Utah Water Watch Harmful Algal Bloom Monitoring Program

A COOPERATIVE EFFORT BETWEEN UTAH WATER WATCH, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AND THE UTAH DIVISION OF WATER QUALITY.

Updated February 6, 2019

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Introduction

What are harmful algal blooms?

Harmful algal blooms (HABs) are large growths of cyanobacteria that are often associated with a change in water color or the formation of surface scums in lakes, reservoirs and ponds. Cyanobacteria blooms are occurring more frequently in Utah, likely in response to increased nutrients in waterbodies and a warmer climate. These bacteria share a trait similar to plants: they use sunlight to produce energy via photosynthesis. When in large concentrations, they are considered 'harmful' because they can produce toxins that are harmful to humans, livestock and pets.

For up-to-date info on algal blooms in Utah, including toxin levels, check ***http://habs.utah.gov.***

Program overview:

Utah Water Watch has partnered with NOAA (National Oceanic and Atmospheric Administration) and Utah Division of Water Quality (UDWQ) to track the development of blooms in Utah's lakes and reservoirs. UWW provides training and materials to volunteers and partners who monitor specific lake and reservoir sites and collect water samples to identify the species present.

There are several goals for monitoring:

- Notify the local health department and state about potential blooms. This may be done by anyone visiting a waterbody.
- Track the occurrence and development of cyanobacteria throughout the year. This requires regular monitoring once or twice a month at a designated location.

What causes blooms? Cyanobacteria blooms can occur in both pristine mountain lakes and polluted urban waterbodies. The makeup of a pond or lake's phytoplankton population naturally shifts over the course of the year as different nutrients become available. Certain conditions, usually warmer waters and high concentrations of phosphorus and nitrogen, can increase the likelihood of blooming. As global temperatures increase, scientists have observed blooms occurring at higher frequencies. Nitrogen and phosphorus are common pollutants from sewage treatment plants, urban and agricultural runoff and erosion. Proper land management and investment in new technologies to treat wastewater can reduce the likelihood of blooms.

Are blooms dangerous? Certain species of cyanobacteria can release toxins into the water which can be dangerous to humans and pets. Some neurotoxins can cause immediate sickness or death while others can lead to long-term kidney or liver damage. Interestingly, not all blooms release toxins and it is not known what triggers cyanobacteria to produce toxins. Nonetheless, even blooms that do not contain detectable levels of toxins, dense concentrations of cyanobacteria can have health effects such as itching, rashes, and intestinal distress. If you notice a bloom, keep yourself and pets out of the water.

What do blooms look like? Though no visual observation will give you an absolute identification, cyanobacteria blooms can be differentiated from blooms of ordinary green algae or growths of duckweed relatively easily using a simple guide found on the Utah Water Watch website and in this manual.

Not cyanobacteria:

- *Green algae* tend to be stringy, bubbly and often float on the surface in blobs.
- *Duckweed* are tiny floating water plants; look closely and you will see small leaves and roots.

Cyanobacteria:

- Cyanobacteria blooms often look like green pea soup, spilled paint, green blobs or streaks.
- Some benthic (bottom-dwelling) blooms may not be detectable at the surface.

How you can help?

- Become a steward of your local lakes, ponds and reservoirs. Use the resources in the manual to become familiar with the visual differences between green algae and cyanobacteria. If something looks suspicious, follow protocols to collect a sample and notify Utah Water Watch or your local health department.
- Attend a Utah Water Watch training and learn to use a microscope to identify cyanobacteria and help monitor a lake, pond or reservoir on a regular basis (twice a month). Report your data to a NOAA database tracking the changes in the cyanobacteria community throughout the year. This is important research to improve our understanding of increasing cyanobacteria blooms and develop satellite imagery.

Interested?

Contact waterquality@usu.edu or call the Water Quality Extension at (435) 797-2580.

