Proposed Update of the CBP Stream Health Indicator - 2014

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Proposed activities & timeline

	Activity	2014 Timeline
1.	Request and receive new stream biological, habitat and water quality data from 20+ county, state and federal monitoring programs; assemble data in common structure (CBP database) – *Note: assembling the data requires some CBPO staff assistance*	Jan-Mar
2.	Develop a stand-alone computer program to calculate biometrics and the stream health indicator	Jan-Mar
3.	Calculate family-level biometrics; refine and validate family-level index	Mar-May
4.	Complete investigation of methods to quantify trends in the stream health indicator	June
5.	Begin development of a genus-level version of the stream health indicator	Mar-Dec
6.	Progress report to CBP Non-Tidal WQ Workgroup and Stream Health Workgroup	Dec

Background

In March 2008, the Chesapeake Bay Program (CBP) combined state agency stream assessments in a map of benthic macroinvertebrate impairment[1] and concluded the result could not adequately represent stream condition on a basin-wide scale. An approach based on a Potomac stream index[2,3] was then applied to the underlying monitoring data and the "Chessie BIBI," or Chesapeake basin-wide index of biotic integrity for stream macroinvertebrates, was developed in late 2008[4] and refined with additional data and analysis in 2011.[5] This stream health indicator is comprised of highly discriminatory family-level biometrics, some of which are used by state and local agencies in their own stream assessments. Biometrics in the index are scored uniformly across state boundaries according values observed at undisturbed reference (REF) sites in each physiographic region ("bioregion") of the basin. The index classifies REF sites and degraded (DEG) sites equally well, with classification efficiencies range from 77.8% in the under-represented North Central Appalachian bioregion to 91.7% in the well-represented Piedmont bioregion. Twenty-eight monitoring programs have now contributed data and a relational database of most of these data and their associated family-level metrics is currently on-line at www.chesapeakebay.net. Spatial coverage in most HUC8 watersheds of the Chesapeake basin between 2000 and 2011 is good. The index has proven to be sensitive to conductivity gradients and nutrient enrichment[6] and to streamflow alteration.[7]

The Chessie BIBI index will be refined and validated when additional macroinvertebrate data are acquired from the data collectors. A concern of the index's developers is the under-representation of reference sites in the North Central Appalachian (NCA) and Northern Appalachian Plateau and Uplands (NAPU) bioregions in Pennsylvania and New York. Additional reference-quality data in these bioregions are now available (Ellyn Campbell SRBC, per. comm.) Another concern, expressed by several state

agencies, is the use of family-level macroinvertebrate metrics. Family-level taxonomy was necessary in 2008 because some agencies only identified taxa to family-level. Since then, most agencies have moved to genus-level identifications. The states believe a genus-level BIBI will have a little more discriminatory power and individual genus-level metrics may prove sensitive to specific stressors. A basin-wide genus-level index can now be developed for the more recent time period.

Funding realignments and changing agency goals and priorities have raised the question of whether the Chessie BIBI should be a programmatic measure of stream health in the Chesapeake basin. Key CBP workgroups (Stream Health Workgroup, Habitat GIT team, Non-Tidal Water Quality Workgroup, and Science and Technical Analysis and Reporting [STAR] team) need to answer this question. If yes, funds are available through a CBP 117 grant to ICPRB to refine the Chessie BIBI index (see "proposed steps" below). However, ICPRB will need a database manager's assistance in acquiring the most recent stream data sets and incorporating them into the CBP relational database. If CBP elects to keep the Chessie BIBI as a CBP measure of stream health, it is possible to complete a refinement and verification of the index in the next year or two. At that point, index values in incremental periods can be compared to a baseline period to identify watershed-based trends in stream health. As before, a technical advisory group of knowledgeable and interested individuals from the various CBP workgroups would guide the effort.

