EPA Region 3 Mid-Atlantic State's Algae Identification Workshop

Interstate Commission on the Potomac River Basin
August 10, 2016

Workshop Objectives:

- Gain knowledge and experience in identifying the general types of plants and algae found growing in Mid-Atlantic streams and rivers

- Understand the basic distinguishing features between filamentous green algae, cyanobacteria (blue-green algae), submerged aquatic vegetation (SAV) and emergent macrophytes

This handout was created by ICPRB staff Gordon Michael Selckmann (Gmselckmann@icprb.org). It outlines significant morphological and habitat traits of common freshwater plants and macroscopic algae found in the Potomac River Basin. Observations and conclusions a field biologist makes based on this document should be considered *field-level* identification of freshwater macroflora. Although some of the field cues presented in this document allow genus level ID's of filamentous green algae and cyanobacteria, confirmation with microscopic identification in a taxonomist's lab should still be considered when available.

Primary Producers in Lotic Systems:

What is that Green Stuff I See?

This handout focuses on how to distinguish between the aquatic plants and “macroscopic” algae found in freshwater streams and rivers of the Mid-Atlantic United States. All plants and algae are autotrophs meaning they use chlorophyll photopigments to absorb energy from light (photosynthesis). The chlorophyll photopigments absorb red and blue wavelengths of light and reflect green wavelengths. Hence, aquatic plants and algae are typically green. Macroscopic means an object is visible without magnification. Most aquatic algae are microscopic and magnification is needed to see important diagnostic features. A few taxa of aquatic algae are capable of growing to macroscopic sizes by forming large multicellular filaments or colonies. They are commonly called ‘filamentous algae’ in freshwater streams and rivers and are known as ‘seaweed’ in saltwater environments. In freshwater streams and rivers, the macroscopic algal forms (habits) are usually attached to hard surfaces such as gravel, rocks, submerged logs (epilithic), and aquatic plants (epiphytic). They can be dislodged by high flows and move downstream until they settle and become reestablished or die off and decompose.

For this field key, three major categories of aquatic plants and macroscopic algae are considered:

Filamentous green algae
Blue-green algae (cyanobacteria)
Vascular plants

The reduction of aquatic macroflora into these three categories is not all encompassing and leaves out significant other contributors to the primary production community. Not reviewed in this document are emergent vegetation, organisms that utilize photo-symbioses, and bryophytes.

Initial Site Considerations

Nuisance levels of algae are generally brought to the attention of local and state agencies only after an algal bloom has reached a level deemed unsuitable for recreational use. This fact makes the initial investigation of blooms sites difficult due to the potential lack of data proximal to bloom sites or times. When looking for potential causes of nuisance algae, biologists should first consider a coarse resolution investigation of the available information. For example, is a WWTP or other nutrient source located upstream? Filamentous blue green algae blooms are often found below effluents. Is there a strong groundwater influence from carbonate rock? Fairly soft water (e.g., <100 mg/liter) coupled with moderate-high total alkalinity (> 40 mg/liter) can make phosphate more available for plant uptake. Has there been a recent prolonged period of low flow? Filamentous green algae blooms typically during low flows because they are weakly attached to their substrate and dislodge in high flow events. Initial site considerations such as these can help set expectations about what algae and plants will be present during a field visit.

A word of caution: relating an algae bloom to proximate and ultimate variables is not straightforward. Blooms can be the result of more than one factor. The conceptual diagram below illustrates some of the many variables that can potentially control or influence the development of algae blooms.