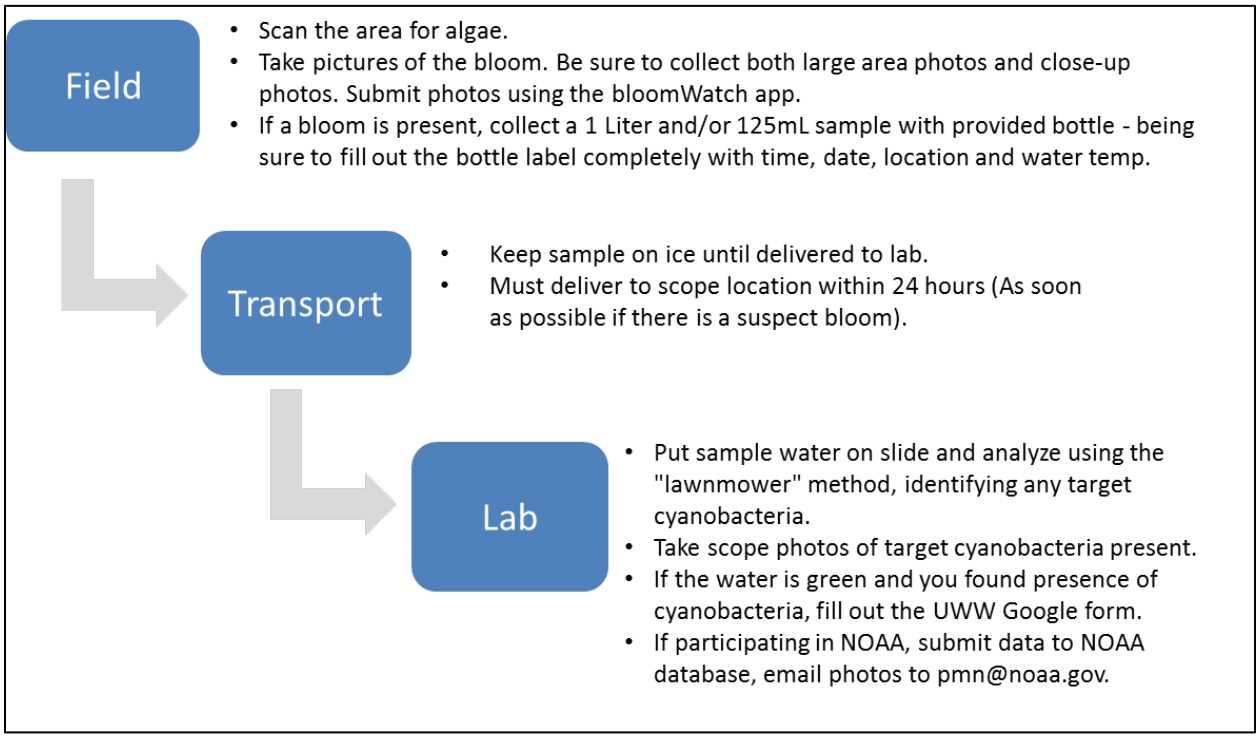
Participation

The amount of time volunteers are able to dedicate to HAB monitoring may vary throughout the year and they may not be able to do everything for the involved agencies. The figure below explains the three levels of commitment. Volunteers doing the highest time commitment will have to attend an additional webinar administered by NOAA.

Low Time Commitment (~30 minutes/month)	Medium Time Commitment (~2-2.5 hrs per month)	Highest Time Commitment (~4hrs/month)
•Go out once monthly •Submit a report using the UWW Google Report if a bloom is present.	•Go out twice monthly (or weekly) •Take Photos and Field Observations using the BloomWatch app from the EPA •Collect a 1L and 125 ml sample and take a water temperature. •Deliver to scope location within 24 hours. (This will need to be coordinated with the scope location contact. and/or additional volunteers.)	•Go out twice monthly (or weekly) •Take photos and field observations using the BloomWatch app from the EPA •Gather a 1L and 125 ml sample and take a water and air temperature. •Deliver sample to scope location within 24 hours. •Analyze sample using a compound microscope and submit report and pictures to NOAA database. Additionaly, fill out the UWW Google form if a large amount of cyanobacteria is present.

Simplified Procedure

While simple observations are made in the field, there are important steps to follow when collecting a sample for transport, identification and reporting. **Note: If you are a dedicated NOAA volunteer you will always collect a 125 mL sample.**



Supplies

The following materials will be provided by Utah Water Watch and NOAA, except where noted. Field equipment may be kept personally while lab materials should be kept at the shared lab site. The HAB binder should be on your person in both the field and the lab.

Note: Depending on your level of commitment, you may or may not need everything listed below. Lab materials are provided at the microscope locations. If you have a personal microscope and need assistance procuring lab materials, contact the Utah Water Watch coordinator.

Field Materials

- Gloves
- Thermometer
- 1L sampling bottle
- 125mL sampling bottle
- Smartphone / digital camera + GPS (not provided)
- Protective eyewear (not provided)
- Bottle Label(s)
- Field Guide
- Marker
- Pencil

Lab Materials

- Microscope (available at centralized locations around the state)
    - Attached camera & USB cable (optional, but best for taking photos)
    - 10X & 20X eyepieces
    - Power cable
- NeoSci ruled slides
- Plastic coverslips
- Pipettes
- Gloves
- Kim Wipes
- Notebook with ID guides

Field Observations

Identification

Use the guide below in the field to differentiate between cyanobacteria and other types of algae. Field identification is not always absolute and it may be necessary to collect a sample to confirm or rule out the presence of cyanobacteria.

Field identification is the first step; it is important for all to be familiar with the difference between cyanobacteria and other types of algae. If it is determined in the field that what you are observing is potentially cyanobacteria, you will want to take extra safety precautions (see below).

