

The Watershed Index Online User Manual

The Watershed Index Online (WSIO) User Manual

An Enhanced Scoring
Workbook for Comparative
Watershed Assessment

The WSIO User Manual

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Disclaimer and User Requirements

- **Software requirements:** The WSIO tool requires Microsoft Excel 2010 (or later) for data download and calculation. Excel 2013, the ESRI Maps for Office Add-in, and access to ArcGIS Online are required to use the tool's interactive mapping feature. Mention of product names does not denote endorsement by the EPA.
- **The WSIO is intended to be used as a decision-support tool** by government, professional, academic, and community users with a basic understanding of how the ecological condition of a watershed and the stressors that act upon it can affect hydrology, biology, and water quality. The WSIO data and tool outputs do not represent, change or substitute for any statute, regulation, policy, EPA decision or position.
- **It is the responsibility of the user to read and evaluate dataset limitations, restrictions, and intended use.** To the best of our knowledge, the data, information, and supporting materials on the WSIO website are accurate; however, no warranty expressed or implied is made regarding the accuracy or utility of the data for general or scientific purposes, nor shall the distribution constitute any such warranty. All modeled geographic data are, by their nature, imperfect. The data provided by this tool shall not be taken as absolute truth, but rather as an approximation made in good faith based on the best available data.
- **For site-specific data, WSIO data will not replace “boots-on-the-ground” measurements or local knowledge.** Better local data may be available from local sources.
- **Neither the EPA, EPA contractors, nor any other organizations cooperating with the EPA assume any responsibility for damages or other liabilities** related to the accuracy, availability, use or misuse of the information provided on this website. The EPA reserves the right to change information at any time without public notice. Any errors or omissions should be reported to the WSIO team using “Contact Us” on the WSIO website. We are always happy to hear your feedback and use that feedback for future enhancements.

Abbreviations

EA	Environmental Atlas
EEA	Essential Environmental Attributes
EPA	Environmental Protection Agency
GIS	Geographic Information System
HCZ	Hydrologically Connected Zone
HUC	Hydrologic Unit Code
HWI	Healthy Watershed Initiative
MS	Microsoft Corporation
NHD	National Hydrography Dataset
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
RPI	Recovery Potential Index (Score)
RPS	Recovery Potential Screening
RZ	Riparian Zone
SAB	Scientific Advisory Board
TMDL	Total Maximum Daily Load
WBD	Watershed Boundary Data
WS	Watershed
WSI	Watershed Index (Score)
WSIO	Watershed Index Online

Introduction

This user manual is organized into two major components. The Introduction and About the Worksheets in the WSIO Tool sections of the manual is an overview of the WSIO history, the WSIO Tool enhancements, and the basic step order for using the tool. The Preparing to use the WSIO Tool and Using the WSIO Tool sections walk users through the WSIO Tool with step-by-step instructions and guidance. More information on the WSIO history, concept, data, and function is available in the “About WSIO” document on the WSIO website.

Comparative Watershed Assessment

Federal, State and Local water quality programs are increasingly using comparative watershed assessment tools to inform their decisions about how to prioritize watersheds for restoration and protection activities in the context of their overall water quality goals. Comparative watershed assessment involves systematically evaluating large numbers of watersheds, in order to identify and communicate the similarities and differences among them. This type of assessment requires that data on various watershed attributes (such as land cover, hydrology, slope, soils, biology, water quality, etc.) be consistently translated into “indicators” of watershed condition and drivers of change (stressors) for the watersheds being compared. The Watershed Index Online (WSIO) is a free, publically available data library of watershed indicators and a decision-support tool, developed by the EPA, to assist resource managers with evaluating, comparing, and prioritizing watersheds to support the user’s objectives.

The Watershed Index Online Project and WSIO Tool

The Watershed Index Online (WSIO) project was initiated in 2008 by the EPA Region 4 WPD and collaborators, to improve ways to compare, prioritize and target watersheds for a broad range of watershed management purposes. The EPA Office of Water Recovery Potential Screening (RPS) project is the primary partner in the WSIO’s development. During the past several years, Region 4’s WSIO team and others compiled a substantial national database of watershed characteristics; while, the RPS project developed and applied an Excel-based watershed comparative scoring tool in over 20 statewide projects. The WSIO merges these efforts into a single product by combining the WSIO indicator database and an enhanced version of the RPS tool into an online watershed analysis resource.

The WSIO was developed to assist federal, state, and local partners in prioritizing activities based on watershed condition and suitability or need for protection, restoration, improved monitoring, and other management activities. The goal of the WSIO is to increase the capacity for states and others to perform comparative watershed analysis by providing a watershed comparison tool and a library of hundreds of the most popular watershed indicators, already processed and compiled for roughly 83,000 12-digit Hydrologic Unit Code (HUC12) watersheds throughout the contiguous United States. These attributes have been measured consistently at a small watershed scale (e.g., 40-square mile average size – see *HUC12*.) The WSIO Tool allows users to easily download uniformly measured watershed indicators for a defined project area, to generate comparative rankings for those watersheds and sub-watersheds based on ecological, stressor, and social context indicators selected by the user, and to save a variety of watershed comparative screenings for further analysis or export of tables, maps, and plots.

The WSIO Tool, an enhanced scoring workbook, the geographic area and watershed indicator data is custom-designed by the user and then downloaded to user's local computer. Although, the workbook's calculations are performed locally, the computer must have internet access in order for the workbook to display and retrieve indicator and geospatial data from external sources. A macro within the workbook connects to a server to download data for selected HUCs and watershed indicators.

[ArcGIS Online and the ESRI Map Sheet](#)

The ESRImap sheet must be positioned as the first tab in the workbook for the map feature to work properly. It is highly recommended that users follow steps in order and avoid jumping around from sheet to sheet. Although it is first, the map sheet should NOT be visited until after a screening run has been performed by clicking on the **RUN SCREENING** button on the Setup sheet.

For a licensed Esri ArcGIS user

All licensed users of Esri ArcGIS have access to Esri's ArcGIS Online platform and the Microsoft Office plug-in, Esri Maps for Office, utilized by the WSIO Tool map sheet. ArcGIS Online is a cloud-based mapping service hosted by Esri, which provides maps, apps, and data to the GIS community. Users can add data layers from ArcGIS Online to the map within the WSIO Tool and even export the map for use in reports or other applications.

The WSIO Tool takes advantage of the Esri Maps for Office plug-in to access ArcGIS online and support functionality of the interactive map. In order to use this plug-in, users must download and install the product software from Esri. A license-sponsored account allows the user to use the full capabilities of Esri Maps for Office. The plug-in will not function with a free public ArcGIS Online account, therefore the map sheet will not function. All other workbook functions will still work without the plug-in.

The EPA GeoPlatform is hosted as part of Esri's ArcGIS Online service, which allows participating organizations to create, manage, and share maps and data online. The WSIO team has made some information and maps publically available through ArcGIS Online, which are easily found by searching 'WSIO.'

For a non-licensed Esri ArcGIS user

Free public access to ArcGIS Online can be obtained through Esri, making it possible for non-licensed users to search, view data, and create maps online. The EPA GeoPlatform is hosted as part of Esri's ArcGIS Online service, which allows participating organizations to create, manage, and share maps and data online. The WSIO team has made available some data and maps within the EPA GeoPlatform, which are easily found by searching 'WSIO.'

The Microsoft Office plug-in, Esri Maps for Office, used within the WSIO Tool is *not* available for a non-licensed Esri user. In this case, the user would not have the ability to use the interactive map within the WSIO Tool. However, the user would be able to use all other tool functions and can extract the data from the WSIO Tool and view it in a map using ArcGIS Online.

About the Worksheets in the WSIO Tool

There are 15 visible worksheets in the WSIO Tool workbook, when first opened. The recommended order is to first visit the Instructions sheet, then proceed to Select Geography and then to Select Indicators to download data. After the download, the HUC12 Data and Indicator Info sheets will be populated with the selected data. Next a screening run is performed on the Setup sheet. This will perform calculations and fully populate the workbook. Descriptions and functions of these and other sheets are provided as part of the step by step instructions. Information for all sheets is provided in the WSIO Tool Worksheet Glossary.

It is highly recommended that users follow the step by step instructions in order and avoid jumping around from sheet to sheet. The WSIO Tool uses macros, scripts, and in-sheet functions that are dependent on data in the worksheet. The calculations that set up sheets for download, running a screen, and creating output can be sensitive and freeze the workbook if performed out of sequence.

Preparing to use the WSIO Tool

Required Programs

There are a few programs needed in order to use all features of the WSIO Tool:

1. Microsoft Excel (version 2013 or later)-

This is the workbook application developed by Microsoft Corporation that allows users to perform calculations, make graphs, use pivot tables and run macros, etc. MS Excel 2010 is sufficient to run the workbook calculations, but MS Excel 2013 is required to use the Esri Maps for Office plug-in described below.

2. Esri Maps for Office-

This is an add-in, powered by ArcGIS Online, which allows users to create dynamic maps within Microsoft Excel and PowerPoint files. Once installed, this software utility adds a new menu to the menu bar, called “Esri Maps,” with features to map Excel data, apply different base maps, sign in to ArcGIS Online, and share maps through ArcGIS Online, etc. All other features of the WSIO Tool may be used without this add-in; however, the user will not be able to take advantage of the functionality of the interactive map without it.

3. ArcGIS Online/EPA GeoPlatform-

This is the cloud-based mapping service hosted by Esri, which provides maps, apps, and data to the GIS community. Data layers relevant to watershed prioritization are available on the EPA GeoPlatform. This data can be mapped and displayed using ArcGIS Online and can be displayed in the WSIO Tool map sheet using Esri Maps for Office. However, in order to use the plug-in, users must have a licensed ArcGIS Online account or a license-sponsored account.

Obtaining the WSIO Tool

The WSIO Tool is available for download directly from the WSIO website at <http://gispub.epa.gov/wsio/>. Clicking on the **Download WSIO Tool** button in the lower right of the webpage will allow the file to be saved to a local computer. At this point, the tool does not contain watershed data and a geographic area of coverage has not yet been defined (see below). The user can now carry out these steps.

Selecting a Project Area

There are two steps in the WSIO process where the user will specify a geographic area, there are different considerations for each stage. The first time the user is selecting the HUC8 watersheds for which to download watershed indicator data. This step is performed on the **Selecting Geography** sheet and it defines the project area. It is recommended that the user be inclusive and that the project area be hydrology-based (i.e. river basin,) although geographic areas such as a state also may provide suitable project areas. It is recommended that user avoid selecting too small of an area because smaller project areas don't provide sufficient hydrologic, ecological, topographic, and physical variety to provide context for normalizing indicators and ranking watersheds.

The second time the user selects a geographic area is when selecting HUC12 watersheds on which to perform a screening. This step is performed on the **Setup** sheet and it defines the screening area. In this step the user can focus on sub-set(s) of the project area. Multiple screenings can be performed and saved using the downloaded data. The project area provides the setting (context) for the analysis, the screening area allows the user to focus in on a sub-set of the larger project area.

Selecting Indicators

A watershed indicator is an attribute of a watershed that is useful for watershed comparison and can be consistently measured throughout the geographic area of interest. Most of the WSIO's several hundred indicators are derived from geospatial data analysis, although some come from field monitoring and other information sources that have been geospatially referenced to watersheds. Indicators in the WSIO database are grouped by Indicator Type into Base (i.e. value-neutral), Ecological, Stressor, or Social classes that make up the primary data used in watershed comparisons. Indicators are further subdivided into **Components** based on the essential ecological attributes and stressors driving change in those attributes. The indicator organizational structure used by the WSIO, shown in Table 1, is based upon the recommendations outlined in a 2002 report produced by the EPA Science Advisory Board (SAB): *A Framework for Assessing and Reporting on Ecological Condition* (EPA-SAB-EPC-02-009). For more information about WSIO watershed indicators and how they are organized see the About WSIO document available on the WSIO website.