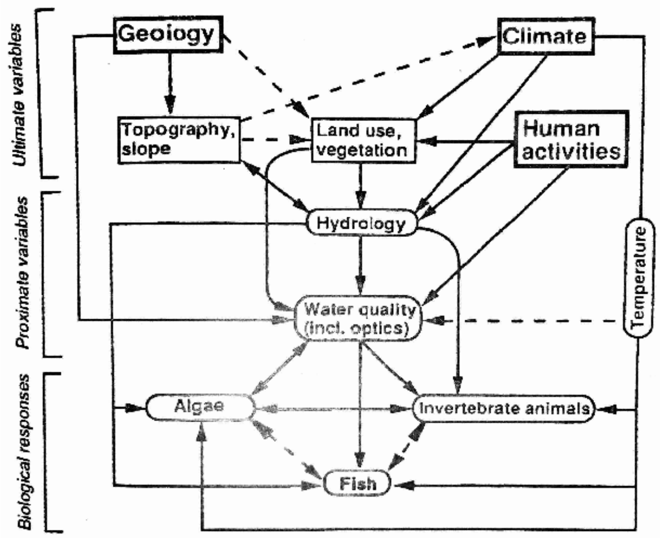


FIGURE 14 Conceptual model of ultimate (landscape) and proximate (stream) variables that control benthic algal communities, their consumers, and interactions in streams (solid lines = strong effects; dashed lines = weaker effects; double arrows indicate feedback interactions. Reproduced with permission from Biggs, B. J., in Stevenson, R. J. *et al.*, Eds., Algal Ecology: Freshwater Benthic Ecosystems. Copyright © 1996 by Academic Press.

Field ID Methods

There are some simple field tests to help identify aquatic macroflora in the field. These methods require no more than what a biologist likely carries into the field on a regular basis. Supplies needed are: gloves for handling specimens and a clear dish or bottle.

- Run through fingers: While wearing gloves, a biologist can rapidly identify filamentous green algae, filamentous cyanobacteria, and submerged aquatic vegetation by picking up a specimen with open hand. In many cases, the ability for the specimen to stay intact while draped over the biologists fingers will be a strong indicator of algae type.

- Suspend specimen in water: Working in lotic systems can change the appearance of the specimen in question due to flow and the presence of other overlapping macroflora. The best way to make a positive field ID is to place a specimen in a clear cup (or cupped in hands with water) and observe the algal morphology.

  The biologist should be looking for:
  1.) Geometric patterning in algae
  2.) Branching/feathering of filaments
  3.) Density of filamentous mat
  4.) Robustness of filamentous mat

- <u>Squeezing sample:</u> While wearing gloves, a biologist can tease apart or squeeze the algal sample. By squeezing the water out of the sample the biologist may infer on the structural robustness of the filaments. In some cases, the structure of the filamentous mass devoid of access water can be an important distinction in field ID.

- <u>Specimen Preservation</u>:
  - Buffered 2.5% glutaraldehyde (long term)
  - Buffered formaldehyde (long term)
  - Collected in river water from sample site and put on ice (short term).
    - Do not collect cyanobacteria in this way.
    - Single samples to reduce biomass as much as possible

Rapid ID of attached filamentous green algae

Primary characteristic: Bright green all the way to 'foot' of plant

1. When you pick up the sample, does it have filaments (remains on hand when picked up), resemble a vascular plant, <u>OR</u> have particles suspended in the water column?
   a. Filaments -> Continue to question 2.
   b. Does it resemble a vascular plant with whorled branches and smell of garlic or skunk? ***<u>Chara sp.</u>***
   c. Suspended in water column -> Collect a sample in a dark bottle. The planktonic sample will need microscopic identification.

2. When picked up, does the sample remain as a robust, intact filamentous mat/chain <u>OR</u> is it fragile and able to slip through the fingers of an open hand?
   a. Robust filaments that do not slip through open hand
      i. Does it have a netlike structure (spread thinly in hand, reveals geometric hexagonal netting?) ***<u>Hydrodictyon sp.</u>***
      ii. Short sample (<20cm) Do the tufts have a small feathery appearance? Long smaple (>20cm) When squeezed free of water, does the algal mat resemble cotton? ***<u>Cladophora sp.</u>***
   b. Fragile and slips through fingers of an open hand.
      i. Are filaments long slimy and slippery and do not easily break? ***<u>Spirogyra sp.</u>***
      ii. Are filaments bright green-yellow, fragile, and epiphytic. Do streamside dewatered reaches have dried "algal paper?" ***<u>Rhizoclonium sp./ Oedogonium sp.</u>***

Rapid ID of attached blue-green algae

Cyanobacteria ID should not be recorded in the field due to the similarities observed between species.

