

EIM Help – Areal Biomass for Periphyton & Macrophyte Data

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What are Periphyton, Macrophytes, and Areal Biomass?

Periphyton is a complex assemblage of microorganisms including algae, cyanobacteria, heterotrophic microbes, and detritus. Periphyton is found attached to submerged surfaces in most aquatic ecosystems, often forming slimy coatings.

Macrophytes are aquatic plants that grow in or near water and are either emergent, submergent, or floating.

Areal Biomass represents the density of periphyton or macrophytes measured per unit area of stream substrate. Areal biomass is often expressed in terms of Chlorophyll *a*, which is an indication of photosynthetic capacity per unit area. Alternatively, Areal Biomass can be expressed as Ash-Free Dry Weight (AFDW), which refers to the water-free weight of the organic material per unit area.

Areal Biomass and Watershed Health

Scientists calculate Areal Biomass for aquatic systems because periphyton and macrophytes are important drivers of dissolved oxygen and pH in waterbodies and play an important role in nutrient cycling. Periphyton and macrophytes are sensitive to changes in concentrations of nutrients such as nitrogen. Elevated nutrient concentrations can cause rapid growth; hence, periphyton and macrophytes are important sentinels for pollution problems. Periphyton and macrophyte growth can also accelerate when waterbodies are exposed to increased sunlight, such as after riparian vegetation is removed.

Areal Biomass and EIM - Overview

Labs report raw periphyton and macrophyte data as mass/volume (such as mg/L) or mass/weight (such as mg/kg). Use this to calculate Areal Biomass, along with sample volume (for periphyton) or sample weight (for macrophytes) and sampling area. See details in “How to Calculate Areal Biomass” below.

You can enter both your raw *Chlorophyll a* labs data AND your calculated Areal Biomass data into EIM. Follow the guidance in Table 1 for naming conventions.

Table 1: Key fields for raw and Areal Biomass data, Result template.

Data Type	Parameter Name	Sample Matrix	Sample Source	Units
Chlorophyll a in periphyton	Chlorophyll a	Tissue	Periphyton	ug/L (or appropriate mass/volume)
Areal biomass of periphyton	Areal Biomass as Chlorophyll a	Tissue	Periphyton	mg/m2 (or appropriate mass/area)
Chlorophyll a in water	Chlorophyll a	Water	Fresh/surface water	ug/L (or appropriate mass/volume)

Sample Collection

Periphyton: Periphyton is scraped with a small brush from submerged surfaces, such as rocks, woody debris, or the stream substrate, into a sample container using a known amount of de-ionized water. For Total Maximum Daily Load (TMDL) sampling, periphyton is not typically scraped from macrophytes because of the potential to contaminate the periphyton biomass with chlorophyll from the macrophytes.

Macrophytes: An area of the streambed is designated to be sampled by placing a template, such as a hoop, over the sampling site. All of the macrophytes located within the template boundary are then collected and placed in a sample container and sent to the lab.

Record this information when sampling:

- Surface area you sampled or scraped.
- Total sample volume at the time of collection (or have your lab determine it for you).
- Whether or not your sample is a composite.

Laboratory Analyses

Raw data from one of the following analyses enable you to calculate periphyton and macrophyte Areal Biomass for your site:

1. **Chlorophyll a:** This is the most common parameter measured to be able to calculate periphyton or macrophyte biomass. Labs most commonly report periphyton chlorophyll *a* as mass per volume (e.g. ug/L or mg/L) and macrophyte chlorophyll *a* as mass per weight (e.g. mg/kg).
2. **AFDW:** For Ash-Free Dry Weight, your lab dries your sample, weighs it, combusts it, and then weighs the ashes. The difference between the two weights is the result value, representing the amount of organic material vaporized during combustion. It is reported in mass per weight (e.g. mg/kg).
3. **Nutrients:** Less commonly, nutrients such as Nitrogen or Phosphorus can be measured and reported as mass per volume (periphyton) or mass per weight (macrophytes).

How to Calculate Areal Biomass

The units in the following examples are examples of what you might receive from your lab. Make sure your units are correct and converted as necessary for your calculations. Examples for calculating Areal Biomass from Carbon, Nitrogen, and Phosphorus are not included in this document.

Periphyton

For this calculation, you need: (1) the result value you received from your lab, (2) the volume of the sample, and (3) the surface area from which you collected your sample.

