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Watershed Health Assessment Tools Investigating Fisheries WHAT IF Version 2: A Manager's Guide to New Features

RESEARCH AND DEVELOPMENT

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Watershed Health Assessment Tools
Investigating Fisheries
WHAT IF Version 2
A Manager's Guide to New Features

Ecosystems Research Division
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Athens, GA 30605-2700

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Office of Research and Development
Washington, DC 20460

Notice

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Foreword

Streams and rivers provide important ecological services, including habitat for fishes and other organisms, and drinking water supplies, yet these ecosystems are among the most impaired across the country. Management of these ecosystems involves the assessment of probable causes of impairments and remediation/restoration alternatives, as well as forecasting future condition in a scientifically defensible fashion to more effectively protect valued ecosystems. Communities, watershed groups and states require decision support tools for managing the quality of aquatic systems. Community-based environmental management is a long-term goal of the Agency, and providing the methods/tools and technical transfer mechanisms to achieve this goal are critical to the role of ORD. Effective client collaborations are the most efficient means to achieve this result.

This report is the result of collaboration with the Canaan Valley Institute (CVI) in which a decision analysis toolkit was produced in order to support management of fisheries in the Mid-Atlantic Highlands. Although there are many ecological endpoints that are important indicators of the condition of aquatic communities and their associated watersheds, fish health is arguably one of the most important, since fishability is a principal designated use for surface waters under the Clean Water Act. The approach used here can be applied to aid CVI and other agencies in the management of aquatic resources in the Mid-Atlantic Highlands, and may serve as a model for management tools for aquatic systems in other regions.

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Abstract

The Canaan Valley Institute (CVI) is dedicated to addressing the environmental problems in the Mid-Atlantic Highlands (MAH). Their goal is to develop and implement solutions to restore damaged areas and protect aquatic systems. In most wadeable streams of the Mid-Atlantic Highlands region of the eastern United States, habitat alteration resulting from agriculture and development is the primary stressor for fish communities. Sedimentation is the primary source of habitat degradation in Highlands's streams, and productive, sustainable fisheries, i.e., trophy trout streams, are among the valued aquatic endpoints. Planned restoration activities in the region include riparian zone restoration and stream channel design to mitigate near stream inputs and stabilize streambanks. Natural Stream Channel Design (NSCD) is also being investigated by CVI for further optimization of instream habitats for fish communities. Models that predict the responses of fish and stream insect populations and communities to key habitat characteristics are necessary for CVI's watershed management goals, both for determining where to restore and how, as well as evaluating the most probable outcome of various alternatives. The USEPA National Exposure Research Laboratory (NERL) has developed a suite of modeling tools to be used for this purpose. The CVI Watershed Health Assessment Tool Investigating Fisheries, WHAT IF version 2, currently contains five components: 1) a Regional Prioritization Tool for identifying areas for riparian restoration and aquaculture; 2) a Hydrologic Tool for predicting hydrologic inputs to streams and bankfull flow; 3) a Clustering Tool for predicting fundamental fish assemblages; 4) a Habitat Suitability Tool for both fishes and benthic insects to relate habitat measures to the suitability of streams for specific species; and 5) the BASS (Bioaccumulation and Aquatic Systems Simulator) model, a generalized aquatic ecosystem simulator to examine fish community dynamics over time. This document describes enhancements to WHAT IF v.1 based on feedback from state managers, specifically regional stream prioritization, bankfull flow and aquatic insect habitat suitability and contains appendices with software documentation. The USEPA Environmental Monitoring and Assessment Program (EMAP) surface water dataset is the basis of the habitat associations derived among fish and insect species and communities.

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List of Acronyms

BASS	Bioaccumulation and Aquatic System Simulator
BMP	Best Management Practice
CVI	Canaan Valley Institute
EMAP	Environmental Monitoring and Assessment Program
EPT	Ephemeroptera, Plecoptera and Trichoptera
ERD	Ecosystems Research Division
GIS	Geographic Information System
GUI	Graphical User Interface
HSI	Habitat Suitability Index
IBI	Index of Biological Integrity
MAH	Mid-Atlantic Highlands
MBII	Macrobenthic Invertebrate Index
NERL	National Exposure Research Laboratory
REMAP	Regional EMAP
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

1 Introduction

The mission of the Canaan Valley Institute (CVI) is to address the environmental problems in the Mid-Atlantic Highlands through a program of environmental stewardship that considers and integrates natural, economic, and human concerns in the management of natural resources (CVI 2002). To accomplish this mission requires sound science that combines theory, detailed knowledge, monitoring and modeling (CVI 2002). CVI developed its own geographic information system (GIS)-based management tool, Landscape Analyst, using the proprietary ArcView GIS (ESRI, Redlands, CA), for estimating land use change impacts on water quantity and quality (http://www.canaanvi.org/). However, the adoption and widespread application of that tool has been less than anticipated. In order to access Landscape Analyst, users must posses the required GIS software and utilities, and be familiar with GIS software and its operation. Complexity of the software user interface, as well as the supporting science modules, is a barrier to widespread adoption of the tool. Refining their aquatic assessment needs further, CVI posed these questions on behalf of regional stakeholders: What conditions will sustain aquatic endpoints in the long-term? Can we evaluate restoration techniques like natural stream channel design (NSCD) and agriculture and forestry stream best management practices (BMPs) for their effectiveness in improving aquatic endpoints? Can we create "what if" scenarios and evaluate management actions based on the response of aquatic endpoints?

In support of CVI, the USEPA National Exposure Laboratory's Ecosystem Research Division (ERD) has conducted research to develop watershed modeling tools for CVI and their stakeholders in the Mid-Atlantic Highlands. Specifically, enhancements have been made to WHAT IF version 2 that provide the information and methods required for additional aquatic ecosystem assessments, including:

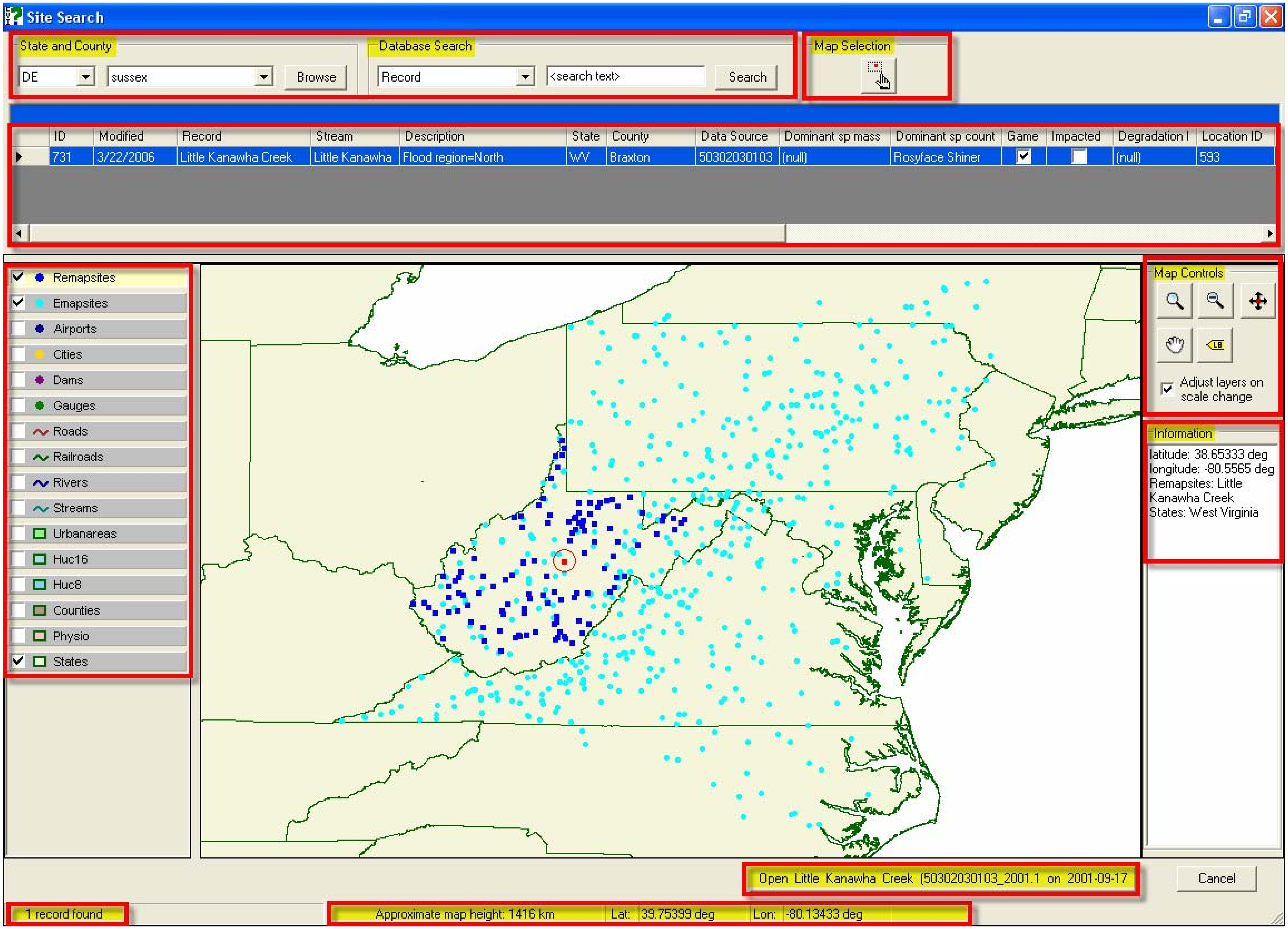
- regional stream prioritization for restoration and aquaculture (Regional Exploration)
- addition of state monitoring data (WV REMAP)
- predicting flood conditions in ungauged/unmeasured streams of interest (Hydro Tool)
- the evaluation of the physical habitat variables that affect suitability for fish and insect species and families/guilds to specify restoration and BMP actions for selected species (Habitat Suitability and Macroinvertebrates Calculator)

The result is a suite of tools packaged for regional application to wadeable Mid-Atlantic Highlands streams, the Canaan Valley Institute – Watershed Health Assessment Tools Investigating Fisheries, CVI–WHAT IF. WHAT IF version 2 is entirely open source and does not require proprietary software. It is not GIS-based, nor does it contain models difficult to apply for all but expert users. The models are complementary to the information provided, and are designed to be efficient and problem focused. For example, WHAT IF incorporates statistical hydrology in the toolset rather than a watershed hydrology model. Models that require a high degree of input data processing and model setup put undue burden on novice users. A fitted parameter model such as the Hydrologic System Program Fortran (HSPF), though widely used, is complex and calibration intensive, and does not match the aquatic assessment needs for evaluating outcomes of near and instream restorations. Similarly, models with a large degree of overhead in their use, including sediment transport and hydrodynamic models are unsuitable for the majority of CVI stakeholders and are not straightforward in application. Instead, the emphasis is on the needs of managers for regional mapping and visualization, while also providing local models for stream assessment and management for scenario development.

Figure 1-1 illustrates the mapping interface, with highlighted areas displaying the various map controls, selection buttons and query tools. As supported by WHAT IF v. 1, all streams can be selected within a state or county of interest through selection of the pulldown list. All streams can also be queried by entering text in the appropriate box and selecting the field of interest from the database in the pulldown list (e.g., stream name, dominant species, or data source). The map window, legend, selection button, map controls, information window and approximate scale have been added in separate frames that can be increased or decreased as needed. For example, the table listing the stream attributes is expandable by selecting and moving the area below the scroll bar. Map features in the legend can be turned on and off as needed, with the default to automatically display all features at the appropriate map scale. Both individual and multiple streams are selected using the map selection button by ‘lassoing’ map features.

In the example shown in Figure 1-1, Little Kanawha Creek was selected using the map selection tool. This is indicated by the red circle outlining the selected stream, in addition to the attributes displayed in the information window. Regardless of the method of query utilized, the total number of streams that satisfy the search criteria or are selected by the map selection tool is displayed in the lower left-hand corner of the interface. The approximate scale is displayed as “approximate map height,” and the geographic position of the cursor is continuously updated by the latitude and longitude coordinates at the bottom on the map window. The commonly used map controls are provided for map navigation as radio buttons as well, including zoom in and out, zoom (return) to full actual extent, panning and labeling. Panning is useful for adjusting the map in any direction to bring features to the center of the window, scrolling across familiar terrain, and following streams and other line features such as railroads and road networks that cross streams. The label tool permits the query of any map feature, with the result displayed in the information window. Multiple streams that have been selected by text query or map selection are highlighted in blue in the attribute table. Streams can be deselected from the attribute table by deletion (the “delete” key on the keyboard), though it is not possible at this time to delete multiple stream entries. Double clicking a stream entry in the attribute table serves to select that stream for WHAT IF tool use and scenario development. The button labeled “Open Little Kanawha Creek” also selects the stream of interest, with the added benefit that the stream name displayed on the button is the currently selected stream that will be used in the following assessment and management scenarios.

Figure 1-1 Mapping interface included with WHAT IF version 2.



State and County: DE | sussex

Database Search: Record | <search text>

	ID	Modified	Record	Stream	Description	State	County	Data Source	Dominant sp mass	Dominant sp count	Game	Impacted	Degradation I	Location ID
▶	731	3/22/2006	Little Kanawha Creek	Little Kanawha	Flood region=North	WV	Braxton	50302030103	(null)	Rosyface Shiner	☑	☐	(null)	593

- ☑ ● Remapsites
- ☑ ● Emapsites
- ☐ ● Airports
- ☐ ● Cities
- ☐ ● Dams
- ☐ ● Gauges
- ☐ ∿ Roads
- ☐ ∿ Railroads
- ☐ ∿ Rivers
- ☐ ∿ Streams
- ☐ □ Urbanareas
- ☐ □ Huc16
- ☐ □ Huc8
- ☐ □ Counties
- ☐ □ Physio
- ☑ □ States

☑ Adjust layers on scale change

latitude: 38.65333 deg
longitude: -80.5565 deg
Remapsites: Little Kanawha Creek
States: West Virginia

Open Little Kanawha Creek (50302030103_2001.1 on 2001-09-17

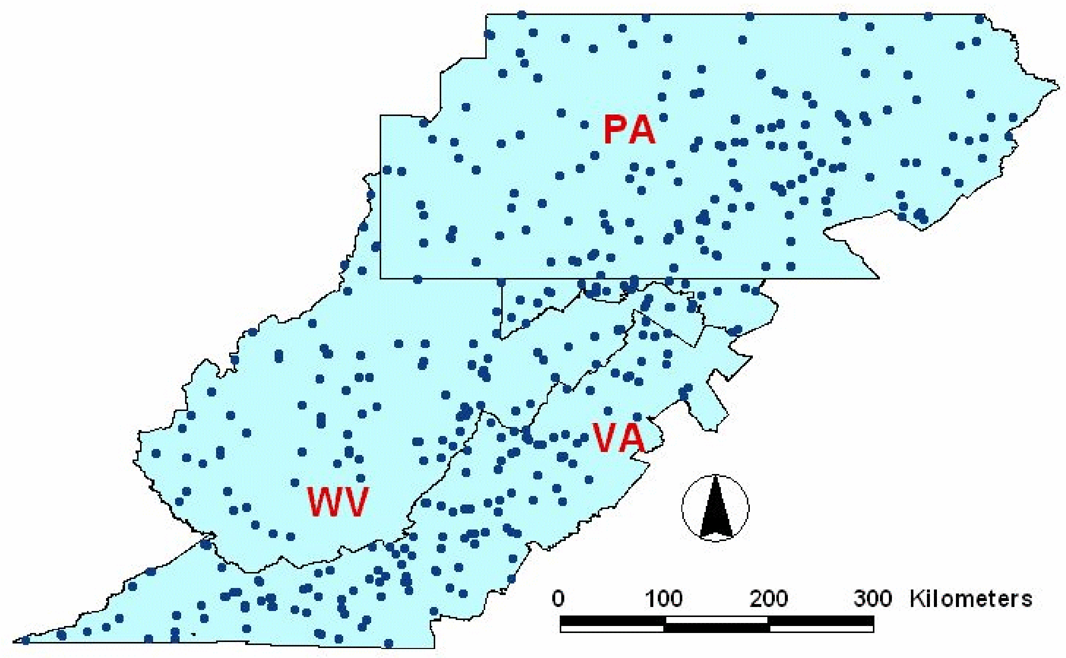
1 record found

Approximate map height: 1416 km | Lat: 39.75399 deg | Lon: -80.13433 deg

WHAT IF consists of models of varying complexity, suited to the problem needs of the manager rather than imposing a ‘one model fits all needs’ restriction. In this manner, the toolset is question driven as opposed to model-focused. WHAT IF is stream-based, permitting users to evaluate streams of interest for outcomes of management approaches and specific restoration actions. Habitat quality and aquatic ecosystem response models have been linked to a regional hydrologic model that simulates habitat characteristics (e.g., water depth, current velocity and water temperature) that determine the survival, reproduction, and recruitment of fish and aquatic invertebrates. To facilitate the use and application of these models, graphical user interfaces (GUI), supporting databases, and libraries of management scenarios were developed. The Canaan Valley Institute (CVI) software/toolset is a stream-based decision support tool that is object-oriented in design and easily maintained. Ultimately, what has been developed, using available data collected by the USEPA Environmental Monitoring and Assessment Program (EMAP), is a framework based on the biogeography of fish suitable for applying all models for regional assessments of important fish health issues in the Mid-Atlantic Highlands.

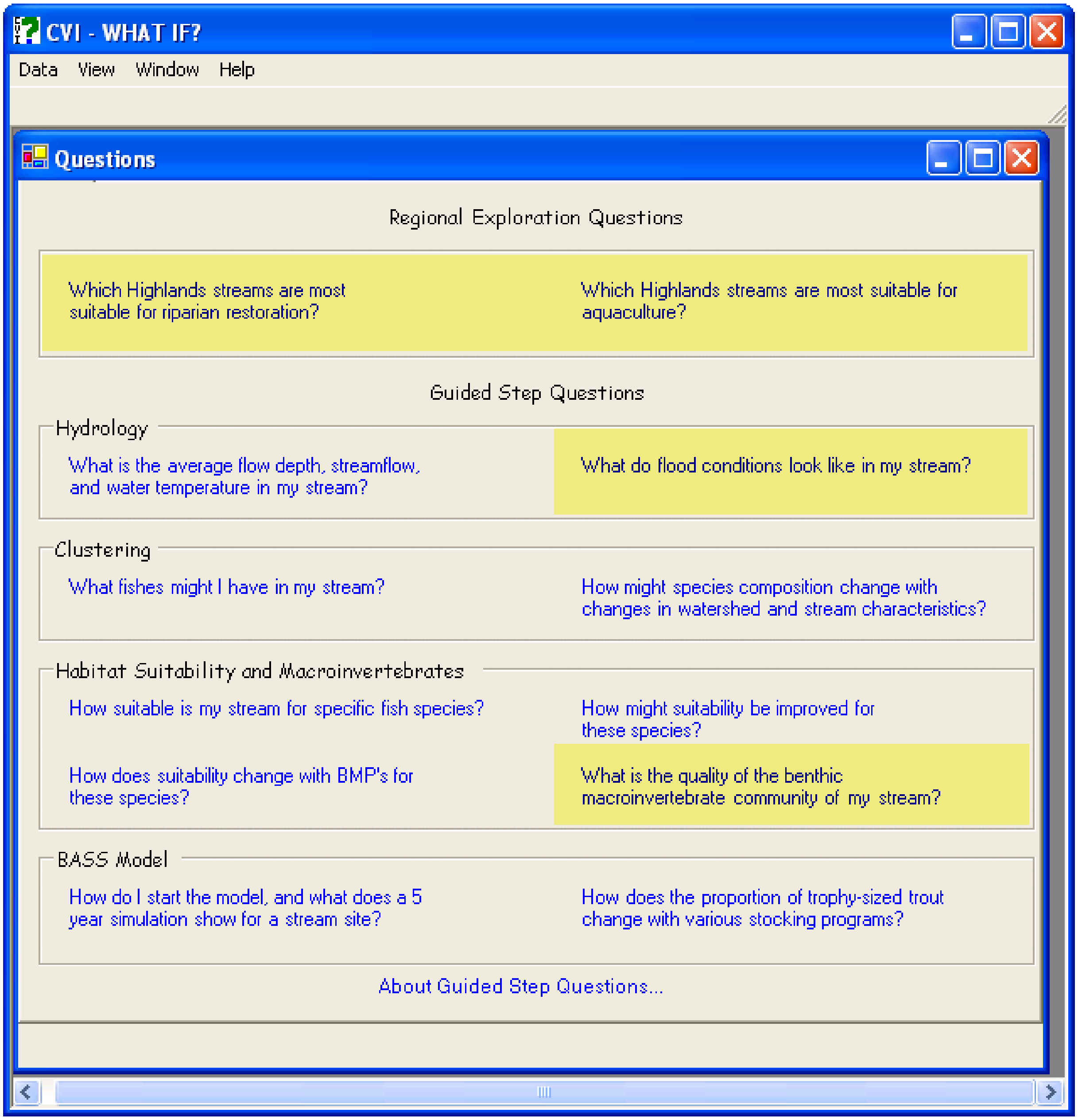
The EMAP surface water dataset (http://www.epa.gov/nheerl/arm/) is a stratified, random sampling design containing over 300 sites and 600 samples (multiple site visits) used in the final research product (Figure 1-2). Fish count data were pre-processed by conversion to biomass for both clustering and habitat suitability analyses, using a utility model associated with the BASS model. In this manner, actual communities were derived from the base data so that conclusions could be made with respect to biomass per unit area and ultimately the carrying capacity of impaired versus restored streams. The EMAP dataset represents two index periods (1993-1995 and 1997-1998).The habitat associations are statistically valid within the region of the Mid-Atlantic Highlands, which includes portions of Pennsylvania, Maryland, West Virginia and Virginia. Watershed characteristics, including stream and near stream habitat quantitative data, are used in addition to fish, benthic insect, and periphyton data (i.e., attached algae). Field data were collected from late Spring to late Summer and span a range of stream sizes and watershed areas throughout the Highlands. In addition to the EMAP streams, WHAT IF v.2 includes Regional EMAP (REMAP) data from the state of West Virginia, adding data from over 100 streams collected in the index periods 2001-2002.

Figure 1-2 Location of EMAP sample sites within the Mid-Atlantic Highlands region.



The overall flow of information between the various models is as follows. The Hydrology Tool supplies stream conditions for sites in the WHAT IF database, as well as a means of calculating conditions (mean monthly flow, bankfull flow, depth and water temperature) for new streams of interest. The Clustering Tool provides a means of assigning the most probable fish community to a stream based on combinations of remotely sensed and field collection data. This tool also permits a user to perform simple screening level assessments of habitat changes (e.g., water flow, temperature and percent fines) and the probable changes in the assigned stream community. After identifying a stream of interest and assigning a fish community, the Habitat Suitability Calculator is used to evaluate that stream's potential to support members of the potential community, on a fish-by-fish basis. Habitat features of interest are those that relate to key aspects of fish life history requirements: water velocity, water depth, stream bottom composition (substrate) and amount of refugia (cover, riparian vegetation, etc.). The BMP tool that is part of the Suitability Calculator provides a means of translating habitat changes (i.e., restoration actions under consideration) into suitability scores for each fish in the community. BASS is a generalized aquatic ecosystem simulator capable of assessing a variety of managed freshwater ecosystems. Here it accepts the assigned fish community properties as initial conditions, as well as any habitat multipliers investigated using the BMP tool. Stream depth and temperature information is also passed from the Hydrology Tool to BASS. With these tools, environmental managers are better able to characterize and quantify relationships between stressors and stream responses for valued ecological resources in a manner that supports diagnosis of current condition and assists in management activities. Examples will be provided for the new Tools included in WHAT IF v.2 in the following sections (Figure 1-3).

Figure 1-3 Highlighted questions new to WHAT IF v.2 covered in this document.



Regional Exploration Questions

Which Highlands streams are most suitable for riparian restoration?

Which Highlands streams are most suitable for aquaculture?

Guided Step Questions

Hydrology

What is the average flow depth, streamflow, and water temperature in my stream?

What do flood conditions look like in my stream?

Clustering

What fishes might I have in my stream?

How might species composition change with changes in watershed and stream characteristics?

Habitat Suitability and Macroinvertebrates

How suitable is my stream for specific fish species?

How might suitability be improved for these species?

How does suitability change with BMP's for these species?

What is the quality of the benthic macroinvertebrate community of my stream?

BASS Model

How do I start the model, and what does a 5 year simulation show for a stream site?

How does the proportion of trophy-sized trout change with various stocking programs?

About Guided Step Questions...

2 Regional Prioritization Tools for Riparian Restoration and Aquaculture

2.1 Introduction

Regionwide evaluation of ecological resources is an assessment need of managers and is outlined in the CVI Highlands Action Plan (CVI, 2002). The general approach described for the Highlands is that management efforts are best applied where political, economic, social and ecological factors all coincide in support of optimal watersheds for restoration. In WHAT IF, the combination of a mapping interface with a query tool of the relational database provide for a wide range of assessments. Stream selection for aquaculture is another example application of this approach and will be covered in the following section.

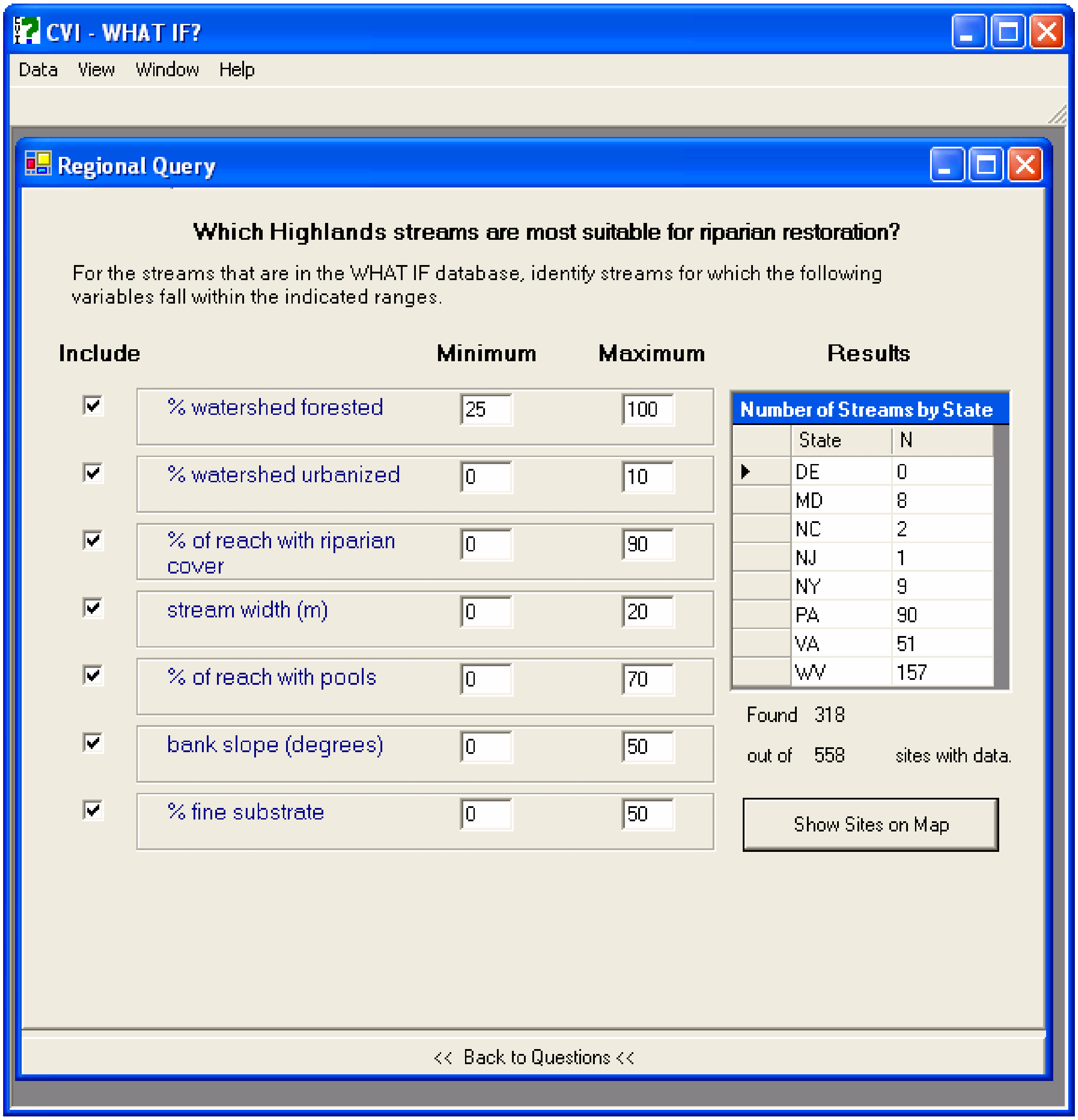
Streams selected for restoration are those expected to respond best to this management action based on a combination of ecological (stream habitat and biology) and watershed parameters. Riparian restoration improves stream habitat condition by:

- decreasing sediment delivery
- decreasing nutrient delivery
- decreasing stormflow (overland runoff)
- decreasing stream temperature

These parameters have been identified in the EMAP data or translated where possible to a suitable surrogate. For example, sedimentation is translated to percent fines, whereas bank slope, stream width and the percent of stream length consisting of pools are used directly. Figure 2-1 illustrates the query interface and lists the additional landscape parameters, i.e., the percentages of the watershed that are forested and urbanized, as well as the extent of the riparian zone (percent of the stream reach) that are also used.

2.2 Which Highlands streams are most suitable for restoration?

Figure 2-1 Regional query tool for riparian restoration with default parameters.



Which Highlands streams are most suitable for riparian restoration?

For the streams that are in the WHAT IF database, identify streams for which the following variables fall within the indicated ranges.