There are two steps in the WSIO process where the user will select indicators, similar to selecting the geographic area. The first time the user is selecting the Base, Ecological, Stressor and Social indicators for download. This step is performed on the **Selecting Indicators** sheet and it determines what indicators will be available to use in screening runs. When downloading indicator data into the workbook, it is recommended that the user be inclusive and include all indicators possibly relevant to their project objectives. Downloading a variety of indicators allows user to perform many different screenings for multiple project objectives and to adapt screening runs when a project's goals are refined, changed, or made more specific. It is recommended to include multiple indicators applicable to

the potential objectives that may be screened for the project area, even if it is not immediately clear which of them will prove most useful.

Table 1. WSIO Indicator Types and Components

Indicator Type	Component
Base	HUC ID Political
	Hydrologic Ecoregion
	User-Defined
Ecological	Biotic Community Condition
	Watershed Natural Condition
	Corridor Natural Condition
	<ul style="list-style-type: none"> • HCZ Corridor Natural Condition • RZ Corridor Natural Condition
	Hydrology Flow & Channel
	Aquatic Condition / Connectivity
	Ecological History
	<ul style="list-style-type: none"> • WS Ecological History • HCZ Ecological History • RZ Ecological History
	Biotic/Climate Risks
	Watershed Disturbance
	Corridor Disturbance
	<ul style="list-style-type: none"> • HCZ Corridor Disturbance • RZ Corridor Disturbance • Other Corridor Disturbance
Stressor	Hydrologic Alteration
	Severity of Pollutant Loading / Fragmentation
	Landuse (History/Legacy, Future Trajectory)
	<ul style="list-style-type: none"> • WS Landuse (History/Legacy, Future Trajectory) • HCZ Landuse (History/Legacy, Future Trajectory) • RZ Landuse (History/Legacy, Future Trajectory)
	Flags
	Leadership
	Level of Information
	Complexity/Suitability
	Protection
	Human Health
Social	

The second time the user is selecting indicators to use in a particular screening run (discussed later in the section **Step-by-Step Instructions**). Indicators that are the most relevant to the objectives of the screening run are selected from the downloaded indicators. This step is performed on the **Setup** sheet. The objective is to select a small numbers of the most relevant indicators for the screen run.

The WSIO organizational structure groups indicators by **Type** and further sub-divides the Types into **Components** based on the essential ecological attributes and stressors driving change in those

attributes. Components include different spatial extents, depending on whether the indicator represents the entire HUC12 watershed (WS), or just the stream corridor, as represented by the Hydrologically Connected Zone (HCZ) or the Riparian Zone (RZ) (See: **Glossary**). A comparison of the RZ and HCZ masks applied to the same waterbody is shown in

Figure 1.

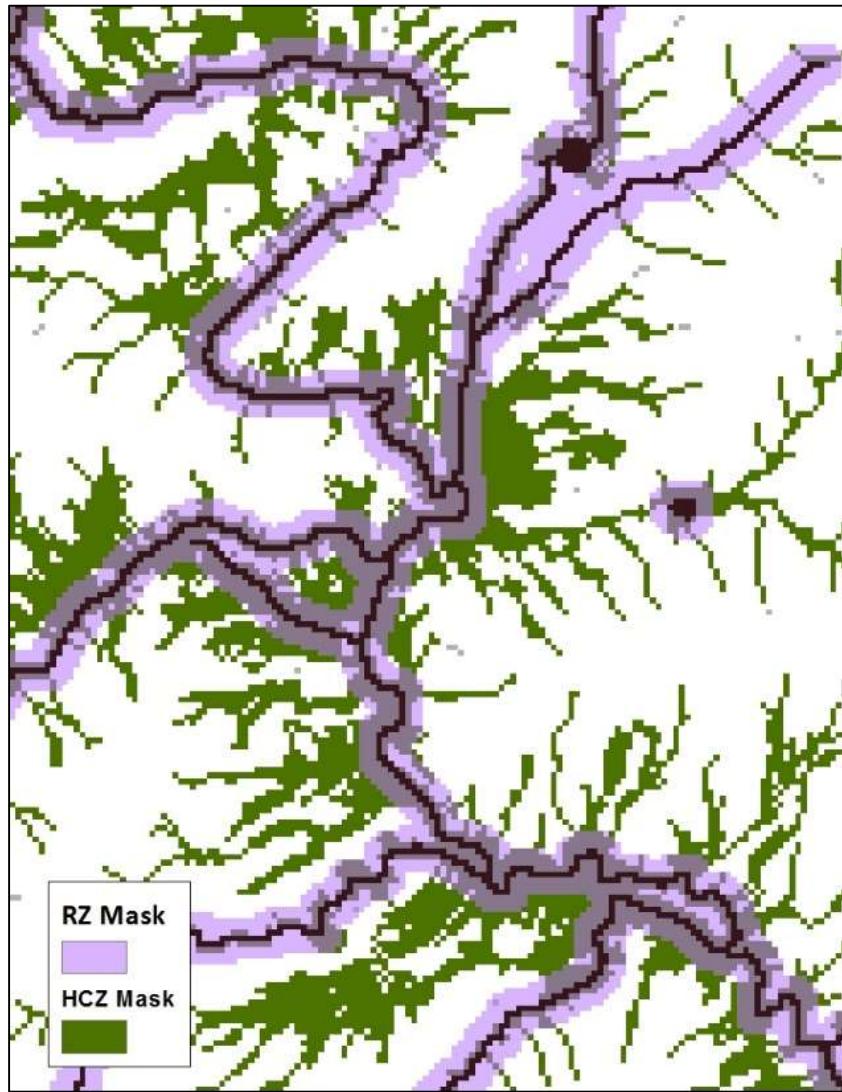


Figure 1: Riparian Zone and Hydrologically Connected Zone mask applied to the same waterbody

Step-by-Step Instructions for the WSIO Tool

I. Launch MS Excel

1. Launch MS Excel (Version 2013 or later) and open a blank workbook.

Opening a blank workbook allows the user to connect to ArcGIS online and check that the ActiveX and Macro Settings within Excel will allow the WSIO Tool to run properly.

2. Use the Esri map Add-in to sign-in to ArcGIS Online.

Go to Esri.com and search for ‘Esri Maps for Office’ to find and download the add-in software.

- a. From within Excel, under the Esri Maps menu, click on **Sign In ArcGIS** on the toolbar:



The menu bar, called “Esri Maps,” contains features to map Excel data, apply different base maps, sign in to ArcGIS Online, and share maps through ArcGIS Online, etc. is available after installing the Esri Maps for Office plug-in. In the box that appears (Figure 22), enter your username and password and then click the **SIGN IN** button. (See [ArcGIS Online and Esri map sheet](#) section above for information on obtaining a username and password to access ArcGIS Online.)



Figure 2. Signing in to ArcGIS online.

You will know you are signed in when the menu option changes to **Sign Out ArcGIS**:



Sigining in to ArcGIS Online will enable use of the interactive map in the WSIO Tool. Although this mapping functionality is not really needed until it is time to look at the results of a screening, the connection to ArcGIS Online should be made before opening the WSIO workbook, because the map does not function as well if the online connection is established after the workbook has been used to download data and run a screening.

3. Check the Trust Center settings in Excel to make sure that macros and ActiveX controls are enabled.

- a. Under the FILE menu, go to Options and then Trust Center to click on the **Trust Center Settings...** button. If necessary, under **ActiveX Settings**, click to “Enable all controls”, and under **Macro Settings**, select the option to “Enable all macros.” Then press **OK** and exit the Trust Center Menus.

****Note: It is NOT recommended to leave these settings on as the default.**

*If the workbook will not allow you to select a filter geography type under Step 1 on the **Select_Geography** sheet, and/or if the available options do not appear in the Step 2 box when a filter geography type is selected, these are signs that the settings are not properly enabled for using the WSIO Tool.*

II. Launch the WSIO Tool

1. Open the WSIO Tool. (Downloaded from WSIO website)

III. Instructions Worksheet

1. The WSIO Tool opens onto the **Instructions** worksheet.

- a. This worksheet contains brief usage instructions for performing a screening run with the WSIO Tool to be used this as a quick reference guide.

IV. Select the Project Area for which to download data

1. Define the geographic project area of interest

- a. The user should define the project area of interest by identifying the HUC8 watersheds that contain it completely. This step is necessary to obtain indicator data for all the HUC12s in the project area. When compiling a list of HUC8 watersheds for which to download indicator data, it is recommended that the user include any watershed within the scope of their project's over-arching objectives. It is also recommended that the project area be hydrology-based (i.e. river basin), although geographic areas such as a states also may provide suitable project areas.

2. Use the **Select_Geography** worksheet to select the geographic project area to download indicator data

- a. Since data for every HUC12 in the lower 48 states is stored in the watershed attribute library accessed by the WSIO Tool, the first step in using the WSIO workbook is to narrow down the geographic area for which to download this information. In the upper left-hand corner of the **Select_Geography** worksheet, click on a radio button under **Step 1** to set the geographic project area filter to one of the following options: **State**, **River Basin**, **Ecoregion** or **EPA Region** (see Figure 3). Note that the River Basin filter is at the HUC6 scale. Once you have made a selection, the available choices of that filter type should appear in the **Step 2** window.
- b. Within the **Step 2** window, use the scroll bar to browse through the available choices and then click on a desired value (Figure 3). It will be highlighted in blue when it is selected. To select more than one state/basin/region, hold down the **Shift** key when clicking on contiguous values, or hold down the **Ctrl** key when clicking on non-contiguous values.

Up to five States, three River Basins, or one EPA Region may be selected at one time for geographic filtering.

- c. Once your selections are made, click on the **Get HUC8 Watersheds** button. This will fill in the window of **Step 3** with a list of any HUC8 watersheds that overlap the selected filter area (Figure 3). The list will be ordered by the eight-digit HUC ID, with watershed names provided in parenthesis. Use the scroll bar to browse the list and choose one or more HUC8 watersheds to add to the project. You may click on a watershed to select it; once this is done it will appear highlighted in blue. To select a group of contiguous HUC8 values, hold down the **Shift** key when clicking. To select non-contiguous HUC8s, hold down the **Ctrl** key when clicking. To select the entire list, click on the **Select All** button. Once the desired watersheds are highlighted, push the **Add Selected** button. It is also possible to re-visit the list of watersheds and add more to the selection by highlighting them and clicking the **Add Selected** button again. The selected watersheds should now appear in the **Input HUC8s** window in the upper right-hand corner of the **Select_Geography** worksheet. The value in the parenthesis is the total number of HUC8s selected. If the list needs to be revised, you may also click on watersheds in the **Input HUC8s** list so that they are highlighted, and then push the **Remove Selected** button. If necessary, click the **Remove All** button to re-do Step 3. To clear the entire worksheet and start the selection process over, push the **Reset Page** button in the upper right-hand corner of the worksheet. Once you are satisfied that the list of **Input HUC8s** fully encompasses the desired project area, press the **Continue** button to move on the next worksheet.

Step 1: Select a filter geography type.  **1. Use the radio buttons to select a filter type**

State River Basin Ecoregions EPA Region

Step 2: Select filter geography values and click Get HUC8 Watersheds.

Region 1
Region 2
Region 3
Region 4  **2. Highlight the desired filter-
i.e. Specific state(s), river basin(s),
ecoregion(s) or EPA region(s)**

Get HUC8 Watersheds  **3. Push this button to get a list
of HUC8 watersheds in that
geographic area**

Step 3: Choose one or more HUC8 watersheds and click Add Selected.

