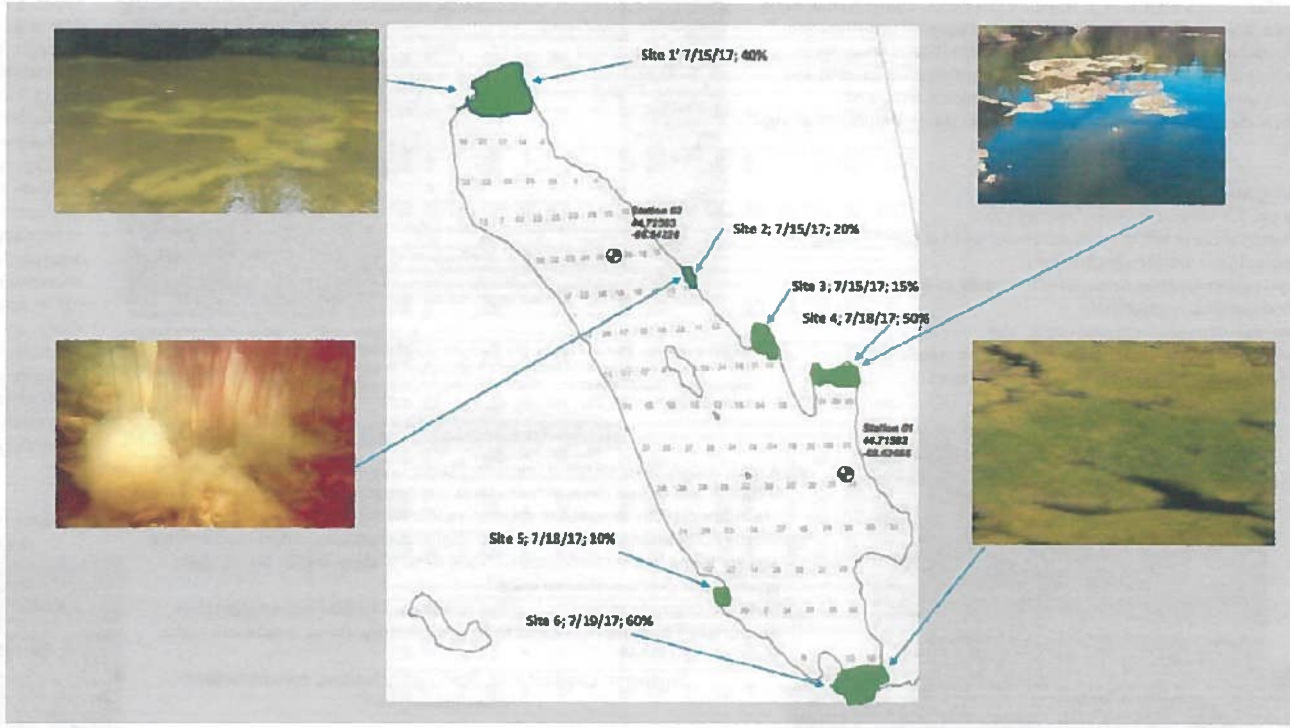
LAKE STEWARDS OF MAINE
Volunteer Lake Monitoring Program

Guidelines for Monitoring Metaphyton Density In Lakes

1. Download and print a bathymetric (depth) map for your lake at lakesofmaine.org. The map can serve as your survey form, or you can attach an additional sheet of paper with the documentation required below.

2. Use a highlighter to shade areas of the lake where significant metaphyton growth is observed (see example). Metaphyton occurs primarily in shallow areas that are protected from wind and wave action. Metaphyton is not rooted, but it commonly becomes entangled in the stems of rooted aquatic plants, where it can form clouds or "pillows".

3. For each highlighted area that you have identified, indicate the approximate percentage of that area where metaphyton is observed. This can be written in the shaded area, or included in a text box (see example).



4. Indicate on the map: Your name; the lake name and MIDAS; current and recent weather (cloud cover, wind, precipitation, air temperature); the date(s) when the survey was done, as well as a location/site number for each area. For example: " July 18, 2017; Site 3".

5. If possible, include a photo for each site number. Photos can be taken from the surface if conditions are relatively calm and surface glare is minimal (see examples). NOTE: If you submit photos as attachments, be sure to label the electronic files clearly, including the lake name and site number. Photos pasted on a field sheet (as illustrated) are more easily associated with your survey.

6. Ideally, all sites should be visited within a one week period. Additional maps can be used to document changes in metaphyton density throughout the open-water season.