Include		Minimum	Maximum
☑	% watershed forested	25	100
☑	% watershed urbanized	0	10
☑	% of reach with riparian cover	0	90
☑	stream width (m)	0	20
☑	% of reach with pools	0	70
☑	bank slope (degrees)	0	50
☑	% fine substrate	0	50

Results

Number of Streams by State

State	N
DE	0
MD	8
NC	2
NJ	1
NY	9
PA	90
VA	51
WV	157

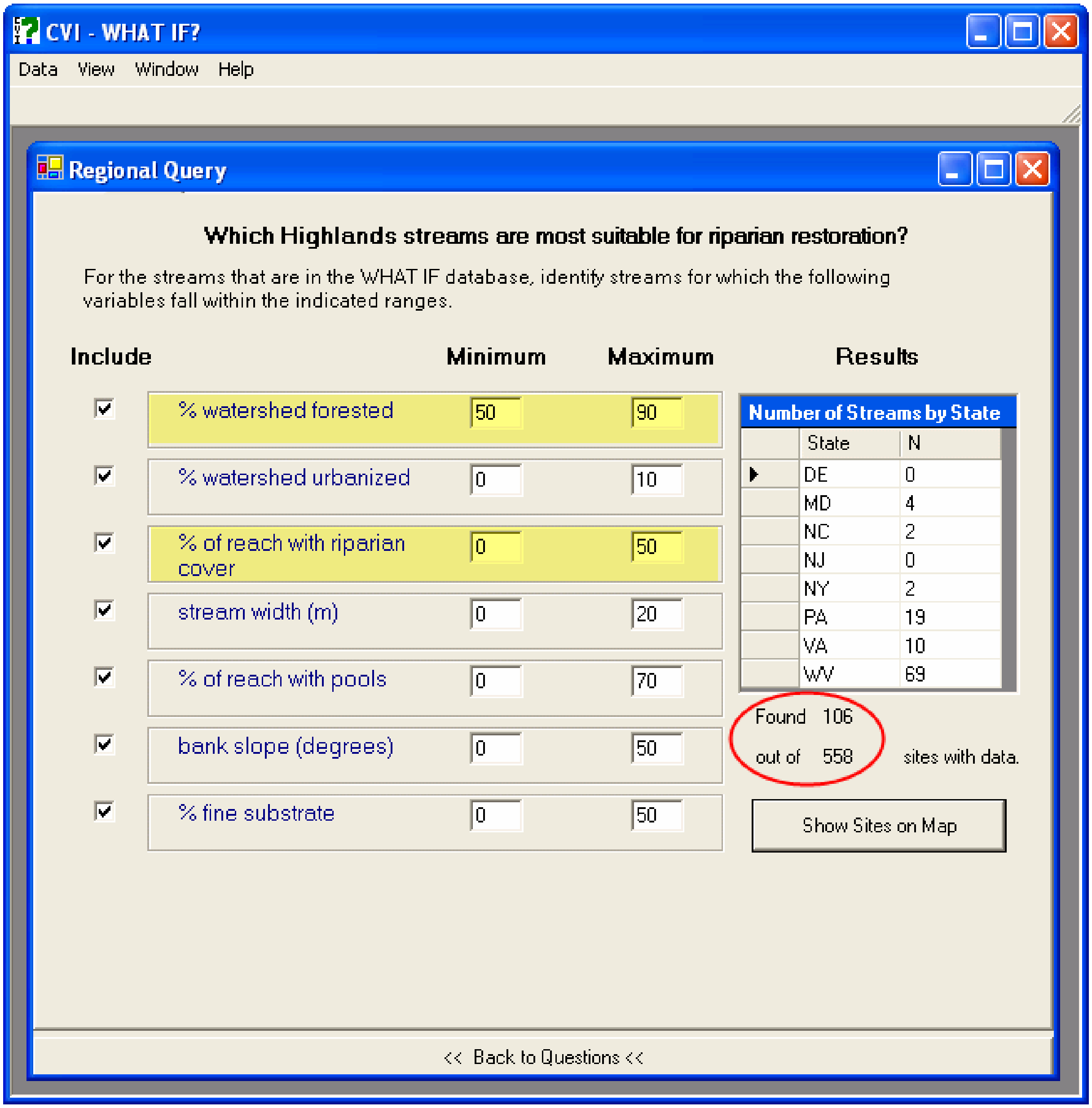
Found 318

out of 558 sites with data.

Prior to displaying the regional map produced by the query parameters, the number of streams present in each state that satisfy the query are calculated. Managers can then change the query parameters further to either widen or constrain the number of streams returned.

Figure 2-2 shows the result of a more constrained query with the associated streams in each state.

Figure 2-2 Regional query tool for riparian restoration with constrained parameters.



Which Highlands streams are most suitable for riparian restoration?

For the streams that are in the WHAT IF database, identify streams for which the following variables fall within the indicated ranges.

Include		Minimum	Maximum
☑	% watershed forested	50	90
☑	% watershed urbanized	0	10
☑	% of reach with riparian cover	0	50
☑	stream width (m)	0	20
☑	% of reach with pools	0	70
☑	bank slope (degrees)	0	50
☑	% fine substrate	0	50

Results

Number of Streams by State

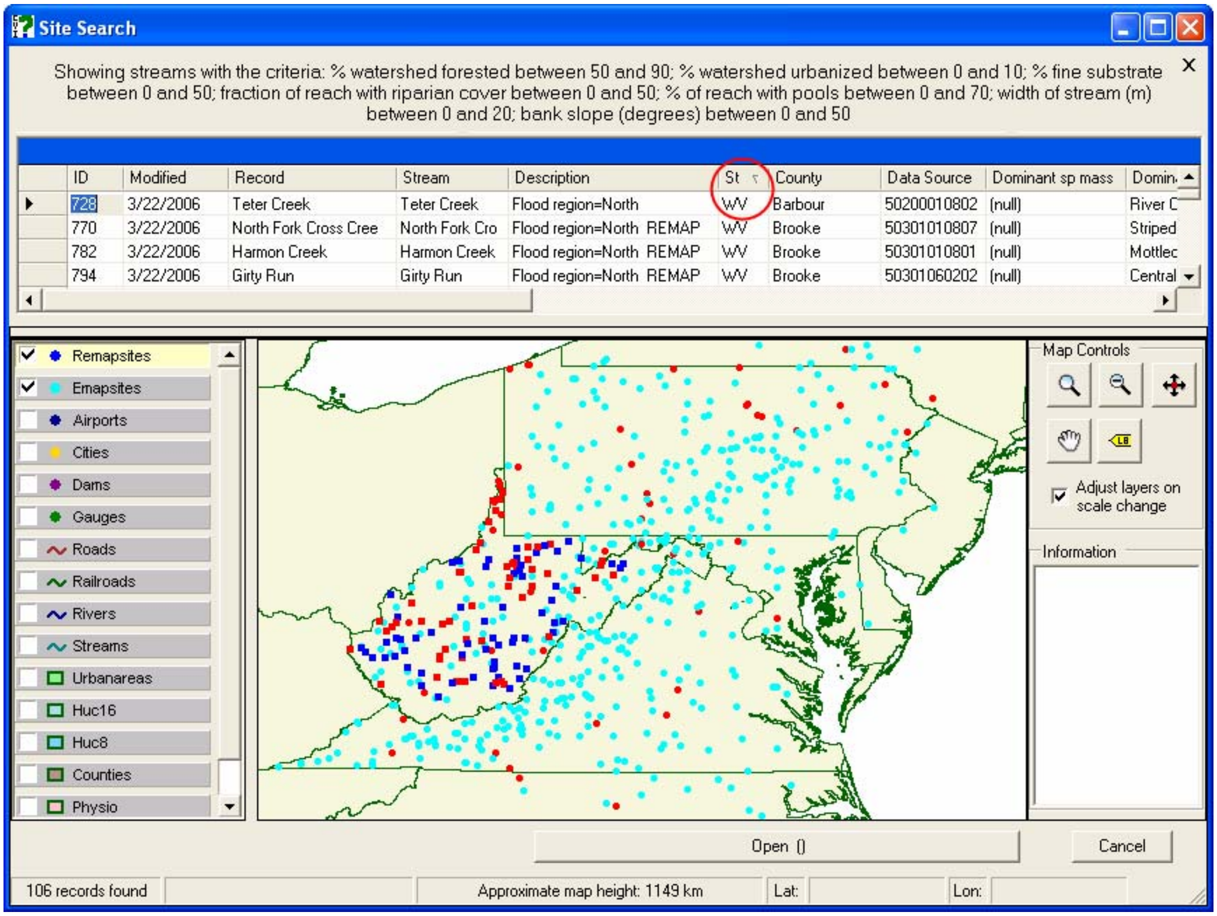
State	N
DE	0
MD	4
NC	2
NJ	0
NY	2
PA	19
VA	10
WV	69

Found 106

out of 558 sites with data.

Note that the "Show Sites" button can be used to rerun the query when cells are updated as well as to return the resulting regional map. Selected streams are displayed in turquoise in Figure 2-3. The map interface includes map controls, automatic display of additional map layers when the appropriate map scale is selected and the stream data displayed in a data table that can be sorted by clicking on the column labels. In this example, streams have been sorted by state, inverting the order of the sort by double-clicking the label. Streams can be sorted by any of the column labels.

Figure 2-3 Regional display of query results, showing map controls and data table.



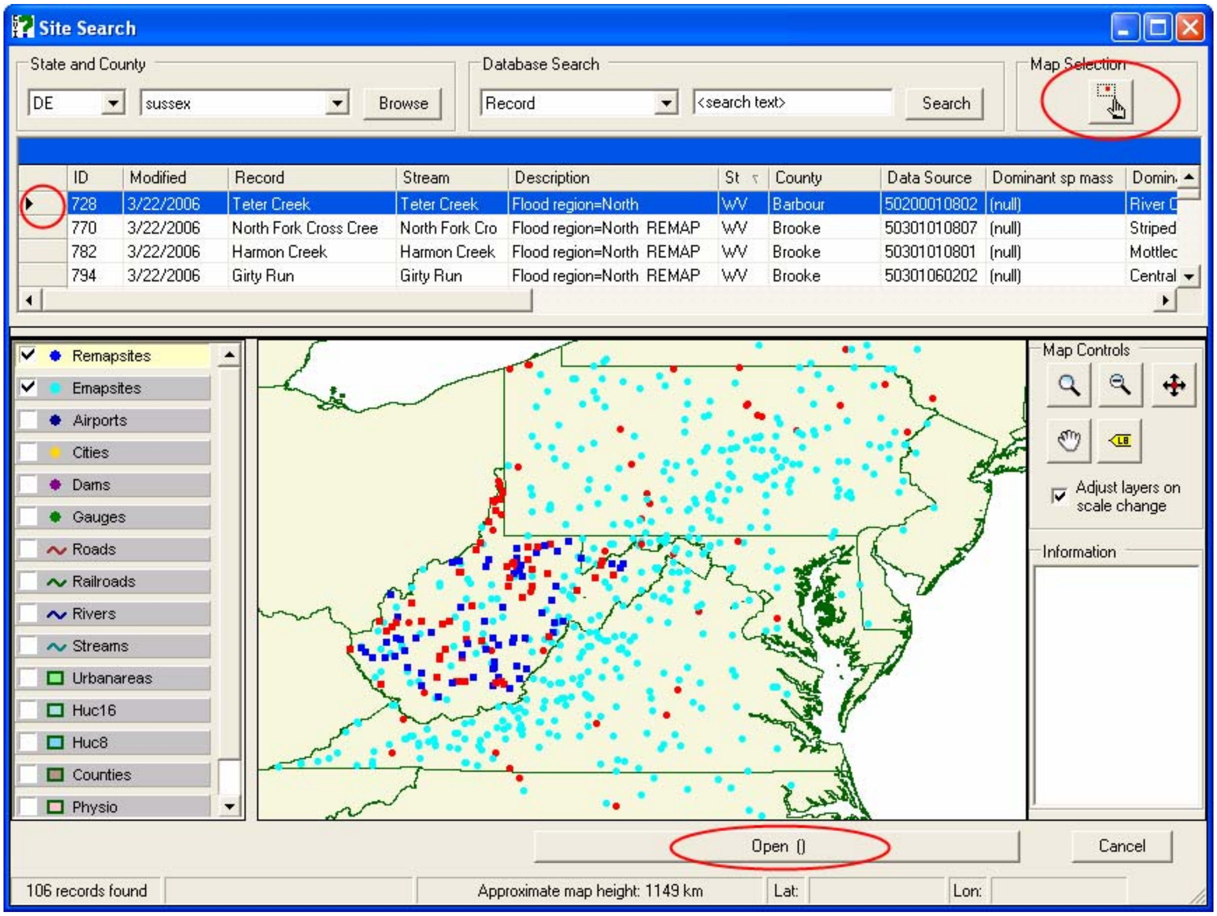
Site Search

Showing streams with the criteria: % watershed forested between 50 and 90; % watershed urbanized between 0 and 10; % fine substrate between 0 and 50; fraction of reach with riparian cover between 0 and 50; % of reach with pools between 0 and 70; width of stream (m) between 0 and 20; bank slope (degrees) between 0 and 50

ID	Modified	Record	Stream	Description	St	County	Data Source	Dominant sp mass	Domin.
728	3/22/2006	Teter Creek	Teter Creek	Flood region=North	WV	Barbour	50200010802	(null)	River C
770	3/22/2006	North Fork Cross Cree	North Fork Cro	Flood region=North REMAP	WV	Brooke	50301010807	(null)	Striped
782	3/22/2006	Harmon Creek	Harmon Creek	Flood region=North REMAP	WV	Brooke	50301010801	(null)	Mottlec
794	3/22/2006	Girty Run	Girty Run	Flood region=North REMAP	WV	Brooke	50301060202	(null)	Central

EMAP and WV REMAP streams in the database are displayed according to the legend shown in the left hand frame of Figure 2-3, in addition to the streams returned from the query. Note that the text describing the current query is displayed at the top of the window until removed from view by clicking on the “X” in the top right corner. Figure 2-4 illustrates the three options for selecting a stream of interest from the map interface: 1) double-clicking the stream row in the table, 2) clicking the Map Selection button and drawing a lasso around the stream in the map window, or 3) clicking the Open button once a stream has been selected in the table. Note that using the Map Select feature can be challenging if used at a small map scale, since streams and other features that are proximate can be selected unintentionally.

Figure 2-4 Options for selecting streams of interest in map selection window.



ID	Modified	Record	Stream	Description	St	County	Data Source	Dominant sp mass	Domin
728	3/22/2006	Teter Creek	Teter Creek	Flood region=North	WV	Barbour	50200010802	(null)	River C
770	3/22/2006	North Fork Cross Cree	North Fork Cro	Flood region=North REMAP	WV	Brooke	50301010807	(null)	Striped
782	3/22/2006	Harmon Creek	Harmon Creek	Flood region=North REMAP	WV	Brooke	50301010801	(null)	Mottlec
794	3/22/2006	Girty Run	Girty Run	Flood region=North REMAP	WV	Brooke	50301060202	(null)	Central

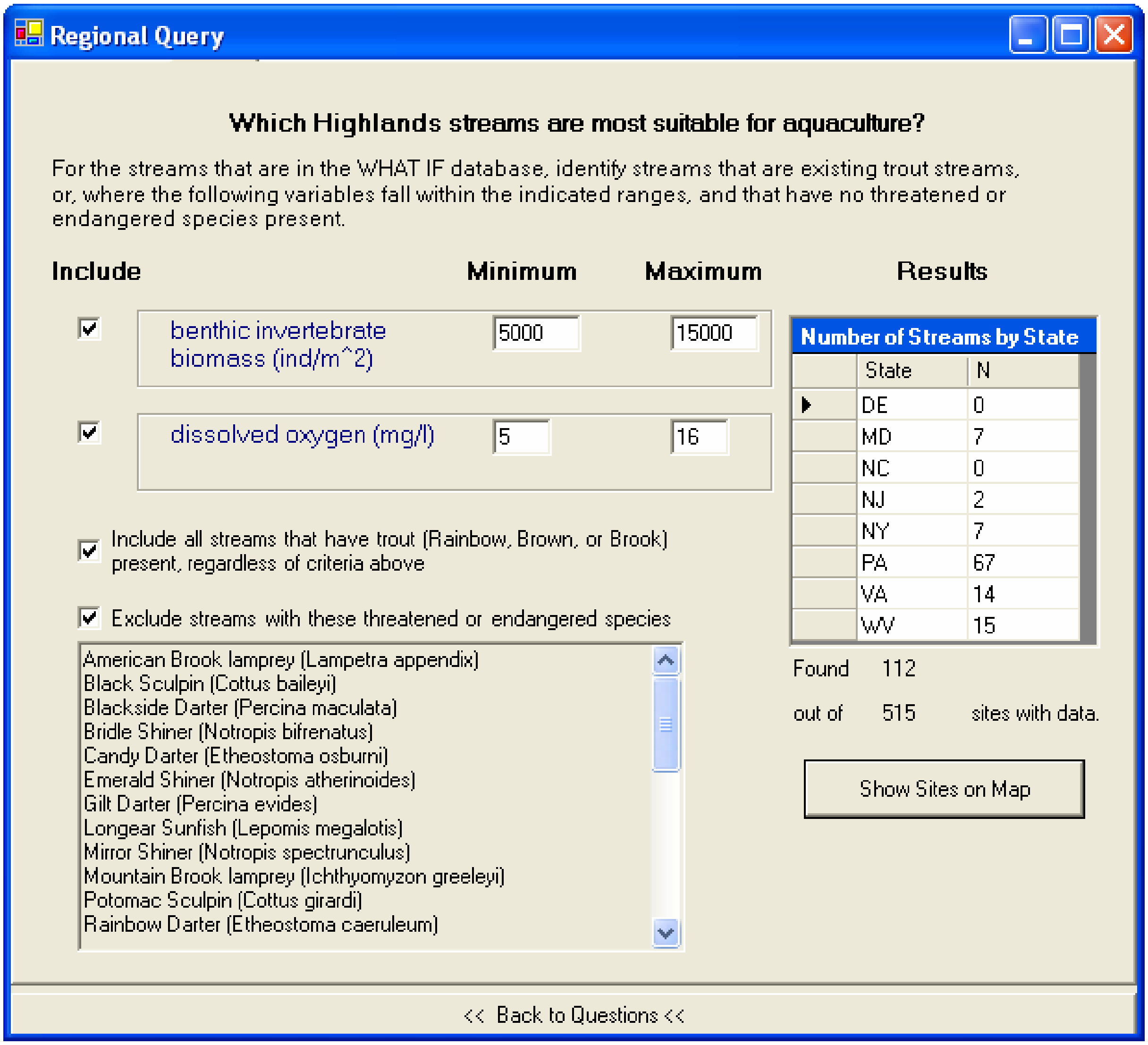
☑ Remapsites
☑ Emapsites
□ Airports
□ Cities
□ Dams
□ Gauges
□ Roads
□ Railroads
□ Rivers
□ Streams
□ Urbanareas
□ Huc16
□ Huc8
□ Counties
□ Physio

106 records found | Approximate map height: 1149 km | Lat: | Lon:

2.3 Which Highlands streams are most suitable for aquaculture?

Similar to the approach taken for riparian restoration, regional stream evaluation for fisheries management involves query operations to the relational database of parameters directly related to carrying capacity for sport fishes: insect productivity and dissolved oxygen (Figure 2-5). In addition, streams can also be displayed and queried in the region containing at least one species of trout (Figure 2-6). Because of concerns to threatened and endangered species (both state and federally listed), managers can include or exclude streams containing species in these groups in the assessment (Figures 2-5 and 2-7).

Figure 2-5 Regional query tool for aquaculture.



Regional Query

Which Highlands streams are most suitable for aquaculture?

For the streams that are in the WHAT IF database, identify streams that are existing trout streams, or, where the following variables fall within the indicated ranges, and that have no threatened or endangered species present.

Include		Minimum	Maximum
☑	benthic invertebrate biomass (ind/m^2)	5000	15000
☑	dissolved oxygen (mg/l)	5	16

☑ Include all streams that have trout (Rainbow, Brown, or Brook) present, regardless of criteria above

☑ Exclude streams with these threatened or endangered species

American Brook lamprey (Lampetra appendix)
Black Sculpin (Cottus baileyi)
Blackside Darter (Percina maculata)
Bridle Shiner (Notropis bifrenatus)
Candy Darter (Etheostoma osburni)
Emerald Shiner (Notropis atherinoides)
Gilt Darter (Percina evides)
Longear Sunfish (Lepomis megalotis)
Mirror Shiner (Notropis spectrunculus)
Mountain Brook lamprey (Ichthyomyzon greeleyi)
Potomac Sculpin (Cottus girardi)
Rainbow Darter (Etheostoma caeruleum)

Results

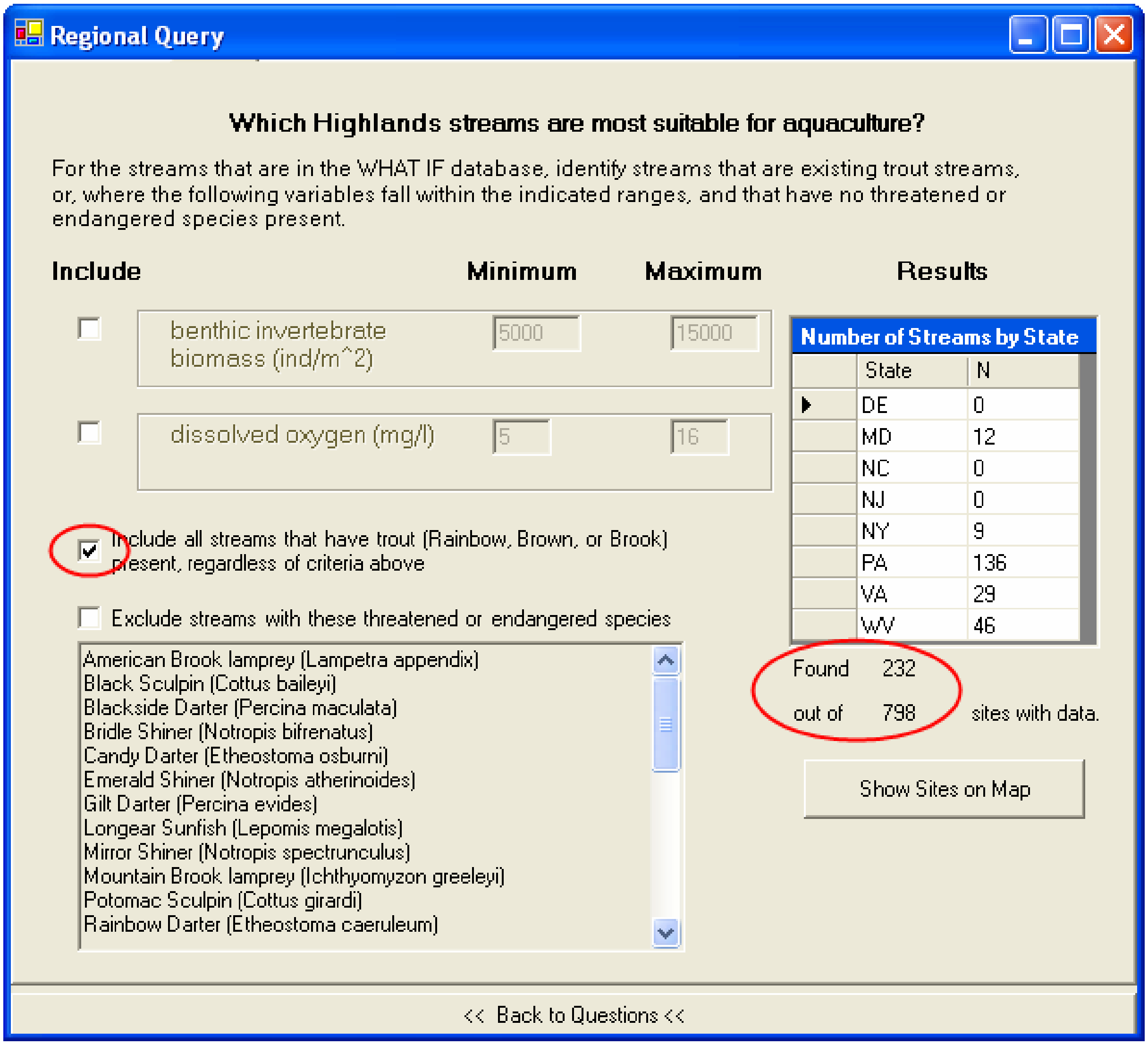
Number of Streams by State

State	N
DE	0
MD	7
NC	0
NJ	2
NY	7
PA	67
VA	14
WV	15

Found 112

out of 515 sites with data.

Figure 2-6 Regional query tool showing existing trout streams.



Which Highlands streams are most suitable for aquaculture?

For the streams that are in the WHAT IF database, identify streams that are existing trout streams, or, where the following variables fall within the indicated ranges, and that have no threatened or endangered species present.

Include		Minimum	Maximum
□	benthic invertebrate biomass (ind/m^2)	5000	15000
□	dissolved oxygen (mg/l)	5	16

☑ Include all streams that have trout (Rainbow, Brown, or Brook) present, regardless of criteria above

□ Exclude streams with these threatened or endangered species

American Brook lamprey (Lampetra appendix)
Black Sculpin (Cottus baileyi)
Blackside Darter (Percina maculata)
Bridle Shiner (Notropis bifrenatus)
Candy Darter (Etheostoma osburni)
Emerald Shiner (Notropis atherinoides)
Gilt Darter (Percina evides)
Longear Sunfish (Lepomis megalotis)
Mirror Shiner (Notropis spectrunculus)
Mountain Brook lamprey (Ichthyomyzon greeleyi)
Potomac Sculpin (Cottus girardi)
Rainbow Darter (Etheostoma caeruleum)

Results

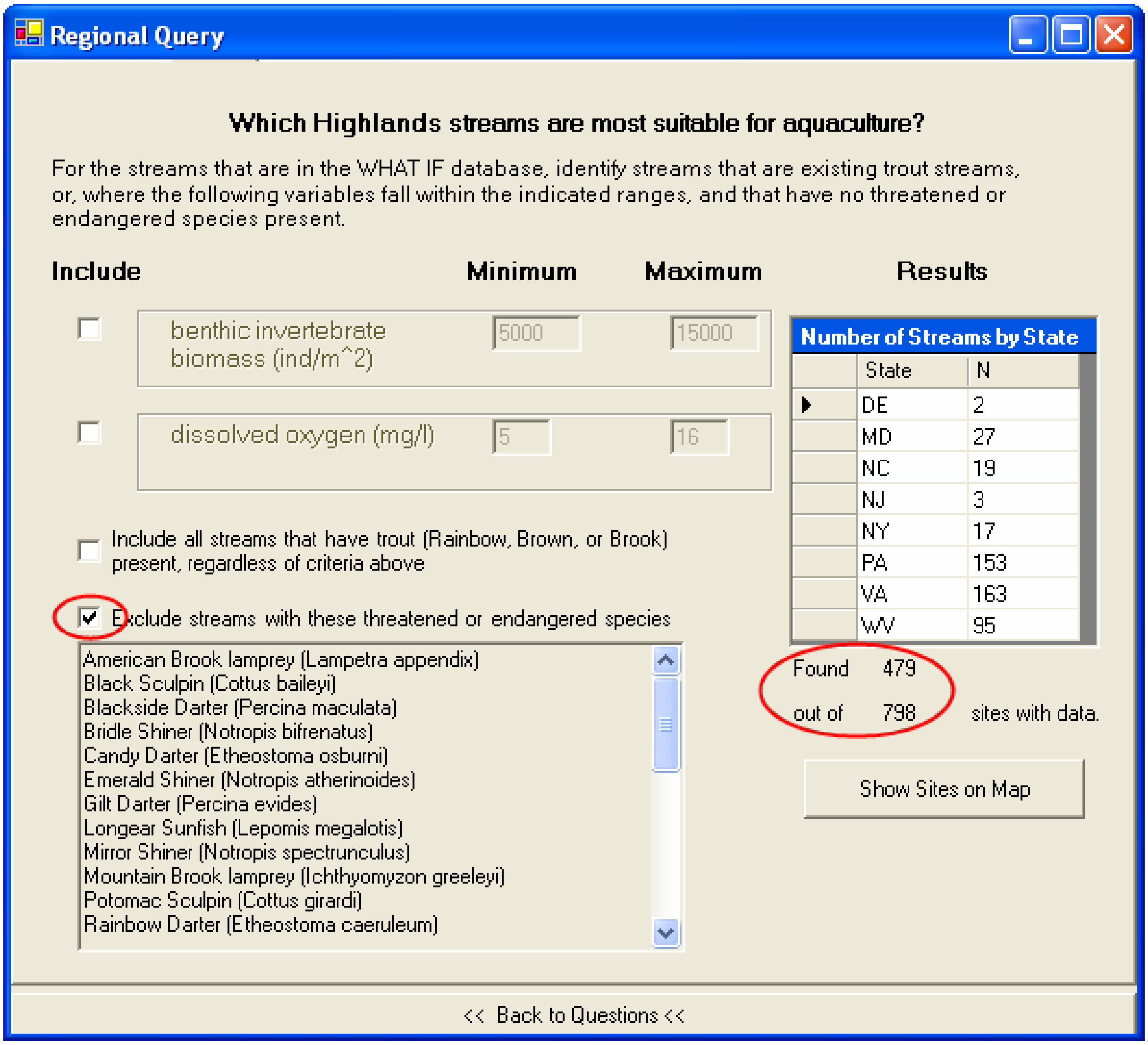
Number of Streams by State

State	N
DE	0
MD	12
NC	0
NJ	0
NY	9
PA	136
VA	29
WV	46

Found 232

out of 798 sites with data.

Figure 2-7 Regional query tool showing streams with species of concern.



Which Highlands streams are most suitable for aquaculture?

For the streams that are in the WHAT IF database, identify streams that are existing trout streams, or, where the following variables fall within the indicated ranges, and that have no threatened or endangered species present.

Include		Minimum	Maximum
□	benthic invertebrate biomass (ind/m^2)	5000	15000
□	dissolved oxygen (mg/l)	5	16

□ Include all streams that have trout (Rainbow, Brown, or Brook) present, regardless of criteria above

☑ Exclude streams with these threatened or endangered species

American Brook lamprey (Lampetra appendix)
Black Sculpin (Cottus baileyi)
Blackside Darter (Percina maculata)
Bridle Shiner (Notropis bifrenatus)
Candy Darter (Etheostoma osburni)
Emerald Shiner (Notropis atherinoides)
Gilt Darter (Percina evides)
Longear Sunfish (Lepomis megalotis)
Mirror Shiner (Notropis spectrunculus)
Mountain Brook lamprey (Ichthyomyzon greeleyi)
Potomac Sculpin (Cottus girardi)
Rainbow Darter (Etheostoma caeruleum)

Results

Number of Streams by State

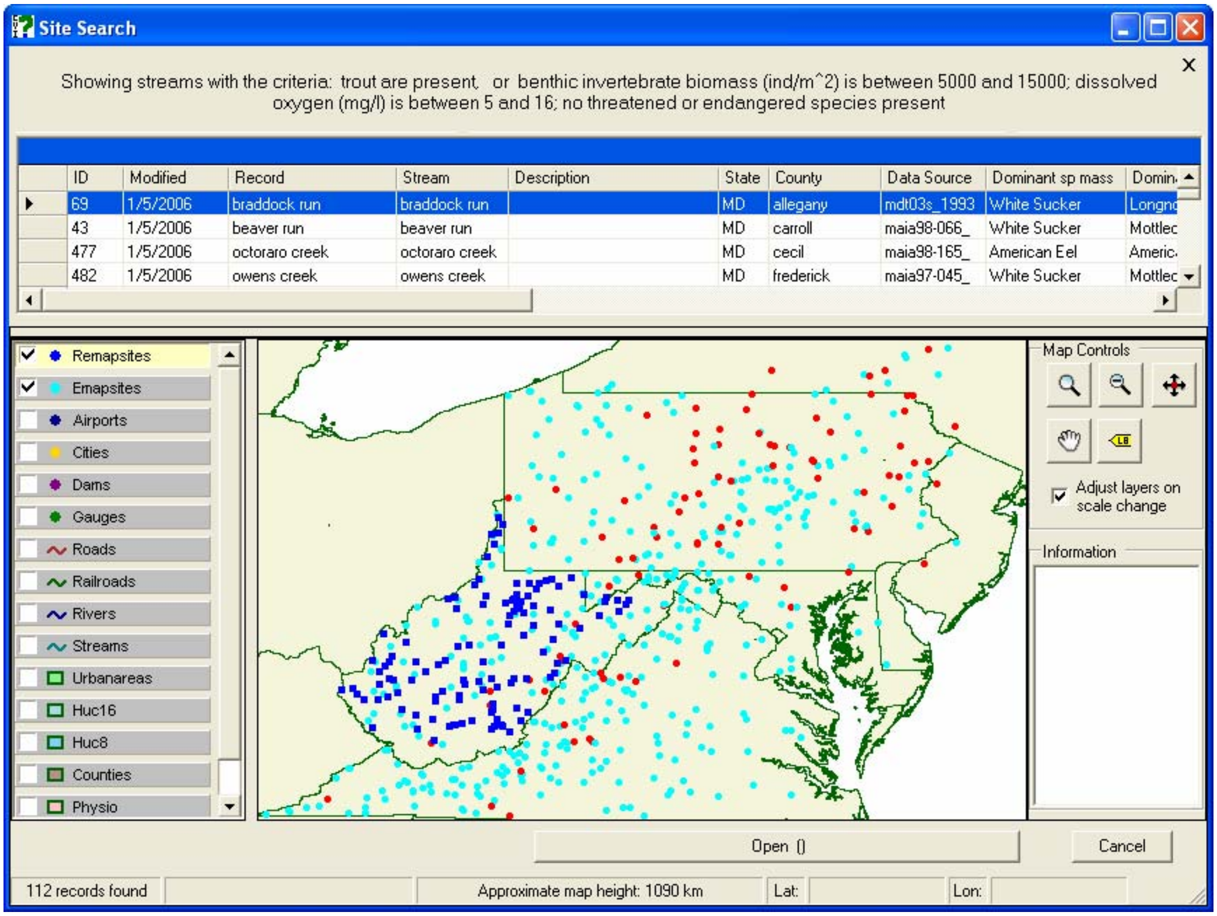
	State	N
▶	DE	2
	MD	27
	NC	19
	NJ	3
	NY	17
	PA	153
	VA	163
	WV	95

Found 479

out of 798 sites with data.