03040202 (Lynches)
03040203 (Lumber)
03040204 (Little Pee Dee)
03040205 (Black)
03040206 (Waccamaw)
03040207 (Carolina Coastal-Sampit)
03040208 (Coastal Carolina)
03050101 (Upper Catawba)
03050102 (South Fork Catawba)
03050103 (Lower Catawba)
03050104 (Wateree)
03050105 (Upper Broad)
03050106 (Lower Broad)
03050107 (Tyger)
03050108 (Enoree)
03050109 (Saluda)
03050110 (Congaree)

 **4. Highlight one
or more HUC8
watersheds
from the list**

 **and then push this button**

Clear Selection **Select All** **Add Selected** **Remove Selected** **Remove All**

 **or use the Select All button, if desired**

Continue  **6. When the list of input HUC8s is complete, push the Continue button**

Input HUC8s: (50)

03010102 (Middle Roanoke)
03010103 (Upper Dan)
03010104 (Lower Dan)
03010106 (Roanoke Rapids)
03010107 (Lower Roanoke)
03010201 (Nottoway)
03010202 (Blackwater)
03010203 (Chowan)
03010204 (Mehermin)
03010205 (Albemarle)
03020101 (Upper Tar)
03020102 (Fishing)
03020103 (Lower Tar)
03020104 (Pamlico)
03020105 (Pamlico Sound)
03020201 (Upper Neuse)
03020202 (Middle Neuse)
03020203 (Contentnea)
03020204 (Lower Neuse)
03020301 (White Oak River)
03020302 (New River)
03030002 (Haw)
03030003 (Deep)
03030004 (Upper Cape Fear)
03030005 (Lower Cape Fear)
03030006 (Black)
03030007 (Northeast Cape Fear)
03040101 (Upper Yadkin)
03040102 (South Yadkin)
03040103 (Lower Yadkin)
03040104 (Upper Pee Dee)
03040105 (Rocky)
03040201 (Lower Pee Dee)

 **5. Finalize the list of
HUC8s selected for
download by adding
or removing IDs as
necessary.**

Figure 3. Steps to selecting a geographic project area on the *Select_Geography* Worksheet.

Although the *Select_Geography* worksheet initially narrows the geographic area at the HUC8 scale, watershed indicator data is downloaded into the workbook at the HUC12 scale. The HUC12 watersheds that will be downloaded, and therefore made available for inclusion in a screening run, are the ones that are wholly or partially included in whatever area is defined by the filter geography type selected, even if the HUC12s intersect the state line, ecoregion, or EPA Region boundary. For example, if the user selects to filter based on a "State" in Step 1, selects "Tennessee" as the only value in Step 2, and then chooses HUC8 "05110002 (Barren)" in Step 3 (a watershed that crosses the state line with Kentucky), the watersheds retrieved by the download will be any HUC12 (05110002####) that lies wholly or partially within the state of Tennessee, but will not include HUC12s wholly within the state of Kentucky (see Figure 4). If the user intended to download/screen the entire HUC8, regardless of the state it drains, the options include filtering based on a State(s) in Step 1, including both "Tennessee" and "Kentucky" as values in Step 2, and then selecting HUC8 "05110002 (Barren)" in Step 3. Another way of accomplishing this would be to filter based on the HUC6 "River Basin" in Step 1, select "051100 (Green)" as value in Step 2, and then select HUC8 "05110002 (Barren)" in Step 3. As long as the filtered geographic area encompasses the entire

HUC8 watershed, the downloaded dataset should include all of the HUC12s that comprise the parent HUC8.

It is also important to note that, since the watershed indicators are calculated at the HUC12 scale, any indicator data brought into the workbook represents the entire areal extent of the associated HUC12, even if the watershed crosses a political boundary outside of the filter area. The exception to this is when the political boundary is the U.S. border with Canada or Mexico. For any HUCs that cross the U.S. border, the data for and area of the HUC only represent the portion within the U.S.

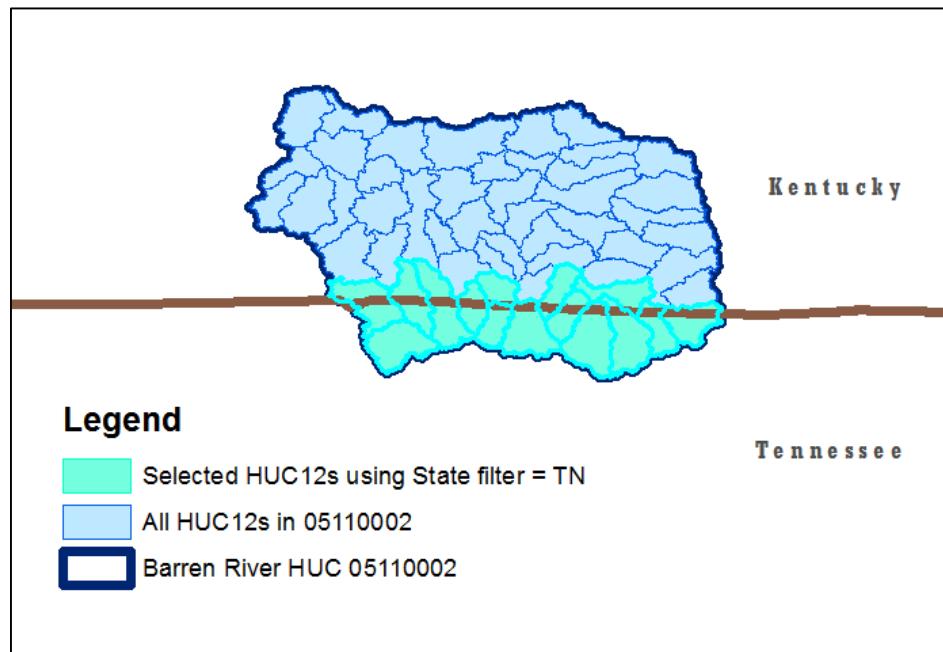


Figure 4. Example project area selection using a State filter.

V. Select the Indicators to download

An indicator is a simplified measure of the state or condition of something that is too complex to measure directly. Since it is not possible to measure every aspect of the natural environment, indicators are used to gain insight into what is happening, such as whether environmental conditions are improving, deteriorating, or holding steady. As used in the WSIO, an indicator is an attribute of a watershed that is relevant to its ecological condition and/or the natural or anthropogenic forces either supporting - or stressing - its health. For example, the percentage of natural cover in a watershed may be used to indicate the extent to which its natural habitats are undisturbed, as well as expected levels of anthropogenic pollution and alteration of natural runoff and infiltration patterns over the landscape. Similarly, the percent impervious cover in a watershed may be used to indicate the extent to which the natural overland flow to the streams has been altered. Since protection of drinking water is an issue that typically engages public concern, the percentage of drinking water source protection areas in a watershed may be used to represent the likely level of public support and involvement in restoration and protection activities.

For indicators to be useful for comparing and contrasting watersheds, it is important that they be consistently measured for each watershed within the geographic area of interest.

The WSIO's watershed indicators are grouped based on the type of influence they have on watershed condition. The WSIO Tool identifies these groups as Base, Ecological, Stressor, and Social Indicators (See the WSIO Glossary for definitions).

1. Use the **Select_Indicators worksheet to select indicators of interest to download**

- a. On the **Select_Indicators** worksheet, under **Step 4**, go through the tabs and select the desired Base, Ecological, Stressor, and Social indicators (Figure 5). Brief descriptions of each indicator are provided in the workbook, but for more detailed information, consult the **Error! Reference source not found.** file, which can be downloaded from the WSIO website. Use the scroll bar to browse through the Base Indicators, and choose which ones to add to the project. You may click on a Base indicator to select it; once this is done it will be highlighted in blue. To select a group of contiguously listed indicators, hold down the **Shift** key while clicking. To select non-contiguous entries, hold down the **Ctrl** key when clicking. To select the entire list, push the **Select All** button. Once the desired Base Indicators are highlighted, push the **Add Selected** button; they should now appear in the **Input Indicators** window in the upper right-hand corner of the worksheet. The value in the parenthesis is the total number of Base Indicators selected. If the list needs to be narrowed, you may also click on an indicator from the list and then push the **Remove Selected** button. If necessary, push the **Remove All** button to start the selection process over.

*Rather than trying to browse an entire list to select and add all the indicators for an indicator type at once, it is often easier to select and add indicators in smaller batches. Even after having added some indicators to the **Input Indicators** window, it is possible to continue scrolling through the indicators and to select additional values to append to the list. The selecting and adding process may be repeated as many times as necessary for the desired indicators of each type to be included-as long as the **Finish** button has not yet been engaged.*

- b. Repeat the selecting and adding process until you have completed selecting candidate Base, Ecological, Stressor, and Social Indicators (Figure 5). Since this part of the workbook only designates indicator data the tool should retrieve, it is okay to include more indicators than what you intend to use for an individual screening run, and/or to add similar indicators to the same selection. After the data is downloaded, there will be a separate step to narrow down the list of watersheds and indicators to a subset to perform a screening. In fact, because the list of Input Indicators for which data will be retrieved is locked in once the **Finish** button is pushed, and because the workbook makes it easy to re-run screenings with different combinations of indicators, it may be

helpful to download the data for a wide range of indicator candidates so that the information is readily available for screening runs.

A total of 22 Base, 86 Ecological, 131 Stressor, and 42 Social Indicators are available. The minimum selection is one indicator for each type (i.e. four total), and the maximum selection is limited to 244 total indicators across all 4 types. In other words, the sum of the number of Base Indicators + the number of Ecological Indicators + the number of Stressor Indicators + the number of Social Indicators selected for download must be less than 244.

2. Download the selected watershed and indicator data

- a. Push the **Finish** button when you are done selecting indicators (Figure 5). The workbook will now retrieve data for every indicator and HUC12 combination within the filtered geographic area specified in the previous steps. Note that the **Select_Geography** and **Select_Indicators** worksheets will be hidden after the **Finish** button is pushed, finalizing those selections, but the **HUC12_Data** and **Indicator_Info** worksheets should now be populated.
-

It is recommended that the user save the workbook as an Excel Macro-Enabled Workbook, with a new name, after the geographic area and indicator selections are final and the indicator data has been downloaded. The saved workbook can then be used as a starting point for screening runs.

Step 4: Select Available Indicators and click Add Selected.

Base	Ecological	Stressor	Social	Indicator types
Percent small natural areas WS	Percent potentially restorable wetlands WS	Percent IUCN status IA WS	Percent IUCN status IB WS	1. Use these tabs to go between
Percent IUCN status II WS	Percent IUCN status III WS	Percent IUCN status IV WS	Percent IUCN status V WS	
Percent IUCN status VI WS	Percent land with any IUCN status WS	Percent GAP status 1 and 2 WS	Percent GAP status 3 WS	
Percent Drinking Water Source Protection Area WS				

2. Highlight the desired Base, Ecological, Stressor or Social Indicators under each tab.

For any indicator selected, a brief description will appear in the light gray window below.

7. The Select All button may be used, if desired,

Step 5: Click Finish to finalize selection.

Finish 9. Push Finish when done.

Input Indicators:

Base (29) | Ecological (55) | Stressor (61) | Social (13) | **Reset Page**

Percent small natural areas WS
 Percent potentially restorable wetlands WS
 Percent IUCN status IA WS
 Percent IUCN status IB WS
 Percent IUCN status II WS
 Percent IUCN status III WS
 Percent IUCN status IV WS
 Percent IUCN status V WS
 Percent IUCN status VI WS
 Percent land with any IUCN status WS
 Percent GAP status 1 and 2 WS
 Percent GAP status 3 WS
 Percent Drinking Water Source Protection Area WS

8. Remove or Add Indicators to these lists as needed.

The numbers in parenthesis on the tabs show how many of that type indicator have been selected for download.

