Background

The EBTJV Catchment Updater is a data visualization and decision support tool that was developed to assist with updating of EBTJV catchment codes representing salmonid species presence.
This tool was designed to assist federal and state agencies, local decision-makers, regional planners, conservation organizations, and natural resource managers using open-source software.

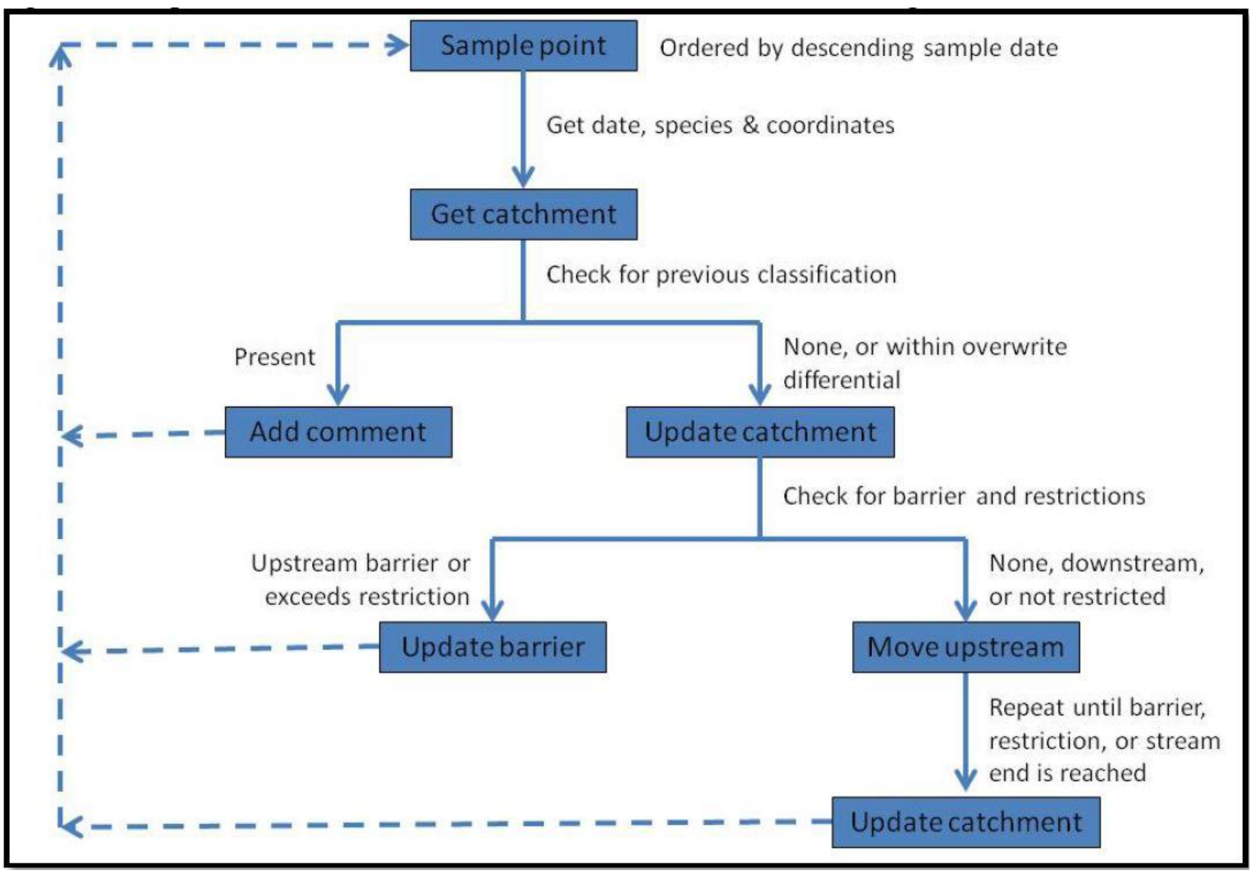
Overview

The EBTJV Catchment Updater presents coldwater resource managers with a means to update the species occurrence classification code through an intuitive browser-based mapping interface.

Rule Set

The Updater is a continuation of the 2015 EBTJV catchment classification effort in that it uses the most recent classification data and fields produced by that algorithm.

2015 Assessment catchment classification algorithm



2015 Assessment catchment classification data fields

Field	Description
EBTJV_Code	The classification code of the catchment based on salmonid species present
Catch_Cnt	Sequential upstream catchment count from the catchment containing the sample point used for classification
Cum_Length	Cumulative stream length from the catchment containing the sample point used for classification
Samp_Year	The year in which the sample point used for classification was conducted
Samp_Dist	The Euclidian distance of the sample point location from the flowline (only calculated for catchments containing the sample point used for classification)
Samp_OID	The object identifier (fid) of the sample point used for classification
Dam	Whether or not the catchment contains a barrier
Samp_Loc	Whether the sample point is above or below the barrier (only determined for catchments containing the sample point used for classification and a barrier)
Str_Order	The stream order of the flowline associated with the catchment
Comment	Adds the classification code and sample year for additional sample points located in the catchment

Catchment classification consisted of determining which salmonid species were present, and how long ago the sample was conducted. All samples occurring greater than 10 years from the analysis year were given a 'P' after the code representing 'predicted'. Catchments upstream of a sample point were inferred from the downstream catchment, and given the classification code of that catchment, until a barrier, different sample, or stream end was encountered. The below table details the different classification codes (BKT = brook trout, BNT = brown trout, RBT = rainbow trout):

Species Present	Code
Not Classified	-1
None	0
None	0P
BNT	0.2
RBT	0.3
BNT & RBT	0.4
Stocked BKT	0.5
BKT	1.1
BKT & BNT	1.2
BKT & RBT	1.3
BKT & BNT & RBT	1.4
BKT & Stocked BKT	1.5

Certain accomodations ended up being necessary due to the sometimes absence of smaller streams in the flowline layer, and the occurrence of multiple stream reaches in a single catchment.

Examples of likely scenarios in which users may need to manually edit a catchment's classification are listed below, along with a supplied reason that should be used as justification in order to standardize data across the range.

- If a catchment includes a portion of the mainstem and tributary and two data points occur in the same catchment in the same year with conflicting results (e.g., Brown Trout in mainstem and Brook Trout in tributary), manually update to the catchment code that best describes the trout community and select "**Conflicting data**". In some cases, this may result in a sympatric patch code.
- If a biologist knows that a barrier is present which changes trout community upstream of the barrier but it is not reflected in the data, manually update catchment code to reflect their knowledge of the stream and in comments for manual edit, select "**Known barrier**".
- The most recent survey results (e.g., allopatric Brook Trout) conflicts with knowledge from prior surveys (e.g., sympatric Brook Trout and Rainbow Trout) and biologist knows Rainbow Trout are still in the stream but the sampling did not pick them up this year because they occur in low density, manually update to the code that best describes the trout community and select "**Biologist knowledge**".
- If data is outdated and includes an inaccurate entry for a trout species present, (e.g., only data available was from 1981 and includes a hatchery rainbow trout that was recorded as a wild Rainbow Trout and is changing the catchment to sympatric Brook Trout and Rainbow Trout, manually update to the code that best describes the trout community and select "**Outdated data**".
- If a situation occurs in which a manual edit is needed and does not fall within the categories outlined above, manually update to the code that best describes the trout community and select "**Other**" and provide brief rationale for why update was made.

Quick Start

Throughout the Updater tool, additional information about a tool or an item can be found by hovering over the icon or the object itself to display a tooltip.

Given the high number of classification scenarios possible from complex spatial and temporal datasets involved with this project, we recommend the following steps as a means to better control and track the update process:

1. Only use sample data that has been collected since the last catchment update
2. Parse the sample data into hydrologic units (e.g. HUC8 or HUC10) to avoid overwriting previous edits
3. Import data using the file import method first, followed by manual edits to prevent overwriting updates.
4. For file imports, download the 'Confirm Edits' table as a CSV file to keep as a record of the updates.

Data Format

When using the 'Import File' method to make updates, the data can be saved as either an Excel or CSV file. Excel files with multiple worksheets will require the user to select the appropriate one. **IMPORTANT**: CSV files cannot have internal commas in any field.

Data should be formatted in rows, where a row represents a sampling event, and must contain information on:

- **Sample location**
  - Coordinates (decimal degrees), or
  - Catchment feature ID
- **Salmonid species present**
  - EBTJV code, or
  - Species occurrence data - A column for each species (BKT, BNT, RBT, stocked BKT (optional))
    - Species occurrence data can be represented by an integer >= 1, or by the word 'true'
- **Sample date**
  - MM/DD/YYYY format

Example data file formats

- Species occurrence (True/False) & Coordinates Excel file
- Species occurrence (counts) & Feature IDs CSV file
- EBTJV codes & Coordinates Excel file (multiple worksheets)
- EBTJV codes & Feature IDs CSV file

Additional Info

Extend Upstream: This is an option in both the manual edit and import file update options that uses information from the 2015 catchment classification, specifically the 'Catchment Count' and 'Sample OID' fields, to update any upstream catchments (catchment counts greater than focal catchment) classified by the same sample data (sample OID).

This option is only available to states classified using the 2015 algorithm (northern states), and should be used with caution as data overwriting is possible.

Tool Development Team

- Jason Coombs
- Keith Nislow

Questions or comments should be directed to Jason Coombs at jcoombs@umass.edu.

Optimal Performance Requirements

The tool is currently supported on the latest versions of all major web browsers, however, Google Chrome is highly recommended for the best user experience. The tool is not intended for use on mobile devices, and is a memory-intensive application. Older computers may have difficulty rendering the interface resulting in sluggish performance. If you run into issues, we recommend closing all other programs and browser tabs to increase available memory.

