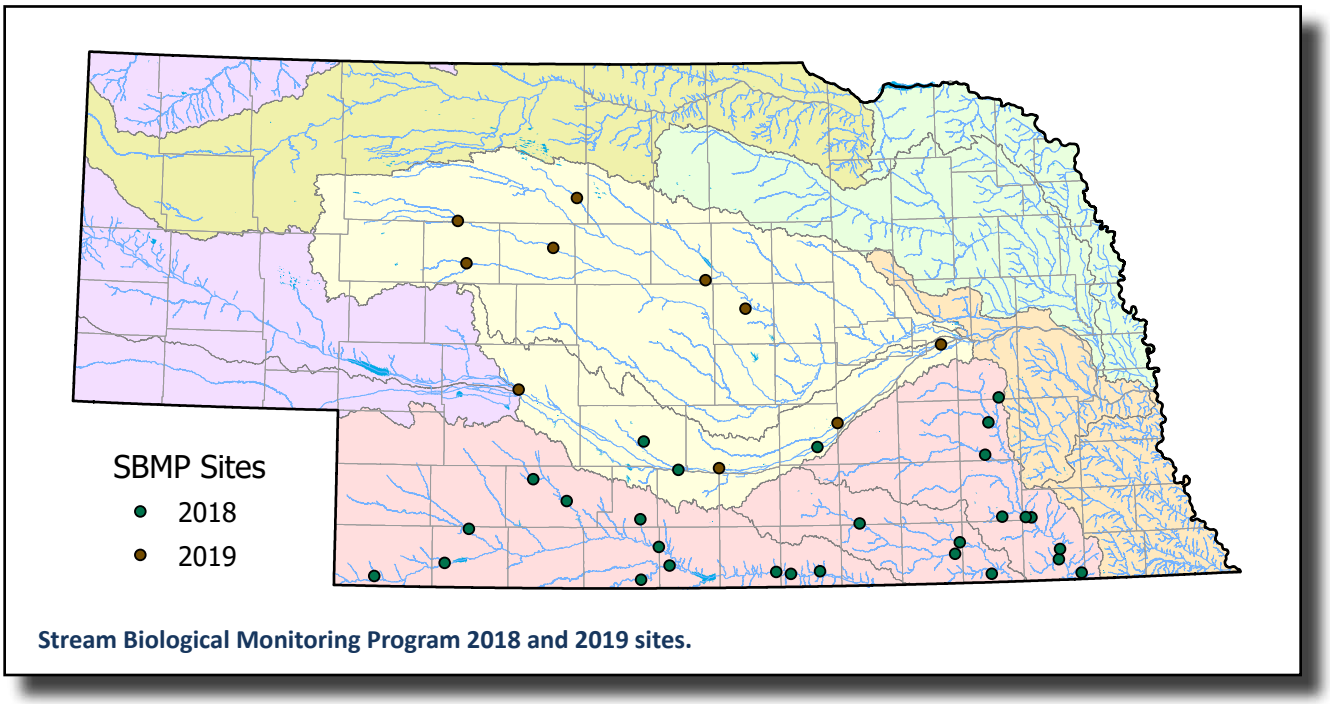


Stream Biological Monitoring Program 2018 and 2019 sites.

Ambient Lake Monitoring Program

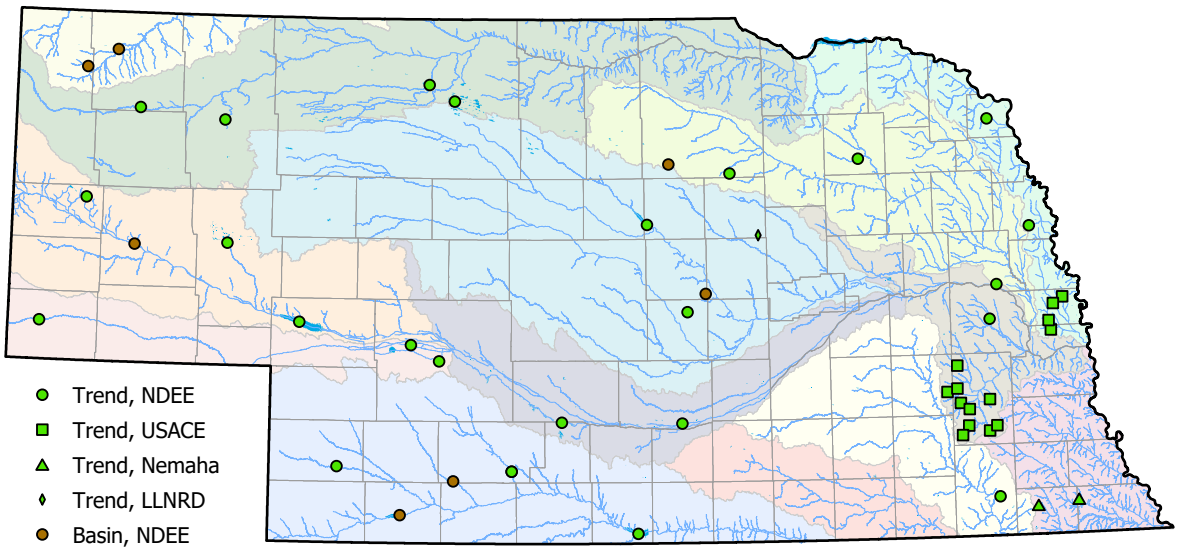
Why Monitor Lakes and Reservoirs?

Nebraska's natural lakes and man-made reservoirs have different public usage throughout the year. NDEE monitors these resources to determine if water quality is sufficient for recreational activities such as swimming and water skiing, and suitable for fish and other aquatic organisms to survive and reproduce.

Monitoring involves the collection of monthly water samples from May through September from publicly owned lakes and reservoirs across the state. In some cases, the streams that flow into reservoirs are also monitored. Since reservoirs are a reflection of their watersheds, data on streams that flow into reservoirs can provide useful information in evaluating water quality problems.

Sample set collected from Lake McConaughy, Keith County.

In 2018 and 2019, 43 lakes were sampled for physical/chemical parameters by NDEE and its lake monitoring partners which include the US Army Corp of Engineers (USACE) and the Nemaha Natural Resources District (NRD). Sampling was discontinued at Box Butte Reservoir and Pelican Lake in 2018 due to renovations. Because of catastrophic flooding in early 2019, sampling was affected and/or completely discontinued at a number of lakes including: Fremont Lake #20 (discontinued - flooding), Pibel Lake (discontinued in June – outfall maintenance), Box Butte Reservoir (discontinued), and Goose Lake (affected May and September – flooding).



Lake sampling locations for 2018 and 2019 (does not include fish tissue sites).

What is monitored?

To determine if water quality is sufficient to meet its intended uses in these lakes, samples are taken monthly near the surface at the deep water site (deepest area) of each lake. These sites are sampled for physical/chemical parameters such as water temperature, dissolved oxygen (DO), pH, conductivity, water clarity, total suspended solids, ammonia, nitrate-nitrite nitrogen, kjeldahl nitrogen, total and dissolved phosphorus, alkalinity, chlorophyll a, and select pesticides. In addition, surface to bottom profiles are collected for temperature, DO, pH, and conductivity. Profile data is collected every 0.5 meters starting at the water surface and are used to determine at what depth lake stratification may take place. An additional profile is also collected at a location approximately in the middle of the lake and is considered a mid-lake site.

Determining water clarity at Merritt Reservoir, Cherry County.

Measuring field parameters at Crescent Lake, Garden County.

Filter disc for chlorophyll analyses.

How are the Data Used?

Collected data are compared to a water quality standard or a benchmark that will indicate if there is a concern. For most parameters, a minimum number of violations or excursions will be allowed before the waterbody is considered to be impaired or not to have sufficient quality. If a waterbody is considered to be impaired, it will be placed on Nebraska's Section 303(d) List of Impaired Waters. Once on this list, more information is collected to develop water quality targets and pollutant reduction goals. These targets and reductions are incorporated into a document called a Total Maximum Daily Load (TMDL). The TMDL then provides the basis for water quality improvement projects sponsored by various resource management and funding agencies such as Natural Resources Districts, municipalities, Nebraska Game and Parks Commission, and USDA-Natural Resources Conservation Service to name a few. While the Section 303(d) list is revised every two years, assessments on each lake or reservoir are conducted on an annual basis. Results of the assessments are presented in the Water Quality Integrated Report that is prepared by NDEE on even numbered years. The 2018 report is available on-line at http://dee.ne.gov/NDEQProg.nsf/OnWeb/TMDL.

Statewide Concerns

Nutrients and algae related issues are the most common lake impairments. Excessive algae growth can increase the pH of the water which can make some things, like ammonia, more toxic to aquatic organisms. Excessive nutrients can also lead to blooms of blue-green algae and high concentrations of microcystin, which is a toxin produced by this algae.

The accumulation of contaminants in the tissue of fish is a growing concern across the country. Approximately 35 percent of the lakes assessed had unacceptable concentrations of contaminants in fish tissue (see "Fish Tissue Monitoring" section of this report). In most cases, the impairments were due to mercury which is believed to be entering lakes through atmospheric deposition.

Filtering water for a dissolved phosphorous sample at Lake Wanahoo, Saunders County.

Lake Improvement Programs

When water quality programs were first initiated at NDEE, most efforts were aimed at reducing the impacts of point source discharges. From the early 1970s through the present, lake and reservoir management has evolved to include nonpoint sources. Several programs administered by NDEE, as well as other local, state, and federal programs, work to protect impounded waters. Some of the programs administered by NDEE that are protective of the quality of impounded waters include Livestock Waste, Wastewater, Storm Water, and Nonpoint Source.

Numerous agencies, including local, state, and federal, are involved in different aspects of lake and reservoir management whether it be the collection and/or assessment of data, water quality planning, or implementing projects to address water quality problems. The coordination of efforts among these entities has allowed for a more comprehensive and cost effective approach to lake and reservoir management.

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Carter P. Johnson Lake, Dawes County.

Fish Tissue Monitoring Program

Why NDEE Does this Monitoring

Each year fish samples are collected from numerous streams and lakes across Nebraska to determine their suitability for human consumption. This is important because certain contaminants have a tendency to bio-concentrate in fish tissue and, when eaten, can cause an increased risk for human health problems. In waterbodies where contaminant levels in fish are of concern, "fish consumption advisories" are issued. These advisories do not ban the consumption of fish from a particular waterbody. Rather, advisories are designed to inform the public of how to safely prepare and eat what they catch, and provide suggested guidelines for limiting consumption. As a food source, fish are a high quality protein, low saturated fat, and high omega-3 fatty acid food source, so anglers should not be discouraged from consuming fish in moderation.

History of Fish Tissue Program

Fish tissue sampling in Nebraska was initiated in the late 1970s, primarily to identify potential pollution concerns throughout the State. Monitoring efforts were focused on whole fish samples collected on large rivers near the bottom of their drainage areas. In the late 1980s, more emphasis was placed on evaluating human health concerns and the Department began analyzing the fillet portions from fish that are most-often consumed. These efforts have continued to the present day.

Where is the Monitoring Conducted?

Monitoring is generally conducted at locations where most fishing occurs; therefore, where the potential risk to human health is greatest. Fish species targeted for collection include those that are most frequently sought by fisherman. They include, but are not limited to: catfish, largemouth bass, walleye, white bass, bluegill, crappie, and carp. From July 1 to September 30 each year, the Department collects fish samples from approximately 40-50 pre-selected streams and publicly owned lakes in one to three of Nebraska's 13 major river basins (see map and table on the following pages for historic sampling locations and information). Fish tissue sampling activities are rotated through all 13 basins on a six-year cycle. In 2018 and 2019, a total of 231 fish tissue samples were collected from 14 streams and 103 lakes throughout the Republican, Little Blue, Big Blue, Middle Platte and Loup River basin's for analysis of contaminants.

Fish collected at Iron Horse Trail Lake, Pawnee County.

What is Monitored?

Currently, the primary pollutant of concern in fish tissue is methyl mercury, but a few locations remain under advisory for polychlorinated biphenyl compounds (PCBs). Information for these pollutants and sites targeted for screening are as follows:

- Fish samples from all waterbodies are screened for *methyl mercury* (organic mercury) – it can occur naturally, but it is also released into the environment from mining operations, fossil fuel combustion, refuse incineration, and industrial waste discharges.
- Only waterbodies currently under advisory for *polychlorinated biphenyl compounds* (PCBs) are screened for this pollutant – prior to 1971, they were used in heat transfer fluids, hydraulic fluids, lubricants, and wax extenders, and later in electrical transformers and capacitors.

Fish tissue sample preparation at Zorinsky Lake, Douglas County

Like other states across the nation, mercury is responsible for the majority of our fish consumption advisories (>95%). Locations where other contaminants are of concern will be given special consideration for additional contaminant analysis.

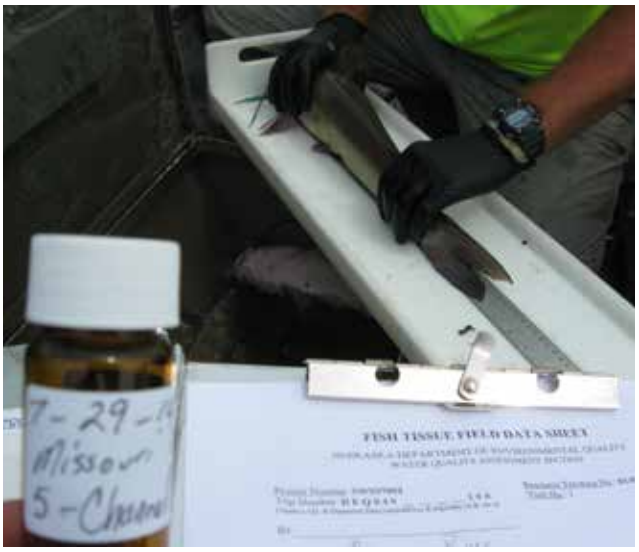
How are the Data Used?

Fish tissue data collected are used to assess human health risks utilizing a risk-based assessment procedure. For non-cancer (noncarcinogenic) effects, the assessment procedure results in a *Hazard Quotient* (HQ) value for each contaminant and takes into account an average adult body weight, ingestion rate, exposure frequency and duration, and percent absorption of contaminants. If more than one contaminant is present in the fish tissue, then the HQs are summed to derive a Hazard Index (HI). If the HI is less than 1.0, then adverse noncarcinogenic effects are not anticipated. If the HI equals or exceeds 1.0 then an advisory is issued.

For a contaminant that may also be associated with a cancer risk, the risk-based assessment procedure results in a *Cancer Risk* (CR) estimate that represents the probability of an individual developing cancer during their lifetime as a result of exposure to the potential carcinogen. If more than one potential carcinogen is present in fish tissue then the risk estimates are summed. Advisories are issued if the estimated CR equals or exceeds 0.0001 (1 in 10,000).

While mercury (methylmercury) is a contaminant accounted for in the HI, Nebraska also utilizes a fish tissue residue criterion (TRC) in place of a water column criterion for the protection of human health. Nebraska's TRC represents the mercury (0.215 mg/kg) concentration in fish tissue that should not be exceeded on the basis of a consumption rate of eight ounces (0.227 kg) per week. Advisories are issued if the mercury concentration in fish tissue equals or exceeds the TRC of 0.215 mg/kg. Exposure to high levels of mercury have been shown to adversely affect the developing nervous system, so women of child-bearing age, pregnant women, and children less than 15 years of age are the most sensitive to the effects of mercury.

Currently the Nebraska Department of Health and Human Services (NDHHS), in cooperation with the NDEE, the Nebraska Game and Parks Commission (NGPC), and the Nebraska Department of Agriculture (NDA), issues fish consumption advisories for waterbodies where high concentrations of contaminants may indicate a health risk for consumers. Waterbodies where sampling has revealed exceedances of health risk criteria and subsequent consumption advisories have been issued will be re-sampled following the six-year rotating basin monitoring approach. Re-sampled sites will be removed from the advisory list if their respective samples indicate contaminant levels below health risk criteria.

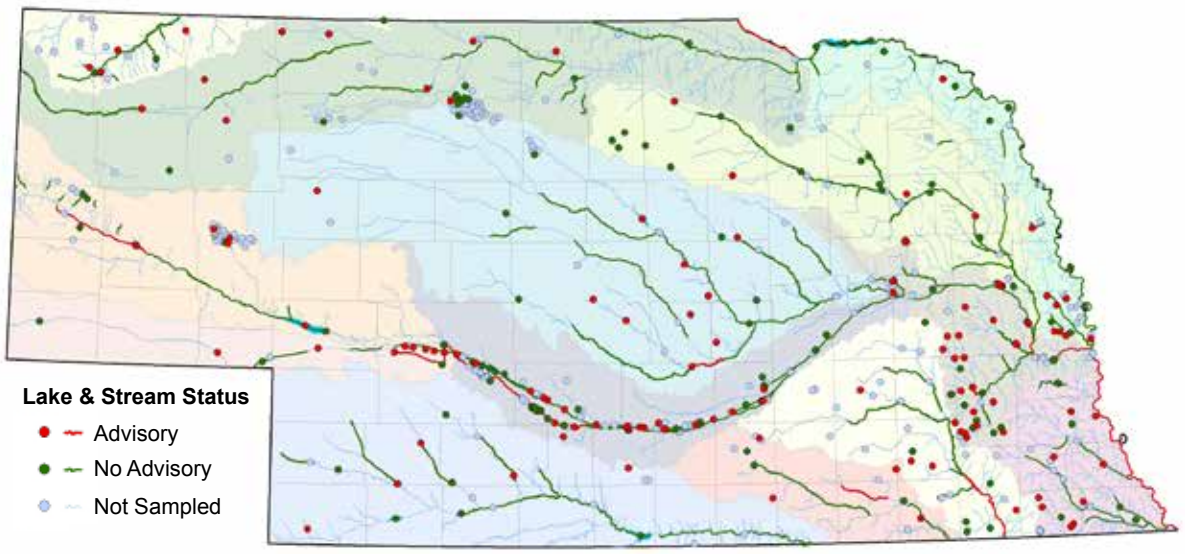


Fish tissue sample preparation.

Fish tissue data are also utilized to assess impairment of Nebraska's waterbodies. Where fish consumption advisories exist, the NDEE places those waters on the State's Section 303(d) List of Impaired Waterbodies with regard to aquatic life. Nebraska does not have an assigned beneficial use of "fish consumption" in Title 117 Surface Water Quality Standards, therefore the assumption is made that if contaminant loads to fish can affect human health, it is probable that these contaminants can impact aquatic life health.

Current Advisories

As of July 2018, the NDHHS, in cooperation with the NDEE, the NGPC, and the NDA, has issued fish consumption advisories for 143 waterbodies, which includes 11 designated stream segments and 132 lakes/reservoirs. These advisories are not bans on eating fish, rather a warning to limit the consumption of specified fish. The map below and following table display advisory locations and information.



Current advisories and historical sample locations.