Clear Selection **Select All** **Add Selected** **Remove Selected** **Remove All**

Figure 5. Selecting base, ecological, stressor and social indicators on the **Select_Indicators** worksheet.

VI. Add any user-supplied watershed indicators to the workbook

1. Insert user-supplied indicator names and values to the HUC12_Data table

- a. This step is only necessary if the user has developed additional watershed indicators for the project. Externally-developed watershed indicators must be added to the data table alongside any downloaded indicators, in order to be available for use in screening runs. The ability to add indicators to the table will, of course, be affected by the availability of consistent, quality data to calculate them throughout the geographic area of interest. To start this process, push the **Add Indicators** button on the **HUC12_Data** worksheet.
- b. In the pop-up window that appears, enter the number of indicators that will be added for each type (Figure 6) and then push the **Update Table** button. You should see a message saying: “Indicators Successfully Added” and explaining that the Indicator names and values must be entered in the worksheet before they can be included in a screening run. Press **OK**. If you scroll to the right in the **HUC12_Data** table, you should discover that the workbook has automatically inserted as many empty columns as were specified in the **Add Indicators** window. The columns will be inserted into their

respective sections of the **HUC12_Data** table. Base indicators are listed first, followed by the Ecological, Stressor and then Social Indicators.

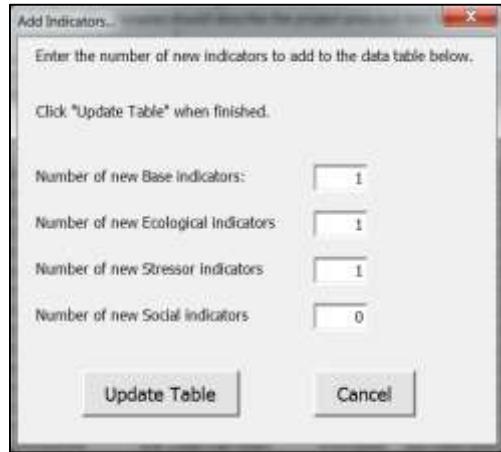


Figure 6. The Add Indicators window.

- c. Add indicator names to any empty columns in row 7 of the **HUC12_Data** worksheet (Figure 7Figure 7). Be aware that the workbook will use whatever is entered as the column heading in row 7 to refer to that indicator on other worksheets (including in charts and maps of screening results). It is therefore recommended that the name be fairly descriptive, but kept to 50 characters or less for readability purposes. Names may be any combination of numbers, letters or special characters, and they may be directly typed-in or copied and pasted.

Type (or paste) indicator names into Row 7 of the HUC12_Data table					
ECOLOGICAL INDICATORS					
	% Not in US	% Not in US HCZ	% Not in US RZ	NOAA Climate Zone	
7	0.0000	0.0000	0.0000	Southeast	0.0201
8	0.0000	0.0000	0.0000	Ohio Central Valley	0.1680
9	0.0000	0.0000	0.0000		51.8871
10	0.0000	0.0000	0.0000		41.0197
11	0.0000	0.0000	0.0000		42.1695
12	0.0000	0.0000	0.0000		36.8716
13	0.0000	0.0000	0.0000		38.7918
14	0.0000	0.0000	0.0000		41.4471
15	0.0000	0.0000	0.0000		42.2590
16	0.0000	0.0000	0.0000		25.0637
17	0.0000	0.0000	0.0000		33.4832
18	0.0000	0.0000	0.0000		23.2874
19	0.0000	0.0000	0.0000		22.8205
20	0.0000	0.0000	0.0000		65.6728
21	0.0000	0.0000	0.0000		60.7890
22	0.0000	0.0000	0.0000		61.3709
23	0.0000	0.0000	0.0000		63.8098
24	0.0000	0.0000	0.0000		51.6408
25	0.0000	0.0000	0.0000		57.7484

Figure 7. Adding User-generated watershed indicators to the HUC12_Data table.

- d. Enter values for each new indicator in the same columns, taking care that the values correspond to the watershed being represented by each row. These values may be typed in directly, or copied and pasted from another sheet. If they are pasted, be sure to select the Paste Special/Values option to ensure that the values will be usable by the workbook for index calculations. A recommended practice is to copy the list of HUC12s from column A of the **HUC12_Data** worksheet, paste the values into another worksheet (either within or outside of the WSIO Tool) and then use the space to set up the (non-normalized, raw) watershed indicator data in a singular column, in the corresponding order as the HUC codes are listed. Any spaces or text in cells containing indicator values will cause errors in RPS calculations. If indicator values are not available for a particular HUC (or HUCs), leave the cells blank. The workbook will calculate indices for those HUCs using only the indicators with data.
- 2. Add descriptions for the new indicators to the **Indicator_Info** worksheet**
- a. Although the workbook will run even if descriptions of user-generated indicators are not added to the **Indicator_Info** worksheet, it is a highly recommended practice to document what the indicators are and how they were calculated. In order to do this, go to the **Indicator_Info** worksheet. Under the **REVIEW** menu, select the option to **Unprotect Sheet**:



You will see the menu option change to **Protect Sheet** once this has occurred:



Then simply enter the indicator name, indicator type and a brief description of the indicator, in accordance with the existing format of the table. When you are done entering information about any new indicators added to the workbook, press the **Protect Sheet** button, but *do not enter a password* before pushing the **OK** button.

VII. Perform a Screening Run

- 1. Using the **Setup** worksheet, select the watersheds, indicators and weights to include in a screening run**
- a. On the **Setup** worksheet, make sure the HUC12 option under the **Select Watersheds** section is active, then click on the down arrow to open the menu of HUC12 watersheds that are available for screening (Figure 8). Use the scroll bar within the drop-down menu to browse through the options, and simply click on a watershed to add it to the list of HUC12 IDs to be included in the screening run. To add the entire list of HUCs at once, push the **Add All Watersheds** button located just below the drop-down menu

(Figure 8). If it becomes necessary to start the selection process over, push the **RESET** button in the blue box near the top of the worksheet. This action will only clear the contents of the **Setup** form (keeping the **Indicator_Data** or **Indicator_Info** worksheets containing any downloaded and user-added indicator data and descriptions).

HINT: If numerous (but not all) HUCs need to be selected, an easier method may be to develop a list of HUCs outside of the **Setup** worksheet. For example, the user could engage the **Add All Watersheds** button on the **Setup** worksheet, then use the mouse to highlight the entire **HUC12 ID** list, and select the **Copy** function from the **Home** menu or from the menu that appears after right-clicking the mouse. Once the list is copied, go to the **HUC12_Subset** worksheet and paste the contents to an open column. The user can take advantage of the space on that sheet to sort and delete HUC12s from the list, as necessary. Once all edits to the **HUC12 ID** list have been completed, highlight and copy it from the **HUC12_Subset** worksheet, and then paste it into cell A18 on the **Setup** worksheet. The **HUC12 ID** list must start with the 12-digit HUC ID, since that is what the workbook will be reading. The list may have (but does not have to include) the corresponding watershed name on the same line. GIS programs (outside of the workbook) may also be used to aid in the identification of HUCs.

Figure 8. Selecting HUC12 watersheds on the **Setup** worksheet.

- b. Still on the **Setup** worksheet, under the section labeled **Select Ecological Indicators**, use the drop-down menu to list a subset of the ecological indicators for screening (Figure 9). The menu of available ecological indicators should include any that were downloaded from the **Select_Indicators** worksheet, plus any ecological indicators added by the user. Clicking on an indicator will immediately add it to the list. It is good practice to select a variety of metrics (6 to 12 indicators per type, 1 or 2 from each component), but keep in mind that the indicator values are effectively averaged in the Ecological Index score, so the more indicators included in the screening calculations, the less influence each indicator will have.
-

A logical starting point for developing a list of potential indicators for a screening is to think about the project's objectives and what factors might be important in those watersheds. The WSIO Tool requires at least one indicator be selected in the base, ecological, stressor and social indicator categories. However, it is recommended that a screening include a variety of indicators among the all the components.

The usefulness of any screening analysis is dependent on the relevance of the indicators used to the purpose of the screening, as well as the applicability of those indicators to the watersheds and communities comprising the project area. Familiarity with the project area and an understanding of how the landscape and hydrology affect the fate and transport of pollutants will help the user identify factors that are likely important in those watersheds. The purpose of the screening, and the questions being asked, will also inform indicator selection. If the project is investigating nutrient enrichment in purely urban watersheds, there is almost certainly no need to include an indicator related to agricultural water use. However, if the purpose of the screening is to help identify the most stressed agricultural watersheds, that indicator may be a good selection. As another example, a project that aims to screen an entire state to identify the relative condition of all of its watersheds will likely pick a different set of screening indicators than projects that are focused on waters impaired by bacteria. If projects are focused on different pollutants (e.g. nutrients vs. bacteria vs. metals), they will probably select different indicators based on the expected pollutant sources and the fate and transport of the pollutants in watersheds.

Since there are many factors affecting watershed condition and recoverability, most screening analyses will benefit from using a variety of indicators that represent different types of influence. Some indicators represent similar attributes, for example: % Woody Vegetation in Watershed, % Forest in Watershed, % Mixed Forest in Watershed, and % Evergreen Forest in Watershed. While the user may choose to download all of those indicators into the spreadsheet so that the data are readily available for screening, it is preferable to select the forest indicator that best represents the type or amount of forested land desired for the project objectives.

When selecting screening indicators for a given Indicator Type (refer to Table 1), it is recommended that the six to twelve indicators be selected, one or two from each Component. It is not recommended to use both RZ and HCZ for the same indicator in the same screening; generally, the user should choose the corridor representation that best suits their objectives.

- c. The **Weights** assigned to each indicator are set to one (1) automatically, but they may be changed by the user simply by typing a new weight value to replace it (Figure 9). Typical weights range from 0.5 to 3, with higher weight values giving the indicator more influence on the final Ecological Index score, and lower weight values making the indicator have less influence on the score. It is recommended that the user perform an initial screening run with the weights set to their default values for each indicator, and only increase or decrease the weights with valid reason. Statistical correlation analysis may provide a basis for showing which indicators are correlated with each other, and which indicators have the strongest relationship to the ecological health of the watershed.

Select Ecological Indicators	
Select the Ecological Indicators of interest below Number of aquatic animal species WS	
2. Select indicators from the menu. 	
Ecological Indicator	Weight
% Forest (2006) in Riparian Zone	1
% Wetlands (2006) in Riparian Zone	1
Slope, Mean Value in Watershed	1
Number of aquatic animal species WS	1
3. Change the weight for an indicator here, as necessary. 	
 Ecological Indicators selected for screening appear in this list.	
	

*Figure 9. Selecting Ecological Indicators for screening runs on the **Setup** worksheet.*

- d. Repeat indicator selection and indicator weight evaluation for Stressor and Social Indicators.

2. Run Screening

- a. Once the watersheds and indicators have been selected, the last step is to click on the **RUN SCREENING** button located at the top of the **Setup** worksheet, to the left of the **RESET** button. You will see the cursor spinning while the workbook is performing its calculations. In the event that one of the indicators you selected has the same value for all of your chosen watersheds, a warning message will open informing you that the normalized values for that indicator will be set to 0.5 to prevent calculation errors. You will have to confirm whether to continue with the screening run. If you decide that a particular indicator does not provide enough discriminatory power for the selected watersheds, you may decide not to continue with the screening run and instead go back and remove or replace that indicator before pressing the **RUN SCREENING** button again.
- b. Once the calculations are done, a pop-up window will open informing you that your project has been created (Figure 10). Push the **OK** button. It is a good idea to save your project at this time, using the **Save As** option under the **File** menu and giving the workbook file a new name.