If you have any questions or concerns regarding these guidelines, please contact LSM at (207) 783-7733 or stewards@lakestewardsme.org.

METAPHYTON IN OUR MAINE LAKES: WHAT IS IT? A LITERATURE REVIEW OF THE MYSTERIOUS GREEN, FILAMENTOUS "COTTON-CANDY" CLOUDS.

HANNAH SHUTE & DR. KAREN WILSON
DEPARTMENT OF ENVIRONMENTAL SCIENCE, UNIVERSITY OF SOUTHERN MAINE

INTRODUCTION

Over the past three decades, anecdotal observations of metaphyton (Figures 1 & 2) abundance has increased in Maine lakes. Much is known about the physiology, structure, and ecology of phytoplanktonic algae, but we lack an understanding of the physical, chemical, and biological role these loosely attached, filamentous algae play in aquatic ecosystems. Informational voids in contemporary limnology include: taxonomy; geographical distribution; seasonal population dynamics; utilization of microhabitats; response to parameters of water movement or water and substratum chemistry; and interactions with other organisms[1]. Due to the physical nature of metaphyton, there are numerous complications in the quantification of algal populations.

This ongoing literature review identifies:

- Most common definition of metaphyton;
- Potential cause-effect relationships between nutrient loading and metaphyton productivity/biomass;
- Ideal environmental parameters for productivity;
- Consumers of metaphyton;
- Metaphyton species composition; and
- Possible research directions—specifically a standardized methodology for quantification in Maine lakes.

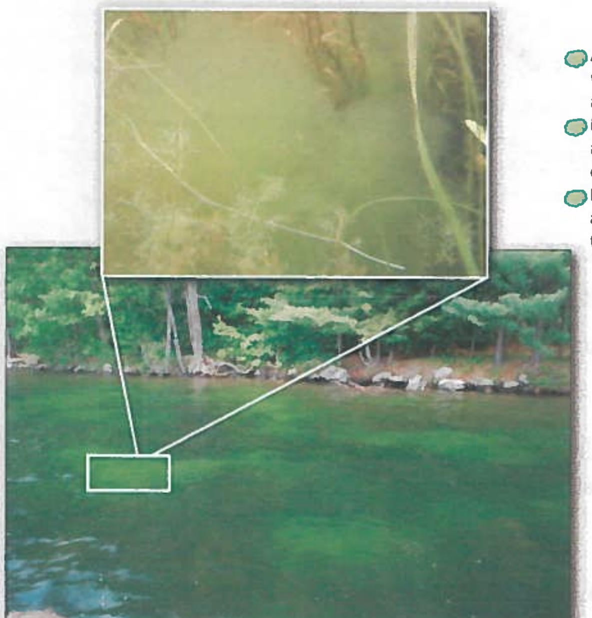


Figure 1. View of metaphyton patches from above water. Top: Underwater close-up of metaphyton among macrophytes in a Maine lake *(Photos: bottom: Ryan Burton, CWD; top: Maine VLMP)*. Metaphyton is the richest of communities in a lake[2]; the productivity and collective metabolism can be very high and thus alter local nutrient cycling[1]. Metaphyton might have negative effects on submerged macrophytes[3] and other organisms (i.e. photoinhibition, localized O_2 depletion, etc.)[4,5,6].

Figure 2. A patch of metaphyton among macrophytes in a Maine lake *(Photo: Maine VLMP)*. Filamentous green algae vary in species comp., architectural structure, and physiological characteristics[7,9] and influence the energy balance, chemical cycling, physical features, and biological conditions in the littoral zone of most lakes[6]. Although presence in the littoral zone is not unusual, in an environment with refuge provided by macrophytes, abundant irradiance, stable water column, and ample nutrients, metaphyton could reach nuisance levels[12].

METAPHYTON DEFINED

- A macroscopic assemblage of primarily filamentous algae loosely aggregated in flooded wetlands and littoral zones of many lakes and ponds and floodplain areas of rivers that are neither strictly attached to substrata nor truly suspended[1] (Figure 3)
- Mostly non-motile algae living in a mucilaginous mass secreted by macrophytes and are found loosely associated with any benthic algae, higher plants, their epiphytes or debris in shallow water[2]
- Mats can originate as benthic biofilms (dominated by filamentous algae) but ascend when buoyant O_2 bubbles form once photosynthesis is sufficient within the algal mass[1,5,7,8,9]

Synonyms: *elephant snot, flab*[7], *tychoplankton, pseudoplankton, psuedoperiphyton*[1]

(Versus periphyton, which is strongly attached to a substrata[1]. Both types have distinct species assemblages of diatom communities[10]).