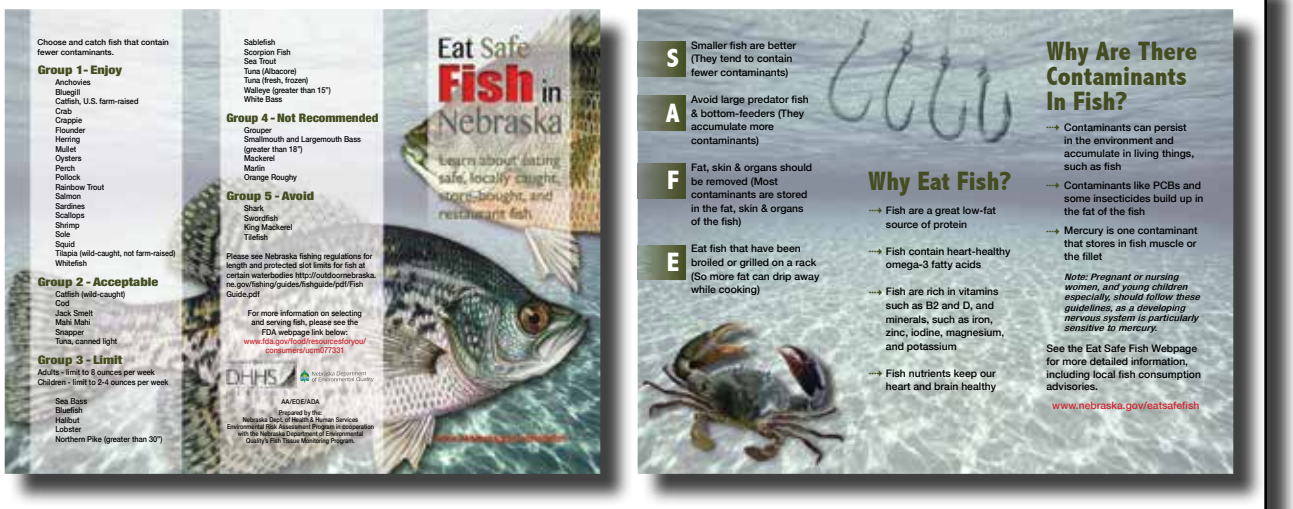
Nebraska Fish Consumption Advisories Through 2018

WATERBODY	COUNTY	FISH SPECIES	PRIMARY POLLUTANT(S) OF CONCERN
Lake Hastings	Adams	Common Carp	PCBs
Bassway Strip Lake No. 5	Buffalo	Largemouth Bass	Mercury
Blue Hole Lake - WMA	Buffalo	Largemouth Bass	Mercury
Coot Shallows Lake - WMA	Buffalo	Largemouth Bass	Mercury
Cottonmill Lake	Buffalo	Largemouth Bass	Mercury
Kea Lake	Buffalo	Largemouth Bass	Mercury
Kea West Lake - WMA	Buffalo	Largemouth Bass	Mercury
Ravenna Lake	Buffalo	Largemouth Bass	Mercury
Sandy Channel Lake - SRA	Buffalo	Largemouth Bass	Mercury
South Loup River	Buffalo	Channel Catfish	Mercury
Union Pacific Lake - SRA	Buffalo	Largemouth Bass	Mercury
War Axe Lake -SRA	Buffalo	Smallmouth Bass	Mercury
Yanney Park Lake	Bufflalo	Largemouth Bass	Mercury
Summit Lake	Burt	Largemouth Bass	Mercury
Homestead Lake	Butler	Largemouth Bass / Bluegill	Mercury
Redtail Lake	Butler	Largemouth Bass	Mercury
Timber Point Lake	Butler	Largemouth Bass	Mercury
Platte River	Cass	Channel Catfish	PCBs, Mercury
Cottonwood Lake	Cherry	Largemouth Bass	Mercury
Duck Lake	Cherry	Largemouth Bass	Mercury
Merritt Reservoir	Cherry	Walleye / Largemouth Bass	Mercury
Schoolhouse Lake	Cherry	Northern Pike / Largemouth Bass / Black Crappie	Mercury
Shell Lake	Cherry	Largemouth Bass	Mercury
Valentine Mill Pond	Cherry	Largemouth Bass / Bluegill	Mercury
West Point City Lake	Cuming	Largemouth Bass	Mercury
Ansley City Lake	Custer	Largemouth Bass	Mercury
Melham Park Lake	Custer	Largemouth Bass	Mercury
Pressey Pond -WMA	Custer	Largemouth Bass	Mercury
Box Butte Reservoir	Dawes	Northern Pike / Largemouth Bass	Mercury
Grabel Pond No. 5	Dawes	Largemouth Bass	Mercury, Selenium
Whitney Reservoir	Dawes	White Bass	Mercury
Cozad Lake - WMA	Dawson	Largemouth Bass	Mercury
Darr Lake -WMA	Dawson	Largemouth Bass	Mercury
Dogwood Lake -WMA	Dawson	Largemouth Bass	Mercury
East Gothenburg Lake - WMA	Dawson	Largemouth Bass	Mercury
Plum Creek Canyon Reservoir	Dawson	Common Carp	PCBs
West Cozad Lake - WMA	Dawson	Largemouth Bass	Mercury
Chappell Interstate Lake	Deuel	Largemouth Bass	Mercury, Selenium
Buckskin Hills Lake	Dixon	Largemouth Bass	Mercury

Fremont Lake No. 1	Dodge	Largemouth Bass	Mercury
Fremont Lake No. 11 - SRA	Dodge	Largemouth Bass	Mercury
Fremont Lake No. 20E - SRA	Dodge	Largemouth Bass	Mercury
PrairieView Lake	Douglas	Largemouth Bass	Mercury
Standing Bear Lake	Douglas	Largemouth Bass / Black Crappie	Mercury
Two Rivers Lake No. 1 - SRA	Douglas	Largemouth Bass	Mercury
Glenn Cunningham Lake	Douglas	Largemouth Bass	Mercury
Lawrence Youngman Lake	Douglas	Largemouth Bass / Black Crappie / Bluegill	Mercury
Rock Creek Lake	Dundy	Largemouth Bass	Mercury
Lone Star Reservoir	Fillmore	Largemouth Bass	Mercury
Medicine Creek Reservoir	Frontier	Largemouth Bass	Mercury
Big Blue River	Gage	Common Carp	PCBs, Dieldrin
Rockford Lake	Gage	Largemouth Bass	Mercury
Wolf-Wildcat Lake	Gage	Largemouth Bass	Mercury
Crescent Lake	Garden	Largemouth Bass	Mercury
Island Lake	Garden	Largemouth Bass	Mercury
Smith Lake	Garden	Largemouth Bass	Mercury
Elwood Reservoir	Gosper	Northern Pike / Largemouth Bass	Mercury
Phillips Lake	Gosper	Common Carp	Mercury
Tri-County Supply Canal -below J1 Hydro	Gosper	Common Carp	PCBs
Frey Lake - WMA	Grant	Largemouth Bass	Mercury
Cheyenne Lake - SRA	Hall	Largemouth Bass	Mercury
L.E. Ray Lake	Hall	Largemouth Bass	Mercury
Mormon Island Middle Lake - SRA	Hall	Largemouth Bass	Mercury
Frenchman WMA West Lake	Hayes	Largemouth Bass	Mercury
Hayes Center WMA Lake	Hayes	Largemouth Bass	Mercury
Goose Lake	Holt	Largemouth Bass	Mercury
Atkinson Lake	Holt	Largemouth Bass	Mercury
Farwell South Reservoir	Howard	Largemouth Bass / Common Carp	Mercury
Crystal Springs NW Lake	Jefferson	Channel Catfish	PCBs, Mercury
Wirth Brothers Lake	Johnson	Largemouth Bass / Black Crappie	Mercury
Lake McConaughy	Keith	Walleye	Mercury, Selenium
Ogallala City Park Lake	Keith	Channel Catfish	PCBs, Chlordane
Cub Creek Lake	Keya Paha	Largemouth Bass	Mercury
Missouri River	Knox	Flathead Catfish	Mercury
Bowling Lake	Lancaster	Largemouth Bass	Mercury
Cottontail Lake	Lancaster	Largemouth Bass	Mercury
Hedgefield Lake - WMA	Lancaster	Largemouth Bass	Mercury
Holmes Lake	Lancaster	Largemouth Bass	Mercury
Merganser Lake	Lancaster	Largemouth Bass	Mercury
Oak Creek	Lancaster	Channel Catfish	Mercury
Olive Creek Lake	Lancaster	Largemouth Bass	Mercury
Pawnee Lake	Lancaster	Largemouth Bass	Mercury

Wild Plum Lake	Lancaster	Largemouth Bass / White Crappie	Mercury
Wildwood Reservoir	Lancaster	Largemouth Bass	Mercury
Yankee Hill Lake	Lancaster	Largemouth Bass / Bluegill	Mercury
Birdwood Lake	Lincoln	Largemouth Bass	Mercury
East Hershey Lake	Lincoln	Largemouth Bass	Mercury
East Sutherland Lake	Lincoln	Largemouth Bass	Mercury
Fort McPherson Lake	Lincoln	Largemouth Bass	Mercury
Fremont Slough - WMA	Lincoln	Largemouth Bass	Mercury
Hershey Lake	Lincoln	Largemouth Bass	Mercury
Interstate Lake - North Platte	Lincoln	Largemouth Bass	Mercury
Maloney Res. Outlet Canal - above hydro	Lincoln	Common Carp	PCBs, Mercury
Maloney Res. Outlet Canal - below hydro	Lincoln	Channel Catfish / Smallmouth Bass	PCBs / Mercury
North Platte River	Lincoln	Largemouth Bass	Mercury
Pawnee Slough Lake	Lincoln	Largemouth Bass	Mercury
Sutherland Cooling Pond	Lincoln	Common Carp / Largemouth Bass	Mercury, Selenium / Mercury
Sutherland Outlet Canal	Lincoln	Channel Catfish	PCBs, Mercury
Sutherland Reservoir	Lincoln	Common Carp	PCBs, Mercury
Calamus Reservoir	Loup	Common Carp	Mercury
Bridgeport Middle Lake	Morrill	Largemouth Bass	Mercury
North Platte River	Morrill	Common Carp	Mercury, Selenium
Auburn Rotary Club Lake	Nemaha	Largemouth Bass	Mercury
Steinart Park Lake	Otoe	Largemouth Bass	Mercury
Wilson Creek 2X - WMA	Otoe	Largemouth Bass / Black Crappie	Mercury
Burchard Lake	Pawnee	Largemouth Bass	Mercury
Mayberry Lake - WMA	Pawnee	Largemouth Bass	Mercury
Iron Horse Trail Lake	Pawnee	Largemouth Bass	Mercury
Prairie Knoll Lake	Pawnee	Largemouth Bass / Bluegill	Mercury
Holdredge Park Lake	Phelps	Largemouth Bass	Mercury, Selenium
Columbus City Park Pond	Platte	Largemouth Bass	Mercury
Lake Babcock	Platte	Common Carp	Mercury
Maple Creek Recreation Area Lake	Platte	Largemouth Bass	Mercury
Kirkman's Cove Lake	Richardson	Largemouth Bass / Common Carp	Mercury
Missouri River	Richardson	Flathead Catfish	Mercury
Willard L. Meyer - Swan Creek Lake 5A	Saline	Largemouth Bass	Mercury
Swanton Lake - Swan Lake No. 67	Saline	Largemouth Bass	Mercury
Walnut Creek Lake No. 2	Saline	Largemouth Bass	Mercury
Offutt Lake	Sarpy	Channel Catfish / Common Carp	PCBs
Walnut Creek Lake	Sarpy	Largemouth Bass / Bluegill	Mercury
Wehrspann Lake	Sarpy	Largemouth Bass	Mercury
Prairie Queen Lake	Sarpy	Largemouth Bass	Mercury
Czechland Lake	Saunders	Largemouth Bass	Mercury
Lake Wanahoo	Saunders	Largemouth Bass	Mercury
Memphis Lake	Saunders	Largemouth Bass	Mercury

Red Cedar Lake	Saunders	Largemouth Bass	Mercury
Morrill Sandpit - North	Scottsbluff	Largemouth Bass	Mercury, Selenium
Morrill Sandpit - Southwest	Scottsbluff	Largemouth Bass	Mercury
Meadowlark Lake	Seward	Largemouth Bass / Bluegill	Mercury
Isham Dam Lake	Sheridan	Largemouth Bass	Mercury
Smith Lake	Sheridan	Largemouth Bass	Mercury
Walgren Lake	Sheridan	Largemouth Bass	Mercury
Sherman Reservoir	Sherman	White Bass	Mercury
Carter P. Johnson Lake	Sioux	Largemouth Bass	Mercury
Maskenthine Lake	Stanton	Largemouth Bass / Bluegill	Mercury
Big Sandy Creek	Thayer	Channel Catfish	Mercury
Auble Pond	Valley	Largemouth Bass	Mercury
Davis Creek Lake	Valley	Common Carp / White Bass	Mercury
Liberty Cove	Webster	Largemouth Bass	Mercury
Pibel Lake	Wheeler	Largemouth Bass	Mercury
Recharge Lake	York	Largemouth Bass	Mercury



Eat Safe Fish in Nebraska brochure available online.

More Information:

http://dee.ne.gov/NDEQProg.nsf/OnWeb/FTMP
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Nebraska Department of Health and Human Services, (402) 471-8880.

Monitoring for Fish Kills and Surface Water Complaints

Why do we sample after fish kills and complaints?

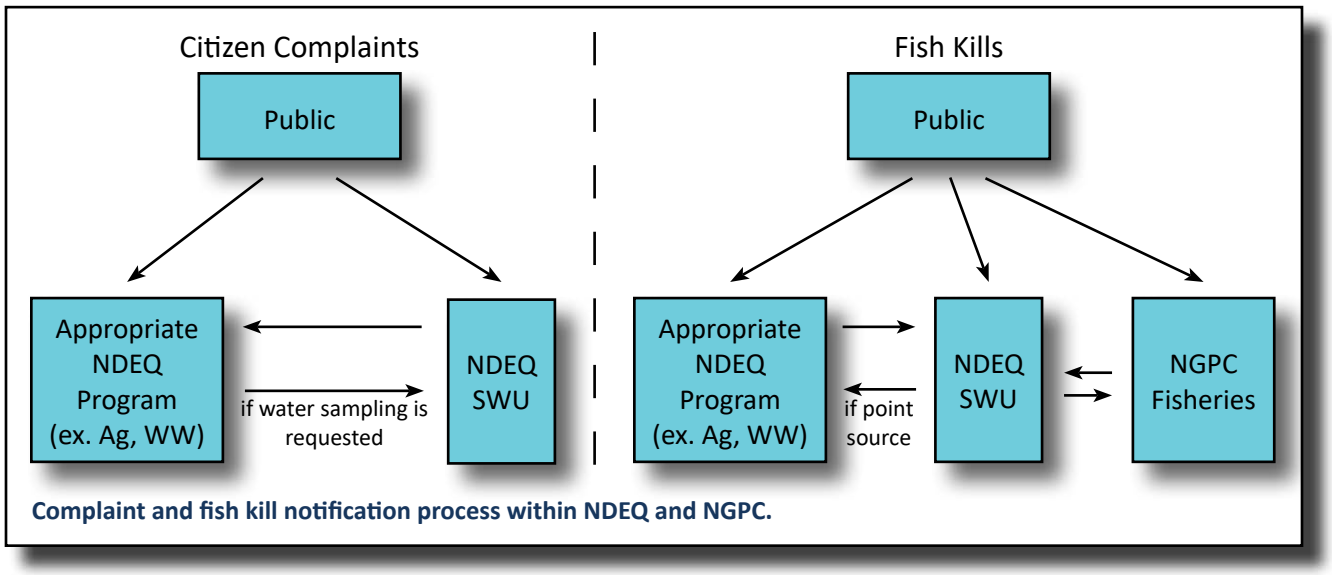
The agency responds to numerous fish kills and surface water complaints annually. In many cases, the investigations surrounding a fish kill may require sampling to document the cause of the water quality problem, the magnitude and extent of the water quality problem, the source of pollution and/or a responsible party. Because a fish kill could result in legal action, sampling requires a relatively high level of data quality.

How does the notification process work?

If a call comes in from the public regarding a surface water complaint to NDEE's Surface Water Unit (SWU) the SWU notifies NDEE personnel within the program most closely related to the problem (ex. Agriculture, Waste Water). That program may then ask for SWU assistance in the investigation if water samples are requested.

Pawnee Creek impacted by nonpoint source run-off, Adams County.

Nebraska Game and Parks Commission (NGPC) fisheries personnel become involved upon notification of a fish kill. If NGPC personnel receive a call of a fish kill from the public they will notify the SWU who will in turn notify the appropriate NDEE program unless the cause is natural and not the result of pollution. Natural fish kills can be the result of such stresses as spawning, disease, and oxygen depletion due to snow and ice cover on surface waters in winter or from the decay of abundant algae or aquatic vegetation within the waterbody which typically occurs during the summer months. If the SWU receives the call from the public, SWU staff will notify the NGPC of all fish kills and the appropriate NDEE program if the kill is related to a pollution event. Within the NDEE, the SWU is always notified of a fish kill regardless of cause or water body affected.



Complaint and fish kill notification process within NDEQ and NGPC.

Confluence of Pawnee Creek (right) and the Little Blue River (left), with Pawnee Creek being impacted by nonpoint source run-off, Clay County.

What types of data are collected?

The cause of fish kills is determined from information collected from the reporting party and/or follow-up investigation and sampling. The types of data collected are determined on a case-by-case basis. Initially, the types of data to be collected are based on information provided by the person who reports the problem. A final determination of data needed is made by the investigator once an initial site evaluation has been made. In many cases, field measurements of pH, temperature, conductivity, and dissolved oxygen are used as screening parameters to determine if a problem exists, but further sampling and investigation may be needed to determine the cause of the fish kill.

Fish Kills Reported

From July 1, 2017 through June 30, 2018 a total of five fish kills were reported to NDEE. Four of the reported fish kills were attributed to low dissolved oxygen levels within the waterbody, whereas one was the result of disease. A total of four fish kills were reported between July 1, 2018 and June 30, 2019. Two of the reported fish kills were attributed to low dissolved oxygen levels within the waterbody and two were the result of disease.

Fish kills in the summer are typically caused by low dissolved oxygen concentrations stemming from "eutrophic" conditions. Eutrophication is a term that describes water quality conditions as a lake or reservoir ages. Lakes or reservoirs that are eutrophic tend to be shallow with high nutrient concentrations and exhibit frequent algae blooms, warmer water temperatures, and large swings of dissolved oxygen concentrations throughout a 24 hour period. Winter fish kills are often caused by low dissolved oxygen concentrations which are the result of prolonged ice and snow cover on lakes and ponds. When lakes are frozen over and have significant snow cover, the amount of oxygen slowly decreases due to decreased photosynthetic activity, low light, and no exposure to atmospheric oxygen.

Citizen Complaints

Between July 1, 2017 and June 30, 2018 the SWU received 47 notifications of concern regarding surface water issues and from July 1, 2018 to June 30, 2019 the SWU received 80 such notifications. While many of these cases were referred to other agency programs that more closely relate to the problem, the SWU provided assistance through investigations and/or sample collection to help document conditions.

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Trash in Bell Creek, Dodge County.

Surface Water Sampling Summary

As discussed in the previous pages, the NDEE performs surface water monitoring throughout the state. This section summarizes the number of samples and parameters analyzed for each monitoring program in 2019. Several of the State's 23 Natural Resources Districts (NRDs) (among other partners) provide monitoring support; the NRD abbreviations and headquarter cities are listed at the end of this section.

Ambient Stream Monitoring Program

Network: 101 sites statewide

Frequency: monthly, 12 months per year

Parameters:

- **Field Measurements:** water temperature, dissolved oxygen (DO), pH, conductivity, turbidity, stream discharge
- **Traditional:** total suspended solids (TSS), chloride, ammonia, nitrate-nitrite, kjeldahl nitrogen, total phosphorus
- **Atrazine:** monthly, May – September
- **Sulfate:** monthly, October – December
- **Quarterly Metals:** 4 times per year (January, April, July, October)
  - ***Bottom of Basin Sites:*** all metals, 17 sites (11 NDEE + 6 USACE) = Total-selenium, mercury and; Dissolved-sodium, magnesium, calcium, arsenic, cadmium, chromium, copper, lead, nickel, silver, zinc
  - ***All other Sites:*** "partial metals list" = Total-selenium; Dissolved-sodium, magnesium, calcium, arsenic
- **Bacteria:** *E. coli*
- **Per – and Polyfluoroalkyl Substances (PFAS):** one time sampling in May at the 11 NDEE Bottom of Basin Sites

Collecting water samples from the Little Blue River.

Collecting water samples from the Little Blue River.

Total Number of Individual Field Measurement Readings and Sample Parameter Analyses:

- **Field Measurements:** 7,272
- **Traditional:** 7,272
- **Atrazine:** 505
- **Sulfate:** 303
- **Metals:** 2,564
- ***E. coli*:** 1,112
- **PFAS:** 360

Assistance: MNNRD, SPNRD, US Army Corps of Engineers (USACE)

Basin Rotation Monitoring Program

Network: 37 stream sites (including 15 shared Ambient Stream sites) in the Middle Platte and Loup River basins

Frequency: weekly, May 1 - September 30 (22 weeks)

Year	River Basin(s)
2018	Big Blue, Little Blue and Republican
2019	Loup and Middle Platte
2020	Niobrara
2021	Lower Platte and Nemaha
2022	Elkhorn and Missouri Tributaries
2023	North Platte, South Platte, & White-Hat

Parameters (streams):

- **Field Measurements:** water temperature, DO, pH, conductivity, turbidity, stream discharge
- **Traditional:** TSS, chloride, ammonia, nitrate-nitrite, kjeldahl nitrogen, total phosphorus
- **Atrazine:** weekly, May – June
- **Bacteria:** *E. coli*

Total Number of Individual Field Measurement Readings and Sample Parameter Analyses:

- **Field Measurements:** 4,884
- **Traditional:** 4,884
- **Atrazine:** 640
- ***E.coli*:** 924

Assistance: ULNRD and LLNRD.

Public Beach Monitoring Program

Network: 54 sites statewide from 51 lakes

Frequency: weekly, May 1 - September 30 (22 weeks)

Parameters: bacteria (*E. coli*) and toxic algae (microcystin)

Total Number of Routine Individual Sample Parameter Analyses:

- ***E. coli*:** 1,134
- **Microcystin:** 1,134

Assistance: MNNRD, NNRD, URNRD, LRNRD, LLNRD, LENRD, SPNRD, Nebraska Public Power District (NPPD), Central District Health Department (CDHD), USACE

Blue-green algae bloom at Merritt Reservoir, Cherry County.