Returning to the example of the default query, clicking "Show Sites" in Figure 2-5 results in the map in Figure 2-8, with the extent of the map window automatically set to the subset of streams satisfying the search criteria.

Figure 2-8 Map selection window showing streams with species of concern returned from query tool.



Site Search

Showing streams with the criteria: trout are present, or benthic invertebrate biomass (ind/m^2) is between 5000 and 15000; dissolved oxygen (mg/l) is between 5 and 16; no threatened or endangered species present

ID	Modified	Record	Stream	Description	State	County	Data Source	Dominant sp mass	Domin.
69	1/5/2006	braddock run	braddock run		MD	allegany	mdt03s_1993	White Sucker	Longnc
43	1/5/2006	beaver run	beaver run		MD	carroll	maia98-066_	White Sucker	Mottlec
477	1/5/2006	octoraro creek	octoraro creek		MD	cecil	maia98-165_	American Eel	Americ.
482	1/5/2006	owens creek	owens creek		MD	frederick	maia97-045_	White Sucker	Mottlec

☑ ● Remapsites
☑ ● Emapsites
□ ● Airports
□ ● Cities
□ ● Dams
□ ● Gauges
□ Roads
□ Railroads
□ Rivers
□ Streams
□ Urbanareas
□ Huc16
□ Huc8
□ Counties
□ Physio

☑ Adjust layers on scale change

112 records found | Approximate map height: 1090 km | Lat: | Lon:

3 Hydro Tool: Predicting Bankfull Flow and Geometry for Small Streams

3.1 Introduction

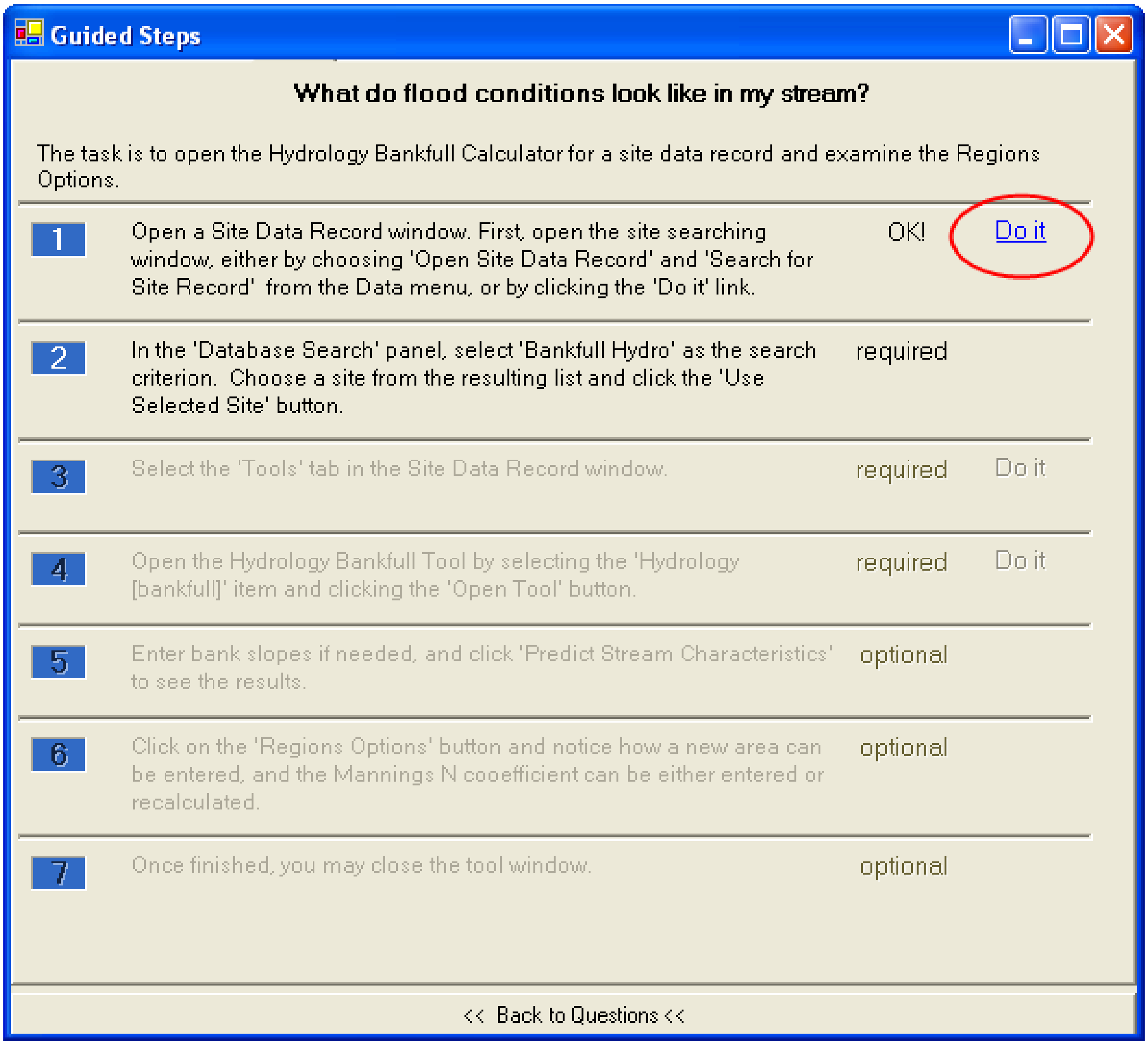
Instream physical habitat characteristics, such as water depth, temperature, and mean flow velocity, are important to the growth and survival of fish species at different life stages. The ecologically-focused average annual discharge is highly correlated with drainage area. In addition, bankfull discharge and average annual discharge are also highly correlated with each other. Both are important for managers who need an estimate of the maximum flow frequency that fills and forms the channel shape (bankfull) and the average discharge available to sustain fish and aquatic habitats throughout the year. A regional regression method was developed and used in WHAT IF v.2. for the determination of water depth and flow velocity variables. This method is based on the quantification of relationships between drainage area and stream hydraulic characteristics (Mohamoud and Parmar, 2006). To enhance the predictive potential of the regression equations and to reduce the percentages of the variability not explained by the models, separate regression equations were developed for each physiographic province. The Mid-Atlantic region consists of four physiographic provinces: Appalachian Plateau, Blue Ridge, Ridge and Valley, and Piedmont. We combined the Ridge and Valley and Blue Ridge Physiographic Provinces into one and developed a total of three sets of regression equations. The Hydrology Tool is applicable to watersheds in these physiographic provinces of Maryland, Pennsylvania, Virginia and West Virginia with drainage areas that range from 3 to 400 square miles.

Bankfull flow is that flow which fills the channel to the top of one or both of its banks. It is of interest both for its significance to developed areas, where overbank events cause flooding and associated losses of property and life, as well as for stream protection and restoration. In the latter case, the interval between bankfull flow events, typically on the order of 1 – 5 years, determines the rate at which streams are restructured: altering bed composition through scouring and creating new channel geometry (i.e., meanders) and depositional zones. An intended application of the Hydrology Tool is the estimation of bankfull flow and geometry for natural stream channel design, a practice used in stream channel restoration. Given bankfull flow, the Tool then estimates mean bankfull depth, width, flow area, wetted perimeter, hydraulic radius and flow velocity for stable, natural channels.

3.2 What do flood conditions look like in my stream?

Selecting the second question of the Hydrology Tool from the interface in Figure 1-3 provides the Wizard Tool of step-by-step actions for locating and launching the Bankfull Tool (Figure 3-1). Clicking “Do It” results in the national map extent display in Figure 3-2, with no streams selected by default in the data table.

Figure 3-1 Hydrology bankfull tool wizard.



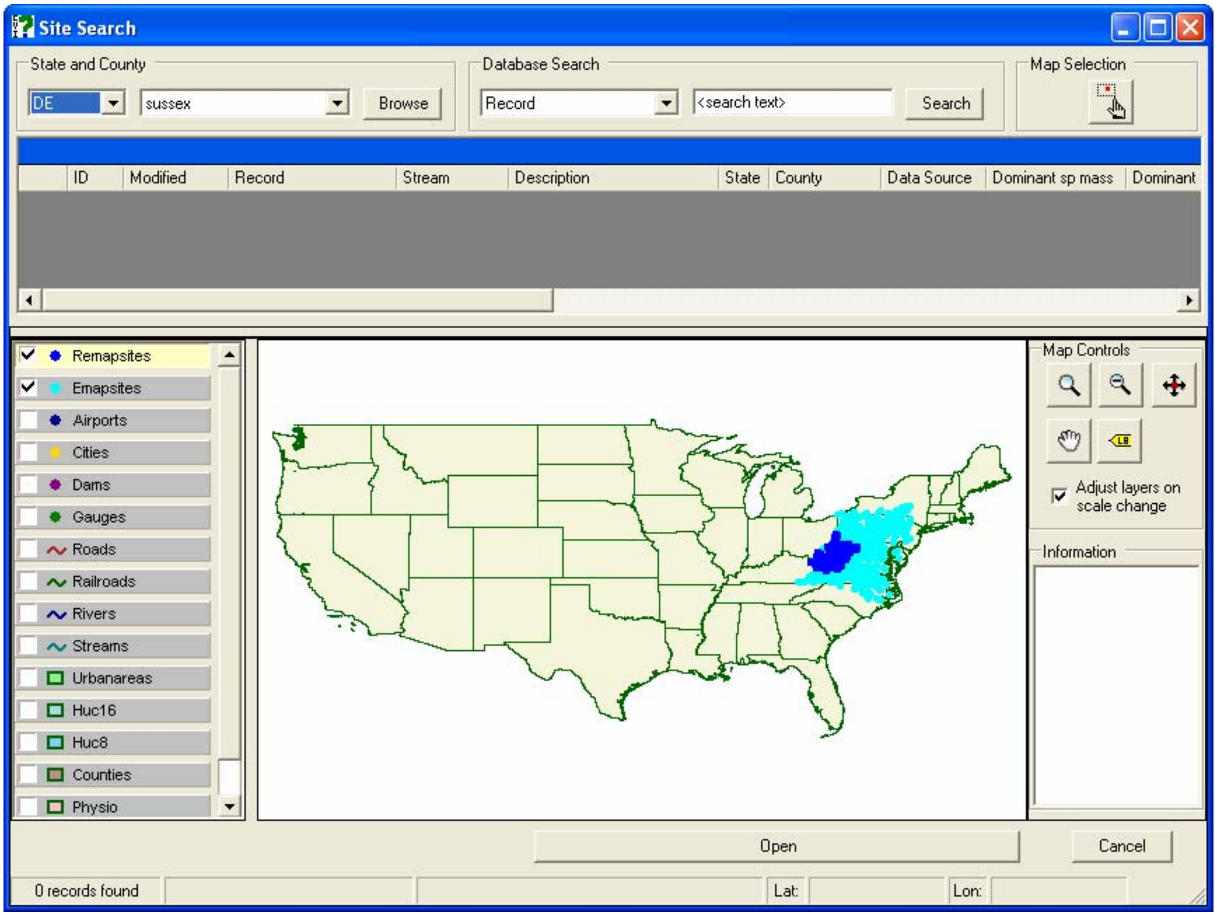
What do flood conditions look like in my stream?

The task is to open the Hydrology Bankfull Calculator for a site data record and examine the Regions Options.

1	Open a Site Data Record window. First, open the site searching window, either by choosing 'Open Site Data Record' and 'Search for Site Record' from the Data menu, or by clicking the 'Do it' link.	OK!	Do it
2	In the 'Database Search' panel, select 'Bankfull Hydro' as the search criterion. Choose a site from the resulting list and click the 'Use Selected Site' button.	required	
3	Select the 'Tools' tab in the Site Data Record window.	required	Do it
4	Open the Hydrology Bankfull Tool by selecting the 'Hydrology [bankfull]' item and clicking the 'Open Tool' button.	required	Do it
5	Enter bank slopes if needed, and click 'Predict Stream Characteristics' to see the results.	optional	
6	Click on the 'Regions Options' button and notice how a new area can be entered, and the Mannings N cooefficient can be either entered or recalculated.	optional	
7	Once finished, you may close the tool window.	optional	

Figure 3-3 illustrates the use of the search result of selecting the field “Stream” [name] and using the stream “Teter” creek from the prior exercise. Note that the map window zooms to the stream of interest, identified by the red-colored icon, and automatically displays additional data layers such as roads, stream networks and USGS gauges. Selection of the stream of interest is achieved by double clicking the row in the data table, using “Map Select” and drawing a box around the stream location in the map window (holding down the left mouse button), or using the “Open” button at the bottom of the window. This returns the window illustrated in Figure 3-4, with the reminder that the database is read only, requiring the manager to save a working copy of the stream as illustrated in Figure 3-5. This is achieved by using the “Data” pulldown menu in the main WHAT IF interface (Figure 1-3) to select “Save Site Data Record As” and renaming the stream. Note that the stream can be named by the default (original) name provided. Figure 3-6 shows that organized under the “Tools” tab, all WHAT IF tools and trials are organized, and trials can be selected by double clicking the trial of interest, or clicking the highlighted control button “Open Tool.” Clicking on this button or double-clicking the Hydrology [bankfull] “base trial 1” icon produces Figure 3-7. Figure 3-7 shows the user entered values for the left and right side channel slopes, and the resulting calculated other stream property values obtained by clicking the “Predict Stream Characteristics” button.

Figure 3-2 Map selection window for stream identification and selection.



Site Search

State and County: DE | sussex

Database Search: Record | <search text>

	ID	Modified	Record	Stream	Description	State	County	Data Source	Dominant sp mass	Dominant

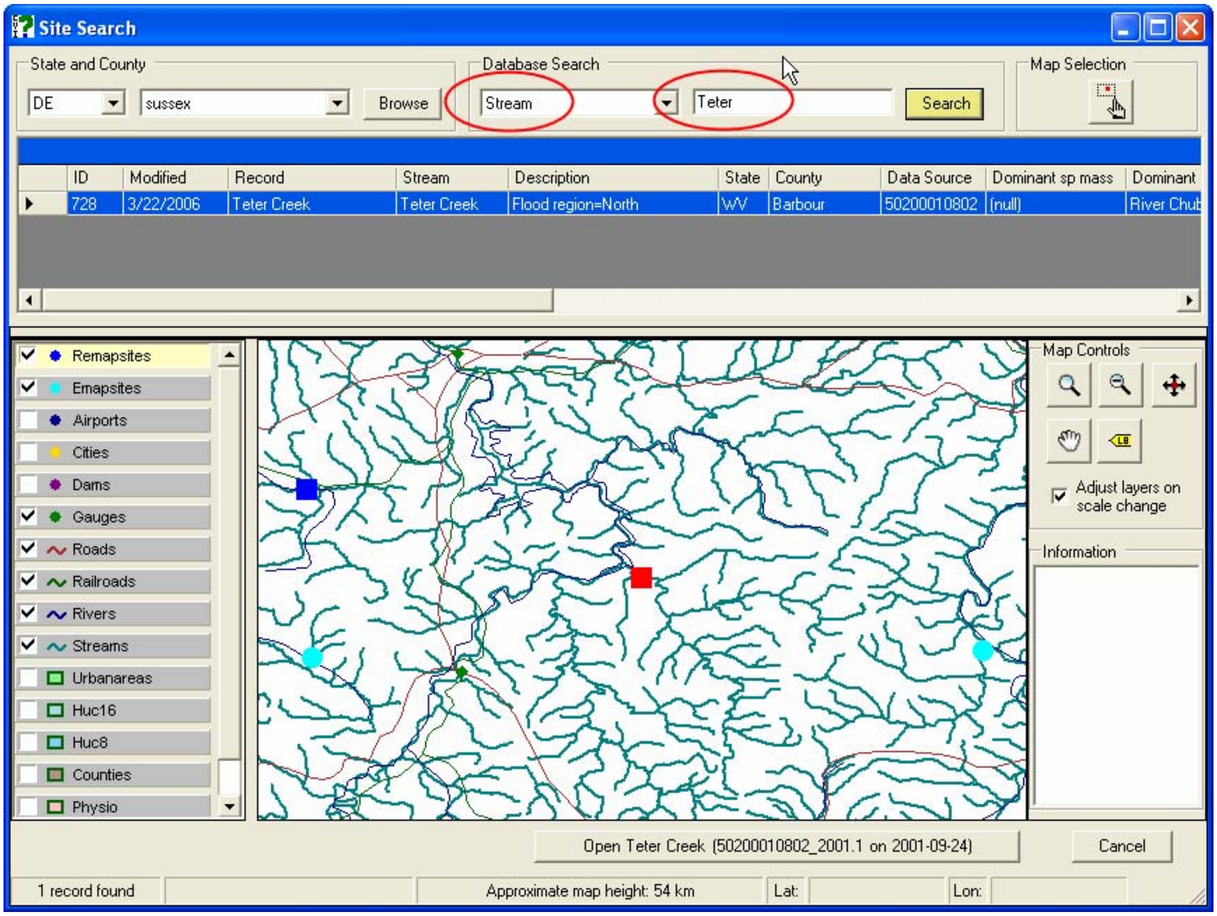
- ☑ ● Remapsites
- ☑ ● Emapsites
- □ ● Airports
- □ ● Cities
- □ ● Dams
- □ ● Gauges
- □ ∿ Roads
- □ ∿ Railroads
- □ ∿ Rivers
- □ ∿ Streams
- □ □ Urbanareas
- □ □ Huc16
- □ □ Huc8
- □ □ Counties
- □ □ Physio

☑ Adjust layers on scale change

0 records found | Lat: | Lon:

Managers/assessors will not typically need to change the Manning's coefficient or drainage area; the left, and right side channel slopes and channel bed slope are the most commonly adjusted input parameters. The predicted flow in cubic feet per second in this example is 1825. The "Bankfull Flow" input box is used when that measured flow is available (by clicking the radio button). The new predicted values are displayed in the highlighted area of Figure 3-7.

Figure 3-3 Map selection window for Teter Creek, WV.



Site Search

State and County: DE, sussex, Browse

Database Search: Stream, Teter, Search

Map Selection

	ID	Modified	Record	Stream	Description	State	County	Data Source	Dominant sp mass	Dominant
▶	728	3/22/2006	Teter Creek	Teter Creek	Flood region=North	WV	Barbour	50200010802	(null)	River Chub

- ☑ Remapsites
- ☑ Emapsites
- ☐ Airports
- ☐ Cities
- ☐ Dams
- ☑ Gauges
- ☑ Roads
- ☑ Railroads
- ☑ Rivers
- ☑ Streams
- ☐ Urbanareas
- ☐ Huc16
- ☐ Huc8
- ☐ Counties
- ☐ Physio

Map Controls

☑ Adjust layers on scale change

Information

Open Teter Creek (50200010802_2001.1 on 2001-09-24)

Cancel

1 record found | Approximate map height: 54 km | Lat: | Lon:

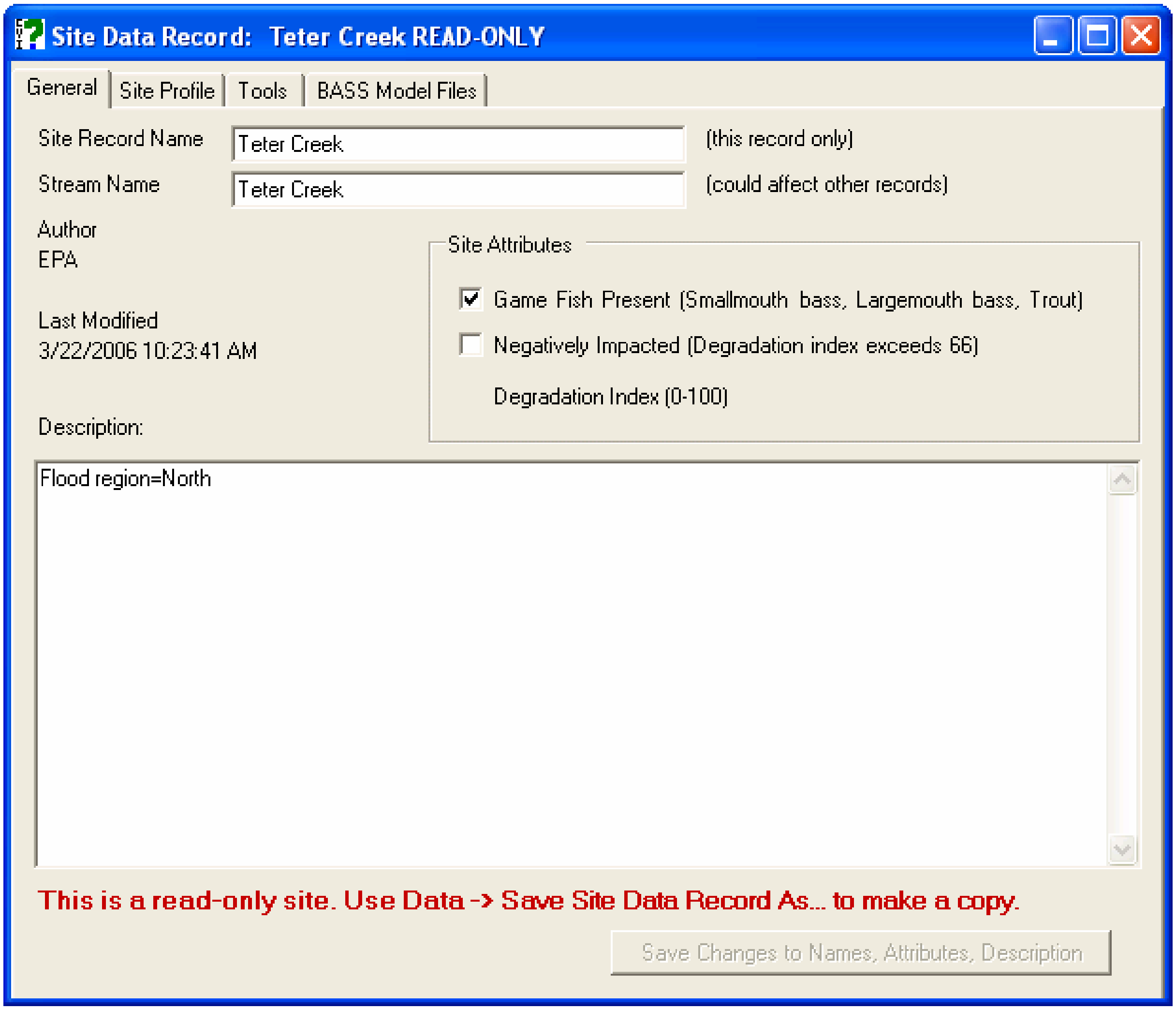
3.3 Adding a new stream/site record to the database.

Managers should note that all site data records included in the WHAT-IF database are marked as "read only." In other words, the base dataset is write protected as shown in Figure 3-4. In order to work with any of the streams listed in the database, such as experimenting with the calculators to evaluate variable sensitivities, one will first need to have a writable copy of the Site Data Record. To copy the site, with the particular site open, select “Copy Site Data Record…” from the “Data” menu. This will bring up a window asking for a new name. Supply a name and click “OK”. The original site will close and the new site will be available. It is now possible to edit many fields, including the site description, and new trials can be created with the each of the calculators.

When a site is copied, as shown in Figure 3-5, a complete copy is made of all site data, including any trials present as well as any BASS model files linked to the site. Most data appearing in a trial of a calculator can be edited. BASS files can be imported into the site as well. There are a few limitations that should be mentioned however. The original data as displayed in the site profile tab is not editable. One cannot change the geographic location of the new site.

The new stream record and its associated data are stored in the WHAT-IF database alongside the original sites. It is possible to make a copy of a copy of a Site Data Record, because the copy behaves much like the original. Note as well that having multiple copies may change the number of hits returned from query questions.

Figure 3-4 Stream data Stream data record window.



Site Record Name: Teter Creek (this record only)

Stream Name: Teter Creek (could affect other records)

Author
EPA

Last Modified
3/22/2006 10:23:41 AM

Site Attributes

☑ Game Fish Present (Smallmouth bass, Largemouth bass, Trout)

☐ Negatively Impacted (Degradation index exceeds 66)

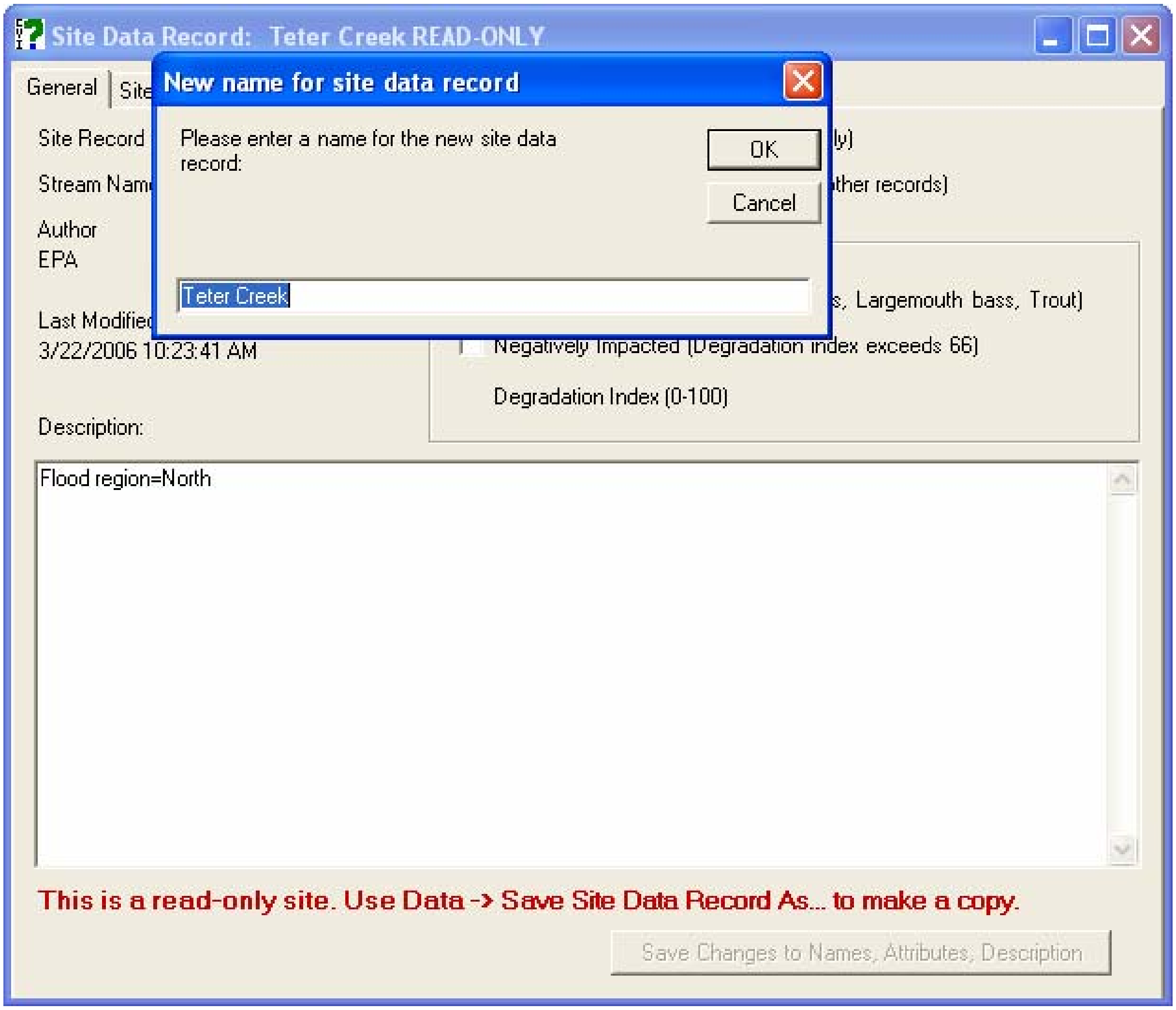
Degradation Index (0-100)

Description:

Flood region=North

This is a read-only site. Use Data -> Save Site Data Record As... to make a copy.

Figure 3-5 Stream data record window with new site name action.