Design and Implementation

The following open-source software libraries were used to create the EBTJV Catchment Updater:

- **PostgreSQL:** Relational database
- **PostGIS:** Spatial database extension for PostgreSQL
- **Node.js:** Web server runtime environment
- **Express:** Web server framework and API
- **Leaflet:** Interactive map framework
- **D3.js:** Data visualization, mapping and interaction
- **Bootstrap:** Front-end framework and styling
- **jQuery.js:** JavaScript library
- **Intro.js:** Guide and feature introduction

Future Work and Contact Info

Development of this tool is currently ongoing. If you have any questions or encounter any errors, please contact Jason Coombs at jason_coombs@fws.gov.

Tool Version

v1.0.0 - 04-20-2022

- Initial release
- **Datasets**
- A list of sources for polygon layers.
-
- **Polygon Layers**

Name	Source	Download
States	United States Census Bureau	
Counties	United States Census Bureau	
HUC-6	USDA Geospatial Data Gateway	
HUC-8	USDA Geospatial Data Gateway	
HUC-10	USDA Geospatial Data Gateway	
HUC-12	USDA Geospatial Data Gateway	
Streams	NHDPlus v2 Streams	

Principal funding for this tool was contributed by the Eastern Brook Trout Joint Venture

Additional support was provided by: US Forest Service: Northern Research Station |

Background

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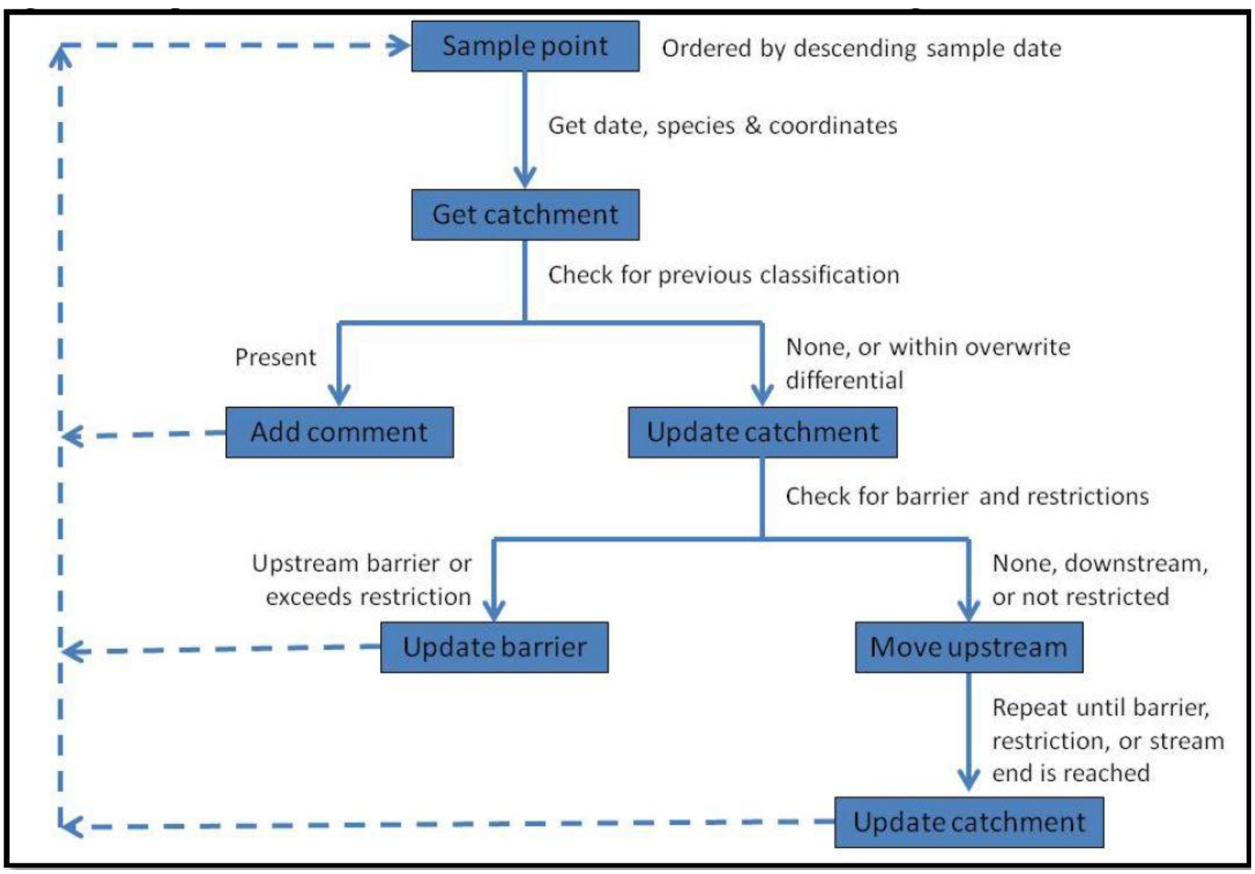
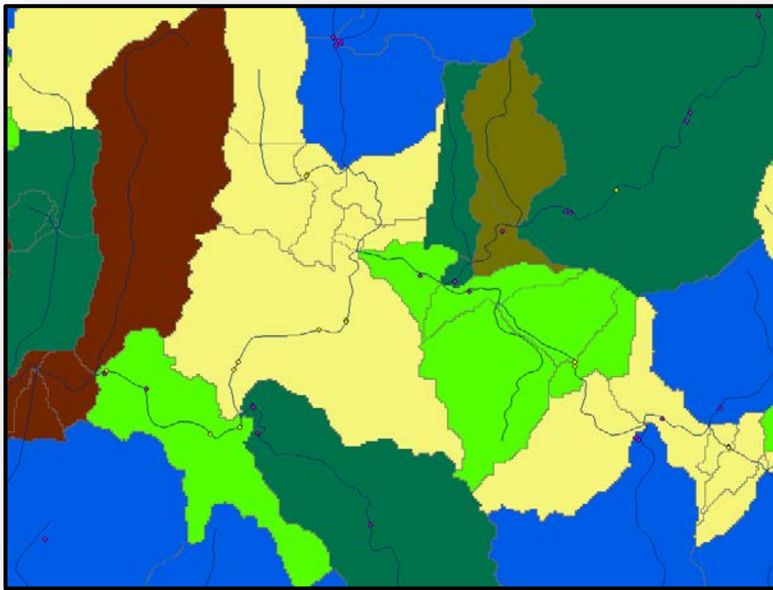
2015 Assessment catchment classification algorithm



2015 Assessment catchment classification data fields

EBTJV Salmonid Catchment Assessment and Habitat Patch Layers



Prepared by:
Jason A. Coombs
Keith H. Nislow

University of Massachusetts Department of Environmental Conservation
USDA Forest Service Northern Research Station
Amherst, MA 01003

Prepared for:
The Eastern Brook Trout Joint Venture

September 23, 2015

Summary: Extending, standardizing, and automating the salmonid status assessment is a fundamental goal of the Eastern Brook Trout Joint Venture. This document provides a step-by-step description of these procedures, as well as providing examples for their application.

Contents

Algorithms

Both the salmonid catchment assessment and habitat patch layers are created using algorithms (Figures 1 & 2) written in Python and implemented through ArcGIS toolboxes (Figure 3).

Figure 1: Simplified flowchart of the salmonid catchment assessment algorithm.

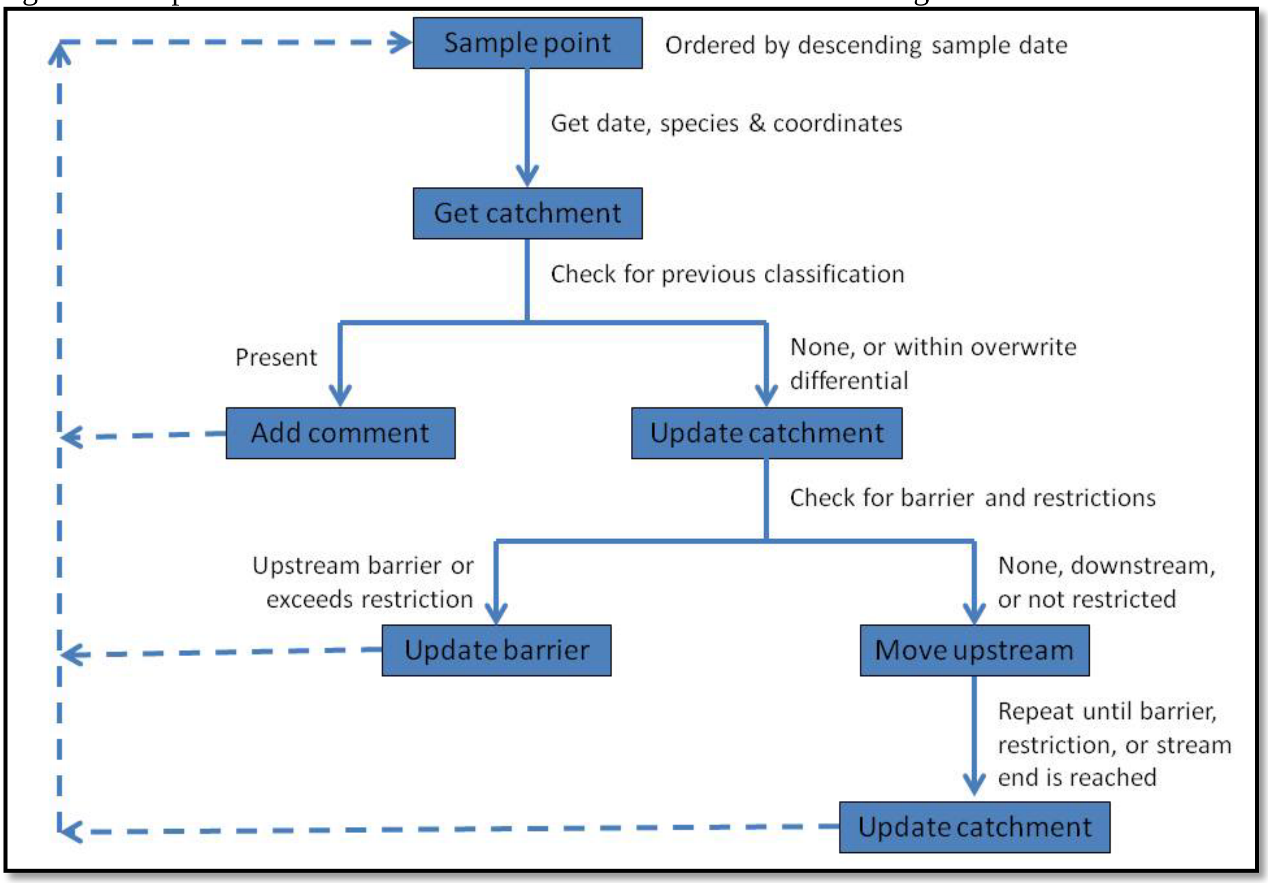


Figure 2: Simplified flowchart of the salmonid habitat patch algorithm.

