Riparian Model

User Guide

San Francisco Estuary Insitute

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Riparian Model
User Guide
Contents

Introduction

This user guide provides information to the analyst who will be running the Riparian Model about software requirements, how to install the model, how to prepare data for use in the model, how to run the model, and what the results of the model are.

The Riparian Model runs in ESRI's (Environmental Systems Research Institute) ArcMap environment and is fully coded in VBA (Visual Basic for Applications) using ArcObjects. The user is required to add data inputs to ArcMap, run the model from a set of forms in ArcMap, then the results are added to ArcMap (and to a Microsoft Access database).

The Riparian Model is organized into two separate modules: ***Stream*** and ***Wetland***. At some point the model may be developed so these run together, but currently they are run separately. The Stream module should be run before the Wetland module as the resulting Stream Riverine areas (the stream channels) are used to exclude Wetland Riparian. It is certainly possible to run just either one (e.g. Wetland and not Stream), in which case the Stream Riverine is not considered when modeling Wetland Riparian areas.

Both Stream and Wetland modules have ***Vegetation*** and ***Hillslope*** "processes". The Vegetation process models the effect of adjacent vegetation on defining riparian function. The Hillslope process models just the effect of slope on defining riparian function. Note that the Vegetation process also takes into account slope in combination with vegetation height to determine if a fallen tree will contribute to riparian function. It is possible to run these processes separately for the Wetland module (e.g. just Vegetation or just Hillslope), however they must be run together for the Stream module (the plan is to decouple these processes in the Stream module).

Software Requirements

Software Version and Extension

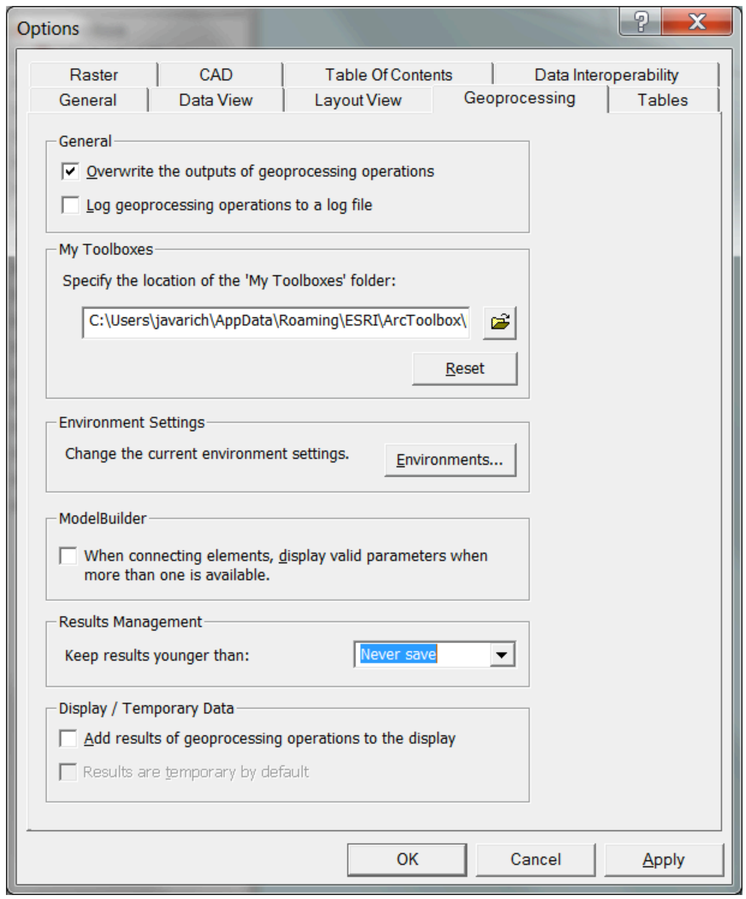
The Riparian Model requires ESRI's (Environmental Systems Research Institute) ArcGIS version 9.3 at the ArcInfo licensing level, with the Spatial Analyst extension. The model is very geoprocessing intensive, and ESRI tends to make many of these tools available only at the ArcInfo licensing level. The model also makes use of the Spatial Analyst extension to convert a Digital Elevation Model (DEM) into a slope raster, plus Spatial Analyst is required to determine areas that flow into wetlands, and to calculate average slope for those contributing areas.

GeoProcessing History

ArcGIS retains a geoprocessing history and provides the ability to configure how much history to retain. By default the history is retained for two weeks. Since the Riparian Model implements a high number of geoprocessing tools the history grows very quickly and can result in a very large ArcMap document. The base Riparian Model ArcMap document is under 3MB in size, but can easily grow beyond, 10, 20, and even 30MB if the geoprocessing history is retained.

There are three solutions to this problem:

1. Use a fresh copy of the base Riparian Model when you run the model.
2. If the ArcMap document grows too large, the geoprocessing history can be cleared, and the document saved to a new copy:
    a. In ArcToolbox, ***Results*** tab, right-click on ***Previous Sessions*** and ***Remove All***.
    b. In ArcToolbox, ***Results*** tab, right-click on ***Current Session*** and ***Remove All***.
    c. From the ***File*** pulldown menu, ***Save a Copy***.
3. Configure ArcMap so that geoprocessing history is never saved. This has already been configured for the base ArcMap document, but it may become necessary to repeat.
    a. From the ***Tools*** pulldown menu, ***Options***, ***Geoprocessing*** tab, set ***Keep results younger than***: to ***Never save***.



Software Checklist

- ☐ ArcGIS version 9.3 or higher
- ☐ ArcInfo licensing level
- ☐ Spatial Analyst extension
- ☐ Configure Geoprocessing History

Installing the Model

Installation Location

There is no installer program to install the Riparian Model, it is simply a matter of copying folders from the source (DVD or zipped file) to a desired location on your hard drive or network drive.

Installation Files

The folder ***RiparianModel*** is the root level of the model and contains all required and support files and folders related to the model. Each subfolder includes a short document describing the contents.

- **Model**
    - Folder that contains the base model ***RiparianModel.mxd***. This file should be copied and used to run the model for specific geographic areas.
- **Documentation**
    - Folder that contains various documentation, including this User Guide.
- **SampleData**
    - Folder that contains sample datasets that are known to work in the model.
- **SampleResults**
    - Folder that contains the results of a model run from the Petaluma watershed.

Results Location

By default the results are stored on the C: drive in the folder RiparianModelResults (***C:\RiparianModelResults***). Note that this location is relatively easy to change by following the instructions in the next section "***Configuring the Model***" (change the value of the variable ***WorkPath*** in the module ***GeneralVar***).

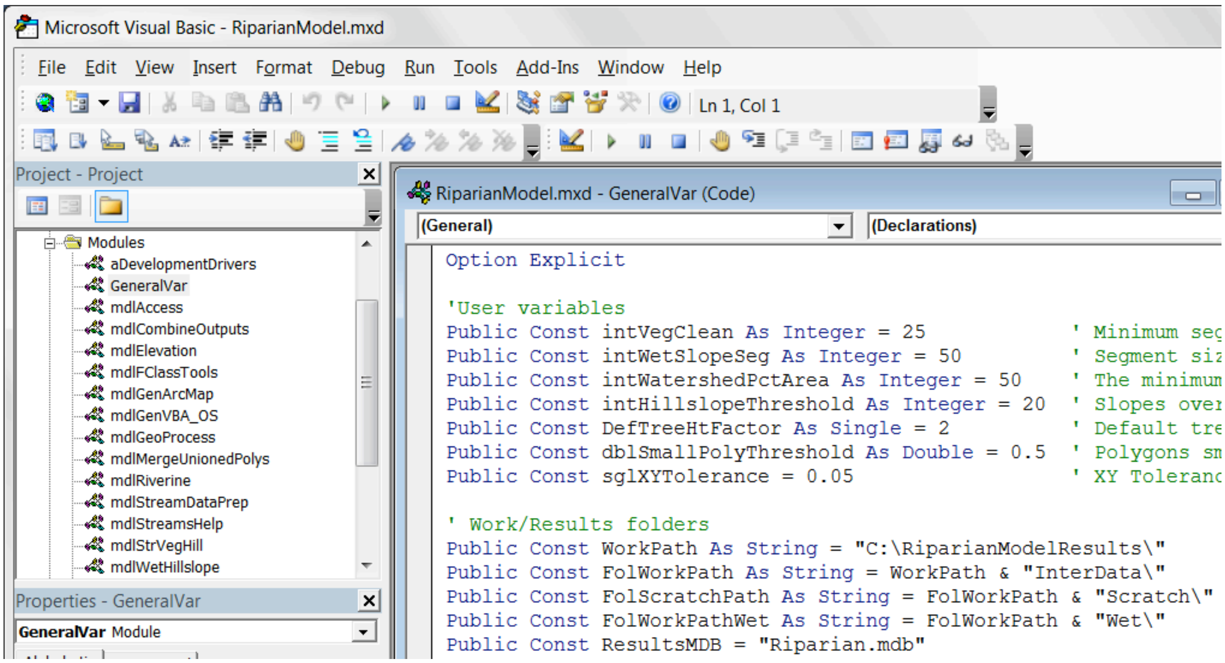
Configuring the Model

Parameters

A possible future enhancement for the model is the creation of a configuration database and accompanying utility to allow the user to set various model parameters that are currently hardcoded into the model. It is currently possible for the user to change some of these hardcoded parameters by editing variables stored in one of the VBA (Visual Basic for Applications) modules called ***GeneralVar***. Editing these parameters doesn't require any programming experience.

One thing to keep in mind: changes made to a particular ArcMap document will only be applicable to that ArcMap document and any copies made from it. If the desire is to apply changes to all instances of the model, then those changes should be made to the base ArcMap document, RiparianModel.mxd. If this happens, then restoring the default values can happen by overwriting RiparianModel.mxd with the original provided on DVD or zipped file.

To open the module ***GeneralVar***, open the desired ArcMap document, pull down the ***Tools*** menu, select ***Macros***, then ***Visual Basic Editor***. In the Project Explorer at the left, expand the ***Modules*** folder, locate ***GeneralVar***, and double-click to open it.