- Primary characteristic: Blue-green color, although some taxa can be dark green, brown or red. The foot will often be attached to a grey diatomaceous mat.
- In almost all cases, cyanobacteria will lack rigidity generally feel slimy.
- Cyanobacteria will manifest as a tuft or benthic mat.
- Unlike filamentous green algae, filamentous cyanobacteria have not been observed in the Potomac Basin filling the water column (with the exception of shallow glides).

Rapid ID of submerged aquatic vegetation

Primary characteristic: Vascular Tissue. More rigid morphology; able to withstand higher flows

Taxa found in streams and rivers in the EPA Region 3 states include the following:

Elodea
Hydrilla
Water stargrass (Heteranthera dubia)
Water milfoil (can be mistaken for Chara)

Wild celery (Vallisneria Americana)
Sago pondweed (Potamogeton pusillus)
Curly pondweed (Potamogeton crispus)

A good resource for in-field SAV identification:
http://ww2.mdsg.umd.edu/store/books/sav/index.php#order_now

Bay Grasses in Chesapeake Bay & Mid-Atlantic Coastal Waters
Guide to Identifying Submerged Aquatic Vegetation

Peter W. Bergstrom, Robert F. Murphy, Michael D. Naylor, Ryan C. Davis, and Justin T. Reel. 2006. UM-SG-PI-2006-01. $29.95. 80 pp.

Algae taxa seen to date by ICPRB staff in WV and VA streams and rivers

(Note: many photos have been borrowed from internet-based picture guides to algae)

Filamentous Green Algae

Hydrodictyon

Class: *Chlorophyceae*

Order: *Chlorococcales*

Family: *Hydrodictyacae*

Genus: *Hydrodictyon*

Synonym(s): Water net, mermaid's net

Field description:

Flow Regime: Low
Habitat: Found in shallow low flow environments that experience abundant, direct light. Hydrodictyon does not attach well to substrate and will easily become dislodged by wading.
Description of Filament: ~ 8" (20cm) mats may entangle and attach to one another giving the appearance of greater length. Key descriptor is the geometric hexagonal pattern of filament.
Tactile: Coarse and heavy (similar to texture Cladophora). Algae will remain intact and look similar to cotton when a sample is removed from the water and squeezed.
Odor: None when healthy. Will smell septic when senescence begins and decomposing mats begin to amass.
Visual: Cup water in hands, small pentagonal/hexagonal/heptagonal nets become apparent. Color is not a good descriptor as it often will transition from deep green, to light green, to yellow depending on development. Early growth will be dense and dark green. As it begins to senesce it will turn yellow and hold gas pockets giving a frothy appearance.

Images:

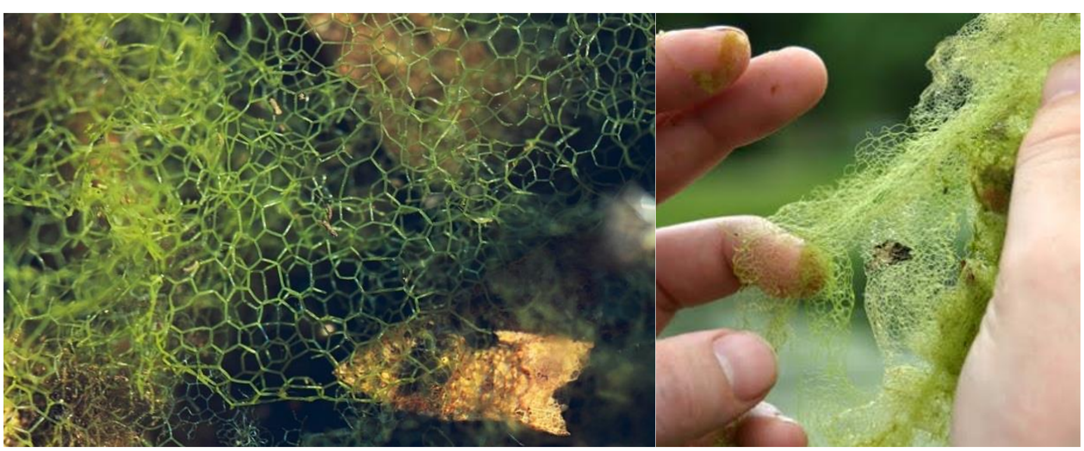


Figure 1. Left: A microscopic image of Hydrodictyon sp. illustrating the characteristic pentagonal/hexagonal/heptagonal morphology of the filaments. Right: An image captured while in the field of the "net-like" structure.

Figure 2. Microscope view of Hydrodictyon.

Figure 3. A Hydrodictyon bloom located on the Cacapon river 2016. This algal mass was observed in a shallow cobble/gravel bar away from the main thalweg (not pictured).

Cladophora sp. (often *C. glomerata*)

Class: *Chlorophyceae*

Order: *Cladophorales*

Family: *Cladophoraceae*

Genus: *Cladophora*

Synonym(s): Cladophora, "algae"

Field description:

__Flow Regime:__ High / Low
__Habitat__: Found in all flow environments that experience abundant direct light. Cladophora does attach well to substrate making wading through thick patches difficult. Unlike Hydrodictyon, there is often a central “backbone” to the long filaments
__Description of Filament__: 5cm to 8m long. Branching is easily visible when young, often looking feathery when cupped in hands. Filaments are less obvious the larger the filament strand becomes.
__Tactile__: Extremely coarse and heavy when it has reached its nuisance form.
__Odor__: None when healthy. Will smell septic when senescence begins and decomposing mats begin to amass.
__Visual__: Cladophora is difficult to identify by a single morphology. When it first forms, Cladophora tufts (6” and shorter) will appear feathery, growing from a single basil foot. As the filaments grow longer, the feathery branches will begin

Figure 4. Left: Early growth of Cladophora will appear as a feathery small tuft. Right: As the filaments grow longer, the feathered appearance will become less obvious, looking instead like a single long filament until suspended in a sample jar.

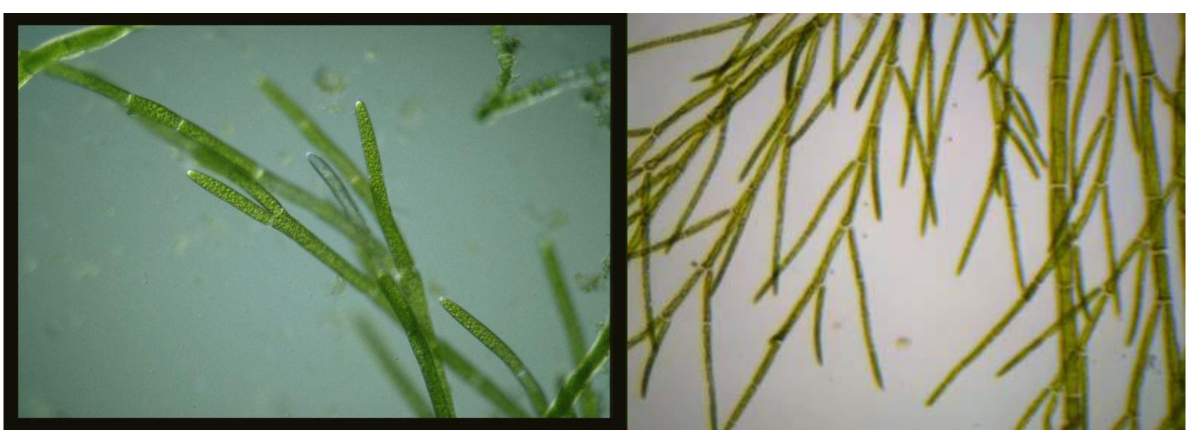


Figure 5. Microscope views of Cladophora


Figure 6. Stream-side view of a Cladophora bloom.