Ambient Lake Monitoring Program

Network: 33 lakes statewide
NDEE: 27 lakes
USACE: 4 lakes
NNRD: 2 lakes

Frequency: Monthly from May through September

Parameters:

- **Traditional:** TSS, total phosphorus, dissolved orthophosphorus, ammonia, nitrate/nitrite, kjeldahl nitrogen, alkalinity, water clarity
- **Atrazine**
- **Chlorophyll-a**
- **Field Measurements (depth profiles taken at deep-water and mid-lake locations):** pH, conductivity, water temperature, DO, turbidity

Filtering water for a phosphorous sample at Merritt Reservoir, Cherry County.

Total Number of Individual Field Measurement Readings: (only the set of Field Measurements collected near the surface are included in this table for each Deep-water and Mid-lake location, however, an undetermined set of Field Measurement are taken every 0.5 or 1.0 meters, depending upon depth at the location, from the surface to the lake bottom)

- **Deep-water:** 825
- **Mid-lake:** 825

Total Number of Individual Sample Parameter Analyses:

- **Traditional:** 1,320
- **Pesticides:** 165
- **Chlorophyll-a:** 165

Assistance: University of Nebraska-Lincoln (UNL), NNRD, USACE

Fish Tissue Monitoring Program

Network: 104 fish samples collected from 44 sites (11 rivers/streams and 33 lakes) in the Middle Platte and Loup River basins

Assistance: Nebraska Game and Parks Commission (NGPC), Nebraska Dept. of Health & Human Services, Nebraska Dept. of Agriculture, and USEPA

Preparing a fish tissue sample collected from the Missouri River, Knox County

Stream Biological Monitoring Program

Network: 10 stream sites in the Middle Platte and Loup River basins

Field measurements: water temperature, pH, DO, conductivity, turbidity and stream discharge, fish and aquatic insect communities, and habitat assessments

Electrofishing for the Stream Biological Monitoring Program at Leander Creek, Cherry County.

Fish Kills and Surface Water Complaints

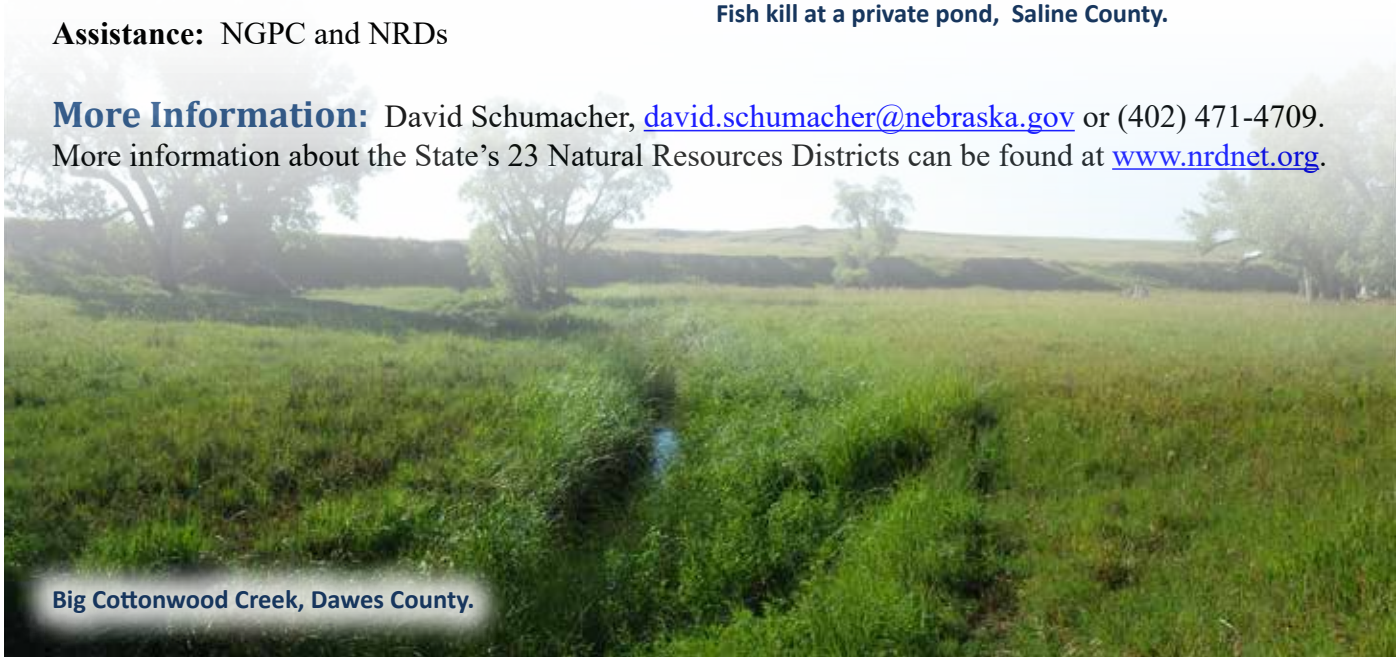
Timeframe: July 1, 2018 to June 30, 2019

A total of 4 fish kills were reported between July 1, 2018 and June 30, 2019. During this same timeframe, the Department received 80 notifications of complaints concerning surface water issues. Many of these cases were referred to other agency programs that more closely relate to the problem, sometimes the Surface Water Unit assisted by providing observations or samples to help document conditions.

Fish kill at a private pond, Saline County.

Assistance: NGPC and NRDs

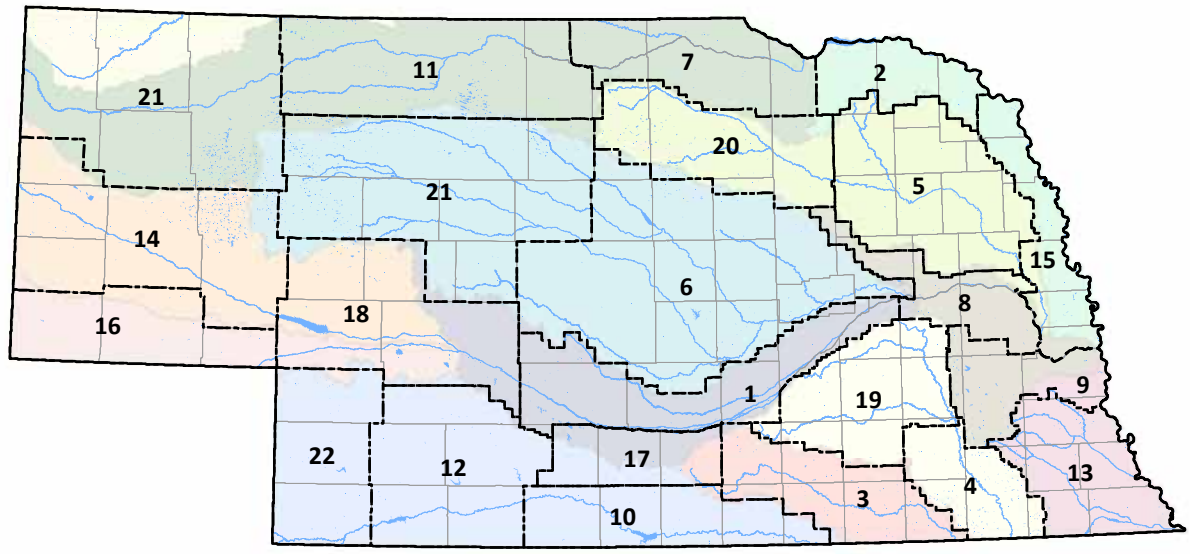
More Information: David Schumacher, david.schumacher@nebraska.gov or (402) 471-4709. More information about the State's 23 Natural Resources Districts can be found at www.nrdnet.org.



Big Cottonwood Creek, Dawes County.

Natural Resources Districts, Abbreviations, and Headquarter Cities

Map #	Natural Resources District	Abbreviation	Headquarter City
1	Central Platte NRD	CPNRD	Grand Island
2	Lewis and Clark NRD	LCNRD	Hartington
3	Little Blue NRD	LBNRD	Davenport
4	Lower Big Blue NRD	LBBNRD	Beatrice
5	Lower Elkhorn NRD	LENRD	Norfolk
6	Lower Loup NRD	LLNRD	Ord
7	Lower Niobrara NRD	LNNRD	Butte
8	Lower Platte North NRD	LPNNRD	Wahoo
9	Lower Platte South NRD	LPSNRD	Lincoln
10	Lower Republican NRD	LRNRD	Alma
11	Middle Niobrara NRD	MNNRD	Valentine
12	Middle Republican NRD	MRNRD	Curtis
13	Nemaha NRD	NNRD	Tecumseh
14	North Platte NRD	NPNRD	Scottsbluff
15	Papio-Missouri River NRD	PMRNRD	Omaha
16	South Platte NRD	SPNRD	Sidney
17	Tri-Basin NRD	TBNRD	Holdrege
18	Twin Platte NRD	TPNRD	North Platte
19	Upper Big Blue NRD	UBBNRD	York
20	Upper Elkhorn NRD	UENRD	O'Neil
21	Upper Loup NRD	ULNRD	Thedford
22	Upper Niobrara-White NRD	UNWNRD	Chadron
23	Upper Republican NRD	URNRD	Imperial



Nebraska's Natural Resources Districts (NRD).

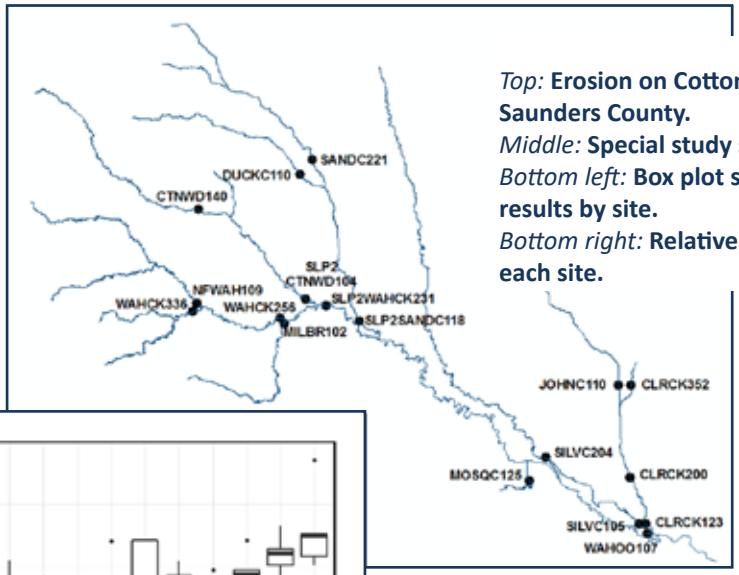
Stream Special Studies

Why Special Studies?

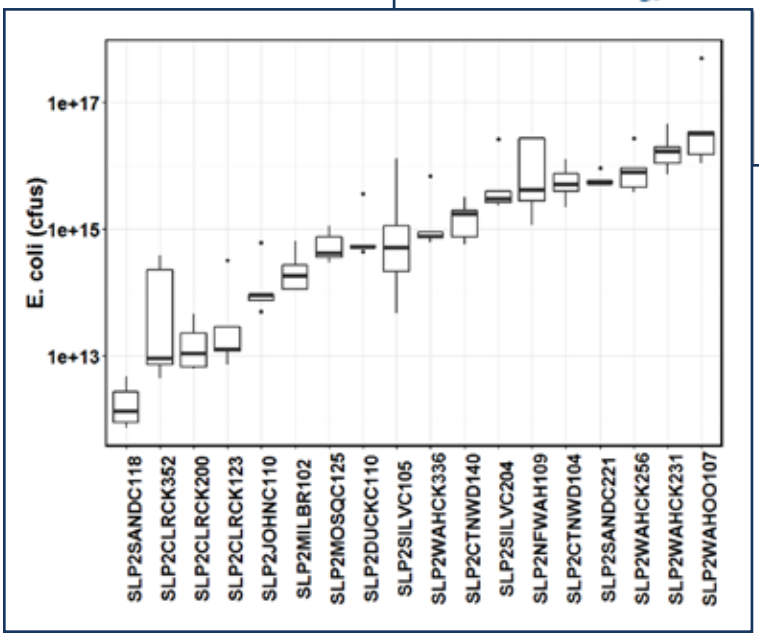
NDEE has now partnered with several Nebraska Natural Resources Districts (NRD) on what we refer to as special studies, or stream projects with goals that are beyond those of our existing monitoring programs. Through these special studies, NDEE utilizes the formidable expertise of its staff to address pressing needs of our NRD partners. In particular, we have aided NRDs in acquiring monitoring data and interpreting this data to build strong watershed management plans, and to serve as baselines in determining the success of future watershed management efforts.

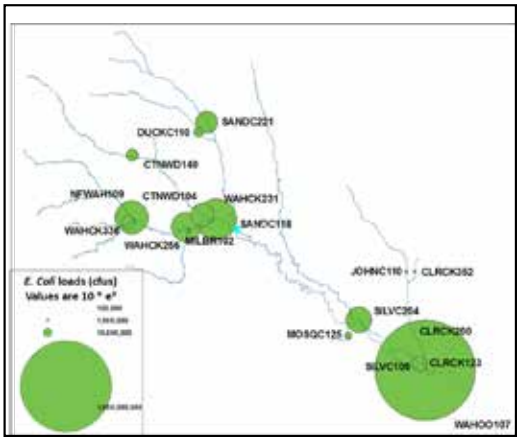
Wahoo Creek Special Study

Segments of Wahoo Creek have recently been impaired because of high concentrations of *E. coli* bacteria and the herbicide atrazine. NDEE partnered with the Lower Platte North NRD to identify tributaries or other areas within the Wahoo Creek watershed that contribute the most to *E. coli* and atrazine concentrations, and are thus deserving of priority management status. The study, which occurred in 2016 and 2017, helped us to determine that *E. coli* loading to Wahoo Creek was fairly evenly distributed across the landscape, though Cottonwood Creek appeared to contribute more than other tributaries. We also helped to determine that Sand Creek and Johnson Creek appeared to be especially important sources of atrazine.



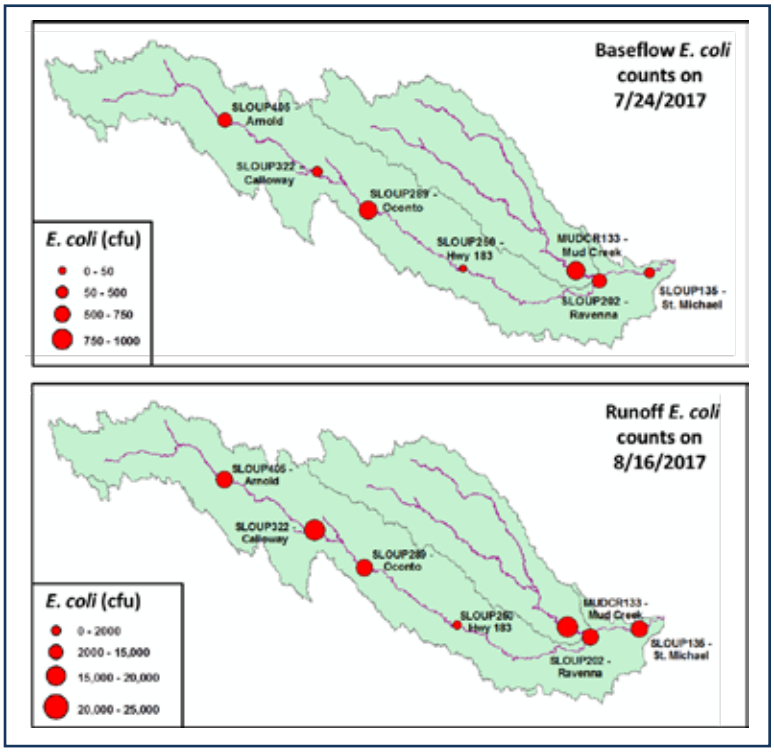
Top: **Erosion on Cottonwood Creek, Saunders County.**
Middle: **Special study sampling sites.**
Bottom left: **Box plot showing *E. coli* results by site.**
Bottom right: **Relative *E. coli* loads at each site.**



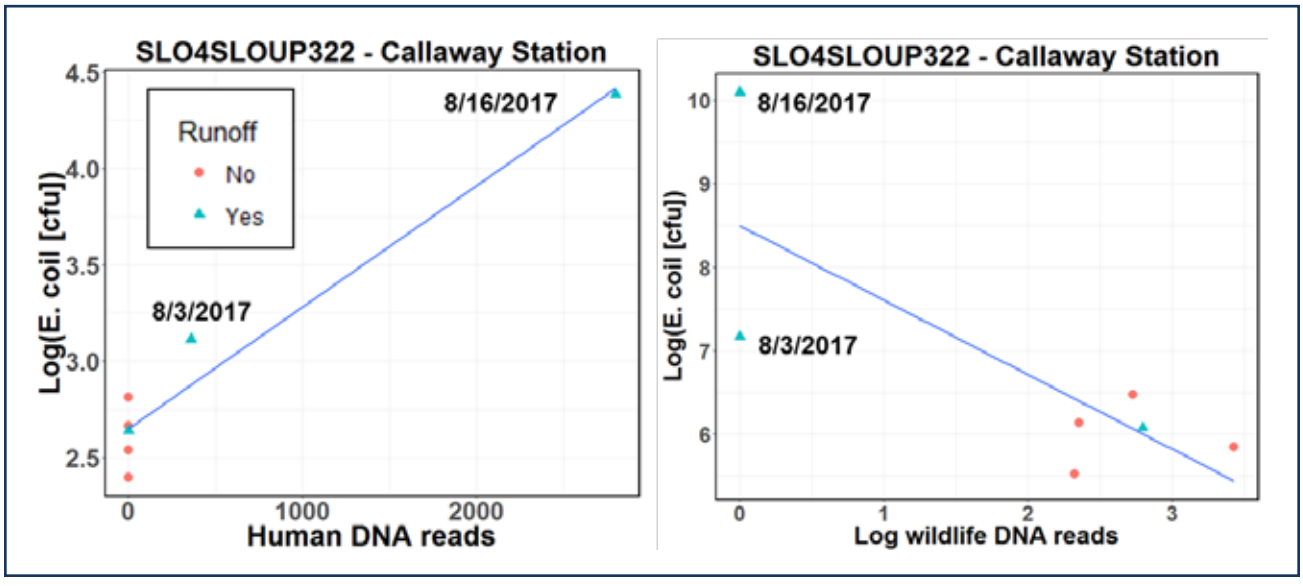


South Loup River Special Study

The South Loup River study was a collaboration with the Lower Loup NRD that occurred in 2017 and 2018. In 2017, we monitored *E. coli* concentrations at six stations along the South Loup River and the Mud Creek tributary. We collected eDNA to observe which mammals appeared to have the strongest connections to the water at these stations during times when *E. coli* concentrations were highest, which could be human or swine DNA depending on the location, or there could be no observed correlations. In 2018 we incorporated quantitative DNA analysis of domestic and wildlife species and found cattle DNA seemed to be associated with *E. coli* higher in the watershed and during the earlier spring floods.



Top: ***E. Coli* loading during baseflow and a large runoff event, South Loup River, McPherson, Logan, Lincoln, Custer, Dawson, Buffalo, Sherman, Howard, and Hall Counties.**
Middle: **Collecting eDNA samples.**
Bottom: **eDNA results from the Callaway sampling station indicating a strong positive relationship of human DNA and *E. coli* concentrations (left figure), and a negative relationship between mammal wildlife DNA and *E. coli* (right figure).**



Chadron Creek Special Study

The Chadron Creek study occurred in 2018, and was built upon information gathered by NDEE in 2017. We worked with the Upper Niobrara White NRD to monitor *E. coli* concentrations and the DNA of specific sources at 10 stations along Chadron Creek. The Creek had low *E. coli* from the headwaters through Chadron Creek State Park, though human DNA was at times at high levels. Below the state park, the creek quickly gained much more *E. coli* and cattle DNA, indicating that pastures next to the creek were important sources of fecal contamination.

Top: **Chadron Creek, Dawes County .**
Left: **Colonized benthic algae tiles used to collect benthic chlorophyll and algal composition data at Chadron Creek.**
Bottom: **Overall pattern of *E. coli* counts versus the copies of cattle DNA in Chadron Creek across all stations. When there were higher amounts of cattle DNA in the water, there were also highr counts of *E. coli*.**

More Information:

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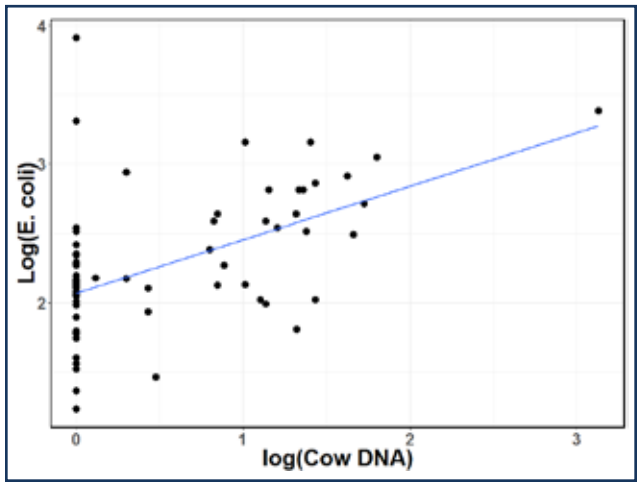
Ryan Chapman, ryan.chapman@nebraska.gov or (402) 471-4227.