Safety precautions
Algal blooms may contain toxin-producing cyanobacteria.

- Samplers should wear elbow/shoulder length gloves, eye protection (such as goggles), and waders/boots during sampling.
- Do not ingest water or allow the water to come into contact with exposed skin. Avoid inhaling spray caused by boats, wind or other water surface disturbances. If these conditions are present, wear a mask to avoid inhalation of water spray.
- Hands should be washed thoroughly after sampling before eating or drinking. Waders/boots should be rinsed of algal material using fresh water (not lake water) before storage.
- To protect your health and safety the following protective equipment should be utilized each time when sampling: extended gloves, safety goggles, mask, chest/hip waders, and PFD.

Filamentous green algae

Types of green algae can look a lot like cyanobacteria and grow in similar nutrient-enriched waterbodies. Unlike cyanobacteria, green algae may form long filamentous strands that make up silky “clouds” below the surface or viscous mats on the surface.

The Stick Test
Find a sturdy stick or pole and pull it through the algae. If the stick pulls out strands that look like green hair or threads, the mat on the pond is likely filamentous green algae (non-toxic). If not, you may have a harmful algal bloom. (Source: Kansas Dept. of Health and the Environment)

Image: Filamentous green algae. (Sources: Clemson U. (L), NYS Department of Environmental Conservation (M, R))

Duckweed

Duckweed are tiny aquatic plants with a grainy texture that can cover the entire surface of calm, nutrient-enriched ponds. If you collect them, you will notice their tiny leaves and root structures.

Image: Examples of the aquatic plant duckweed. (Source: Ohio Environmental Protection Agency).

Examples of cyanobacteria

Cyanobacteria blooms tend to take two forms: they can be suspended throughout the water column (planktonic) or form a layer on the surface. Collect a sample if you see either of these forms of cyanobacteria.

Surface scums (likely cyanobacteria)

Often, HABs are described as looking like "spilled paint" (green, white or blue). A blooms' color may change over time - the photos below were all taken at Utah Lake. Surface scums develop when the cyanobacteria begin to die and cannot control their buoyancy. Be careful, these scums can be especially toxic!

Image: surface sums

Phytoplankton (possibly cyanobacteria)

Besides cyanobacteria, many types of phytoplankton (euglena, diatoms) can form planktonic blooms. The water has been described as looking like "pea soup". You may see clumps, which are cyanobacterial colonies (center pic).

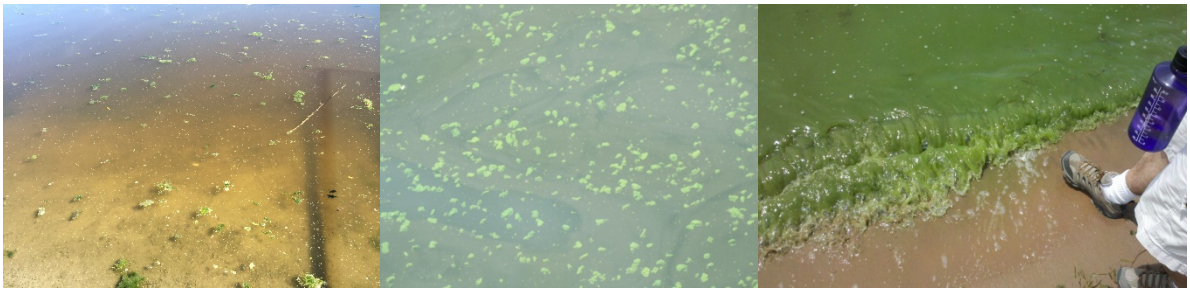


Image: Phytoplankton (Sources: Raymond Li and the Utah County Health Department)

Additional Resources:

Refer to the "Field Guide to Scums" produced by the United States Geological Survey (located on the Utah Water Watch website) for more info on common types of algae and cyanobacteria. **(See http://extension.usu.edu/utahwaterwatch/monitoring/lakes/hab)**

Photo documentation

Photos are extremely helpful to lake managers and the health department to determine the location and severity of the bloom present. If you find a bloom on our waterbody, take several photos of the bloom. Photos should include close ups in addition to the extent of the bloom (i.e. how far out does the bloom extend beyond the cove or beach?). The goal of the photos is to be able to determine how wide the bloom extends across the waterbody.

Photos are submitted to Utah Water Watch using a Google Form available on the website or through the bloomWatch App. The bloomWatch App is available for Android and iOS and the images and observations are sent directly to the Division of Water Quality. The App walks the user through steps to document the bloom and allows you to easily provide GPS coordinates.

Image: bloomWatch App

Sample Collection

This next section will outline the proper procedures for sample collection, handling, and transport. NOAA volunteers will be collecting a sample even if there is no obvious cyanobacteria present. If there is no obvious bloom, a 125mL sample is sufficient for identification.