Examples:

1. If your lab reported results as **chlorophyll *a*** (mass/volume):

$$\text{Areal Biomass (mg/m}^2\text{)} = \frac{\text{Chlorophyll } a \text{ (mg/L) x Sample Volume (L)}}{\text{Sampling Surface Area (m}^2\text{)}}$$

2. If your lab reported results as **AFDW** (mass/weight):

$$\text{Areal Biomass (mg/m}^2\text{)} = \frac{\text{AFDW (mg/kg dw) x Sample Dry Weight (kg)}}{\text{Sampling Surface Area (m}^2\text{)}}$$

Notes: Convert high mg/m² values to g/m²

Result Basis is DRY

Macrophytes

For this calculation, you need: (1) the result value you received from your lab, (2) the sample weight, and (3) the surface area from which you collected your sample.

Example:

$$\text{Areal Biomass (mg/m}^2\text{)} = \frac{\text{Lab Result (mg/kg) x Sample Weight (kg)}}{\text{Sampling Surface Area (m}^2\text{)}}$$

How to Enter Areal Biomass Data into EIM

In addition to EIM's standard required fields described in the [Result Help](#), follow the guidance in Table 2 for entering your data into your [Result template](#):

Table 2: Key Result template fields for Areal Biomass Data

Column	Field Name, Result template	Valid Value(s)	Comments
D	Field Collection Type	Sample	
J	Field Collection Comment		<p>For periphyton, explain what type of substrate you sampled. For example, did you scrape the periphyton off rocks, pieces of wood, or an artificial substrate, etc.? You can also enter the number of transects and substrate (e.g. rocks) scraped.</p> <p>You also might want to explain more about your sampling method. For example, the way a sample is composited may differ between Ecology TMDL and River and Stream Ambient Biological Monitoring (Ambient) studies. For an Ambient study, enter a comment like "Sample composited following Ecology publication #10-03-109. Sample composited from 5-8 transects distributed within a 150-1000 meter long stream reach."</p>
V	Sample Composite Flag	Y, N	<p>Y - if you moved to different areas of the stream to collect the periphyton or macrophytes (e.g. if you moved your macrophyte sampling template to different locations in the stream).</p> <p>N - if you collected periphyton or macrophytes from one general area of the stream (even if periphyton was collected from multiple rocks at that one location).</p>
X	Sample Matrix	Tissue	For both periphyton and macrophytes.
Y	Sample Source	Periphyton, Plant Tissue	<p>Periphyton - Periphyton</p> <p>Macrophytes - Plant Tissue</p>

Column	Field Name, Result template	Valid Value(s)	Comments
AA	Sample Collection Method	See Tables 3 and 4.	<p>Periphyton</p> <p>If you are following Ecology SOP EAP085 for TMDL studies (Mathieu et al., 2013), Ecology SOP EAP085 V2.0 (Anderson et al., 2016) or Ecology publication 10-03-109 for Ambient Biological Monitoring in Rivers and Streams (Adams, 2010), see Table 3 below.</p> <p>If you used methods from one of the following USGS documents, contact your EIM Data Coordinator to have those methods added to EIM:</p> <p style="padding-left: 40px;">Porter, S.D., T.F. Cuffney, M.E. Gurtz, and M.R. Meador, 1993. Methods for Collecting Algal Samples as Part of the National Water-Quality Assessment Program; U.S. Geological Survey, Open-File Report 93-409, Denver, CO. Link: http://water.usgs.gov/nawqa/protocols/OFR-93-409/</p> <p style="padding-left: 40px;">Moulton, S.R., J.G. Kennen, R.M. Goldstein, and J.A. Hambrook, 2002. Revised Protocols for Sampling Algal, Invertebrate, and Fish Communities as Part of the National Water-Quality Assessment Program; U.S. Geological Survey, Open-File Report 02-150, Reston, VA. Link: http://pubs.usgs.gov/of/2002/ofr-02-150/</p> <p>Macrophytes – see Table 4.</p>
AB	Sample Preparation Method	Ex. FILTER.45um-GFF	If you field filtered, add the filter method here, such as FILTER.45um-GFF (optional).
AD	Sample Taxon Name	See comments	Periphyton - Leave blank Macrophytes - Enter "Plantae"
AF	Sample Tissue Type	See comments	Periphyton – Leave blank Macrophytes - Enter "Whole organism (plant)"

Column	Field Name, Result template	Valid Value(s)	Comments
AH	Result Parameter Name	Areal Biomass as Chlorophyll a Areal Biomass as Ash-Free Dry Weight Areal Biomass as Nitrogen Areal Biomass as Phosphorus Areal Biomass as Carbon	
AM	Result Value		Enter your calculated Areal Biomass. Do not enter the raw data value you received from your lab.
AN	Result Value Units		Your units should be mass/area (such as mg/m ²). These are from your calculated Areal Biomass, not the raw data units you received from your lab.
AY	Result Method		Enter the method your lab used to analyze your samples. See Table 5 below for examples.