Spirogyra

Class: *Zygnematophyceae*

Order: *Zygnematales*

Family: *Zygnemataceae*

Genus: *Spirogyra*

Synonym(s): Frog snot

Field description:

Flow Regime: Low
Habitat: Found in very low flow environments. Will manifest in pools and among shallows.
Description of Filament: Very fragile. Filaments do not grow longer than 8" (20cm).
Odor: None when healthy. Does not collect in dense mats so even during senescence there is usually no olfactory cue.
Visual: Clustered distribution often making spherical assemblages. Spirogyra is generally a darker green than other filamentous green algae (but lacking blueish tint of cyanobacteria) until late summer when flows decrease and temperature increases. These two stressors will cause the algae to senesce and turn a yellow-green color that is very short lived.

The very distinctive spiral chloroplasts sometimes make Spirogyra identifiable in the field with a hand-held magnifier.

Figure 7. Left: Fragile Spirogyra colonies growing near the shore. Right: A field sample viewed under a microscope can quickly confirm Spirogyra due to its characteristic chloroplasts.

Chaetophora

Class: *Chlorophyceae*
Order: *Chaetophorales*
Family: *Chaetophoraceae*
Genus: *Chaetophora*

Synonym: Unknown

No field identification tips available.
Plants globose, tuberculose or arbuscular, mucilaginous or somewhat cartilaginous. Thalli comprised of highly branched, intertwined, uniseriate filaments, each branch tapering to a blunt point or giving rise to a long, multicellular hair.

Figure 8. Microscope view of Chaetophora.

Field differentiation between the next two taxa cannot be confirmed in the field

Rhizoclonium

Class: *Ulvophyceae*

Order: *Cladophorales*

Family: C*ladophoraceae*

Genus: *Rhizoclonium*

Synonym(s): Unknown

Field description:

Flow Regime: Low flow

Habitat: Shallow. Does not grow well on substrate, instead often grows on established SAV, other algae, and/or organic material.

Description of filaments: Individual filaments will appear very fragile and non-branched. These algae form large tangled coarse mats that float near the surface, held up by the oxygen they produce, or snagged by underwater.

Tactile: Slimy, fine threads. Extremely fragile and will flow through fingertips. Cupping in hands will not show branching patterns.

Odor: Only upon breaking free and decomposing in collected mats.

Visual: Unbranched filaments, found growing attached to submersed plants or organic debris, as long strands or short fuzz. Visually very similar to Oedogonium in the field.

Oedogonium

Class: *Clorophyceae*

Order: *Oedogoniales*

Family: *Oedogoniaceae*

Genus: *Oedogonium*

Synonym(s): Unknown

Field description:

Flow Regime: Low Flow

Habitat: Shallow. Does not grow well on substrate, instead often grows on established SAV, other algae, and/or organic material.

Description of filaments: Individual filaments will appear very fragile and non-branched. These algae form large tangled coarse mats that float near the surface, held up by the oxygen they produce, or snagged by underwater.

Tactile: Slimy fine filaments. Will adhere to hand rather than slip through like Spirogyra and Rhizoclonium.

Odor: Only upon breaking free and decomposing in collected mats.

Visual: Unbranched filaments, found growing attached to submersed plants or organic debris, as long strands or short fuzz. Visually very similar to Rhizoclonium in the field.

Images:

Figure 9. Left: Macro photograph of Rhizoclonium/Oedogonium smothering a Hydrilla bed in the Cacapon River, WV. Rhizoclonium/Oedogonium, due to its fragile structure, has established opposite of the thalweg on a low flow bank (epiphytic from, attached to Hydrilla bed).

Figure 10. Microscope view of Oedogonium.

