8 January 2019
Prepared by Friends of the Kinni, under Wisconsin Surface Water, River Planning Grant Project #: RP31318

Procedure for Citizen Assessment of Benthic Algal Abundance in Wadeable Streams

Applicability

Algal abundance is designated by the Wisconsin DNR (WDNR) as a response indicator for total phosphorus (TP) impairment in wadeable streams in Wisconsin (see at https://www.epa.gov/wqc/bioassessment-and-biocriteria-programstatus-wisconsin-streams-and-wadeable-rivers). Algal abundance is used as a screening tool to identify streams where there is clearly an algal response to TP enrichment and those that may need further study. This procedure applies to all citizens and citizen groups interested or involved in collecting benthic algae abundance (cover) measurements in shallow, wadeable stream reaches using a viewing bucket (WDNR 2018).

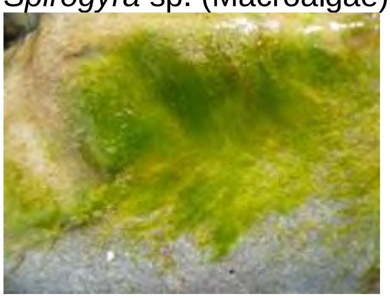
Why Benthic Algae?

Primary producers, such as algae, use phosphorus directly from the water column and are often the first organisms to show a response to nutrient loading. Algae have been shown to respond more predictably to phosphorus than other assemblages (i.e., macroinvertebrates, fish) at higher trophic levels (Diebel 2015).

This method is applicable to any wadeable stream where light penetrates to the sediment surface and has stable substrate (typically sand or larger) that allows for benthic macroalgae and microalgae to attach and grow.

Macroalgae are algae that have either a large colonial structure or a plant-like structure visible to the naked eye. Microalgae are algae that are either unicellular or colonial without structure visible to the naked eye.

Spirogyra sp. (Macroalgae)



Vaucheria sp. (Macroalgae)

Gomphoneis sp (Microalgae)

Fact: It is often hard to tell the difference between moss and algae. Here are some tips based on the image below. Moss (**top**) is more coarsely branched and almost "woody" in feel, versus algae which is soft and less structured – like "wet cat fur" or slimy by feel (**bottom left**). Sometimes algae is mixed in with the moss (**bottom right**). When in doubt, pick it up. Feel it. Look closely for coarse branching.

Moss versus algae - additional images

Stream bryophytes (mosses and liverworts; from left to right):

- *Hygroablystegium* (moss, stems with leaves), colonized by clumps of the green alga *Chaetophora*.
- *Fontinalis* (moss)
- *Fissidens* (moss)
- *Chiloscyphus* (leafy liverwort)

Method Summary:

- Algal abundance estimates are made during summer baseflow conditions.
- Estimates are made along 12 transects that are laid out along a reach of stream according to WDNR quantitative stream habitat protocols (WDNR 2002).
- The percentage of each category of algal coverage (i.e., a score of 0-3) is visually estimated at sample points along each transect line.
- Each viewing bucket has a grid of 25 equally-spaced points that help guide the viewer during visual estimates of coverage (**Figure 1**). Holding the viewing bucket above the sample point and looking directly over the sediment below, the sampler estimates the algal biomass below each point on the grid (**Figure 2**).

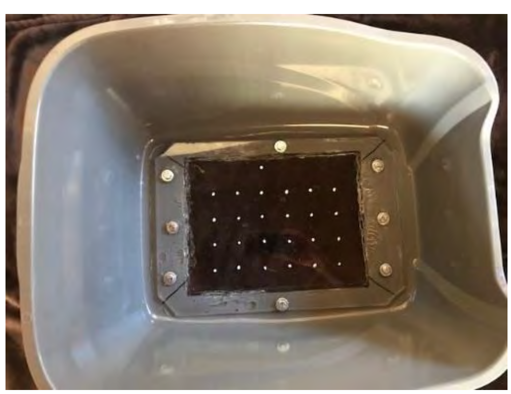


Figure 1. *Viewing bucket showing 25 point grid as discussed above (see details on how to make a viewing bucket provided in **Attachment 2**).*

Figure 2. *Citizen volunteer demonstrating use of the viewing bucket above a sample point.*

Materials:

- Viewing Bucket (**Figure 1**)
- Metric Ruler
- Datasheet (**Attachment 1**)
- Clipboard
- Rite in the Rain paper
- Pencil or Rite in the Rain Pen
- Chest Waders
- Life jacket

<u>Optional</u>:
Range finder (similar to Nikon® Aculon® laser rangefinder)
Counter clicker
Tape Measure
Wading rod to measure depth
Polarized sunglasses (to reduce glare)

Field Measurement Procedure:
It is important to consider your monitoring goals and pre-select your stream reaches prior to performing the measurements. For example, you may want to compare sites upstream and downstream of cities or townships, of other semi-permanent structures such as dams, or in reaches reflective of different landscapes (agricultural, forested, urban, mixed, etc.). It is always wise to consult with WDNR staff and stakeholder groups prior to selecting your stream sampling areas for any long-term monitoring program.