Although mentioned in a previous section, it is worth mentioning safety once again, as it is of the most vital importance. See safety guidelines below.

Safety precautions:

Algal blooms may contain toxin-producing cyanobacteria. The following tips will help keep you safe. Be sure to bring gloves, safety/sun glasses, clean water and soap if none is available on site.

Samplers should:

- Wear elbow/shoulder length gloves,
- Wear eye protection (such as sunglasses or goggles), and waders/boots during sampling.
- Do not ingest water or allow the water to come into contact with exposed skin.
- Avoid inhaling spray caused by boats, wind or other water surface disturbances.
    - If these conditions are present, wear a mask to avoid inhalation of water spray.
- Hands should be washed thoroughly after sampling before eating or drinking with clean water (not lake water).
- Waders/boots should be rinsed of algal material using clean water (not lake water) before storage.

Collect sample

- Find a location where the bloom is most concentrated to collect the sample.
- Use the thermometer to collect a water and air temperature and record on the bottle labels.
- Label the 1L sample bottle using the permanent marker, included in your kit.
    - Site name, your initials, date (MMDDYY), time, water and air temperature
- Put on protective gear: gloves and safety glasses
- Collect sample from the top 1-2 inches in the area of thick scum, pushing the sample into the bottle if necessary.
- If algae are distributed in the water column, collect a sample to elbow-depth.
- Wash hands thoroughly with soap and clean water.
- Place the sample on ice for transport.

Transport and store the sample

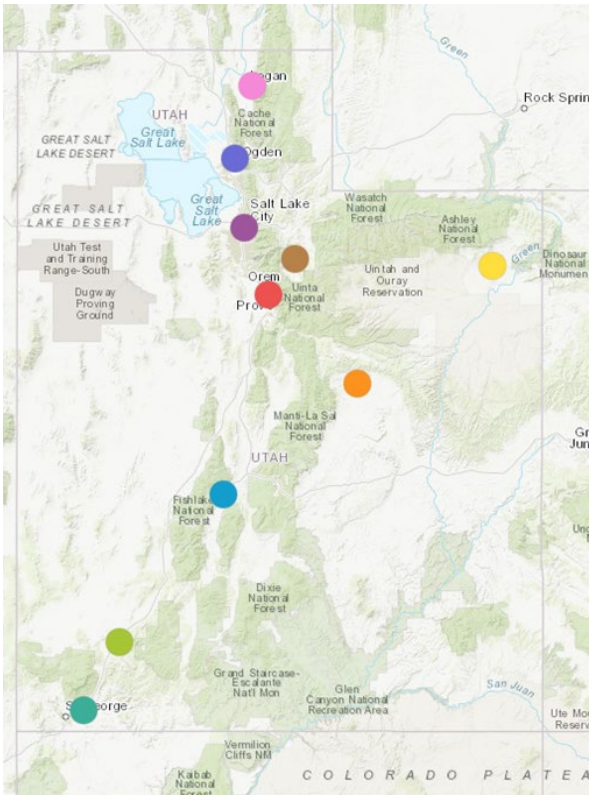
Once you have collected a sample, make sure the bottle is well-sealed and kept cool. A sample may be stored up to 24 hours when refrigerated for identification. If a toxin test is necessary, best to get the sample to the lab as soon as possible as some toxins break down rapidly (increased by warmer temperatures and sunlight).

Image: Algae sample collection. Note the protective gloves. Sample will not necessarily be thick as in the photo. (Photo source: Utah Division of Water Quality)

Contacts

Regional Harmful Algal Bloom Scopes and DWQ Contacts

Please call ahead. Bring samples, along with filled out label, to these locations. *If you have access to other microscopes, you may use that for identification, but be sure to notify UWW, DWQ or local health department if there is a concern.*



Logan, USU - 5230 Old Main Hill, Logan, UT 84321

- Water Quality Extension: (435) 797-2580 or waterquality@usu.edu
- 9am -4pm

Salt Lake City, Salt Lake County USU Extension - 2001 State St S1200, SLC, UT 84190

- Call ahead (385) 468-4820
- 8am –5pm

Provo, BYU Campus

- Contact Erin Jones
- Call ahead (10am -5pm) 801-473-6338
- Email: erinfjones3@gmail.com

Heber City, Wasatch County USU Extension - 55 S 5th E, Heber City, UT 84032

- Call ahead, (435) 657-3235
- 8-5pm

Vernal, Tri-County Health - 133 S 500 E, Vernal, UT 84078,

- Call ahead: (435) 247-1177 ask for environmental health.
- 8:30am – 4:30pm

Price, Southeast Utah Health - 28 S 100 E, Price, UT 84501

- Call ahead (435) 637-3671, ask for environmental health.
- 8am – 5pm

Richfield, Central Utah Public Health - 70 Westview Dr, Richfield, UT 84701

- Call ahead (435) 896-5451, ask for environmental health.
- 8am – 5pm

St. George, Washington County USU Extension – 339 S 5500 W Hurricane, UT 84737

- Call ahead: (435) 634-5706
- 8am – 5pm

Ogden, Weber-Morgan Health Department - 477 23rd Street, Ogden, UT 84401

- Call ahead: 801-399-7160, ask for environmental health
- 8am – 5pm

Cedar City, SUU Biology Department – 351 West University Blvd.