National Lakes Assessment

What is the National Lakes Assessment?

National Lakes Assessment (NLA) is a nationwide statistical survey organized by EPA on the condition of the nation's lakes and reservoirs. It analyzes numerous water quality values to give each waterbody sampled a quality rating. Those ratings are then used to assess lake water quality across ecoregions and consequently across the nation.

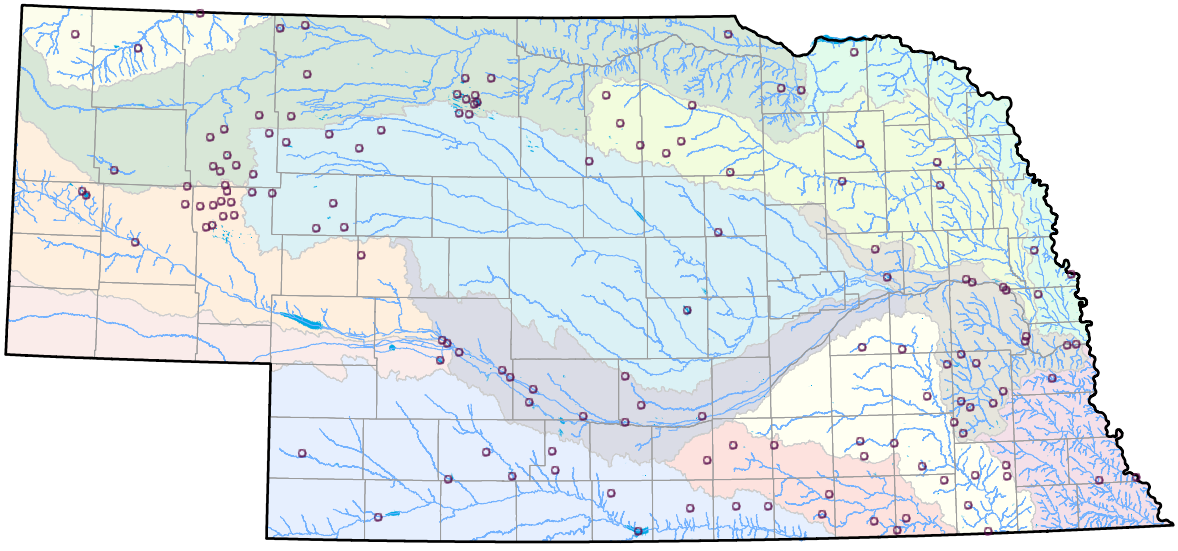
Collecting macroinvertebrate samples, Saunders County.

When and Where was the Monitoring Conducted?

In 2017 Nebraska Department of Environment and Energy employees sampled 30 randomly selected lakes, ponds, and reservoirs. The assessment was a statewide effort and included waterbodies greater than 2.47 surface acres and at least 3.3 feet deep.

What was Monitored?

Data were collected included indicators to assess the biological, chemical, physical, and recreational aspects of the waterbody. Some of those indicators included zooplankton, chlorophyll A, ambient air quality, nutrients, pesticides, lakeshore habitat, shallow water habitat, human disturbance, and cyanobacteria.



Nebraska's National Lake Assessment (NLA) sites.

Collecting macroinvertebrate samples, Saline County.

Preparing to sample, Jefferson County.

What is done with the data?

Analysis conducted on the data provides a score of each waterbody sampled as well as the range of waters found across ecoregions, states, and the nation as a whole. Information from the 2012 assessment is available, https://www.epa.gov/national-aquatic-resource-surveys/national-lakes-assessment-2012-results with results from the 2017 assessment expected to be available in 2021.

More Information:

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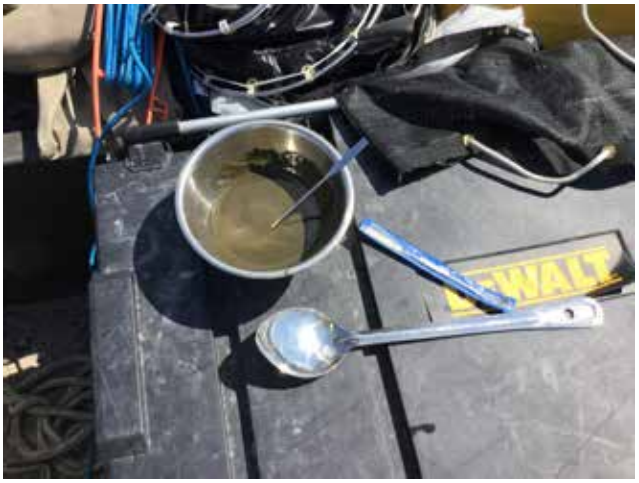

Preparing a lake bed sediment sample.

Sherman Lake, Loup County.

National Rivers and Streams Assessment

What is the National Rivers and Streams Assessment (NRSA)?

NRSA is a national-scale survey of stream condition, also organized and funded by EPA. The survey uses standardized methods and a probability-based sampling design that allows for direct comparisons of stream condition across regions and over time. NRSA is one component of the National Aquatic Resource Survey (NARS) that also includes lakes, wetlands, and estuaries. NRSA is performed two of every five years with the most recent occurring in 2018-2019.

When and Where was the Monitoring Conducted?

In Nebraska, 61 streams were sampled in the summers of 2018 and 2019. Sites were chosen randomly and included every river basin in the state as well as the Missouri River. In addition, there were separate protocols for wadeable and boatable streams, though the basic data collected were the same.

Surveying stream elevations at unnamed trib of Salt Creek, Lancaster County.

Electrofishing at Niobrara River, Sheridan County.

What was Monitored?

Chemical, physical, and biological parameters were measured. First, NDEE collected temperature, conductance, pH, and dissolved oxygen with a handheld meter. Next, grab samples were collected for measurements of nutrients, pesticides, algal toxins, and total suspended solids. After that one crew collected physical habitat measurements, macroinvertebrates, and periphyton samples from each of the 11 sample transects. Following them, a second crew measured stream slope and then electroshocked the fish community, with plugs of fish tissue kept for analyses of mercury. Finally, a grab sample was collected for enterococci.

Electrofishing at Johnson Creek, Pawnee County.

What is done with the data?

The data are used to rate the conditions of streams in broad regions, with overall scores of good, fair, and poor. The most recent report for 2008-2009 can be accessed here: https://www.epa.gov/national-aquatic-resource-surveys/national-rivers-and-streams-assessment-2008-2009-results. Overall, 46% of the nation's streams were poor and 28% were good. The Plains and Lowlands, in which Nebraska is located, was similar to the national averages. The primary impairments to stream condition were nutrient pollution, riparian structural changes, and excess sedimentation.

Electrofishing on Turkey Creek, Buffalo County.

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David Schumacher, david.schumacher@nebraska.gov or (402) 471-4709

Measuring stream depths at Paririe Dog Creek, Harlan County.

Processing samples.

Surveying stream elevations at Middle Loup River, Hooker County.

Stream Nutrient Assessment Procedure (SNAP) Pilot Study

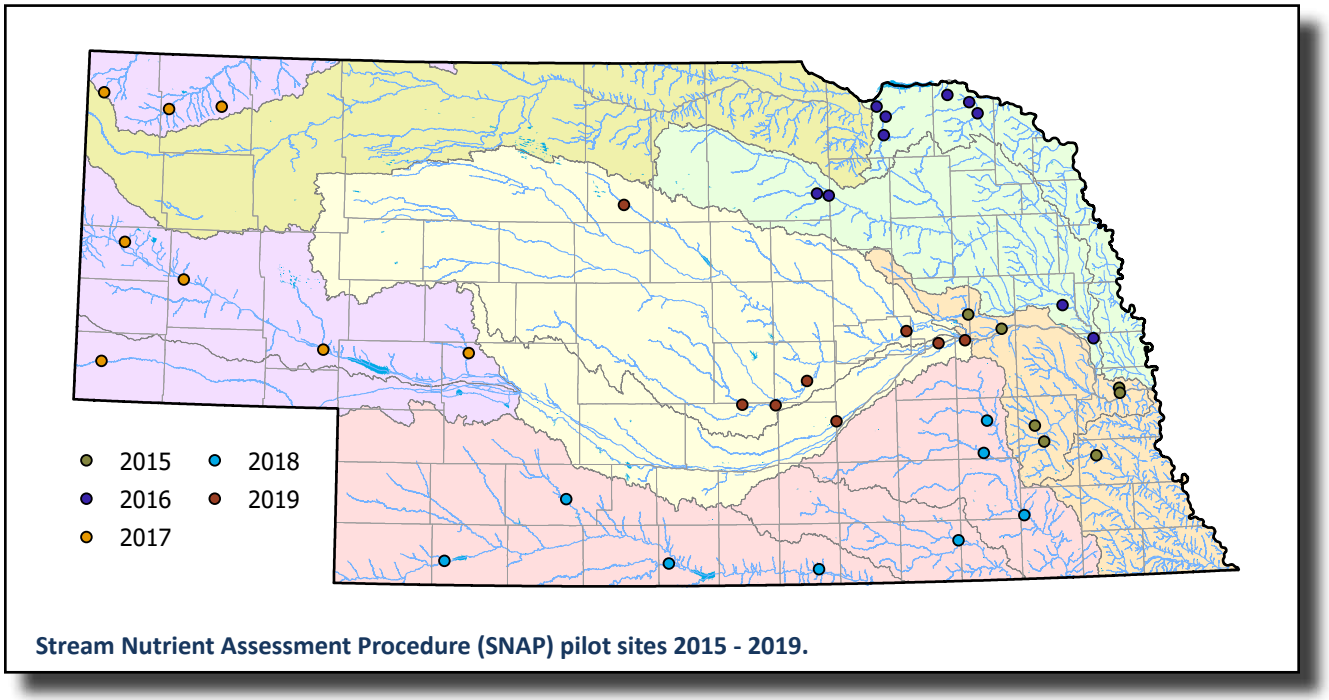
What is SNAP?

The purpose of SNAP is to determine how nutrient enrichment affects Nebraska's stream ecosystems. Locally, excess nutrients may not cause such obvious problems as dead zones in estuaries. However, the nitrogen and phosphorus that enter our waterways is expected to alter the amount and composition of algae, which are an important base resource for fishes and macroinvertebrates. Therefore, NDEE has been focusing on the composition of algal communities, and measures such as dissolved oxygen that are linked to stream algae.

An engaged audience gathers to observe benthic chlorophyll and periphyton sample collection at Howe Creek, Knox County.

SNAP Implementation

Each year, the SNAP program occurs concurrently with the Basin Rotation Monitoring Program (BRMP) to take advantage of the high frequency nutrient sampling. Eight sites from the BRMP are chosen per year, and each of the streams is sampled for algal communities that have been colonized on tiles, chlorophyll-*a* in the water column and accrued on tiles, diel (24 hour) changes to dissolved oxygen concentrations, as well as habitat, macroinvertebrate, and fish sampling in conjunction with the Stream Biological Monitoring Program.



Stream Nutrient Assessment Procedure (SNAP) pilot sites 2015 - 2019.

Environmental DNA (eDNA) sampling was added to SNAP in 2016. This sampling is quite easy, being done with a filter attached to a syringe, and the return of data on the entire suite of algal species is unmatched in terms of rapidity and price. Environmental DNA also has other advantages over algae grown on tiles: eDNA sampling includes both sestonic (water column) and benthic (stream bottom) algae; eDNA sampling is not subject to difficulties that may arise from colonizing tiles such as burial after storms and grazing by herbivorous macroinvertebrates; and eDNA is easily collected at the time of weekly Basin Rotation chemical sampling.

Preliminary Results and Update

Sample collections from 2015-2018 have received preliminary analyses, and NDEE is awaiting sample identifications from tiles and eDNA from 2019. The primary producers in Nebraska streams generally appeared to be limited by nitrogen concentration. Several parameters in different basins correlated with nitrogen availability (especially nitrate + nitrite), including tolerant and sensitive algal species, the ratio of cyanobacteria to diatom cells, and overall algal assemblage structure. In some basins there was also increased sestonic chlorophyll-*a* with increased nitrogen. These results suggest that increased nitrogen in the streams is the most likely to alter the structure and function of these ecosystems. The SNAP pilot study sampling will continue through 2020 to complete an entire basin rotation, which will allow NDEE to determine localized nutrient impacts on every river basin in the state.

More Information:

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Multi-parameter meter deployed to measure 24 hour dissolved oxygen variation at Antelope Creek, Cedar County.

Multi-parameter meter and benthic algae tiles at Monroe Creek, Sioux County.

Benthic algae tiles used to collect benthic chlorophyll and algal composition data at Antelope Creek, Cedar County.

Regional Monitoring Network

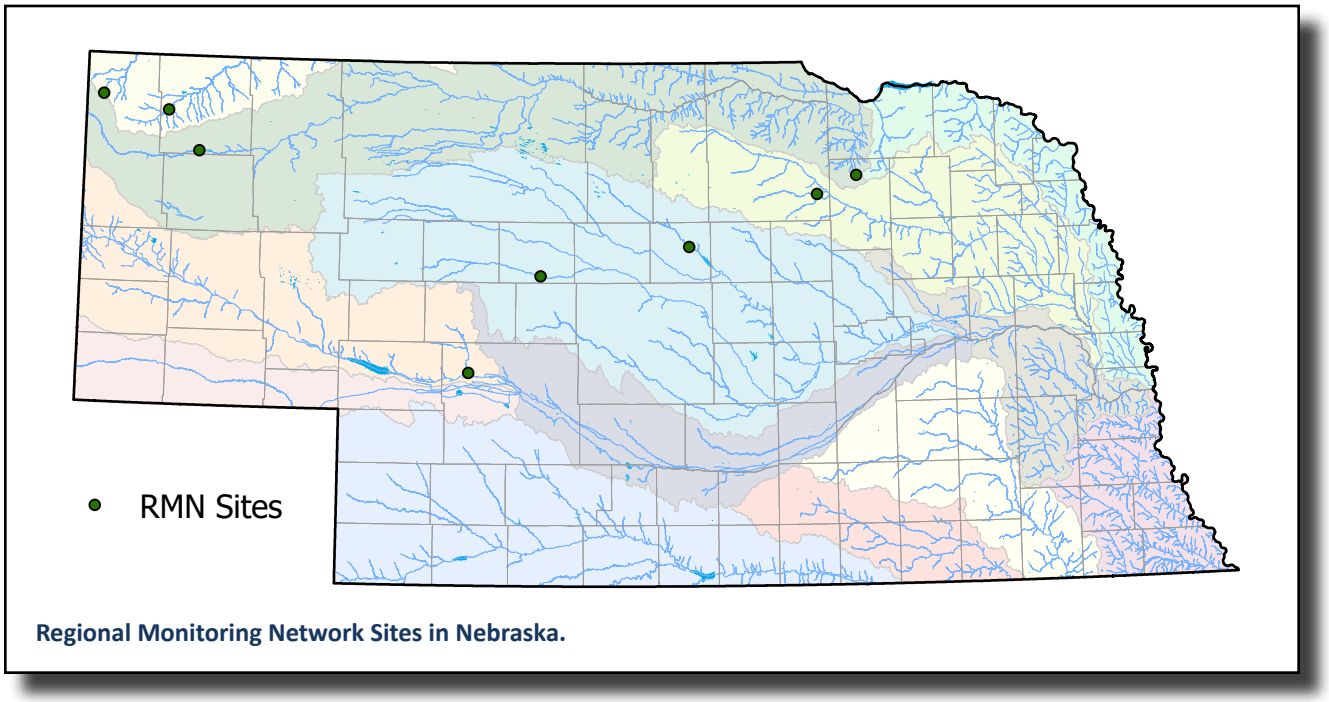
What is the Regional Monitoring Network?

The Regional Monitoring Network (RMN) is a collaboration between the USEPA and numerous states, tribes, and other organizations to collect continuous stream discharges and temperatures and other chemical and biological data. The data will then be used as baselines for long term comparisons of stream condition. Having many sensors deployed nationwide that collect continuous data will allow NDEE, USEPA, and other partners to detect significant yet subtle trends in stream condition.

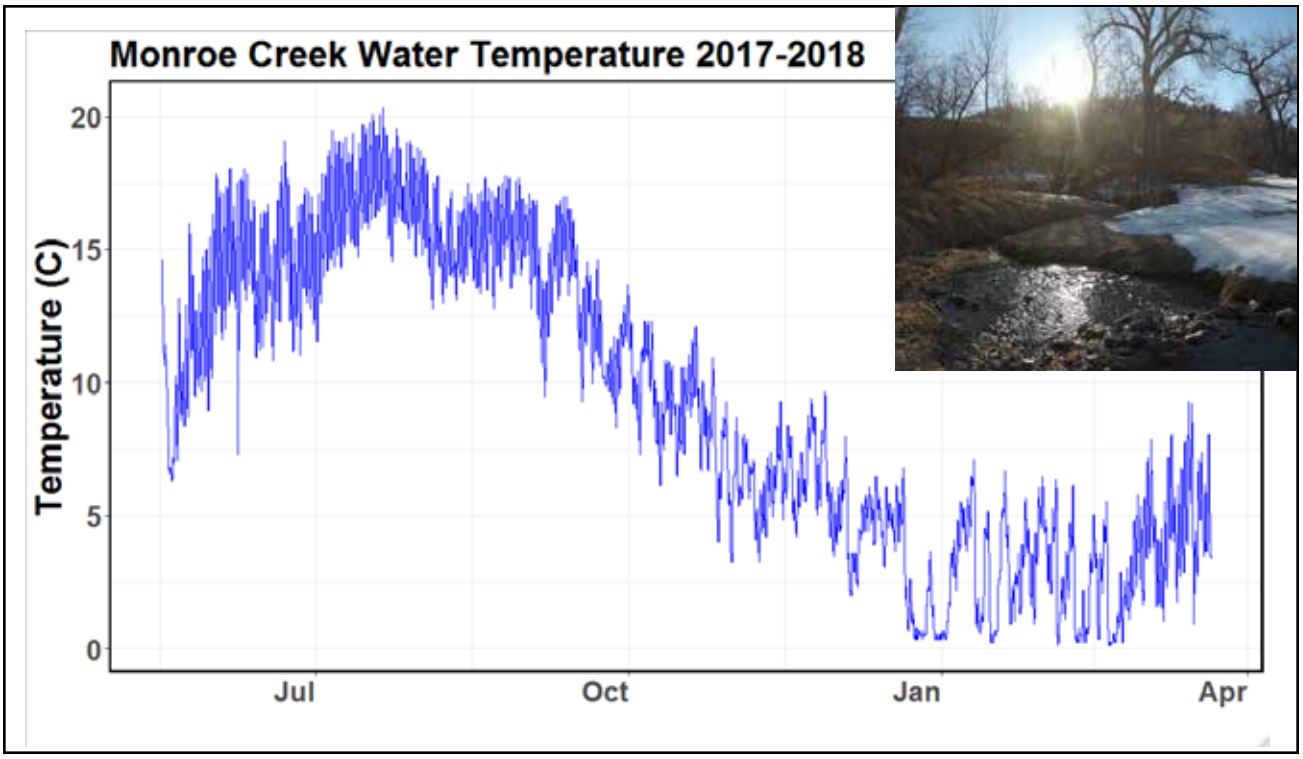
What and Where is the Monitoring Conducted?

NDEE has been monitoring eight streams since May 2017. Each location has a sensor that collects water level and temperature every thirty minutes, typically bolted to a fence post driven into the stream bottom. NDEE staff download data from the sensors and perform maintenance once every autumn and spring. Each of the study locations is also sampled as part of the NDEE Ambient Stream Monitoring Program.

East Branch Verdigre, Antelope County.



Regional Monitoring Network Sites in Nebraska.



Temperature readings from Monroe Creek in 2017 and 2018, Sioux County.

More Information:

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Greg Michl, greg.michl@nebraska.gov or (402) 471-4709.

Dismal River, Thomas County.

Air pressure sensor used to compensate instream pressure sensors to measure stream depth/stage.

Flathead Chub Stocking Plan

Why Stock Flathead Chubs?


Netted flathead chub, Knox County.

The flathead chub is a larger member of the chub family, reaching a foot in length and gets its name from having a broad, flat head that tapers to a point. This species is found mostly in large turbid rivers with sand or gravel bottoms. It is native to North America, where it is distributed throughout central Canada and the central United States; however, major declines over much of its range have been documented largely due to habitat loss. In the Missouri River system, impoundment and channelization has changed the slow moving, warm, turbid water to reservoir habitat with dams also negatively affecting the ability of larval fish to recolonize downstream river reaches. Flathead chubs exist within tributaries of the lower Missouri River but have otherwise been extirpated throughout their lower range in the river below Gavins Point Dam near Yankton, SD.