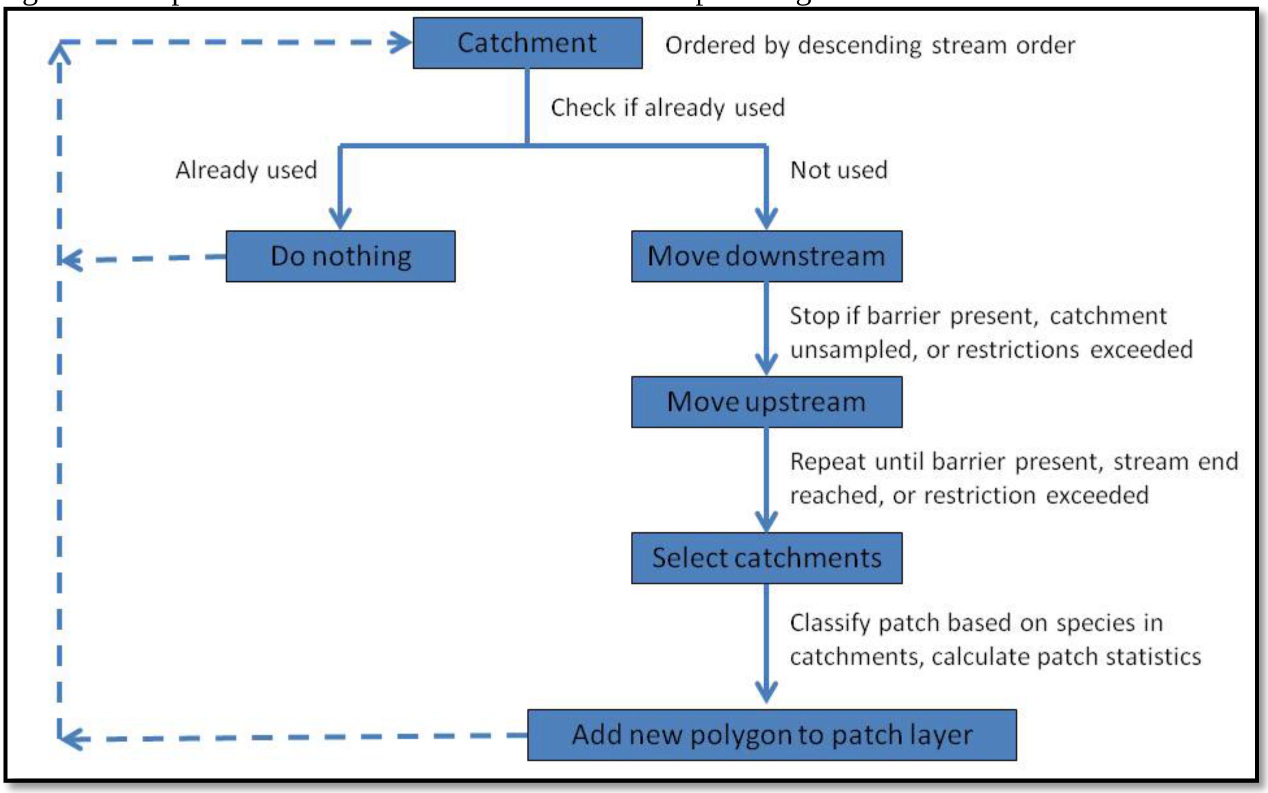
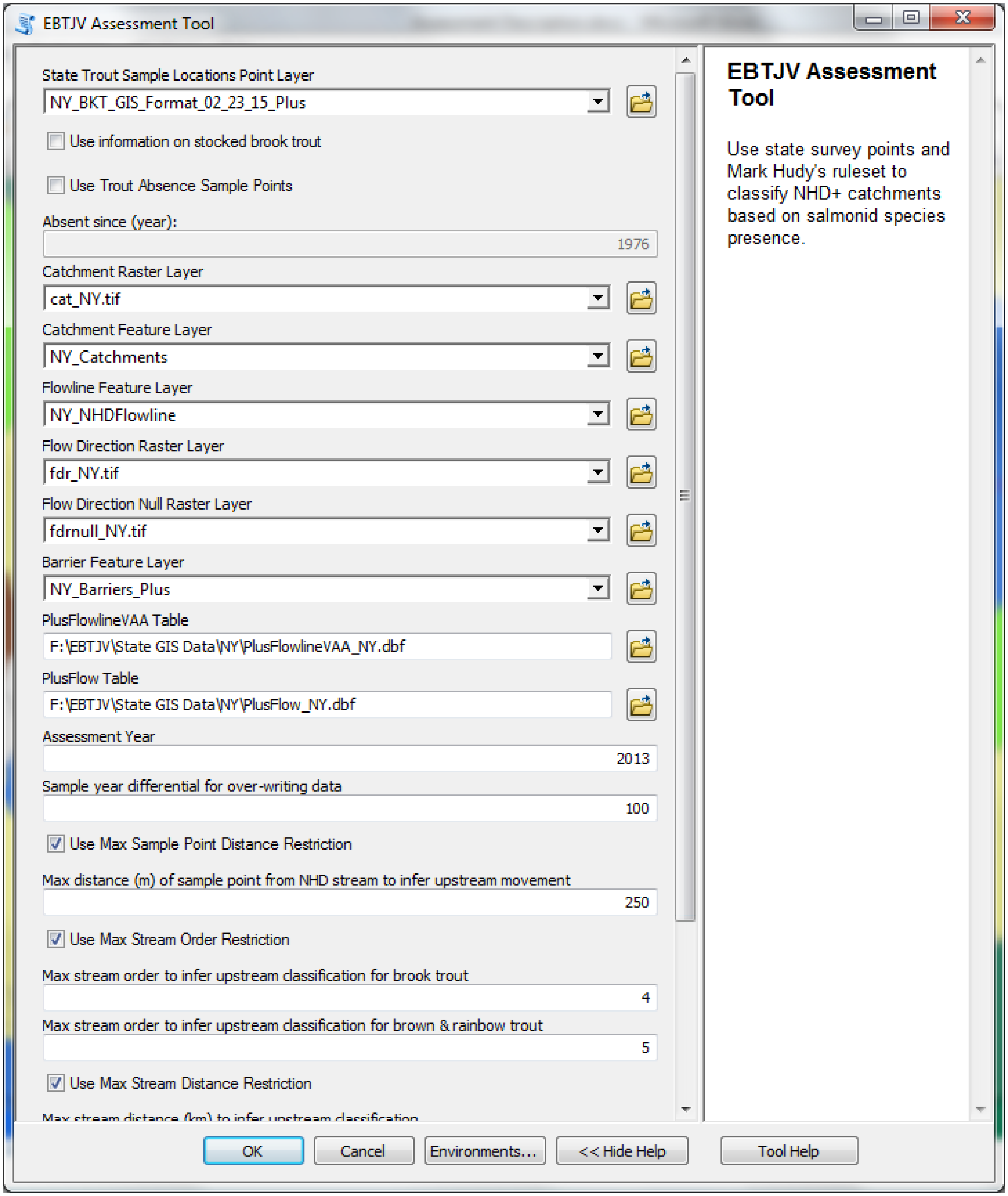
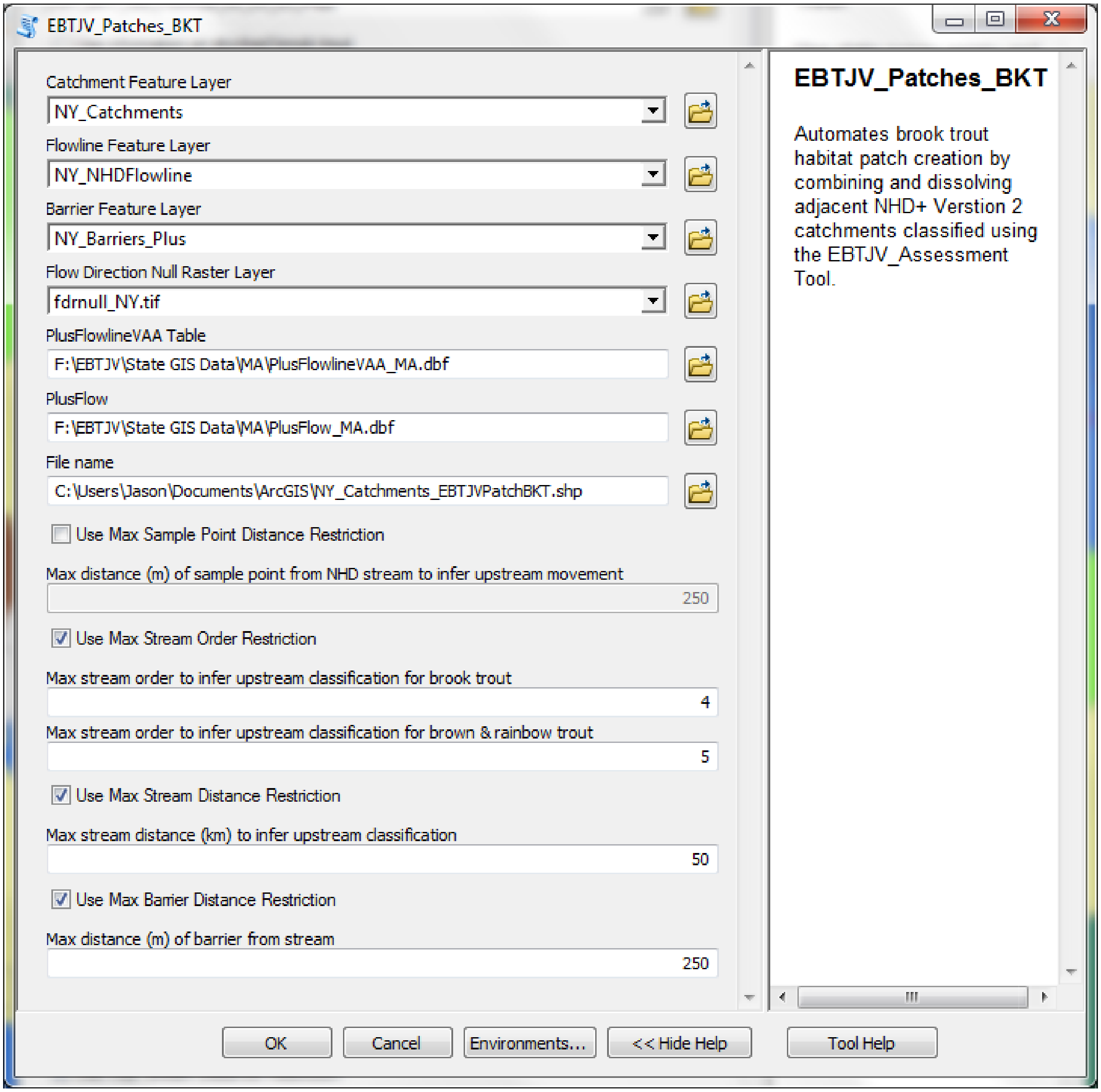