Parameters that can be modified include:

- **intVegClean**
    - After overlaying stream or wetland boundaries with vegetation, segments shorter than this length are merged with longer connected segments.
- **intWetSlopeSeg**
    - If just running the hillslope module (and therefore no overlay with vegetation), watershed boundaries are segmented to this length.
- **intWatershedPctArea**
    - If the area of the contributing watershed that intersects with a wetland boundary segment buffer is less than this percentage of the segment buffer area, then the average slope of the wetland boundary segment is set to 0; otherwise it is set to the average slope of the area of the intersecting area.
- **intHillslopeThreshold**
    - When calculating hillslope riparian, an additional meter is added to the riparian buffer for each percent slope above this value. If this value is 20 and percent slope is 21, the hillslope buffer will be 1 (20 – 21).
- **DefTreeHtFactor**

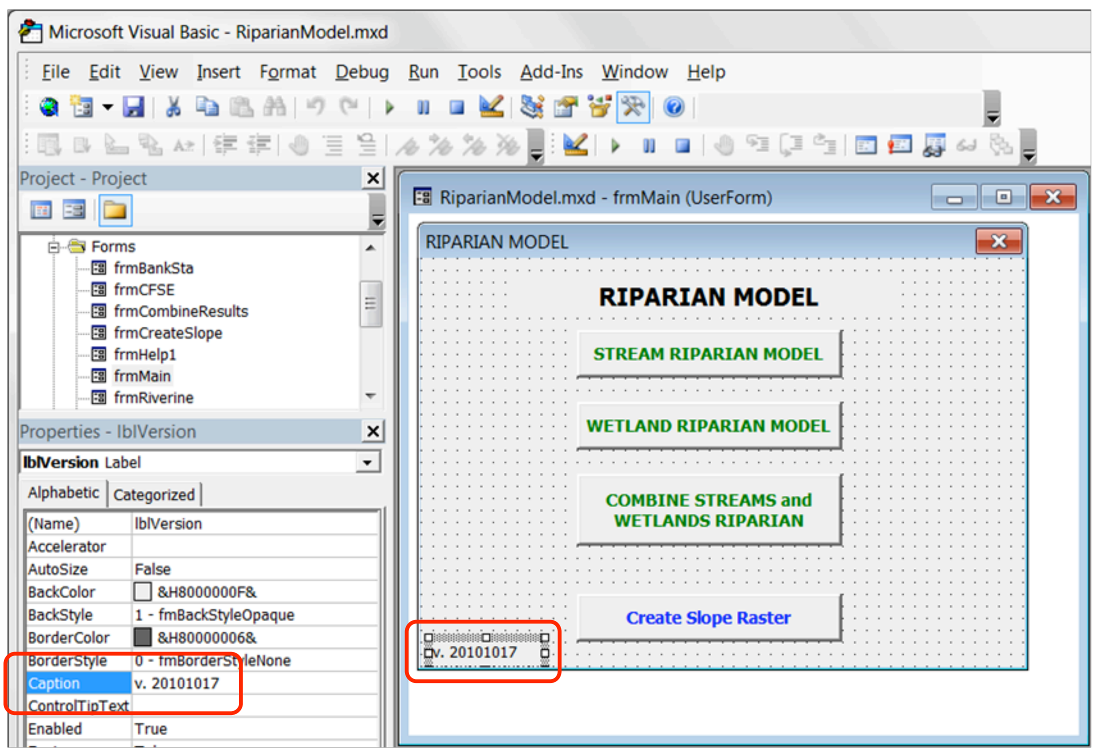
- This is the default Tree Height Factor, and can be changed in either (Stream or Wetland) of the vegetation input forms.

- **dblSmallPolyThreshold**
  - Polygons smaller than this are either merged with larger neighbor polygons, or deleted.
- **WorkPath**
  - The drive and path of the model results.

Model Version

The convention for tracking model versions is to put and maintain a version number on the main form. While this is not essential, it is an effective technique for keeping track of different versions or variations of the model, and it is not difficult to change this label on the main form. The model number is based on the calendar date, and is in the form of “v. yyyymmdd”. For example, “v. 20101017” is the version created on October 17, 2010.

To open the main form ***frmMain***, open the desired ArcMap document, pull down the ***Tools*** menu, select ***Macros***, then ***Visual Basic Editor***. In the Project Explorer at the left, expand the ***Forms*** folder, locate ***frmMain***, and double-click to open it.



With frmMain open, click on the version label at the lower left corner. If the properties window is not open (as shown in the graphic), right-click on the label and select ***Properties***. In the Properties window, locate the ***Caption*** property, then change its value as desired.

Data Requirements

Data Format

During development of the model, vector data inputs were stored in a Personal Geodatabase, and raster data inputs were stored in GRID format. However the model was tested using both Shapefiles and File Geodatabase for storing vector data, so the model should work with any of these three formats.

All intermediate and final datasets created by the model are stored in Shapefile and GRID formats.

Coordinate System

The model makes a number of calculations (buffer distances, slope angles) using metric units and it currently does not accommodate conversion from any other units (e.g. feet) to metric (the one exception is elevation units of the Digital Elevation Model, which can be feet or meters). Therefore the coordinate system of any input data ***must be metric***.

Furthermore, the model does not accommodate mixing of coordinate systems; therefore all input data ***must be in the same coordinate system***.

Two logical coordinate systems for use in California are ***California (Teale) Albers NAD83*** and ***UTM NAD83*** (zones 10 or 11).

Input Datasets

		Required For			
Dataset	**Format**	**Stream Module**	**Wetland Module**	**Vegetation Riparian**	**Hillslope Riparian**
Stream Network	Vector	✓			
Wetland	Vector		✓		
Vegetation	Vector	✓	✓	✓	
Digital Elevation Model *Necessary for Wetland module, both Vegetation and Hillslope Riparian processes*	Raster		✓	✓	✓
Slope *Necessary for the Stream module, both Vegetation and Hillslope Riparian processes. Can be created from DEM in using the Create*	Raster	✓		✓	✓

Slope Raster tool on the main form.					

Field coding for input datasets can be somewhat complex (especially Standard Bank Distance for Stream, Tidal Hierarchy for Wetland, and Tree Height for Vegetation). It may be helpful to review the sample data provided with the model.

Stream Network

Requirements

- Must be Planarized (no crossing linework without intersections).
- Must not be Multi-Part (must be Single-Part).
- Topology Rules:
    - Must not have Dangles
    - Must not Overlap
    - Must not Self-Overlap
    - Must not Intersect
    - Must not Self-Intersect
- Must have correct flow direction.
- Should not have Pseudo Nodes (not required, but should be single features between confluences).

Fields

Field	**Type**	**Represents**	**Sample Values**	**Constraints**
Stream Type	String	Channels or Ditches.	RWC *(Channel)* RWD *(Ditch)*	No missing or NULL values.
Bayland	Integer or Long	Stream is located on Bayland or Upland area.	0 (Upland) 1 (Bayland)	No missing or NULL values.
StreamOrder	Integer or Long	Strahler Stream Order.	1, 2, 3 … 8	No higher than 8. No skipped values.
Standard Bank Distance *(optional, can be added by the model based on user input)*	Float or Double	For each Stream Order value and for Bayland and Upland, the distance from the center of the stream to the bank (half the width of the stream).	0.5 1 1.5 2 2.5	No missing or NULL values.
	Standard Bank Distance varies by Stream Order, Bayland/Upland, and Wetland Type (Ditch or Channel). There will be one set of distances for each Stream Order value for Bayland, and another set of distances for each Stream Order value for Upland. Ditches will be assigned a single value for Bayland, and a single value for Upland, regardless of Stream Order.			

Wetlands

Requirements

- Must not be Multi-Part (must be Single-Part).

- Topology Rules:
    - Must not Overlap
    - Must not have Gaps
    - These Topology rules are very important. The model evaluates relationships between adjacent polygons and expects that adjacent polygons have identical boundaries.

Fields

Field	Type	Represents	Sample Values	Constraints
Wetland Type	String	Type of Wetland.		No missing or NULL values.
Open Water *(optional)*	Integer or Long	Wetland is Open Water or not.	0 *(Not Open Water)* 1 *(Open Water)*	No missing or NULL values.
	If there are wetland types representing Open Water, this field should be coded to allow the model to apply the appropriate logic (open water does not provide riparian function).			
Tidal *(optional)*	String	***If*** Tidal Logic is to be observed by the model, this field indicates the type of tidal wetland.	TidalMarsh TidalRiparian TidalNon-Riparian Upland Wetland	
	If there tidal wetlands polygons, this field should be coded to allow the model to apply the appropriate logic. For example, Tidal non-Riparian does not provide riparian function, nor does anything provide riparian function to it.			

Vegetation

Requirements

- Must not be Multi-Part (must be Single-Part).
- Topology Rules:
    - Must not Overlap
    - Must not have Gaps

Fields

Field	Type	Represents	Sample Values	Constraints
Vegetation Code	String	Type of vegetation. Classification system is not important; this field helps the user determine/assign Tree Height and Standard Buffer Distance, plus this field will be included in the model results. All features of a particular vegetation code should have the same Tree Height or Standard Buffer Distance.		No missing or NULL values.
Tree Height	Float or Double	Tree height (in meters) for tree types. Use a value of -1 for non-tree types.	-1, 10, 18.5, ….	No missing or NULL values.
Standard	Float or	Standard buffer distance for non-tree	-1,	No missing or

Buffer Distance	Double	types. Use a value of -1 for tree types.	0.5, 1, ….	NULL values.
	Tree Height and Standard Buffer Distance values are based on research and understanding of local vegetation types. The table ***VegetationLookup*** in the Access database ***LookupTables*** in the ***SupportingData*** folder holds sample values used for the California Department of Forestry and Fire Protection (CalFire) FRAP (Fire and Resource Assessment Program - http://frap.cdf.ca.gov/) vegetation data.			

Digital Elevation Model

The model relies significantly on slope, which is derived from a Digital Elevation Model (DEM). The Wetland Module requires a DEM, whereas the Stream Module requires a Percent Slope Raster. The model provides a tool to convert a DEM into a Percent Slope Raster, so the user only needs to acquire a Digital Elevation Model.

The criteria for the DEM are:

- It covers at least 40 meters beyond the extent of all streams and wetlands data.
- It is in the same coordinate system as all other data.
- The elevation (Z) units are known, and are in Feet or Meters (the Percent Slope conversion routines will ask for this and make the appropriate conversion).
- Format must be GRID, Imagine (.img), Personal Geodatabase Raster, or File Geodatabase Raster.

Slope

It is not necessary to provide a slope raster to the model since it can be created from a DEM by the model. If you choose to provide a slope raster however, then it must meet the following requirements:

- It covers at least 40 meters beyond the extent of all streams and wetlands data.
- It is in the same coordinate system as all other data.
- It is an Integer (not floating point) GRID.
- Slope values are Percent, not Degrees slope.
- Format must be GRID, Personal Geodatabase Raster, or File Geodatabase Raster.

Data Requirements Checklist

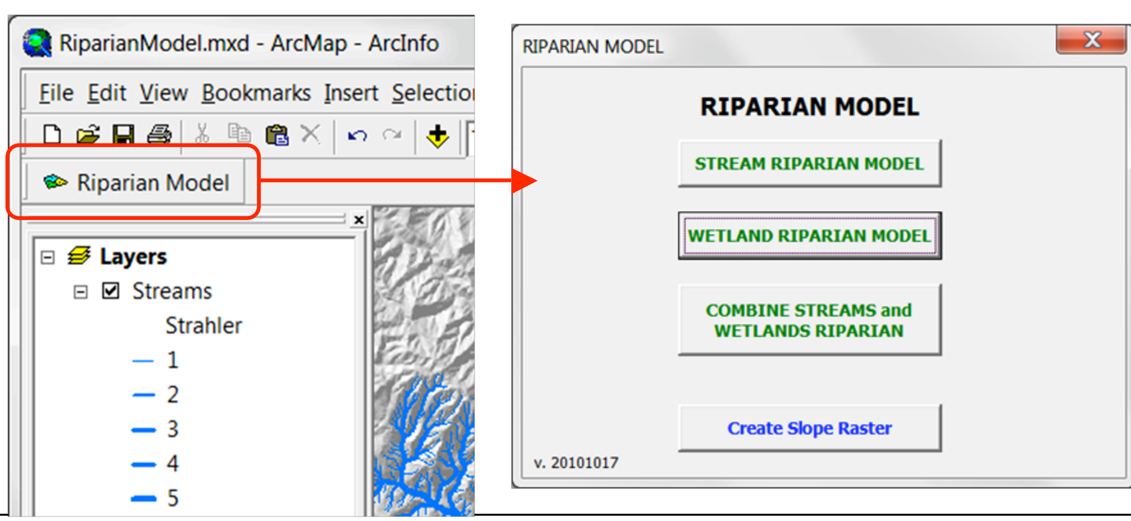
- [ ] Common, metric coordinate system
- [ ] Streams (polylines)
    - String Stream Type field (indicates Ditch or Channel)
    - Integer/Long Bayland field (indicates Bayland or Upland)
    - Integer/Long Stream Order field (Strahler stream order)
    - Optional Float/Double Standard Bank Distance field (distance from center of channel to bank)
- [ ] Wetlands (polygons)
    - String Wetland Type field