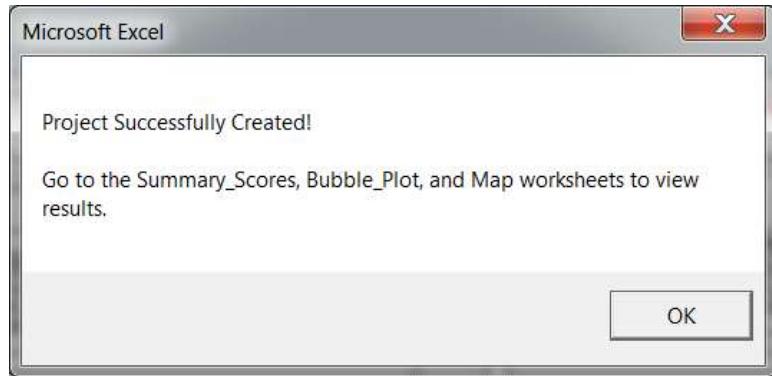


Figure 10. Pop-up window showing a successful screening run.

3. Record Screening Run Details

- a. Users are encouraged to enter notes about each screening run on the **Notes** worksheet to preserve this information when comparing the results of different screening runs. Include a descriptive name for the screening run, the objectives of the screening and which indicators were selected and why.

VIII. Look at the Results

The WSIO Tool will automatically calculate Ecological Index, Stressor Index, Social Index and combined Watershed Index (WSI) scores and ranks for each HUC12 analyzed as part of the screening calculations. These results may be examined as a table, map, or bubble plot within the WSIO Tool, or exported for

use in other software. The values for individual watershed indicators included in a screening run may also be viewed in a table or map.

1. Compare tabular data of Index Scores and Indicator Values for each HUC12 watershed.

- a. The **Values_Only_Summary** worksheet displays a table of the Ecological, Stressor, Social Index Scores, and combined Watershed Index (WSI) Scores for each watershed included in the screening run. Next to the normalized index scores, the rank order of each watershed is provided (Figure 11). Also on this sheet, in the columns to the left of the index scores and ranks, are the values for the individual indicators that were selected by the user to be included in the determination of the Ecological, Stressor, Social index scores.
 - b. Users can sort data on any column and apply filters to parse data for analysis. Base indicators such as ecoregions or HUC8 can be used to filter data in the table. This allows the user to evaluate logical subsets of the entire area. Additionally, the user can define their own subsets on which to filter data.
-

All of the watershed indicator values are normalized to have a maximum value of 1.0.

For the Ecological and Social Index values, higher index scores imply a higher probability that the watershed will support ecological services and higher probability that the social setting is favorable to action, respectively.

For the Stressor Index, a lower score implies that there are fewer stressors driving negative change in the watershed.

For the combined WSI score, higher scores imply a higher likelihood that conditions are favorable to the user's objectives.

The Ecological, Stressor, Social and WSI Rank orders will range from one, up to the total number of watersheds used in the screening run. For all rank orders, a value of one is the best match to user's criteria, and the watershed that ranks last has the least correlation to the objective criteria. All watersheds are ranked relative to each other.

*It is important to understand that small differences in index scores and/or rank order are probably not important. However, the index scores and rank orders provide a simple, easy to understand way to compare the relative condition of a group of screened waters, and to organize them from higher to lower likelihood of meeting users objectives based on their scores. The summary information provided on the **Values_Only_Summary** worksheet makes it easy to look at the range of scores, and to see whether any of the screened watersheds had especially high or low scores for any of the indices or individual indicators.*

This information may be used to group rank-orders into classes- typically by quartile- or to select a specific number or percentage of the watersheds for further investigation. Results may be sorted and filtered to parse and view data in a variety of ways.

Watershed ID	Watershed Name	Ecological Index	Ecological Rank	Stressor Index	Stressor Rank	Social Index	Social Rank	WSI Score	WSI Rank
030101020801	Little Grassy Creek	23.03	118	11.58	81	19.54	217	43.66	110
030101020802	Mountain Creek-Grassy Creek	24.55	94	10.58	70	19.34	236	44.44	93
030101020803	Beech Creek-Johnson Creek	23.33	112	14.60	113	19.94	195	42.89	129
030101020804	Spewmarrow Creek-Grassy Cr	24.10	102	10.78	72	22.00	124	45.11	84
030101020805	Beaver Pond Creek North-Gra	24.73	90	17.80	146	23.28	89	43.40	118
030101020806	Beaver Pond Creek South-Gra	25.78	75	6.38	37	26.88	51	48.76	31
030101020901	Little Island Creek	25.10	82	8.38	51	23.22	93	46.65	58
030101020902	Island Creek	24.93	88	11.08	75	25.26	63	46.37	65
030101021001	Anderson Creek-Mill Creek	20.50	178	18.55	153	23.78	83	41.91	145
030101021002	Headwaters Nutbush Creek	22.18	138	18.90	157	29.10	37	44.13	99
030101021003	Nutbush Creek-John H Kerr R	16.90	229	7.95	50	33.30	22	47.42	50
030101021004	Eastland Creek-John H Kerr R	19.68	193	7.58	45	37.00	8	49.70	21
030101030102	Archies Creek-Dan River	46.15	2	12.23	88	19.64	214	51.19	18
030101030103	Little Dan River	45.78	3	10.13	61	19.24	244	51.63	15

Figure 11. View of index results and ranks on the **Values_Only_Summary** worksheet.

2. Use the Bubble Plot to visually compare how watersheds scored on all three indices.

- The chart on the **Bubble_Plot** worksheet allows users to visualize the relative influence of the ecological, stressor and social index factors in each watershed (Figure 12). A three-dimensional plot displays screening results as waters plotted relative to X (Stressor Index), and Y (Ecological Index), with the dot size varying by Social Index score. Moving the mouse cursor over a bubble will open a window with information about that watershed, including its name and 12-digit HUC ID, the Ecological, Stressor, and Social Index scores calculated for it, as well as the Watershed Index Score and Rank it received. The default setting is for the plot's axes to be placed at the median Stressor and median Ecological Scores, meaning that half of the assessed watersheds will have scored higher than, and half lower than, the value at which the axis is placed.
 - The upper left quadrant would contain waters that have ecological and stressor scores better than the mean.
 - Waters in the upper right quadrant have higher (than the mean) ecological scores, but elevated stressor scores.
 - Waters in the lower left quadrant will have lower stressor index scores, but also low ecological index scores.
 - The lower right quadrant shows which watersheds have high stressor and low ecological scores, making those waters probably more expensive and challenging to restore.
 - Larger dot sizes indicate better social scores based on the indicators chosen.
- On the **Bubble Plot Options** worksheet, the user may change the settings for the bubble plot. Examples of options that may be changed include: re-positioning the axes, adding labels, re-sizing the bubbles, grouping the bubbles into classes, etc.

- There are three options for axes position. The default position is the 50th percentile of the data in the screen. Axes can also be positioned based on user-defined percentiles. A third option is to use custom or 50th percentile of all the data in the download.
- Points can be labeled with watershed name or ID. Users can select watersheds individually or label all watersheds in bubble plot. Selected watersheds can also be highlighted.
- Bubble sizes can be increased or decreased.
- Bubbles can be colored based on any index or indicator included in the project. This enables the user to see the influence of individual indicators or highlight watersheds by classifying the values of the selected indicator.
- Users can also save an image file of the bubble plot for use in reports.

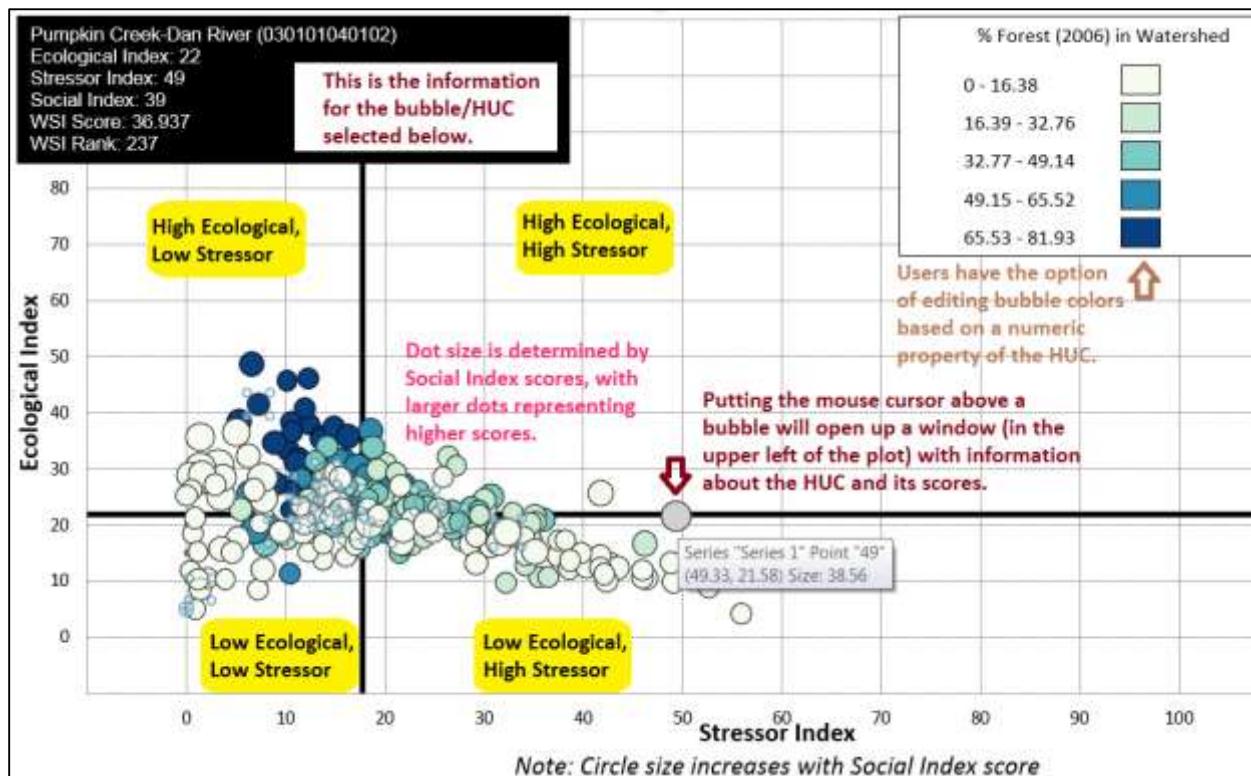


Figure 12. Example Bubble plot.

3. View the ESRI map to look for spatial patterns in Index Scores.

The **ESRImap** worksheet contains an embedded map that allows users a way to visualize indicator data and screening results to better understand any geographic factors that may be influencing the index scores. When first viewed on the worksheet, the map will be set to display Ecological Index results,

although it may take a minute or two for the map to update. Once the map is done processing, it is possible to bring in other index scores or data for display.

a. Add data to map

- i. Under the Esri Maps menu and click on **Add Excel Data** on the toolbar:



A window titled **Add Excel Data for Map 1** will open (Figure 13). At the top of the window, under the **Current Selection** section, click on ([Change Selection](#)).



Figure 13. The Add Excel Data for Map 1 window.

- ii. When the **Data Source** window opens, click on the **Table or Named Range** option (Figure 14). Scroll down the **Table or Range** list that opens and select **mapAllData** and then click **Next**. Back in the main **Add Excel Data for Map 1** window, the **Current Selection** should now be set to **mapAllData**.



Figure 14. Data Source window to Add Excel Data.