Figure 3: Screen shots of salmonid catchment assessment and habitat patch toolboxes in ArcGIS used to parameterize and run their associated algorithms.





Each toolbox has a simple and intuitive visual interface that enables the user to supply layer and table names, and to specify the use of conditions to restrict the algorithm. The algorithms operate using several spatial layers. The first is a point layer of sample locations containing sample date, salmonid species captured (count or presence), and location coordinates. Additional layers and tables from the NHD+ version 2 dataset are also required. These include the catchment polygon layer, flowline vector layer, catchment raster layer, flow direction raster layer, flow direction null raster layer, plus flowline VAA table, and plus flow table. Finally, a barrier layer is required. The baseline barrier dataset is derived from the National Anthropogenic Barrier Dataset (NABD) 2012. This dataset was further supplemented with the Nature Conservancy's dam layer, and state dam and impassable waterfall locations if provided. All layers were assembled for the entire EBTJV range before being clipped by the outline of HUC 10 drainages spatially joined to a state and dissolved into a single feature in order to alleviate edge effects.

Catchment classification consisted of determining which species were present, and how long ago the sample was conducted. All samples occurring greater than 10 years from the analysis year were given a 'P' after the code representing 'predicted'. Catchments upstream of a sample point were inferred from the downstream catchment, and given the classification code of that catchment. Table 1 details the different classification codes.

Table 1: Catchment classification code definitions (BKT = brook trout, BNT = brown trout, RBT = rainbow trout).

Species Present	Code
Not Classified	-1
None	0
None	0P
BNT	0.2
RBT	0.3
BNT & RBT	0.4
Stocked BKT	0.5
BKT	1.1
BKT & BNT	1.2
BKT & RBT	1.3
BKT & BNT & RBT	1.4
BKT & Stocked BKT	1.5

Certain restrictions ended up being necessary due to the sometimes absence of smaller streams in the flowline layer (Figure 4), the occurrence of multiple stream reaches in a single catchment (Figure 5), and unrealistic biological outcomes. There are four available restriction conditions:

1) Maximum sample point distance
2) Maximum dam point distance
3) Maximum stream order to infer upstream catchment classification
4) Maximum upstream distance to infer catchment classification from the sample point

Restrictions 1 and 2 rectify sample and barrier locations occurring on streams not present in the flowline layer (Figure 4). Restriction 3 deals with sample locations occurring on streams not present in the flowline layer that flow into a large river, or catchments containing multiple flowlines where the sample location occurs in a smaller stream while the catchment is associated with the larger stream or river (Figure 5). Restriction 4 enables the user to limit upstream catchment classification inferred from a downstream sample location based on total stream distance.

Additional options incorporated into the algorithm to enhance flexibility include:

1. The ability to trump a "0" classification (no salmonids) with an older sample positive for salmonid occurrence present in the same catchment as long as the older sample was conducted on or after a user-specified cutoff year.
2. The ability to classify a catchment based on the combination of species present in different samples within the same catchment within the same year instead of restricting it to only the most recent sample.

Figure 4: Image depicting a single catchment containing multiple sample (purple diamond) and barrier (yellow diamond) locations, with several of them occurring well away from the flowline (blue line).

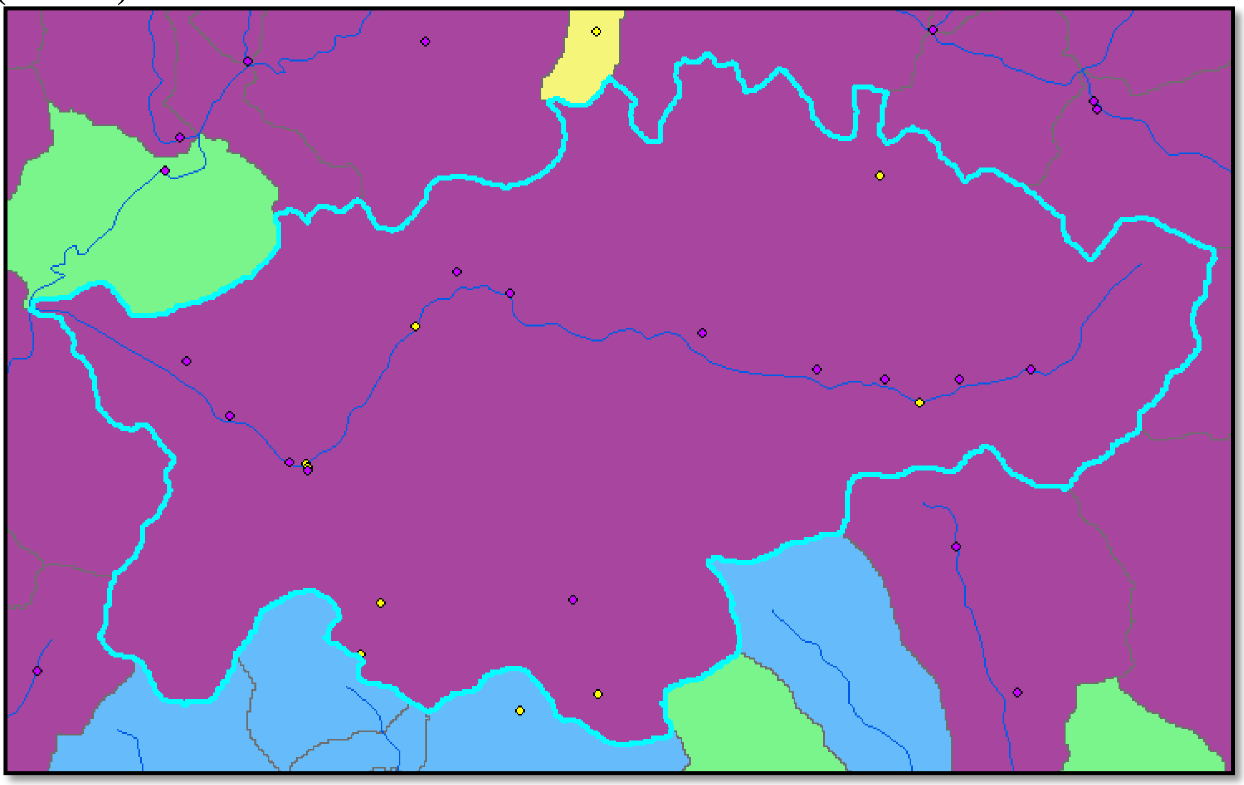
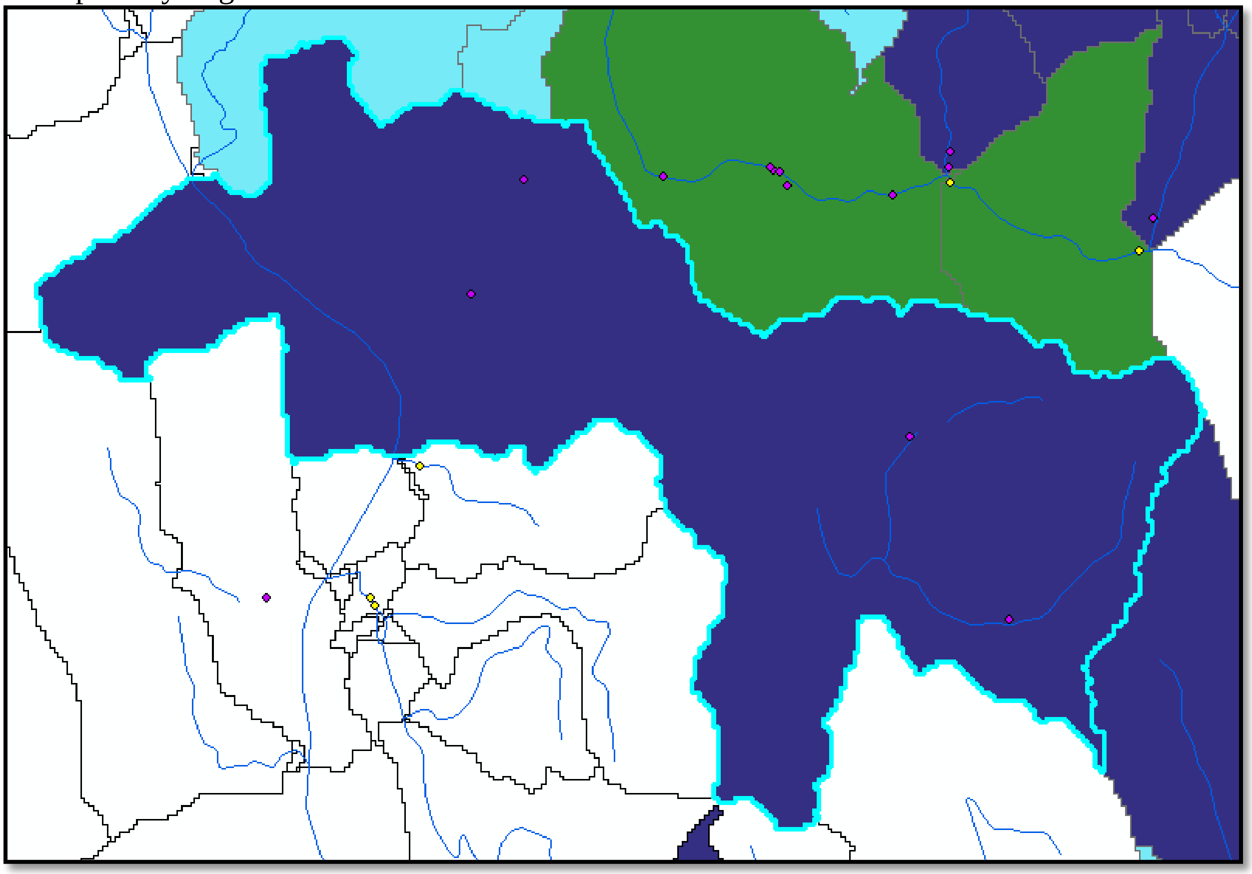