- Call or email ahead: Roger Gold, rogergold@suu.edu, 435-586-7931

Utah Division of Water Quality Contacts

- Ben Holcomb, (801) 536-4373, bholcomb@utah.gov

Local Health Department Contacts:

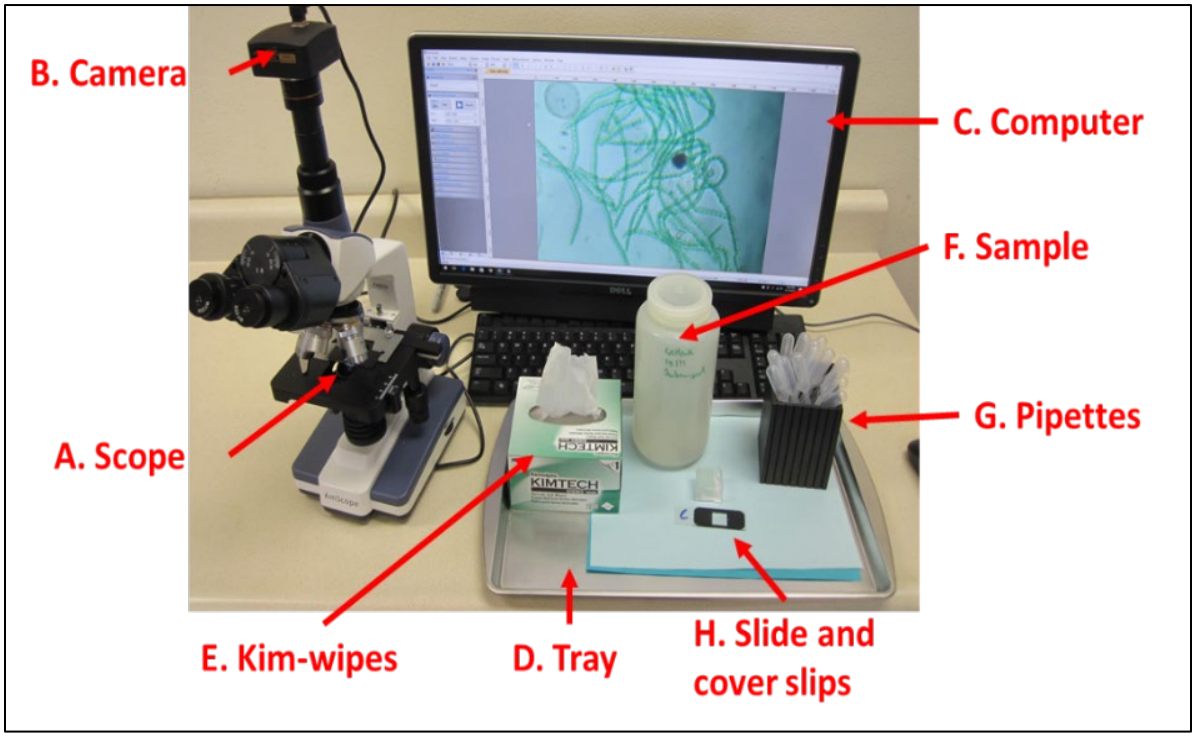
- Ogden, Weber-Morgan Health Department - 477 23rd Street, Ogden, UT 84401 801-399-7160
- Price, SE Utah Health Department - 28 S 100 E, Price, UT 84501, (435) 637-3671
- Richfield, Central Utah Public Health - 70 Westview Dr, Richfield, UT 84701, (435) 896-5451
- Vernal, Tri-County Health - 133 S 500 E, Vernal, UT 84078, (435) 247-1177
- Wasatch County Health Department - 55 South 500 East Heber City, Utah 84032, 435-657-3264
- Bear River Health Department -655 East 1300 North Logan, Utah 84341, 435-792-6500
- Salt Lake County Health Department - 788 East Woodoak Lane (5380 South)
  Murray, UT 84107, 385-468-3862
- Cedar City – SW Utah Health Department – 435-865-5180 – 260 E. DL Sargent Dr. Cedar City, UT
- St. George – SW Utah Health Department – 435-986-2580 – 620 S. 400 E. St. George, UT

Lab Analysis

When doing the lab analysis, be sure to follow the safety guidelines and wear the appropriate Personal Protection Equipment (PPE); namely, protective eyewear and nitrile or latex gloves.