    - Optional Integer/Long Open Water field (indicates if open water wetland). Required only if modeling open water.
    - Optional Integer/Long Tidal Hierarchy field (indicates transition from Ocean/Bay to upland). Required only if modeling tidal.
- Vegetation (polygons)
    - String Vegetation Code field (indicates vegetation type)
    - Float/Double Tree Height field (tree height for tree vegetation types)
    - Float/Double Standard Buffer Distance field (buffer distance for non-tree vegetation types)
- Digital Elevation Model
    - Raster format (GRID, Imagine, Personal Geodatabase Raster, File Geodatabase Raster)
    - Elevation units are known and in Feet or Meters
- Slope (optional)
    - Raster format (GRID, Personal Geodatabase Raster, File Geodatabase Raster)
    - Integer Percent Slope

Running the Model

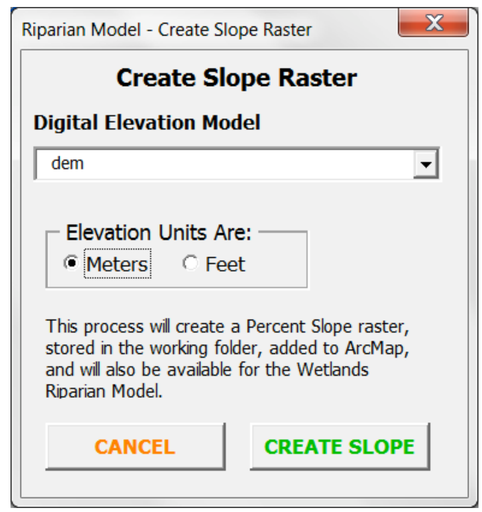
The ArcMap document RiparianModel.mxd has a toolbar with a single button labeled Riparian Model that is used to open the main menu, which offers access to all the model functions. These model functions include:

- Stream Riparian Model
    - Provides access to the Stream Riparian Model.
- Wetland Riparian Model
    - Provides access to the Wetland Riparian Model.
- Combine Stream and Wetland Riparian
    - Combines the results of the Stream and Wetland Riparian models.
- Create Slope Raster
    - This button looks different than the previous three because it is simply a utility that allows the user to properly create a slope raster from the input Digital Elevation Model (DEM).



The model should also be executed in the same order. Stream should be run before Wetland since the Riverine areas generated by the Stream module are used to erase wetland riparian areas. However it is possible to run only Wetland, in which case Riverine areas will not be removed from wetland riparian. Likewise it is common to run only the Stream Riparian Module. It is only possible to combine the results of the Stream and Wetland modules if both have been run.

Create Slope Raster

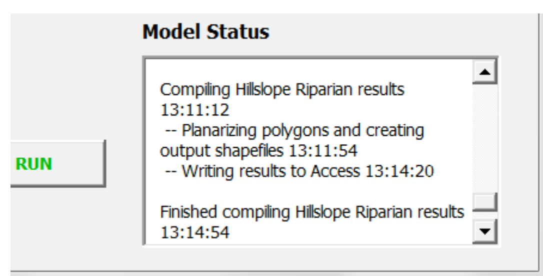


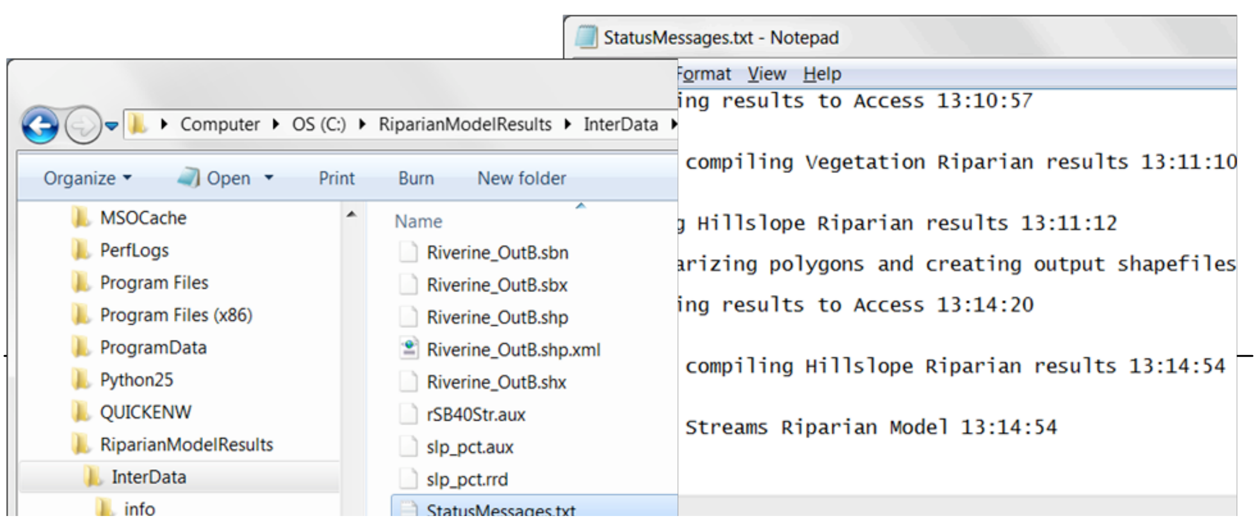
A percent slope raster is required for the Stream module, but creating one takes a bit of time, experience with Spatial Analyst, and is subject to mistakes. The ***Create Slope Raster*** utility simplifies the process and helps ensure consistent results. The resulting slope raster will be a GRID named "***slp_pct***" and will be stored in the ***RiparianModelResults\InterData*** folder. If desired, ArcCatalog can be used to copy this to the input data folder. The Wetland module will automatically use this slope raster, saving a small amount of processing time.

The input Digital Elevation Model must be in ArcMap, the vertical units must be either Feet or Meters, and must be selected by the user.

Tracking Model Progress

Both Stream and Wetland modules are very compute-intensive, and depending on the size (number of features) of input datasets can take hours to run. To help the analyst know model progress, forms include "Model Status" windows. As the models run, status messages are posted to these windows, and additionally to a text file (***StatusMessages.txt***) located in the ***RiparianModelResults\InterData*** folder. As the model is running it can be difficult to scroll the status window in the form; however the text file is easily opened with Notepad or any other text editor. The graphic to the right shows an example from the Stream model form; graphics below show





StatusMessages.txt.

Stream Riparian Module

The Stream Module runs in two separate steps: an Input Data Preparation, and the actual Stream Riparian Module. The execution of either step can be rather time-consuming, and is related to the number of features in the stream dataset. Run times depend on hardware and network performance, but the following table gives an indication of what to expect for different size datasets:

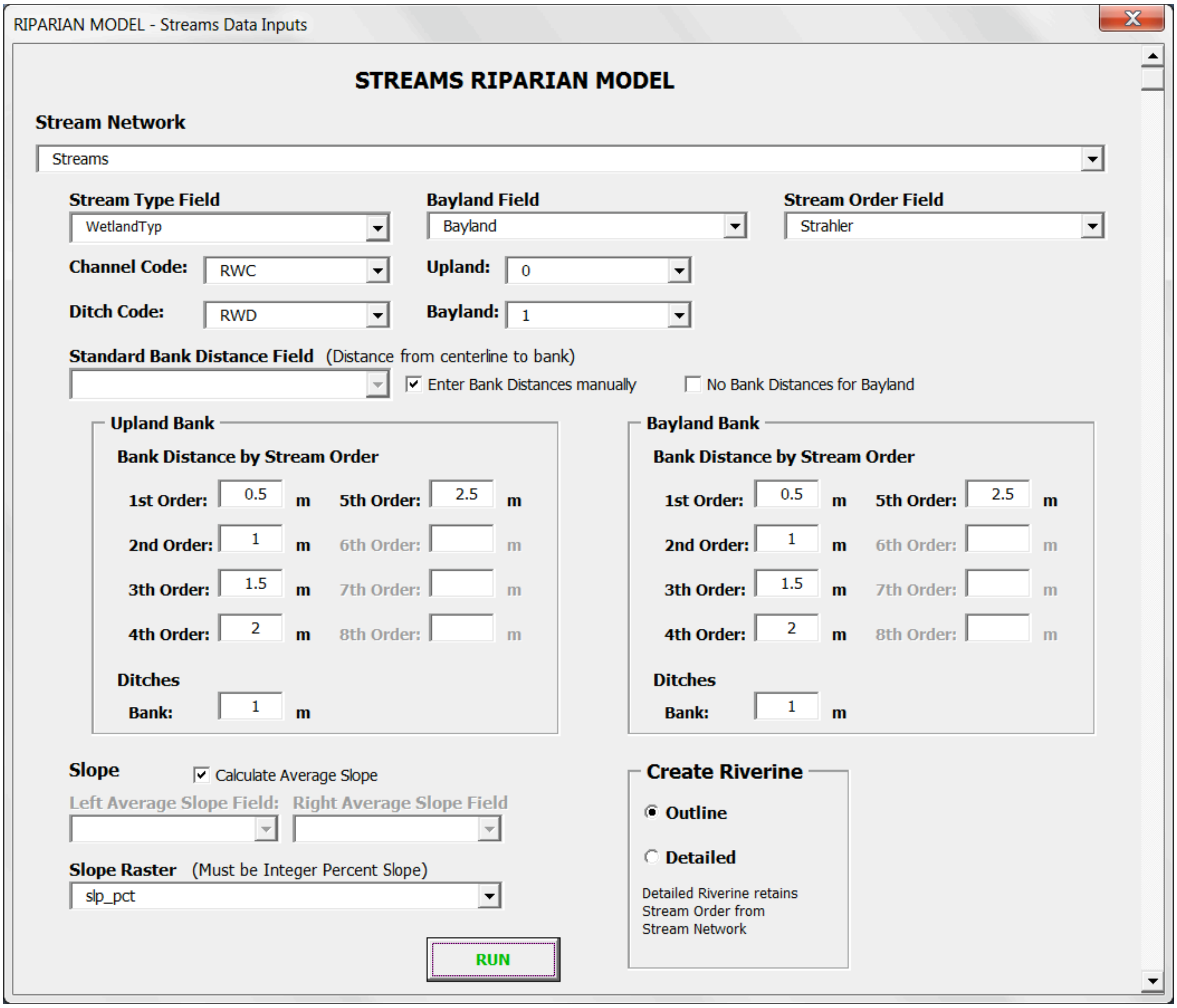
Feature Count	Input Data Preparation	Stream Riparian	Total
2500	10 minutes	15 minutes	25 minutes
25,000	1 hour	6 hours	7 hours

Input Data Preparation

The Input Data Preparation routine gathers information about the stream network from the user, then performs the following:

- Creates the StaBankDis field and populates it with the standard bank distances provided by the user.
- Creates Left and Right banks of each stream based on the standard bank distances.
- Creates the AvSloL and AvSloR fields then calculates and populates them with the average slopes for the Left and Right banks of the stream.
- Creates a "Zero-Order" (0-Order) point shapefile and calculates the average slope for each point. 0-Order points are the end points of first order streams (those that don't touch other streams).
- Creates a "Riverine" polygon layer that represents each stream channel as an area. Width of the polygon is based on the Standard Bank Distance provided by the user. This Riverine layer will be added to ArcMap and will be requested by subsequent input forms.