Also in the main **Add Excel Data for Map 1** window, scroll through the **Location Type** section. If there is an existing location type related to HUC12s, select it. If not, the location type will have to be added. To do this, click on  at the bottom of the **Add Excel Data for Map 1** window. An **Add Location Type** window will open (Figure 15). In the search field at the top, type “WSIO” and then click on the magnifying glass  (or hit the Enter key on your keyboard).

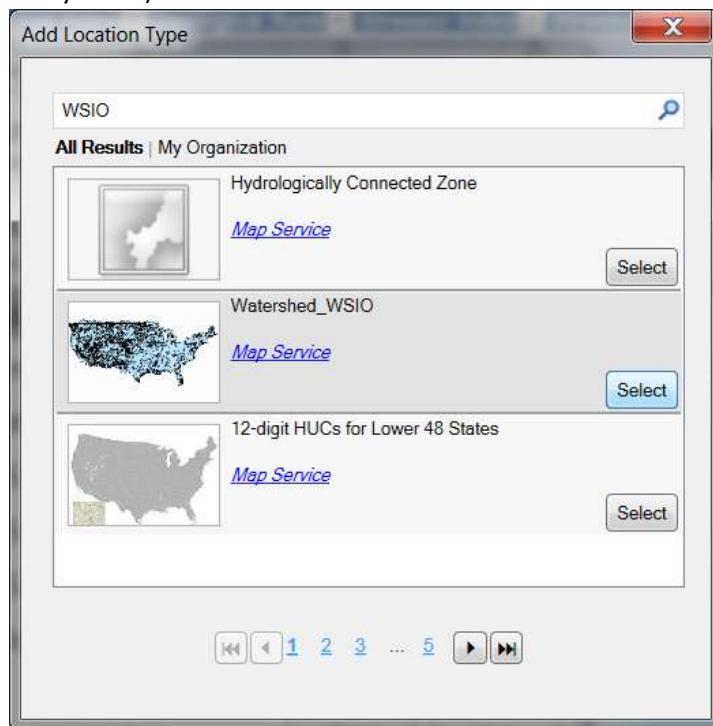


Figure 15. Adding a Location Type to the Excel Map.

- iii. In the results that appear, click on the **Select** button for the **Watershed_WSIO** map service (Figure 15). Then click on the “WSIO_HUC12” option. When asked to choose columns within “WSIO_HUC12”, check the box next to HUC_12 and then press **Next**. Type “WatershedID” in the **Name:** field and then click the **Add** button. Now, under the **Location Type** section of the main **Add Excel Data for Map 1** window, highlight  **Watershed ID** and then click **Next**.
- iv. In the **Location Columns** window that opens, use the drop-down menu to specify which field contains the Watershed ID values and then click on **Add**. A new **mapAllData 1** field should be added to the Map Contents Legend.
- v. Wait until the map has finished processing the locations, then right-click on the **mapAllData 1** item and select the **Rename** option. Type the name of whichever variable you would like to display on the map.
- vi. Under the **Esri Maps** menu and click on the **Grouping** function on the toolbar:



Under the **Grouping** tab of the **Style Configuration** window that opens, use the drop-down menu to choose which value to group. (This is essentially how you are selecting what data will be mapped with that layer.) Then use the other menus to decide whether to group the data by a Number range or Category, and what Classification Method to use (e.g. Equal-Interval, Natural Break, or Quartile). Also pick the number of groups and the desired Color Ramp. When the selections have been made, press **OK**. The added parameter should now be displayed in the map legend (Figure 16).

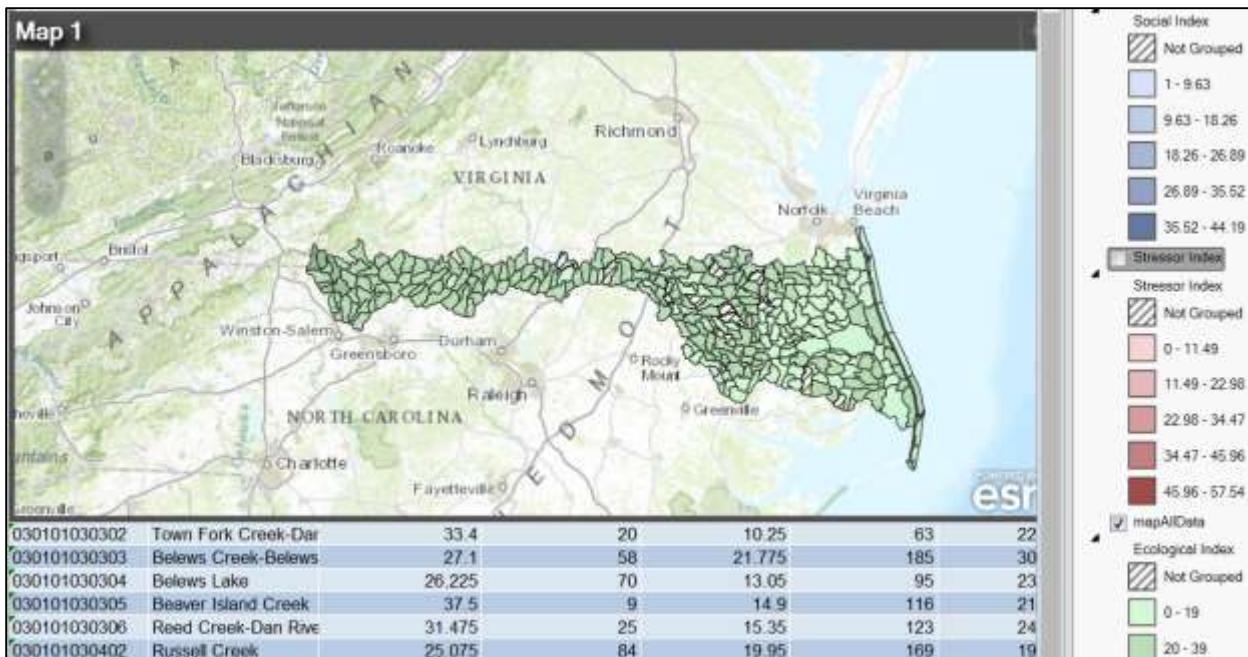


Figure 16. ESRIMap displaying Ecological Index scores, with Social and Stressor Index Scores added.

The **ESRIMap** plug-in is a new software function in Excel and is subject to freezing (not responding) when multiple data columns are added to map. It is possible to bring in all the index scores as separate layers for display, however it is likely that the software will freeze. It is recommended that two data columns be mapped. User can re-group these layers to display other indices or data.

b. Additional Map functions include:

- The map tools will allow you to pan (north, south, east, west); zoom in ; zoom out ; and zoom to the full extent .



- To zoom in to a specific area on the map, hold down the Shift key, and use the left mouse button to draw a red, rectangular box. The map will automatically zoom in to the defined area when the mouse button is released.



- To change basemaps, click on the **Basemap** button on the toolbar, select from among the available options, and press **OK**.
- To re-size the entire map window, hold the **Shift** key, and hold down the left mouse button while dragging a corner of the map window.
- To add data to the map from ArcGIS online, switch to the Search tab within the **Esri Maps** legend on the **ESRImap** worksheet. Type a relevant search term (such as WSIO) in the search field, and then click on the magnifying glass or hit the **Enter** key on your keyboard. Click on the corresponding **Add** button for the desired dataset to add.



References

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The WSIO Tool Worksheet Glossary

The descriptions in this glossary are written from the perspective of a user that has created and downloaded their custom copy of the WSIO Tool by identifying the project area, selecting indicators, and finishing the tool setup process. This section describes all the individual Excel worksheets within a finished copy of the Tool, including the worksheets that were used while creating the Tool as well as those worksheets used later in performing screening runs.

ESRImap

This worksheet contains an interactive map of the user's selected screening area as defined earlier, which may be used to display WSIO screening results overlaid on a selected map base. It is important to note that the user must be signed in to ArcGIS Online in order to use the map, and the ESRImap sheet must be positioned as the first tab in the workbook for the map feature to work properly. Although it is first, it is highly recommended that the map sheet NOT be visited until after a screening run has been performed by clicking on the **RUN SCREENING** button on the Setup sheet.

Instructions

This worksheet contains brief usage instructions for performing a screening run with the WSIO Tool.

Select_Geography

This worksheet is used to identify the project area. The fields on this worksheet are used to narrow the geographic area of interest from the contiguous United States to a subset of specified HUC8 watersheds. Indicator data will only be downloaded (at the HUC12 scale) for the HUC8 watersheds added to this selection. Since data may only be downloaded once per workbook, the **Select_Geography** worksheet will be hidden in a finished WSIO Tool after the download is complete.

Select_Indicator

This worksheet is used to choose all the indicators that might be used in future screenings for the project area. The fields on this worksheet are used to specify which of the available Base, Ecological, Stressor and Social indicators should have data imported into the workbook. The minimum selection allowed is four indicators (i.e. one per indicator type). The maximum selection the Tool will allow is 244 indicators (i.e. sum of the Base, Ecological, Stressor and Social indicators selected). Since data may only be downloaded once per workbook, the **Select_Indicator** worksheet will be hidden in a finished WSIO Tool after the download is complete.

Setup

This worksheet is used to set up and run screenings on the data and calculate watershed index scores and ranks for each watershed. The user may select subsets of HUC12 watersheds and Base, Ecological, Stressor and Social indicators from any of the downloaded dataset for use in screening runs. The **Setup** worksheet is also where users may apply different weighting to indicators, giving them more or less influence on the calculated watershed index scores. The **RUN SCREENING** button completes all the index calculations for the HUCs, indicators, and weights selected on this worksheet. The **RESET** button will clear all the user's selections on this sheet, as well as all calculated data sheets, but will leave the raw **HUC12_Data** and **Indicator_Info** sheets populated with the project data. The reset function is used after saving a screening run as a new workbook, so that another screening run may be developed from the same project data.

Notes

Use of this worksheet is optional. It serves as reserved space to document information describing different WSIO screening runs, such as the objectives of the screening, which indicators were used and how they were weighted, etc. This can be useful when comparing trial screening runs to refine indicator selection for a project. The notes are saved in a PDF format whenever bubble plots and maps are exported from the workbook.

Summary_Scores

This worksheet is protected and cannot be edited by the user. The calculated summary scores and ranks for the Ecological Index, the Stressor Index, the Social Index, and the overall Watershed Index are presented on this sheet for each HUC12 in a watershed screening run. For access to this data, refer to the **Values_Only_Summary** worksheet.

Bubble_Plot

The bubble plot on this worksheet will be automatically generated after a screening run has been performed. A bubble plot is a type of 3-dimensional scatter chart, in which data points are all the individual HUC12s from the screening run represented by circles of varying sizes. The position and size of each bubble is determined by the Ecological (Y-axis), Stressor (X-axis), and Social Index (Z-axis/bubble size) scores for each screened HUC12 watershed. The **Bubble_Plot_Options** worksheet allows the user to customize various settings of the bubble plot.

Bubble_Plot_Options

This worksheet is used to modify properties of the bubble plot after a screening run has been completed. The user has the option to: re-position the bubble plot's X and Y axes from the default setting (to cross at the median Ecological and Stressor Index Scores); add labels to some or all of the bubbles; highlight the bubbles for particular watersheds; edit bubble sizes; change the color of the bubbles based on some property and/or change the number of color classes used; and save the plot image to a *.jpg file for use in other applications.

Indicator_Values

This worksheet is protected and cannot be edited by the user. For each HUC12 watershed that was screened, the raw, un-weighted value of each indicator will be presented on this sheet, at its original scale, allowing the user to see the range of raw indicator scores among the analyzed watersheds. Individual indicators are measured in different units (e.g. %, cm, km², kg/m², mi/mi², MGD, etc.) Many watershed indicators have values ranging from 0-100 (e.g. % Forest), while the possible values for other indicators range in the thousands (e.g. Empower Density, Elevation in cm).

