APPENDIX A. Full set of candidate metrics computed for the Mid-Atlantic Highlands Area, and considered for inclusion in the Characterization Model.

Variable Name	Description
PHYSICAL/ TOPOGRAPHIC VARIABLES	
AREA	area of watershed
PERIMETER	perimeter of watershed
ELEVMIN	minimum elevation in watershed
ELEVMAX	maximum elevation in watershed
ELEVMEAN	mean elevation in watershed
ELEVRANGE	elevation range in watershed
SLP-MIN	minimum slope in watershed
SLP-MAX	maximum slope in watershed
SLP-MEAN	mean slope of watershed
MSI	mean shape index
AWMSI	area weighted mean shape index
MPAR	mean perimeter to area ratio
MPFD	mean patch fractal dimension
AWMPFD	area weighted mean patch fractal dimension
CTI_MIN	compound topographic index - minimum
CTI_MAX	compound topographic index - maximum
CTI_MEAN	compound topographic index - mean
CURVMIN	minimum local curvature
CURVMAX	maximum local curvature
CURVMEAN	mean local curvature
FLOWMIN	minimum flow accumulation
FLOWMAX	maximum flow accumulation
FLOWMEAN	mean flow accumulation
BOLMIN	minimum bolstad concavity/convexity index
BOLMAX	maximum bolstad concavity/convexity index
BOLMEAN	mean bolstad concavity/convexity index
FDIRMIN	minimum flow direction (degrees)
FDIRMAX	maximum flow direction (degrees)
FDIRMEAN	mean flow direction (degrees)
MCNABMIN	minimum McNab topographic index
MCNABMAX	maximum McNab topographic index
MCNABMEAN	mean McNab topographic index
SOILS VARIABLES	
RVOL_AW (L1-L11)	rock fragment volume, area weighted, for each of 11 soil layers
SAND_AW (L1-L11)	sand percentage, area weighted, for each of 9 soil layers
CLAY_AW (L1-L11)	clay percentage, area weighted, for each of 10 soil layers
SILT_AW (L1-L11)	silt percentage, area weighted, for each of 11 soil layers
PHAW (L1-L11)	pH, area weighted, for each of 10 soil layers
PERMAW (L1-L11)	permeability, area weighted, for each of 11 soil layers
AWC_100AW	available water capacity in top 100 cm, area weighted
AWC_150AW	available water capacity in top 150 cm, area weighted

AWC_250AW	available water capacity in top 250 cm, area weighted
BDAW (L1-L11)	bulk density, area weighted, for each of 11 soils layers
POROS_AW (L1-L11)	porosity, area weighted, for each of 11 soils layers
ROCKDEPMA	depth to bedrock, area weighted
KFACTA	Universal Soil Loss Equation (USLE) *k*-factor, without rocks
KFFACTA	Universal Soil Loss Equation (USLE) *k*-factor, with rocks
HSGAA	% Hydrologic Soil Group A in watershed
HSGBA	% Hydrologic Soil Group B in watershed
HSGCA	% Hydrologic Soil Group C in watershed
HSGDA	% Hydrologic Soil Group D in watershed
HSGWA	% Hydrologic Soil Group W (Water) in watershed
PIA_AW (L1-L11)	plasticity index, area weighted