The graphic on the following page shows the Stream Data Inputs form. Dataset and field requirements are described earlier in this document (see Data Requirements).



<u>Form Inputs</u>

Stream

<u>Stream Network</u> - The input stream network.

<u>Stream Type Field</u> – The field containing Channel and Ditch codes.

- ***<u>Channel Code</u>*** – The value representing Channels in the ***Stream Type Field***.
- ***<u>Ditch Code</u>*** – The value representing Ditches in the ***Stream Type Field***.

<u>Bayland Field</u> – The field containing Upland and Bayland codes.

- ***<u>Upland</u>*** – The value representing Uplands in the Bayland Field.
- ***<u>Bayland</u>*** – The value representing Baylands in the Bayland Field.

<u>Stream Order Field</u> – The field containing Stream Order.

Standard Bank Distance Field – The field containing Standard Bank Distances. This field will exist if the stream network has already been modeled (it will be called ***StaBankDis***), or if it has been added and populated prior to running the model. If the values are considered valid, then simply select the field name. If the values are not considered valid or this field does not exist, check ***Enter Bank Distances Manually***, then populate the Bank Distances (in meters) as follows:

For ***Upland***:

- Enter a distance for each stream order.
- Enter a distance for ditches.

For ***Bayland***:

- Note that there may not be Baylands in the Stream Network.
- Enter a distance for each stream order.
- Enter a distance for ditches.
- Optionally check ***No Bank Distances*** for Bayland, which will set all bank distance values to 0.

Slope

Left and Right Average Slope Fields – The fields containing average slopes for the Left and Right banks.

Calculate Average Slope – Tells the model to create and populate fields ***AvSloL*** and ***AvSloR***. Typically the first time a stream network layer has been modeled, it will be necessary to check ***Calculate Average Slope***. If the stream network layer has already been modeled and the average slopes previously calculated are considered valid, then selecting the ***Left and Right Average Slope Fields*** will save significant processing time.

Slope Raster – Raster dataset containing percent slope. Note that this can be created using the ***Create Slope Raster*** utility on the main menu. A ***Slope Raster*** will be required if ***Calculate Average Slope*** has been checked, or if the model does not find the 0-Order point layer created from a previous run.

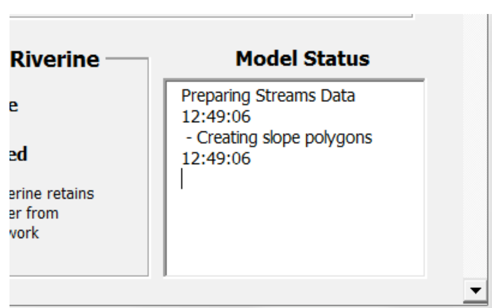
Create Riverine

Outline – indicates that the resulting Riverine layer should be dissolved into a single buffer polygon.

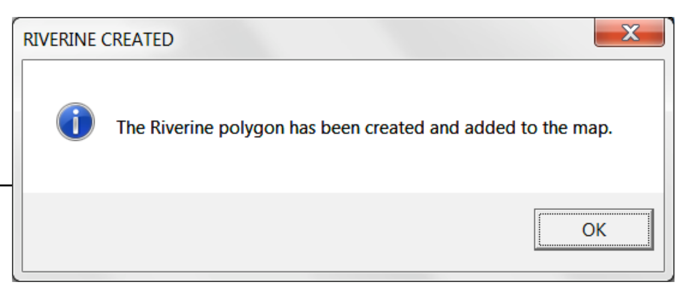
Detailed – Indicates that the resulting Riverine layer should remain as individual polygons that carry the attributes of the individual stream segments from they were created. This requires significantly more processing time.

Tracking Progress

As the stream network is being processed, progress is displayed in the Model Status window that appears at the lower right corner of the form. Additionally, the same text is written to the text file RiparianModelResults\InterData\StatusMessages.txt, which can be viewed by Notepad.



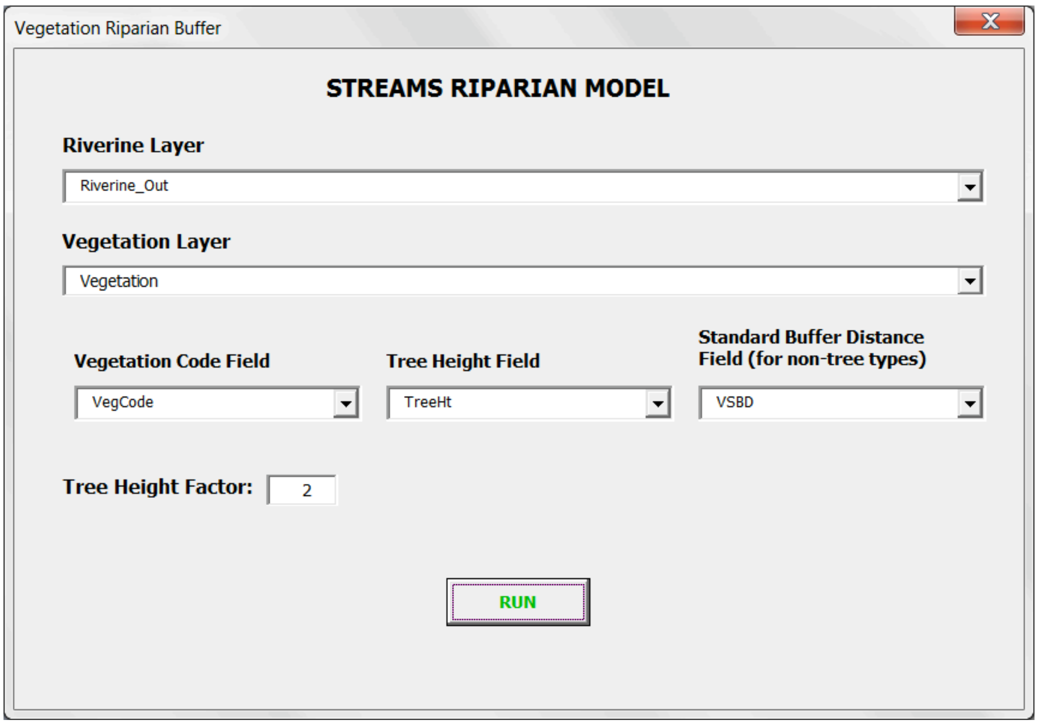
Results



Upon completion of input data processing the resulting stream Riverine layer is added to the map and the following message is displayed:

Riparian Model

Upon completion of Input Data Processing, the Vegetation Riparian Buffer form appears:

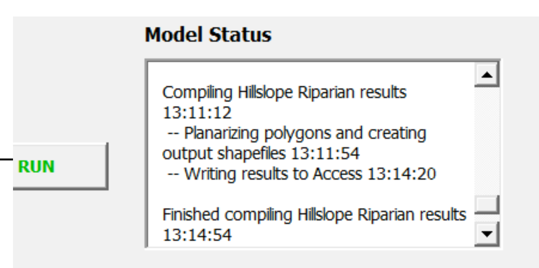


This form gathers information about the vegetation layer from the user, then models Vegetation and Hillslope Riparian areas. Note that this modeling process can be very time-consuming (see earlier table for approximate times).

Form Inputs

Dataset and field requirements are described earlier in this document (see Data Requirements).

Riverine Layer – The Riverine layer created by the Input Data Processing form.
Vegetation Layer – The input vegetation layer.
- ***Vegetation Code Field*** – The field holding vegetation codes.
- ***Tree Height Field*** – The field holding tree heights.
- ***Standard Buffer Distance Field*** – The field holding a standard buffer distances for non-tree vegetation types.
- ***Tree Height Factor*** – A multiplier applied to all tree heights.

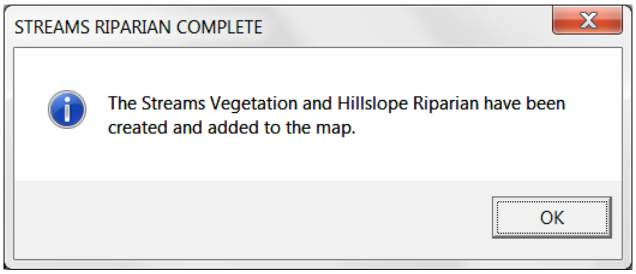


Tracking Progress

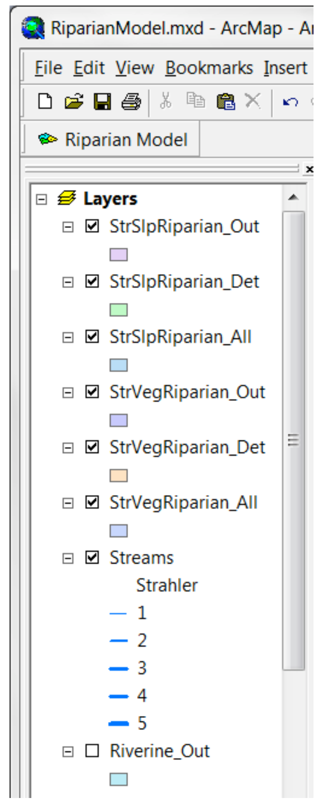
As the stream network is being processed, progress is displayed in the Model Status window that appears at the lower right corner of the form. Additionally, the same text is written to the text file RiparianModelResults\InterData\StatusMessages.txt, which can be viewed by Notepad.

Results

Upon completion of input data processing the resulting stream riparian layers are added to the map and the following message is displayed:



The resulting stream riparian layers are described later in the Model Results section.



Wetland Riparian Module

The Wetland Riparian Module models riparian areas adjacent to wetlands. Input data are wetland polygons, vegetation (same as used for the Stream Riparian module), and a Digital Elevation Model (DEM). The Wetland Module can be run independent of the Stream Module, however if both are run then the Stream Module should be run first since the Wetland Module can optionally remove resulting wetland riparian areas with the riparian layer created by the Stream Module.

While the Stream Riparian Module models both vegetation and hillslope riparian, the Wetland Module offers a choice of modeling vegetation riparian, hillslope riparian, or both. Additional options are to model Open Water, model Tidal wetlands, and remove stream riverine from wetland riparian. Choosing to model Open Water removes any areas designated as open water from resulting wetland riparian areas. Choosing to model Tidal wetlands applies a set of rules that determine how areas designated as

Tidal Marsh, Tidal Riparian, Tidal Non-Riparian, and Upland interact in terms of contributing riparian function.

Tidal Logic

The Tidal Logic models the ability of one type of tidal wetland to provide riparian habitat to anything else. For example, Tidal Marsh can provide riparian to Tidal Riparian, but Tidal Riparian cannot provide riparian to Tidal Marsh. Put another way, Tidal Riparian is a receiver, and Tidal Marsh is a contributor. The model implements this logic using buffers, so to follow the example, Tidal Riparian can buffer into adjacent Tidal Marsh, but not vice-versa.

Definitions

Tidal Marsh – Tidal Marsh.

Tidal Non-Riparian – Tidal that cannot grow (buffer) into anything (TP, TC, BayDeep, BayShall). Put another way, nothing can provide riparian to Tidal Non-Riparian.

Tidal Riparian – Tidal that can buffer into Tidal Marsh (e.g. Tidal Marsh can provide riparian to Tidal Riparian).

