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# Background Information

During the recent Memorial Day weekend a water quality event occurred in the Middle Snake River from about the East Perrine Coulee (or approximately 0.97 miles east of the Perrine Bridge) through the upper stretches of Auger Falls (or approximately 1.83 miles west of the Perrine Bridge). The event was more noticeable on Memorial Day (May 26$^{th}$) due to its extent across the river through the Centennial Park area. Most likely the event began a day or two before. DEQ believes, after some extensive search of the affected reach, that the event was characteristic of a freshwater algal bloom.

Eye witness reports indicate that it commenced within the water column as small dark-like (violet, purple to black) patches immediately below the Perrine Bridge and eastward towards the East Perrine Coulee confluence. As the event continued for at least a day or two, the algal bloom covered the width of the river and immediately began to move downstream with the stream flow past the Perrine Bridge, past Centennial Park and on to Auger Falls.

The algal bloom dissipated in the Auger Falls rapids most likely due to the churning action of the rapids. At Centennial Park, the concentration of the algal bloom appeared (by sight) to have lodged on the south bank between the three boat docks. The discoloration progressed through several days from the initial dark colors to a reddish-rust color. Wind action on the water surface began to mix the algal bloom within the water column. As the mixing occurred, the algal bloom appeared to show a change from the reddish-rust color to an emerald green, and later to a darker green.

The length of time for the algal bloom to progressively turn emerald green within the affected reach was approximately 5 days. By the sixth day the remains of a bloom was confined along the north and south banks of the river channel, with the south bank being the most affected. In these localized areas of the river channel a large number of rooted aquatic plants (known as Potamageton crispus) acted as anchors for the suspended algae in the water column; thus suspending the algal bloom in the water column and holding it longer in these localized areas. Visually, the reddish-rust colored algae could be seen in layered microscopic strands through the water column.

It should be noted that algae are a natural component of the aquatic food chain and are typically not harmful to people. However, the overabundance of algae as part of an algal

bloom can be aesthetically unappealing and potentially harmful to the environment, particularly if it produces toxins that affect native aquatic organisms, fish, pets and potentially people if they come in contact with it. Additionally, the decomposition of dying algae, after an algal bloom, has the potential to reduce the levels of dissolved oxygen in the water, which aquatic animals breathe; and this by itself could affect aquatic organisms deleteriously.

**THE CAUSE OF THE ALGAL BLOOM**

The cause of the algal bloom may be attributed to a number of factors that act in combination with each other and may have an effect on different algal groups (such as diatoms, green algae, blue-green algae or cyanobacteria, dinoflagellates, etc.) in unique ways. The four main conditions that may contribute to an algal bloom are higher water temperatures, light penetration through the water column, low flow conditions and excess nutrients. Some research indicates that there may be a link between water temperature and year-to-year differences in bloom intensities. The mode of nutrition for the algae is by photosynthesis because of the pigments they contain.

First, water temperature may have the greatest bearing as a trigger to the algal bloom cycle. In general, as water temperature increases the potential for an algal bloom may increase as well. In the case of the Middle Snake River, the ambient maximum day temperatures prior to May 22$^{nd}$ were less than 69°F. But from May 22$^{nd}$ through May 27$^{th}$ the maximum day temperatures ranged from 79°F to 91°F, which most likely warmed the water temperature sufficiently through May 26$^{th}$ to induce the algal bloom. The optimum water temperature for cyanobacteria (a toxic alga) to trigger an algal bloom is 77°F. Other algae (and not as toxic) may be triggered at 53.6-59°F. The water temperature in the Middle Snake River at various locations showed levels that ranged from 63.3°F to 64.8°F, which falls in the middle of the two types of algae that may be susceptible to algal blooms.

Second, high light intensity from the sun exposed the water column sufficiently to cause light penetration into the water column to the levels where the algae were present. Because this stretch of the river has a relatively higher water quality, the turbidity was very low (< 8 NTUs) along all stretches of the affected reach (based on DEQ's assessment); even in those areas where the localized areas appeared darker in color. When turbidity is low, more light can penetrate through the water column; and this creates the potential for optimal growth conditions for an algal bloom. During the Memorial Day weekend the sun was out and light penetration into the Snake River was most likely fairly deep because of the low turbidity.