CLIMATE VARIABLES

ANNFF	length of freeze-free period, 30-year average
ANNGDD	annual growing degree days, 30-year average
ANNPRECIP	annual precipitation, 30-year average
ANNSNOW	annual snowfall, 30-year average
ANNTMEAN	average of "ANNTMAX" and "ANNTMIN" variables
ANNTMAX	maximum daily temperature, 30-year average
ANNTMIN	minimum daily temperature, 30-year average
JAN_MAR_PR	Jan - Mar precipitation, 30-year average
APR_JUN_PR	Apr - Jun precipitation, 30-year average
JUL_SEP_PR	Jul - Sep precipitation, 30-year average
OCT_DEC_PR	Oct - Dec precipitation, 30-year average
TMEAN_JAN	mean Jan temperature, 30-year average
TMEAN_FEB	mean Feb temperature, 30-year average
TMEAN_MAR	mean Mar temperature, 30-year average
TMEAN_APR	mean Apr temperature, 30-year average
TMEAN_MAY	mean May temperature, 30-year average
TMEAN_JUN	mean Jun temperature, 30-year average
TMEAN_JUL	mean Jul temperature, 30-year average
TMEAN_AUG	mean Aug temperature, 30-year average
TMEAN_SEP	mean Sep temperature, 30-year average
TMEAN_OCT	mean Oct temperature, 30-year average
TMEAN_NOV	mean Nov temperature, 30-year average
TMEAN_DEC	mean Dec temperature, 30-year average
TMAX_JUL	maximum Jul temperature, 30-year average
TMIN_JAN	minimum Jan temperature, 30-year average

HYDROLOGIC VARIABLE SET (for all watersheds)

SINUOUS_AV	average sinuosity
CHAN_SLP_A	average channel slope
SD_CHAN_SL	standard deviation of channel slope
TNODE_DNS	density of stream network nodes
STRM1_PCT	% of 1-3 order streams that are 1st order
STRM2_PCT	% of 1-3 order streams that are 2nd order
STRMLEN_TO	total stream length

STRMDENS	total stream density
STRMDENS1	density 1st order streams
STRMDENS2	density 2nd order streams
SEG_LENGTH	average stream segment length

HYDROLOGIC VARIABLE SET (for "pass-through" watersheds only)

INORD	iInitital stream order
PRORD	stream order at pour point
ORDINC	order increase
FAC_MAX	maximum flow accumulation
FWA_INELEV	flow weighted average input elevation
PRELEV	pour elevation
MSRELIEF	mainstem relief
MS_LENGTH	mainstem length
LWA_SIN	length weighted average sinuosity
MSMINGRAD	mainstem minimum gradient
MSMAXGRAD	mainstem maximum gradient
MSMNGRAD	mainstem mean gradient
ORD1ND	density of 1st order stream nodes
ORD2ND	density of 2st order stream nodes
ORD3ND	density of 3st order stream nodes
ORD4ND	density of 4st order stream nodes
ORD5ND	density of 5st order stream nodes
ORD6ND	density of 6st order stream nodes
ORD7ND	density of 7st order stream nodes
ORD8ND	density of 8st order stream nodes

APPENDIX B. Publications, draft manuscripts, and a prototype of a stakeholder tool developed as part of this study.

Publications and Draft Manuscripts

Constantz, G., B. Rashleigh, B. Griscom, and A. McQueen. In prep. Associations between watershed characteristics and benthic macroinvertebrate communities in streams of the Central Appalachian Mountains. 36 ms. pages.

Griscom, B., G. Constantz, A. McQueen, and B. Rashleigh. In prep #1. Influence of elevation on West Virginia Stream Condition Index: vulnerability differences and calibration needs.

Griscom, B., A. McQueen, A. Bayard, R. Brooks, G. Constantz, G. Rocco, and W. Myers. In prep #2. Vulnerability of watersheds to acidification in the Mid-Atlantic Highlands.

Griscom, B., A. McQueen, R. Brooks, W. Myers, G. Constantz, M. Easterling, and J. Bishop. In prep #3. Spatial patterns of land use in the Mid-Atlantic Highlands: Factors affecting avoidance or concentration of human impacts in the riparian zone.

Griscom, B., A. McQueen, W. Myers, G. Constantz, R. Brooks, M. Easterling, G. Rocco, and J. Bishop. In prep #4. Classification of watersheds in West Virginia based on vulnerability of streams to human impacts.

