Purpose

This tool calculates the three main benthic algal indices of biotic integrity (IBIs) that have been developed for bioassessment applications in southern California wadeable streams (Fetscher et al. 2014) by SCCWRP and collaborators at California State University San Marcos, the University of Colorado Boulder, the San Diego Regional Water Quality Control Board, and the California Department of Fish and Wildlife. At this time, validation of the IBIs for use in streams outside of southern California has not be conducted rigorously, but preliminary analyses (Fetscher et al. 2013) suggest that the IBIs may also have applicability in other parts of the state.

Data input

To use this tool, input data must be uploaded in the form of an Excel .csv file, formatted as shown in this example template. The fields (columns) in this template mimic the way data types are named in California's Surface Water Ambient Monitoring Program (SWAMP) database. In order for the calculator to work, all fields must be present, with the field names spelled exactly the same way that they are presented in the template, and data must be entered in a very specific way (described below). Field definitions are as follows:

- SampleID – the sample ID is a concatenation of the StationCode, SampleDate and Replicate with an underscore separating the three. Example: 901SJSJC9_2008-05-05_1
- FinalID – the name of the algal taxon; in order for the tool to work properly, the FinalIDs *should reflect the taxonomic naming conventions put forth for the SWAMP program* by investigators at the California State University San Marcos and the University of Colorado Boulder. These Master Taxa Lists can be attained at http://checker.swamp.mpsl.mlml.calstate.edu/SWAMP_Checker/LookUpLists.php (the soft algae version is called "OrganismLookUp - CAD-TWG Algae List" and the diatom version is called "OrganismLookUp - CAD-TWG Diatom List"). Note also that, for use of this tool, it is highly recommended that samples be field-collected using the SWAMP standard operating procedures described by Fetscher et al. 2009. In addition, for the soft algae laboratory analysis, it is imperative that the procedures described by Stancheva et al. 2012 be followed in order to generate soft algal taxonomic data compatible with this calculator.
- SampleTypeCode – each record (row) of data must have a sample type specified that fits into one of 5 categories: "Microalgae", "Macroalgae", "Epiphyte", or "Qualitative" (all for the soft algae), or "Integrated" (for diatoms). Note that generally only a single Qualitative sample is collected/recorded per sampling event. As such, if replicate samples were collected at a given site, *the data from the Qualitative sample should be duplicated in the input spreadsheet: once for each of the replicates*.
- BAResult – this field is for the "count" data recorded for the Epiphyte and Integrated sample types; if the record in question is of sample type Microalgae or Macroalgae, then "NA" should be populated in this field.
- Result – this field is for the soft algal Microalgae and Macroalgae biovolume data (e.g., measured in units of m^3/cm^2); if the record in question is of sample type Epiphyte or Integrated, then "NA" should be populated in this field. Note that there is *never* a numerical value associated with the Qualitative samples. As such, *for Qualitative samples, both the "Result" and "BAResult" fields should be left blank*.

- ActualOrganismCount – this refers to the total number of diatom valves counted (a minimum of 600 is recommended) and total number of soft-algal microalgal "entities" counted (a minimum of 300 is recommended; Stancheva et al. 2012); thus only the Integrated and Microalgae sample types require data in this field – all others can be populated as "NA". Diatom count can be determined by the user. It is simply the sum of counts across all FinalIDs within the sample. Unlike the case with diatoms, *soft algae entity count is information that must be provided by the laboratory producing the data, as there is no way to infer entity count from the Microalgae results.*

Output of Results

The calculator produces results in the form of another .csv file, which contains the following information:

- If data for both the diatom and the soft algae assemblages were fed into the calculator, then results will appear for all three main benthic algal IBIs developed by Fetscher et al. (2014)
  - D18 – an IBI based solely on metrics from the diatom community
  - S2 – an IBI based solely on metrics from the non-diatom (i.e., "soft") algal community (including cyanobacteria)
  - H20 – an IBI based on a combination of diatom and soft-algae metrics
- Metrics that, in various combinations, comprise the three indices are described in the table below:

Metric	Assemblage	Metric category	Metric theme	Data type	Metric description
DO.50 (proportion requiring >50% DO saturation)	diatom	autecological guild	dissolved oxygen	proportion of valves	proportion of valves that require at least 50% dissolved oxygen saturation (sum 50+75+100)
DO.100 (proportion requiring nearly 100% DO saturation)	diatom	autecological guild	dissolved oxygen	proportion of valves	proportion of valves that require nearly 100% dissolved oxygen saturation
halo (proportion halobiontic)	diatom	autecological guild	ionic strength/ salinity	proportion of valves	proportion of valves that are brackish-fresh+brackish (i.e., they have a tolerance of, or requirements for, dissolved salts)
eutro (proportion poly- & eutrophic)	diatom	autecological guild	nutrients	proportion of valves	proportion of valves that are polytrophic+eutrophic
N.het (proportion N heterotrophs)	diatom	autecological guild	organic pollution	proportion of valves	proportion of valves that are heterotrophs (includes both obligate and facultative heterotrophs)
sapro (proportion oligo- & beta-mesosaprobic)	diatom	autecological guild	organic pollution	proportion of valves	proportion of valves that are oligosaprobous+beta-mesosaprobous
highly.mot (proportion highly motile)	diatom	morphological guild	sedimentation	proportion of valves	proportion of valves that are highly motile
sed.tol.high (proportion sediment tolerant--highly motile)	diatom	morphological guild	sedimentation	proportion of valves	proportion of valves for which there is information that are highly motile + all planktonic taxa
nonref.b (proportion "non-reference" indicators)	soft	relationship to reference	reference	relative biovolumes	proportion of total micro+macro biovolume composed of indicators of "non-Reference" sites
nonref.sp (proportion "non-reference" indicators)	soft	relationship to reference	reference	relative species numbers	proportion of total species richness composed of indicators of "non-Reference" sites (where "Reference" is defined as minimally disturbed by human activities)

AchMin (proportion *A. minutissimum*)	diatom	taxonomic group	*A. minutissimum*	proportion of valves	proportion of valves that are *Achnanthidium minutissimum*
propBiovolChlor (proportion Chlorophyta)	soft	taxonomic group	Chlorophyta	relative biovolumes	proportion of total micro+macro biovolume composed of Chlorophyta
totalBiovolCRUS (proportion of green algae belonging to CRUS)	soft	taxonomic group	Chlorophyta	relative biovolumes	proportion of green algae (Chlorophyta+Charophyta) micro+macro biovolume composed of Cladophora glomerata, Rhizoclonium hieroglyphicum, Ulva flexuosa, and Stigeoclonium spp.
propBiovolZHR (proportion ZHR)	soft	taxonomic group	ZygnHetero Rhod	relative biovolumes	Zygnemataceae+ heterocystous cyanobacteria + Rhodophyta
meanZHR (proportion ZHR)	soft	taxonomic group	ZygnHetero Rhod	relative species number and biovolumes	mean of scores for the ZHR (see above) species number and biovolume metrics
high.Cu.sp (proportion high Cu indicators)	soft	tolerance/ sensitivity	copper	relative species numbers	proportion of total species richness composed of high copper (dissolved) indicators
low.N (proportion low TN indicators)	diatom	tolerance/ sensitivity	nitrogen	proportion of valves	proportion of valves that are indicators for low TN levels
high.DOC.b (proportion high DOC indicators)	soft	tolerance/ sensitivity	organic pollution	relative biovolumes	proportion of total micro+macro biovolume composed of indicators of high DOC
high.DOC.sp (proportion high DOC indicators)	soft	tolerance/ sensitivity	organic pollution	relative species numbers	proportion of total species richness composed of high DOC indicators
low.P (proportion low TP indicators)	diatom	tolerance/ sensitivity	phosphorus	proportion of valves	proportion of valves that are indicators for low TP levels
low.TP.sp (proportion low TP indicators)	soft	tolerance/ sensitivity	phosphorus	relative species numbers	proportion of total species richness composed of low TP indicators

Each metric is reported both in its "raw" (unprocessed) form, as indicated by "RAW" in the metric's name, and the scaled version of the metric (with "SCALED" in the metric name). For all the SCALED metrics, the lowest possible value is 0 and the highest is 10. The SCALED versions of the metrics are the ones that are added together to calculate the various IBIs. All IBIs are scaled such that they have a possible score of 0 (lowest-quality condition) to 100. Refer to Fetscher et al. (2014) for more details on the metrics and how they are combined into the various IBIs. "NA" reported in any of the metric/IBI results fields indicates that data were insufficient to calculate that data type. For example, if no diatom community data are input, then "NA" will be returned for all diatom metrics and all IBIs (i.e., both D18 and H20) that require diatom data.