Upland Wetland – Upland wetland.

Upland – non wetland areas, e.g. where any wetland does not border another wetland.

Logic

Tidal Riparian

- Can buffer into Tidal Marsh (by one meter)
- Can ***NOT*** buffer into Tidal Non-Riparian
- Can ***NOT*** buffer into other Tidal Riparian
- Can buffer into Upland

Tidal Marsh

- Can ***NOT*** buffer into Tidal Marsh
- Can ***NOT*** buffer into Tidal Non-Riparian
- Can ***NOT*** buffer into other Tidal Riparian
- Can buffer into Upland

Tidal Non-Riparian

- Can ***NOT*** buffer into Tidal Marsh
- Can ***NOT*** buffer into Tidal Non-Riparian
- Can ***NOT*** buffer into other Tidal Riparian
- Can ***NOT*** buffer into Upland

Upland Wetland

- Can ***NOT*** buffer into Tidal Marsh
- Can ***NOT*** buffer into Tidal Non-Riparian
- Can ***NOT*** buffer into other Tidal Riparian
- Can buffer into Upland

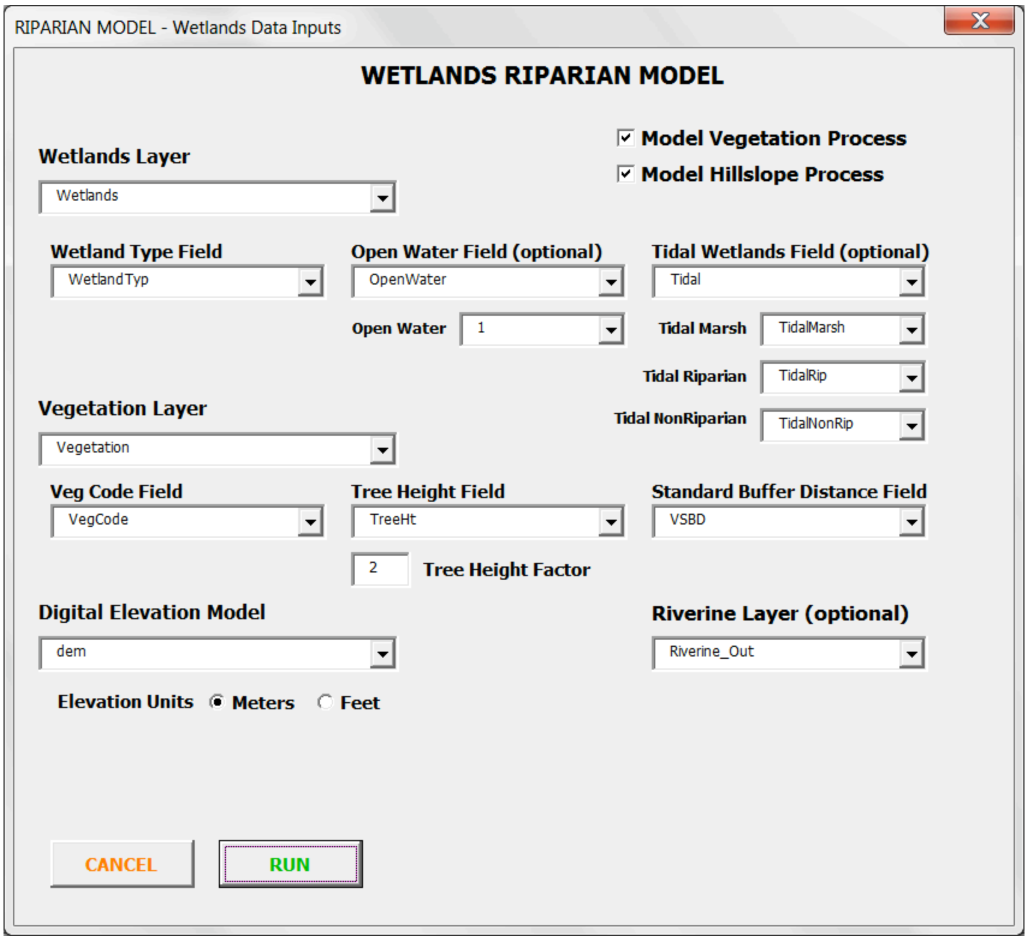
Input Form Options

The following graphics illustrate two alternatives for filling out the Wetland Riparian Model input form.

<u>Sample Input Form – All Options</u>

All options are chosen in this example, including:

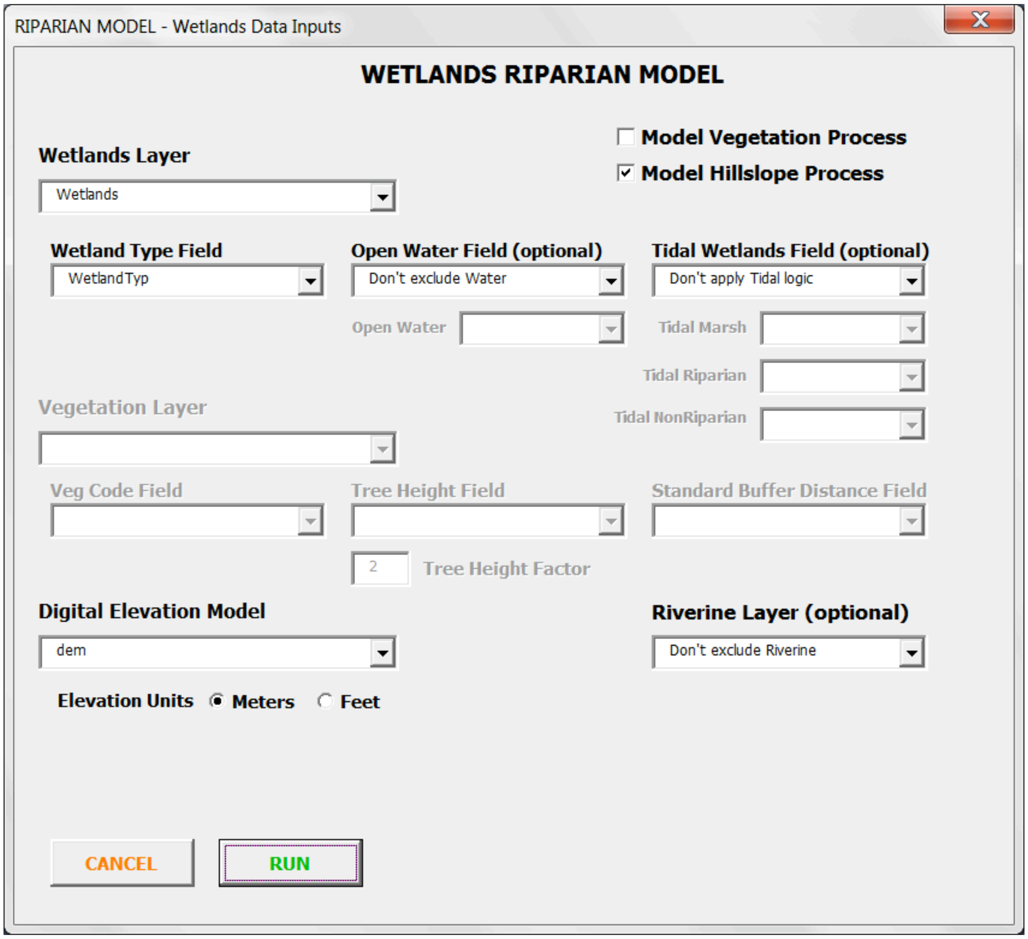
- Both Vegetation and Hillslope processes
- Open Water
- Tidal Wetlands
- Riverine



Sample Input Form – Hillslope Only

Minimal options are selected in this example:

- No Vegetation process
- No Open Water
- No Tidal Wetlands
- No Riverine



Form Inputs

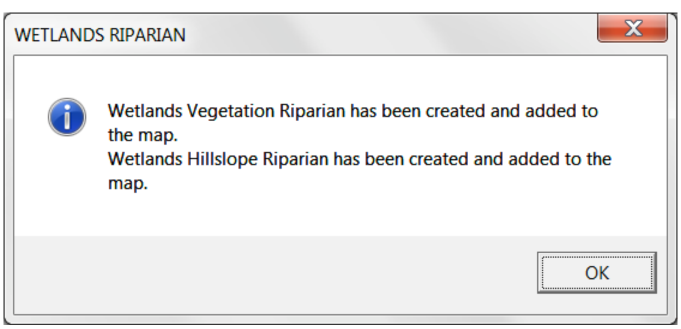
Process Options – Can choose to model either or both Vegetation and Hillslope processes.
Wetlands Layer – The input wetlands layer.
  Wetland Type Field – The field holding wetland codes.
  Open Water Field – The field holding a code designating Open Water. Optional; can choose "Don't exclude Water".
    Open Water – The value indicating if a polygon is Open Water in the Open Water Field.
  Tidal Wetlands Field – The field holding Tidal Codes. Optional; can choose "Don't apply Tidal logic".
    Tidal Marsh – The value representing "Tidal Marsh" in the Tidal Wetlands Field.
    Tidal Riparian – The value representing "Tidal Riparian" in the Tidal Wetlands Field.
    Tidal NonRiparian – The value representing "Tidal Non-Riparian" in the Tidal Wetlands Field.
Vegetation Layer – The input vegetation layer.
  Vegetation Code Field – The field holding vegetation codes.
  Tree Height Field – The field holding tree heights.
  Standard Buffer Distance Field – The field holding a standard buffer distances for non-tree vegetation types.
  Tree Height Factor – A multiplier applied to all tree heights.
Digital Elevation Model – A raster containing elevation values.
  Elevation Units – Vertical units of the Digital Elevation Model (Feet or Meters).
Riverine Layer – The Riverine layer created by the Input Data Processing form.

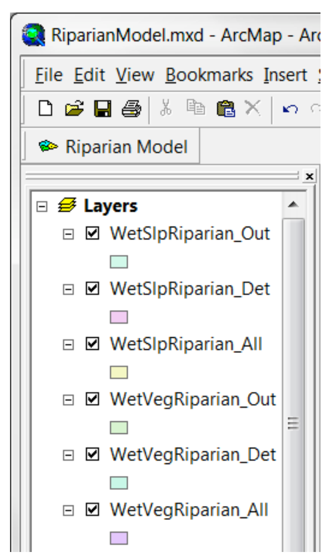
Tracking Progress

As the Wetland Module is progessing, status is displayed in the Model Status window that appears at the lower right corner of the form. Additionally, the same text is written to the text file RiparianModelResults\InterData\StatusMessages.txt, which can be viewed by Notepad.

Results

Upon completion of the Wetland Module the resulting riparian layers are added to the map and the following message is displayed:





The resulting wetland riparian layers are described later in the Model Results section.