The citizen analysts will make measurements of the amount and score of benthic algae cover. Algal abundance estimates should be made during summer baseflow conditions, ***typically from July 1st to September 15th***. It is important not to sample algae too early in the growing season as algal growth is strongly tied to temperature and sunlight. Even in June, algae may not have had enough time to reach stable population sizes. When possible, assess algal abundance samples when the stream has not experienced high flows for a couple of weeks. Flooding may scour algae from substrates, leading to underestimation of algal abundance and altering stream diatom communities. If significant rain events have occurred before the site visit, note that on the Algal Abundance data sheet (**Attachment 1**). Depending on volunteer experience and stream characteristics measurements may take 1-2 hours at each site. Aim to collect measurements earlier in the benthic algal season growing (July 1st to September 15th) because algae may not have time to recover from September scouring events.

Steps:

1. **Establish mean stream width (MSW) transects**. The MSW is based on the mean of a few preliminary measurements of stream width from throughout the stream reach (within approximate reach boundaries). If the stream width does not vary significantly throughout your sample stretch, you may save time by estimating the distance by eye close to the start of the reach instead of walking the entire approximate reach length.
   - Per the graphic depiction below (**Figure 3**), all transects after the first are spaced three (3) MSW apart. In general, start the first transect at the end of a riffle.

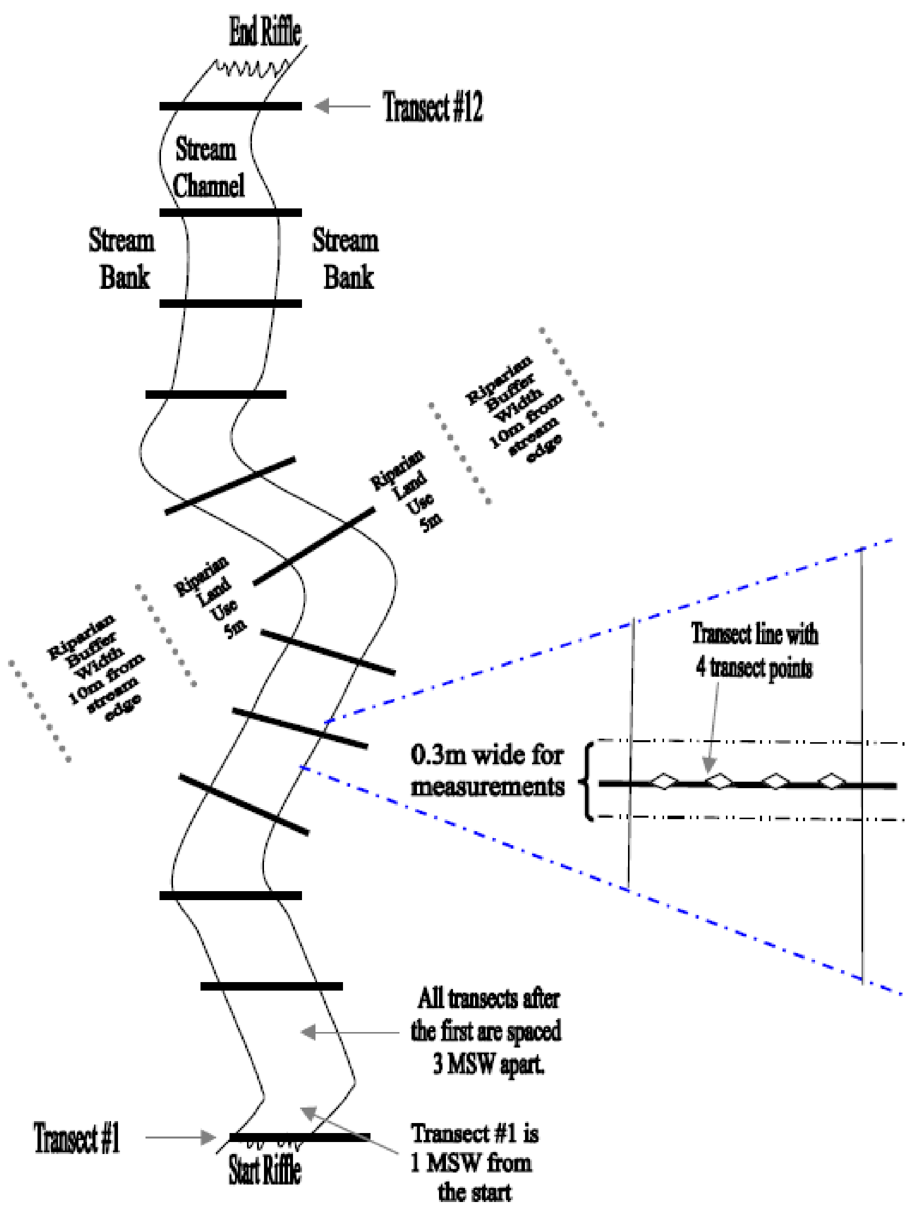
Safety First! Always work in pairs on the water, with one citizen analyst acting as scribe to record scores and one to use the viewing bucket.