Normalized_Indicator_Values

This worksheet is protected and cannot be edited by the user. The values on this sheet are the weight-adjusted, normalized indicator values automatically calculated from raw indicator data as part of a screening run. Normalizing the indicators so they all have the same range from 0 to 1 removes the unintended weighting that would occur by combining data measured on different scales. Once the ranges are equal, the workbook applies any weights assigned by the user to calculate the final Ecological, Stressor, Social, and Watershed Index Scores.

Values_Only_Summary

This worksheet is a copy of values that were calculated on the **Normalized_Indicator_Values** and the **Summary_Scores** worksheets. The reason for providing copies of these values, without their underlying Excel formulas, is to allow users the option of sorting or filtering them as part of reviewing results from a screening run. **WARNING:** Copying screening results from all the other worksheets, which use auto-calculation formulas, can result in value changes when pasted into new workbooks unless PASTE SPECIAL/VALUES ONLY is used. Copying from this worksheet alone will retain the true values as copied.

HUC12_Data

This worksheet automatically populates with the names and identifiers for the HUC12s that were selected by the user on the **Select_Geography** worksheet, and the raw values for indicators selected by the user on the **Select_Indicators** worksheet, after those selections are finalized and the data are downloaded. Thus the **HUC12_Data** sheet will contain the complete Base, Ecological, Stressor, and Social indicator dataset for all HUC12 watersheds in the project. The **Setup** worksheet reads this information to determine which HUC12s and indicators are available options for screening runs. If the user collects and calculates any HUC12 indicators for the project area, they must be added to this worksheet in order to be available for use in a screening. For each new indicator added, the name, type, and description should also be added to the **Indicator_Info** worksheet. Instructions for adding new indicators and data must be followed exactly to maintain the Tool's proper function.

Indicator_Info

This sheet is automatically populated with the name, type, and description for each indicator selected by the user on the **Select_Indicators** worksheet after those selections are finalized and the data are downloaded. This same information must be manually filled in for any user-calculated Base, Ecological, Stressor, or Social indicators the user added to the project on the **HUC12_Data** worksheet.

HUC_Subsets

This worksheet was added to provide space for users to list specific groups of HUC12s (e.g., all watersheds with a given fish species; watersheds with impaired waters; watersheds in a given ecoregion) of interest to the project, allowing easy retrieval of this information when setting up watershed index screening runs. The HUC12s must be pasted as values only into a single column on the **HUC_Subsets** worksheet under a given subset name at the top of the column. Each cell's content must start with the 12-digit HUC identifier, although the name of the HUC may be included after the numeric ID, if desired. When setting up a screening run, the user may revisit the **HUC_Subsets** worksheet to select and copy a group of HUC ID numbers as a single column, without any headers, and paste the list as values in the first column (i.e. in the Select Watersheds section) of the **Setup** worksheet. Depending on the number of watersheds available for selection within the workbook, and the number of watersheds to be included in the screening run, this is a much quicker and easier process than selecting the watersheds one at a time from the drop-down menu on the **Setup** worksheet. Further, if several different subsets are to be screened with the same indicators and weights, just the watersheds column of the **Setup** worksheet can be replaced each time between screenings instead of clearing the entire **Setup** worksheet using the **RESET** button.

WSIO Glossary

Base Indicator:

A value-neutral characteristic of a watershed, such as its name, HUC code, parent HUCs, area, ecoregion, state(s) where it is located, etc. that provides useful information about the watershed but is generally not indicative of the watershed's ecological integrity, stressors, or social context. Base indicator data may be selected for download into the workbook, and used to sort data and/or label screening results, but are not used in the calculation of an index score during screening runs.

Catseed:

Raster hydrology data. See: **National Hydrography Dataset CatSeed**.

Component:

As used in the WSIO, a sub-division of an Indicator Type based on the nature of the indicator's relationship to essential ecological attributes and stressors driving change in those attributes. When selecting indicators to use in building a screen it is recommended that indicators are selected from as many components as is practical for project objectives.

Ecological Index (Ecological Index Score):

A value calculated to reflect the overall condition and capacity of the watershed to provide ecological services, based on metrics related to natural watershed processes and structure.

Ecological Indicator:

One of the classes of watershed indicators used in the WSIO. Ecological Indicators are measurable characteristics of a watershed related to the structure, composition, or function of its ecological systems. Examples include the number of aquatic species, percent natural cover, mean elevation, and mean slope of a watershed.

Ecoregion:

Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. By recognizing the spatial differences in the capacities and potentials of ecosystems, ecoregions stratify the environment by its probable response to disturbance. These general purpose regions are critical for structuring and implementing ecosystem management strategies across federal agencies, state agencies, and nongovernment organizations that are responsible for different types of resources within the same geographical areas.

Empower Density:

Empower density is the flow of energy released per unit time by a unit volume. Energy is the available energy of one kind previously used up directly and indirectly to make a product or service.

EnviroAtlas:

Ecosystems, such as forests and wetlands, provide many essential benefits, including clean air and water, food, fiber, and recreational opportunities. These and other benefits from nature,

referred to as “ecosystem services,” are multifaceted, often intertwined, and can be difficult to quantify because of their complexity. Due to this complexity and a lack of information, planning efforts often discount or overlook the impacts of decisions on the full suite of ecosystem services. To help fill this information gap, the EPA and its partners researched effective ways to measure and communicate the type, quality, and extent of services that humans receive from ecosystems so that their true value can be considered in decision-making. These research efforts and data are incorporated into the EnviroAtlas, a web-based tool that combines maps, analysis tools, and interpretive information on ecosystem services. Data are provided for subwatersheds across the contiguous United States and at a higher resolution for selected communities. More information can be found here: <http://enviroatlas.epa.gov/enviroatlas/atlas.html>

Healthy Watershed Initiative

EPA created the Healthy Watersheds Program to proactively protect aquatic ecosystems as dynamic systems across landscapes in order to maintain the natural structure and function of ecosystems as intended by Congress in the 1972 Federal Water Pollution Control Act amendments. This systems approach protects aquatic biota and their habitat as well as watershed characteristics and processes that support them such as vegetative riparian corridors and headwaters, hydrology, geomorphology, and natural disturbance regimes. The holistic protection approach provided by the Healthy Watersheds Program is essential for addressing the pervasive threats to healthy watersheds, including loss and fragmentation of habitat, hydrologic alteration, invasive species, and climate change. More information can be found here: <http://water.epa.gov/polwaste/nps/watershed/index.cfm>

HUC (Hydrologic Unit Code):

HUC is an acronym for Hydrologic Unit Codes, which is a numeric system for uniquely identifying all of the drainage basins in the United States. HUCs represent multiple, hierarchical levels of nested geographic units, from the largest unit (Hydrologic Region), to the smallest (Subbasin). The scale of the watershed can be determined by the number of digits in the HUC, such that smaller watershed scales have more digits in their codes, representing additional sub-divisions. The United States has been divided into 21 Hydrologic Regions, which are further divided into 221 Subregions. The Subregions are divided into Basins, and then Subbasins. Many geographic datasets use six levels, resulting in 12-digit HUCs. A 12-digit HUC indicates the hydrologic Region (first two digits), hydrologic Subregion (second two digits), Basin (third two digits), Subbasin (fourth two digits), Watershed (five two digits), and Subwatershed (last two digits).

HUC8:

One level in a hierarchically nested series of surface drainage-based geographic units identified by their Hydrologic Unit Codes (HUC) and the number of digits in that level's identifier (in this case, eight). HUC8s may be referred to as Subbasins, or sometimes Cataloging Units. A typical HUC8 Subbasin is around 700 square miles.

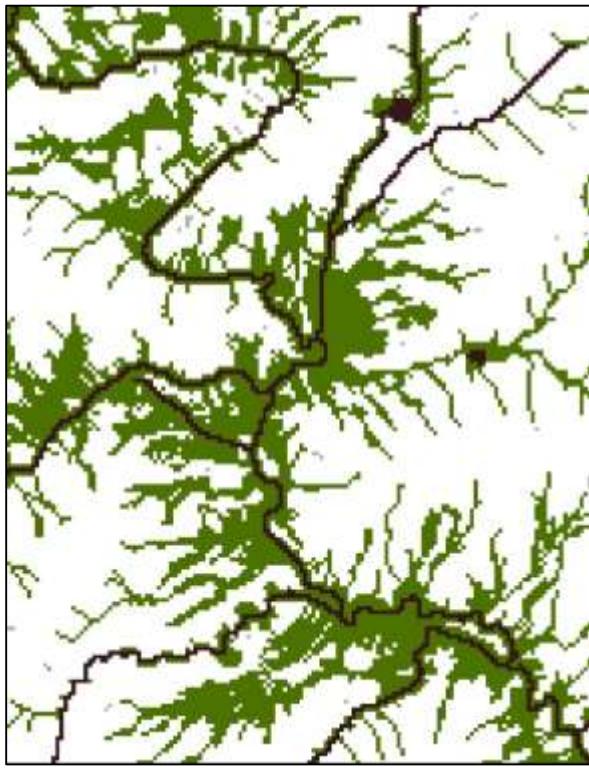
HUC12:

One level in a hierarchically nested series of surface drainage-based geographic units identified by their Hydrologic Unit Codes (HUC) and the number of digits in that level's identifier (in this case 12). HUC12s average roughly 40 square miles in area, and there are about 83,000 HUC12s covering the lower 48 states. Together, the geospatial data on the several levels of HUCs comprise the Watershed Boundary Dataset (WBD). As the WBD is frequently modified through mapping updates, a “WBD snapshot” was benchmarked and integrated with the National

Hydrography Dataset's most recent major update (see *National Hydrography Dataset Plus Version 2*). Although the terms "watershed" and "HUC" are often used synonymously, HUCs may be either a true watershed or a drainage-defined portion of a larger watershed that includes many HUCs. Multiple HUC levels have been used in RPS and WSI projects, but the WSIO indicator data are all compiled at HUC12 scale.

Hydrologically Connected Zone:

This term is used to describe indicators that are measured only within a specified part of the HUC12 – in this case, only the HUC12 areas that have a compound topographic index score greater than 550 and are contiguous to the Water Mask. The naming convention for these indicators includes the abbreviation "HCZ." For example, the **Hydrologically Connected Zone percent urban land cover** in the HUC12 is calculated by first measuring the urban area in the HUC12 only within the HCZ as defined above, and then dividing by the total area of the HUC12 (including all land and water). Because the HCZ is based on a topographic index rather than as a zone of assigned proximity to waters mapped at 1:100,000 scale, it sometimes can differ substantially from the RZ -- such as when river floodplains far exceed the RZ's standard 100 meters-per-side width, or when moist HCZ areas occur along small tributaries not mapped at 1:100,000 scale (see also **Riparian Zone**).



Hydrologically-Connected Zone

Indicator(s) (and Indicator Type):

As used in the WSIO, an attribute of a watershed that is useful for watershed comparison and can be consistently measured throughout the geographic area of interest. Most of the WSIO's several hundred indicators are derived from geospatial data analysis, although some come from field monitoring and other information sources that have been geospatially referenced to watersheds. Indicators in the WSIO data table are grouped by **Indicator Type** into Ecological,

Stressor, Social, or Base (i.e. value-neutral) classes that make up the primary data used in watershed comparisons. See also: Base Indicator, Ecological Indicator, Stressor Indicator, and Social Indicator.