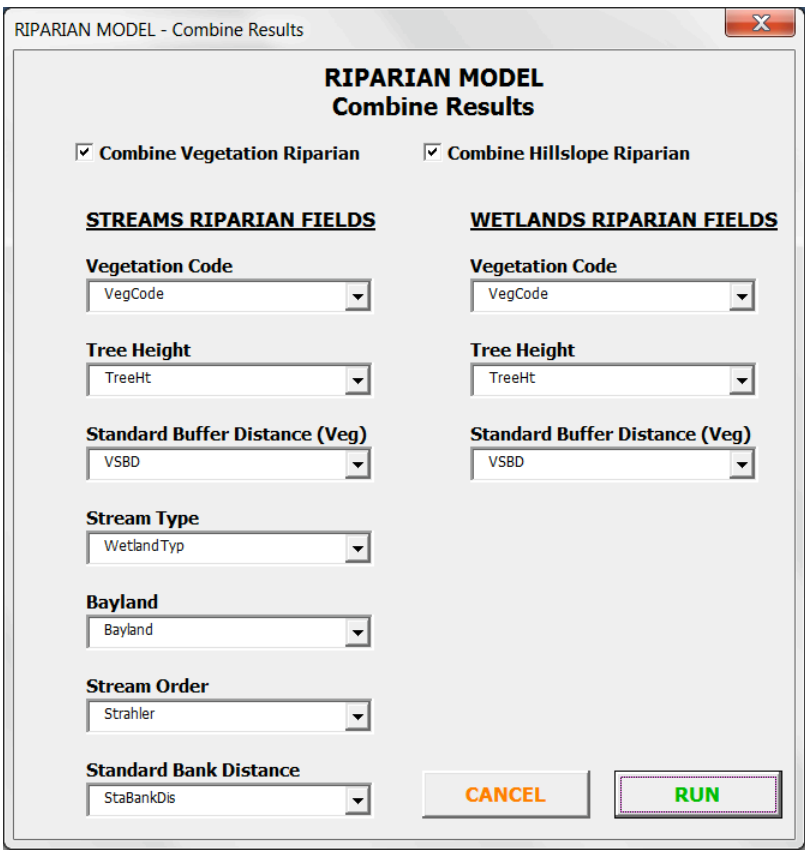
Combine Results

If both the Stream and Wetland modules are run, there will be independent results for each. The Combine Results tool will combine both into a single set of results. There are options to combine just stream and wetland vegetation riparian, just stream and wetland hillslope riparian, or both. The form is organized so that all stream inputs are in a column on the left, and wetland inputs on the right. Note that even though the form requests both, vegetation code field, tree height field, and standard buffer distance field will be the same for both the stream and hillslope results.

Input Form Options

Sample Input Form – Combine Vegetation and Hillslope Results

The following graphic illustrates the Combine Results input form (with status messages displayed):



Combine Vegetation Riparian – Combine Stream and Wetland Vegetation results.
Combine Hillslope Riparian – Combine Stream and Wetland Hillslope results.
Streams Riparian Fields – Fields found in Stream Riparian Results.

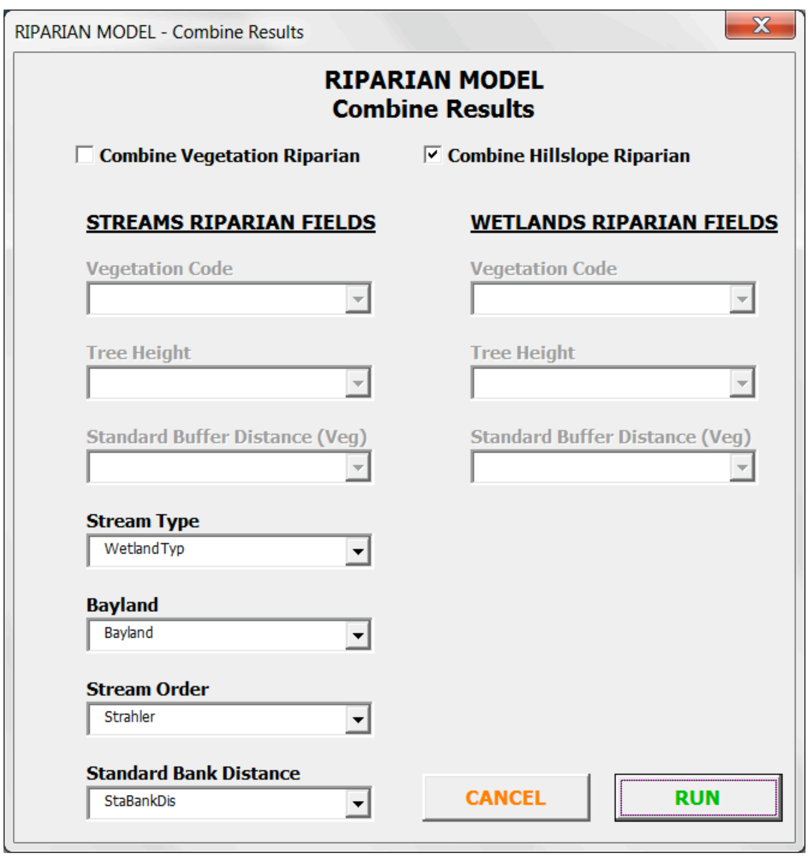
- ***Vegetation Code*** – The field holding vegetation codes.
- ***Tree Height*** – The field holding tree height.
- ***Standard Buffer Distance (Veg)*** – The field holding the Standard Buffer Distance for vegetation.
- ***Wetland Type*** – The field holding the wetland type (from streams).
- ***Bayland*** – The field holding Bayland/Upland codes.
- ***Stream Order*** – The field holding stream order values.
- ***Standard Bank Distance*** – The field holding the standard bank distances (based on stream order).

Wetlands Riparian Fields

- ***Vegetation Code*** – The field holding vegetation codes.
- ***Tree Height*** – The field holding tree height.
- ***Standard Buffer Distance (Veg)*** – The field holding the Standard Buffer Distance for vegetation.

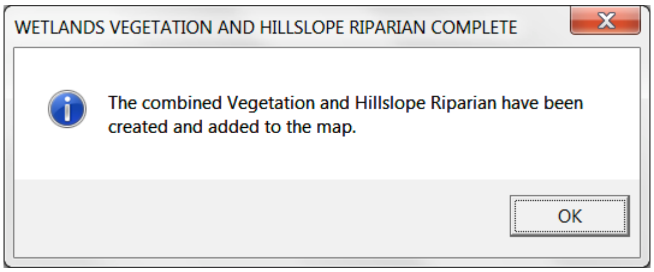
Sample Input Form – Combine Hillslope Results Only

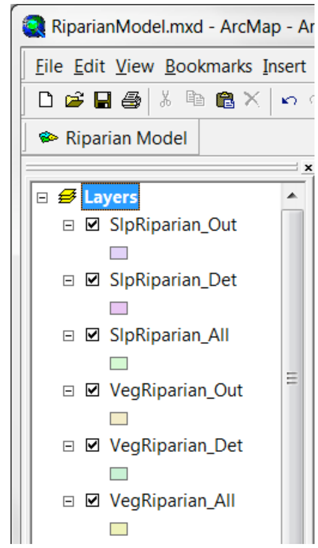
The following graphic illustrates the Combine Results input form. Note that any vegetation field inputs are greyed out:



Results

Upon completion of Combine Results tool, the resulting combined riparian layers are added to the map and the following message is displayed:





The resulting combined riparian layers are described next in the Model Results section.

Model Results

The Riparian Model creates outputs in the form of both Shapefiles and Microsoft Access database tables. The Access tables are basically a copy of the Shapefile attribute tables, but offer the ability to apply more robust relational query logic to the results.

The outputs created by the model have varying levels of detail, ranging from one record for each individual buffer polygon, to all buffer polygons merged ("dissolved") into one. The former retains all the information about the individual features from which buffer polygons were created, while the latter presents a simplified and clear picture illustrating riparian areas predicted by the model.

The following table shows the combinations of resulting datasets available as shapefiles and Access tables and at All, Detailed, and Outline levels of detail:

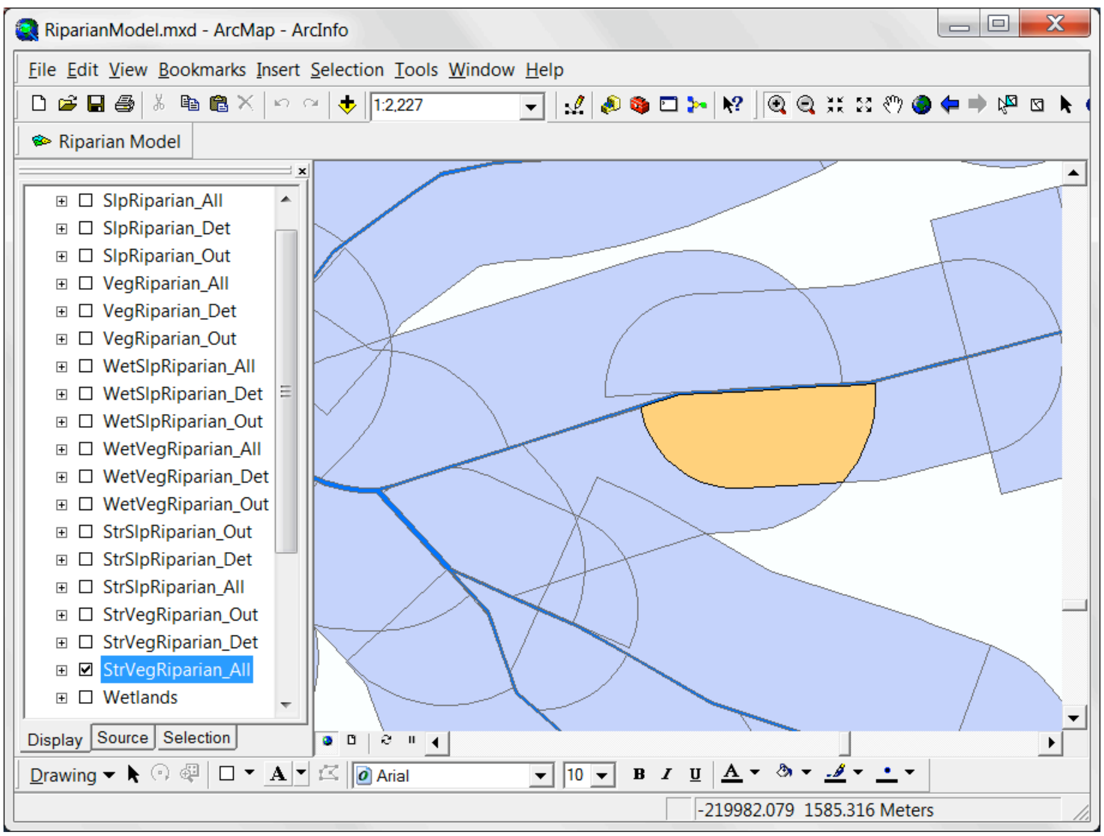
		All		**Detailed**		**Outline**	
		Shapefile	***Access***	***Shapefile***	***Access***	***Shapefile***	***Access***
Riverine		✗✗	✗✗	✓	✗✗	✓	✗✗
Stream	***Vegetation***	✓	✓	✓	✓	✓	✗✗
	HillSlope	✓	✓	✓	✓	✓	✗✗
Wetland	***Vegetation***	✓	✓	✓	✓	✓	✗✗
	HillSlope	✓	✓	✓	✓	✓	✗✗
Combined	***Vegetation***	✓	✓	✓	✓	✓	✗✗
	HillSlope	✓	✓	✓	✓	✓	✗✗

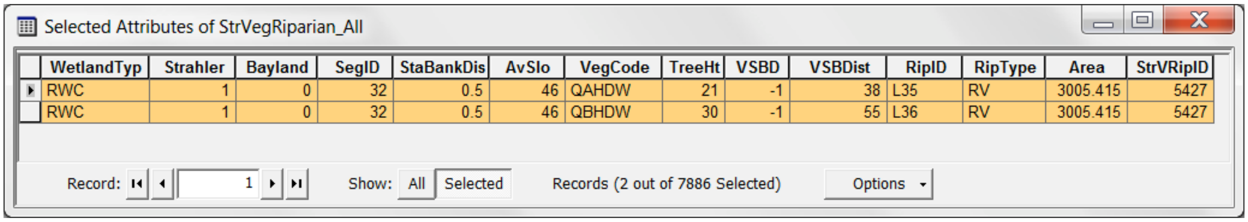
All, Detailed, and Outline

The basic approach of both the Stream and Wetland Riparian Modules is that they create buffer polygons around stream segments and wetland bank segments. By nature, buffers of features in close proximity will overlap. This offers a great amount of information about each particular location; however it can be too much detail when attempting to create simple and clear displays of modeled riparian areas. To offer alternatives for analyzing riparian areas created by the model, datasets are created at three levels of detail: All, Detailed, and Outline.