Sample Reach Length: The total sampled reach length along which to assess extent of benthic algal cover should be 35 times MSW. If MSW is greater than 10 meters wide, the sample reach is capped at 400 m. In this case you will equally space your transects throughout your 400 meter sample reach.

For example: 400 m ÷ 12 transects = 33 m per between transects.

Tip: Use of a laser rangefinder (e.g., Nikon® Aculon®) for determining distance between transects is both accurate and efficient.

Figure 3. *Graphic depiction of a sample stream reach with 12 transects established 3 mean stream widths (MSWs) apart (image originally Figure 1 in WDNR 2002).*

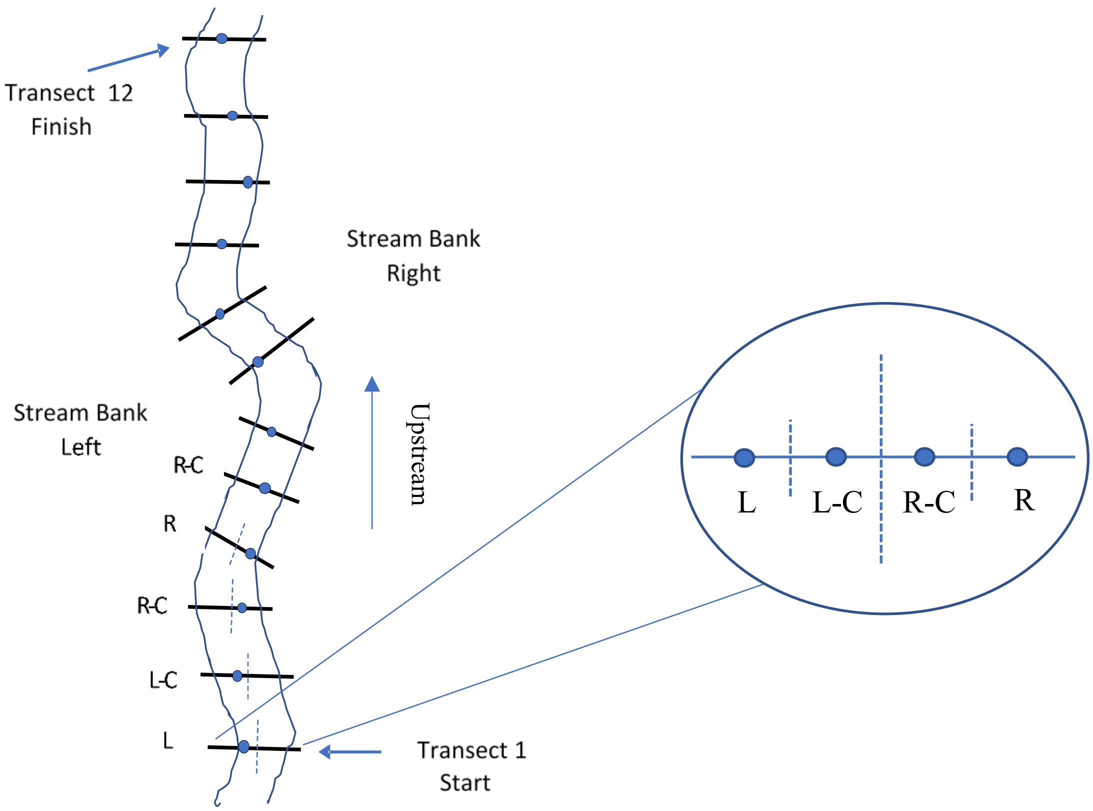


2. Record the stream segment station name and number, date, time, and analyst names at the top of the data sheet or field notebook.