Site Data Record: Teter Creek READ-ONLY

New name for site data record

Please enter a name for the new site data record:

Teter Creek

Site Record

Stream Nam

Author
EPA

Last Modifie
3/22/2006 10:23:41 AM

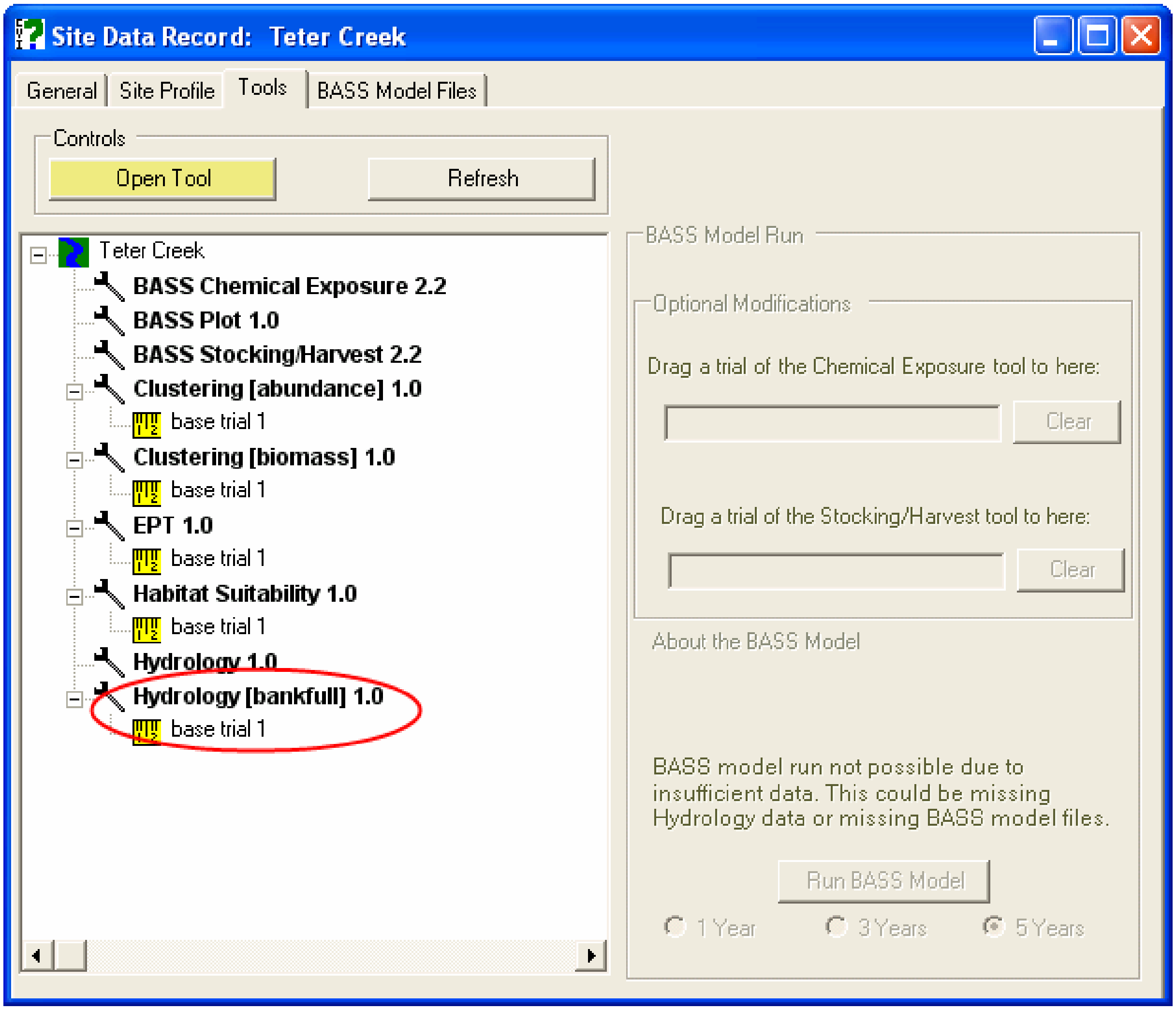
Description:

Flood region=North

This is a read-only site. Use Data -> Save Site Data Record As... to make a copy.

General
Site
OK
Cancel
ly)
ther records)
s, Largemouth bass, Trout)
Negatively Impacted (Degradation index exceeds 66)
Degradation Index (0-100)
Save Changes to Names, Attributes, Description

Figure 3-6 Stream data record tools tab window.



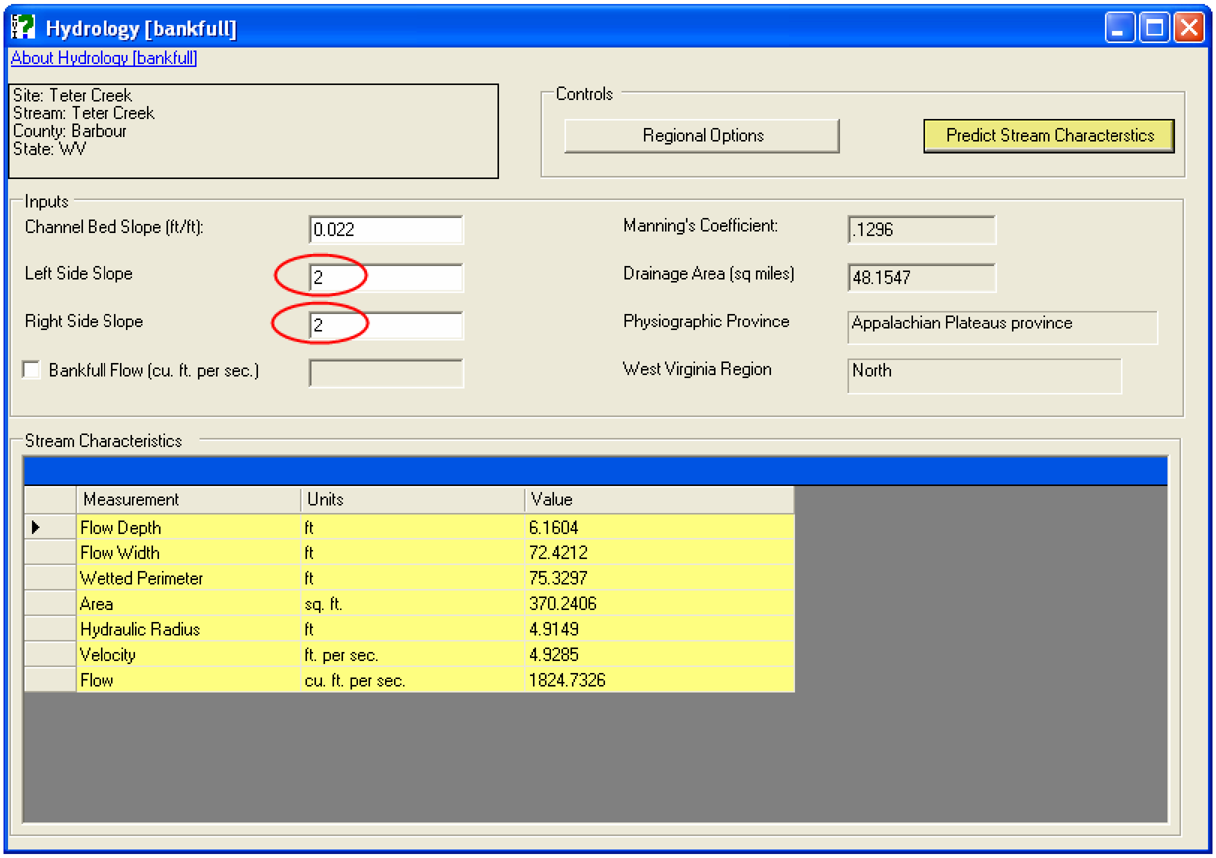
Drag a trial of the Chemical Exposure tool to here:

Drag a trial of the Stocking/Harvest tool to here:

BASS model run not possible due to insufficient data. This could be missing Hydrology data or missing BASS model files.

○ 1 Year ○ 3 Years ● 5 Years

Figure 3-7 Hydrology bankfull tool.



Site: Teter Creek
Stream: Teter Creek
County: Barbour
State: WV

Inputs

Channel Bed Slope (ft/ft): 0.022

Left Side Slope: 2

Right Side Slope: 2

□ Bankfull Flow (cu. ft. per sec.)

Manning's Coefficient: .1296

Drainage Area (sq miles): 48.1547

Physiographic Province: Appalachian Plateaus province

West Virginia Region: North

Stream Characteristics

Measurement	Units	Value
Flow Depth	ft	6.1604
Flow Width	ft	72.4212
Wetted Perimeter	ft	75.3297
Area	sq. ft.	370.2406
Hydraulic Radius	ft	4.9149
Velocity	ft. per sec.	4.9285
Flow	cu. ft. per sec.	1824.7326

4 Habitat Suitability and Macroinvertebrates

4.1 Introduction to habitat suitability assessment and benthic indices

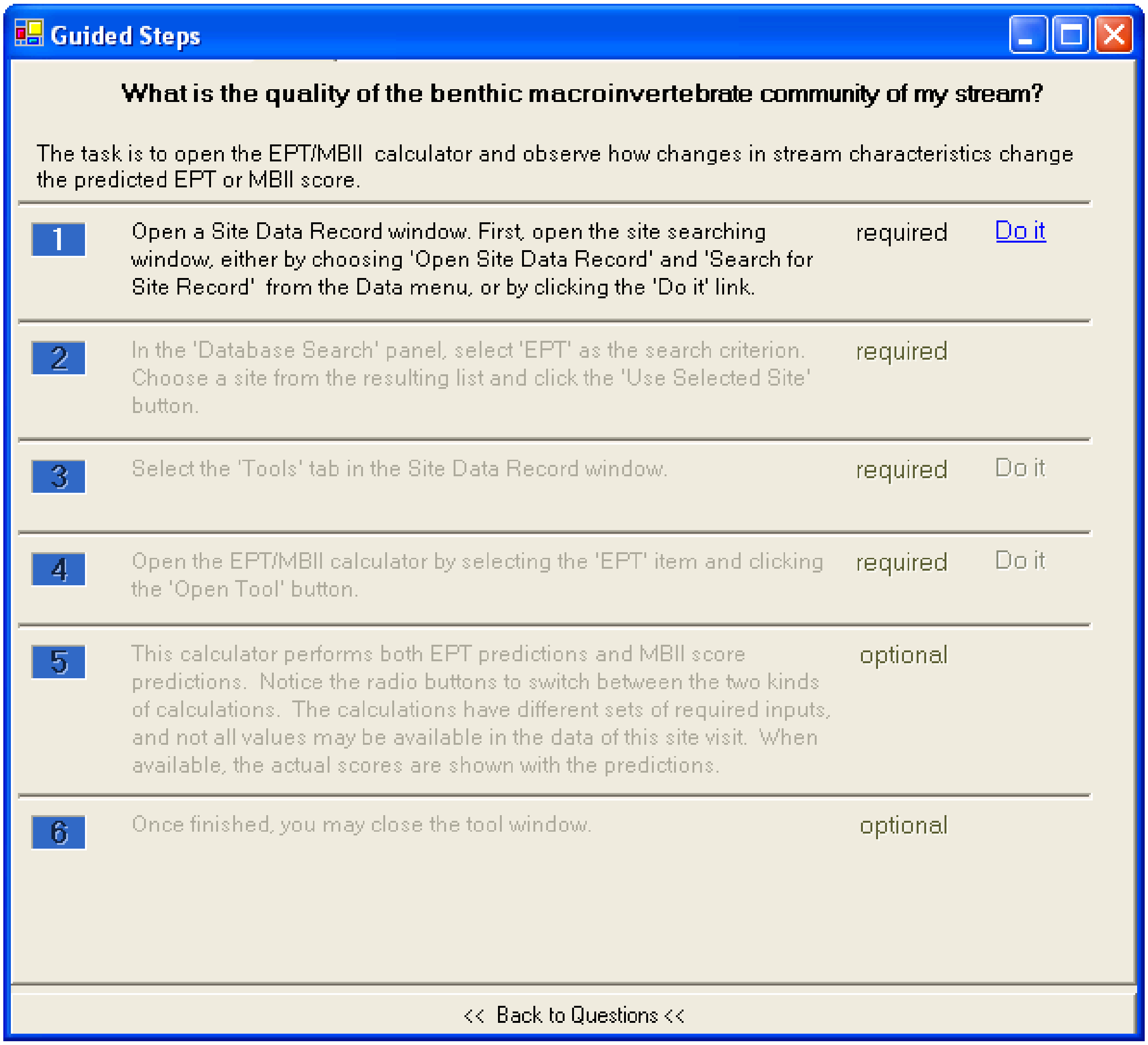
Similar to the method used in WHAT IF v.1 for stream fishes, habitat suitability index (HSI) models were developed for stream macroinvertebrates using the most commonly collected instream habitat measures. WHAT IF v.2 contains models for both the EMAP developed macrobenthic invertebrate index (MBII) and the more commonly applied EPT index (Ephemeroptera, Plecoptera and Trichoptera) used by states in the Mid-Atlantic. Multiple logistic regression was used to develop quantitative relationships (i.e., models) between selected, measured instream habitat variables and the presence or absence of both MBII and EPT taxa. These index models calculate a composite score of the suitability of a few, statistically meaningful predictor habitat variables. For each of the habitat variables, suitability ranges from 0 (unsuitable) to 1 (fully supporting of the species). An important point of clarification is that these models are *similar* to those developed by the US Fish and Wildlife Service but they are not *identical* in approach. The approach herein is based on the assumption of a positive relationship between the suitability index and habitat carrying capacity, but employs logistic regression as the method of data analysis (USFWS 1981).

Also similar to WHAT IF v.1, reach-scale habitat variables were used as predictors, resulting in a stream reach assessment tool for benthic insects. The insect and habitat data used in this analysis were produced by the USEPA EMAP program for MAH surface waters during 1993-6 (http://www.epa.gov/emap/html/dataI/surfwatr/data/ma9396.html). Only samples within the boundary of the MAH were included in the analysis, and newly available WV state data (REMAP) were added to the assessment capabilities of WHAT IF v.2.

4.2 What is the quality of the benthic macroinvertebrate community of my stream?

Similar to the operations in the preceding section, a manager selects the stream of interest through the assistance of the Wizard Tool, if necessary, as in Figure 4-1. This results in the map selection window in Figure 4-2. Note that experienced managers/WHAT IF users can also select streams using the main pulldown menu “Data,” then clicking “Open Site Data Record,” and finally selecting “Search For Site Data Record.” This series of actions also produces the map selection window with the default extent and no streams currently selected as in Figure 4-2.

Figure 4-1 Stream wizard tool for benthic stream selection.



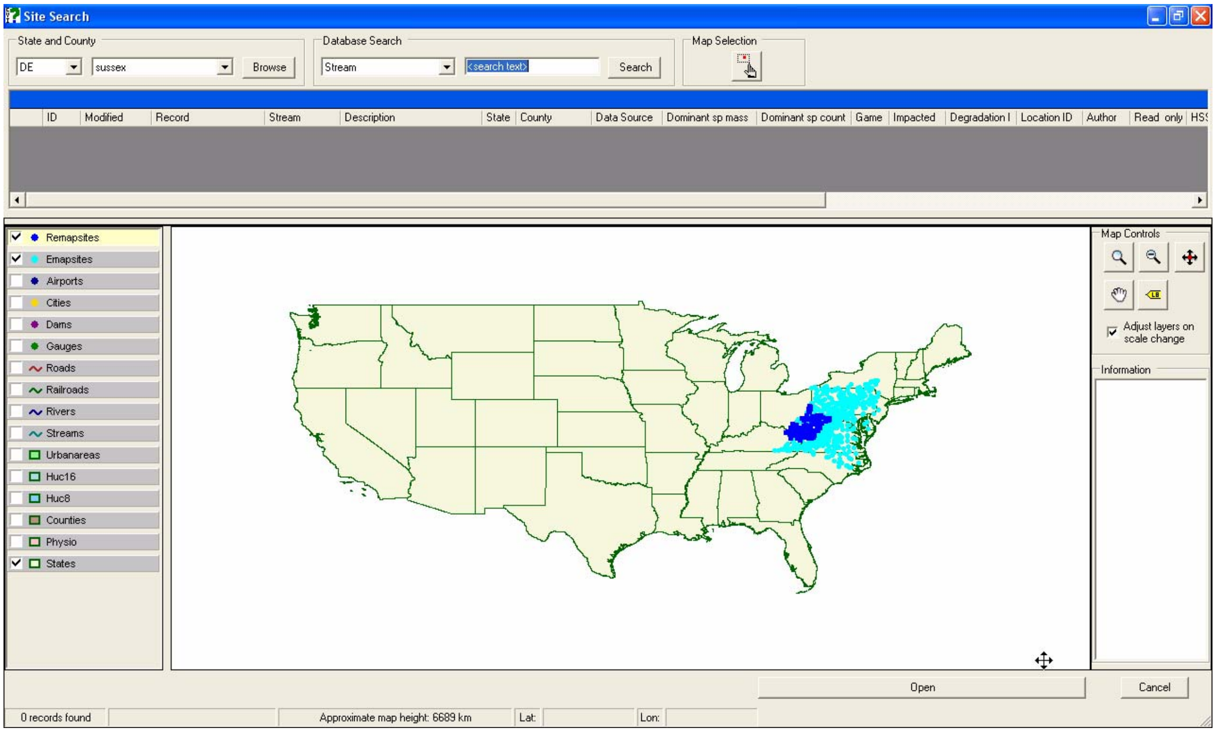
What is the quality of the benthic macroinvertebrate community of my stream?

The task is to open the EPT/MBII calculator and observe how changes in stream characteristics change the predicted EPT or MBII score.

1	Open a Site Data Record window. First, open the site searching window, either by choosing 'Open Site Data Record' and 'Search for Site Record' from the Data menu, or by clicking the 'Do it' link.	required	Do it
2	In the 'Database Search' panel, select 'EPT' as the search criterion. Choose a site from the resulting list and click the 'Use Selected Site' button.	required	
3	Select the 'Tools' tab in the Site Data Record window.	required	Do it
4	Open the EPT/MBII calculator by selecting the 'EPT' item and clicking the 'Open Tool' button.	required	Do it
5	This calculator performs both EPT predictions and MBII score predictions. Notice the radio buttons to switch between the two kinds of calculations. The calculations have different sets of required inputs, and not all values may be available in the data of this site visit. When available, the actual scores are shown with the predictions.	optional	
6	Once finished, you may close the tool window.	optional	

Selecting “Do It” in Figure 4-1 produces the map selection window in Figure 4-2. Since we are interested in Teter Creek as an extension to the Bankfull Tool example, we access the “Database Search” by entering “Teter” into the <search text> field and clicking on the nearby “Search” button. Figure 4-3 is produced that shows the EMAP stream of that name in addition to the new stream created with the identical name in the Bankfull Tool example.

Figure 4-2 Map selection window with default extent.


Site Search

State and County: DE ▾ | sussex ▾ | Browse

Database Search: Stream ▾ | <search text> | Search

Map Selection

	ID	Modified	Record	Stream	Description	State	County	Data Source	Dominant sp mass	Dominant sp count	Game	Impacted	Degradation I	Location ID	Author	Read only	HS

☑ Remapsites
☑ Emapsites
☐ Airports
☐ Cities
☐ Dams
☐ Gauges
☐ Roads
☐ Railroads
☐ Rivers
☐ Streams
☐ Urbanareas
☐ Huc16
☐ Huc8
☐ Counties
☐ Physio
☑ States

Map Controls

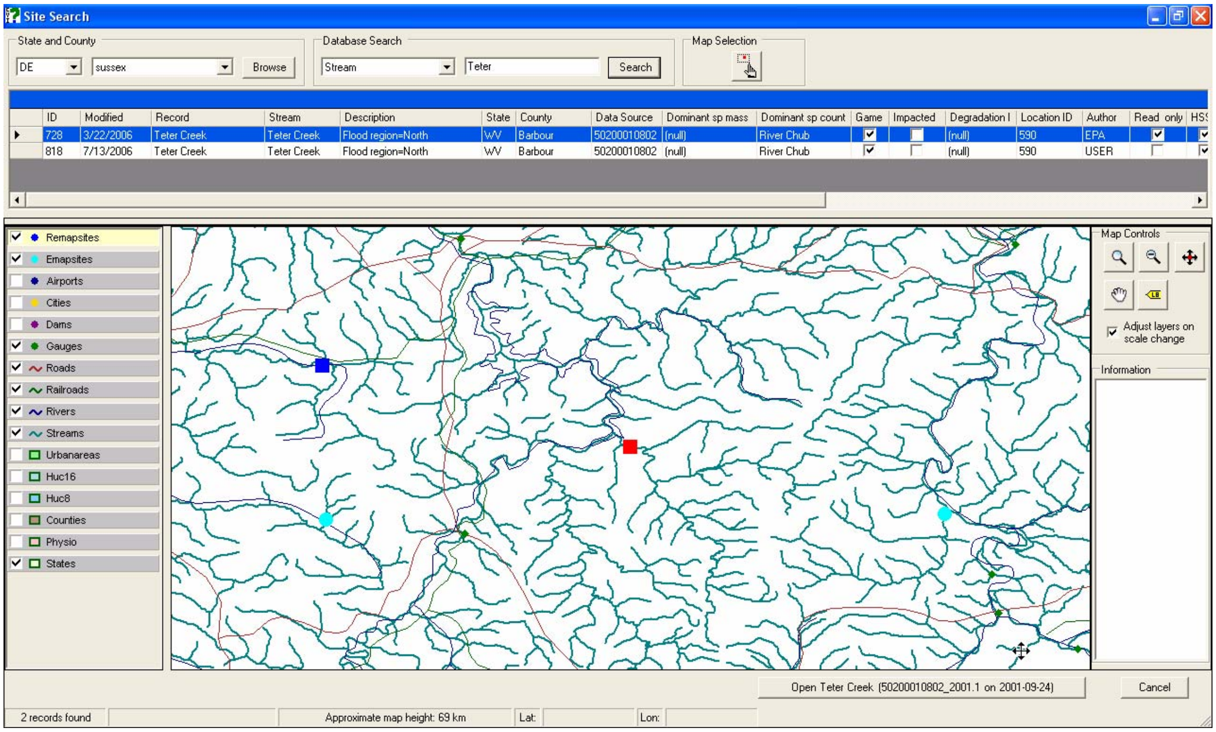
☑ Adjust layers on scale change

Information

Open | Cancel

0 records found | Approximate map height: 6689 km | Lat: | Lon:

Figure 4-3 Map selection window showing Teter Creek and duplicate name.


Site Search

State and County: DE ▾ | sussex ▾ | Browse

Database Search: Stream ▾ | Teter | Search

Map Selection

	ID	Modified	Record	Stream	Description	State	County	Data Source	Dominant sp mass	Dominant sp count	Game	Impacted	Degradation I	Location ID	Author	Read only	HS
▸	728	3/22/2006	Teter Creek	Teter Creek	Flood region=North	WV	Barbour	50200010802	(null)	River Chub	☑	☐	(null)	590	EPA	☑	☑
	818	7/13/2006	Teter Creek	Teter Creek	Flood region=North	WV	Barbour	50200010802	(null)	River Chub	☑	☐	(null)	590	USER	☐	☑

☑ Remapsites
☑ Emapsites
☐ Airports
☐ Cities
☐ Dams
☑ Gauges
☑ Roads
☑ Railroads
☑ Rivers
☑ Streams
☐ Urbanareas
☐ Huc16
☐ Huc8
☐ Counties
☐ Physio
☑ States

Map Controls

☑ Adjust layers on scale change

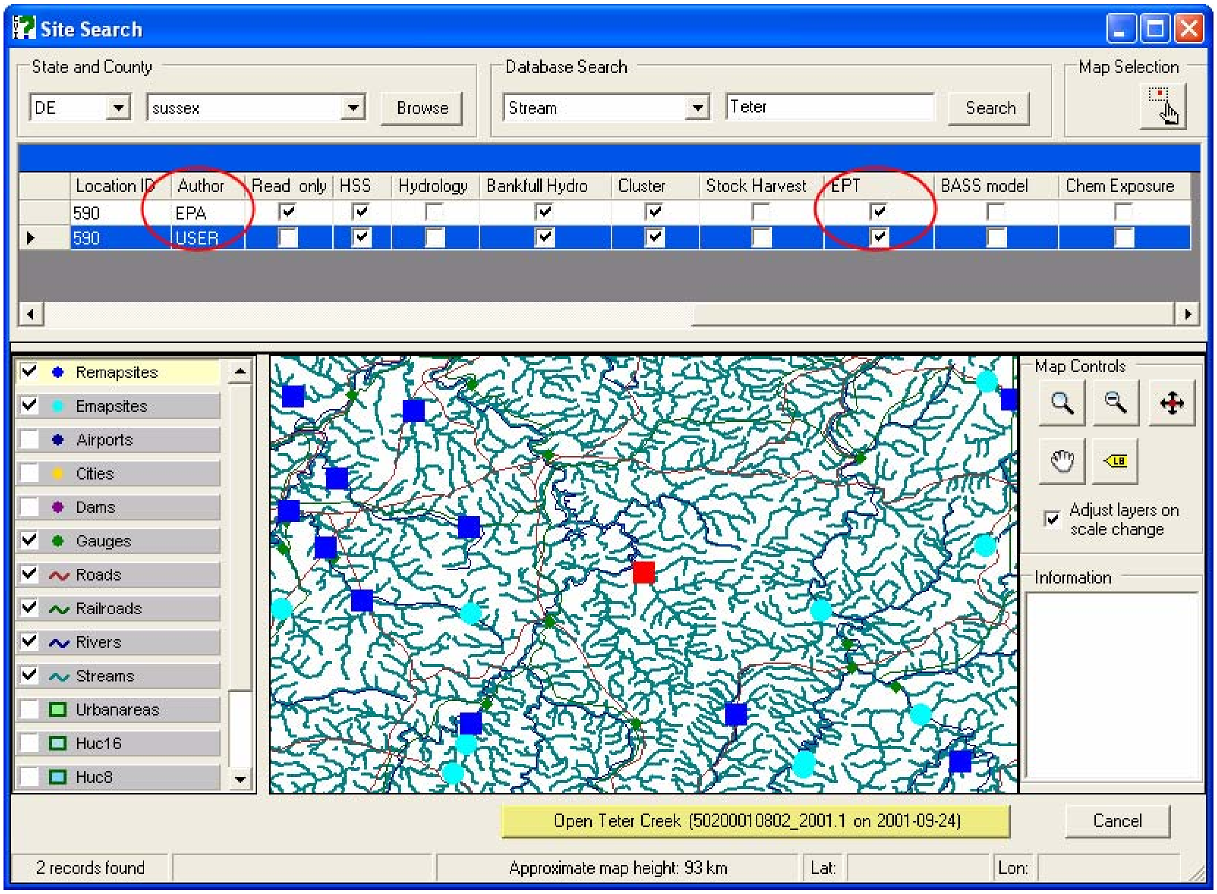
Information

Open Teter Creek (50200010802_2001.1 on 2001-09-24) | Cancel

2 records found | Approximate map height: 69 km | Lat: | Lon:

Streams are identified in the database with unique IDs, as shown in the left hand side of the table view in Figure 4-3. The “Author” of the stream is also noted, whether as the collection agency or the manager using WHAT IF to create new trials of the various tools. Figure 4-4 illustrates the identical “Location ID” and “Author” associated with the stream that is centered on the screen. Note as well that the “EPT” column shows the existence of a default trial using this tool, as well as several others. Figure 4-4 also shows that the user who might be also interested in the BASS model for chemical exposure or a trout stocking and harvest assessment has yet to use the WHAT IF tool to populate these entries in the table view.

Figure 4-4 Map selection window showing details of Teter Creek.



State and County: DE, sussex

Database Search: Stream, Teter

	Location ID	Author	Read only	HSS	Hydrology	Bankfull Hydro	Cluster	Stock Harvest	EPT	BASS model	Chem Exposure
	590	EPA	☑	☑	☐	☑	☑	☐	☑	☐	☐
▶	590	USER	☐	☑	☐	☑	☑	☐	☑	☐	☐

☑ Remapsites
☑ Emapsites
☐ Airports
☐ Cities
☐ Dams
☑ Gauges
☑ Roads
☑ Railroads
☑ Rivers
☑ Streams
☐ Urbanareas
☐ Huc16
☐ Huc8

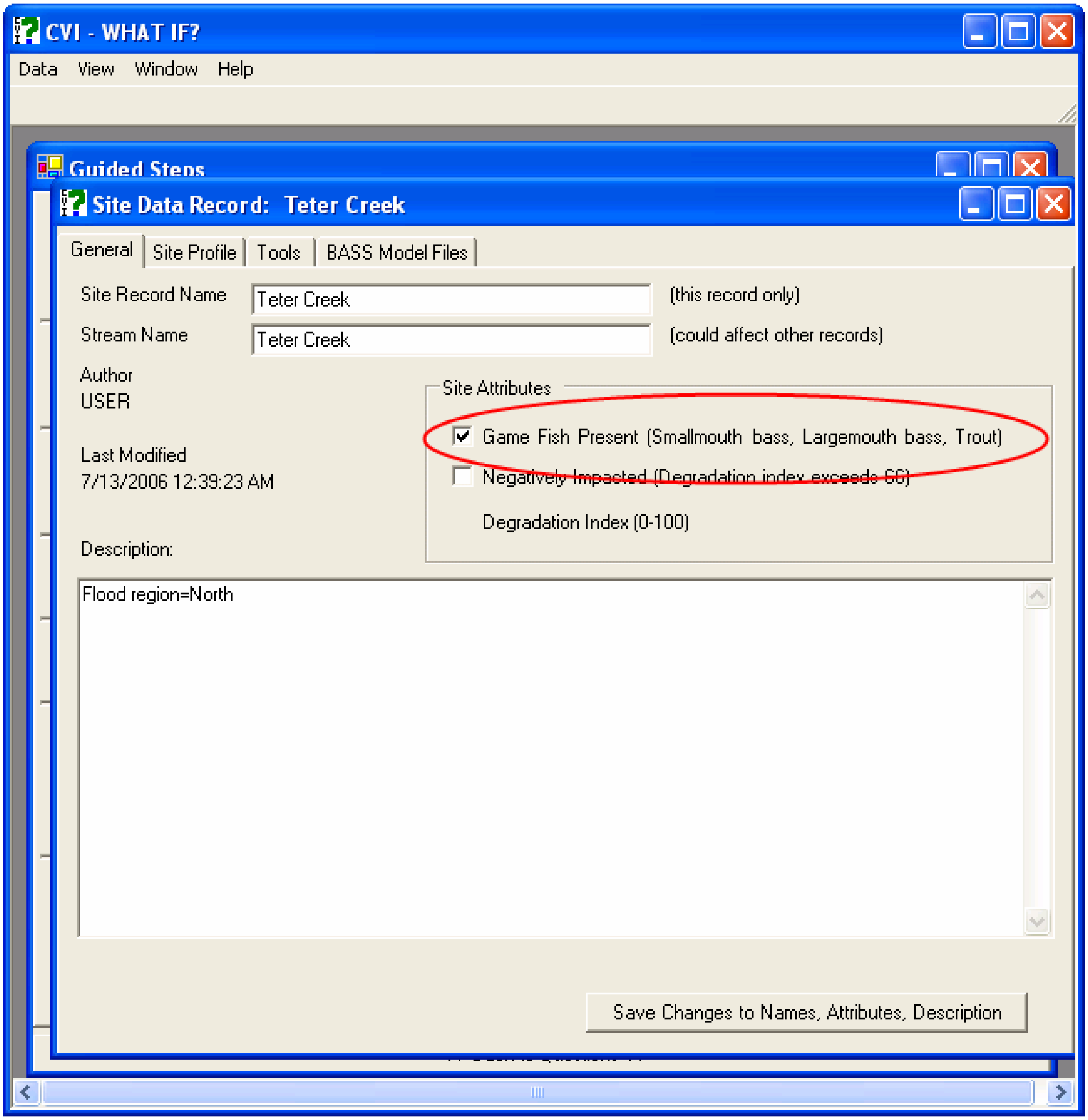
☑ Adjust layers on scale change

Open Teter Creek (50200010802_2001.1 on 2001-09-24)

2 records found | Approximate map height: 93 km | Lat: | Lon:

In this example, the manager/WHAT IF user can select the stream saved in the previous example, since this is not a “Read Only” site in the default database, and can be modified as necessary for all trials. The stream of interest is shown as selected by presence of the blue highlighting in Figure 4-4, and the clicking of the highlighted “Open Teter Creek” button at the bottom of the map selection window. Figure 4-5 is thereby returned displaying the “General” tab by default.

Figure 4-5 Stream data record for Teter Creek with default General information tab.