Myers, W., G. P. Patil and Y. Cai. 2006. Exploring patterns of habitat diversity across landscapes using partial ordering. Pp. 309-325 in: R. Bruggemann and L. Carlsen, eds. Partial Order in Environmental Sciences and Chemistry. Berlin: Springer. 406 p.

Myers, W. L., M. McKenney-Easterling, K. Hychka, B. Griscom, J. A. Bishop, A. Bayard, G.L. Rocco, R. P. Brooks, G. Constantz, G. P. Patil and C. Taillie. 2006. Contextual clustering for configuring collaborative conservation of watersheds in the Mid-Atlantic Highlands. Environmental and Ecological Statistics 13 (4): 391-407.

Rocco, G. Unpublished. Modeling of Nutrients for the Watershed Classification Project.

Prototype of Stakeholder Tool

Map of Study Area showing HUC-14 watersheds (including watershed reference number), streams, and counties.

Database (Microsoft Access) of selected watershed information, by watershed reference number

APPENDIX C. Summary of Meetings with Stakeholders.

As part of this project, CVI coordinated three meetings with stakeholders. From these state officials, nonprofit conservation groups, and other potential users, we solicited two general kinds of comments, (1) critical evaluations of our watershed classification scheme and (2) a conjecture of whether they might use it in their natural resources management programs.

On 12 Oct 05 at State College PA, the PSU-CVI team met with representatives of Trout Unlimited, the Coldwater Heritage Partnership, and the PA Fish & Boat Commission. After we outlined our project, they offered the following comments:

- Delete “buffer” from the term “Watershed Storage Buffer Categories.”
- More completely define “ANC,” the acronym we use for acid neutralizing capacity. What is it? Characterize it chemically. Is it always correlated with pH?
- Consider forecasting changes in a watershed’s class to reflect expected land development changes.

The first two seek clarifications, while the last suggests a task unattainable with present data.

On 19 Jan 06 in Harrisburg PA, the research team met with fisheries biologists and program managers of the PA Fish & Boat Commission. Our presentation included an overview of the project, alternate classifications based on inherent characteristics and stressors, and examples of watersheds prioritized for restoration. In a structured session, we solicited their advice on high-priority questions, most useful tools, and most relevant scales. Stakeholders offered the following suggestions:

- Use a different color to indicate forest land cover.
- Come to a consensus on the terms vulnerability, dose, and stressor.
- To distinguish cold- and warm-eater fisheries, try including water temperature.
- To support the protection of instream flows, include stream discharge volumes in our classification.
- Integrate PA’s 303(d) list into our watershed classification process.
- Evaluate the relationship between Rosgen’s stream classes and our watershed classes. Test this with a subset of stream reaches that have been classified by the Rosgen classes.
- For nitrate, phosphate, and pH, use EPA’s STORET water-quality database to evaluate our watershed classes.
- Consider using Strager’s decision-support system in the prioritization phase of our process.
- Try to overlay the PA categories of protection and our prioritization maps.
- They liked the tiered steps we used to identify reference watersheds.

We consider these comments to be mainly substantive, going to the core of how to improve our scheme's usefulness. Where appropriate, we incorporated some of these suggestions.

Lastly, on 14 Jul 06 in Pleasant Gap PA, the CVI members presented a more advanced version of our watershed classification to members of the PA Fish & Boat Commission. Although they felt it might be useful for statewide program managers, it seemed to offer little to within-state regional restorationists because the scale of our data was too coarse. Because of the scale of pre-existing datasets, we classified watersheds of 10,000 to 50,000 acres each. The stakeholders stated that our product did not provide enough within-watershed data to allow prioritization of restoration sites within individual watersheds.

After each stakeholder meeting during all-hands team work sessions, all comments were taken seriously. As you can infer, some recommendations (e.g., definitions) were easily implementable, others (e.g., using finer-scale data) were not. Overall, the stakeholders' collective comments have placed us in a stronger position for applying and advocating the uses of our watershed classification system.