3. Carefully enter the stream at the most downstream (first) transect at the left bank (**Figure 4 below**). By starting at the most downstream sampling point, the possibility for disruption of sediment and obscuring the bottom of the stream will be minimized. Locate the left bank transect point. Always start at the left bank point for consistency.

Figure 4. *Graphic depiction of a sample stream reach with 12 transects established 3 mean stream widths (MSWs) apart. Note that sampling points begin at left bank and then move rightward at the next (upstream) transect. Once the right bank point is reached (on transect 4), the sampling points move stepwise back to the left.*

Did you know? Left and right bank are identified by facing in the upstream direction of stream flow. Imagine segmenting the stream width into four equally-spaced horizontal quadrants along the transect. Each transect point – Left, Left-Center, Right-Center, Right – lies in the center of each of the four equally-spaced quadrants (see bubble visual enhancement in Figure 4).



4. Immerse the viewing bucket into the stream so that approximately 4 inches of the bottom of the bucket is underwater. The viewing bucket should be oriented with the longest length perpendicular to flow. The field analyst should stand downstream of the viewing bucket to minimize sediment disruption obscuring visibility of the bottom (**Figure 2**). The citizen analyst should bend over or squat in the water to view the bottom of the stream without interference. If glare or floating is a problem, add a little water to the viewing bucket (**polarized sunglasses help too**!).

5. The citizen analyst will observe a grid of 25 white dots painted on the clear acrylic sheet in the bottom of the viewing bucket (**Figure 1**). Using this grid the analyst will estimate the coverage of each category of algae using the Scoring Criteria explained below. The 25, equally-spaced white dots on the viewing bucket are meant to help guide the analyst during visual estimates and should be individually estimated only when needed. For instance, if five (5) points in the viewing bucket are over sediment with category 3 algal coverage (see **Scoring Criteria** below), then the total coverage of type 3 algal abundance as a percent is 5 x 4 = 20% coverage.

6. Estimations are made at one sample point along each of the 12 transects. When finished with one transect, move upstream to the next transect and move over one sample point using the "zig-zag" pattern shown in **Figure 4**. Again, the transect 1 measurement is made at transect point "Left", the transect 2 measurement is made at transect point "Left-Center", transect 3 starts at point "Right-Center" continuing until all transects are completed.

Scoring criteria:

NA – Substrate unstable and not suitable for algal growth. This will typically include substrates that are sand sized and smaller.
0 – Almost no algal growth: Substrates feel rough or slightly slimy with none to very little green, golden or brown discoloration/film on substrate surface.
1 – Film: A thin layer of green, golden or brown algal film present on substrate surfaces but underlying substrate is still mostly visible. Film/coloration will be visibly removed to reveal underlying substrate if rubbed with finger or scraped with fingernail.
2 – Short filaments: Algal coverage usually includes some algal filaments, generally less than 1 cm long or algal mats less than 2mm thick. Short filaments or algal mats obscure the color and texture of the underlying surface.
3 – Long filaments. Algal filaments longer than 1 cm or algal mats are greater than 2mm thick. Surface may appear to be covered in "fur-like' filaments or in extreme cases the surface will be covered with extremely long, bright green hair-like filaments.

Figures 5, 6 and 7 (below) provide examples of the bird's eye view of viewing bucket area (25 point grid) and scoring:

Figure 5.