Site Record Name: Teter Creek (this record only)

Stream Name: Teter Creek (could affect other records)

Author
USER

Last Modified
7/13/2006 12:39:23 AM

Site Attributes

☑ Game Fish Present (Smallmouth bass, Largemouth bass, Trout)

☐ Negatively Impacted (Degradation index exceeds 60)

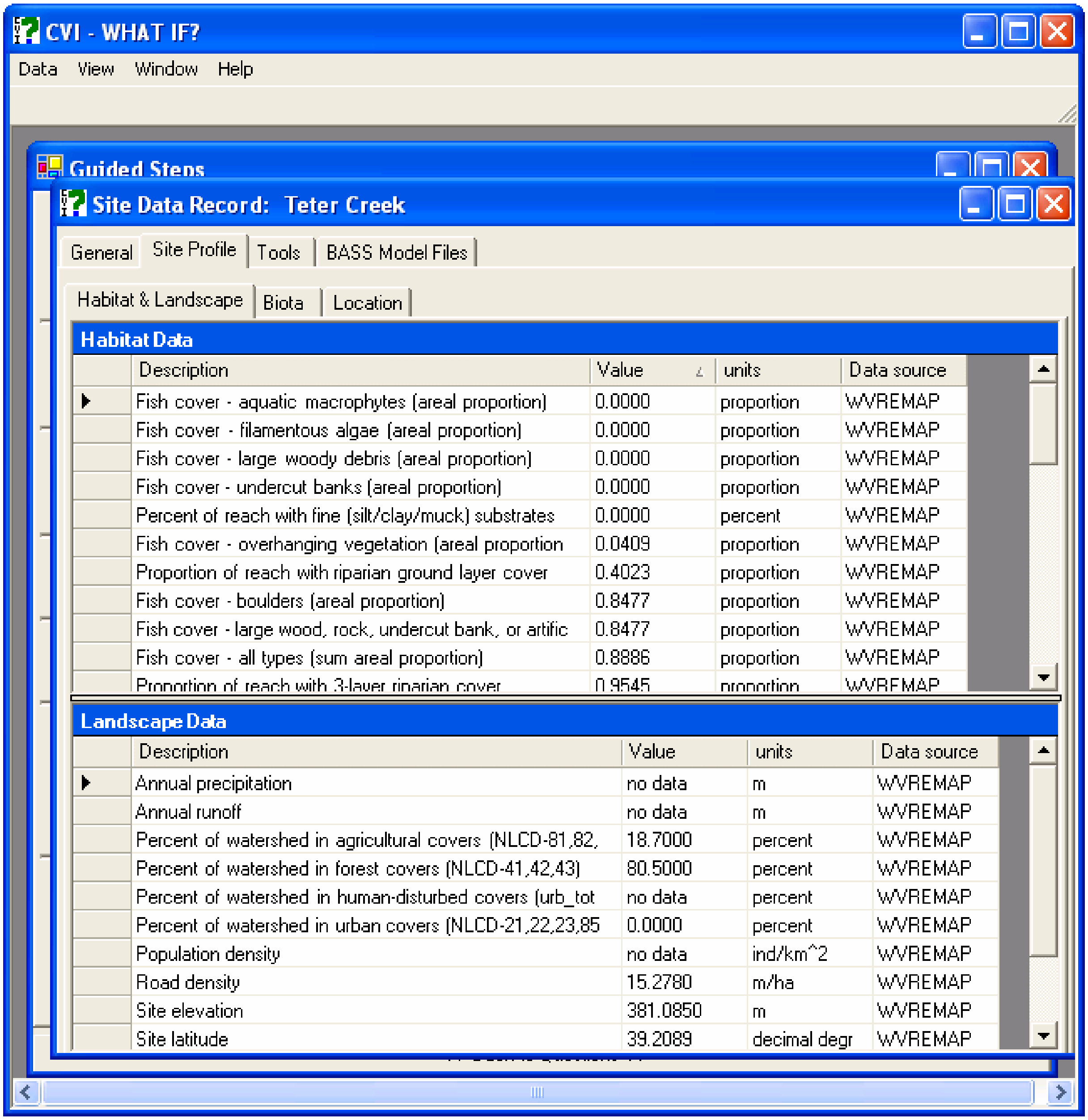
Degradation Index (0-100)

Description:

Flood region=North

On this “General” information tab is included default stream queries from WHAT IF v.1, namely the presence of any game fish, and whether a degradation index had been calculated for the stream (if blank, missing data prevented the calculation and no tool is provided for this). Additional information concerning each stream selected is provided using Figure 4-5 by clicking on the various tabs. The “Site Profile” tab organizes the majority of the data of interest; the results of its use are shown in Figure 4-6.

Figure 4-6 Stream data record for Teter Creek showing Habitat and Landscape tab.



Habitat Data

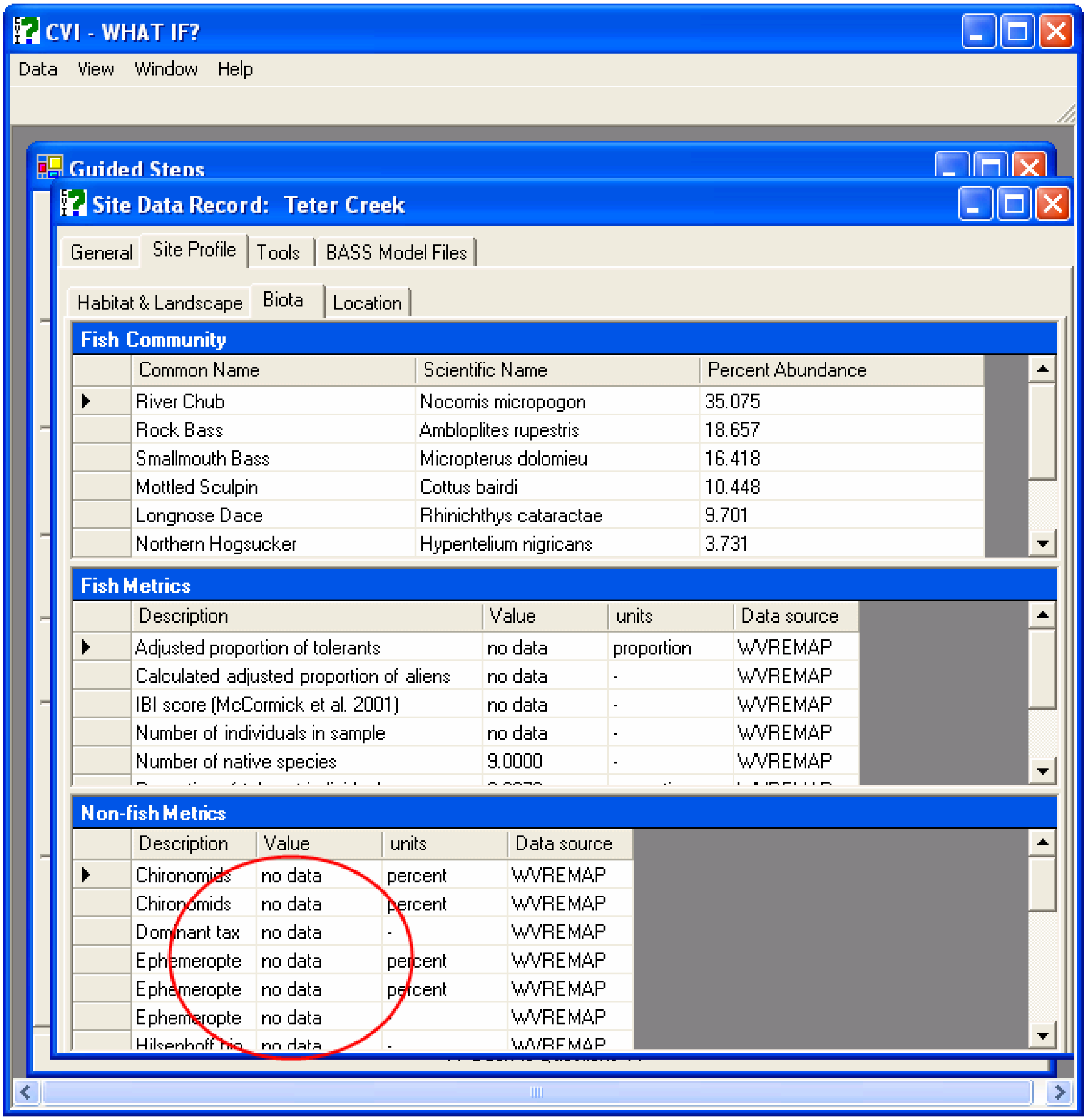
Description	Value	units	Data source
Fish cover - aquatic macrophytes (areal proportion)	0.0000	proportion	WVREMAP
Fish cover - filamentous algae (areal proportion)	0.0000	proportion	WVREMAP
Fish cover - large woody debris (areal proportion)	0.0000	proportion	WVREMAP
Fish cover - undercut banks (areal proportion)	0.0000	proportion	WVREMAP
Percent of reach with fine (silt/clay/muck) substrates	0.0000	percent	WVREMAP
Fish cover - overhanging vegetation (areal proportion	0.0409	proportion	WVREMAP
Proportion of reach with riparian ground layer cover	0.4023	proportion	WVREMAP
Fish cover - boulders (areal proportion)	0.8477	proportion	WVREMAP
Fish cover - large wood, rock, undercut bank, or artific	0.8477	proportion	WVREMAP
Fish cover - all types (sum areal proportion)	0.8886	proportion	WVREMAP
Proportion of reach with 3-layer riparian cover	0.9545	proportion	WVREMAP

Landscape Data

Description	Value	units	Data source
Annual precipitation	no data	m	WVREMAP
Annual runoff	no data	m	WVREMAP
Percent of watershed in agricultural covers (NLCD-81,82,	18.7000	percent	WVREMAP
Percent of watershed in forest covers (NLCD-41,42,43)	80.5000	percent	WVREMAP
Percent of watershed in human-disturbed covers (urb_tot	no data	percent	WVREMAP
Percent of watershed in urban covers (NLCD-21,22,23,85	0.0000	percent	WVREMAP
Population density	no data	ind/km^2	WVREMAP
Road density	15.2780	m/ha	WVREMAP
Site elevation	381.0850	m	WVREMAP
Site latitude	39.2089	decimal degr	WVREMAP

The “Habitat and Landscape” tab shows the entries from both EMAP and REMAP datasets, as well as the units and description to assist managers with a more complete background for each stream. Habitat parameters used in WHAT IF v.2 tools are displayed with a variety of others that may be of interest to managers. Figure 4-7 shows the information displayed with the “Biota” tab.

Figure 4-7 Stream data record showing Biota tab and associated data fields.



Fish Community

Common Name	Scientific Name	Percent Abundance
River Chub	Nocomis micropogon	35.075
Rock Bass	Ambloplites rupestris	18.657
Smallmouth Bass	Micropterus dolomieu	16.418
Mottled Sculpin	Cottus bairdi	10.448
Longnose Dace	Rhinichthys cataractae	9.701
Northern Hogsucker	Hypentelium nigricans	3.731

Fish Metrics

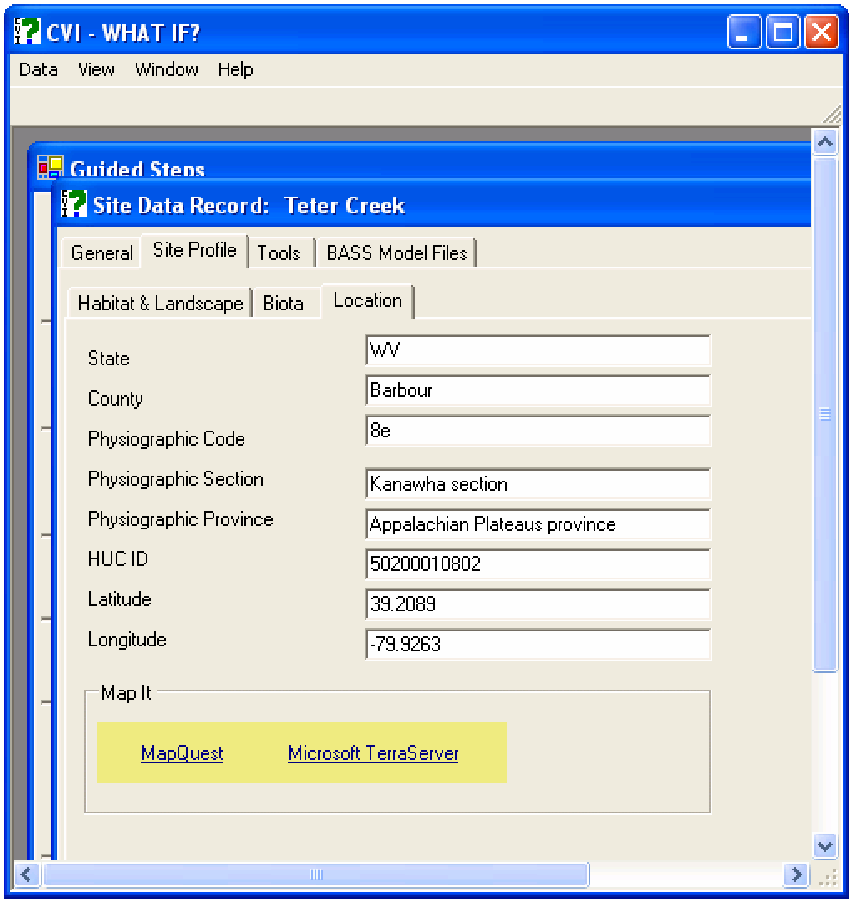
Description	Value	units	Data source
Adjusted proportion of tolerants	no data	proportion	WVREMAP
Calculated adjusted proportion of aliens	no data	-	WVREMAP
IBI score (McCormick et al. 2001)	no data	-	WVREMAP
Number of individuals in sample	no data	-	WVREMAP
Number of native species	9.0000	-	WVREMAP

Non-fish Metrics

Description	Value	units	Data source
Chironomids	no data	percent	WVREMAP
Chironomids	no data	percent	WVREMAP
Dominant tax	no data	-	WVREMAP
Ephemeropte	no data	percent	WVREMAP
Ephemeropte	no data	percent	WVREMAP
Ephemeropte	no data	-	WVREMAP
Hilsenhoff bio	no data	-	WVREMAP

Of note in Figure 4-7 is the non-existent “Non-fish Metrics,” which is often an issue associated with the use of the EPT tool. In this case the manager/WHAT IF user will not be able to compare predicted to observed EPT values. A manager/WHAT IF user has several choices, including manually entering the data required for the benthic calculators, opting to use fish as the stream bioassessment endpoint, or going back to the map selection window and searching for a nearby stream to Teter Creek that provides benthic insect information. In this example, the first option will be investigated in the following section. Note that since WV REMAP contains fish measurements only, this is a limitation of attempting to use other than EMAP streams. Figure 4-8 illustrates an additional feature for managers/WHAT IF users with an Internet connection: hotlinks to Mapquest and TerraServer for automated image retrieval, in the latter case for digital orthophoto display.

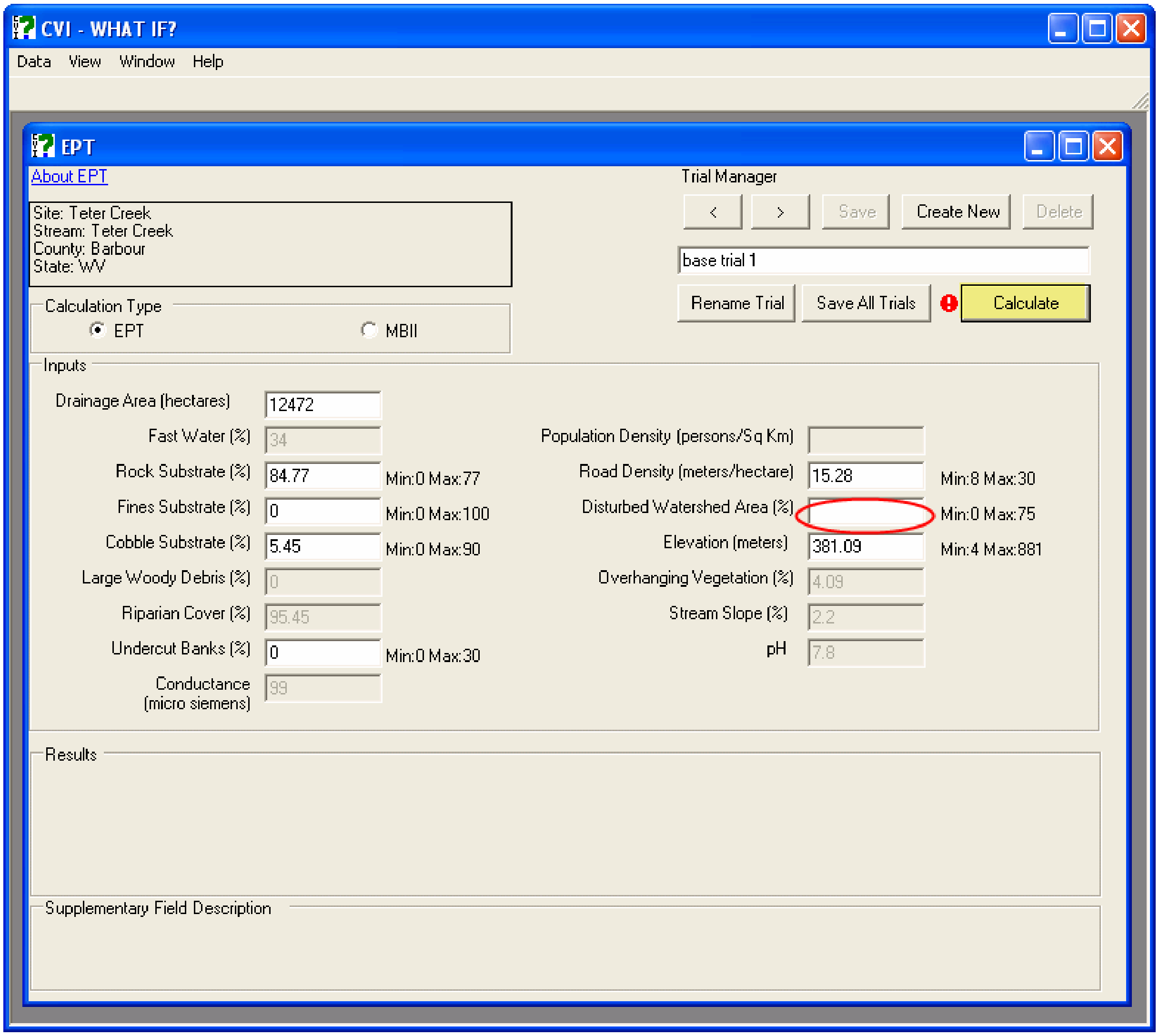
Figure 4-8 Stream data record location tab



State	WV
County	Barbour
Physiographic Code	8e
Physiographic Section	Kanawha section
Physiographic Province	Appalachian Plateaus province
HUC ID	50200010802
Latitude	39.2089
Longitude	-79.9263

4.3 What is the quality of the benthic macroinvertebrate community of my stream? (continued)

Figure 4-9 EPT habitat suitability tool.



Site: Teter Creek
Stream: Teter Creek
County: Barbour
State: WV

Calculation Type
● EPT ○ MBII

base trial 1

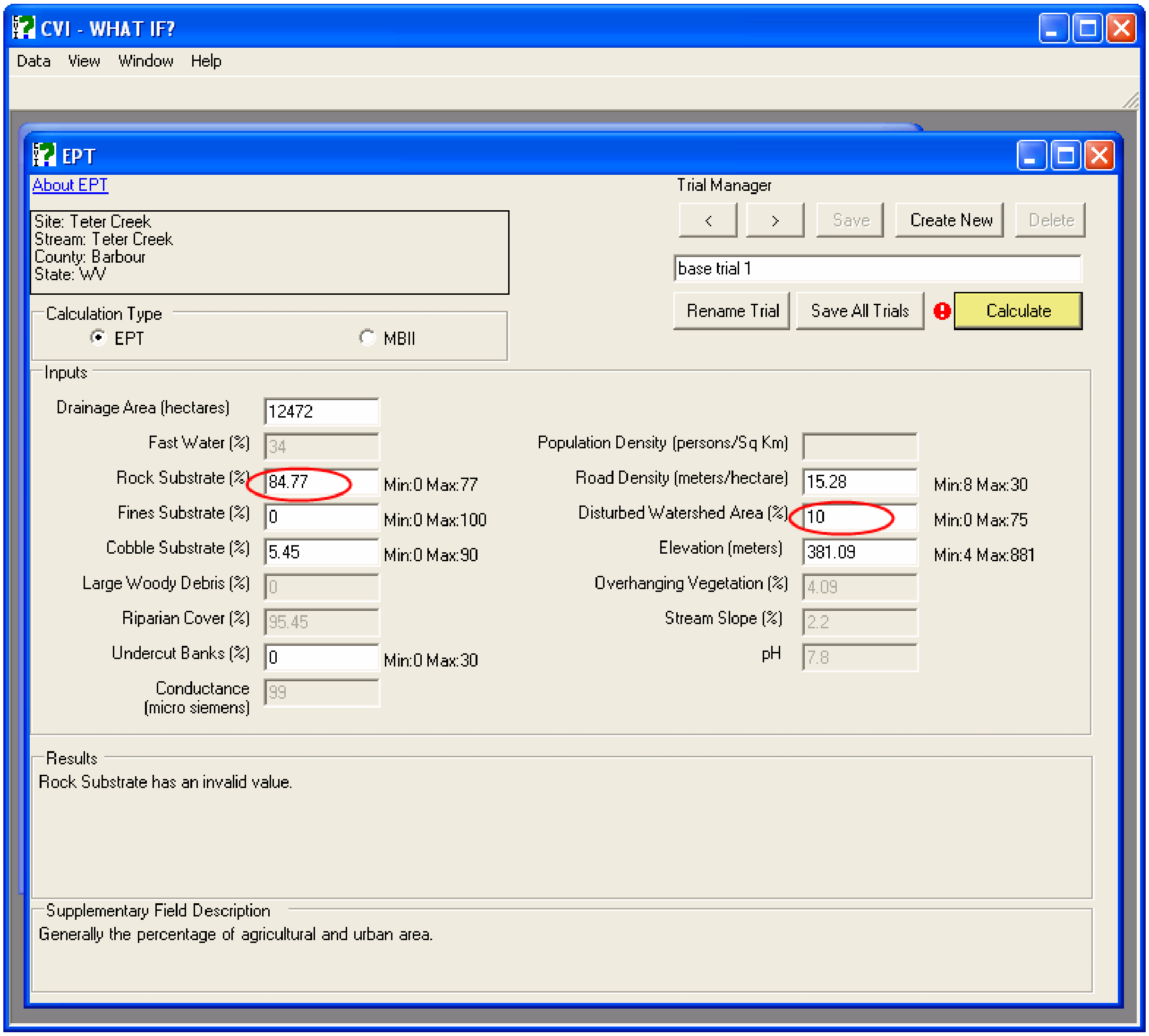
Inputs

Drainage Area (hectares) 12472
Fast Water (%) 34
Rock Substrate (%) 84.77 Min:0 Max:77
Fines Substrate (%) 0 Min:0 Max:100
Cobble Substrate (%) 5.45 Min:0 Max:90
Large Woody Debris (%) 0
Riparian Cover (%) 95.45
Undercut Banks (%) 0 Min:0 Max:30
Conductance (micro siemens) 99

Population Density (persons/Sq Km)
Road Density (meters/hectare) 15.28 Min:8 Max:30
Disturbed Watershed Area (%) Min:0 Max:75
Elevation (meters) 381.09 Min:4 Max:881
Overhanging Vegetation (%) 4.09
Stream Slope (%) 2.2
pH 7.8

As shown in Figure 4-9, the calculator is incomplete, as indicated by the red exclamation icon near the highlighted calculate button. Moving the mouse over the red icon produces a message to aid in locating the missing parameters, in this case “Disturbed Watershed Area.” Estimating this value as 10 (percent of agricultural and urban land) and clicking “Calculate” results in Figure 4-10. Note that there is still an issue, as explained in the “Results” field, that “Rock Substrate” has a value outside the acceptable range. Rather than truncate values from the WV REMAP database automatically, managers/model users are prompted to modify an entry, and WHAT IF provides the minimum and maximum values for each input parameter to assist in this process. Since EMAP data were used to develop the models, values in the REMAP dataset may also occasionally be outside the acceptable range.

Figure 4-10 EPT tool showing explanatory fields and value outside accepted range.



Site: Teter Creek
Stream: Teter Creek
County: Barbour
State: WV

Calculation Type
● EPT ○ MBII

base trial 1

Inputs

Drainage Area (hectares) 12472
Fast Water (%) 34
Rock Substrate (%) 84.77 Min:0 Max:77
Fines Substrate (%) 0 Min:0 Max:100
Cobble Substrate (%) 5.45 Min:0 Max:90
Large Woody Debris (%) 0
Riparian Cover (%) 95.45
Undercut Banks (%) 0 Min:0 Max:30
Conductance (micro siemens) 99

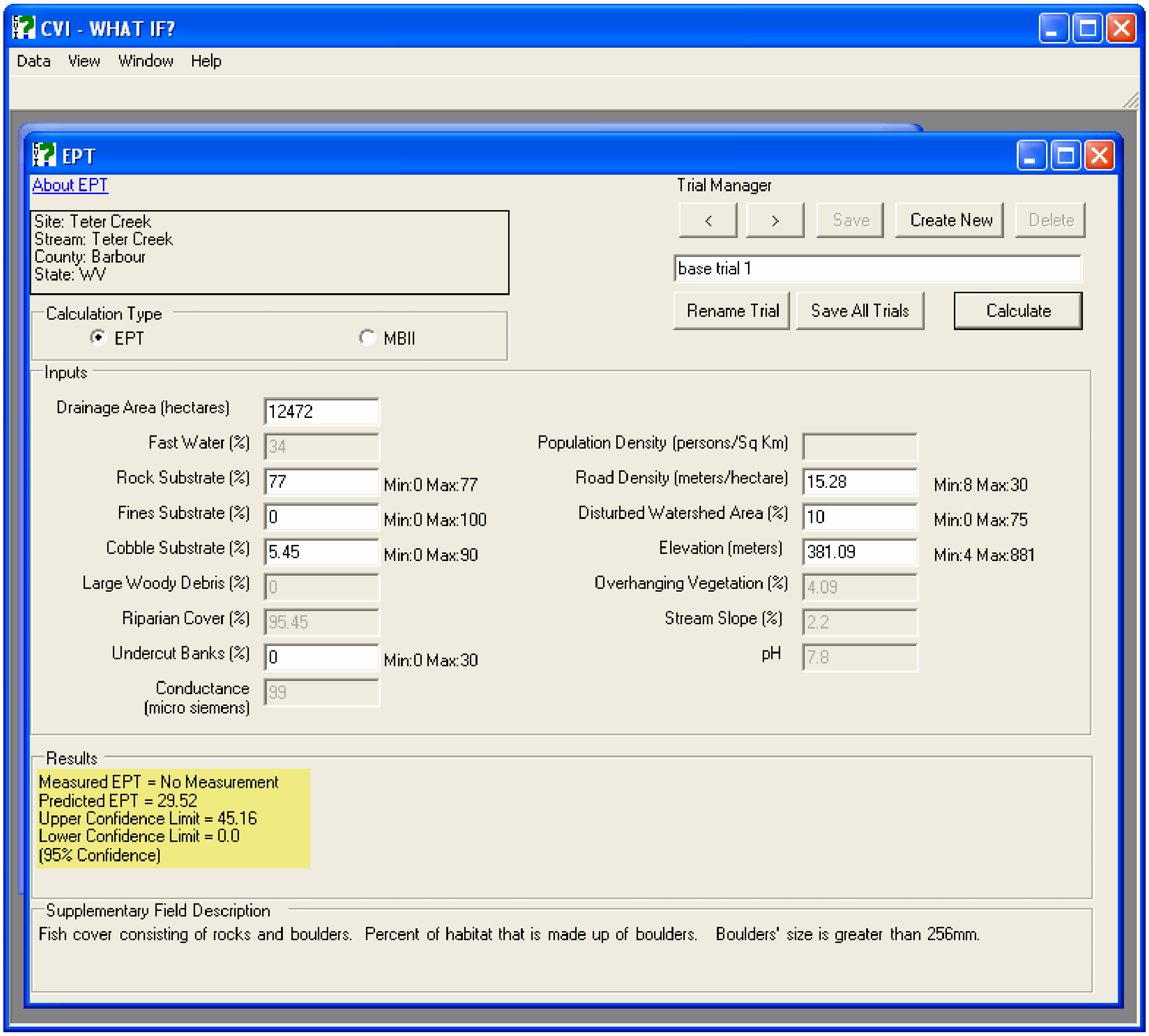
Population Density (persons/Sq Km)
Road Density (meters/hectare) 15.28 Min:8 Max:30
Disturbed Watershed Area (%) 10 Min:0 Max:75
Elevation (meters) 381.09 Min:4 Max:881
Overhanging Vegetation (%) 4.09
Stream Slope (%) 2.2
pH 7.8

Results
Rock Substrate has an invalid value.

Supplementary Field Description
Generally the percentage of agricultural and urban area.

Figure 4-11 illustrates the successful completion of the input/setup process, resulting in a predicted EPT value of 29.5. In this case there is no measured EPT value with which to compare the predicted value, but the lower and upper confidence bounds of the calculated value can help with its interpretation. Note that the EPT and MBII tools have a shared interface such that a number of additional input habitat parameter values are displayed but in shaded format. Managers can continue to modify any of the currently used required model input parameters, provided the values are within the acceptable ranges.

Figure 4-11 EPT tool with predicted value and confidence limits.