In addition to the IBIs and their component metrics, the output file provides some quality-control data to assist the user in determining how much confidence might be placed on metric and IBI scores, as a function of: 1) the amount of laboratory "effort" carried out and 2) how comprehensively the taxa in the sample have trait data available for the metric calculations (which may be important because, on a metric-by-metric basis, only the taxa that have trait assignments for that metric are included in the calculation, thus effective "count" size can be reduced if little trait information is available for that metric/sample combination). Definitions of the quality-control fields are as follows:

- SoftAlgaeSampleTypesPresent – a list of the sample types ("Microalgae", "Macroalgae", "Epiphyte", "Qualitative") that were present in the sample
- QualPresent – yes/no (whether or not a Qualitative sample had been analyzed)

- DiatomSamplePresent – yes/no
- totalDiatomCount – gives the total number of diatom valves in the sample
- EntityCount – gives the soft microalgae entity count
- DiatomCountFlag – indicates "Adequate" if the number of diatom valves counted for the sample was at least 450 (arbitrarily selected); otherwise "Inadequate" is indicated if the valve count was lower
- SoftAlgaeEntityCountFlag – indicates "Adequate" if the number of soft algal entities counted was at least 225 (arbitrarily selected)
- numberPurged – gives the number of FinalIDs that were eliminated from a given sample because they did not appear on the SWAMP Master Taxa List (see above), and thus could not be used in any metric calculations;
- purgedTaxa – lists the eliminated FinalIDs if the value of numberPurged is non-zero. The user should check to make sure taxa were not eliminated due to simple misspellings, otherwise these FinalIDs should be noted as candidates for additions during periodic Master List updating
- QC. (as a prefix to a metric name) – the proportion of diatom valves or soft algae biovolume (or taxa, depending upon the metric) for which trait information is available; a high value for this is desirable
- .QCmin (as a suffix after an IBI name) – the QC value for the metric comprising that IBI that has the lowest QC value; a high value for this is desirable

How to Cite Website and Calculator

This website was developed by Shelly Moore and should be cited as:

SCCWRP. 2014. algaeMetrics: a calculator for southern California algal Indices of Biotic Integrity (IBIs) for wadeable streams. Retrieved [Date], from http://207.141.116.159:8080/algaeIBI/.

The underlying R package that calculates the algae IBIs and its component metrics was developed by Mark Engeln, Raphael Mazor, and A. Elizabeth (Betty) Fetscher, and should be cited as:

SCCWRP. 2014. algaeMetrics: a calculator for southern California algal Indices of Biotic Integrity (IBIs) for wadeable streams.

References

Fetscher, A.E., L. Busse., and P.R. Ode. 2009. Standard operating procedures for collecting stream algae samples and associated physical habitat and chemical data for ambient bioassessment in California. Bioassessment SOP 002. Prepared for the California State Water Resources Control Board. Sacramento, CA.

Fetscher, A.E., M.A. Sutula, L. Busse, and E.D. Stein. 2013. Condition of California perennial wadeable streams based on algal indicators. Technical Report 0781. Southern California Coastal Water Research Project. Costa Mesa, CA.

Fetscher, A.E., R. Stancheva, J.P. Kociolek, R.G. Sheath, E.D. Stein, R.D. Mazor, P.R. Ode, and L.B. Busse. 2014. Development and comparison of stream indices of biotic integrity using diatoms vs. non-diatom algae vs. a combination. *Journal of Applied Phycology* 26:433-450.

Stancheva, R., A.E. Fetscher, and R.G. Sheath. 2012. A novel quantification method for stream-inhabiting, non-diatom benthic algae, and its application in bioassessment. *Hydrobiologia* 684:225-239.