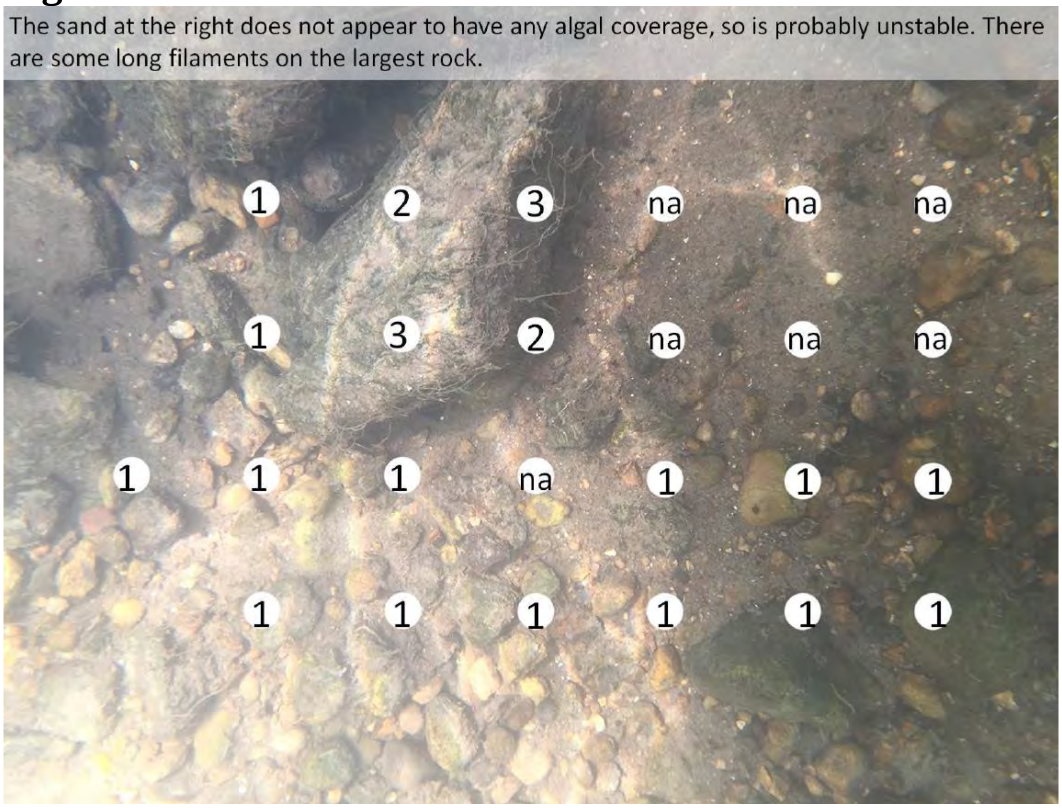


Photo by G. LaLiberte (WDNR; with permission)

Figure 6.

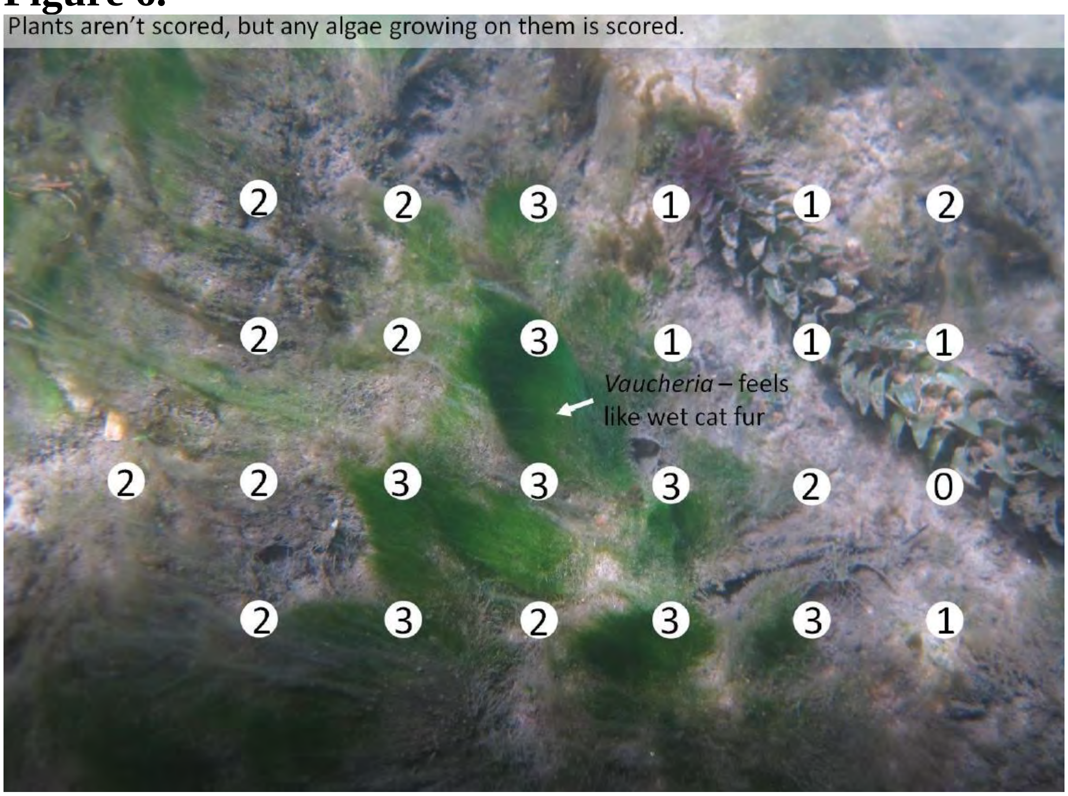


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Figure 7.