Biologists on the lower Missouri River working with the federally endangered pallid sturgeon have identified a trend in declining growth of sturgeon at adult sizes that is likely linked to an inability to find or feed piscivorously. It is thought that flathead chubs once served as a very important food item to pallid sturgeon before their decline and if re-established could help fill an integral void in the ecosystem of this reach of river. Biologists believe that it is probable that flathead chubs could re-establish populations in the several hundred miles of Missouri River below Gavins Point Dam if founder populations of these chubs could be established.

A proposal was developed by state and federal agencies working with pallid sturgeon to provide a stocking regimen of native flathead chubs below Gavins Point Dam and evaluate to determine persistence of those fish and re-establishment of their populations. The initial step to this process was for the US Fish and Wildlife Service Gavins Point National Fish Hatchery (GPNFH) located in Yankton, SD to establish propagation methodologies that could lead to a consistent stocking regimen. The Surface Water Unit (SWU) of NDEE was first contacted by the GPNFH in 2016 and asked if they would collect flathead chubs from tributary streams to the Missouri River that would serve as initial brood stock for this propagation effort. A one-day sampling event in the fall of 2016 resulted in the collection of 85 adult flathead chubs that were delivered by hatchery truck to the GPNFH where the rearing of flathead chubs began in large circular tanks. SWU staff have continued to provide additional adult flathead chubs to the GPNFH from various tributary streams annually as hatchery staff continue to develop and refine propagation methodologies. To date, GPNFH has been able to produce over 9,000 adult flathead chubs from the 245 brood stock that were provided to them by NDEE.


Electrofishing in Verdigre Creek, Knox County.

More Information:

Dave Schumacher, david.schumacher@nebraska.gov or (402) 471-4709.

Integrated Report for Nebraska Waters

Nebraska's Assessment of Lakes and Rivers

The federal Clean Water Act (CWA) requires states to assess the water quality of their lakes and rivers to determine if they meet state and federal water quality objectives. Nebraska's water quality objectives are defined in Title 117- Nebraska Surface Water Quality Standards (NDEE, 2019). Title 117 defines the beneficial uses that are to be supported by each of Nebraska's lakes and streams. Examples of beneficial uses for Nebraska's waterbodies include:

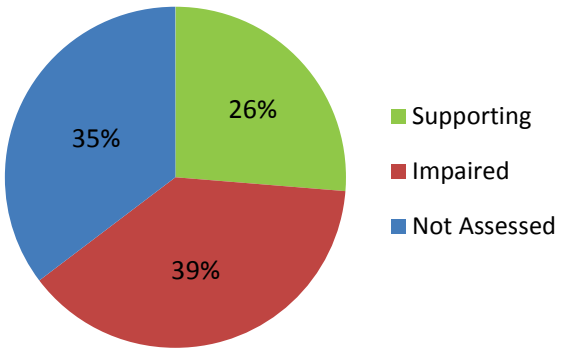
- drinking water (public drinking water supply)
- recreation (swimming, wading)
- aquatic life (health of water insects, fish, and wildlife)
- agricultural supply (livestock water supply)

Title 117 also specifies the numeric levels of pollutants such as *E. coli* bacteria and nitrate that can be present in a waterbody without impairing the assigned beneficial uses. When determining the water quality for a specific waterbody, NDEE assesses the water quality data against the pollutant criteria defined in Title 117 for each assigned beneficial use.

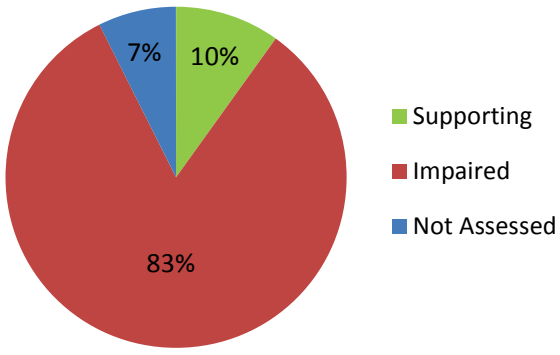
Lake under health in 2019 and impaired for Microcystin in the integrated report.

Reporting Water Quality Conditions

Every two years the CWA requires that states develop an "Integrated Report" (NDEE, 2018) that summarizes the water quality condition of all surface waterbodies in the state. For this report, states evaluate all available water quality data and determine which waterbodies are or are not supporting their designated beneficial uses. Waters that do not fully support all of their assigned beneficial uses are considered "impaired" and place on an impaired waterbodies list (303(d) list); waters that support assigned uses are considered "supporting" or good quality waters.



Status of Nebraska streams in miles as reported in the 2018 Integrated Report.

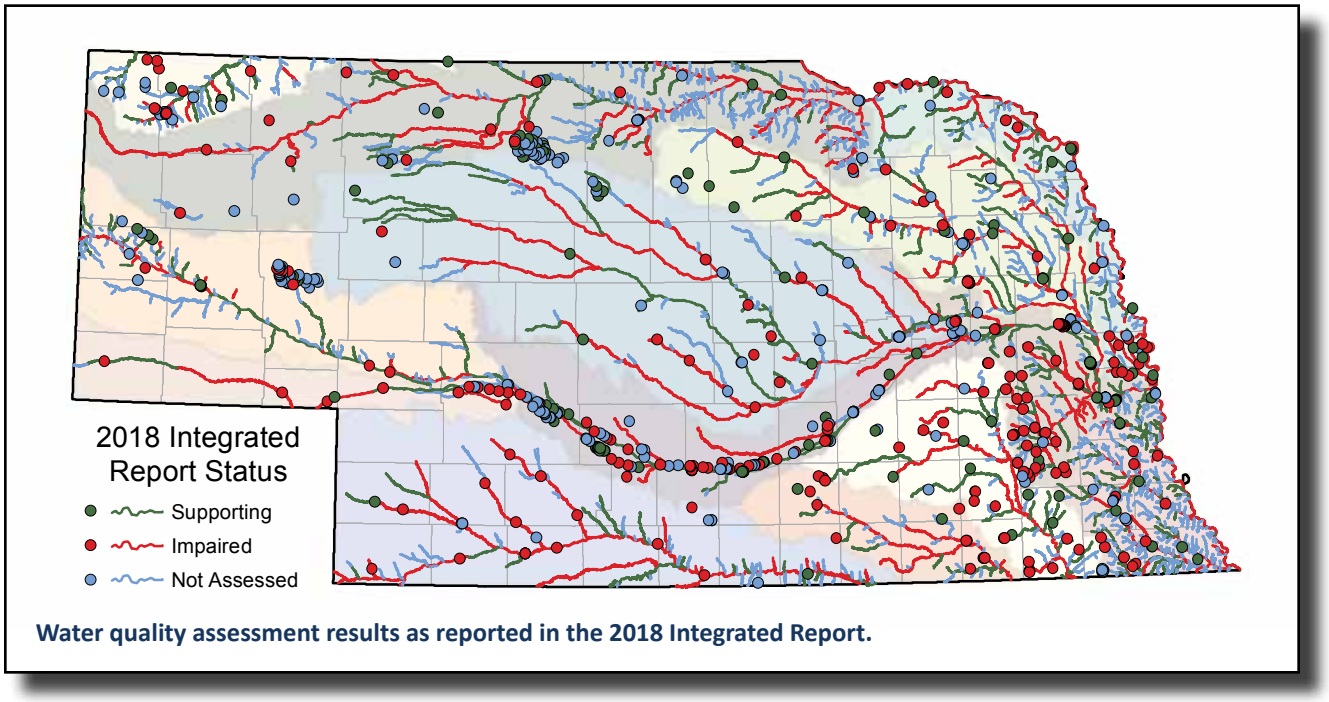


Status of Nebraska lakes in acres as reported in the 2018 Integrated Report.

Summary of Nebraska's 2018 Integrated Report

Nebraska has 1558 stream segments flowing over 16,670 miles and 539 lakes and reservoirs that cover more than 134,389 acres. As of the 2018 Integrated Report (issued April. 2018), NDEQ staff had conducted assessments on 628 stream segments and 329 lakes equating to more than 11,312 miles of streams and 125,269 lake acres being assessed (see figures below). While numerous waterbodies still need assessment, NDEE has made a concerted effort to focus sampling and assessments on the waterbodies used more widely by the public. This has resulted in assessments on all lakes over 50 surface acres in size and all main stem rivers (see map, below).

Of the 628 stream segments assessed, 351 were supporting their assigned uses, while 277 were impaired. Lake assessments found 208 of the 329 lakes assessed were impaired while 121 lakes were supporting their uses (see figures below).



Water quality assessment results as reported in the 2018 Integrated Report.

Common Stream and Lake Impairments

The most common impairments for Nebraska's streams and lakes can be seen in the following figures. *E. coli* bacteria impaired more than three times as many streams as the next leading cause, impaired stream biology. Atrazine, fish consumption advisories, and low dissolved oxygen were also common stream impairments. The most common lake impairment was elevated nutrients followed closely by fish consumption advisories, Chlorophyll a and elevated pH. Low dissolved oxygen and *E. coli* bacteria were also notable causes of lake impairments.

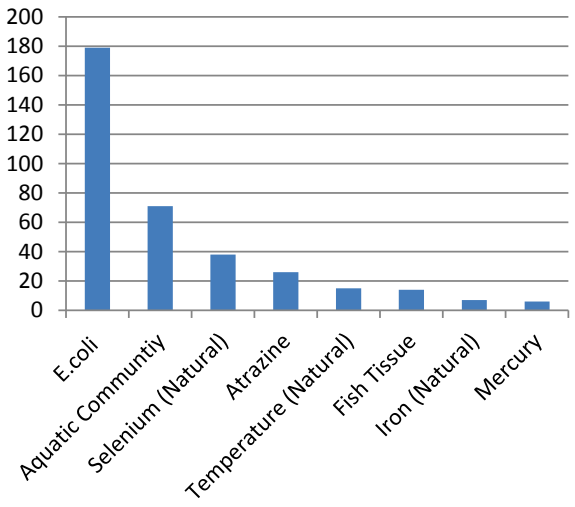
Summarizing the assessment information as simple percentages of impaired waterbodies does not tell the entire story. However, because Nebraska's water quality criteria are designed to be fully protective, impairment of one beneficial use does not mean the waterbody is not supporting other beneficial uses.

Strategies to Resolve Water Quality Impairments

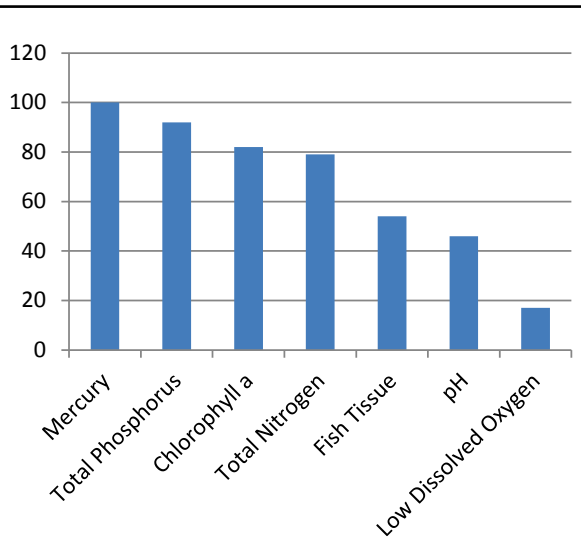
Once a waterbody is determined to be impaired, the CWA requires the state to develop a plan or method to reduce pollutant levels so that waterbody is able to support its designated uses. Point source pollution is managed by the National Pollutant Discharge and Elimination System (NPDES) permitting program, and nonpoint source pollution is typically addressed by Total Maximum Daily Loads (TMDLs), and Watershed Management Plans (WMPs). Both TMDLs and WMPs involve determining the cause and sources of the water quality impairment, while Watershed Management Plans also incorporate working with stakeholders to develop and implement on the ground pollution control strategies. Continuous water quality monitoring provides the needed data to determine if the plan is working or if modifications are required.

More Information:

http://dee.ne.gov/NDEQProg.nsf/OnWeb/TMDL
Brian Barnes, brian.barnes@nebraska.gov or (402) 471-6988



Common stream impairments from the 2018 Integrated Report.



Common lake impairments from the 2018 Integrated Report.

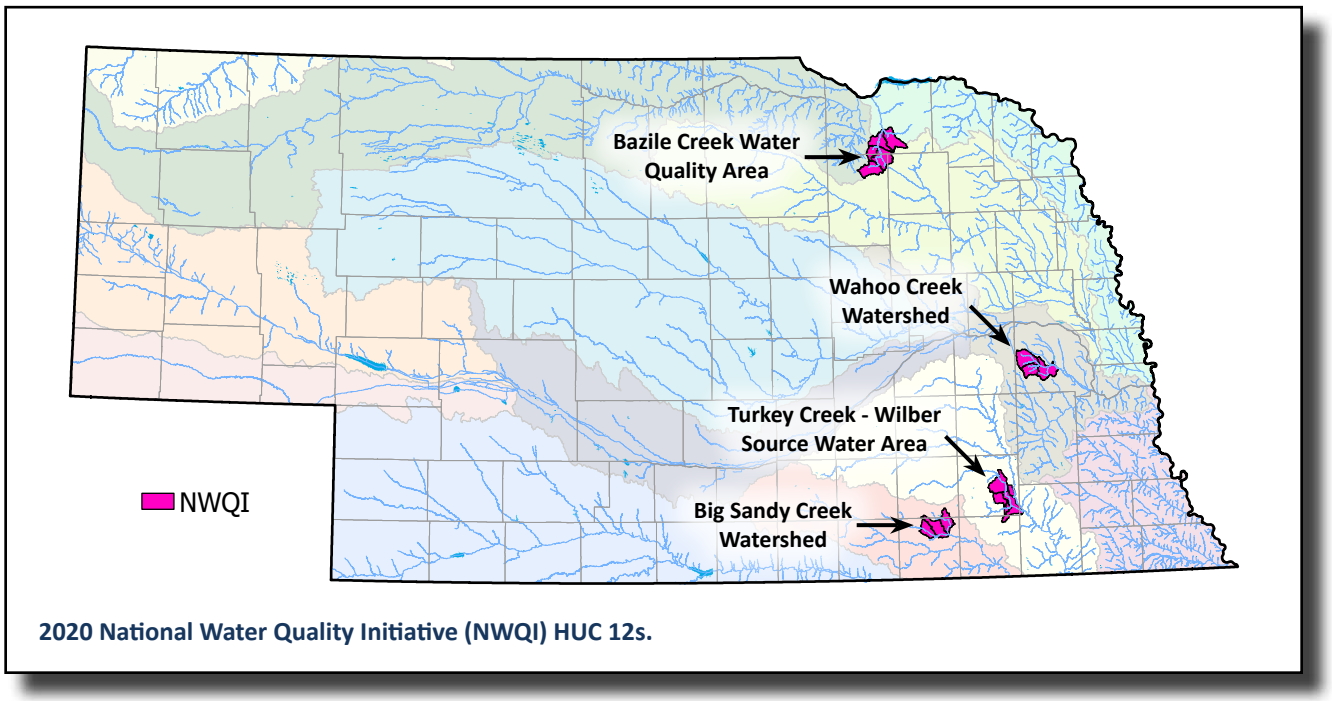
White River, Sioux County.

National Water Quality Initiative

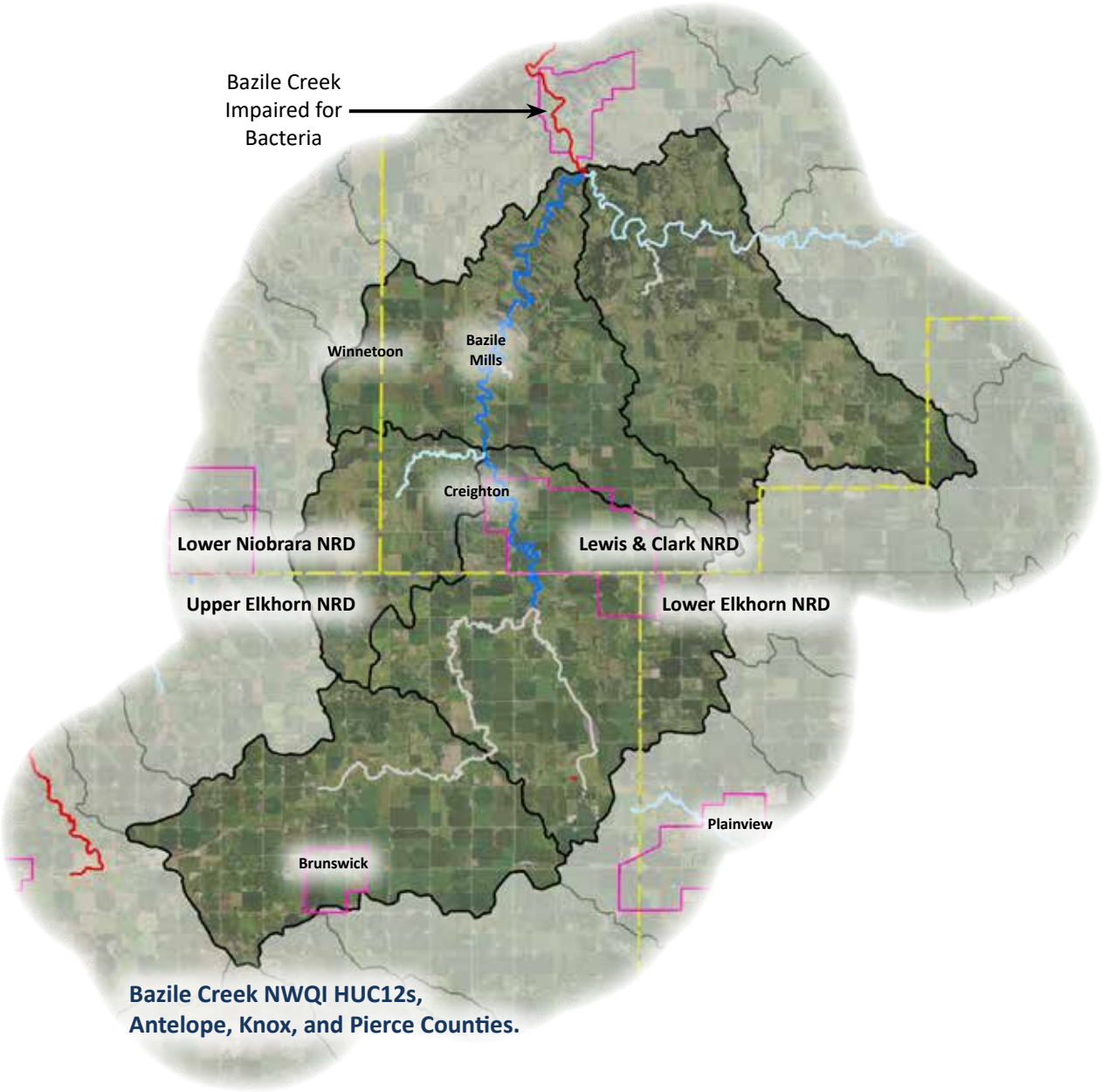
Launched in 2012, the National Water Quality Initiative (NWQI) is a partnership among Natural Resources Conservation Service (NRCS), state water quality agencies, and the US Environmental Protection Agency (EPA) to help producers voluntarily improve water quality in priority watersheds while maintaining agricultural productivity.

NRCS provides financial and technical assistance to implement conservation systems that help avoid, trap, and control run-off and erosion from agricultural fields in NWQI targeted watersheds. Practices may include nutrient management, cover crops, conservation cropping systems, and filter strips. State water quality agencies and other partners contribute additional resources for watershed planning, monitoring, implementation, and outreach.

In Nebraska, collaboration between NRCS and the NDEE Section 319 Program has resulted in leveraging funding from both programs for NWQI watersheds. USDA, NRCS, and NDEE have worked closely together to select four NWQI areas for Nebraska: Bazile Creek Water Quality Area, Wahoo Creek Watershed, Big Sandy Creek Watershed, and Turkey Creek Watershed-Wilber Source Water Area. This is the fifth year Wahoo Creek and Bazile Creek were selected to participate in this program. Big Sandy Creek watershed in the Little Blue River basin was selected as a 2017 NWQI Pilot project for enhanced watershed planning and was accepted as a new NWQI area for 2018. The Turkey Creek Watershed-Wilber Source Water Area was selected as a 2019 NWQI pilot project for enhanced watershed planning.