Figure 5: Image depicting catchment with multiple flowlines (blue lines) where sample locations (purple diamonds) occur in secondary or non-existent flowlines, while the catchment is assigned to the primary larger ordered flowline.



Analyses for all Northern states (except Maine) were run using the following default conditions:

- Max sample point distance = 250 meters
- Max dam distance = 250 meters
- Max stream order BKT = 4th order
- Max stream order Invasives = 5th order
- Max upstream distance = 50 kilometers

Note: Settings for Maine were No max sample point distance (because catchment centroids were used instead of sample points), max stream order for brook trout was 5, max upstream distance for brook trout was 80 km, and max upstream distance for invasives was 10 km.

The sample point condition was not used for patch reconstruction because the stream order condition appeared to take care of small tributaries flowing into larger rivers and multi-flowline catchments, and I wanted to allow connectivity for other instances.

For patch reconstruction, two different algorithms are used. The first algorithm (brook trout) delineates patches for catchments containing brook trout in either allopatry or sympatry, but ignores catchments containing only brown and/or rainbow trout. The second algorithm (wild trout) delineates patches for catchments containing any combination of salmonids.

Results

Both algorithms output results to ESRI shapefiles. The catchment assessment algorithm adds several fields directly to the NHD+ catchment polygon attribute table (Table 2, Figure 6).

Table 2: Descriptions of fields added to the NHD+ catchment layer by the catchment assessment analysis.

Field	Description
EBTJV_Code	The classification code of the catchment based on salmonid species present
Catch_Cnt	Sequential upstream catchment count from the catchment containing the sample point used for classification
Cum_Length	Cumulative stream length from the catchment containing the sample point used for classification
Samp_Year	The year in which the sample point used for classification was conducted
Samp_Dist	The Euclidian distance of the sample point location from the flowline (only calculated for catchments containing the sample point used for classification)
Samp_OID	The object identifier (fid) of the sample point used for classification
Dam	Whether or not the catchment contains a barrier
Samp_Loc	Whether the sample point is above or below the barrier (only determined for catchments containing the sample point used for classification and a barrier)
Str_Order	The stream order of the flowline associated with the catchment
Comment	Adds the classification code and sample year for additional sample points located in the catchment

Figure 6: A portion of the catchment assessment layer attribute table after analysis containing newly added fields.

EBTJV_Code	Catch_Cnt	Cum_Length	Samp_Year	Samp_Dist	Samp_OID	Dam	Samp_Loc	Str_Order	Comment
1.1	1	1.523	2010	123.693169	1628	No		2	Sampled in 2009 and had an assessment code of 1.1. Sampled in 2007 an
1.1	2	2.984	2010	0	1628	No		2	
1.1	2	6.585	2010	0	1628	No		2	
1.1	3	4.363	2010	0	1628	No		2	
1.1	3	6.013	2010	0	1628	No		2	
1.1	3	7.048	2010	0	1628	Yes		1	
1.1	4	5.704	2010	0	1628	No		2	
1.1	4	9.039	2010	0	1628	No		2	
1.1	5	6.096	2010	0	1628	No		2	
1.1	5	8.908	2010	0	1628	No		2	
1.1	6	8.98	2010	0	1628	Yes		2	
1.1	6	6.589	2010	0	1628	Yes		2	

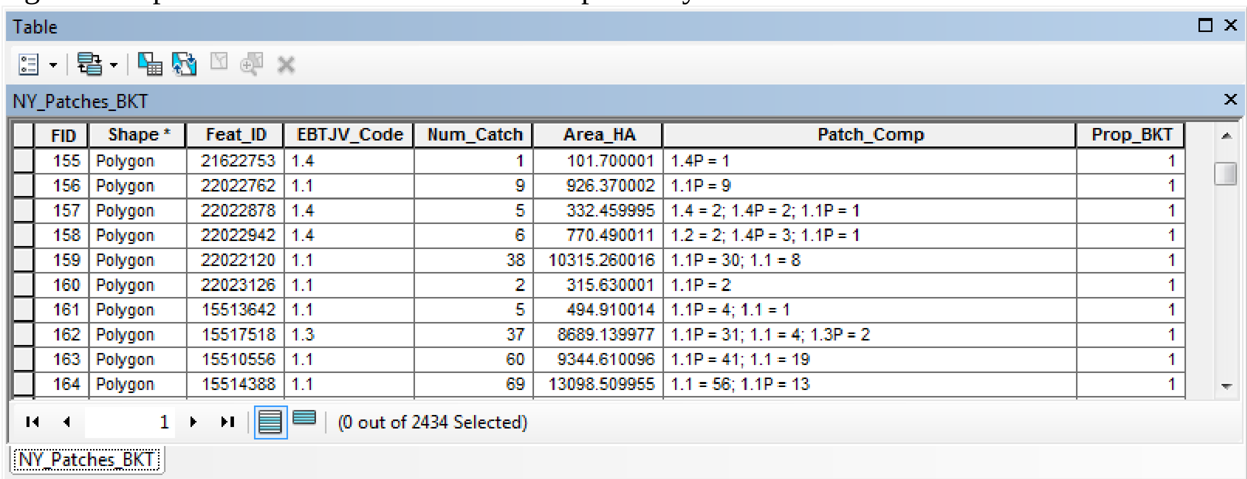
The habitat patch algorithms save all patches to a shapefile named by the user. Each algorithm (brook trout, wild trout) creates its own shapefile. Table 3 and Figure 7 detail the information contained in the attribute table of each habitat patch shapefile.

Table 3: Descriptions of fields output to the habitat patch layer attribute table.

Field	Description
Feat_ID	The FEATUREID of the most-downstream catchment contained in the patch
EBTJV_Code	The classification of the patch based on the classification of the catchments within it

Num_Catch	The number of catchments contained within the patch
Area_HA	The total area of the patch in hectares
Patch_Comp	The classification composition of the catchments within the habitat patch
Prop_BKT	The proportion of catchments within the patch classified as containing brook trout

Figure 7: A portion of the brook trout habitat patch layer attribute table.



Table

NY_Patches_BKT

FID	Shape *	Feat_ID	EBTJV_Code	Num_Catch	Area_HA	Patch_Comp	Prop_BKT
155	Polygon	21622753	1.4	1	101.700001	1.4P = 1	1
156	Polygon	22022762	1.1	9	926.370002	1.1P = 9	1
157	Polygon	22022878	1.4	5	332.459995	1.4 = 2; 1.4P = 2; 1.1P = 1	1
158	Polygon	22022942	1.4	6	770.490011	1.2 = 2; 1.4P = 3; 1.1P = 1	1
159	Polygon	22022120	1.1	38	10315.260016	1.1P = 30; 1.1 = 8	1
160	Polygon	22023126	1.1	2	315.630001	1.1P = 2	1
161	Polygon	15513642	1.1	5	494.910014	1.1P = 4; 1.1 = 1	1
162	Polygon	15517518	1.3	37	8689.139977	1.1P = 31; 1.1 = 4; 1.3P = 2	1
163	Polygon	15510556	1.1	60	9344.610096	1.1P = 41; 1.1 = 19	1
164	Polygon	15514388	1.1	69	13098.509955	1.1 = 56; 1.1P = 13	1

1 (0 out of 2434 Selected)

NY_Patches_BKT

Validation Process

The validation process involved each state looking at the catchment layer classifications (EBTJV_Code) and determining if they should differ from what the algorithm produced. For example, a catchment classified as containing only rainbow trout (0.3) should also contain brook trout and so should be changed to 1.3. Or, an unclassified catchment (-1) should be classified as having brook trout and so should be changed to 1.1.