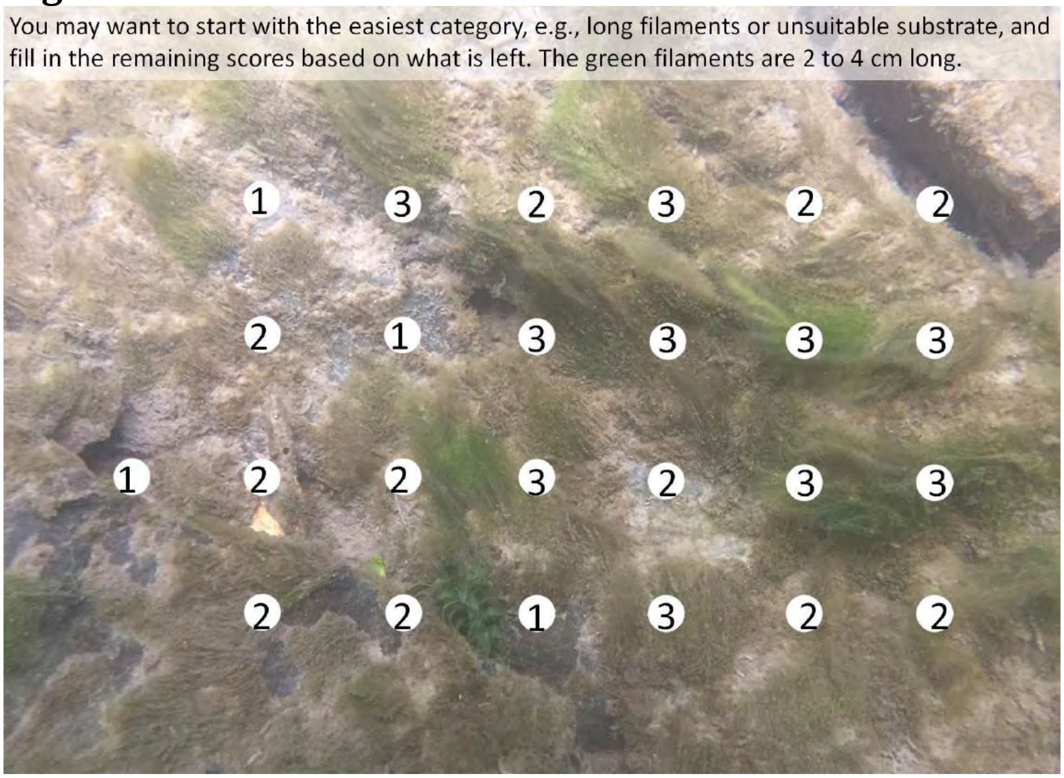

Photo by G. LaLiberte (WDNR; with permission)

IMPORTANT!
Multiple Scoring Categories:
In most cases there will be multiple scoring categories visible at any one transect point. On the data sheet record the percent coverage of each type of scoring category using the scoring criteria above. Using the gridded points on the viewing bucket scoring categories can be recorded to the nearest 5%; however, citizen analysts are encouraged to score to the nearest 10% to save time.

Unstable Substrate:

- In most situations substrates larger than sand will provide stable enough substrate for algal growth. However, some streams have stable sand substrates that can be colonized by some algae (diatoms form thin golden-brown films) and the measurement should be conducted at these sites (see **Figure 8**).
- Large objects such as root wads, large woody debris, stable fine woody debris or stable manmade objects such as concrete, bricks, etc. should be included as substrates available for algal growth.
- Macrophytes and moss are not included in the algal abundance estimates, but the algae <u>attached</u> to the macrophytes may be included (appearance will be dark golden brown if diatom coverage is extensive, otherwise estimate filamentous green or other filamentous algae coverage).