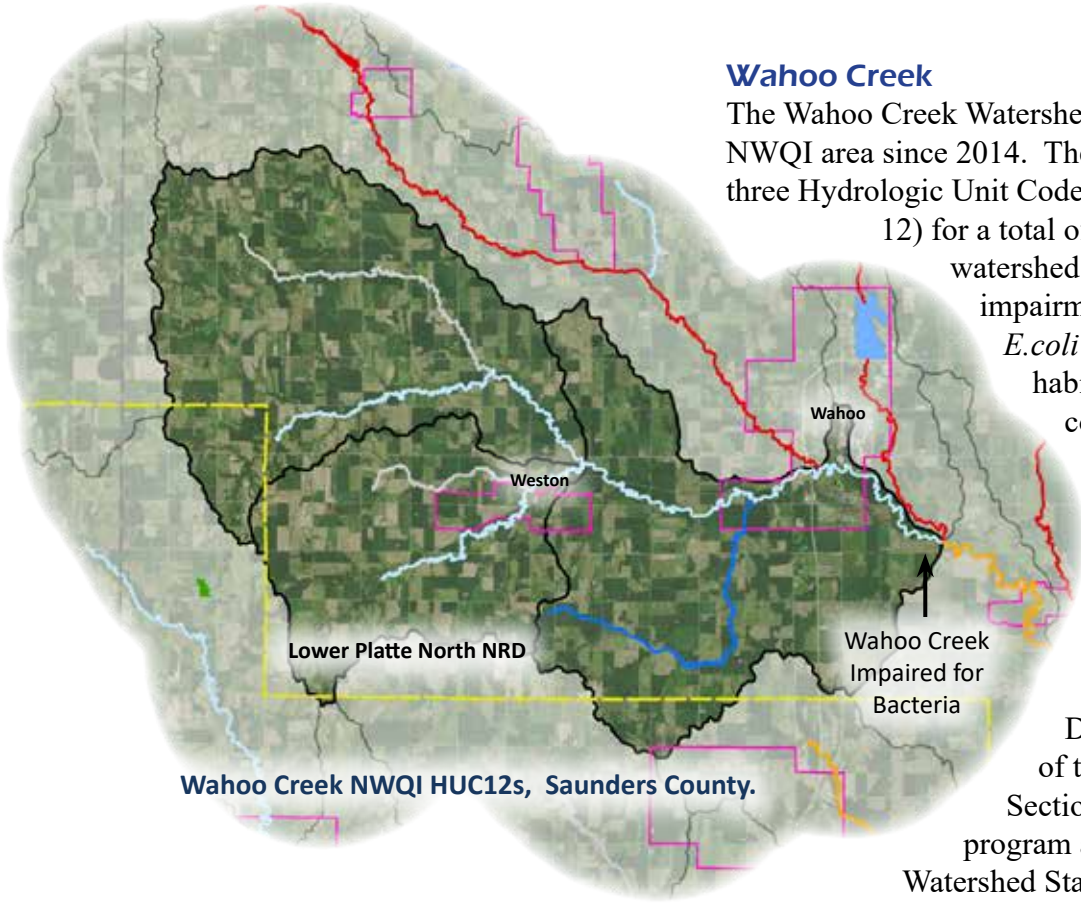
2020 National Water Quality Initiative (NWQI) HUC 12s.



Bazile Creek NWQI HUC12s, Antelope, Knox, and Pierce Counties.

Bazile Creek

The Bazile Creek Water Quality Area has been a designated NWQI area since 2014. The Bazile Creek watershed eligibility area was increased by one HUC12 watershed in 2016, so now consists of five HUC12s and a total of 113,059 acres. This watershed was chosen due to impaired recreational use of Bazile Creek due to high *E.coli* concentration and high concentration of nitrates in groundwater. Bazile has groundwater nitrate levels ranging from 3.7 to 18.9 mg/L and an average of 13 mg/L across the area. There are four Natural Resources Districts (NRDs) in this NWQI area that are serving as sponsors for the Clean Water Act Section 319 portion of the program: Lewis and Clark NRD, Lower Elkhorn NRD, Lower Niobrara NRD, and Upper Elkhorn NRD. In addition, a local technical and community advisory council was established for this project to review information and establish goals and objectives for the area. Conservation practices funded through NWQI in this area include cover crops and nutrient and irrigation management.



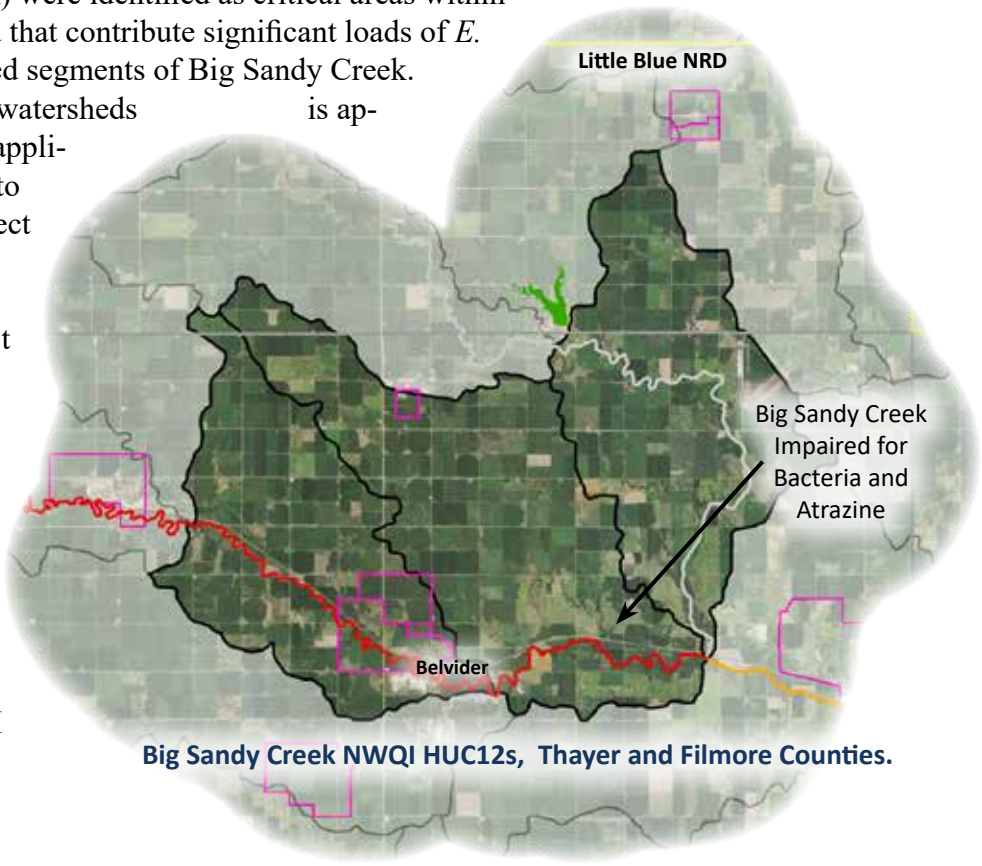
Wahoo Creek NWQI HUC12s, Saunders County.

Wahoo Creek

The Wahoo Creek Watershed has been a designated NWQI area since 2014. The area consists of three Hydrologic Unit Code subwatersheds (HUC 12) for a total of 70,245 acres. This watershed was chosen due to impairment of recreation by *E.coli* and lack of aquatic habitat. The primary conservation practices targeted for funding in this watershed are cover crops, no till, and terraces. In this NWQI area, the Lower Platte North Natural Resources District is the sponsor of the Clean Water Act Section 319 portion of the program and the Wahoo Creek Watershed Stakeholder Group is involved in the planning process.

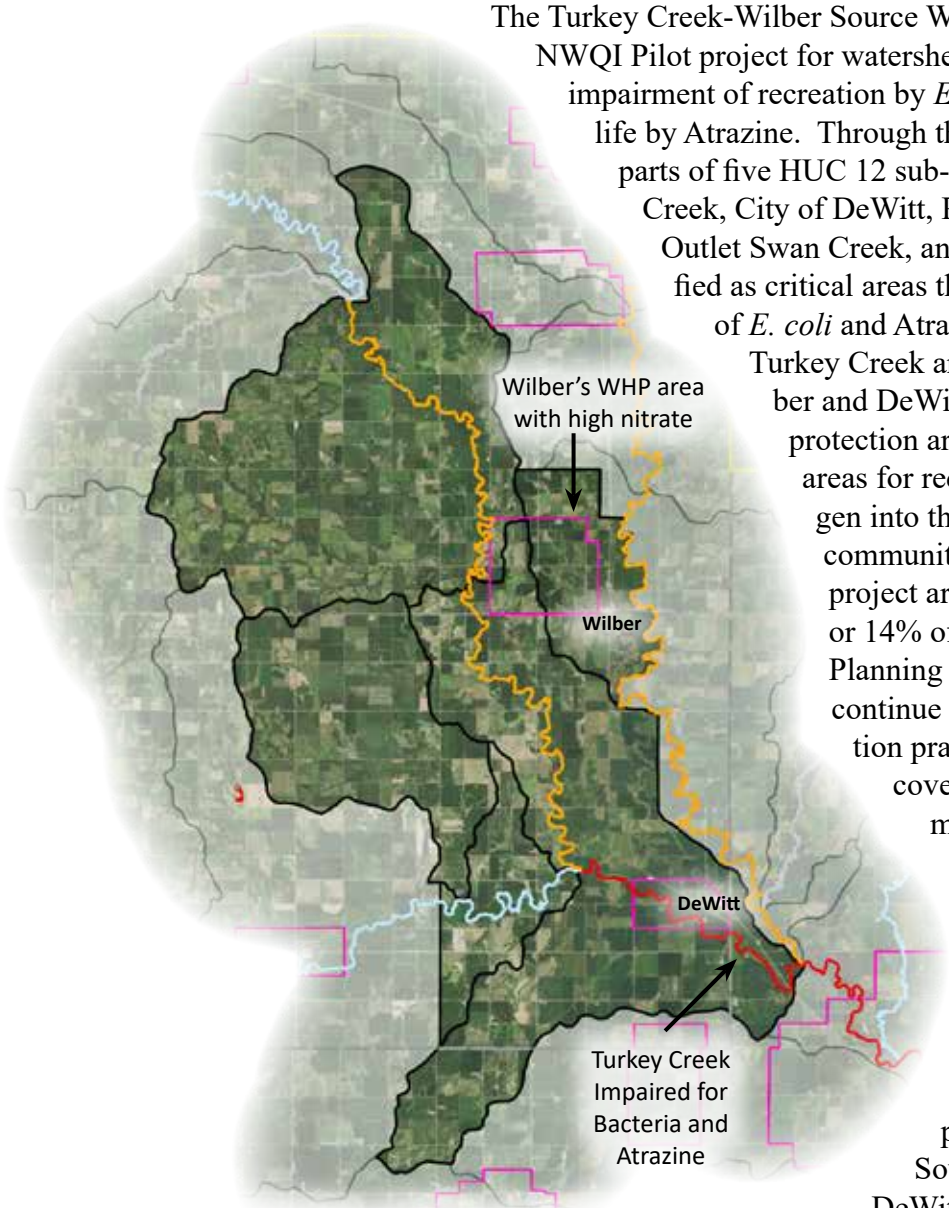
Big Sandy Creek

The Big Sandy Creek Watershed was selected as a 2017 NWQI Pilot project for watershed management planning due to impairment of recreation by *E. coli* and impairment of aquatic life by Atrazine. Through the pilot planning process, three HUC 12 sub-watersheds (City of Belvidere, Big Sandy Creek, Outlet Dry Sandy Creek) were identified as critical areas within the Big Sandy Creek watershed that contribute significant loads of *E. coli* and Atrazine to the impaired segments of Big Sandy Creek. The total size of the target sub-watersheds is approximately 58,000 acres. An application was accepted by USDA to initiate an implementation project in 2018. The implementation project focuses on reduced tillage, cover crops, integrated pest management, and buffer strips to reduce Atrazine runoff from cropland. Controlled grazing, exclusion fencing, stream crossings, and facility management is targeted to livestock operations to reduce *E. coli* runoff. The Little Blue Natural Resources District is the local sponsor for the NWQI project.



Big Sandy Creek NWQI HUC12s, Thayer and Filmore Counties.

Turkey Creek-Wilber Source Water Area



Turkey Creek HUC12s and Wilber Source Water Area
Saline, Jefferson, and Gage Counties
Lower Big Blue NRD

The Turkey Creek-Wilber Source Water Area was selected as a 2019 NWQI Pilot project for watershed management planning due to impairment of recreation by *E. coli* and impairment of aquatic life by Atrazine. Through the pilot planning process, all or parts of five HUC 12 sub-watersheds (Dry Creek-Turkey Creek, City of DeWitt, Plummers Branch, and parts of Outlet Swan Creek, and City of Wilber were identified as critical areas that contribute significant loads of *E. coli* and Atrazine to the impaired segments of Turkey Creek and the Big Blue River. The Wilber and DeWitt source water areas (wellhead protection areas) were identified as critical areas for reducing leaching of nitrate-nitrogen into the groundwater source of those communities' drinking water supply. The project area encompasses 75,300 acres or 14% of the Turkey Creek Watershed. Planning for the implementation phase continue in 2020. Targeted conservation practices include reduced tillage, cover crops, integrated pest management, and buffer strips to reduce Atrazine runoff from cropland. Controlled grazing, exclusion fencing, stream crossings, and facility management will be targeted to livestock operations to reduce *E. coli* runoff. Nutrient and irrigation management practices will be targeted to the Source water areas of Wilber and DeWitt. The Lower Big Blue Natural Resources District is the local sponsor for the NWQI project.

Impacts to water quality in NWQI watersheds will be modeled annually as practices are installed. Water quality data collected on Wahoo Creek, Bazile Creek, Big Sandy Creek, and Turkey Creek through existing NDEE monitoring programs will be assessed biennially for the Integrated Report. Groundwater quality data will be collected annually through existing groundwater monitoring programs by NDEE and local Natural Resources Districts.

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Delisting – Antelope Creek

Permeable pavers installed at Lincoln Children's Zoo.

Antelope Creek (LP2-20900) is 8.06 miles long and runs diagonally through the City of Lincoln, Nebraska from southeast to northwest where it drains into Salt Creek. Holmes Lake intercepts the creek at approximately one third of its length. The watershed of Antelope Creek is 9,322 acres, contains approximately 75,000 people and is fully developed as an urban watershed. The monitoring location for Antelope Creek is just upstream of its confluence with Salt Creek. The Nebraska Department of Environment and Energy (NDEE) listed Antelope Creek (LP2-20900) as impaired for recreation use due to elevated *E. coli* levels in 2004. The recreational geometric mean of monitoring data collected in 2004 was 3,433 cfu/100mL which is well above the standard of 126 cfu/100 mL. NDEE developed a TMDL in 2007 and estimated load reductions of 90% would be needed to attain water quality standards. Sources of *E. coli* in the Antelope Creek watershed included pet waste, runoff from zoo exhibits, illicit discharge, sewer leakage, pigeons, and livestock waste at the former state fairgrounds with other contributing sources including stream erosion and sewage overflow.

Improving Antelope Creek and the surrounding area has been a collaborative effort for more than 20 years involving the City of Lincoln, Lower Platte South Natural Resources District (NRD), University of Nebraska-Lincoln (UNL), NDEE , Nebraska Environmental Trust (NET), Environmental Protection Agency (EPA), US Army Corps of Engineers and other partners and local businesses. Numerous small projects and best management practices were implemented in the watershed to help reduce *E. coli* levels. Pet waste receptacles were placed along Antelope Creek to encourage pickup and disposal of pet waste in order to prevent *E. coli* bacteria from reaching the water. More than 120 raingardens were installed on private property throughout the watershed to retain storm water, reduce runoff and improve water quality.

Antelope Creek open channel near Union Plaza.

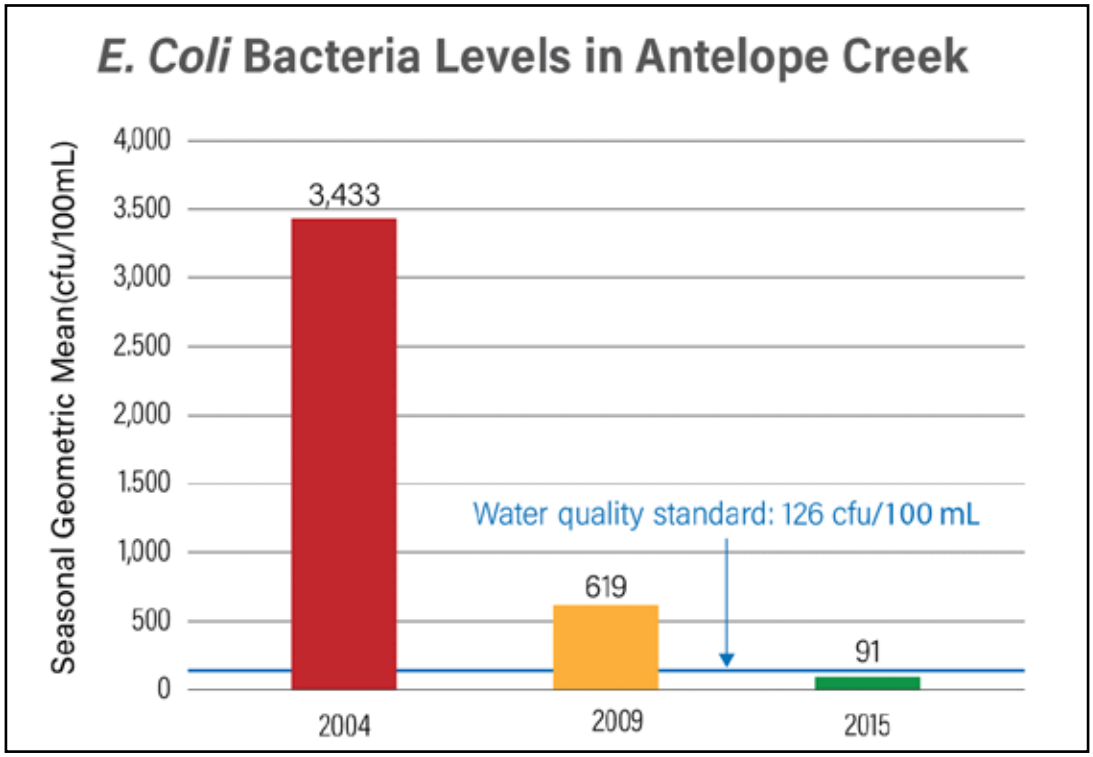
Permeable pavers were installed at the Lincoln Children's Zoo, Union Plaza, and the Assurity Life Insurance Campus bordering Antelope Creek to increase infiltration and reduce the amount of runoff reaching the stream. Other storm water management practices implemented throughout the watershed include bio-swales, constructed wetlands, silva cells, infiltration basins, streambank stabilization, and various native plantings to help slow down runoff and improve storm water quality by allowing the storm water to be naturally treated by native plants. The Assurity Life Insurance Campus

is the anchor point of the Antelope Valley Corridor and set the standard for how other properties would be developed in the now open flood plain. The building is LEED Gold Certified from the U.S. Green Building Council and contains a green roof to help reduce heating and cooling costs and provide stormwater benefits. Other prominent features include an innovative approach to stormwater management using abandoned storm drains as underground cisterns to store runoff for grounds irrigation, pervious paving surfaces and bioswales to reduce runoff and allow absorption of rainwater into the subsoil, and use of low input native and naturalized plantings to minimize irrigation and fertilization needs.

One unique part of the Antelope Valley Project was creating a new open channel parallel to the underground portion of the creek. While the primary purpose of this channel was to reduce flooding, it also allowed more exposure of the water to ultraviolet (UV) light to kill *E. coli* bacteria and inhibit new bacterial growth. The new open channel also created recreation access to the stream and new economic development opportunities along the stream corridor.

Results:

Monitoring data collected by NDEQ in 2015 showed the geometric mean of *E. coli* levels (91 cfu/100 ml) had fallen below the recreation water quality standard of 126 cfu/100 mL. Numerous projects throughout the watershed contributed to the load reduction of *E. coli* to the creek and exceeded the TMDL target of 90% load reduction. As a result of those efforts Antelope Creek is now supporting its recreational use and was delisted in the 2018 Nebraska Integrated Report for *E. coli* impairment. The stream however, remains impaired for aquatic life use due to elevated copper levels.



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Persistence Leads to Atrazine Delisting of Shell Creek

Shell Creek is a 110-mile-long stream in northeastern Nebraska flowing into the Platte River near the city of Schuyler. It drains a 304,897-acre watershed dominated by row crop production (primarily corn and soybeans) and pastureland. Very low levels of conservation practices on croplands in the watershed encouraged high runoff rates and elevated levels of atrazine in Shell Creek. Numerous exceedances of the aquatic life standard for atrazine led to the listing of Shell Creek stream segment LP1-20700 as impair for Aquatic Life Use due to atrazine in 2006.

Tile outlet terraces complement reduced tillage in holding back runoff.