Site: Teter Creek
Stream: Teter Creek
County: Barbour
State: WV

base trial 1

Calculation Type

● EPT ○ MBII

Inputs

Drainage Area (hectares) 12472
Fast Water (%) 34
Rock Substrate (%) 77 Min:0 Max:77
Fines Substrate (%) 0 Min:0 Max:100
Cobble Substrate (%) 5.45 Min:0 Max:90
Large Woody Debris (%) 0
Riparian Cover (%) 95.45
Undercut Banks (%) 0 Min:0 Max:30
Conductance (micro siemens) 99

Population Density (persons/Sq Km)
Road Density (meters/hectare) 15.28 Min:8 Max:30
Disturbed Watershed Area (%) 10 Min:0 Max:75
Elevation (meters) 381.09 Min:4 Max:881
Overhanging Vegetation (%) 4.09
Stream Slope (%) 2.2
pH 7.8

Results

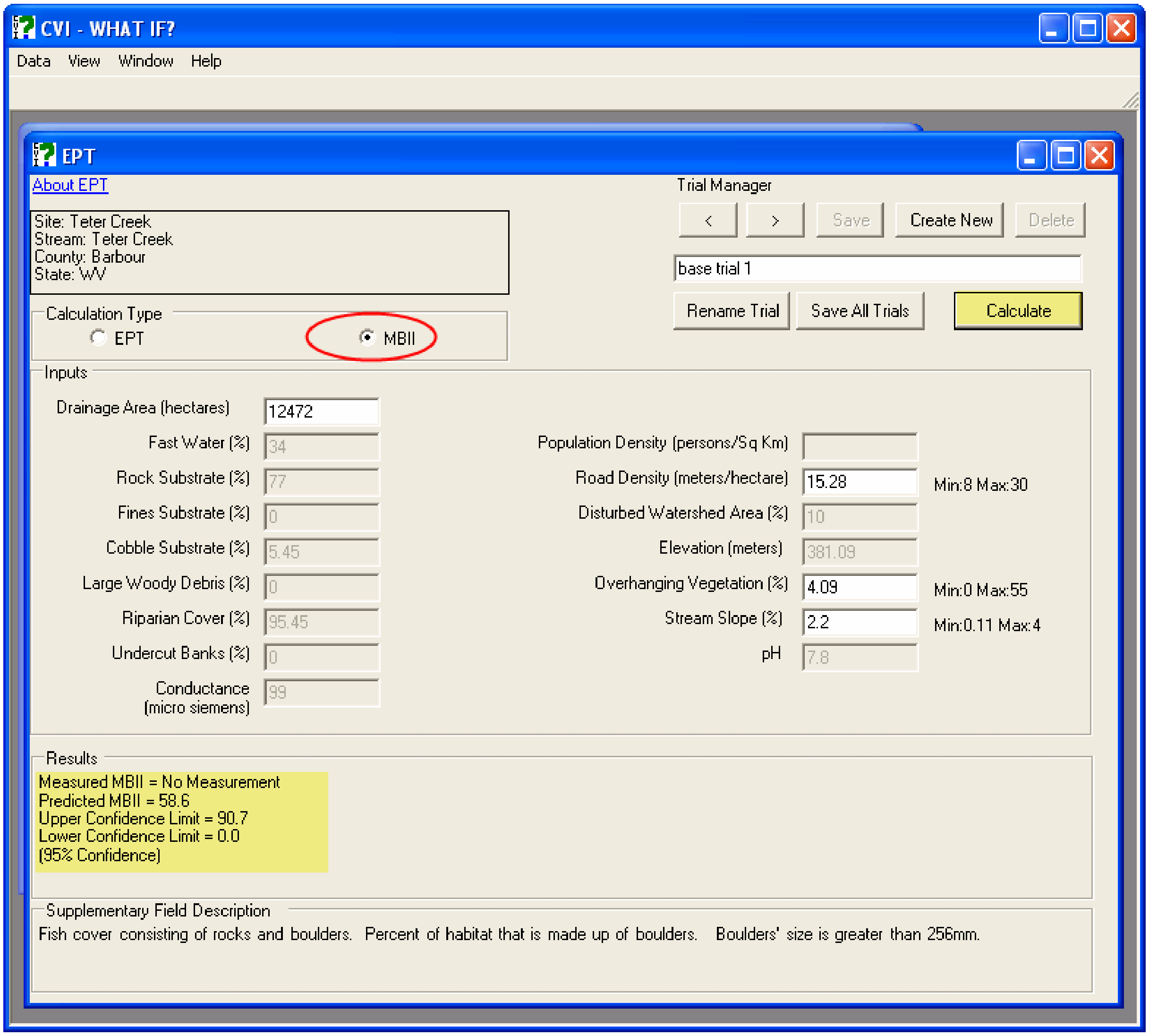
Measured EPT = No Measurement
Predicted EPT = 29.52
Upper Confidence Limit = 45.16
Lower Confidence Limit = 0.0
(95% Confidence)

Supplementary Field Description

Fish cover consisting of rocks and boulders. Percent of habitat that is made up of boulders. Boulders' size is greater than 256mm.

The MBII calculator input/setup and result is shown in Figure 4-12. Trial results can be saved by creating and renaming each trial. WHAT IF stores all saved trials. An example of this is shown in Figure 4-13 where road density was doubled, resulting in a decrease of calculated MBII score to half of its value in Figure 4-12. After completing the needed assessments (trials) using the EPT and MBII tools, managers/model users return to the Tools Wizard (Figure 4-14).

Figure 4-12 MBII calculator.



Site: Teter Creek
Stream: Teter Creek
County: Barbour
State: WV

Trial: base trial 1

Calculation Type
○ EPT ● MBII

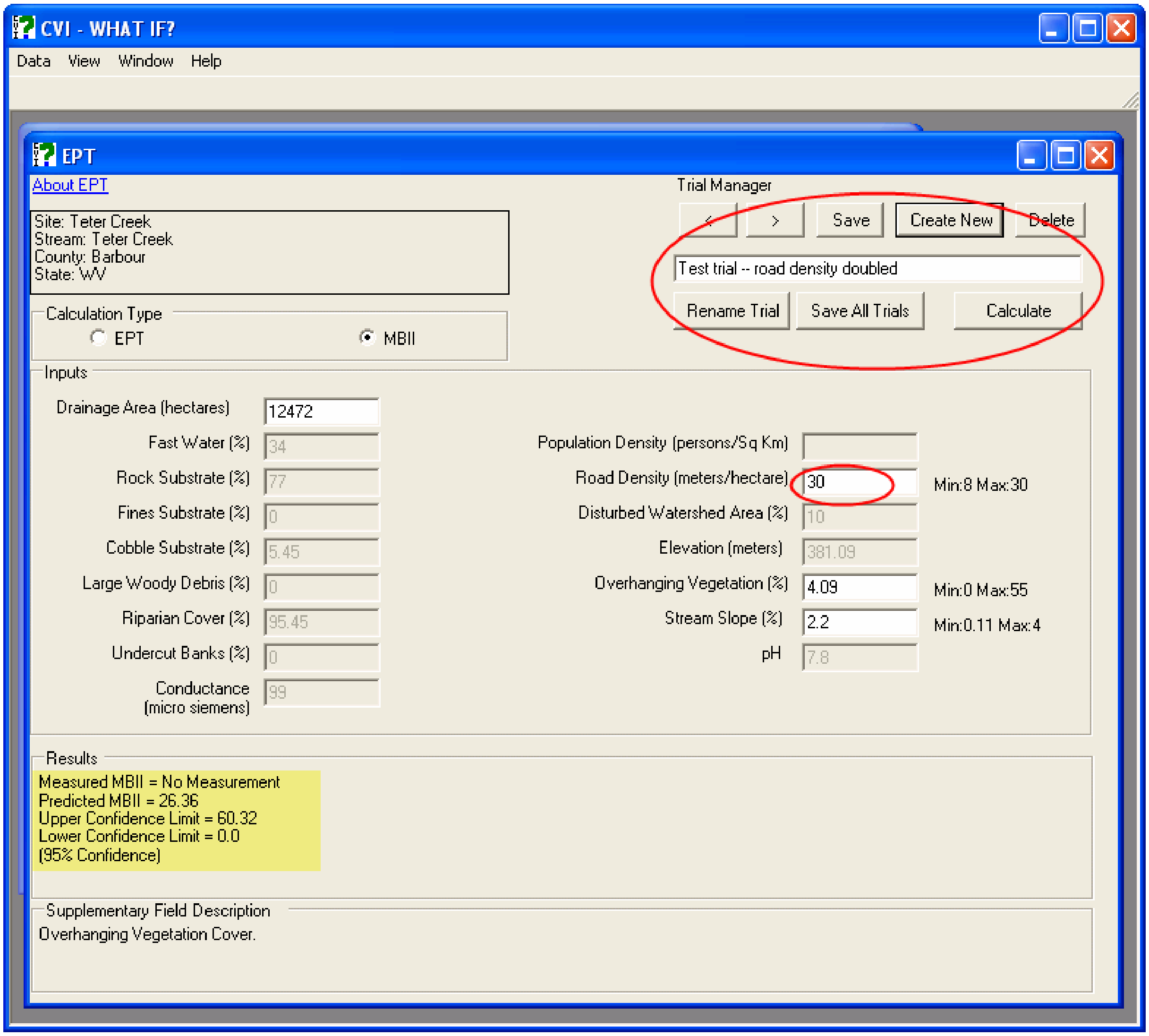
Inputs

Drainage Area (hectares)	12472			
Fast Water (%)	34	Population Density (persons/Sq Km)		
Rock Substrate (%)	77	Road Density (meters/hectare)	15.28	Min:8 Max:30
Fines Substrate (%)	0	Disturbed Watershed Area (%)	10	
Cobble Substrate (%)	5.45	Elevation (meters)	381.09	
Large Woody Debris (%)	0	Overhanging Vegetation (%)	4.09	Min:0 Max:55
Riparian Cover (%)	95.45	Stream Slope (%)	2.2	Min:0.11 Max:4
Undercut Banks (%)	0	pH	7.8	
Conductance (micro siemens)	99			

Results
Measured MBII = No Measurement
Predicted MBII = 58.6
Upper Confidence Limit = 90.7
Lower Confidence Limit = 0.0
(95% Confidence)

Supplementary Field Description
Fish cover consisting of rocks and boulders. Percent of habitat that is made up of boulders. Boulders' size is greater than 256mm.

Figure 4-13 MBII calculator with trial selected.



Site: Teter Creek
Stream: Teter Creek
County: Barbour
State: WV

Calculation Type

○ EPT ● MBII

Test trial -- road density doubled

Inputs

Drainage Area (hectares)	12472			
Fast Water (%)	34	Population Density (persons/Sq Km)		
Rock Substrate (%)	77	Road Density (meters/hectare)	30	Min:8 Max:30
Fines Substrate (%)	0	Disturbed Watershed Area (%)	10	
Cobble Substrate (%)	5.45	Elevation (meters)	381.09	
Large Woody Debris (%)	0	Overhanging Vegetation (%)	4.09	Min:0 Max:55
Riparian Cover (%)	95.45	Stream Slope (%)	2.2	Min:0.11 Max:4
Undercut Banks (%)	0	pH	7.8	
Conductance (micro siemens)	99			

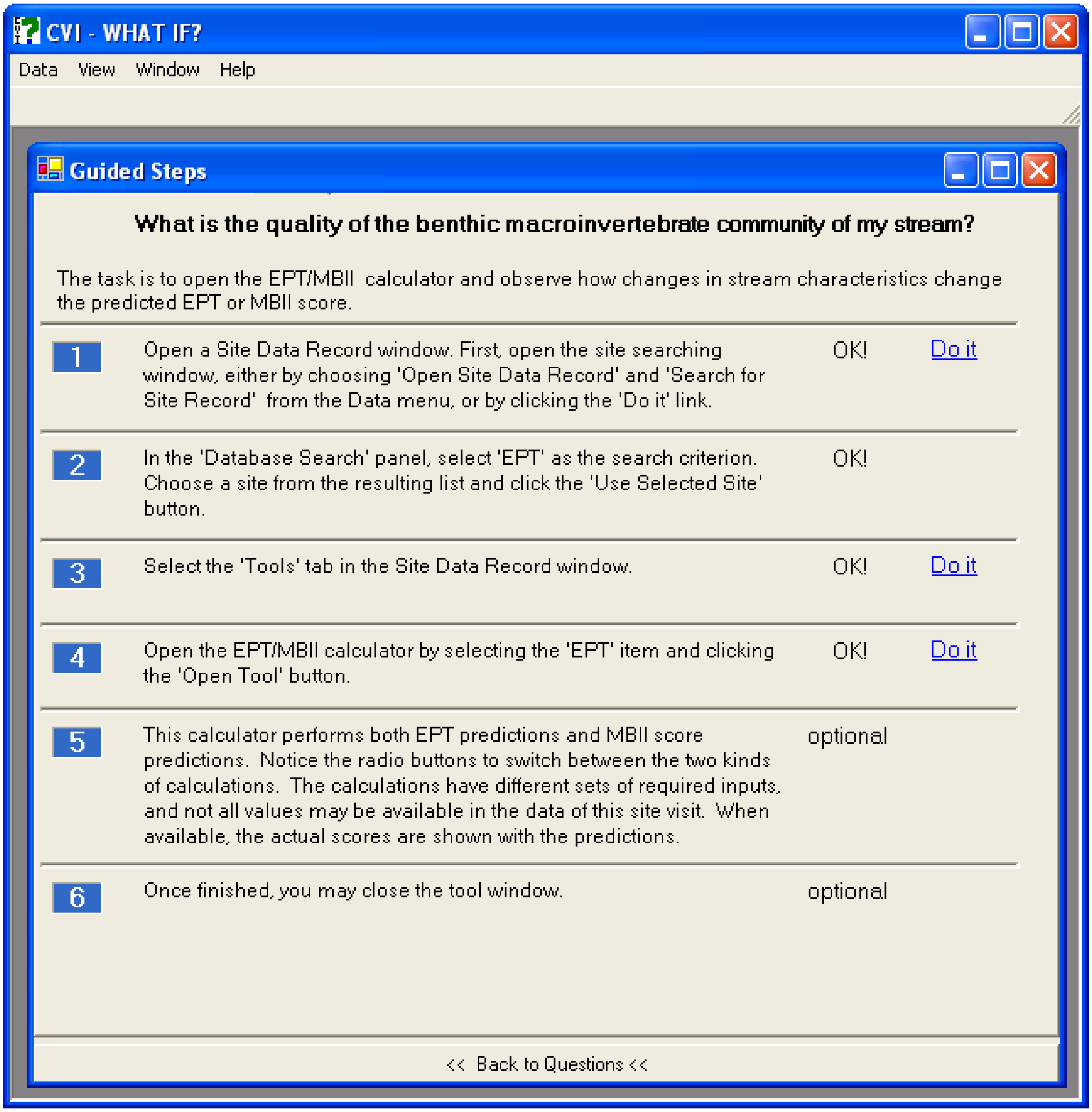
Results

Measured MBII = No Measurement
Predicted MBII = 26.36
Upper Confidence Limit = 60.32
Lower Confidence Limit = 0.0
(95% Confidence)

Supplementary Field Description

Overhanging Vegetation Cover.

Figure 4-14 Benthic tool wizard showing completion of all steps.



What is the quality of the benthic macroinvertebrate community of my stream?

The task is to open the EPT/MBII calculator and observe how changes in stream characteristics change the predicted EPT or MBII score.

1	Open a Site Data Record window. First, open the site searching window, either by choosing 'Open Site Data Record' and 'Search for Site Record' from the Data menu, or by clicking the 'Do it' link.	OK!	Do it
2	In the 'Database Search' panel, select 'EPT' as the search criterion. Choose a site from the resulting list and click the 'Use Selected Site' button.	OK!	
3	Select the 'Tools' tab in the Site Data Record window.	OK!	Do it
4	Open the EPT/MBII calculator by selecting the 'EPT' item and clicking the 'Open Tool' button.	OK!	Do it
5	This calculator performs both EPT predictions and MBII score predictions. Notice the radio buttons to switch between the two kinds of calculations. The calculations have different sets of required inputs, and not all values may be available in the data of this site visit. When available, the actual scores are shown with the predictions.	optional	
6	Once finished, you may close the tool window.	optional	

References

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Rashleigh, B., M.C. Barber, M.J. Cyterski, J.M. Johnston, Y. Mohamoud, and R. Parmar. 2004. Population models for stream fish response to habitat and hydrologic alteration: the CVI Watershed Tool. EPA/600/R-04/190, U.S. Environmental Protection Agency, Athens, Georgia.

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USFWS. 1981. Standards for the development of habitat suitability index models for use in the Habitat Evaluation Procedures. U.S. Department of Interior, Fish and Wildlife Service, Division of Ecological Services. ESM 103.

Appendix A
Appendix B Overview

WHAT IF is software that integrates a number of calculators and tools for assessing the health of watersheds and streams with an emphasis on fish communities. The software is built upon a database of stream measurements that provides the inputs to the various WHAT IF calculators and tools. These calculators and tools vary in complexity, ranging from regression-based predictions to comprehensive fish population simulation model, the Bioaccumulation and Aquatic System Simulator (BASS).

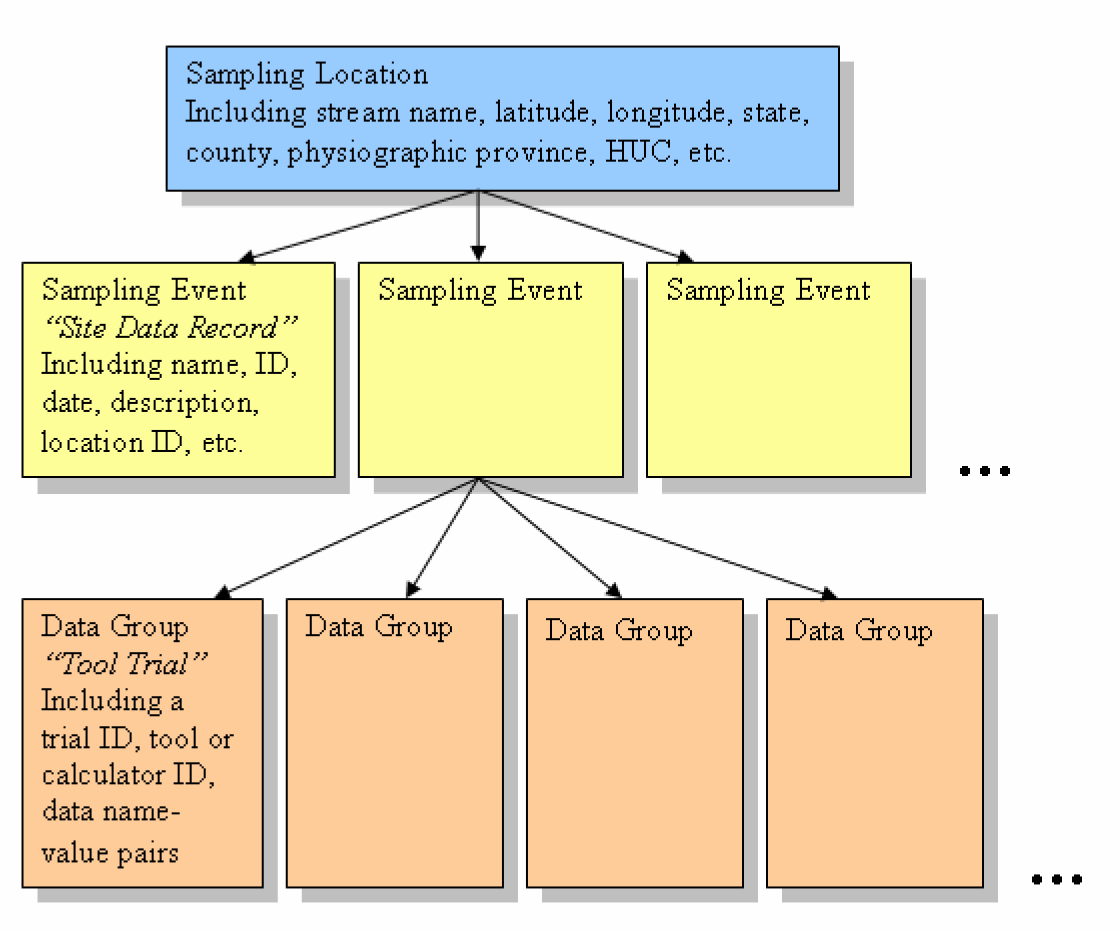
The software allows the user to investigate a location on a stream or river by examining the data that have been collected at the location, and then using that data with the calculator's tools to compare actual conditions with predicted or possible conditions.

For example, the Species Cluster tool might predict that a stream in this location would likely support a trout population, while the data show that no trout have been observed. Then, the Habitat Suitability calculator could be used to examine the scores for trout to see if an explanation can be found for this observation in the current stream conditions. The user could then explore what changes could be made to the stream, such as increased overhanging vegetation or erosion control, to allow trout to thrive. Finally, trout could be "stocked" in the simulation model to see if they persist and how other species are affected.

All of the data, both original observations and user-generated experimental data, are stored in the central database that allows access by any WHAT IF tool or calculator. Thus, the output of one tool can become the input to another; this feature is exploited by some WHAT IF calculators and tools for certain kinds of data.

Figure A1 illustrates a simplified view of the central database. Each stream sampling site contains information related to its geographic location. A location can also be referenced by one or more sampling events; these represent multiple visits to a site for data collection. Each sampling event, in turn, has one or many data groups. A data group is a set of data associated with a particular tool, calculator, or category. The original field data for a site constitutes one of the data groups. A data group can contain inputs and outputs related to a WHAT IF calculator or tool. For THE BASS simulation model, the data group includes the model's input files and can include graphs generated from model output.

Figure A.1 A simplified view of the WHAT IF database of stream site data. A location can have one or more sampling events, and a sampling event one or more groups of data values.


Sampling Location
Including stream name, latitude, longitude, state, county, physiographic province, HUC, etc.
Sampling Event
"Site Data Record"
Including name, ID, date, description, location ID, etc.
Sampling Event
Sampling Event
...
Data Group
"Tool Trial"
Including a trial ID, tool or calculator ID, data name-value pairs
Data Group
Data Group
Data Group
...

In a WHAT IF application, the sampling event is referred to as a *Site Data Record*, and the data group is called a *Tool Trial*, or simply *Trial*. The following table contains the current number of Trials based on data grouping. EMAP and WVREMAP are the site observations for the 797 sites.

Table 1 Calculators and their respective trial counts.

Calculator, Tool, or Category of Data	Number of Trials
BASS model	476
Clustering [abundance]	607
Clustering [biomass]	609
EMAP	669
EPT	723
Habitat Suitability	605
Hydrology	540
Hydrology [bankfull]	434
WVREMAP	128

Appendix C

Appendix D How WHAT IF Works

There are a set of tutorial questions to guide the user through the process of using WHAT IF. The window of questions opens when the software is started.

Generally, one starts by searching for a stream site of interest, then opening one of its Site Data Records. In the window of the Site Data Record, some of the site's data are displayed in the various window tabs. The Tools tab shows the relevant calculators and tools, and the Trials that are associated with them. If a tool or calculator has a Trial pre-made, it is called the *base trial.* A base trial has been created for any site for which the tool is applicable, and the site had sufficient data to use as inputs to the tool or calculator. However, a user can still open a calculator/tool and supply inputs with which to experiment, even if no base trial has been created. If the calculator/tool does not support the current site, it will inform you and you can try another site. Usually, when a calculator does not support a site it is due to some characteristic of the site that is outside the bounds of the acceptable inputs.

To experiment with a site, the user first chooses "Save Site Data Record As…" from the Data menu. Doing this will create a complete copy of the data associated with this Site Data Record, but not the location information, that other data records may share. With this data copy the user can create new Trials for the different calculators and examine different scenarios for the stream. All data created as Trials are saved to the database.

Links to help files near the top of the calculator windows or the Help menu can be used to find documents that describe the theory and science behind the tools/calculators.

Appendix E Software Architecture

A.3.1 Development tools

Microsoft Visual Studio .NET 2003 is used to compile and build an application. MySQL 4.1.x isused to build the database and it is also the server used at runtime. The .NET libraries are used for XML parsing and transformations. Visual SourceSafe is used to manage source files. The MySQL Connector/NET from MySQL AB is used as the database driver.

A.3.2 Language and Components

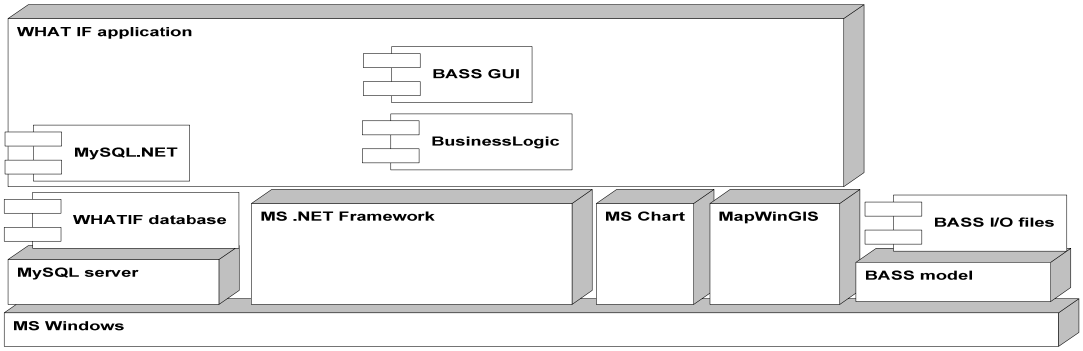
WHAT IF consists primarily of C#.NET source code. It uses several XML files for externalized information such as SQL, configuration strings, and other text data. See Appendix B for a list of external files. It uses SQL statements for database access, and the XML Stylesheet Language (XSL) for transformations of XML data to text or other XML data formats.

In addition, the following components are included in WHAT IF:

1. The BASS model GUI
   The GUI for the BASS model was built as a separate application using C#.NET. The code has been integrated into WHAT IF, unchanged, by sharing sources between the BASS GUI standalone and WHAT IF. Parts of the BASS GUI—editor windows for game fish stocking and chemical exposures—appear in the WHAT IF user interface. It is possible to switch modes and go into the full BASS GUI while running WHAT IF.
2. MS Chart control
   This COM control is used to draw plots of BASS model output.
3. MapWinGIS ActiveX control 3.x
   This open source (Mozilla Public License 1.1), COM control renders ESRI shapefile formatted data, among other formats, and draws maps that respond to mouse events. Along with a map legend COM control, it enables the site searching dialog to allow site selection by spatial characteristics. See http://www.mapwindow.org
4. MySQL Connector/Net 1.0.4 from MySQL AB
   This is an open source (Lesser General Public License), .NET native data provider to interface with the MySQL database server. See http://sourceforge.net/projects/mysqlnet
5. CVIDatabaseConnector
   A DLL created from a C#.NET project outside of the WHAT IF solution to manage database connectivity.

6. BusinessLogic DLL
   This library contains the functions that implement the scientific algorithms and equations behind the various calculators. It is shared with the Web-based version of WHAT IF.

Figure A.2 Overall component organization



A.3.3 Organization of code

Overall, the C#.NET source code can be divided into two sections: the BASS GUI support code and the WHAT IF application code. The former consists of the following components:

- BASS_22_GUI_code
- BASS_Controller
- BASS_FORM_LIBRARY
- BASS_Interfaces
- BASS_IO
- BASSPlotFish
- DOM_Manager

The remainder of the components are part of the WHAT IF application:

- CVI_App
- CVI_DataManagers
- CVI_GUI
- CVI_Interfaces
- CVI_Middleware
- GroverUtilities
- MapWinManager
- StepByStepCntl

Two other components handle installation tasks, for a total of 17. In general, the component name is the same as the Namespace of the classes it.

To help the user become oriented towards which parts of the code are responsible for which tasks, we will briefly describe each component in turn. Further details can be found in the source code itself, and in the HTML documentation generated from the source.

A.3.3.1 BASS_22_GUI_code

This component contains support code for the BASS GUI. The BASS model accepts many different kinds of commands, and each type has an editor. The large number of classes in this component reflects the different BASS commands and related support code.

A.3.3.2 BASS_Controller

The BASS model works on a messaging system. Events from the GUI are turned into messages and the messages are broadcast to all registered components. Components check to see if they are the receiver, and if so, will respond to the message. This component contains the class that brokers this communication, as well as classes to log errors and run the model.

A.3.3.3 BASS_FORM_LIBRARY

The forms of the BASS GUI are contained in this component. Form inheritance is used in many cases.

A.3.3.4 BASS_Interfaces

This component is USED (imported) by several others. It has interfaces to facilitate communication among components and avoid circular referencing. It includes a class of static common variables. In addition, it has the BASS message class and related classes.

A.3.3.5 BASS_IO

Classes in this component handle BASS file input and output. This task involves bi-directional converting between the BASS input file text format and the internal XML representation of the BASS inputs. XML to text is handled with an XSL transformation. Text to XML is performed in two stages: parsing of the text to XML, followed by an XSLT transformation to another, more rigorous XML format. There are several different BASS file formats and command formats.

A.3.3.6 BASSPlotFish

There are forms and classes in this component to plot BASS output. The output file is a large XML document. Code in this component reads and transforms the XML, which is then read into a DataSet for extracting arrays for plotting.

A.3.3.7 DOM_Manager

The BASS input files exist in a pre-defined directory structure called the BASS root. The BASS root directory and all sub-directories are read into an XML Document Object Model (DOM). Edits are made to this structure. When saving, a node is extracted to write as a file.

A.3.3.8 CVI_App

This component is the entry point for the application.

A.3.3.9 CVI_DataManagers

There is a large class that handles connecting to the database (using CVIDatabaseConnector.DLL), submitting SQL statements, and packaging result sets into DataTables. All but a few SQL statements are stored in SQL.resx.

A.3.3.10 CVI_GUI

The forms for the WHAT IF GUI are here, along with some logic for the help steps and other support files. Form inheritance is used for the calculators.

A.3.3.11 CVI_Interfaces

Most of this component consists of interfaces to allow indirect access to classes and methods across components. A few classes requiring visibility are found here along with static global variables and custom exception classes.

A.3.3.12 CVI_Middleware

The classes within this component are concerned with interfacing to the BASS GUI and preparing and running the BASS model. To run the BASS model, some input files are exported from the database, where they are stored as XML, and transformed to their text form. Other BASS files are created from stream data or trial data in preparation for the model run. These files are written to a temporary directory from which the model is run.

A.3.3.13 GroverUtilities

Classes here manage the MRU (recent menu items lists) functionality.

A.3.3.14 MapWinManager

This component handles all of the functions associated with the MapWinGIS control and the MapLegend control. Communication from this component to the SiteSearcherPicker class occurs via a simple interface—IgisHost. The SiteSearcherPicker class accesses a single public class, MWManagerPublic, in this component.

A.3.3.15 StepByStepCntl

This component defines a custom control that is used as a step panel in the guided steps window. The step control contains some of the logic of the guided steps function.

A.4. Database description

A.4.1 Overview

For the purposes of the WHAT IF toolset software, a stream site is considered to be the collection of data necessary to describe the physical, biological, and spatial coordinates and boundaries of an actual stream reach, along with the data produced and consumed by the tools of the application. Except for tool configuration parameters, all of the data used by the application are read and written to the stream site database, and are associated with a particular site. A major tool of the software toolset is the BASS model, version 2.2. BASS input files are required to parameterize the model for a particular body of water; these files, if present, are stored in the database.

CSC’s goal in database design was to create a flexible and comprehensive database schema. CSC anticipates that needs will change, and as a result tried to minimize any assumptions about the data. For example, rather than create a table with columns that represent the data values of a particular tool,   generic tables that hold all data for all tools were created. The definitions of the data are stored as rows in another table and can be easily extended to include new data types.

At the time of this writing, WHAT IF version 2.0 uses MySQL version 4.1.11. That does not use transactions or stored procedures. All tables are of type MYISAM.

The database of WHAT IF (designated cvi_wif_1, but referred-to in this document as the WHAT IF database) is described next in terms of its tables, relationships, limitations, and example queries.

The database comprises 24 tables, summarized and described next:

Table 2 CVI database tables and their descriptions.

Table	**Description**
bass_file	Stores BASS model files in XML form.
bass_plot	Stores graphical output as base64-encoded binary data
Bmp	Holds the name of a Best Management Practice type
bmp_adjust	Holds adjustment parameter(s) and direction for a given BMP type
Cluster	Defines a cluster in terms of a number and a name.
cluster_filter_6	Defines fish species allowed in a given 6 digit HUC, and used to filter results in the Clustering tools.
cvi_tool	Defines tools or calculators, or, more broadly, “categories” of data associated with a stream site.
fish_species	Defines fish in terms of common name, scientific name, and name used by BASS. Note that some records define groups, unknown species of some genus, and hybrids.
Physiographic	Defines physiographic code, province, and section.
sp_cluster	Holds a list of fish for the cluster number along with the predicted abundance.