Third, low flow conditions existed in the affected reach. Decreased flows (< 500 cfs) generally create a slowing down of the flow of water which has a tendency to trigger the growth of algae. But in addition, thermal stratification of the water generally occurs where the cooler water remains in the lower layer, while the upper layer near the surface warms up. When the two layers fail to mix, algae have a tendency to grow in the upper layer. During the Memorial Day weekend, it is most likely that the upper layer of the slow moving water was warmer and the lower layer was cooler. Fishermen reported

to DEQ that the bass fishing was good, but the fish were mostly in the lower layer. Additionally, the dissolved oxygen in the Middle Snake River at various locations were > 6.0 mg/L indicating that the water quality standard was being met with no apparent anoxic zones throughout the reach. And, the water pH was alkaline (pH 8.5-8.6) indicating that no acidic chemicals (pH <7) were present in the system.

Fourth, nutrients in the water, depending on their concentration, cause eutrophication of the water column. This means that the nutrients create a nutrient enrichment that stimulates algal growth. Phosphorus and nitrogen contribute as enrichment nutrients in the water column. According to DEQ's Upper Snake Rock Five-Year Review (2010) the median phosphorus concentration since 2000 is 0.077 mg/L TP.

The lab results at two locations in the most affected areas of the discoloration indicate the following:

| PARAMETER | MAIN BOAT DOCK | UPPER BOAT DOCK | HISTORICAL WATER QUALITY IN SNAKE RIVER at PILLAR FALLS |
|---|---|---|---|
| Total Phosphorus, mg/L | 0.08 | < 0.05 | 0.077[B] |
| Total Kjeldahl Nitrogen, mg/L | 0.83 | 0.36 | 0.57[A] |
| Ammonia Nitrogen, mg/L | < 0.05 | < 0.05 | 0.09[A] |
| Nitrate + Nitrite, mg/L | 1.66 | 1.62 | 1.62[A] |
| Escherichia coli, MPN/100 mL | 4.1 | 5.2 | 2.0[B] |

[A] Pillar Falls data for Total Kjeldahl Nitrogen, Ammonia Nitrogen and Nitrate + Nitrate is based on the median value for 2000-2011.

[B] Pillar Falls data for Total Phosphorus and Escherichia coli is from the 2010 Upper Snake Rock Five-Year Review.

The phosphorus concentration, although near the TMDL water quality instream target of 0.075 mg/L, is still greater than 0.03 mg/L and therefore provides sufficient nutrients for an algal bloom to be triggered under the right environmental conditions.

Escherichia coli is meeting water quality standards for primary contact recreation.

Nitrate + Nitrite is about the same as the historical value.

Ammonia nitrogen is much less than the historical value.

Total Kjeldahl Nitrogen is statistically the same as the historical value.

In general, the amount of nitrogen in the system is sufficient to provide nutrients for an algal bloom to trigger under the right environmental conditions.

**OTHER CONSIDERATIONS**

DEQ has determined, after several days of extensive investigation that the event was not due to discharges coming from any permitted facility or from agricultural nonpoint sources. The event was also not the result of stormwater runoff because no rain event had occurred since May 22$^{nd}$ within the Twin Falls area. And most of these rain events since May 19$^{th}$ were either at trace levels or less than 0.01 inches of precipitation. However, it should be noted that intense storms causing rainfall to occur in more concentrated bursts followed by long dry periods may increase the potential for harmful algal blooms.

DEQ considered the potential for a fish kill. Over a period of 5 days, DEQ investigated the affected area, spoke with local fishermen and other recreationists, and determined that no fish kill had resulted from the event. In addition, no animal kills (dogs, rodents, varmints, etc.) were found. DEQ also investigated the potential for water plants to be affected from possible chemical products. This too resulted in no evidence of plants being affected from pesticides or herbicides. An intensive river run by DEQ along the entire stretch of the affected area, especially along the north and south banks, indicated an alkaline condition in the water; thus, no acid-based chemicals were noted, meaning that acidic chemicals were not present in the water column. Also, there were no associated bad odors with the algal bloom as is typical with blue-green algae that is toxic.

Because of public safety concerns, DEQ also tested the water at the boat docks for Escherichia coli. Both samples tested 4 and 5 CFU/100 mL, which means that the primary contact recreation water quality standard (< 406 CFU/100 mL) was being met and by a very large margin.

Finally and from a historical perspective, a similar incident appears to have occurred in the same location in 1977-1978, based on the memory of former local District Health employees. The incident appears to have been of a similar nature in that the same types of colors appeared as the algal bloom progressed for about 5-6 days. Since then, it has not been reported to DEQ that an algal bloom of this type has occurred in the same area.