In 1999, a group of landowners formed the Shell Creek Watershed Improvement Group (SCWIG) to address chronic flooding, poor water quality, poor fishery and instability of Shell Creek. With the help of conservation agencies, they developed and implemented a watershed management plan (2005-2015) to resolve these issues. A decade of dedicated conservation work in the watershed significantly reduced the number of exceedances of the Aquatic Life standard for atrazine (12 µg/L), allowing segment LP1-20700 to be delisted in 2018 for aquatic life impairment due to atrazine. A series of projects were conducted under the Shell Creek Watershed Management Plan to abate contamination of the stream and its tributaries by atrazine and *E. coli* and to enhance habitat to improve aquatic life in the stream. To focus conservation efforts, the watershed was divided into 10 sub-watershed. Cost share for conservation practices was offered in the sub-watersheds for two years on a rotational basis until the entire watershed was covered.

Newman Grove students lead discussion on volunteer stream monitoring.

Funding for conservation practices was provided by NE Department of Environment and Energy (Section 319), Natural Resources Conservation Service (EQIP), NE Environmental Trust, Lower Platte North NRD and producers. Practices implemented over the course of the projects included no till (8,040 ac), nutrient management (2,749 ac), contour buffers (17 ac), habitat buffers (97 ac), filter strips (175 ac), grassed waterways (45 ac), cover crops (2,571 ac), sediment basins (75), septic system replacements (88) and well decommissions (58). Many additional acres of the more popular practices (no till, nutrient management and cover crops) were applied without cost share by producers.

The Shell Creek Watershed Improvement Group (SCWIG) and partner agencies provided outreach to producers in the watershed through news articles, newsletters, billboards, meetings, tours and field demonstrations. Outreach was also extended through local schools to engage students and the public in learning about and responding to water quality issues in Shell Creek. Newman Grove High School was particularly successful in establishing and maintaining a student volunteer monitoring program on Shell Creek from 2002 to present. The student group has earned numerous awards and recognition for their work and are considered one of the most effective means of reaching adults in the watershed with information about watershed issues and the restoration efforts.

Results

Shell Creek segment LP1-20700 was first added to EPA's List of Impaired Waters in 2006 due to impairment of aquatic life caused by atrazine. Out of 48 water samples collected from Shell Creek between 2007 and 2016, only seven samples out of a permissible eight samples exceeded the water quality standard of 12 µg/L atrazine, allowing the stream to be delisted for atrazine impairment in 2018. In addition, phosphorous loads decreased by 9,788 lbs./yr., nitrogen loads decreased by 36,455 lbs./yr. and sediment loads decreased by 6,398 tons/yr.

More Information:

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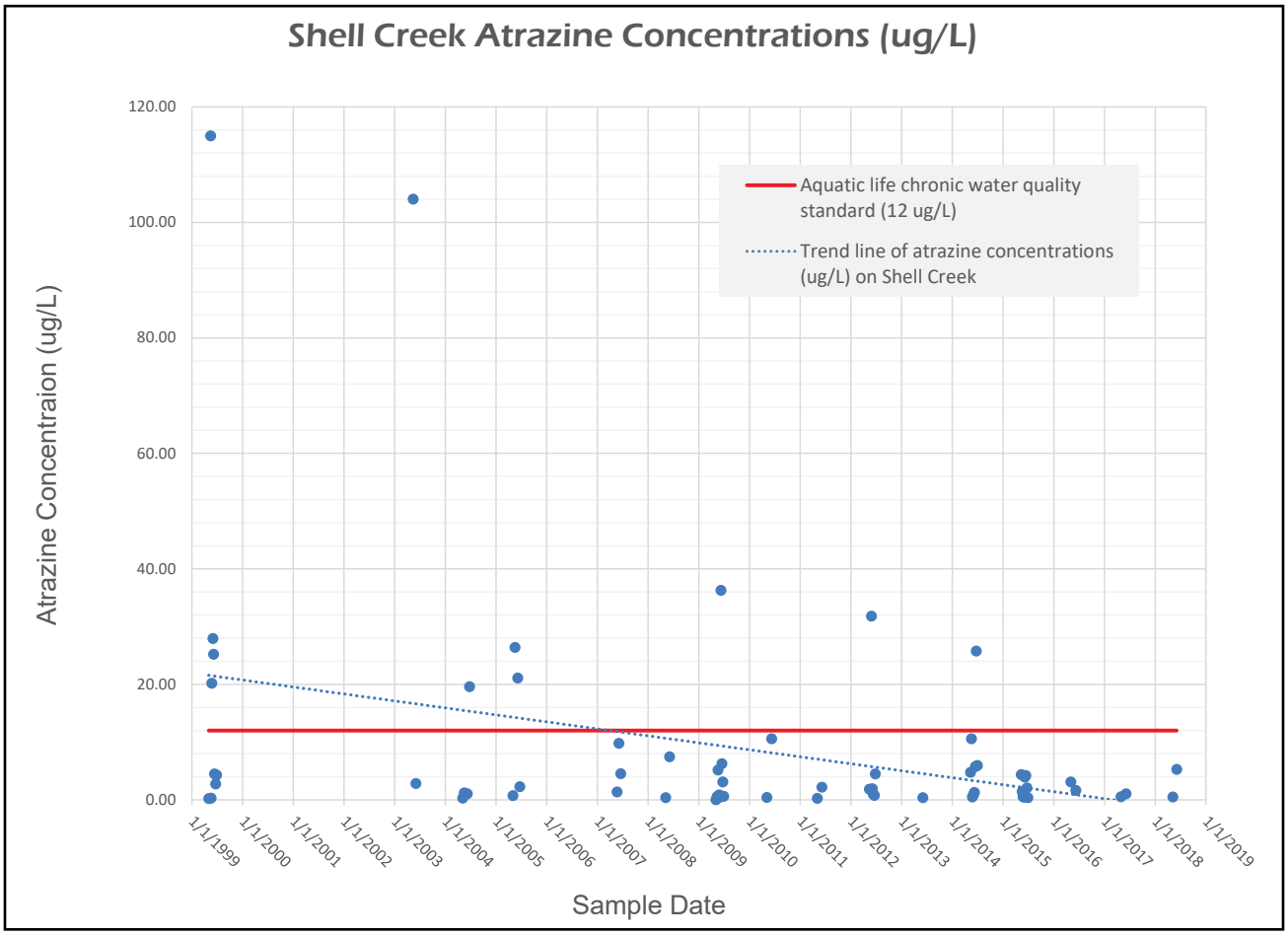


Declining number of exceedances of the Atrazine aquatic life standard resulting from implementation of Shell Creek Watershed Management Plan. Implementation began in 2005.

Groundwater Quality Monitoring Report to the Legislature

Why NDEQ Does this Report

The 2001 Nebraska Legislature passed LB329 (Neb. Rev. Stat. §46-1304) which, in part, directed the Nebraska Department of Environment and Energy (NDEE) to report on groundwater quality monitoring in Nebraska.

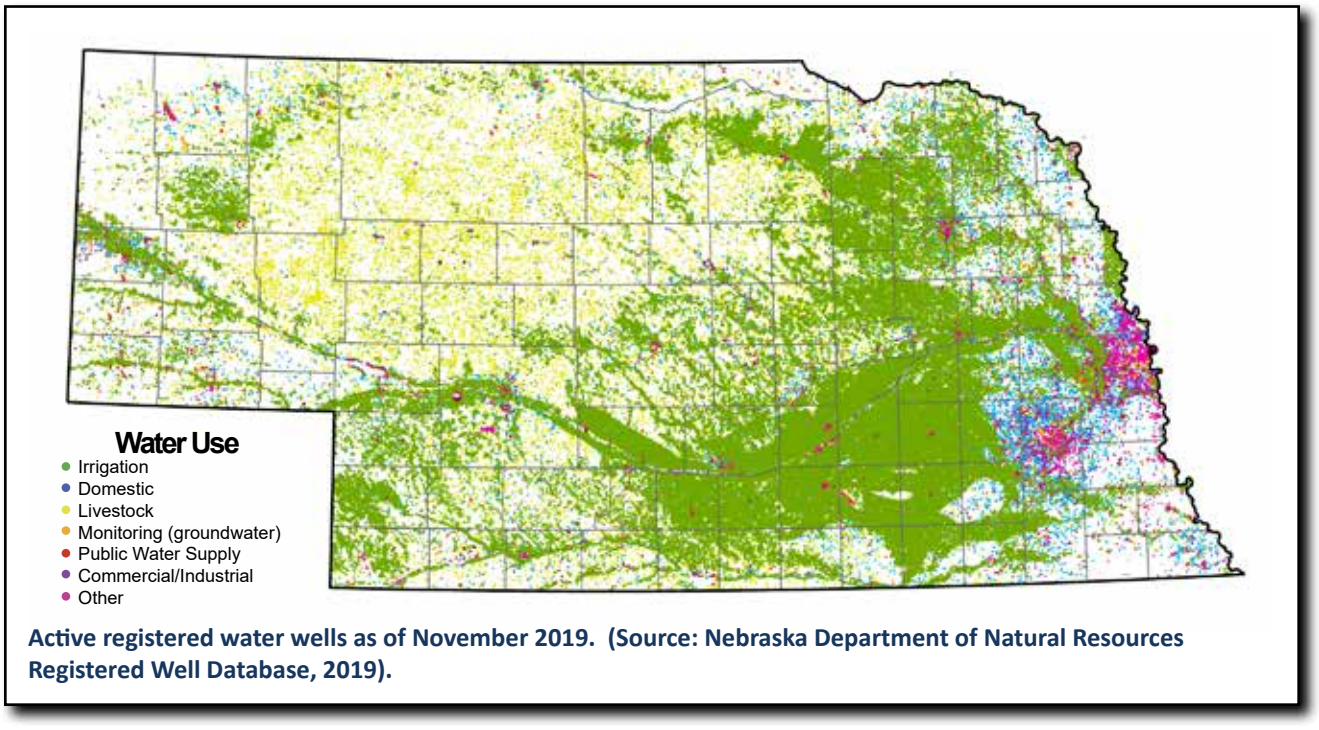
History of this Report

Beginning in December 2001, the Department has prepared a report outlining the extent of groundwater quality monitoring conducted by Natural Resources Districts (NRDs) during the preceding calendar year. The Department uses the data submitted by the districts in conjunction with all other readily available and compatible data for the purpose of the annual groundwater quality trend analysis.

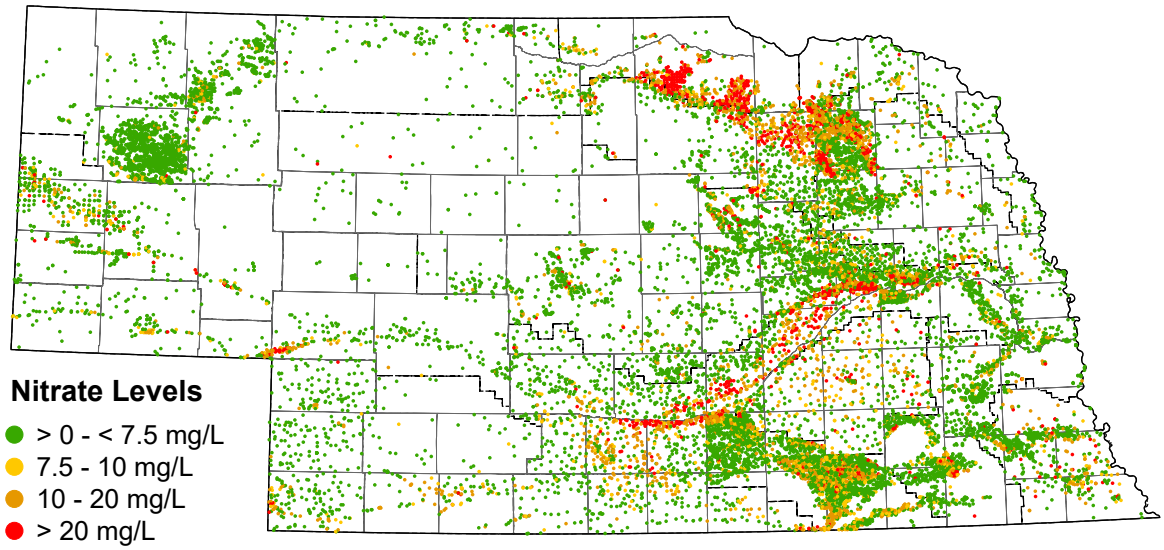
Groundwater sample, Grant County *(Lexi Hingtgen, Upper Loup NRD)*.

Where is the Monitoring Conducted?

The State of Nebraska is a large geographic area, over 77,000 square miles. There are over 185,000 active registered wells in Nebraska including irrigation, industrial, municipal, and domestic wells. In 2018, 4,625 wells were sampled. Since 1974, over 25,000 wells across the state have been sampled by state agencies, University of Nebraska, federal agencies, and local NRDs. Monitoring is typically conducted in areas of Nebraska with groundwater problems.



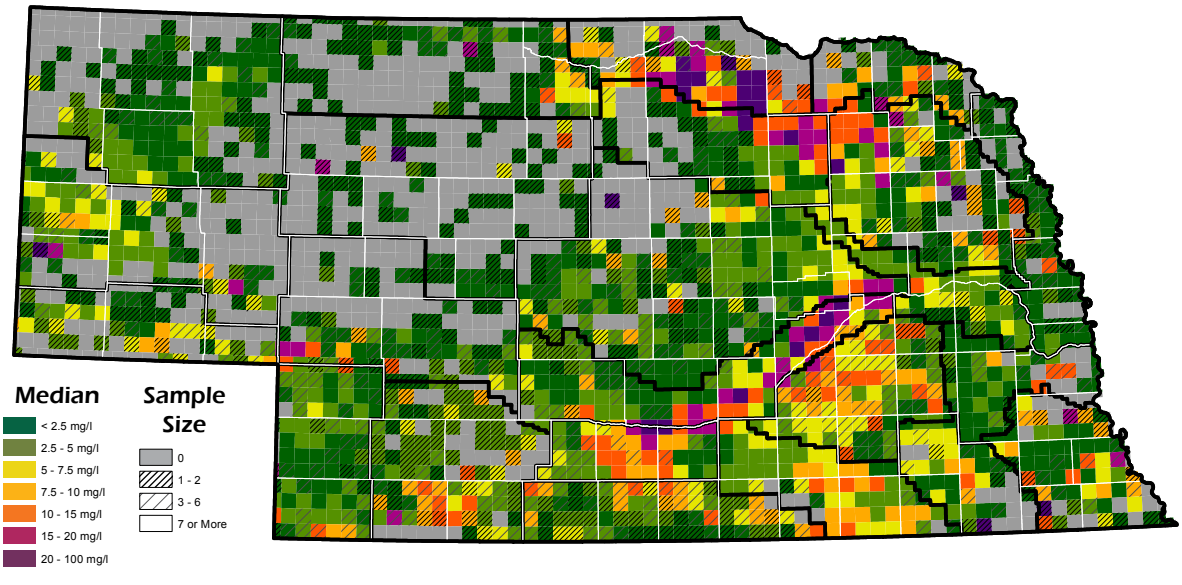
Active registered water wells as of November 2019. (Source: Nebraska Department of Natural Resources Registered Well Database, 2019).



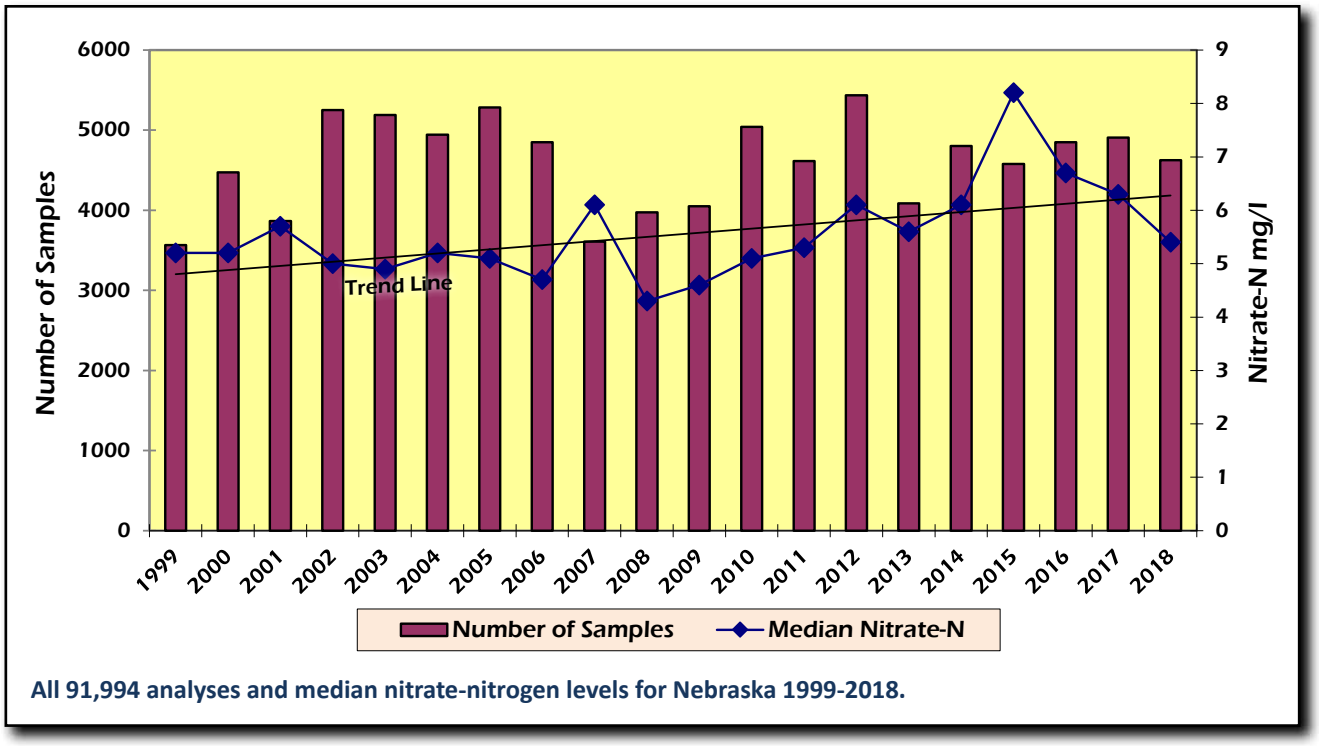
Most recent recoded Nitrate-N concentration 18,299 wells from 1999-2018. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2019)
Empty areas indicate no data reported, not the absence of nitrate in groundwater.

What is Monitored?

There are over 240 compounds monitored for since 1974 and used in this report. Some of the compounds that have been detected more than just a few times throughout this period include nitrate-nitrogen and atrazine. Nitrate is a form of nitrogen common in human and animal waste, plant residue, and commercial fertilizers. Atrazine is a herbicide used for weed control in a variety of crops such as corn and sorghum.



Median of the most recent Nitrate-N concentration by township of 18,299 wells from 1999-2018. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2019)
Gray areas indicate no data reported, not the absence of nitrate in groundwater.



All 91,994 analyses and median nitrate-nitrogen levels for Nebraska 1999-2018.

How is the Data Used?

The Department analyzes the data collected for the purpose of determining whether or not groundwater quality is degrading or improving and presents the results to the Natural Resources Committee of the Legislature beginning December 1 of each year. The State's 23 NRDs use the data to make decisions on the management of groundwater. All NRDs have designated Groundwater Management Areas over part or all of their districts to address groundwater quality problems.

Irrigation pivot, Logan County *(Lexi Hingtgen, Upper Loup NRD)*.

Results as of 2018

The majority of Nebraska's residents rely on groundwater for drinking water, agriculture, and industry. Most public water supplies that utilize groundwater do not require any form of treatment for drinking water before serving it to the public. Nitrate is Nebraska's number one groundwater contaminant. There are some limited areas in Nebraska where the nitrate concentration is greater than the drinking water standard of 10 mg/L (see map below).