Table	**Description**
sp_datum_property	Links fish_species to trial_datum to define which fields are required by species, and also provides some fields for storing species-specific parameters; currently for HSS, but could be used for other tools as well. (This is no longer in use with the new HSI calculator)
sp_group	Defines species into groups for HSS
ss_aux_att	Stores auxiliary attributes for a site; data for which a field doesn't exist.
ss_bass_file	Link table between streamsite and bass_file for many-to-many relationship.
ss_fish	Link table between streamsite and fish_species for many-to-many relationship. The site's actual community.
ss_geopol	Stores geo-political data, e.g. state, county, physiographic code. Sites can share records in this table.
ss_loc	Currently stores latitude and longitude. Could be replaced with spatially enabled tables in the future.
ss_source_huc	Stores HUC ID's matched to geopol ID's.
ss_source_site	Stores stream site ID's with foreign ID's, ie, identifiers used in various source material such as EMAP site ID's.
Streamsite	The main site table. Stores the site name, author, last modified date, description, and other metadata.
tool_property	Stores tool configuration parameters.
tool_trial	A row defines a trial for a tool. A trial is a named set of inputs and outputs.
trial_data	The inputs and outputs for the tools' trials.
trial_datum	Defines an input or output of a tool.

The 24 tables of the WHAT IF database can also be categorized into three types: static property data, stream site data, and location information. The static properties data tables define tool-related items such as species, clusters, and tool input definitions. The stream site data tables store data that can be manipulated, such as site observations, model files, and other tool and calculator inputs. The location information tables store the geographic coordinates, geopolitical boundaries, and related information for a stream. Location data may link to multiple site sampling events, and is normally not edited. The following table shows the WHAT IF database tables in each of these three categories.

Table 3 CVI database tables by category.

Table	**Category**
bmp	Static data
bmp_adjust	Static data
cluster	Static data
cluster_filter_6	Static data
cvi_tool	Static data
fish_species	Static data
physiographic	Static data
sp_cluster	Static data
sp_datum_property	Static data
sp_group	Static data
tool_property	Static data
trial_datum	Static data
bass_file	Site data
bass_plot	Site data
ss_aux_att	Site data
ss_bass_file	Site data
ss_fish	Site data
ss_source_site	Site data
streamsite	Site data
tool_trial	Site data
trial_data	Site data
ss_geopol	Location data
ss_loc	Location data
ss_source_huc	Location data

See Appendix B for the complete database schema.

Data Limitations

The number of sites possible is large; ID’s on most tables allow millions to billions of records.

Some field sizes and other limitations are listed below:

Table 4 Important data fields and their sizes and/or values.

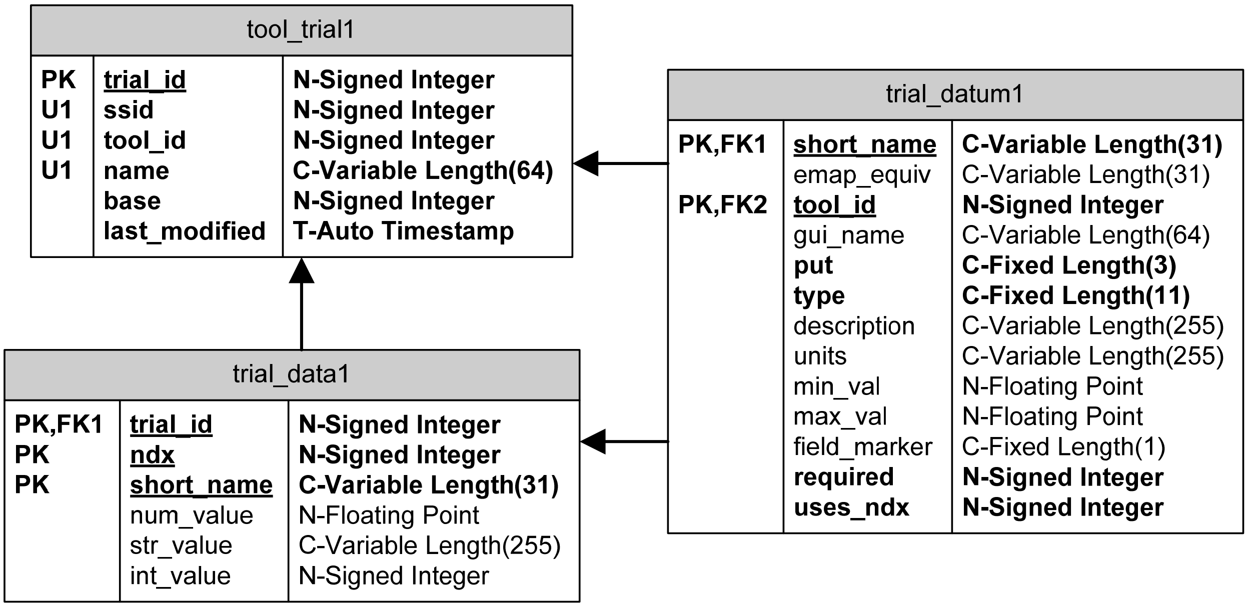
streamsite name, src_emap, src_hydro, src_bio	255 characters each
streamsite description	64,000 characters
ss_geopol county, physiographic province & section	64 characters each
ss_geopol stream_name	255 characters
ss_geopol state	2 characters
species com, sci, and bass names	255 characters each
cvi_tool name and version	32 and 10 characters
BASS file name	255 characters
BASS file size	64,000 characters
Graphical output binary	16 MB
HUC ID	20 decimal digits
Character based attribute or tool datum	255 characters
streamsite game, impacted, readonly; tool_trial.base	True or false
Number of clusters per trial, number of species used per trial, number of months per datum per trial	256
Values for streamsite.author	‘CVI’, ‘EPA’, ‘USER’
Values for trial_datum.put	‘in’, ‘out’
Values for trial_datum.type	'number', 'integer', 'string', 'sp_id', 'cluster_num', 'bmp', 'switch', 'feedback', 'periodic', 'list'

A.4.1.1 SQL statements and templates

In order to provide some guidance in using the WHAT IF database, sample SQL queries are provided here to use as tests or templates by the user. The user may want to examine the file SQL.resx from the source code for more SQL statements.

With some exceptions, data for a stream sampling event (known as a Site Data Record in the GUI) are stored in the trial_data table and are associated with a specific Trial. Exceptions include general stream site descriptions (streamsite table), fish communities (ss_fish), BASS input files (bass_file), and BASS plots (bass_plot). To retrieve the value of a particular stream variable for a particular Site Data Record, one needs to link/join, at a minimum, tool_trial, trial_data, and trial_datum, to specify the site, tool category, and variable name. The user can link/join tool_trial to trial_data using trial_id; trial_datum to tool_trial using the tool_id; and trial_datum to trial_data using the short_name. After supplying the ssid and tool_id values, and the user can then read the num_value, int_value, or str_value field of trial_data, depending on the value of trial_datum's type field.

Figure A. 3 WHAT-IF Database tables illustrating the relationships for an example SQL query.



tool_trial1		
PK	**trial_id**	**N-Signed Integer**
U1	**ssid**	**N-Signed Integer**
U1	**tool_id**	**N-Signed Integer**
U1	**name**	**C-Variable Length(64)**
	base	**N-Signed Integer**
	last_modified	**T-Auto Timestamp**

trial_datum1		
PK,FK1	**short_name**	**C-Variable Length(31)**
	emap_equiv	C-Variable Length(31)
PK,FK2	**tool_id**	**N-Signed Integer**
	gui_name	C-Variable Length(64)
	put	**C-Fixed Length(3)**
	type	**C-Fixed Length(11)**
	description	C-Variable Length(255)
	units	C-Variable Length(255)
	min_val	N-Floating Point
	max_val	N-Floating Point
	field_marker	C-Fixed Length(1)
	required	**N-Signed Integer**
	uses_ndx	**N-Signed Integer**

trial_data1		
PK,FK1	**trial_id**	**N-Signed Integer**
PK	**ndx**	**N-Signed Integer**
PK	**short_name**	**C-Variable Length(31)**
	num_value	N-Floating Point
	str_value	C-Variable Length(255)
	int_value	N-Signed Integer

This example retrieves pH:

```
select def.description, dat.num_value as "value"
from tool_trial "tri" join trial_data "dat" using(trial_id)
join  trial_datum def using(short_name)
 where  tri.tool_id = def.tool_id
 and def.short_name = 'phstvl'
 and tri.ssid = 123
 and def.tool_id in (select tool_id from cvi_tool where version =
'original');
```

The sub-select will return all of the tool_ids associated with original data (EMAP, WVREMAP, etc.) but only one will be in use by the given site.

To retrieve multiple values, the tool_trial and trial_data (and possibly trial_datum) tables need to be joined for each variable, as in this example:

```
select site.source_site , ss.name, g.state, g.county, didat.num_value as
DI,  eptdat.num_value as EPT, mbidat.num_value as MBII,
lo.latitude_dd,and lo.longitude_dd from streamsite ss; join ss_geopol g
using(geopol_id) join ss_loc lo on ( lo.loc_id = g.loc_id);
join ss_source_site site on (ss.ssid = site.ssid);
left join tool_trial di on (di.ssid = ss.ssid and di.tool_id = 11);
left join trial_data didat on( di.trial_id = didat.trial_id);
left join tool_trial ept on (ept.ssid = ss.ssid and ept.tool_id = 14 )
left join trial_data eptdat on( ept.trial_id = eptdat.trial_id and
eptdat.short_name = 'ept_ptax');
left join tool_trial mbi on (mbi.ssid = ss.ssid and mbi.tool_id = 14);
left join trial_data mbidat on( mbi.trial_id = mbidat.trial_id and
mbidat.short_name = 'MBII_score');
having not ( DI is null and EPT is null and MBII is null);
```

For tool_id 11, only one short_name exists and so it was not needed. The ‘having’ clause simply eliminates rows for which none of the selected values existed.

Each record in trial_data should have a value. Here is a check on trial data (should return 0):

```
select count(dat.short_name)from trial_data dat; join tool_trial tri
using(trial_id);
join  trial_datum def on(dat.short_name=def.short_name and tri.tool_id =
def.tool_id)
where ( (def.type='number' and dat.num_value is  null)
 or (def.type='string' and dat.str_value is  null)
 or (def.type='integer' and dat.int_value is  null)
 or (def.type='sp_id' and dat.int_value is  null)
 or (def.type='cluster_num' and dat.int_value is  null));
```

Which locations have the most site visits?

```
select g.geopol_id, g.stream_name, count(ss.ssid) as visits
from streamsite ss; join ss_geopol g using(geopol_id)
group by geopol_id
having visits = (select count(ss.ssid) as visitNum
from streamsite ss join ss_geopol g using(geopol_id)
group by g.geopol_id
order by visitNum desc limit 1);
```

This statement will perform a dump of the trial data for the given site.

```
select tool.name as 'Tool-Calculator', def.description,
if( dat.num_value is not null, dat.num_value,if(dat.str_value is not
null, dat.str_value,dat.int_value)) as value,
 dat.ndx as 'index', def.units
from streamsite ss; join tool_trial tri using(ssid);
join trial_data dat using(trial_id);
join trial_datum def on( def.short_name = dat.short_name and def.tool_id
= tri.tool_id);
join cvi_tool tool on ( tool.tool_id = def.tool_id )
where ss.ssid = 6;
order by tool.name, def.description, dat.ndx;
```

A.4.1.2 Loading a table from a text file

Use the LOAD DATA INFILE command to batch load tables from text files. The MySQL manual, http://dev.mysql.com/doc/refman/4.1/en/ details its use, but here are some tips.

The defaults are tab delimited fields, one record per line, no delimiters around the field values. It looks for files in the database's directory if no path is specified. Therefore, the simplest form is:

LOAD DATA INFILE 'new_recs.txt' INTO TABLE someTable;

The file should have all fields in order, separated by the tab character. Be aware that Excel may add quotes around fields that contain a comma, and these quotes will become part of the data.

Enter null values using \N in the field. A caveat is that if the last field in a line is given \N, it seems to miss that field (perhaps confusing the \N null with the \n newline) and that field takes on its default value (which may not be null, of course). The workaround is to have a trailing tab on each line.

The LOAD DATA INFILE command has options for

1. REPLACing records that have matching keys,
2. changing the field delimiter,
3. indicating that fields may be [OPTIONALLY] enclosed in a specified character,
4. skipping lines,
5. and skipping over leading text on each line.

There is also a reciprocal SELECT ... OUTFILE command.

It is important to check the table after an import to look for errors.

When using Excel to create a file for importing, it is sometimes necessary to enter, say, ID’s of fish species. To do this, first SELECT com_name, sp_id FROM fish_species order by com_name. Then copy this whole table into your Excel workbook. Finally, use Excel’s VLOOKUP function to look up the com_name and return the ID into the cell where it is needed. The range you are doing lookups on can be given a defined name to make it easier to use the function.

A.4.1.3 Copying a site

Stream sites that are loaded into the database probably will be marked as ‘readonly’, and the user will have to first make a copy before any editing is allowed.

Records in the following tables will be copied to create a user-editable site:

streamsite (1)(change fields ‘readonly’ and ‘author’; new ssid generated, keep old geopol_id; add old ssid to src_ssid),
ss_source_site (0..*)(change ssid)
ss_aux_att (0..*)(change ssid),
src_fish (0..*)(change ssid),
tool_trial (0..*) (change ssid, new trial_id generated),
trial_data(0..*)(change trial_id),
bass_plot(0..*)(change trial_id),
bass_file(0..*)(new file_id generated);
new records created in ss_bass_file(0..*)(set ssid, file_id).
ss_geopol, ss_loc, ss_source_huc, share the geopol record with the original.

A.5 Modifying WHAT IF 2.0

This section is intended for software developers who wish to build new calculators or tools to extend the functionality of WHAT IF. This section will explain the data architecture, the concept of trials, and a step-by-step example for creating a new calculator.

Readers of this section will benefit from some understanding of C#, Microsoft .Net development concepts, database technology (SQL and relational databases), and XML. To do software development, users must have the following software installed:

- The Microsoft .Net framework v. 1.1.

- A C# IDE. Ideally, Visual Studio 2003. However, any C# IDE, such as SharpDevelop or Eclipse (with the appropriate plug-ins), will work.
- MySQL 4.1

Developers will want to use a WHAT IF application to increase familiarity with WHAT IF operations.

We will explain how to create a simple calculator that adds two numbers. It's a bit more than 'Hello World', but this document's objective is not to create a brilliant calculator for WHAT IF, but to explain the mechanics behind creating a tool that can extend and add to WHAT IF applications.

Each calculator is unique. Methods shown here are not comprehensive. The methods that are overridden in the following example will most likely be overridden in each calculator's code; however, additional methods may need further customization to meet requirements.

A.5.1 Terms

The following are terms used frequently in WHAT IF:

- **Calculator** – a GUI that takes input, typically numbers and character strings, and uses the WHAT IF BusinessLogic to compute a result that is returned to the user. Calculators typically interact with the back end database to draw inputs and outputs; however, it is not necessary for all calculators to get their inputs from the database. Specific calculators are subclasses of class Calculator.
- **Tool** – a GUI that either takes input and stores it in a database for use with another application or displays data in a database. Specific tools, such as the GraphicalOutputTool, are subclasses of ToolBase.
- **Trial** – a set of inputs and outputs for a specific calculation in a specific calculator associated with an individual site.

A.6 Data

The information in the section on the WHAT IF database will be very helpful in understanding the operations outlined in this section.

When creating a new streamsite (directly inserted into the database, not created by the user in WHAT IF), it is best to set the read-only value to 1 (true). Marking initial sites read-only helps maintain data integrity, since WHAT IF users can do a "Save As" and create their own trial sites; in this way users cannot change developer entered data. Trials that are created by a developer and marked read-only are commonly referred to as 'base trials'. In the tool_trial table, a base trial's name field should be blank. The 'base' integer field should contain a 1.

Assuming that the streamsite data in the database is satisfactory, one is ready to extend the data to support a new calculator. To do this, follow the nest steps:

1. Define a calculator in the cvi_tool table.
   a. This step involves assigning an id, name, and version number to the tool.
   b. Example:

      ```
      INSERT INTO cvi_tool(tool_id,version, name) VALUES (16,
      '1.0', 'My Calculator');
      ```

      (The tool_id is just the next number in the series.)

2. Define inputs for the calculator in the trial_datum.

Table 5 Descriptions of the different columns in trial datum. Note: only the most relevant columns are covered here.

Column	Definition	Example
short_name	The name of an input or output for a calculator.	Xdepth
emap_equiv	The EMAP equivalent of the variable.	
GUI_name	A name displayed in the GUI (not as cryptic as the abbreviation used in the short_name)	Thalweg Mean Depth
put	Indicates whether input or output	in
tool_id	Relates the trial_datum table to the cvi_tool table.	
type	The type of the data. A developer has a lot of freedom with this field (see cluster_num).	string, double, integer, cluster_num.

required	If an input should not be null in the trial_data table, the trial_datum record should contain a 1, otherwise it should contain a 0.	
uses_ndx	Some inputs may be multidimensional (such as tabular data). If this trial_datum is such, its record should contain a 1, otherwise it should contain a 0.	

Example Code

```
Insert into trial_datum
(short_name, tool_id,gui_name,put,type,description,required,uses_ndx)
values
('firstvalue',16,'First Value','in','number','First value used in
calculating a sum',1,0);

Insert into trial_datum
(short_name, tool_id,gui_name,put,type,description,required,uses_ndx)
values
('secondvalue',16,'Second Value','in','number','Second value used in
calculating a sum',1,0);

Insert into trial_datum (short_name,
tool_id,gui_name,put,type,description,required,uses_ndx) values
('mc_result',16,'Result','out','number','My Calculator Result',1,0);
```

3. Create base trials.
   a. Do not name the trials. Leave the name field blank, but set the base field to 1.
   b. Put the data for each trial in the trial_data table.
      i. Use the corresponding trial_id in the tool_trial table as a foreign key in the trial_data table.

4. Link streamsites to trials and calculators by assigning streamsite id numbers (ssid's) to trial records.

   Example Code

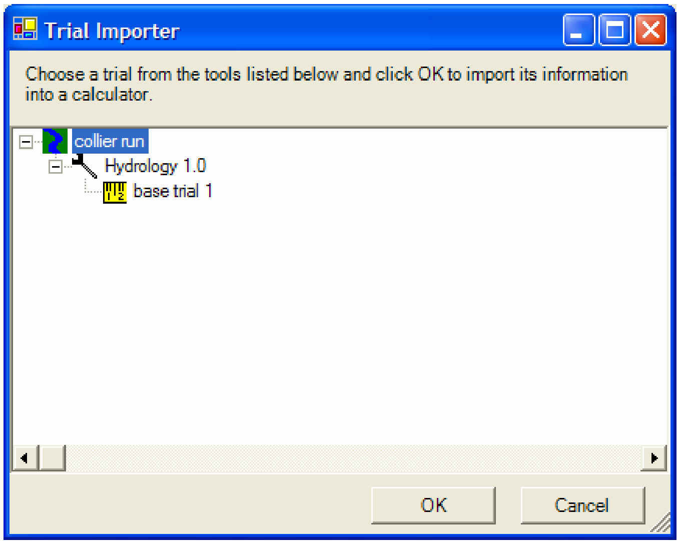
```
insert into tool_trial (ssid, tool_id,base) values (782,16,1);

insert into trial_data (trial_id, ndx,short_name,num_value)
values(3616,0,'firstvalue',23.2);
insert into trial_data (trial_id, ndx,short_name,num_value)
values(3616,0,'secondvalue',16.8);
insert into trial_data (trial_id, ndx,short_name,num_value)
values(3616,0,'mc_result',50.0);
```

A.7 Trials

The previous section contained instructions for loading data into trial_datum, trial_data, and tool_trial tables. Trial data are information about the inputs and outputs of each calculator or tool defined in WHAT IF. Each trial has a name (unless it's a base trial) and a unique trial ID number (trial_id). The concept of a trial in WHAT IF is critical because trials allow the user/developer to organize information into individual instances. This includes information that enters into a calculator and information that results from use of a calculator. Other tools or applications can retrieve this data from the database, thus allowing calculators to share information.

For example, the Cluster Biomass calculator takes stream depth as an input. The hydrology calculator calculates stream depth. The Cluster Biomass GUI includes a button that lets the user retrieve the stream depth value from a calculation performed by the hydrology calculator in order to estimate the stream depth. Figure A.4 and Figure A.5 show how a calculator/tool can import values/data from another WHAT IF calculator/tool.

Figure A. 4 Trial Importer allows the calculator to choose which inputs to import.

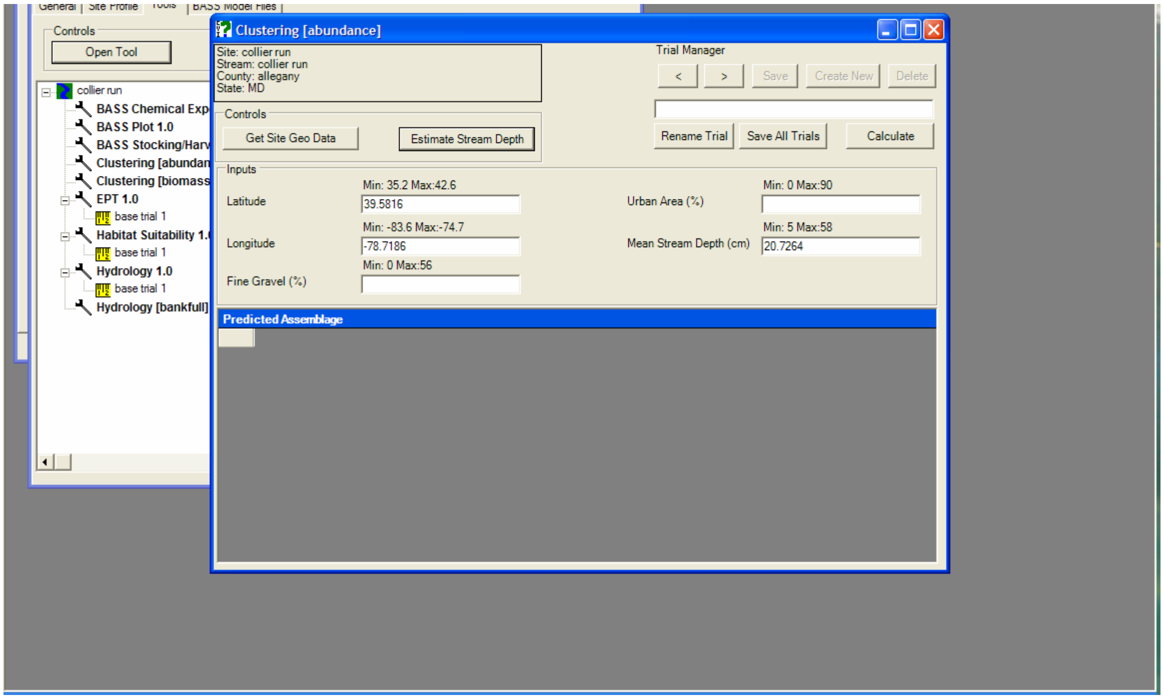


Trial Importer

Choose a trial from the tools listed below and click OK to import its information into a calculator.

- collier run
  - Hydrology 1.0
    - base trial 1

Figure A. 5 The calculator has successfully imported the stream depth figure from the Hydrology calculator.



Clustering [abundance]

Site: collier run
Stream: collier run
County: allegany
State: MD

Inputs

Latitude: Min: 35.2 Max:42.6 — 39.5816

Longitude: Min: -83.6 Max:-74.7 — -78.7186

Fine Gravel (%): Min: 0 Max:56

Urban Area (%): Min: 0 Max:90

Mean Stream Depth (cm): Min: 5 Max:58 — 20.7264

A.8 Creating Calculators and Tools

A.8.1 Trial Manager

Once you have prepared the data for a tool or calculator, you are ready to begin extending WHAT IF to create the UI. Calculators and tools are instanced from the TrialManager class in the CVI_GUI namespace. In the space where your WHAT IF code resides, go into the xml folder and look for the file named toolfilter.xml. Add a `<Tool>` node to the list of `<Tool>` nodes. The text content of these nodes goes into an SQL statement. That statement gets a list of tools or calculators that are suitable for the TrialManager class. If your tool is named ‘My Calculator’, enter the following:

```
<Tool>My Calculator</Tool>
```

Now, when you open the TrialManager, you should see your tool/calculator in the treeview list, assuming you have created the tool definition in the database.

A.8.2 Instancing a Tool

Go to the `OpenCalculator(int toolID, int trialID)` method. In the switch statement, add a case statement that contains the concatenated version number and name of the tool as it appears in the Trial Manager window. If you created a model called ‘My Model 1.0’, add the following case statement:

```
case “MyCalculator1.0”:
    calc = new MyCalculator (toolID, trialID, out toolDataOK);
break;
```

Note: if you do this, your code will not be in a buildable state because you have not yet created a MyCalculator class. To remedy this issue, add a MyCalculator class, go to its class signature and implement an iPhaseIICalculator interface as follows:

```
public class MyCalculator : System.Windows.Forms.Form, iPhaseIICalculator
```

Your new calculator will be a blank form, but the code will be in a buildable state. If you wish to test this, rebuild the CVISolution, Run CVI, pick the site with My Calculator trials, select the ‘Tools’ tab on the Trial Manager, select ‘My Calculator 1.0’ in the treeview and click Open Tool. A new blank form window should appear.

A.8.3 Creating a data enabled tool or calculator

A.8.3.1 Building the initial form

In the previous example, creating a simple window class and making it implement the iPhaseIICalculator interface qualified it as a calculator (though it doesn’t do anything yet). This section will step through the transformation of that code into a useful utility.

Open the MyCalculator class and change its signature so that it is a subclass of CVI_GUI.Calculator. The signature should look like:

```
  public class MyCalculator : CVI_GUI.Calculator
```

and the code modified to look like the following:

```
using System;
using System. Collections;
using System.ComponentModel;
using System.Drawing;
using System.Windows.Forms;

namespace CVI_GUI
{
      public class MyCalculator : CVI_GUI.Calculator
      {
            private System.ComponentModel.IContainer components = null;

            public MyCalculator()
            {
                  // This call is required by the Windows Form Designer.
                  InitializeComponent();

                  // TODO: Add any initialization after the
InitializeComponent call
            }
```

```
        /// <summary>
        /// Clean up any resources being used.
        /// </summary>
        protected override void Dispose( bool disposing )
        {
            if( disposing )
            {
                if (components != null)
                {
                    components.Dispose();
                }
            }
            base.Dispose( disposing );
        }

        #region Designer generated code
        /// <summary>
        /// Required method for Designer support - do not modify
        /// the contents of this method with the code editor.
        /// </summary>
        private void InitializeComponent()
        {
            components = new System.ComponentModel.Container();
        }
        #endregion
    }
}
```

No need to implement the iPhaseIICalculator interface because the CVI_GUI.Calculator does that. Rebuild the CVI_GUI project and view class in Designer mode. That should produce a screen such as the one in Figure A.6.

Figure A. 6 Form after inheriting from Calculator

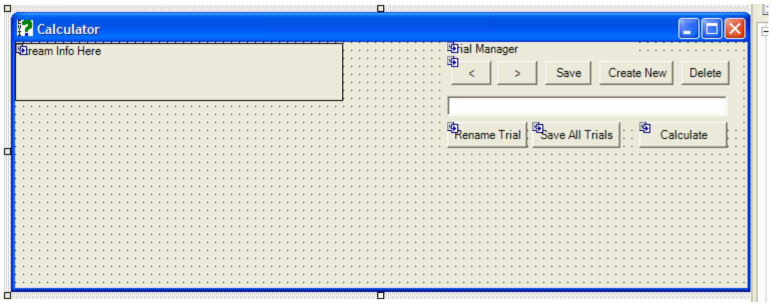
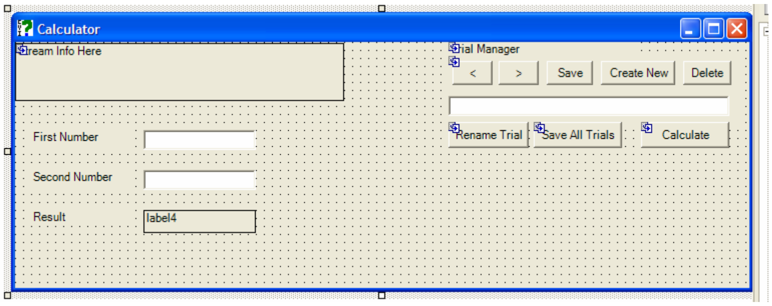


Figure A. 7 A form with two textboxes and a label.



Now, add controls to the form that will let the user specify inputs for adding two numbers and viewing the result. Figure A.7 shows an example of two textboxes and a label with a FixedSingle BorderStyle. The controls are named txtFirstNumber, txtSecondNumber, and lblResult. Set all of their Text properties to blank, and add labels that describe the inputs and results. Go into the code for this form and add the following constructor:

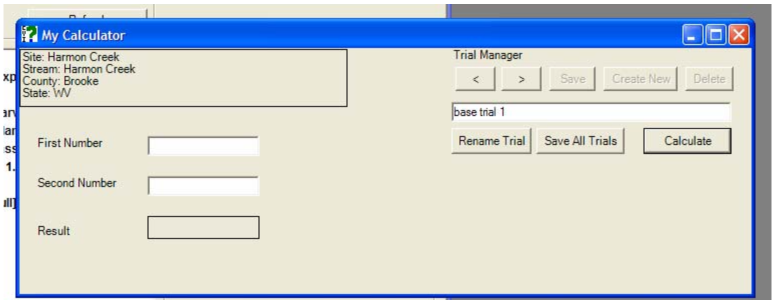
```
public MyCalculator(int toolID, int trialID, out bool toolOK):
base(toolID,trialID)
        {
                toolOK = true;
                try
                {
                        InitializeComponent();
                        initializeTool();
                        MyCalculator.CVITOOLNAME =
base.cvi_db_manager.getCalculatorName(toolID);
```

```
                        bindControlsToTrialDataset();

                  }
                  catch(CVIDataException cde)
                  {
                        CVIStaticCommon.handleCVIDataException(cde);
                        toolOK = false;
                  }
                  catch(CVIToolException cte)
                  {
                        CVIStaticCommon.handleCVIToolException(cte);
                        toolOK = false;
                  }
                  catch(CVIioException cioe)
                  {
                        CVIStaticCommon.handleCVIioException(cioe);
                        toolOK = false;
                  }
            }
```

The call to `InitializeComponent()` renders the GUI controls local to this form. The `initializeTool()` call tells the calculator to perform the tasks that make it ready to handle data such as downloading the data from the database, making that data into a dataset, and binding that data to the controls in the GUI. `toolOK = true` signals back to the TrialManager that the tool opened successfully. If an exception occurs, it is caught by the CVI exception `catch` statements. The `bindControlsToTrialDataset()`binds the controls to the data from the database. Override this method to bind the data to your specific controls.

At this point, if the user builds, runs, and opens the calculator, see a form like Figure A.8 should appear.

Figure A. 8 A form that is data bound. The trial name appears in the trial control manager.