<u>**Note**</u>: If only a portion of the viewing bucket area is unsuitable for algal growth (i.e., 50% unstable sand and 50% cobble), then record these conditions on the data sheet. If the entire viewing bucket area, and hence the transect point, is unsuitable for algal growth continue moving horizontally across the stream channel until a suitable site is found. In some streams the Left-Center and Right-Center may be unsuitable for algal growth because the **thalweg**[1] is too deep for light to penetrate.

[1] **Thalweg** is the path of deepest and fastest water.

Areas too deep for light to penetrate to the bottom are not suitable for benthic algal assessments. If all the entire transect is unsuitable for benthic algal growth, then record the transect point as 100% "NA" on the data sheet.

Figure 8.

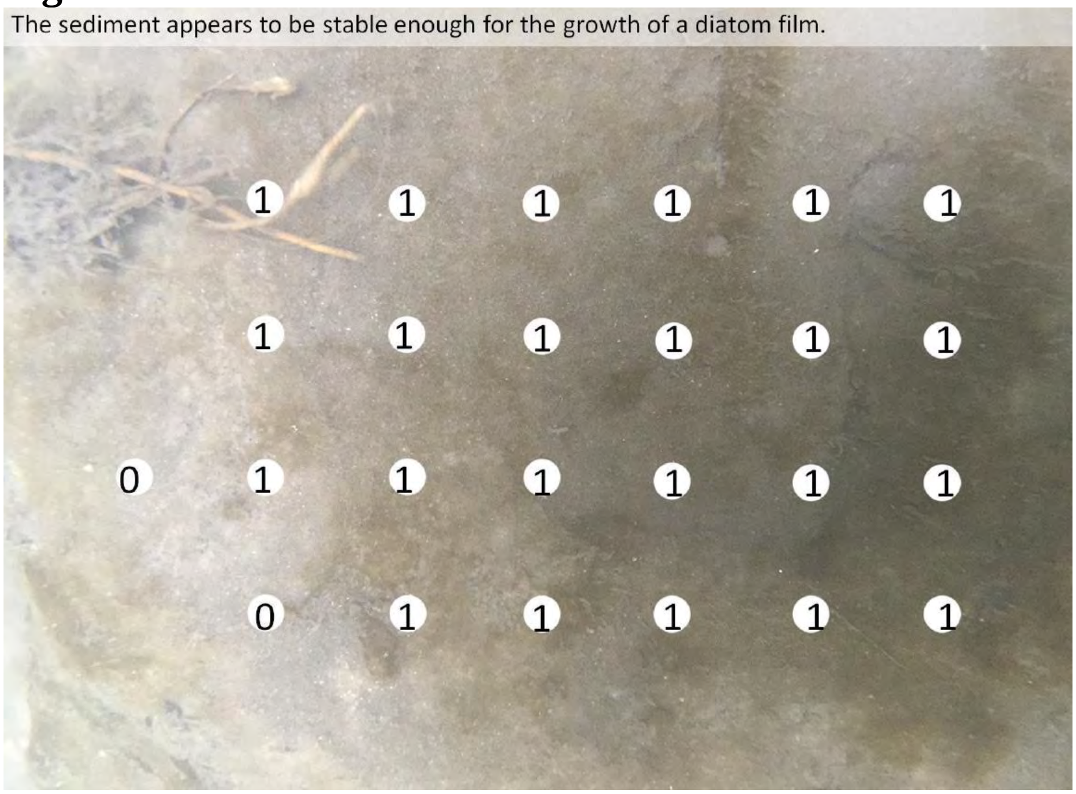

Photo by G. LaLiberte (WDNR; with permission)

A Note about Standard Quality Assurance and Control (QA/QC) practices

- It is helpful to implement standard QA/QC procedures. These include field duplicates taken by two different citizen analysts, i.e., repeating the measurements of the entire procedure independently at the same stream assessment reach. This should be done 1 out of every 10 sample stream reaches assessed.

- Estimates of areal coverage of different classes of algal abundance should be within 10% between two observers. If measurements are outside of this range, the observers should view the same location, consult this guide, and re-evaluate algal abundance estimates.

Safety Disclaimer

You will be working in potentially fast moving water using chest waders. Footing may be treacherous due to algae covered rocks. Know your limitations. Do not sample if conditions appear unsafe. It is strongly advised to bring a walking stick or other stabilizing instrument (e.g., 4 foot length of 1 inch PVC® pipe with end cap – useful also for marking depth and testing substrate). Like any outdoor activity, dress appropriately, bring drinking water to avoid dehydration, and carry a first aid kit. Always let others know where you are and when to expect you. Total procedure time varies, but expect 1 to 2 hours.