N-Index:

An index of natural cover, not urban or agricultural, by the NLCD. N-index Land cover classifications include 'Barren Land (Rock/Sand/Clay)' (code 31), 'Deciduous Forrest' (code 41), 'Evergreen Forest' (code 42), 'Mixed Forest' (code 43), 'Shrub/Scrub' (code 52), 'Grassland/Herbaceous' (code 71), 'Woody Wetlands' (code 90), and 'Emergent Herbaceous Wetlands' (code 95). N-index is consistent with the Analytical Tools Interface for Landscape Assessments (ATtILA) version 2004. ATtILA user guide can be found here: http://www.epa.gov/esd/land-sci/attila/pdf/user_guide.pdf.

N-index 2:

A modified N-index of natural cover (excludes barren, urban or agricultural classifications). N-index 2 cover classifications include 'Deciduous Forrest' (code 41), 'Evergreen Forest' (code 42), 'Mixed Forest' (code 43), 'Shrub/Scrub' (code 52), 'Grassland/Herbaceous' (code 71), 'Woody Wetlands' (code 90), and 'Emergent Herbaceous Wetlands' (code 95) by the 2006 National Land Cover Database. N-index 2 was modified from the Analytical Tools Interface for Landscape Assessments (ATtILA) version 2004. ATtILA user guide can be found here: http://www.epa.gov/esd/land-sci/attila/pdf/user_guide.pdf.

National Ecological Framework:

The National Ecological Framework (NEF) is a GIS based model of the connectivity of natural landscapes in the lower 48 United States. It was developed to provide a guide for the protection of the natural ecosystem processes that give us clean air, pure water and protected lands that are part of EPA's mission to protect. The purpose was to develop a mapped data set of ecologically important areas that could be connected with a hub/corridor model. See EPA's Geoplatform.

National Hydrography Dataset CatSeed:

Raster data of the flowline and waterbody features only from the National Hydrography Dataset (NHD) Plus version 2.

National Hydrography Dataset Plus Version 2:

The current standard for EPA and many other users of nationally consistent geospatial data on surface waters at 1:100,000 scale. *NHDplus2* represents the most recent major update of national surface waters mapping (the NHD), but in addition contains several value-added attributes on other environmental parameters. Further, *NHDplus2* was integrated with the Watershed Boundary Dataset (WBD) snapshot to benchmark a standard, watershed and surface waters dataset at a specific point in time (see also *HUC12*).

National Land Cover Database:

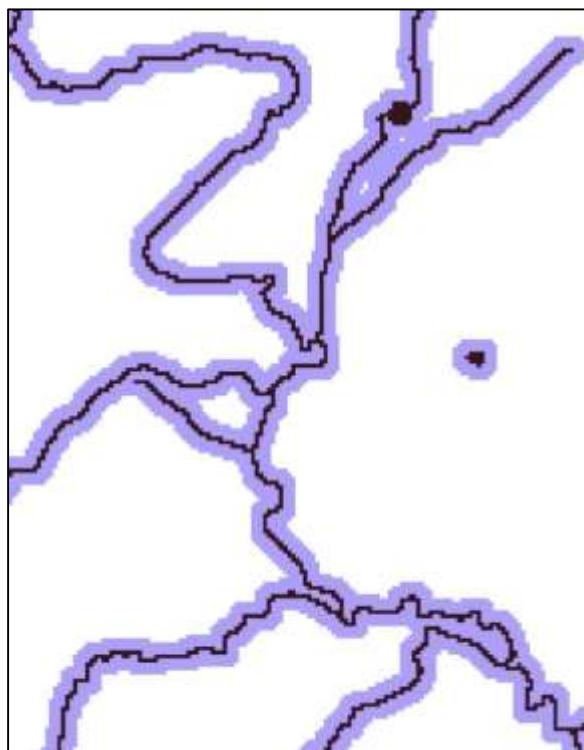
Serves as the definitive Landsat-based, 30-meter resolution, land cover database for the Nation. NLCD provides spatial reference and descriptive data for characteristics of the land surface such as thematic class (for example, urban, agriculture, and forest), percent impervious surface, and percent tree canopy cover. Multiple years are available at about 5 year intervals.

Recovery Potential Screening:

A watershed comparative assessment method using ecological, stressor, and social indicators in each watershed to compare restorability differences among the watersheds and set priorities for action. The Recovery Potential Screening (RPS) tool is a customized Excel workbook that houses all the watershed indicator data and auto-calculates four RPS indices, displaying the watershed comparison results as rank-ordered tables, graphics, and maps. Users can select the watersheds to be screened, indicators and their weights, and customize the graphic and map outputs as well as save the latter as images for later use. As of 2014, the RPS data from the WSIO and statewide RPS tools cover the entire lower 48 states at the HUC12 and HUC8 watershed scales (tools for remaining states and territories are planned), and over 20 states have applied the RPS tool in watershed screenings for a variety of purposes since 2005.

Riparian Zone:

This term is used to describe indicators that are measured only within a specified part of the HUC12 – in this case, within only the HUC12 lands that occur within 100 meters of the Water Mask; then summed to provide one total value for the HUC12. The naming convention for these indicators includes the abbreviation ‘RZ.’ For example, the ***Riparian Zone percent urban land cover*** in the HUC12 is calculated by first measuring the urban area in the HUC12 only in the riparian zones as defined above, and then dividing by the total area of the HUC12 (including all land and water). As a standard-width measurement generalized to include shorelands for any size or type of water body, the RZ may be wider than floodplains of small streams and narrower than floodplains of larger rivers (see also **Hydrologically Connected Zone**).



Riparian Zone

Social Index (or Social Index Score):

A value calculated to account for social factors, such as community involvement, incentives, economics, governance, regulation, and planning status that, while not directly reflective of watershed condition, often strongly influence the level of effort and complexity of making improvements in a given watershed.

Social Indicator:

One of the classes of watershed indicators used in the WSIO. Social Indicators are metrics of socially-related parameters that may affect prospects for success of restoration or protection efforts. Examples include measures related to TMDLs, NPDES permit counts, drinking water sources, and size of natural areas, etc.

Stressor Index (or Stressor Index Score):

A value calculated to reflect the pressures (drivers of change) on watershed condition from several primary sources of pollutants and water quality impairments.

Stressor Indicator:

One of the classes of watershed indicators used in the WSIO. Stressor Indicators relate to pressures on the watershed from either natural or anthropogenic sources, such as watershed- or corridor-level disturbances, hydrologic alteration, and measures of pollutant emissions, etc. Examples include the percent imperviousness, road density, and the percentage of agriculture in a watershed.

U-Index:

An index of urban and human disturbed land-uses, including agricultural or urban classifications by the NLCD. U-index Land cover classifications include 'Developed, Open Space' (code 21), 'Developed, Low Intensity' (code 22), 'Developed, Medium Intensity' (code 23), 'Developed, High Intensity' (code 24), 'Pasture/Hay' (code 81), and 'Cultivated Crops' (code 82) by the 2006 National Land Cover Database. U-index is consistent with the Analytical Tools Interface for Landscape Assessments (ATtILA) version 2004. ATtILA user guide can be found here: http://www.epa.gov/esd/land-sci/attila/pdf/user_guide.pdf.

U-Index 2:

A modified U-index of urban and human disturbed land-uses that includes barren, agricultural and urban land-uses. U-index 2 cover classifications include 'Developed, Open Space' (code 21), 'Developed, Low Intensity' (code 22), 'Developed, Medium Intensity' (code 23), 'Developed, High Intensity' (code 24), 'Barren Land (Rock/Sand/Clay)' (code 31), 'Pasture/Hay' (code 81), and 'Cultivated Crops' (code 82) by the 2006 National Land Cover Database. U-index 2 was modified from the Analytical Tools Interface for Landscape Assessments (ATtILA) version 2004. ATtILA user guide can be found here: http://www.epa.gov/esd/land-sci/attila/pdf/user_guide.pdf.

Water Mask:

Represents all surface waters, including lakes, rivers, streams, wetlands, estuaries, and nearshore ocean waters, as mapped in the 1:100,000-scale National Land Cover Database (NLCD) and National Hydrography Dataset (NHD). Surface water features from the 2006 NLCD included are 'Open Water' (code 11), 'Woody Wetlands' (code 90) and 'Emergent Herbaceous Wetlands' (code 95). Flowline and waterbody features included are consistent with the catseed grid from the NHD Plus version 2. In developing the WSIO, the Water Mask was a geospatial

dataset specially produced for use in measuring many of the indicators in terms of their proximity to surface waters (see also *Riparian Zone* and *Hydrologically Connected Zone*).

Watershed:

This term is used to describe indicators that are measured throughout the entire geographic area of the HUC12; the naming convention for these indicators includes the abbreviation 'WS.' For example, the **watershed percent urban land cover** is calculated by measuring the total urban area in the HUC12 and dividing by the total area of the HUC12 (including all land and water). Although all indicators in the WSIO are expressed as attributes of HUC12s, many indicators (such as Riparian Zone metrics) are measurements of only part of the HUC12 (e.g., only the riparian zones throughout the HUC12). Note that the use of this term in an indicator name implies measurement within the HUC12 only and does not imply that the indicator value was calculated cumulatively from the entire watershed (e.g., full drainage basin above the HUC12) unless specifically noted.

Watershed Index (Watershed Index Score):

A value calculated from the combined effects of the Ecological, Stressor and Social Index values to reflect the overall condition of a watershed. The Watershed Index is calculated as:

$$\text{Watershed Index} = \frac{\text{Ecological} + \text{Social} + (100 - \text{Stressor})}{3}$$

Watershed Index Online:

The Watershed Index Online (WSIO) project was initiated in 2008 to improve ways to compare, prioritize and target watersheds for a broad range of watershed management purposes on local, state, regional, and national scales. Developed to assist federal, state, and local partners in prioritizing activities based on watershed condition and suitability or need for protection, restoration, improved monitoring, and other management activities. The goal of the WSIO is to increase the capacity for states and others to perform comparative watershed analysis by providing a library of hundreds of the most popular watershed indicators, already processed and compiled for roughly 83,000 12-digit Hydrologic Unit Code (HUC12) watersheds throughout the contiguous United States. These attributes have been measured consistently at a small watershed scale (e.g., 40-square mile average size – see *HUC12*.) The WSIO Tool allows users to easily download uniformly measured watershed indicators for a defined project area, to generate comparative rankings for those watersheds and sub-watersheds based on ecological, stressor, and social context indicators selected by the user, and to save a variety of watershed comparative screenings for further analysis or export of tables, maps, and plots.

Wetness Index:

The wetness index, also known as the compound topographic index (CTI), is a steady state wetness index. It was derived from the NHDPlus flow accumulation and slope of the Digital Elevation Model (DEM) to represent topographic areas that are typically wet. The Wetness Index used for the WSIO tool was created using the following equation:

```
grid wet_ndx = 100*(ln (flow accumulation/tan(slope)) + 3x3 mean of ln (flow accumulation/tan(slope))/2
```

The values were not scaled by an area factor and were smoothed by $\frac{1}{2}$ to make up for some inconsistencies across the national DEM, because of differences in the resolution of the DEM by USGS quad sheet. The data were then compared to the 2001 NLCD wetland classes, Region 4 FEMA flood zone classes, and Georgia National Wetlands classes. The threshold for value of 800, of the wetness index, represents areas which are usually wet. This was primarily based on the 2001 NLCD comparison, but also supported by the other analyses (Moore, 1991 and Wollock, 1993). The wetness index, tends to overestimate wet areas, in part because it does not consider precipitation and evaporation water balances. It will also overestimate wetness in areas with highly permeable soils that do not retain water. Finally, CTI indicates wet areas based entirely on topography and surface water flow and will miss wet areas created by other factors such as heavy precipitation or irrigation outflow.

WSIO Tool:

The WSIO Tool is a coded Excel workbook used to download data, perform calculations and compare and contrast watersheds. The WSIO tool is downloaded and run locally by users. See **WSIO Tool Worksheet Glossary** for descriptions of the WSIO Tool worksheets.