All

Model results that fall into the ***All*** category have names ending in "All" and retain detailed information about the individual stream or wetland bank segments from which they were created. Overlapping buffer polygons are intersected with each other to create overlapping polygons with identical shape. In any one riparian location there can be one or more polygons. In the following graphics there are actually two polygons in the highlighted area, which are described by the two associated records in the attribute table. In this example there was one original stream segment that crossed over two vegetation polygons (QAHDW and QBHDW), thus resulting in two different buffer distances.





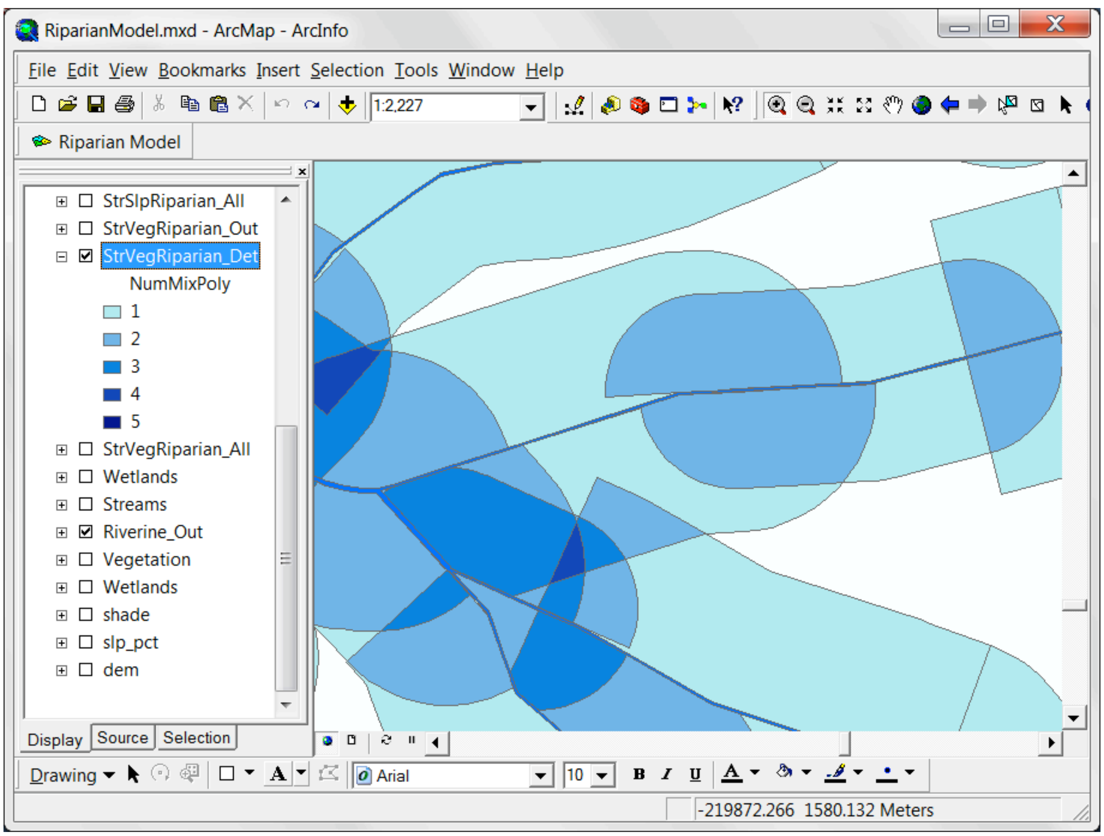
Selected Attributes of StrVegRiparian_All

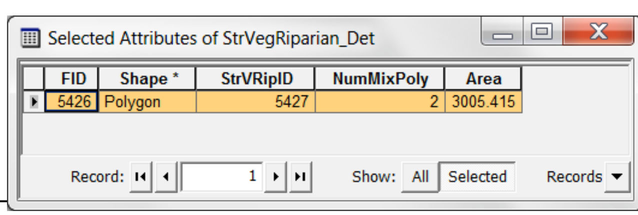
	WetlandTyp	Strahler	Bayland	SegID	StaBankDis	AvSlo	VegCode	TreeHt	VSBD	VSBDist	RipID	RipType	Area	StrVRipID
▸	RWC	1	0	32	0.5	46	QAHDW	21	-1	38	L35	RV	3005.415	5427
	RWC	1	0	32	0.5	46	QBHDW	30	-1	55	L36	RV	3005.415	5427

Record: 1 Show: All Selected Records (2 out of 7886 Selected) Options

Detailed

Model results that fall into the ***Detailed*** category have names ending in "Det" and have had any overlapping (and identical) polygons merged into a single polygon. This process requires aggregating information from merged polygons; the only information retained is the number of polygons that were merged, and the area of the resulting polygons (which is the same as the individual polygons that were merged). This single record is assigned an ID (StrVRipID in this case) that the corresponding polygons in the "All" dataset are populated with, allowing a relationship to be established between the two datasets (this is explained in greater detail in the ***Access Tables and Query Samples*** section later in this document). The graphics below illustrate polygon counts and show the merged record from the ***All*** example above. Note that all sample polygons from "All" and "Det" have a StrVRipID of 5427.





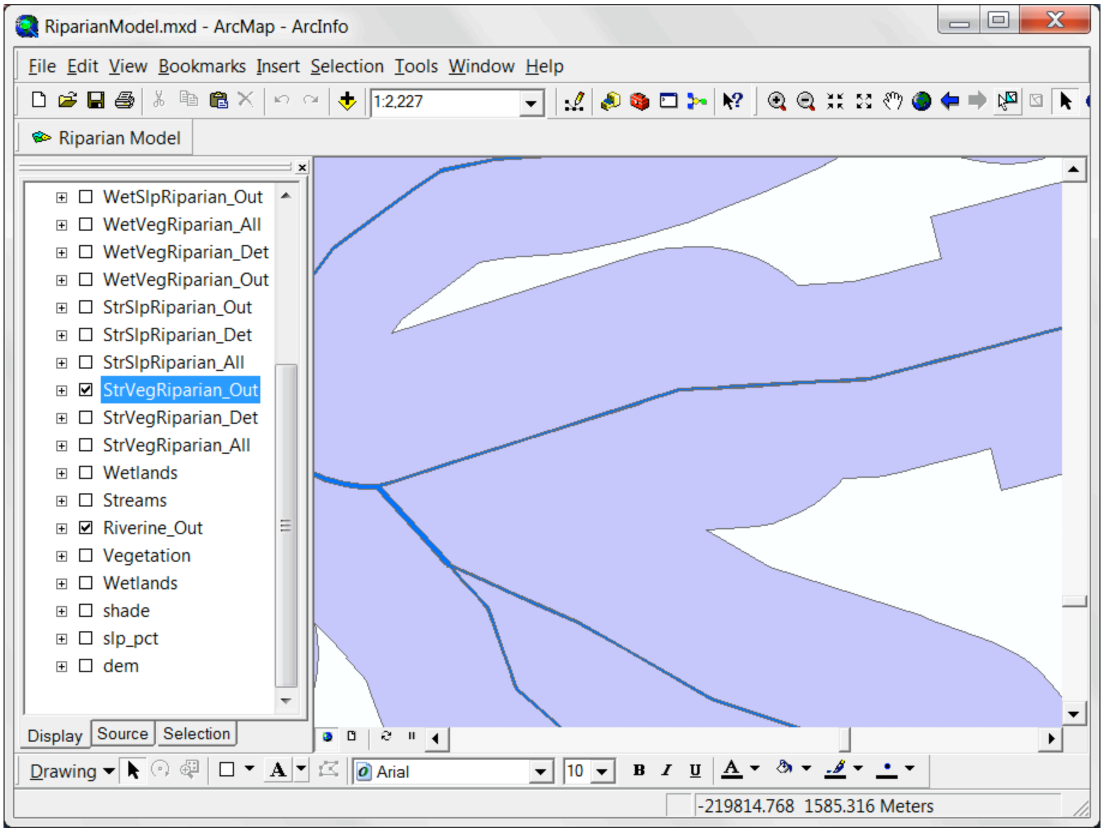
Selected Attributes of StrVegRiparian_Det

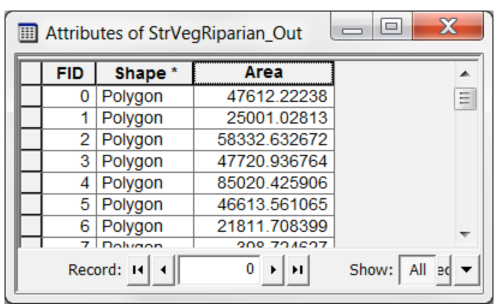
	FID	Shape *	StrVRipID	NumMixPoly	Area
▸	5426	Polygon	5427	2	3005.415

Record: 1 Show: All Selected Records

Outline

Model results that fall into the ***Outline*** category names ending in “Out” and have had all touching riparian polygons merged into a single polygon. There can be multiple polygons if there are disconnected riparian areas (in GIS terms there are no multi-part polygons).





Riverine, Stream, Wetland, Combined

The shapefiles and Access tables created by the model for Riverine, Stream, Wetland, and Combined Stream and Wetland are as follows:

Riverine

Riverine is only available in shapefile format in Detailed and Outline levels of detail. Naming is as follows:

Detailed	Outline
Riverine_Det.shp	Riverine_Out.shp

Riverine_Det.shp retains all the input stream dataset fields (including Stream Type, Bayland, Stream Order, Standard Bank Distance, and FID). Where buffer polygons overlap, the one with the lowest stream order takes precedence over (or erases) any with a higher stream order.

Stream

Streams are available in both shapefile and Access table format. Naming is as follows:

		All	Detailed	Outline
Vegetation	***Shapefile***	StrVegRiparian_All.shp	StrVegRiparian_Det.shp	StrVegRiparian_Out.shp
	Access	StrVegRipAll	StrVegRipDet	***
HillSlope	***Shapefile***	StrSlpRiparian_All.shp	StrSlpRiparian_Det.shp	StrSlpRiparian_Out.shp
	Access	StrSlpRipAll	StrSlpRipDet	***

Fields found in the ***Detailed*** datasets StrVegRiparian_Det.shp and StrSlpRiparian_Det.shp shapefiles, and StrVegRipDet and StrSlpRipDet Access tables include:

StrVRipID *(veg)* **StrHRipID** *(slope)*	Unique identifier of riparian buffer polygon.
NumMixPoly	The number of identical, overlapping polygons that were combined to create this polygon.
Area	Area (in square meters) of this polygon.