A part of DEQ's mission and in accordance with current policy, it plans to coordinate with the Mid-Snake Watershed Advisory Group to discuss this incident and determine if priorities for this stretch of the river need to be considered and if a preventive approach is necessary for possible future occurrences. As such, there are no short-term solutions

to correct an algal bloom. Once it occurs, the only option is to wait for weather changes to disrupt the algae's growth.

**REFERENCES**

Source: http://waterdata.usgs.gov/id/nwis/uv?site_no=13090500

The flow in the river was fairly low (approximately < 500 cfs from May 19 through June 2, 2014; USGS Gage 13090500, Snake River at Twin Falls).

| | | | Flow, cfs | |
|---|---|---|---|---|
| Time ---> | 00:00 | 06:00 | 12:00 | 18:00 |
| May 19 | 387 | 387 | 396 | 405 |
| May 20 | 401 | 396 | 401 | 401 |
| May 21 | 396 | 392 | 401 | 401 |
| May 22 | 410 | 396 | 405 | 410 |
| May 23 | 414 | 405 | 410 | 410 |
| May 24 | 405 | 405 | 401 | 392 |
| May 25 | 396 | 383 | 401 | 405 |
| May 26 | 410 | 410 | 432 | 442 |
| May 27 | 423 | 414 | 410 | 410 |
| May 28 | 414 | 405 | 405 | 401 |
| May 29 | 414 | 405 | 405 | 410 |
| May 30 | 419 | 410 | 419 | 410 |
| May 31 | 414 | 414 | 414 | 419 |
| Jun 01 | 419 | 423 | 432 | 446 |
| Jun 02 | 455 | 460 | 469 | 474 |

Source: http://www.nws.noaa.gov/climate/index.php?wfo=boi

Temperature and wind conditions from the National Weather Service Forecast Office, indicates:

| | Temperature | | | Precipitation | Wind Speed, mph | | |
|---|---|---|---|---|---|---|---|
| | Max | Min | Avg | inches | High | Gust | Avg |
| May 19 | 66 | 43 | 55 | 0.00 | 17 | 22 | 9.7 |
| May 20 | 62 | 38 | 50 | 0.01 | 17 | 22 | 8.0 |
| May 21 | 69 | 39 | 54 | Trace | 23 | 27 | 9.5 |
| May 22 | 80 | 44 | 62 | 0.00 | 16 | 19 | 7.5 |
| May 23 | 85 | 50 | 68 | 0.00 | 23 | 30 | 10.6 |
| May 24 | 79 | 53 | 66 | 0.00 | 28 | 33 | 16.8 |
| May 25 | 81 | 51 | 66 | 0.00 | 20 | 24 | 11.5 |
| May 26 | 84 | 54 | 69 | 0.00 | 20 | 25 | 11.5 |
| May 27 | 91 | 52 | 72 | 0.00 | 21 | 29 | 9.5 |
| May 28 | 79 | 50 | 65 | Trace | 32 | 41 | 13.5 |
| May 29 | 69 | 40 | 55 | 0.00 | 21 | 26 | 11.2 |
| May 30 | 83 | 40 | 62 | 0.00 | 16 | 22 | 10.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| May 31 | 77 | 52 | 65 | Trace | 40 | 50 | 10.8 |
| Jun 01 | 78 | 48 | 63 | 0.00 | 23 | 28 | 12.1 |
| Jun 02 | 89 | 56 | 73 | 0.00 | 24 | 31 | 8.3 |

Source: http://www.wrc.org.za/Lists/Knowledge%20Hub%20Items/Attachments/6596/WaterSA_1992_18_0729_abstract.pdf
A note on a light-temperature dependent model for algal blooms in the Vaal River.
ISSN 0378-4738 = Water SA Vol. 18, No. 4, October 1992, p 299.
By A Cloot, SW Schoombie', AJH Pieterse and JC Roos

Source: http://www.iopan.gda.pl/oceanologia/411plins.pdf
Temperature and N: P ratio as factors causing blooms of blue-green algae in the Gulf of Gdańsk.
Oceanalogia, 41 (1) 1999. Pp 73-80.
By Marcin Pliński and Tmomasz Jóźwiak.

Source: http://floridaswater.com/algae/
Algae are a natural component of the aquatic food chain and are typically not harmful to people. However, the overabundance of algae in a bloom can be aesthetically unappealing and harmful to the environment. If the types of algae that produce toxins reach high concentrations, then native aquatic organisms, livestock, pets, and perhaps even people who come in contact with the toxins, can be affected. In the St. Johns River, harmful algal blooms have occurred in past years. Dense, widespread blooms occurred in summer of 2005 and 2010 in the river's lower basin (that portion between Welaka and Mayport). These blooms led to fish kills and numerous reports of skin rashes, unappealing odors, and accumulations of foam and shoreline scums.