Table 3: Ecology periphyton Sample Collection Methods.

Sample Collection Method (AA)	Method Description
PeriphytonCoarse	Periphyton Sampling Method for Epilithic (Course Substrate) Habitats
PeriphytonFine	Periphyton Sampling Method for Epipsammic (Pea gravel/Sand) and Epipellic (Silt) Habitats
PeriphytonCoarseFine	Periphyton Sampling Methods for composite sample containing material collected from Course Substrate + Pea gravel/Sand or Silt Habitats
PeriphytonVeg	Periphyton Sampling Method for Epiphytic (Submerged or Emergent Vegetation) Habitats
PeriphytonCoarseVeg	Periphyton Sampling Methods for composite sample containing material collected from Course Substrate + Emergent Vegetation or Submerged Vegetation Habitats
PeriphytonFineVeg	Periphyton Sampling Methods for composite sample containing material collected from Pea gravel/Sand or Silt Habitats + Emergent Vegetation or Submerged Vegetation Habitats
PeriphytonWoody	Periphyton Sampling Method for Epidendric (Woody Snag) Habitats

Sample Collection Method (AA)	Method Description
PeriphytonMultiple	Periphyton Sampling Methods for composite sample containing material collected from multiple (more than two) kinds of habitats
PeriphytonAS	Periphyton collected by in situ Artificial Substrate Sampler

Table 4: Macrophyte Sample Collection Methods.

Sample Collection Method (AA)	Method Description
Hoop-Macrophyte	Hoop method for collection of macrophytes and filamentous algae

Table 5: Examples of Result Methods for Areal Biomass.

Result Parameter Name (AH)	Result Method (AY)	Result Method Description	Method Source
Areal Biomass as Chlorophyll <i>a</i>	SM10200H3	Fluorometric determination of chlorophyll <i>a</i> in presence of pheophytin	Standard Methods
Areal Biomass as Ash-Free Dry Weight	SM10300C(5/6)	Periphyton Sample Analysis – Ash-Free Dry Weight	Standard Methods
Areal Biomass as Nitrogen	SM4500NB	Nitrogen, In-Line UV/Persulfate Digestion and Oxidation with Flow Injection Analysis	Standard Methods
Areal Biomass as Nitrogen	EPA440.0	Elemental Carbon and Nitrogen by Combustion and Thermal Conductivity	EPA-NERL
Areal Biomass as Phosphorus	EPA200.7	Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	EPA-NERL
Areal Biomass as Carbon	SM5310B	Total Organic Carbon (TOC), High Temperature Combustion Method	Standard Methods
Areal Biomass as Carbon	EPA440.0	Elemental Carbon and Nitrogen by Combustion and Thermal Conductivity	EPA-NERL

References

Adams, K., 2010. Quality Assurance Monitoring Plan: Ambient Biological Monitoring in Rivers and Streams: Benthic Macroinvertebrates and Periphyton, August 2010, Appendix C-3. Link: <https://fortress.wa.gov/ecy/publications/summarypages/1003109.html>

Anderson, P.D., N. Mathieu, and S. Collyard, 2016. Standard Operation Procedure (SOP) for Collection and Processing of Periphyton Samples. SOP No. EAP085, V 2.0 DRAFT. WA Department of Ecology, Olympia, WA.

Mathieu, N., S. Collyard, and T. Mohamedali, 2013. Standard Operating Procedure (SOP) for the Collection of Periphyton Samples for TMDL studies. Version 1.1. Washington State Department of Ecology, Olympia, WA. SOP Number EAP085. Link: <https://ecology.wa.gov/About-us/How-we-operate/Scientific-services/Quality-assurance>

Document Revision History

Revision Date	Revision No.	Summary of Changes	Reviser(s)
12/20/13	1.0	Original Document.	CL, KC, CN
5/15/14	1.1	Editorial revisions – to match Periphyton Count help document.	CN
05/17/16	2.0	Changed matrix to “tissue” for both periphyton and plant tissue. Removed the sentence “Do not enter the raw lab data into EIM for Areal Biomass; instead enter your calculated Areal Biomass values.” Raw chlorophyll a data is now allowed in addition to calculated Areal Biomass. Added Sample Preparation Method example, added Sample Collection Method “PeriphytonAS.” Added Sample Taxon and Sample Tissue Type for Macrophytes.	KC
09/29/17	2.1	Updated links.	KC
10/20/19	2.2	Updated links and accessibility.	CN