Sample storage

Keep the sample in a refrigerator or on ice until ready for the lab procedure. If there is a suspected bloom, look at the sample as soon as possible. A toxin test may be required, which is best done within a few hours of collection (test are available at the local health department, see page 15).



Lab setup and supplies

Recommended setup for the microscope, computer and lab supplies. While microscopes may be different, the basic steps are the same. You may even use a microscope that does not link to a computer or tablet.

List of Supplies

Plating materials:
Kim-wipes, gridded slide, coverslips, small pipettes

Scope:
Scope, computer, mounted camera

For replacement lab supplies (notify the scope administrator or contact Utah Water Watch – waterquality@usu.edu or 435-797-2580)

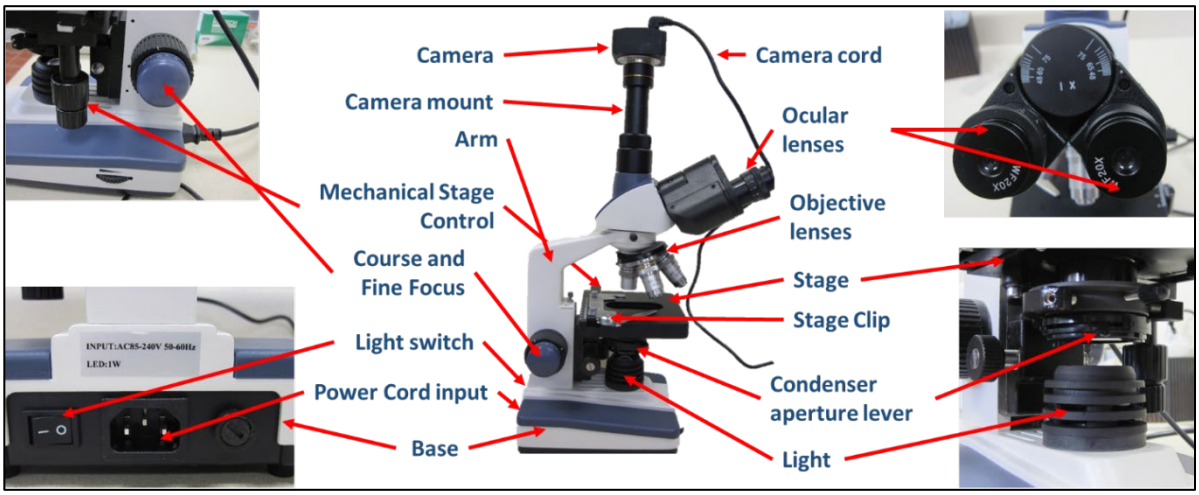
- 1ml pipettes, Amazon, 100 for $7.
- Gridded microscope slides, http://labscientific.com/ Catalog number 4456 one box costs $65.
- Glass Cover slips 18X18 mm, http://labscientific.com/ catalog number 7781 $7
- Microscope Parts (AmScope)
  http://www.amscope.com/ or call 1-**888-950-2888 for help ordering a specific part.**
  - **The AmScope scope product ID is T120B-5M**

Microscope setup

Instructions and photos are shown using the model scope provided by USU Water Quality Extension, though other models may be used at some locations. If the scope is unfamiliar, get an orientation from the microscope host if possible.

Get to know the microscope

Familiarize yourself with the microscope controls, camera, and parts as shown below.



Set up the Microscope

1. Rotate ocular lenses so they are facing you, make sure the 20x lenses, if possible, are installed
2. Screw on the camera mount, if unattached, and slide in the camera attachment.

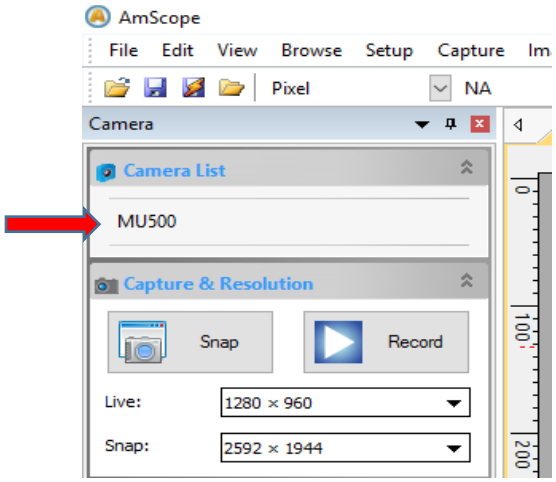
3. Plug in the USB cord to the camera and the computer.
4. Plug in the power cord for the microscope into the nearest outlet and
5. Turn on the scope light, using the switch on the back of the microscope.
6. **Note: Do not use 4th oil lens (100x);** this lens requires specially prepared slides and can be damaged by improper use.