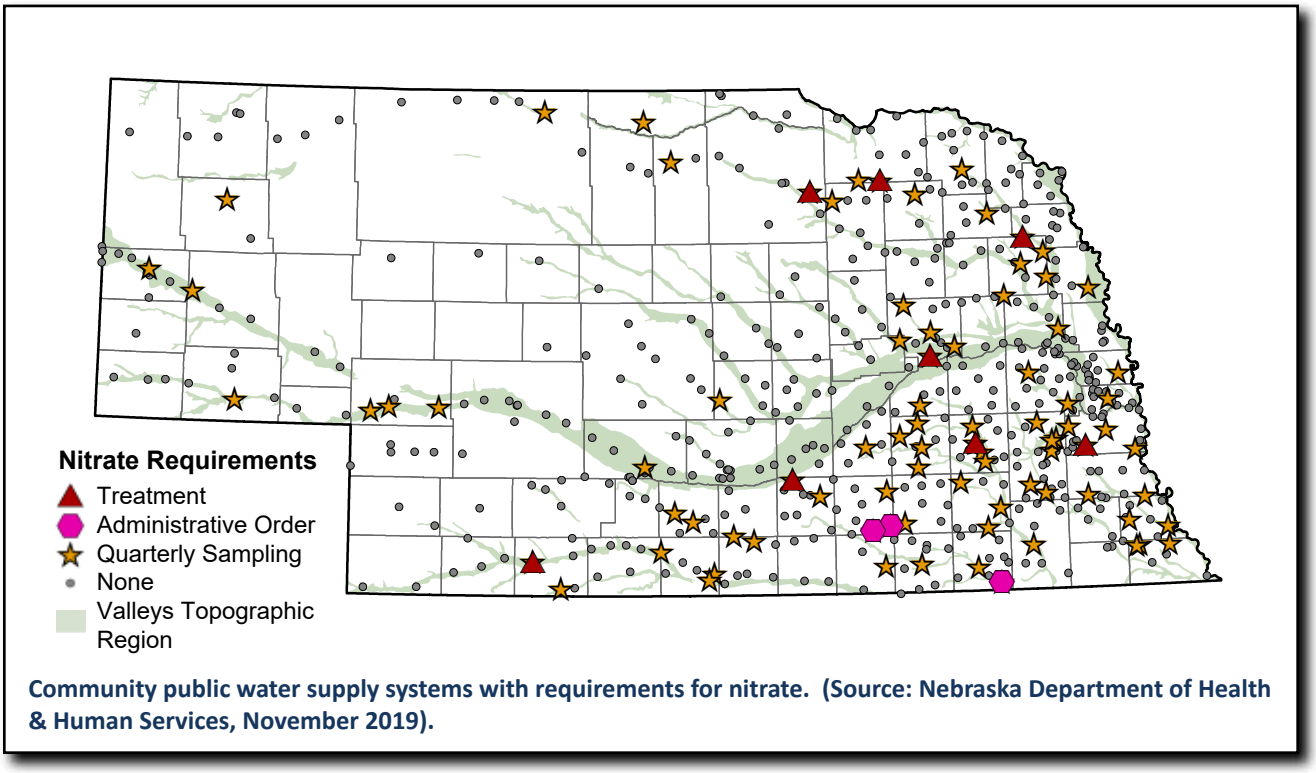
Reverse Osmosis treatment plant to remove nitrate, Seward County.

The most representative picture of the statewide nitrate concentration is from the time period from 1999 to 2018 due to the number and spatial relationship of the samples collected. The overall trend indicates only a slight increase in nitrate median concentrations statewide (see chart above).

All of the results for agricultural chemicals (including nitrate) can be found on the Nebraska Department of Natural Resources (NDNR) website (http://clearinghouse.nebraska.gov). The entire database can be accessed at NDNR's website, where the database may be searched or 'queried' for numerous subsets of data, such as results by county, type of well, Natural Resources District, etc.

More Information:

http://dee.ne.gov/Publica.nsf/Pages/WAT248
David Miesbach, david.miesbach@nebraska.gov or (402) 471-4982.



Community public water supply systems with requirements for nitrate. (Source: Nebraska Department of Health & Human Services, November 2019).

Groundwater Monitoring at Permitted Livestock Facilities

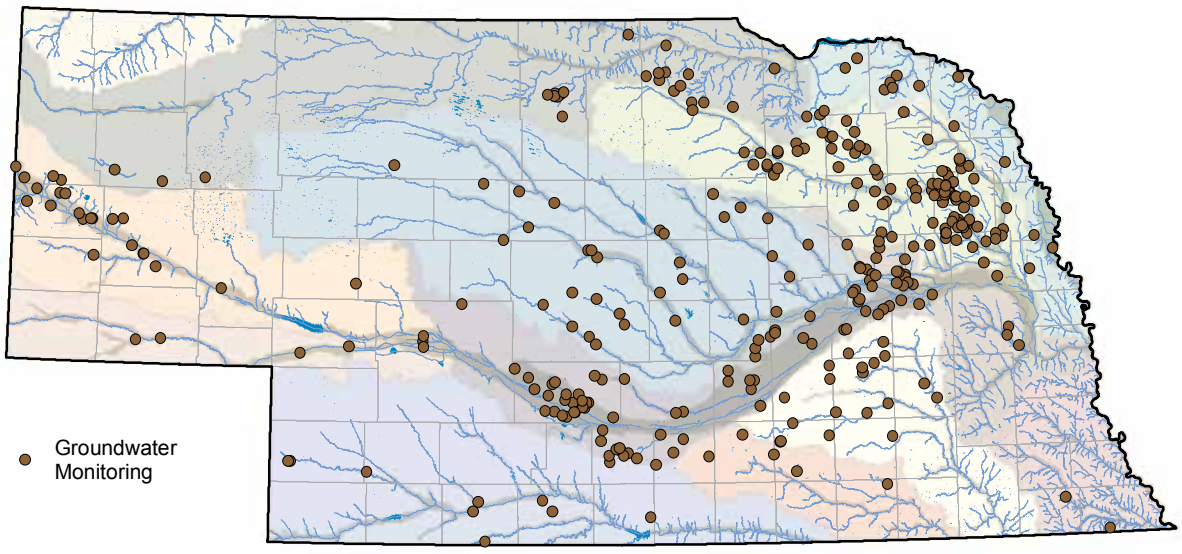
Why require monitoring at livestock facilities?

Nebraska's groundwater may be negatively impacted by leakage from holding ponds or lagoons at livestock waste control facilities (LWCFs). The liquid waste in the holding ponds has elevated levels of nitrate-nitrogen, ammonia, and chloride ions. The NDEE requires monitoring of these chemical parameters to document any impact to groundwater. The contaminated groundwater may negatively impact public water supplies and domestic wells. The NDEE oversees the investigation and remedial measures conducted by the owners of the facilities if groundwater has been impacted.

Feedlot in Central Nebraska.

History of the monitoring program

The NDEE's Groundwater Section began reviewing permitting plans for LWCFs in 1997. The site-specific hydrogeology, soils, depth to water, and use of the groundwater are reviewed to determine the vulnerability of the groundwater. The Groundwater Section has reviewed 1,469 LWCFs (as of November 2019) and recommended monitoring at 493 of them. Currently, there are 479 approved groundwater monitoring plans with 346 operations where semi-annual monitoring is conducted. Twenty-eight operations conduct annual sampling due to little or no change in the water quality. The map below shows the locations of the facilities where groundwater monitoring is conducted.



Livestock Operations with Ongoing Groundwater Monitoring.

What is monitored?

Groundwater samples are collected from monitoring wells installed around the lagoons or holding ponds and analyzed at a laboratory for

- nitrate-nitrogen,
- ammonia, and
- chloride concentrations.

Groundwater naturally has low concentrations of chloride and nitrate-nitrogen while ammonia is not naturally present in groundwater. Additionally,

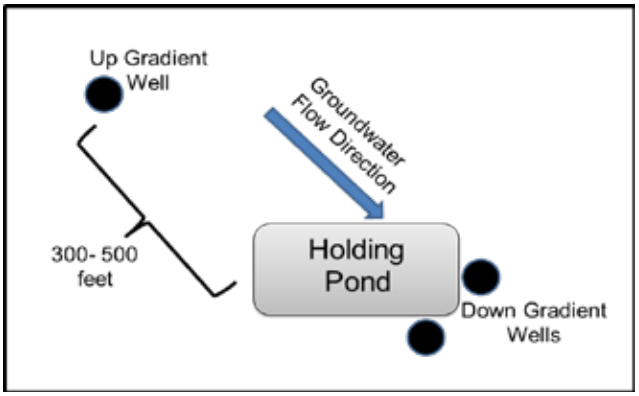
- depth to water,
- pH,
- temperature, and
- specific conductivity

are collected from each monitoring well. The groundwater quality and the flow direction are monitored in the spring (before irrigation season) and the fall (after irrigation season).

Samples from groundwater monitoring wells near a failing lagoon.

Where are the wells installed?

A typical livestock facility with groundwater monitoring has three monitoring wells. One well is located 300-500 feet up gradient of the holding pond to record the water quality conditions prior to flowing down gradient under the lagoon. Two monitoring wells are located adjacent to each holding pond in the down gradient flow direction to more quickly identify possible impacts to groundwater. The adjacent diagram shows a generic map of recommended locations for groundwater monitoring wells.



Recommended locations for groundwater monitoring wells.

How are the data used?

The LWCF is responsible for conducting the semi-annual monitoring and submitting a report to NDEE twice a year. Monitoring is conducted either by a hired consulting firm or by the owner of the livestock operation. Groundwater Section staff review the results from the groundwater sampling. A facility that has had at least three sampling events is evaluated to determine if groundwater has been negatively impacted. In the event a facility has impacted groundwater, the facility is required to address the issues. Currently there are less than five LWCFs with more comprehensive groundwater investigations underway. To date, NDEE does not know of any private or public drinking water wells that have been contaminated from a livestock waste control facility.

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Crow Butte Resources, Inc. Groundwater Monitoring

Crow Butte Resources, Inc. in-situ recovery uranium facility. Dawes County.

Crow Butte Resources, Inc. uranium mine has been operating in western Nebraska for over three decades. The site consists of several thousand Class III injection wells used for In-Situ Recovery (ISR) uranium mining, and it has been regulated and monitored by the Nebraska Department of Environment and Energy (NDEE) since active mining began in 1985. Part of this regulation includes a local ban on drilling any water wells in the permitted area other than those associated with the mining process.

The Class III production/injection wells are used in the ISR method of uranium mining. The U.S. Nuclear Regulatory Commission (NRC) defines ISR uranium mining as a process using a leaching solution to extract uranium from underground ore bodies in place (in other words, in-situ). The leaching agent, called lixiviant, contains an oxidant such as oxygen with sodium bicarbonate. The uranium in the aquifer is in a reduced environment and therefore in a solid state, occupying some of the pore spaces in the aquifer. The lixiviant is injected through injection wells into the ore body in a confined aquifer to oxidize the reduced environment and liberate the uranium. The solution is then pumped via other wells, called production wells, to the surface for processing.

Permit Modifications

CBR most recently requested a minor permit modification in 2018. This modification request had two purposes; to allow all mine units to be officially placed in the restoration phase during non-active mining operational phases, and to eliminate required daily pressure readings in well houses that have been isolated and no longer have the potential for flow of mining solutions to or from the well house. Because this was a minor permit modification, no official public notice period was required.

Groundwater Monitoring at the facility

There are two types of groundwater monitoring wells at the CBR uranium mining facility – deep (production zone) monitoring wells and shallow (Brule Formation) monitoring wells. The wells are screened through the entire aquifer to ensure that the mining fluids do not migrate laterally or vertically outside the portion of the aquifer being mined. Deep monitoring wells are drilled into the Chadron Formation, where the mining is occurring. These deep wells surround each mine unit and are located no more than 300 feet from the mine unit (or production zone) and approximately 400 feet apart. Shallow monitoring wells are spatially distributed throughout the mine units, with at least one well every four acres. These wells are drilled into the Brule Formation aquifer, which locally serves as a drinking water source, to ensure mining fluids are not migrating upward. Both the shallow and the deep monitoring wells are sampled biweekly (once every two weeks) for chloride, conductivity, alkalinity, water level, and barometric pressure. The shallow monitoring well samples are also, at a minimum, analyzed annually for uranium and radium-226 to the lowest detection limit available. Currently, 381 monitoring wells are actively sampled on a biweekly basis, 180 of these are deep monitoring wells and 201 are shallow monitoring wells.

Reporting Requirements

CBR submits monitoring well analyses to the NDEE in a quarterly report, and each quarter NDEE randomly checks laboratory analyses by splitting samples from the monitoring wells with the facility. The samples are collected by NDEE field staff and are sent to the State Health Lab to be analyzed for chloride, conductivity, and alkalinity. The analytical result from both CBR laboratory and the State Health Lab are statistically compared for quality assurance purposes. NDEE takes a duplicate sample of one well during each split sampling event to ensure the quality of the lab analyses.

Drilling rig at Crow Butte Resources Inc., Dawes County.

Quality Assurance/Quality Control in 2019

Groundwater monitoring well samples are collected and analyzed by the laboratory at CBR. In 2019, the NDEE randomly split 56 of those groundwater samples (7 from deep monitor wells and 7 from shallow wells each quarter) with CBR. Samples collected by NDEE are sent to the State Health Lab for analysis. Comparisons between CBR laboratory's analyses and NDEE's analyses for the samples were within a statistically reasonable margin of error.

Future Expansion

There are currently 11 mine units constructed at the facility. Mine Unit 1 has reached restoration and stabilization goals as determined by NDEE. Mine Units 2, 3, 4, and 5 are being monitored for stabilization. Mine units 6 and 7 are currently undergoing restoration activities. To date, CBR has no plan to extend mining at their current facility beyond Mine Unit 11.

Future expansion would occur at two satellite facilities, Marsland and Three Crow. Applications have already been received and initial review conducted for Marsland. These satellite facilities are expected to have similar groundwater monitoring plans and requirements as the current CBR mining operation. At this time, it has been requested by CBR that these expansion applications be tabled until further notice.

Well field at Crow Butte Resources, Inc., Dawes County.

More Information:

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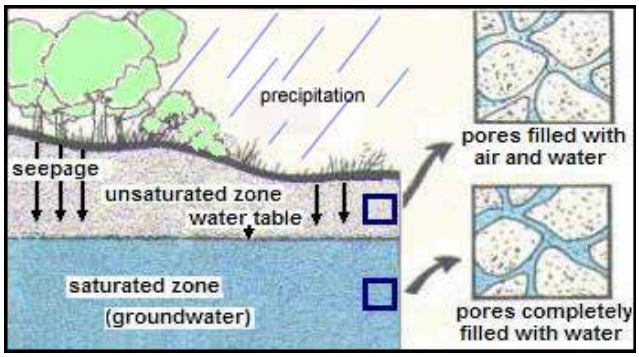
Nebraska Vadose Zone Nitrate Assessment

Why do NDEE and Partners Monitor the Vadose Zone?

Nitrate is the most common contaminant in groundwater worldwide (Exner, Hirsh, et al. 2014) and the most prevalent cause for impairment of public water supplies in the United States (Burow, Nolan, et al. 2010), (Gurdak and Qi, 2013). A recent study describing growing trends of nitrate in Nebraska's groundwater concluded that overall concentrations and areal extent are likely to increase. A major driver for this trend is the fact that nitrate occurring in the unsaturated zones above much of the state's groundwater resources have not yet reached steady state (Exner, Hirsh et al. 2014). Continued leaching will result in increasing nitrate concentrations in many areas. While recent changes in producer management practices have slowed increases in groundwater nitrate in some areas, irrigation and nutrient applications must be more effectively controlled to retain nitrate in the root zone. Nebraska's Natural Resources Districts now wrestle with regulations designed to improve management of surface activities to both reduce loading and minimize continued leaching of nitrate already stored in the vadose zone.



Vadose (unsaturated) zone diagram. ***Source: NYSDEC***

In the early 1990s researchers at the University of Nebraska cored over 10,000 feet of vadose zone through continuous hollow stem auger coring of areas with a variety of land use practices (Spalding 1996). Subsequent studies have been conducted by public water utilities to examine the levels of nitrate in the unsaturated zone as part of their wellhead protection program. This data forms the basis for a proactive vadose zone monitoring program for the state.

Geoprobe collecting a vadose zone soil core, Clay County.

Developing an effective monitoring and management program for vadose zone nitrate in Nebraska requires compilation and organization of existing data in such a way that spatial and temporal trends can be easily identified. Geospatial databases exist for showing trends in groundwater nitrate and other agrichemicals, but no such database was available for nitrate and agrichemicals in the unsaturated zone. To meet this need, an online vadose zone database was developed to include historical occurrence and distribution of vadose zone nitrate along with hydrologic details that can help predict of transport rates. This online framework will ultimately permit identification of areas across Nebraska where additional sampling can fill gaps and better predict the effect of changing nitrogen management at the surface.

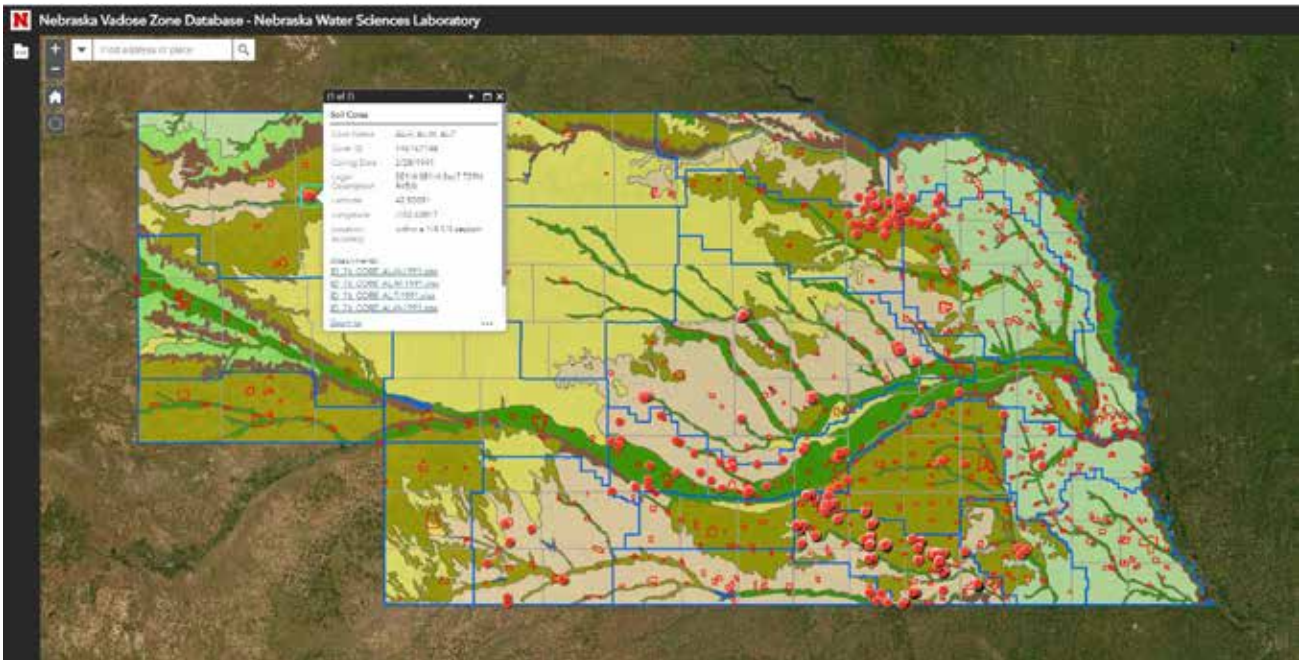
Results and Future Plans

Development of the database, a framework for standardized collection, processing, analysis, and sharing, and a push to collect additional data began in 2016 by UNL with financial and technical assistance from entities including: NDEE, Nebraska Environmental Trust, Nebraska Water Center, Conservation and Survey, Institute of Agriculture and Natural Resources, Lower Platte South NRD, Lower Loup NRD, Central Platte NRD, and Hastings Utilities.

Extracted vadose zone soil core in corn field. ***Source: https://nebraskavadose.unl.edu***

Database

A geospatial database was created using historical data and linked to a map of Nebraska depicting locations of past measurements of nitrate and other agrichemicals in the unsaturated zone. This database includes, at a minimum: sampling date, latitude, longitude, total depth, method of coring, intervals sampled and sediment nitrate concentrations for each interval. Additional information is included in the database such as sediment texture, bulk density, particle size, pH, moisture content, ammonia, iron, uranium, selenium, arsenic, atrazine and other pesticide residues that helps predict leaching and loading rates of nitrate and other contaminants impacting Nebraska's groundwater. Over 750 location across Nebraska are included and more are being added. The databases and interactive map along with more information can be found online: http://nebraskavadose.unl.edu/



Interactive map depicts the locations where measurements of nitrate and other agrichemicals, such as pesticides and heavy metals, have been recorded in the vadose zone in Nebraska. ***Nebraska Water Center. 2020. Nebraska Vadose Zone Dabatase. University of Nebraska. Lincoln, NE USA. https://nebraskavadose.unl.edu***

Standardized methods

The Nebraska Vadose Zone program is standardizing data collection, processing, analysis, and sharing of vadose zone monitoring data. A quality assurance project plan template, standard operating procedures, training videos, and select publications are available on the Nebraska Vadose Zone website as guidance for those wishing to establish or enhance a vadose zone monitoring program.

Coring and lab work

Coring and laboratory work has been completed in Waverly's Wellhead Protection (WHP) area, Springfield WHP area, Hastings WHP area, areas of the Central Platte NRD and Lower Platte South NRD. Planning is underway to begin coring in the Bazile Groundwater Management Area (BGMA), Wilbur WHP area, and Syracuse WHP area.

More Information:

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Drill rig collecting a vadose zone soil core in corn field, Clay County.

Measuring water table depth in a borehole after extracting core. ***Source: https://nebraskavadose.unl.edu***

Physical analysis of soil core at Water Sciences Laboratory. ***Source: https://nebraskavadose.unl.edu***