To accomplish this, each state received the following spatial layers (file name where XX is state abbreviation):

- Catchments ('XX_Catchments')
- Habitat patches (1 combined and 1 for each species) ('XX_Patches', 'XX_Patches_BKT', 'XX_Patches_BNT', 'XX_Patches_RBT')
- Sample locations ('XX_BKT_GIS_Format_Plus')
- Barrier locations ('XX_Barriers_Plus')
- Streams ('XX_NHDFlowline')
- Waterbodies ('XX_NHDWaterbody')
- State outline (State name)
- HUC_10 outline ('XX_HUC10_Outline')
- Roads ('XX_Roads')
- Style files ('Catchment_Style_10.0.lyr' or 'Catchment_Style_10.1.lyr' for ArcMap, 'Catchment_Style.sld' for Quantum GIS)

Catchments were visualized and examined using either ArcGIS or Quantum GIS (QGIS) software (NOTE: See below for steps on how to add and style the data). Catchments requiring changes to the classification code had the following information written to a file (see example in Table 4):

- FEATUREID of the catchment
- Current EBTJV_Code
- Replacement EBTJV_Code
- Reason

Table 4: Format for returning edits to the catchment assessment layer.

FEATUREID	EBTJV_Code CURRENT	EBTJV_Code CHANGE	Reason
22152571	1.2	1.1	Brown trout were stocked
22152673	-1	1.1	Knowledge of trout presence

Received edits were applied to the associated catchment layer through an automated process that performed the following steps:

- The fields val_change and val_reason were added to the catchment layer

Field	Description
val_change	The original classification code of the catchment
val_reason	The justification for the classification code change

- The classification code for the catchment was changed to the edited value
- Any catchments upstream of the edited catchment deriving their classification code from the same source as the edited catchment were changed to the edited value
- The val_change and val_reason fields are populated with the original catchment classification and the reason for the edit.

Visualization

The final catchment and patch layers can be viewed and downloaded at the following websites:

http://ecosheds.org:8080/geoserver/www/Web_Map_Viewer.html

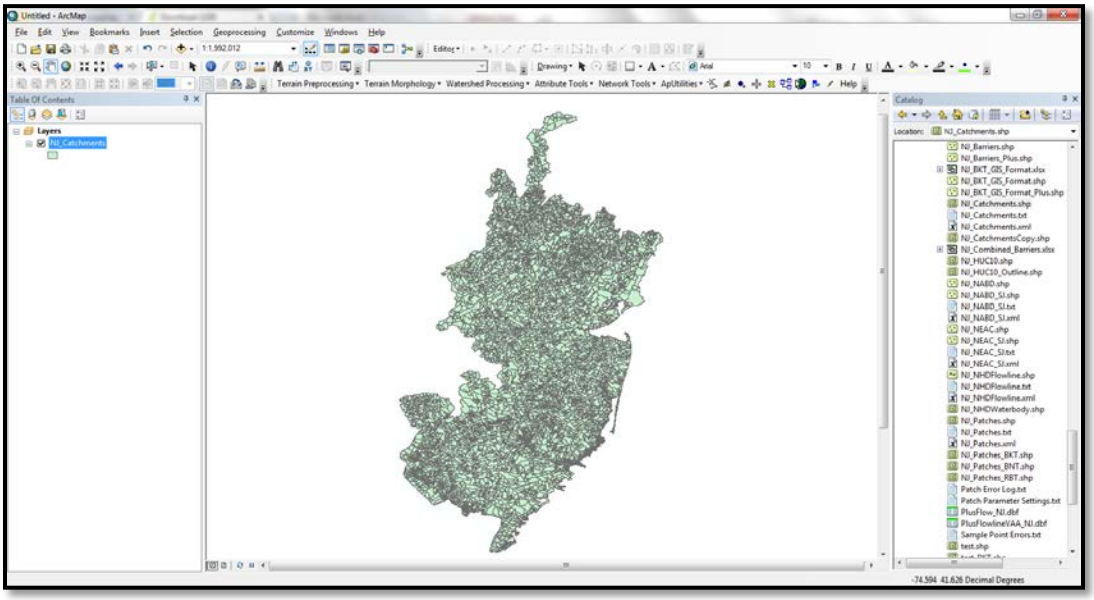
http://www.conservationdesign.org/

A geodatabase containing the catchment and patch layers is also available for download here:

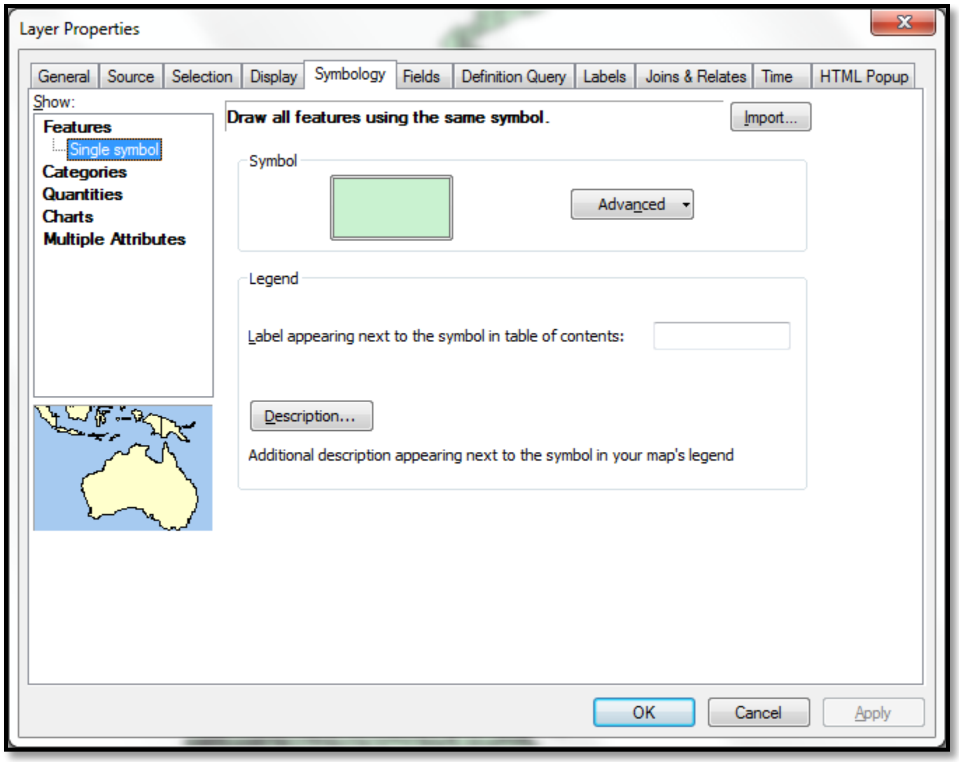
http://ebtjv.s3.amazonaws.com/Assessment/EBTJV%20Range-Wide%20Layers%2009_23_15.gdb.zip

Steps for adding the catchment layer to ArcMap 10.1

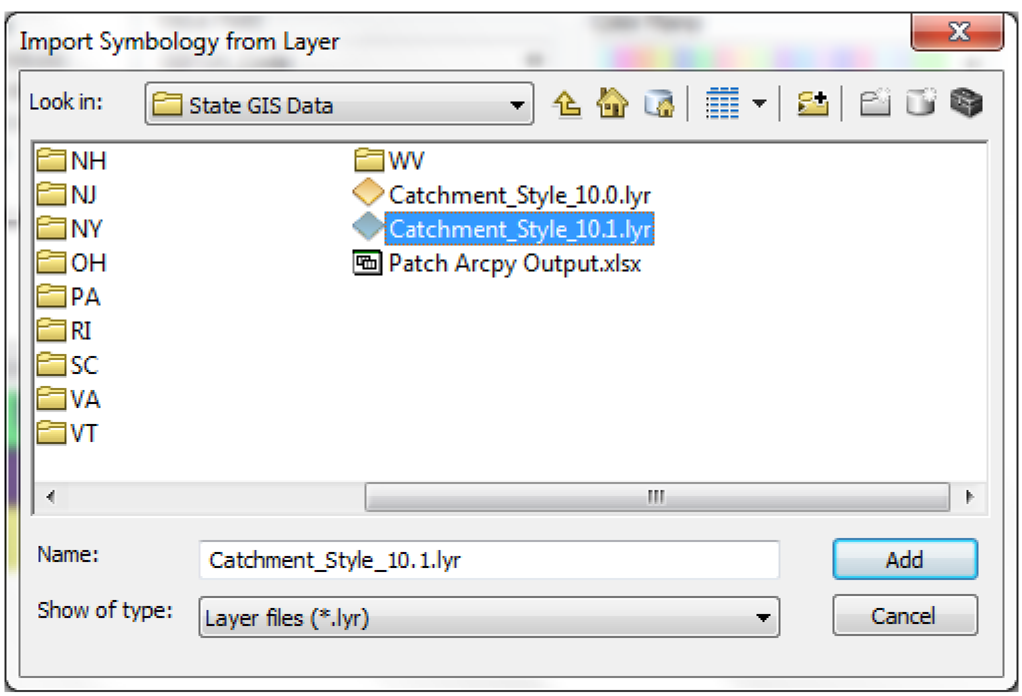
1) Add the 'xx_catchment.shp' file to your map where 'xx' represents your state abbreviation.