Site: Harmon Creek
Stream: Harmon Creek
County: Brooke
State: WV

base trial 1

A.8.3.2 Constructing the local data

Now that the local form is constructed, call the methods that build the local data tables to which the input and output controls are bound. Go into the CVI_DataManagers class and open the CVIDatabaseManager class. In this class, there is a method called `factoryMake<CalculatorName>DataTables(int toolID)`. Since the calculator in the example is called MyCalculator, create a method called `factoryMakeMyCalculatorDataTables(int toolID)`.

```
            public DataTable [] factoryMakeMyCalculatorDataTables(int
toolID)
            {
                  return factoryMakeCommonDataTables(toolID,2);
            }
```

Go back to the MyCalculator class. Override the method, makeTrialDataset. Add the following code to the MyCalculator class:

```
protected override void makeTrialDataSet(int toolID)
{
      try
      {
            base.makeTrialDataSet (toolID);
```

```
        this.dsTrialData.Tables.AddRange(base.cvi_db_manager.factoryMak
    eMyCalculatorDataTables(toolID));
    }
    catch (NullReferenceException nre)
    {
        throw new CVIException("Error while making the trial
dataset.",nre,false);
    }
    catch (Exception ex)
    {
        throw new CVIException("Error while making the trial
dataset.",ex,false);
    }
}
```

Next, override the `bindControlsToTrialDataset()` and the `fillTrialDataSet ()` methods.

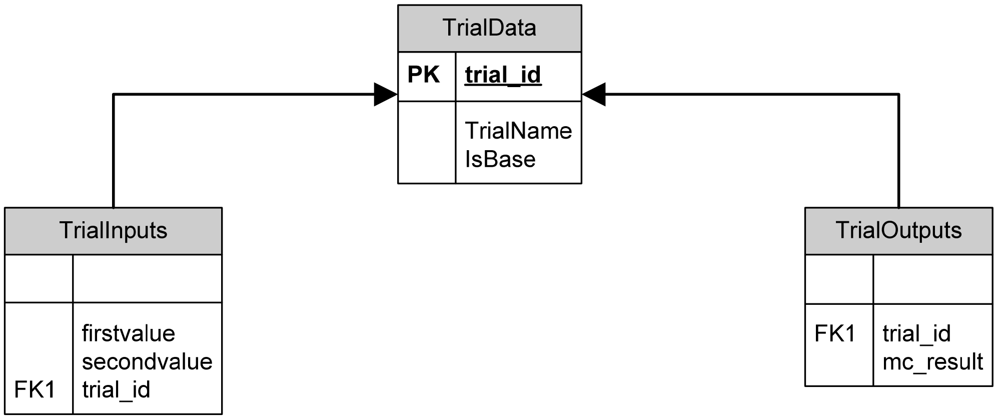
```
protected override void bindControlsToTrialDataset(int toolID)
{
    base.bindControlsToTrialDataset ();
    this.txtFirstNumber.DataBindings.Clear();
    this.txtSecondNumber.DataBindings.Clear();
    this.lblResult.DataBindings.Clear();
    //bind textboxes to inputs and outputs.

    this.txtFirstNumber.DataBindings.Add("Text",dsTrialData.Tables["Trial
Inputs"],"firstvalue");
    this.txtSecondNumber.DataBindings.Add("Text",dsTrialData.Tables["Tria
lInputs"],"secondvalue");
    this.lblResult.DataBindings.Add("Text",dsTrialData.Tables["TrialOutpu
ts"],"mc_result");

    this.txtFirstNumber.DataBindings["Text"].Format += new
ConvertEventHandler(CalculatorNumber_Format); //CalcualtorNumber_Format is
in the superclass.
```

```
      this.txtSecondNumber.DataBindings["Text"].Format += new
ConvertEventHandler(CalculatorNumber_Format);
      this.lblResult.DataBindings["Text"].Format += new
ConvertEventHandler(CalculatorNumber_Format);

}
protected override void fillTrialDataSet(int toolID)
      {
            base.fillTrialDataSet (toolID);
            foreach (DataRow dr in dsTrialData.Tables["TrialData"].Rows)
            {
                  int _trialid =
Convert.ToInt32(dr["trial_id"].ToString());

                        //get the trial from the list that came from the
database and the put is in.
                  DataRow drInput =
dsTrialData.Tables["TrialInputs"].NewRow();
                  foreach (DataRow drInputs in
dtFillTrialDataSet.Select("tool_trial_trial_id = " + _trialid + " and put =
'in'"))
                  {
                        drInput["trial_id"] =
                        drInputs["tool_trial_trial_id"].ToString();
                        drInput[drInputs["trial_data_short_name"].ToString(
                        )] = distillRowValue(drInputs);
                              //look out for invalid cast exceptions
                        try
                        {
//in a case statement incase some variables should be treated
differently than others.

                              switch(drInputs["trial_data_short_name"].ToSt
                        ring())
                              {
                                    case "firstvalue":  //put your data
variable names here.
```

```
                                    case "secondvalue":

      drInput[drInputs["trial_data_short_name"].ToString()] =
drInput[drInputs["trial_data_short_name"].ToString()];

      break;
                              }
                        }
                        catch (InvalidCastException)
                        {

      drInput[drInputs["trial_data_short_name"].ToString()] =
System.DBNull.Value;
                        }

                  }
                  if (dsTrialData.Tables["TrialInputs"].Select("trial_id =
" + drInput["trial_id"]).Length == 0)
                  {

      dsTrialData.Tables["TrialInputs"].Rows.Add(drInput);
                  }

                        //do the output.
                  DataRow drOutput =
dsTrialData.Tables["TrialOutputs"].NewRow();
                  foreach (DataRow drOutputs in
dtFillTrialDataSet.Select("tool_trial_trial_id = " +
                        _trialid + " and put = 'out'"))
                  {
                        drOutput["trial_id"] =
drOutputs["tool_trial_trial_id"].ToString();

                        if
(drOutputs["trial_data_short_name"].ToString().Equals("mc_result"))
                        {
                              drOutput["mc_result"] = 
drOutputs["trial_data_num_value"];
                        }
                        else
                        {

      drOutput[drOutputs["trial_data_short_name"].ToString()] = 
distillRowValue(drOutputs);
                        }

                  }
                  if (drOutput["trial_id"] != System.DBNull.Value)
                  { //do not allow rows with no output to go into the 
output table.
                        if 
(dsTrialData.Tables["TrialOutputs"].Select("trial_id = " + 
drOutput["trial_id"]).Length == 0)
                        {

      dsTrialData.Tables["TrialOutputs"].Rows.Add(drOutput);
                        }
                  }
            } //close the outer foreach loop
                  dsTrialData.AcceptChanges();
      } //close the method.
```

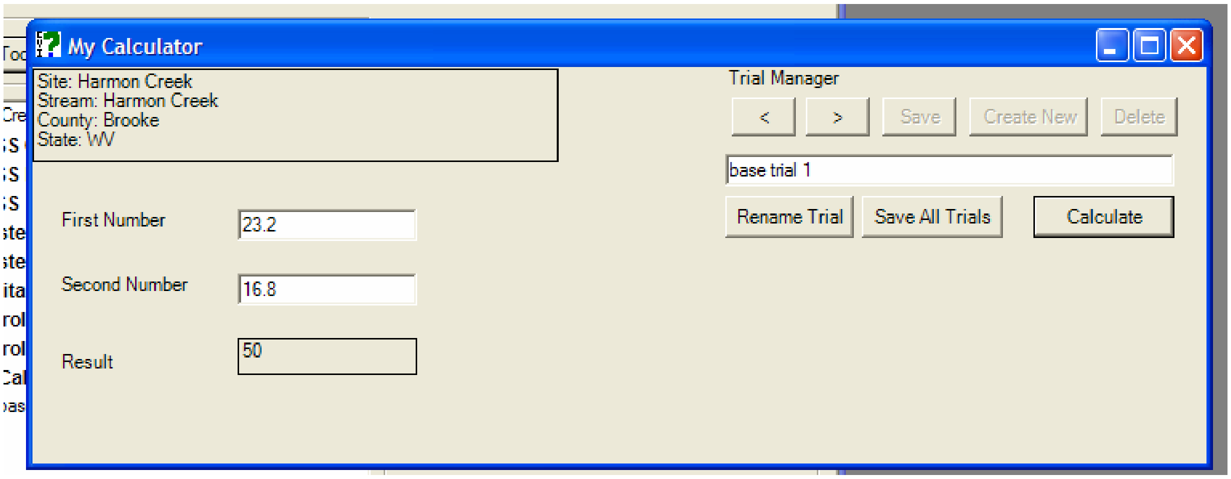
Code reviews may reveal that this is not the cleanest approach to populating the dataset.   Future revisions of CVI may afford the opportunity to better design such data mechanics. For now, this code will properly populate the dataset.

Figure A. 9 Diagram of the backend dataset for My Calculator



After writing the code, rebuild and run the solution. Open the MyCalculator tool and the following form should appear with data in the controls.

Figure A. 10 MyCalculator with data in controls.



Site: Harmon Creek
Stream: Harmon Creek
County: Brooke
State: WV

base trial 1

First Number 23.2

Second Number 16.8

Result 50

A.8.3.3 Performing a calculation

Since the calculator now has data in its input fields, it can calculate a result. To do this, override the method `performCalculation(int trialID)` with the code below

```
public override tool performCalculation(int trial_id)
        {
```

```
                  base.performCalculation (trial_id);
                  //for brevity, I will not add any data validation.  Pleae
add data validation here.
                  decimal fv = Convert.ToDecimal(this.txtFirstNumber.Text);
                  decimal sv =
Convert.ToDecimal(this.txtSecondNumber.Text);
                  decimal result = fv+sv;  //This is where a call to
business logic would go.

                  DataRow [] drs =
dsTrialData.Tables["TrialOutputs"].Select("trial_id = " + trial_id);

                  if (drs.Length != 0)
                  {
                        DataRow dr = drs[0];
                        dr["mc_result"] = result;
                  }
                  else
                  {
                        DataRow dr =
dsTrialData.Tables["TrialOutputs"].NewRow();
                        dr["trial_id"] = trial_id;
                        dr["mc_result"] = result;
                        dsTrialData.Tables["TrialOutputs"].Rows.Add(dr);
                  }
                  dsTrialData.AcceptChanges();

                  return true;

            }
```

Note: you can modify a base trial, but you cannot save that trial back to the database. If the ‘Create New’ trial button is disabled, the site is read-only. Click Data, Save Site Data Record As … in the main menu to save the record as a writable site.

A.8.3.4 Saving a New Trial

Saving a new trial requires overriding the `pushNewTrialToDataBase(string newTrialName)` method.

```
    protected override void pushNewTrialToDataBase(string newTrialName)
        {
            base.pushNewTrialToDataBase (newTrialName);
            prepDataTransport("TrialInputs");
            prepDataTransport("TrialOutputs");
            this.tempTrialID =
cvi_db_manager.InsertNewTrialData(this.dataTransport,newTrialName,toolID);

        }
```

Note: If the user has string or integer fields in the dataset, he may also have to override prepDataTransport. Clicking the button on the calculator labeled ‘Create New’ will create a new trial and put its data into the database.

A.8.3.5 Updating a Trial

After a trial is created and changes are made, users will save their changes back to the database. To implement this functionality, override the sendSingleUpdate method as shown below:

```
protected override void SendSingleUpdateToDatabase(int TrialID)
        {
            try
            {
                this.suspendErrorNotification = true;
                base.SendSingleUpdateToDatabase (TrialID);
                DataRow [] drTemp =
dsTrialData.Tables["TrialData"].Select("trial_id = " + TrialID);
                if (drTemp.Length == 1)
                {
                    DataRow tdr = drTemp[0];
```

```
                              DataRow [] tdins =
dsTrialData.Tables["TrialInputs"].Select("trial_id = " + TrialID);
                              DataRow [] tdouts =
dsTrialData.Tables["TrialOutputs"].Select("trial_id = " + TrialID);

      cvi_db_manager.UpdateHydroClusterTrial(tdr,tdins,tdouts);
                        }
                        else
                        {
                              throw new CVIException(drTemp.Length + " rows
were found in the datasetfor trial " + TrialID);

      }broadcastCVIDataEvent(TrialID,this.toolID,getUpdateTrialName(TrialID
),ClusterCalculator.CVITOOLNAME,TrialManager.CVITOOLNAME,CVI_DataManagers.C
VIDataEventArgs.operationEnum.UpdateTrial);
                  }
                  catch (Exception ex)
                  {
                        throw new CVIException("Error occurred while
attempting to save trial.",ex,false);
                  }
                  finally
                  {
                        this.suspendErrorNotification = false;
                  }
            }
```

Two important parts of this code to note are the

```
cvi_db_manager.UpdateHydroClusterTrial(tdr,tdins,tdouts)
```

and the

```
broadcastCVIDataEvent(TrialID,this.toolID,getUpdateTrialName(TrialID),Clust
erCalculator.CVITOOLNAME,TrialManager.CVITOOLNAME,CVI_DataManagers.CVIDataE
ventArgs.operationEnum.UpdateTrial).
```

The statement **cvi_db_manager.UpdateHydroClusterTrial(tdr,tdins,tdouts),** though listed as updating the hydro or cluster trials, will work for generic calculators that only have number inputs. **broadcastCVIDataEvent** tells other WHAT IF components about changes to the data. For instance, when the trial is saved with a new name, the TrialManager window will refresh with the new trial name under the treeview because it is looking for CVIDataEvents.

A.8.3.6. Deleting Trials

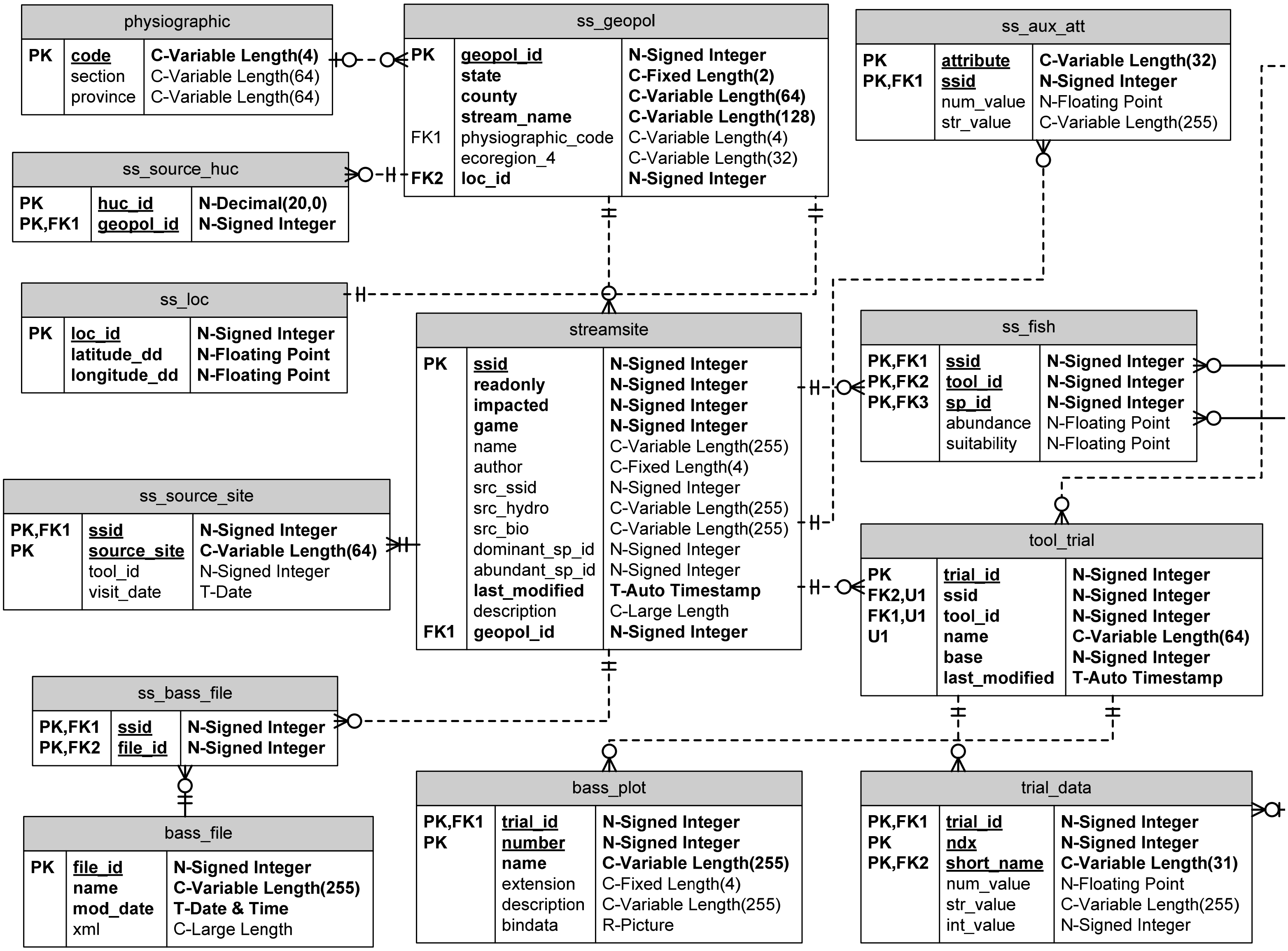
When deleting a trial, override the deleteTrial method and paste the code below.

```
            protected override void deleteTrial(int _trialID)
            {
                  try
                  {
                        base.deleteTrial (_trialID);

      broadcastCVIDataEvent(_trialID,this.toolID,"",CVITOOLNAME,TrialManage
r.CVITOOLNAME,CVI_DataManagers.CVIDataEventArgs.operationEnum.DeleteTrial);
                        object o = new Object();
                        EventArgs e = new EventArgs();
                        TrialData_PositionChanged(o ,e); //the parameters
are just filler
                  }
                  catch (Exception ex)
                  {
                        throw new CVIToolException ("Error in deleteTrial
for trial id " + _trialID + ".",ex,false);
                  }
            }
```

Realistic Additions

The example shown was simple. WHAT IF may serve as host to different kinds of calculators of varying complexity. For example, some may display their results in a label, while others display their results in data grids. Developers may have to either override additional methods, or modify the methods in this example more extensively to achieve the desired results.

Appendix F Database Schema



physiographic		
PK	code	C-Variable Length(4)
	section	C-Variable Length(64)
	province	C-Variable Length(64)

ss_geopol		
PK	geopol_id	N-Signed Integer
	state	C-Fixed Length(2)
	county	C-Variable Length(64)
	stream_name	C-Variable Length(128)
FK1	physiographic_code	C-Variable Length(4)
	ecoregion_4	C-Variable Length(32)
FK2	loc_id	N-Signed Integer

ss_aux_att		
PK	attribute	C-Variable Length(32)
PK,FK1	ssid	N-Signed Integer
	num_value	N-Floating Point
	str_value	C-Variable Length(255)

ss_source_huc		
PK	huc_id	N-Decimal(20,0)
PK,FK1	geopol_id	N-Signed Integer

ss_loc		
PK	loc_id	N-Signed Integer
	latitude_dd	N-Floating Point
	longitude_dd	N-Floating Point

streamsite		
PK	ssid	N-Signed Integer
	readonly	N-Signed Integer
	impacted	N-Signed Integer
	game	N-Signed Integer
	name	C-Variable Length(255)
	author	C-Fixed Length(4)
	src_ssid	N-Signed Integer
	src_hydro	C-Variable Length(255)
	src_bio	C-Variable Length(255)
	dominant_sp_id	N-Signed Integer
	abundant_sp_id	N-Signed Integer
	last_modified	T-Auto Timestamp
	description	C-Large Length
FK1	geopol_id	N-Signed Integer

ss_fish		
PK,FK1	ssid	N-Signed Integer
PK,FK2	tool_id	N-Signed Integer
PK,FK3	sp_id	N-Signed Integer
	abundance	N-Floating Point
	suitability	N-Floating Point

ss_source_site		
PK,FK1	ssid	N-Signed Integer
PK	source_site	C-Variable Length(64)
	tool_id	N-Signed Integer
	visit_date	T-Date

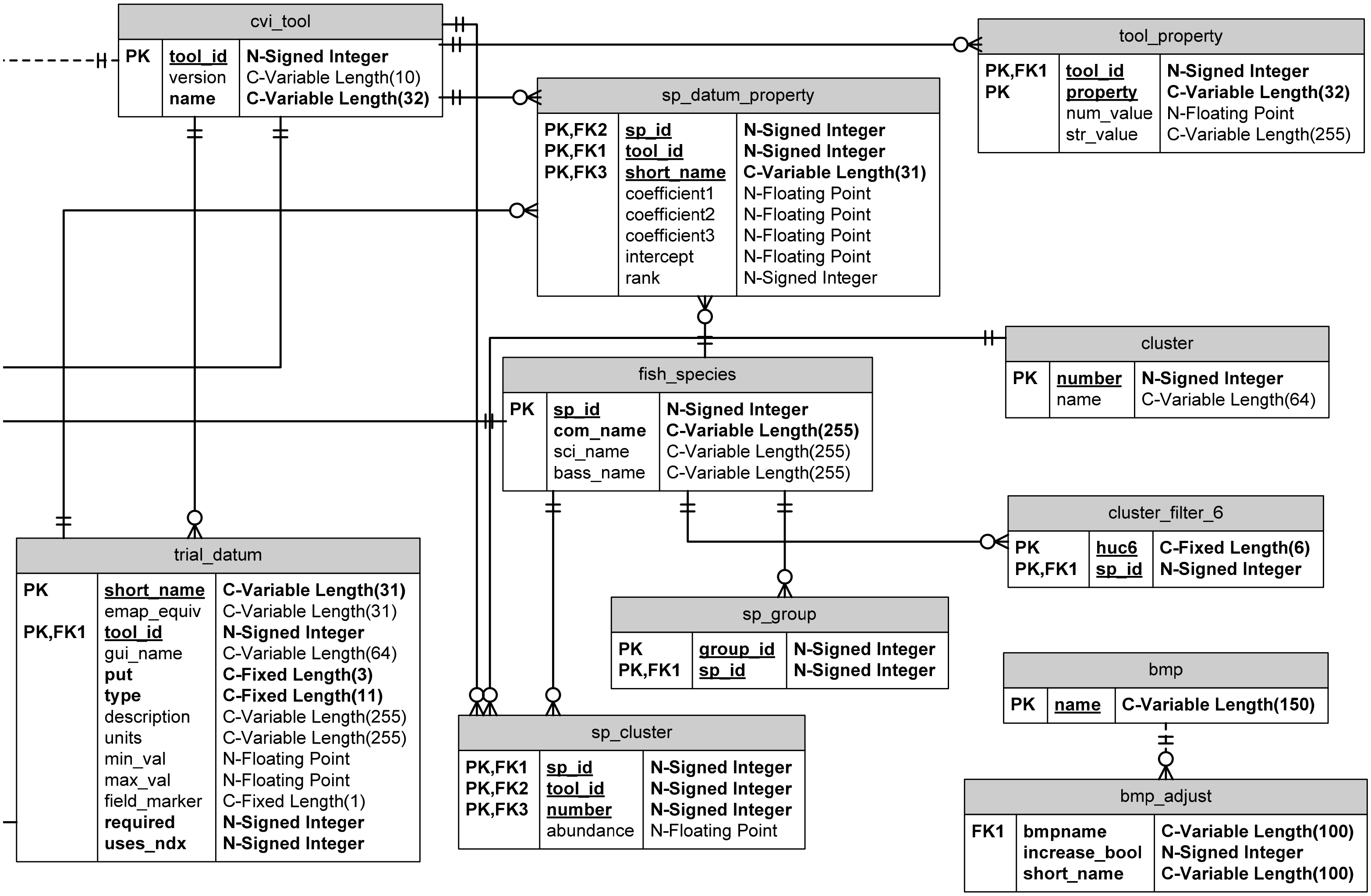
tool_trial		
PK	trial_id	N-Signed Integer
FK2,U1	ssid	N-Signed Integer
FK1,U1	tool_id	N-Signed Integer
U1	name	C-Variable Length(64)
	base	N-Signed Integer
	last_modified	T-Auto Timestamp

ss_bass_file		
PK,FK1	ssid	N-Signed Integer
PK,FK2	file_id	N-Signed Integer

bass_file		
PK	file_id	N-Signed Integer
	name	C-Variable Length(255)
	mod_date	T-Date & Time
	xml	C-Large Length

bass_plot		
PK,FK1	trial_id	N-Signed Integer
PK	number	N-Signed Integer
	name	C-Variable Length(255)
	extension	C-Fixed Length(4)
	description	C-Variable Length(255)
	bindata	R-Picture

trial_data		
PK,FK1	trial_id	N-Signed Integer
PK	ndx	N-Signed Integer
PK,FK2	short_name	C-Variable Length(31)
	num_value	N-Floating Point
	str_value	C-Variable Length(255)
	int_value	N-Signed Integer



cvi_tool

PK	**tool_id**	**N-Signed Integer**
	version	C-Variable Length(10)
	name	**C-Variable Length(32)**

tool_property

PK,FK1	**tool_id**	**N-Signed Integer**
PK	**property**	**C-Variable Length(32)**
	num_value	N-Floating Point
	str_value	C-Variable Length(255)

sp_datum_property

PK,FK2	**sp_id**	**N-Signed Integer**
PK,FK1	**tool_id**	**N-Signed Integer**
PK,FK3	**short_name**	**C-Variable Length(31)**
	coefficient1	N-Floating Point
	coefficient2	N-Floating Point
	coefficient3	N-Floating Point
	intercept	N-Floating Point
	rank	N-Signed Integer

cluster

PK	**number**	**N-Signed Integer**
	name	C-Variable Length(64)

fish_species

PK	**sp_id**	**N-Signed Integer**
	com_name	**C-Variable Length(255)**
	sci_name	C-Variable Length(255)
	bass_name	C-Variable Length(255)

cluster_filter_6

PK	**huc6**	**C-Fixed Length(6)**
PK,FK1	**sp_id**	**N-Signed Integer**

trial_datum

PK	**short_name**	**C-Variable Length(31)**
	emap_equiv	C-Variable Length(31)
PK,FK1	**tool_id**	**N-Signed Integer**
	gui_name	C-Variable Length(64)
	put	**C-Fixed Length(3)**
	type	**C-Fixed Length(11)**
	description	C-Variable Length(255)
	units	C-Variable Length(255)
	min_val	N-Floating Point
	max_val	N-Floating Point
	field_marker	C-Fixed Length(1)
	required	**N-Signed Integer**
	uses_ndx	**N-Signed Integer**

sp_group

PK	**group_id**	**N-Signed Integer**
PK,FK1	**sp_id**	**N-Signed Integer**

bmp

PK	**name**	**C-Variable Length(150)**

sp_cluster

PK,FK1	**sp_id**	**N-Signed Integer**
PK,FK2	**tool_id**	**N-Signed Integer**
PK,FK3	**number**	**N-Signed Integer**
	abundance	N-Floating Point

bmp_adjust

FK1	**bmpname**	**C-Variable Length(100)**
	increase_bool	**N-Signed Integer**
	short_name	**C-Variable Length(100)**

Appendix G External Text Files

CSV Files

ClusterIBI_AbundanceModel.csv	Coefficient matrix for predictor variables and clusters for Cluster Abundance.
ClusterIBI_BiomassModel.csv	Coefficient matrix for predictor variables and clusters for Cluster Biomass.
ClusterSpecies_AbundanceModel.csv	List of fishes, the clusters to which they correspond, and their abundance.
ClusterSpecies_BiomassModel.csv	List of fishes, the clusters to which they correspond, and their biomass.
Coefficients_Cluster_AbundanceModel.csv	Coefficient matrix for predictor variables and clusters for Cluster Abundance.
Coefficients_Cluster_BiomassModel.csv	Coefficient matrix for predictor variables and clusters for Cluster Biomass.
Coefficients_HSS.csv	Species, Parameter, and Value table for the HSS calculator predictor coefficients.
drainageBasinSpecies.csv	True false matrix that tells if a species is either present in or absent from a HUC.
maha_maia_biota.csv	Biomass density grid for species at the sites where they were observed.
maha_maia_relativeAbundance.csv	Relative abundance grid for species at the sites where they were observed.
parameters_Cluster.csv	Parameter definitions for the Cluster Calculators. Contains descriptions, equivalent EMAP names, input range definitions, units, and supplementary notes. (These notes are not used in the CVI Applications.)
parameters_HSS.csv	Parameter definitions for the HSS Calculators. Contains descriptions, equivalent EMAP names, and input range definitions.
Physio.csv	Map between emap names and physiographic provinces.
subSpecies_HSS.csv	Map between the fish groups and their species.

XML Files

bassCommandDefaults.xml	Contains default values for select BASS command xml nodes.
bassFileDefaults.xml	Contains xml that defines templates for new bass files. For instance, the project xml node creates a new BASS project with default BASS commands.
cvi_support_info.xml	Contains the release date for WHAT IF. Has the potential to hold other support information for WHAT IF.
map_config.xml	Configures the MapWindow GIS control.
toolfilter.xml	Governs which tools appear in the trial manager. So far, all tools appear in the Trial Manager window, but this file has the flexibility to change which tools are directly available to the user.
bassCommandNames.xml	Defines command names for each type of file in BASS. Loads the command names into the combo box on the file editor.
bassRootMRU.xml	Stores paths to BASS root directories for the MRU menu.
mru.xml	Stores site names and ID's selected by the user. Data is loaded into the MRU menu in WHAT IF under Data, Open Site Data Record.
bassconfig.xml	Contains supporting information for both BASS commands and the BASS application. The first section holds information about BASS commands, and the corresponding editor needed to use those commands in BASS. This section also configures the controls on different editors. For example, a command that takes three parameters is edited with a data grid. One of the xml nodes contains the definitions for editor columns and the row values for default parameters.
cvi_cnxn.xml	Contains configuration parameters for the database connection tool. All database connection inputs are stored here.
cvi_supplements.xml	todo: write
graphingOptions.xml	Holds parameters that tell the plotting tool how to draw different graphs.
tooldoc.xml	This document supports the building of the meta document that will open when the user clicks the About link. The name attribute will be appended to the tag of the About Hyperlink on each GUI form in CVI. The link will take the following form: [targetdirectory]/tooldoc/index.html

XML Schema Files

bass-22.xsd	BASS XML Schema. Governs the structure and allowable values of the BASS XML DOM.
cvi_cnxn_schema.xsd	Defines dataset that holds the CVI Database Connection parameters. Only used with the Connection Editor Window.
dat-file.xsd	Defines the data structure that supports the dat-file editor in the BASS GUI.
initial_conditions.xsd	Defines the data structure that supports the initial conditions editor in BASS.
plots.xsd	Defines the data structure that supports the dataset behind the plotting tool. Dataset holds transformed xml data from the BASS model.

XML Stylesheet Language Files

bassOut2DS.xslt	Transforms BASS output xml into that which can be loaded by a dataset through the dataset LoadXML method.
extractDirView.xslt	Constructs a hierarchical view of the BASS DOM so that the files are viewable in the file hierarchy.
stage2Parser.xslt	This stylesheet will convert the output of the stage 1 parser to XML that is compatible with the BASS 2.2 schema. The stage1 parser is C# code in the BASS_IO namespace that reads BASS input files and parses them into an intermediate XML form, which is the input to this transformation code.
bass-22.xsl	Transforms BASS DOM data back to flat files, readable by the BASS model
meta_index.xsl	Transforms the tooldoc.xml file into the meta_index.html file.

Other Files

helpdoc.css	Cascading style sheet for the meta document that links to WHAT IF calculator documents.
basscmdoptions.txt	File contains command line options and descriptions for configuring BASS runs. Used in BASS application when the 'View Command Line Options' link is clicked.