Proposed steps

ICPRB has committed to the following additional task in the remaining 4 years of its 6-year 117 grant with the CBP:

> Develop stand-alone computer program to calculate stream health indicator (Chessie BIBI); work with CBPO staff to acquire and assemble additional years of data; begin development of a genus-level version of the stream health indicator; complete investigation of methods to quantify trends in stream health indicator.

The steps ICPRB will take to accomplish this task are briefly discussed here.

Acquire and incorporate recent data sets

ICPRB needs the cooperation and assistance of CBP in acquiring the most recent stream macroinvertebrate, water quality and habitat data collected by the various monitoring programs, and incorporating these data into the existing CBP relational database. Current holdings are:

Agency	Agency Program Name	Start	End	Samples
AAC_DPW	AACO-Watershed, Ecosystem, and Restoration Service	3/8/2004	4/14/2008	239
BAL_DPW	CITY OF BALTIMORE- Stream Monitoring Program	4/3/2002	5/6/2010	277
BC_DEP	Baltimore Co. Watershed Management and Monitoring	4/1/2003	4/29/2008	607
DC_DDOE	District of Columbia-Stream Monitoring Program	6/19/2003	5/21/2009	44
DNREC	Delaware Biological Monitoring Program	10/16/2001	11/8/2010	87
FC-DPW	Frederick County Watershed Management Program	4/23/2001	9/18/2009	351
FC-SPS	Fairfax County Stream Quality Assessment Program	7/31/2001	4/10/2008	239
HC_DPW	Howard Co Bio-Monitoring and Assessment Program	3/7/2001	3/30/2009	266
LC-DBD	Loudoun County Stream Quality Assessment Program	3/27/2009	10/12/2010	201
MC-SPS	Montgomery Co Dept. of Environmental Protection	3/22/1993	5/7/2008	1651
MDDNR	Maryland Biological Stream Survey	5/10/1994	11/18/2010	7472
MDDNR	Maryland Core/Trend Monitoring Network	5/10/1994	11/18/2010	7472
NYDEC	New York Routine Statewide Monitoring Program	7/29/2002	8/7/2008	346
PADEP	Pennsylvania Other Water Quality Assessments	3/12/1999	12/22/2010	1652
PADEP	Pennsylvania Surface Water Monitoring Program	3/12/1999	12/22/2010	1652
PADEP	Pennsylvania Unassessed Watersheds	3/12/1999	12/22/2010	1652
PADEP	Pennsylvania USGS	3/12/1999	12/22/2010	1652
PGC-DER	Prince Georges Co Programs and Planning Division	3/11/1996	4/7/2008	501

SRBC	SRBC-Watershed Assessment and Protection-TMDL	7/6/1998	10/19/2009	1167
SRBC	SRBC-Watershed Assessment Program	7/6/1998	10/19/2009	1167
USEPA	EPA-EMAP WADEABLE STREAMS ASSESSMENT	4/27/1993	11/10/2004	500
USEPA	EPA-MID-ATLANTIC HIGHLANDS ASSESSMENT	4/27/1993	11/10/2004	500
USEPA	EPA-Wadeable Stream Assessment Program	4/27/1993	11/10/2004	500
USFS	National Forest Service Stream Assessment	5/18/2000	5/8/2003	7
USGS	USGS-National Water Quality Assessment Program	6/2/1993	8/27/2008	243
VADEQ	Virginia DEQ Non-Tidal Stream Monitoring Program	10/18/1993	12/22/2010	3335
VCU	INteractive STream Assessment Resource	6/11/1999	11/24/2010	729
WVDEP	West Virginia Div. of Water and Waste Management	8/19/1996	8/31/2010	918

Computer program to calculate the Chessie BIBI

Several computer programs are now used to derive the Chessie BIBI from the CBP relational database. A single, stand-alone computer program would be more useful for CBP as well as for contributing agencies wanting to calculate the Chessie BIBI themselves. The Commission has the expertise in-house to create the stand-alone program. The program will be derived from the original code written by the Jacqueline Johnson, formerly the Living Resources Data Manager at CBPO.