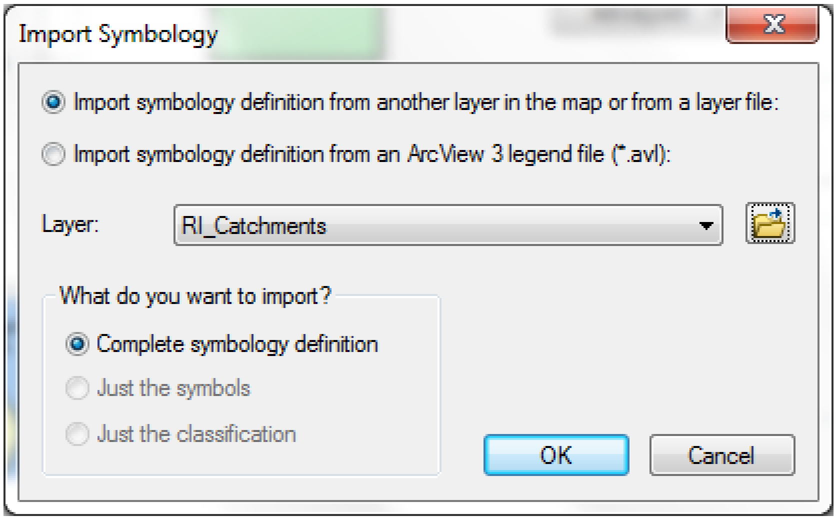


2) Open the catchment layer's properties (either double-click on layer name in table of contents or right-click on layer name and select properties), and select the 'Symbology' tab.

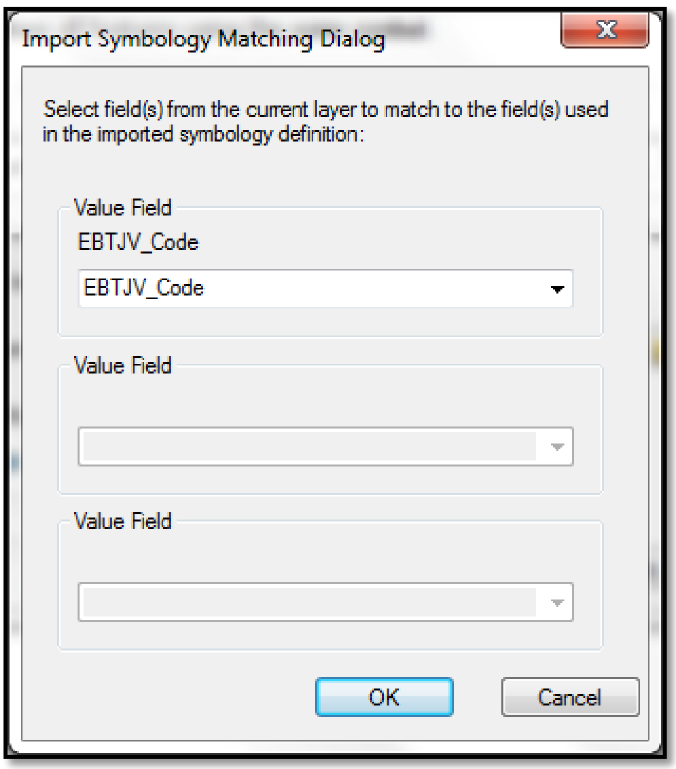


3) Click the 'Import...' button in the upper right corner and select the 'Catchment_Style_10.1.lyr' file.
NOTE: For ArcMap 10.0 use the 'Catchment_Style_10.0.lyr' file.
NOTE: Layer will say 'RI_Catchments', but this is alright.

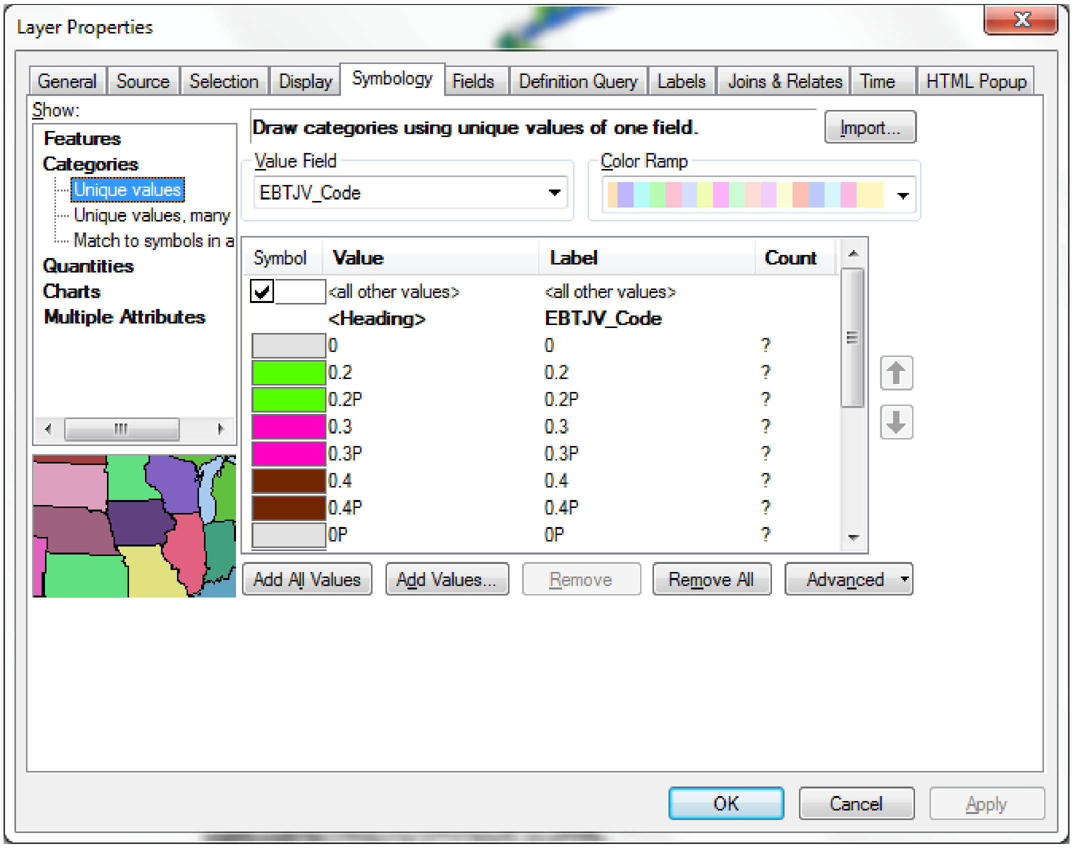




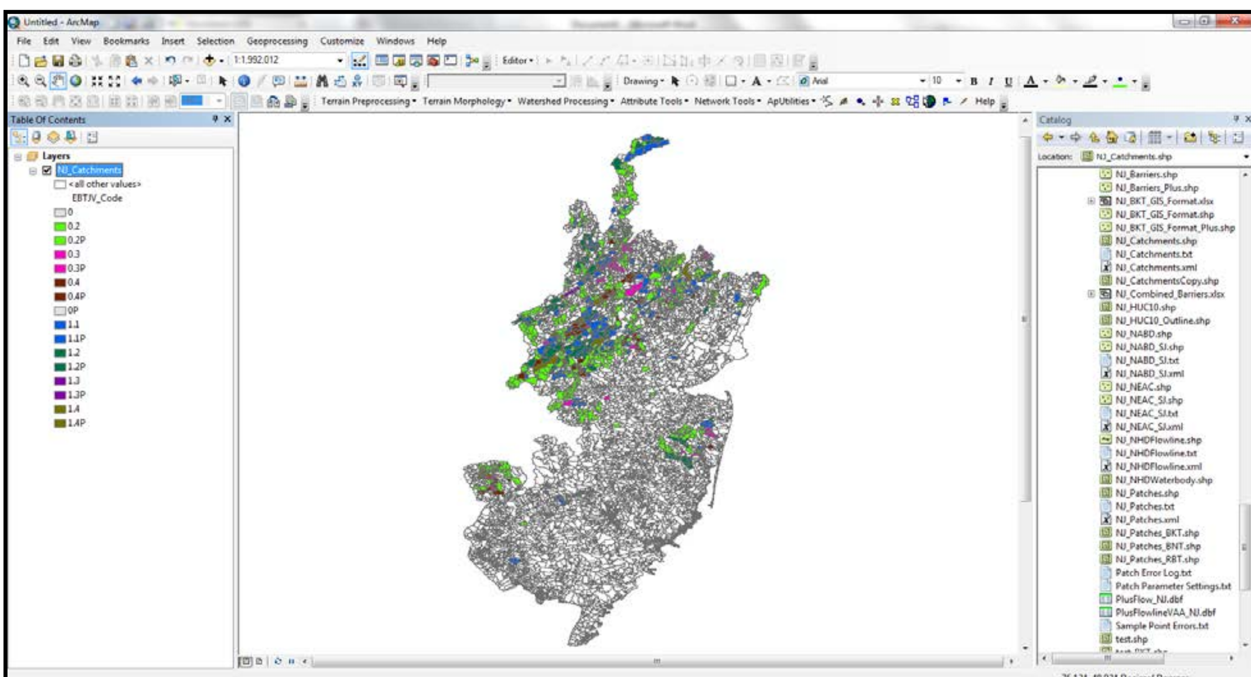
4) Click 'OK'.



5) Leave the value field as 'EBTJV_Code', and Click 'OK'.