In addition to all the input stream and vegetation dataset fields (names of which can vary, but include the Stream Type, Bayland, Stream Order, Standard Bank Distance,Vegetation Code, Tree Height, and Vegetation Standard Buffer Distance), fields found in the ***All*** datasets StrVegRiparian_All.shp and StrSlpRiparian_All.shp shapefiles, and StrVegRipDet and StrSlpRipDet Access tables include:

StrVRipID *(veg)* **StrHRipID** *(slope)*	Unique identifier of the corresponding polygon in the "Detailed" dataset. In this "All" dataset there can be multiple, overlapping identical polygons that are merged into a single polygon in the "Detailed" dataset. This StrVRipID or StrHRipID field allows the two tables to be joined together using standard SQL queries in Access or other relational database applications.
VSBDist *(veg)* **SBDist** *(slope)*	Distance used by buffer to create riparian polygon.
AvSlp	Average slope of this polygon.
Area	Area (in square meters) of this polygon.
SegID	A unique identifier assigned to each stream segment (generally from confluence to confluence) before being intersected by vegetation.
RipID	A unique identifier assigned to each riparian buffer polygon *before* all buffer polygons are intersected to create identical overlapping polygons. After the intersection there will be multiple polygons with

	the same RipID. RipID can be used to show the parent polygon from which resulting polygons came. RipID is also somewhat reflective of the original stream segments after they have been divided by overlaying with vegetation. Polygons resulting from a Left buffer will be preceded by "L", those from a Right buffer will be preceded by "R".
RipType	"RV" if vegetation riparian (StrVegRiparian_All.shp and StrVegRipAll), "RS" if hillslope riparian (StrSlpRiparian_All.shp and StrSlpRipAll).

Wetland

Wetland results are available in both shapefile and Access table format. Naming is as follows:

		All	Detailed	Outline
Vegetation	***Shapefile***	WetVegRiparian_All.shp	WetVegRiparian_Det.shp	WetVegRiparian_Out.shp
	Access	WetVegRipAll	WetVegRipDet	***
HillSlope	***Shapefile***	WetSlpRiparian_All.shp	WetSlpRiparian_Det.shp	WetSlpRiparian_Out.shp
	Access	WetSlpRipAll	WetSlpRipDet	***

Fields found in the ***Detailed*** datasets WetVegRiparian_Det.shp and WetSlpRiparian_Det.shp shapefiles, and WetVegRipDet and WetSlpRipDet Access tables include:

WetVRipID *(veg)* **WetHRipID** *(slope)*	Unique identifier of riparian buffer polygon.
NumMixPoly	The number of identical, overlapping polygons that were combined to create this polygon.
Area	Area (in square meters) of this polygon.

In addition to all the input wetland and vegetation dataset fields (names of which can vary, but include the Wetland Type, Vegetation Code, Tree Height, and Vegetation Standard Buffer Distance), fields found in the ***All*** datasets WetVegRiparian_All.shp and WetSlpRiparian_All.shp shapefiles, and WetVegRipDet and WetSlpRipDet Access tables include:

WetVRipID *(veg)* **WetHRipID** *(slope)*	Unique identifier of the corresponding polygon in the "Detailed" dataset. In this "All" dataset there can be multiple, overlapping identical polygons that are merged into a single polygon in the "Detailed" dataset. This WetVRipID or WetHRipID field allows the two tables to be joined together using standard SQL queries in Access or other relational database applications.
VegBDist *(veg)* **SlpBDist** *(slope)*	Distance used by buffer to create riparian polygon.
AvSlp	Average slope of this polygon.
Area	Area (in square meters) of this polygon.
WetID	Unique identifier of input wetland polygon.
WetSegID	Unique identifier of input wetland polygon outline after it has potentially been divided into separate segments based on overlap with vegetation and length. Riparian polygons are created (buffered) from these segments.

Combined Stream and Wetland

Combined Stream and Wetland are available in both shapefile and Access table format. Naming is as follows:

		All	Detailed	Outline
Vegetation	***Shapefile***	VegRiparian_All.shp	VegRiparian_Det.shp	VegRiparian_Out.shp
	Access	VegRipAll	VegRipDet	***

HillSlope	***Shapefile***	SlpRiparian_All.shp	SlpRiparian_Det.shp	SlpRiparian_Out.shp
	Access	SlpRipAll	SlpRipDet	***

Fields found in the ***Detailed*** datasets VegRiparian_Det.shp and SlpRiparian_Det.shp shapefiles, and VegRipDet and SlpRipDet Access tables include:

VegRipID *(veg)* **SlpRipID** *(slope)*	Unique identifier of riparian buffer polygon.
NumMixPoly	The number of identical, overlapping polygons that were combined to create this polygon.
Area	Area (in square meters) of this polygon.

The ***Combined All*** datasets retain many fields from the ***Stream All*** and ***Wetland All*** datasets:

- The original input fields from Stream (Stream Type, Bayland, Stream Order, Standard Bank Distance) and Wetland (Wetland Type).
- The results fields from Stream (StrVRipID or StrHRipID, SegID, RipID, RipType) and Wetland (WetVRipID or WetHRipID, WetID, WetSegID).
- New fields created include:

VegRipID *(veg)* **SlpRipID** *(slope)*	Unique identifier of the corresponding polygon in the "Detailed" dataset. In this "All" dataset there can be multiple, overlapping identical polygons that are merged into a single polygon in the "Detailed" dataset. This VegRipID (vegetation) or SlpRipID (slope) field allows the two tables to be joined together using standard SQL queries in Access or other relational database applications.
Area	Area (in square meters) of this polygon.
AvSlpS	Average slope from Stream.
AvSlpW	Average slope from Wetland.
Vegetation only fields	
VegCodeS	Vegetation code from Stream.
VegCodeW	Vegetation code from Wetland.
TreeHtS	Tree height from Stream.
TreeHtW	Tree height from Wetland.
VSBDS	Vegetation standard buffer distance from Stream.
VSBDW	Vegetation standard buffer distance from Wetland.
VegBDistS	Riparian buffer distance from Stream.
VegBDistW	Riparian buffer distance from Wetland.
Slope only fields	
SlpBDistS	Riparian buffer distance from Stream.
SlpBDistW	Riparian buffer distance from Wetland.

Access Tables and Query Samples

Model results in the form of shapefiles offer the ability to visualize and create cartographic products showing the extent and characteristics of riparian areas predicted by the model, and provide the ability to use those results in subsequent analytical exercises. However GIS tools offer somewhat limited capabilities for fully understanding the results of the model. Specifically, to better analyze the resulting overlapping polygons it is advantageous to use relational database tools commonly available in database applications. For this reason, the model also writes results to a Microsoft Access database.

The following are a number of examples of Access queries that can use the tables created by the model. Note that the model does not create any of these queries. Included is the SQL behind the queries.

Sum of Total Hillslope Riparian Area

Shows the total area (in acres) of Stream Hillslope Riparian. Since it is based on the table ***StrSlpRipDet*** (that has no overlapping polygons), this is the true total riparian area predicted by the model.

qStrSum_TotalRiparian

Acres
13465817.9

Record: 1 of 1 No Filter

```
SELECT Sum(StrSlpRipDet.Area/4047) AS Acres
FROM StrSlpRipDet
```

Sum Area of Wetlands by Wetland Type

This query summarizes the area (in acres) of each wetland type. Since it is based on the table ***WetVegRipAll*** (which has overlapping polygons), areas will get counted multiple times, thus the entire reported area can be much greater than the total riparian area.

qWetSumAcres_Type

WetType	Acres
DPOWU	10.328469315
DPVU	9.2261702092
SN	5.4923470543
SU	0.240705823

Record: 1 of 4 No Filter

```
SELECT WetVegRipAll.WetType, Sum([Area]/4047) AS Acres
FROM WetVegRipAll
GROUP BY WetVegRipAll.WetType
```

Sum Area of Streams by Stream Type and Stream Order

This query is similar, but slightly more complex than the previous since it is grouping on and summing the area (in acres) of the unique combinations of both WetlandTyp and Strahler fields. Reported acreage will be greater than the total predicted by the model since the query is based on the table ***StrVegRipAll***.

qStrSumAcres_Type_Order

WetlandTyp	Strahler	Acres
RWC	1	1376.4407757
RWC	2	376.00539073
RWC	3	119.91866208
RWC	4	91.726303937
RWC	5	99.915731873
RWD	1	18.707388791
RWD	2	5.5721747257
RWD	3	22.240391084

Record: 1 of 8 No Filter Search

```
SELECT StrVegRipAll.WetlandTyp, StrVegRipAll.Strahler,
Sum([Area]/4047) AS Acres
FROM StrVegRipAll
GROUP BY StrVegRipAll.WetlandTyp, StrVegRipAll.Strahler
```

Crosstabulation of Wetland Types

This example is quite a bit more complex than the previous since it involves two separate queries that create a new table. It would be possible to write it as a single query that does not create a table, but:

- Breaking it down into two queries makes the query logic much more understandable; and
- By creating a table it is possible to display the Yes/No results of the queries as checkboxes rather than values of -1 or 0.

qWetVegXTab_onWetType

WetVRipID	DPOWU	DPVU	SN	SU
137	-1			
138	-1	-1		
139	-1	-1		
140	-1			
141	-1	-1		
142	-1	-1		
143	-1	-1		
144	-1	-1		

Record: 61 of 173 No Filter Search

First Query – Crosstabulation on WetType

This query uses ***WetVegRipAll*** as its source, and creates one record for each value of ***WetVRipID*** (recall that there can be multiple instances of the same WetVRipID value in WetVegRipAll). It then creates a field for each ***WetType***, and places "-1" (True) in the corresponding record if that WetType was found for that WetVRipID.

Second Query – Join NumMixPoly and Area, Make Table

This query joins the fields ***NumMixPoly*** and ***Area*** from the table ***WetVegRipDet*** (the number of records now match between the first query and WetVegRipDet), and places the results into a new table ***tWetVegXTab_WetType***. Since Area comes from WetVegRipDet it is being single-counted.

```
SELECT WetVegRipDet.WetVRipID, WetVegRipDet.NumMixPoly, WetVegRipDet.Area,
qWetVegXTab_onWetType.DPOWU, qWetVegXTab_onWetType.DPVU, qWetVegXTab_onWetType.SN,
qWetVegXTab_onWetType.SU
INTO tWetVegXTab_WetType
FROM WetVegRipDet
INNER JOIN qWetVegXTab_onWetType
ON WetVegRipDet.WetVRipID = qWetVegXTab_onWetType.WetVRipID
```

Resulting Table

tWetVegXTab_WetType

WetVRipID	NumMixPoly	Area	DPOWU	DPVU	SN	SU
137	1	134.2627	☑	☐	☐	☐
138	2	600.4958	☑	☑	☐	☐
139	2	148.6906	☑	☑	☐	☐
140	2	42.76674	☑	☐	☐	☐
141	3	925.8464	☑	☑	☐	☐
142	2	87.83015	☑	☑	☐	☐
143	4	0.957195	☑	☑	☐	☐
144	4	423.1894	☑	☑	☐	☐

Record: 1 of 173 No Filter Search

The resulting table has one record for each unique riparian polygon (e.g. no overlapping polygons), a valid area for that polygon, the number of corresponding overlapping polygons (from WetVegRipAll), and a check for each WetType found in that polygon. Note that the value of NumMixPoly does not necessarily signify the number of WetType values found for that polygon; in the case of WetVRipID=140, both overlapping polygon were ***DPOWU***. Note also that the properties of fields DPOWU, DPVU, SN, and SU were modified to display as checkboxes.