Launching the software

Select the software app on your computer compatible to the microscope you are using. Make sure the USB is plugged into the camera. Launch the software and open the camera.

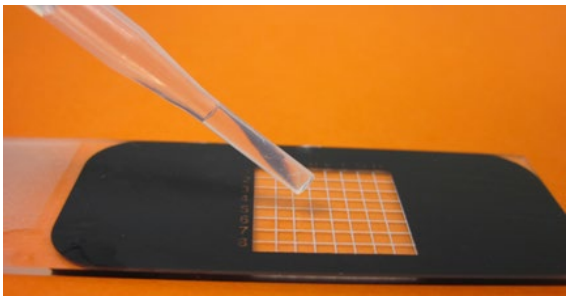
By connecting the scope to the computer, you can view the slide in real time on the screen and take pictures of the sample.

Several available microscopes use AmScope software. Instructions: Plug in the USB, launch the software and select the camera, from the camera list in the top left corner.

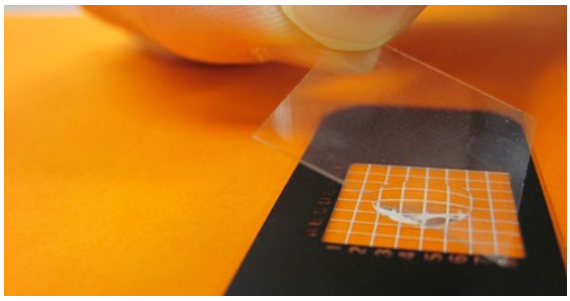


Preparing the slide

1. Put on protective gloves.
2. Mix sample by turning the sample bottle gently down and back.
3. Squeeze pipette and take your first sample from the lower portion of the sample. Place one drop on the middle of the gridded slide.
4. Take a second sample from the middle portion of the sample. Place a drop onto the middle of the gridded slide.
5. Gently lay cover slide over the sample, see images below.



Place a drop from the pipette onto the middle of the top surface of the gridded slide.



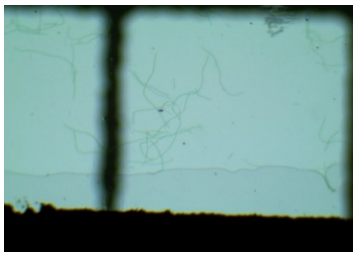
Gently lay cover slip at an angle to avoid air bubbles.

Microscope operation

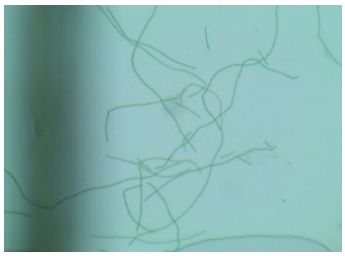
1. Lower the stage using the coarse knob on the right-hand side.
2. Rotate the objective lens carousel to the lowest magnification lens (4x), and move the stage to its lowest point.
3. Place the prepared slide on the stage, using the stage clip to hold it in place.
   - Use the two vertical knobs to the right to move the stage left/right or up/down.
4. Raise the stage to its highest point (it will not hit on lowest magnification)
5. Now look through the eyepiece and lower the stage (fine knob) until the sample comes into focus.
6. If further magnification is needed rotate the objective carousel to the next highest (10x or 40x) magnification. Use the fine focus knob to return the sample to focus.

Calculate total magnification:

To calculate total magnification, simply multiply the magnification of the eyepiece or the camera (look on eyepiece – 10x or 20x) with the magnification of the objective lens (usually 4x, 10x and 40x). For example, if the microscope you are using has an eye piece with 20x magnification and you are using the 10x objective lens the total magnification will be 200x.



At 80x magnification bacteria are just becoming visible.



At 200x magnification individual cells are visible but identification may not yet be possible.

If greater detail is necessary for identification, use 800x magnification.

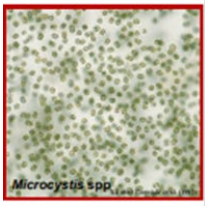
Accompanying documentation

These documents below are included in the binder accompanying the microscope and available online.

- NOAA Freshwater Phytoplankton ID Sheet: Quick ID for toxin producing cyanobacteria https://extension.usu.edu/utahwaterwatch/ou-files/HABs/NOAA_Freshwater_ID_Sheet.pdf

- Basic Cyanobacteria ID Guide – by Jen Maucher Fuquay, NOAA Phytoplankton Monitoring Network https://extension.usu.edu/utahwaterwatch/ou-files/HABs/Basic_cyano_ID_guide2.pdf

Analyze the sample



We will be identifying the types of cyanobacteria present and determining the approximate abundance.