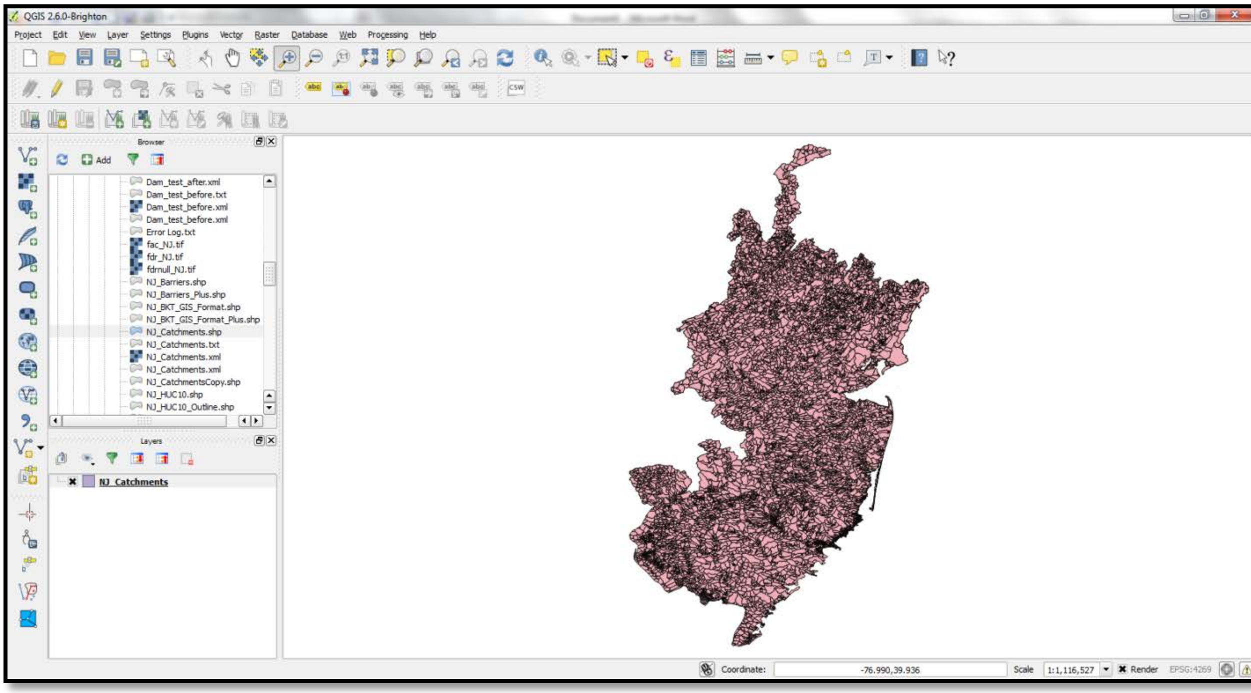


6) Click OK again to close properties.

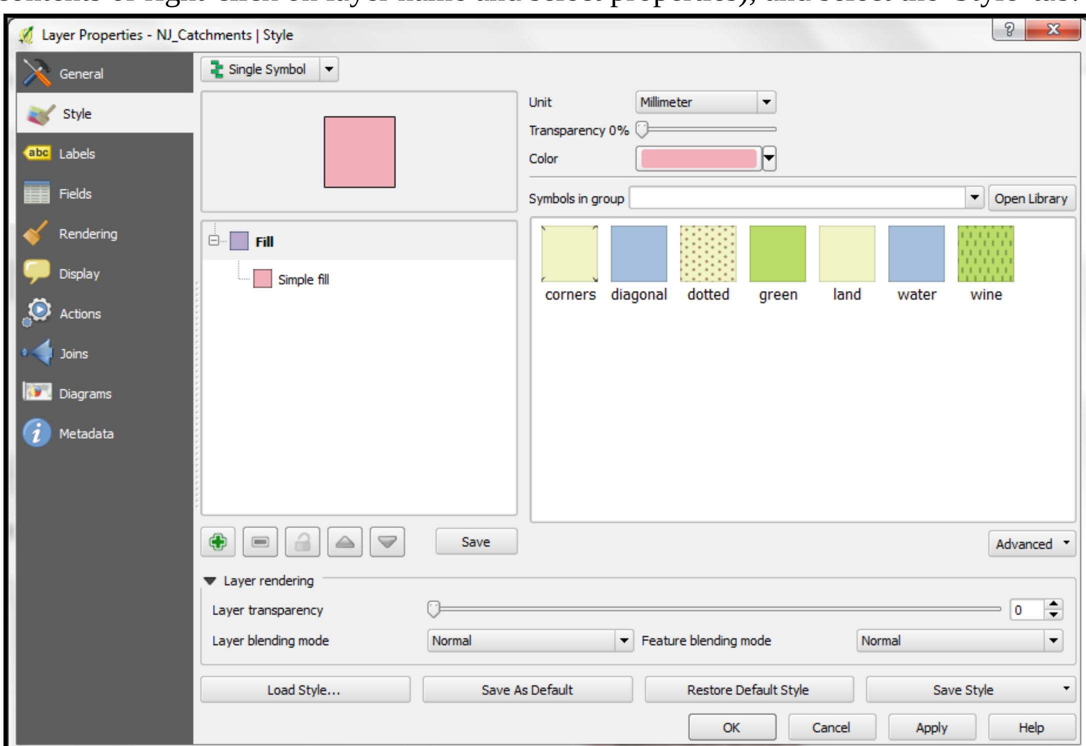


Steps for adding the catchment layer to Quantum GIS (QGIS) 2.6

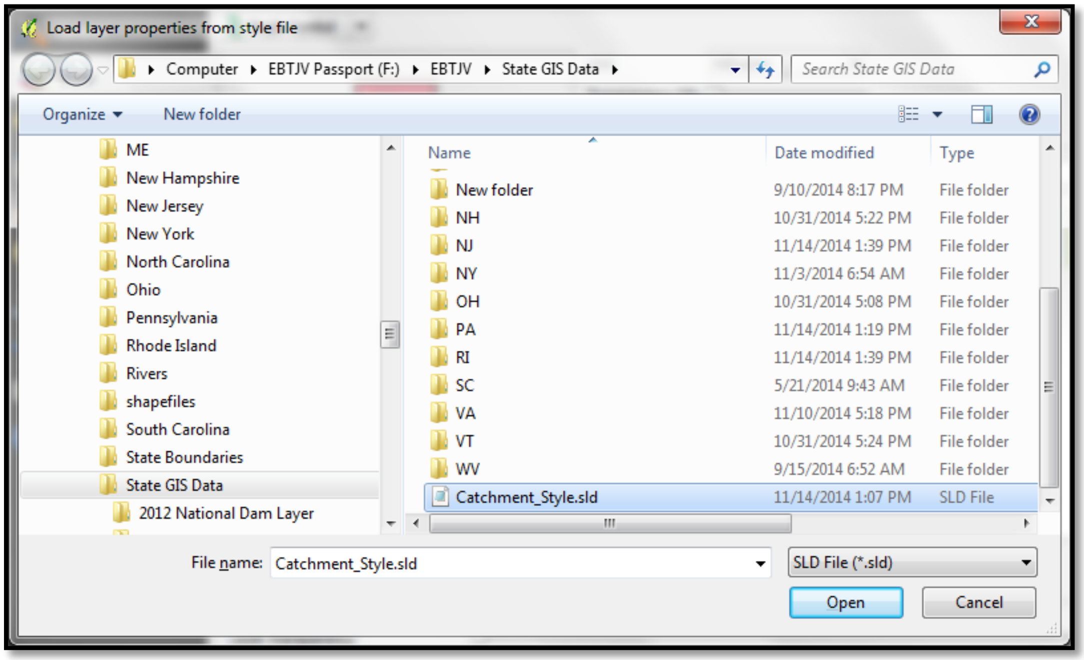
1) Add the 'xx_catchment.shp' file to your map where 'xx' represents your state abbreviation.



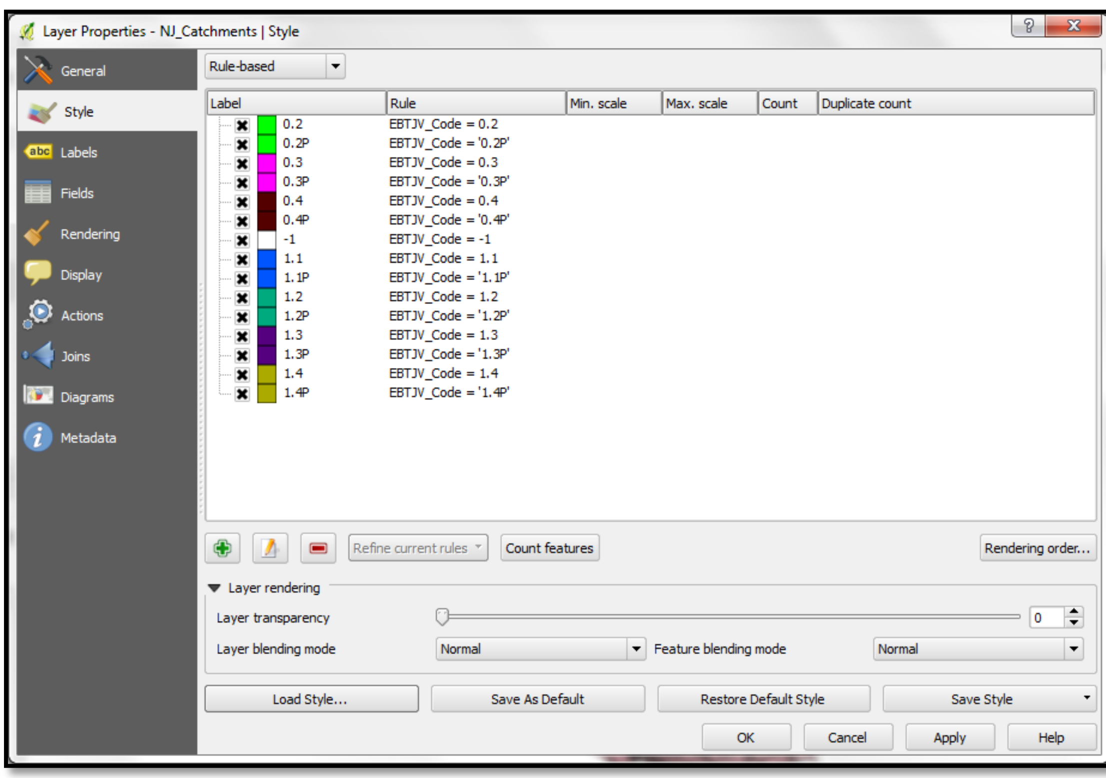
2) Open the catchment layer's properties (either double-click on layer name in table of contents or right-click on layer name and select properties), and select the 'Style' tab.



3) Click the 'Load Style...' button in the lower left corner and select the 'Catchment_Style.sld' file. NOTE: Change file extension to 'SLD File (*.sld)'.



4) Click 'Open'.



5) Click 'OK' to close properties.