When to be Wary of Water (WDNR 2015):
Water appearance can indicate water pollution. However, it can also indicate a possible safety hazard. If you notice any unusual water characteristics, DO NOT ENTER THE WATER and contact your local DNR office to report it. Below is a list of normal and possibly hazardous characteristics of water:
Clear - colorless, transparent
Milky - cloudy-white or gray, not transparent; might be natural or due to pollution
Foamy - might be natural or due to pollution such as detergents or nutrients (foam that is several inches high and does not brush apart easily is generally due to some sort of pollution)
Turbid - cloudy brown due to suspended silt or organic material
Dark brown - tea-colored water might indicate that a naturally occurring, harmless acid is being released into the stream (normal for some streams)
Oily sheen - multicolored reflection might indicate oil floating in the stream, although some sheens are natural
Orange - might indicate unnatural acid drainage
Green - might indicate excess nutrients being released into the stream

Water odor can also be an indicator of possibly hazardous water pollution. If you detect any unusual odors, DO NOT ENTER THE WATER and contact your local DNR office.

No smell or a natural odor
Sewage - might indicate the release of human waste
Chlorine - might indicate over-chlorinated sewage treatment from water treatment plant or swimming pool discharges
Fishy - might indicate the presence of excessive algae growth or dead fish
Rotten eggs - might indicate sewage pollution (the presence of methane from anaerobic conditions)

References:

Diebel, M.W. 2015. Evaluation of the relative effects of phosphorus and nitrogen on stream biological community structure. Wisconsin Department of Natural Resources, Madison, WI. DNR PUB-WY-3200-2015-03.

Wisconsin Department of Natural Resources (WDNR). 2002. Guidelines for Evaluating Habitat of Wadeable Streams. (June 2002 Revision, available at: https://infotrek.er.usgs.gov/doc/wdnr_biology/FieldSampling/Wadable/QuantitativeStreamHabitatProtocols.pdf).

Wisconsin Department of Natural Resources (WDNR). 2018. Viewing Bucket Method for Estimating Algal Abundance in Wadeable Streams v1.0 (available upon request from: Michael Shupryt, Wisconsin DNR, Water Resources Management Specialist-Advanced, (608) 261-6404, Michael.Shupryt@wisconsin.gov).

University of Wisconsin-Extension, Water Action Volunteers. 2015. Habitat Assessment: The Parts Equal the Whole. (Available at: http://watermonitoring.uwex.edu/pdf/level1/methods/HabitatAssessment_2015.pdf).

Attachment 1:
Algal Abundance Data Sheet
(Note: It is best to use Rite in the Rain paper to print your data sheets on)

Site Name: ______________________ Date: ____________

SWIMS ID: ______________________ Staff: ____________

	Location	NA	0	1	2	3
Transect 1						
Transect 2						
Transect 3						
Transect 4						
Transect 5						
Transect 6						
Transect 7						
Transect 8						
Transect 9						
Transect 10						
Transect 11						
Transect 12						

DPI Sample: Y N

Note: DPI stands for Diatom Phosphorus Index. A DPI sample can be collected working in cooperation with Local WDNR staff. Consult with local WDNR field biologist for methods.

Attachment 2
How to make a Viewing Bucket

Equipment to make a viewing bucket can be purchased from local hardware and department stores. The original construction by WDNR consisted of a Remington® 20 quart tote purchased from Farm-n-Fleet. Other totes and buckets can also be used, such as a dishwashing basin or kitty-litter box (as shown in **Figure 1**). The exact tote used is not as important as the viewing area and the spacing of the dots on the Plexiglas, which need to be identical to the original if new totes are constructed. If using a different tote to construct the viewing buckets be sure that the tote is opaque and darker in color to reduce outside light, has a flat bottom to allow a watertight seal with Plexiglas, and is comfortable to hold for extended periods of time.

Viewing bucket specifications:

- Remington all-purpose stacking tote, 20 quarts
    - Dimensions: 10.3”H x 11.6”W x 18.1”D
- Window opening in bottom of tote
    - 10 5/8” x 7 3/8”
- ¼ inch Plexiglas (clear acrylic) cut into 13” x 8” rectangles
    - Sheets can be cut with a table or circular saw, it is not important to have clean edges
- Dot spacing, 1.5 inches in a 4 x 6 dot grid plus one additional dot
- White paint pen to mark dots
- ¼ inch stainless steel bolts, nuts and washers
- Silicone caulk