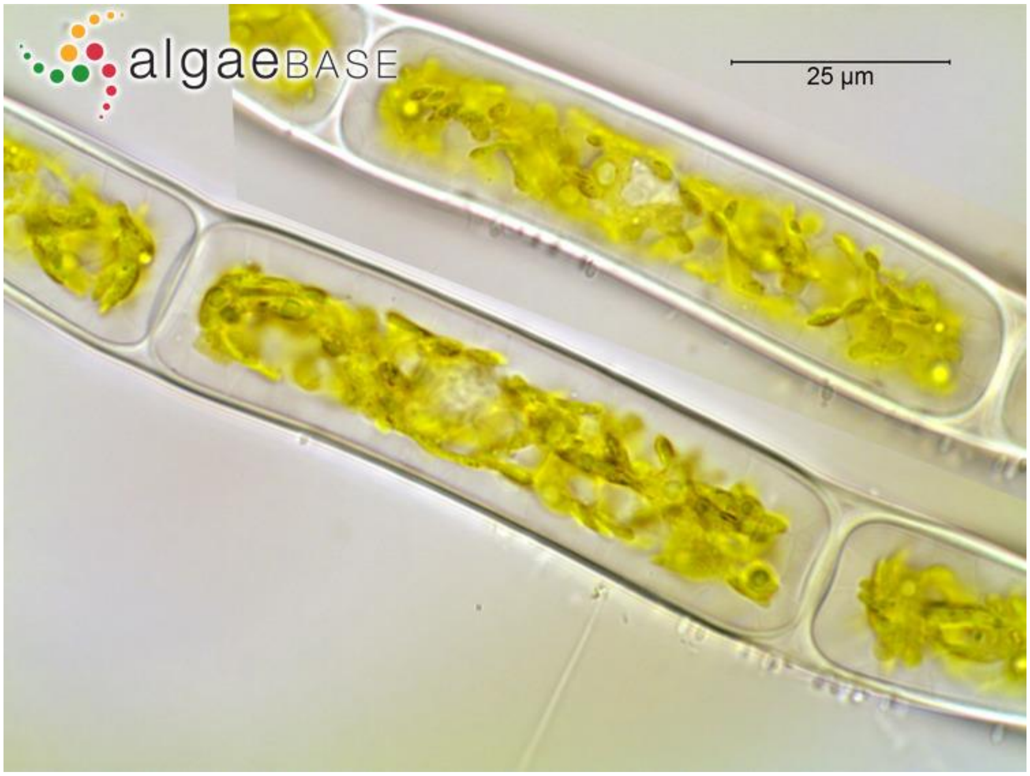


Figure 11. Microscope view of Rhizoclonium.

Zygnema

Class: *Zygnematophyceae*

Order: *Zygnematales*

Family: *Zygnemataceae*

Genus: *Zygnema*

No field identification tips available. Has been seen entangled with other taxa, including Cladophora.

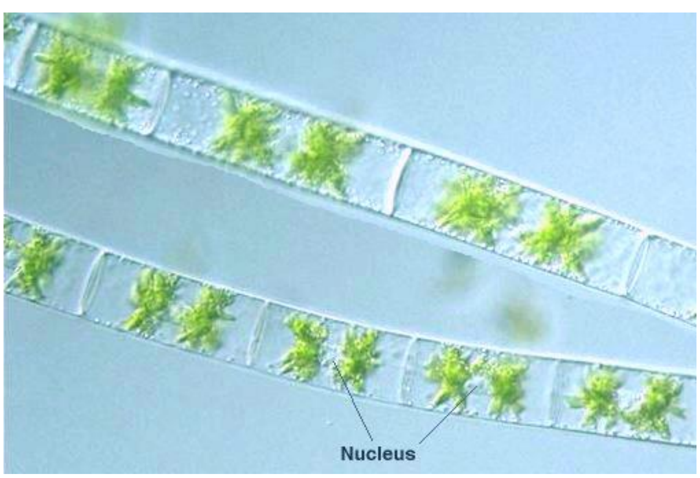


Figure 12. Microscope view of Zygnema. Note the dual stellate (star-like) chloroplasts. Image from www.protist.i.hosei.ac.jp/pdb/images/

Stigeoclonium

Class: *Chlorophyceae*

Order: *Chaetophorales*

Family: *Chaetophoraceae*

Genus: *Stigeoclonium*

No field identification tips available. Has been seen entangled with other taxa, including Cladophora.