To determine whether cyanobacteria or a bloom is present, there are 5 identified target cyanobacteria to look for. These are identified with detailed images on the "NOAA Freshwater Phytoplankton ID Sheet". These are as follows:

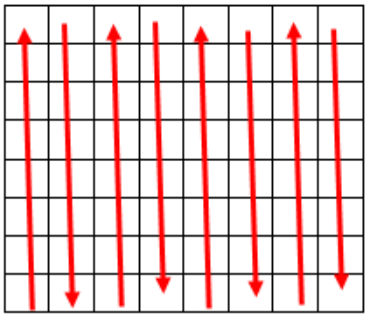
- *Microcystis*
- *Dolichospermum* (*Anabena)*
- *Aphanizomenon*
- *Cylindrospermopsis*
- *Oscillatoria* (*Planktothrix*)

Each of these has the potential to produce a large suite of cyanotoxins, whose effects range from mild skin irritants to potent neurotoxins. When 65% of the slide is covered with any or a combination of these 5 the cyanobacteria is elevated and, a harmful algal bloom is present.

Look at pages 36 through 40 of the USGS "Field and Laboratory Guide to Freshwater Cyanobacteria Harmful Algal Blooms for Native American and Alaskan Native Communities" (https://extension.usu.edu/utahwaterwatch/ou-files/Instructions/USGS_Guide_HABs.pdf) to familiarize yourself with some of the other algae you might find while examining a sample.

Is algae present? Is it cyanobacteria?

1. First, determine the presence or absence of algal cells. There may be many other things on the slide including microscopic animals, bubbles, and debris.
2. Use the "lawnmower method" and NOAA guides to search the slide. Remember - you are only responsible to identify the 5 target cyanobacteria present.



Lawnmower method: moving up and down or side to side in a grid pattern to look for cyanobacterial cells. This should be done at 10x magnification.

Slide coverage of each type of cyanobacteria

1. Roughly estimate the total slide coverage of each of the five target cyanobacteria types present. If there is greater than 65% coverage, the cyanobacteria is "elevated".
2. **Be sure to record all data in the NOAA database (see Reporting on page 20).**

Take a picture.

1. Take a picture of anything you suspect may be a cyanobacteria. Photos are required for any report of target cyanobacteria and NOAA will confirm if the identification is accurate (pmn@noaa.gov).
2. Use your camera connected to the microscope to take the picture (using the "Snap" button when using the AmScope located in the upper left-hand section of the screen). Save these images to a folder on the computer and use the naming convention - site name, suspected type of cyanobacteria, magnification and the date (DDMMYY). E.g.: "Mantua _140817_ Mycrocystis_100x".

Note: If you do not have a camera attached to the microscope, use your smartphone to take a picture by holding it steady over the eyepiece.

Clean Your Station

1. Carefully wash slides and covers with soap and water and dry.
2. Cover the microscope and place it in a safe place.
3. Wipe down the workspace with a disinfecting spray and a moist rag.
4. If you are finished with the sample dispose of it down the drain and wash the sample bottle with soap and water.
5. Wash your hands thoroughly with soap and water.

Reporting

NOAA PMN database reporting

Submit data to the NOAA database. This should be submitted even if you do not find any cyanobacteria!

1. The database is located at: https://coastalscience.noaa.gov/research/stressor-impacts-mitigation/pmn/data/submit-data-regions/
2. Select "Freshwater" for the region.
3. Use the **ID UT05** and submit data accordingly. If you have additional water quality data,
4. Send any photos of target species following the instructions in the database to pmn@noaa.gov

In event of a bloom

When cyanobacteria is present in a potential bloom (thick accumulation, green water, 65% slide coverage), complete the UWW Google form located in the link below to share field and lab observations and photos with UWW, health departments and Division of Water Quality.

2019 form - https://goo.gl/forms/JNr1XxbpmQAwnIc82

Note: If you used the bloomWatch app, you will only need to complete the lab section.

If there is an immediate concern, contact the Division of Water Quality Spill Line (801) 536-4123. If you have collected a sample, provide your 1L water sample to the local health department for a toxin test, or you may be asked to drop the sample for further testing.

References

"Utah Department of Environmental Quality Water Quality." *Harmful Algal Blooms Home*, Utah Department of Environmental Quality, 22 March 2018, https://deq.utah.gov/water-quality/harmful-algal-blooms-home Utah DWQ.

"National Centers for Coastal Ocean Science." *Phytoplankton Monitoring Network (PMN)*. National Centers for Coastal Ocean Science, 2017, https://coastalscience.noaa.gov/research/stressor-impacts-mitigation/pmn/.

Rosen, Barry H. and Ann St. Amand. *Field and Laboratory Guide to Freshwater Cyanobacteria Harmful Algal Blooms for Native American and Alaskan Native Communities*. US Geological Survey, Reston, Virginia: 2015.