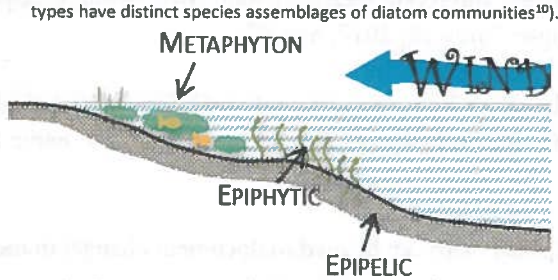


Figure 3. Cross-section diagram of a littoral zone in a lake. Epiphytic algae colonize on submersed surfaces of live/dead macrophytes; epipelic algae are in illuminated sediments (fine, organic) in open water[4]. Parameters of a "metaphytic" zone[13] to summarize common responses to physical, chemical, and biotic resource parameters have yet to be defined. Metaphyton abundance changes rapidly over time in most water bodies (i.e. storm events can tear apart floating mats). Floating mats usually end up downstream or at the downwind end of small water bodies as a result of wind-induced water movement. Spatial and temporal variability in metaphyton abundance results in differences in shading and localized nutrient availaility[14].

MAJOR FINDINGS

- Metaphyton does not form before March in temperate regions (light, ice, etc.)[8,9]
- Zygnematacea family: filaments generally free-floating. Oedogoniaceae can be free-floating but also attached to substratum. Different sexual reproduction (Z: conjugation; O:isogamous, monoecious, or dioecious[20]) (Figures 4, 5, 6, & 7)
- Stratification of temperature, O_2 content, and pH vary diurnally within a cluster of filamentous algae[7]
- Low pH (≤ 6.0[13,16]) positively influences growth, abundance, and impacts of metaphyton
- Combinations of factors affect metaphyton productivity, i.e., dissolved organic carbon (DOC) is the primary attenuator of solar radiation in many lakes, but acidification decreases the concentration of DOC which leads to (spikes) in ultraviolet radiation, esp. in shallow water, encouraging metaphyton growth[17]
- Linkage between land use in catchment basin and downstream aquatic ecosystems may promote metaphyton (*Zygnema, Spirogyra*) growth in littoral zone[12] through tributary effluent (↑ P)
- Metaphyton is a better competitor for limiting nutrients: largest contributor to total algal productivity (60-80% total) compared to phytoplankton, epipelon, & epiphyton[4,18,19] Metaphyton biomass and productivity ↑in response to enhanced nutrient inputs (N & P)[12,19]. Alters consumer food web, but variability in presence results in an unreliable energy source for the littoral food web[6]
- Provides food and shelter for invertebrates, tadpoles, and small fish[14], but there is little evidence to support that algal grazing controls abundance[7]; *Spirogyra* preyed upon by herbivorous fish, fungi, & protozoans[20]
- **Research directions:** define ideal environmental parameters for metaphyton and conduct C/N/P ratios to better understand nutrient-based relationships.

TAXONOMY

Filamentous algae identified in Maine lakes[15]: *Mougeotia* (198 species[20]), *Zygnema* (443 species[20]), *Spirogyra* (640 species[20]), & *Oedogonium* (1314 species[20]):

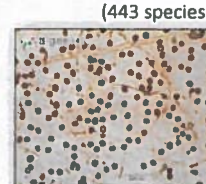


Figure 4[21]. Mass of *Mougeotia parvula* zygospores.© C.F.Carter.

Figure 5[22]. *Spirogyra grevilleana*. Replicate cell walls.© C.F.Carter.

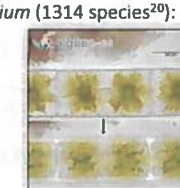


Figure 6[23]. *Zygnema stellinum*. © C.F.Carter.

Family: Zygnematacea
Genera free-floating filaments, widespread in freshwater habitats. Generally wide range of tolerance for climate, habitat, brackish, quiet/running water, etc. No major economic use/nuisance. Related to lower land plants[20]

Figure 7[24]. *Oedogonium braunii*. © Rossella Barone

Family: Oedogoniaceae
Typically epiphytic, sometimes free-floating in shallow standing freshwaters (i.e., ponds, lakes, ditches) worldwide. Most abundant in temperate/subtropical climates[20]

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References see attached.