Refine and validate the family-level Chessie BIBI

Refine the family-level index in North Central Appalachian (NCA) and Northern Appalachian Plateau and Uplands (NAPU) bioregions in Pennsylvania and New York; refine and validate the family-level index in Piedmont, Valleys, and Ridges bioregions. We expect to perform the following:

- Update tolerance score assignments for family-level biometrics; assign tolerance scores to genus-level biometrics; check feeding and habit assignments.
- Identify reference sites using stricter water quality and habitat criteria and additional watershed criteria; explore a karst-specific scoring approach for Valley bioregion
- Use RPART to confirm the influence of Ecoregion IV on final reference sites
- Identify degraded sites using stricter criteria
- Develop biometric scoring thresholds and calculate discrimination efficiencies
- Reassess biometrics used in index and try to include at least one that is sensitive to flow alteration, one that is sensitive to elevated nutrients, and possibly one that is sensitive to elevated conductivity. Select biometrics that give high BIBI classification efficiencies.
- Perform jackknife validation of index
- Confirm consistency of narrative rating thresholds across bioregions (e.g., excellent is BIBI $\geq$ 67; good is BIBI 50 - <67; etc.)
- Compare with state qualitative ratings

Trend analysis

Several trend analysis approaches were explored by Adam Griggs (ICPRB) and presented to the NTWQW in a November 9, 2011 conference call. When the stream macroinvertebrate database is updated and the Chessie BIBI method refined, development of a trend analysis approach can be finalized. At that time, a baseline can be calculated for the 2000 – 2008 time period.

Begin development of a genus-level Chessie BIBI

This effort is expected to extend into 2015. In 2014, a large suite of genus-level metrics will be calculated and an exploratory analysis will be performed to identify metrics that discriminate most strongly between reference and degraded stream habitats. A set of highly discriminating metrics will be selected for each bioregion. Discrimination efficiencies of the metrics and classification efficiencies of each bioregion-specific index will be determined.

Citations

[1] Map prepared by John Wolf, Chesapeake Bay Program GIS team, March 2008. "Benthic macroinvertebrate impairments, freshwater streams and rivers health assessment." Available online at: http://www.chesapeakebay.net/maps/map/benthic_macroinvertebrate_impairments

[2] Astin, L.E. 2006. Data synthesis and bioindicator development for nontidal streams in the interstate Potomac River basin, USA. Ecological Indicators 6: 664-685.

[3] Astin, L. E. 2007. Developing biological indicators from diverse data: The Potomac Basin-wide Index of Benthic Integrity (B-IBI). Ecological Indicators 7: 895-908.

[4] Foreman, K., A. Nagel, and C. Buchanan. 2008. Development of ecosystem health indexes for non-tidal wadeable streams and rivers in the Chesapeake Bay basin. Progress report prepared for the CBP Non-Tidal Water Quality Workgroup by the Chesapeake Bay Program Office and the Interstate Commission on the Potomac River Basin.

[5] Buchanan, C., K. Foreman, J. Johnson, and A. Griggs. 2011. Development of a basin-wide benthic index of integrity for non-tidal streams and wadeable rivers in the Chesapeake Bay watershed: final report to the Chesapeake Bay Program Non-Tidal Water Quality Workgroup. ICPRB Report 11-1. Available online at: www.potomacriver.org/pubs/pubs.

[6] Mandel, R., C. Buchanan, A. Griggs, A. Nagel, and O. Devereux. 2011. Data analysis to support development of nutrient criteria for Maryland free-flowing waters. Final Report to Maryland Department of the Environment. ICPRB Report 11-2. Available online at: www.potomacriver.org/pubs/pubs.

[7] Buchanan, C., H. L. N. Moltz, H. C. Haywood, J. B. Palmer, and A. N. Griggs. 2013. A test of the Ecological Limits of Hydrologic Alteration (ELOHA) method for determining environmental flows in the Potomac River basin, USA. J. Freshwater Biology doi:10.1111/fwb.12240.