Figure 13. Microscope view of Stigeoclonium. Image from www.protist.i.hosei.ac.jp/pdb/images/

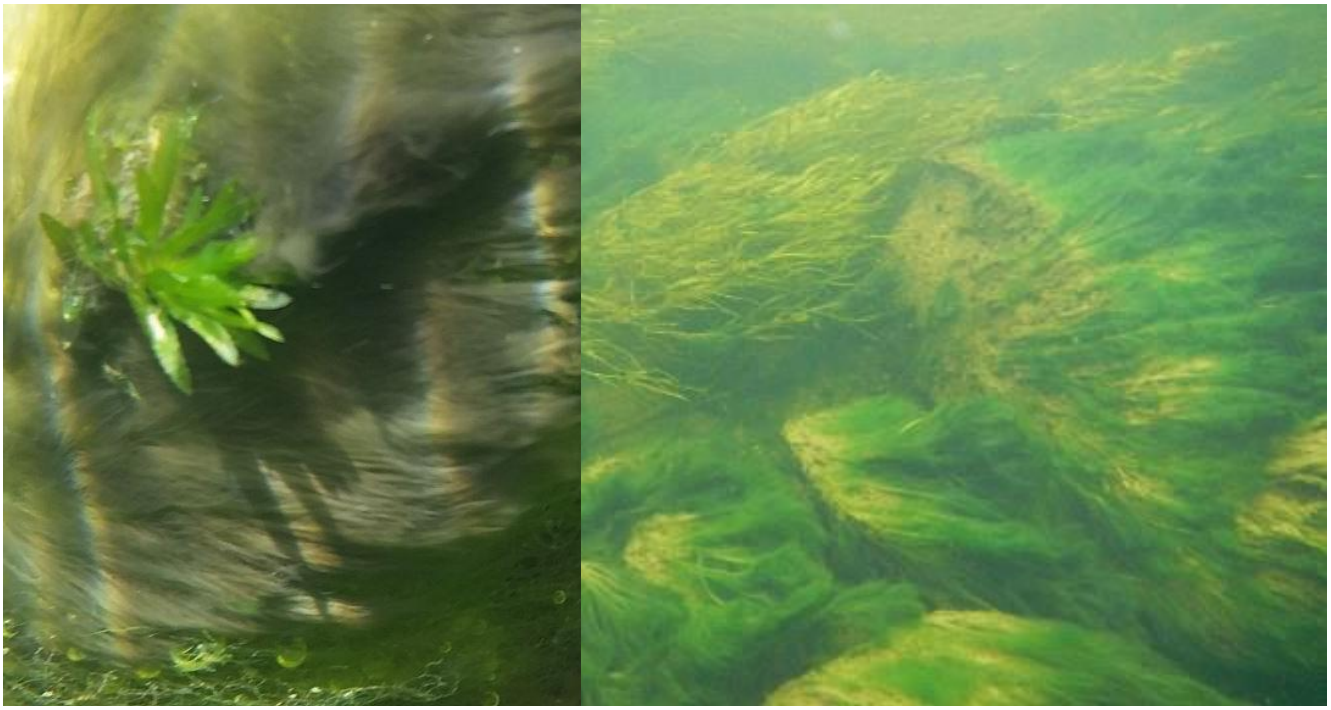
Possible other taxa (not confirmed)

Tribonema
Chara

Macroscopic Views of Blue-Green Algae (Cyanobacteria)

Anabaena

Oscillatoria



Lyngbya

Nostoc

Helpful Resources

Online keys

http://cfb.unh.edu/	University of New Hampshire online taxonomic keys
http://www.algaebase.org/	Algae Base
http://www.cyanodb.cz/main	On-line database of cyanobacterial genera

Books

Wehr, J. D. and R. G. Sheath. 2003. Freshwater Algae of North America: Ecology and Classification. Academic Press.