When algal blooms block vital sunlight from reaching beneficial underwater plants that provide food and a place to live and grow for fish and other animals, the ecosystem can be negatively impacted. Algae become stressed and die when they deplete the nutrient supply or move from freshwater into saltier waters. Decomposition of dying algae can reduce levels of dissolved oxygen in the water, which fish and other aquatic animals breathe. Some fish species with little tolerance for low dissolved oxygen levels may die. In addition, some algal species can cause fish kills directly either by production of algal toxins or by clogging the gills.

While the possibility of algal toxins in the environment is a serious concern, the more common problems associated with harmful algal blooms are environmental damage and the impact on recreational activities and commerce due to the unsightly green scum and accompanying unpleasant odor.

Source: http://www2.epa.gov/sites/production/files/documents/climatehabs.pdf
**Rainfall**
Future climate projections suggest an increase in extreme weather events. For example, the incidence of intense storms causing rainfall to occur in more concentrated bursts followed by long dry periods of drought may increase. Extreme rainfall could

increase the transport of nutrients from land into water bodies via runoff. If followed by drought conditions as is projected, water bodies may retain those nutrients for longer periods of time, which increases the potential for Harmful Algal Bloom development. Source: http://www.pca.state.mn.us/index.php/about-mpca/mpca-news/current-news-releases/high-temperatures-can-bring-harmful-algal-blooms.html

## High temperatures can bring harmful algal blooms

Contact: Alexis Donath, 651-757-2312
July 15 2013 08:53

St. Paul, Minn. -- When the summer sun shines and temperatures climb, conditions are ripe for Minnesota lakes to produce harmful algal blooms. The Minnesota Pollution Control Agency (MPCA) is reminding people that some types of algae can harm pets, livestock and even humans.

Algae, microscopic aquatic plants, are a natural part of any aquatic ecosystem. Most algae are harmless, but under the right conditions certain types of algae can pose health risks. People or animals may become sick if they touch or ingest affected water. In extreme cases, dogs and other animals have died after exposure to lake water containing toxic blue-green algae.

“High rainfall, which has been common throughout much of Minnesota this spring, results in nutrient-rich runoff entering our lakes, fueling algae growth,” MPCA lakes expert Steve Heiskary said. “While spring and early summer temperatures were cooler than normal, lake temperatures have warmed rapidly. Given these conditions, we are likely to see blue-green algae blooms on many of our lakes.”

There are many types of blue-green algae. They are found throughout Minnesota, but thrive particularly in warm, shallow, nutrient-rich lakes. Often blown toward downwind shorelines, it is under these conditions that humans and animals most often come in contact with blue-green algae and where the risk of algal toxins is greatest.

Not all blue-green algae are toxic, and there’s no visual way to predict whether a blue-green algal bloom contains toxins and is harmful to humans or animals. But harmful blooms are sometimes said to look like pea soup, green paint, or floating mats of scum, and they often have a bad odor.

“You don’t have to be an expert to recognize an algae bloom that might be harmful,” Heiskary said. “If it looks bad and smells bad, don’t take a chance. Stay out and keep children and pets away from the water until the bloom subsides.”

An animal that has ingested toxins from an algal bloom can show a variety of symptoms, ranging from skin irritation, vomiting, severe disorders involving the circulatory, nervous and digestive systems, and severe skin lesions. In worst cases, the animal may suffer convulsions and die.

Humans are rarely affected, probably because the unpleasant odor and appearance of a blue-green algal bloom tend to keep people out of the water. But human health effects can include irritation of skin, eyes and nasal passages, and nausea and vomiting. Extreme cases can produce paralysis and respiratory failure.

These factors make it important to take a preventive approach to dealing with potentially harmful algal blooms. There are currently no short-term solutions to correct a blue-green algal bloom. Once a bloom occurs, the only option available is to wait for weather changes, such as significant rainfall, wind shifts or cooler temperatures, to disrupt the algae's growth.

Over the long term, the key to solving algae problems is to reduce the amount of phosphorus that is allowed to flow into lakes through runoff. Some sources of phosphorus include pet waste, lawn clippings and yard debris, and certain fertilizers. Phosphorus-containing fertilizers are now banned in Minnesota under most circumstances.

For more information, go to the MPCA's Blue-green Algae and Harmful Algal Blooms webpage or call 651-296-6300 or 800-657-3864.