BAT Quick Guide

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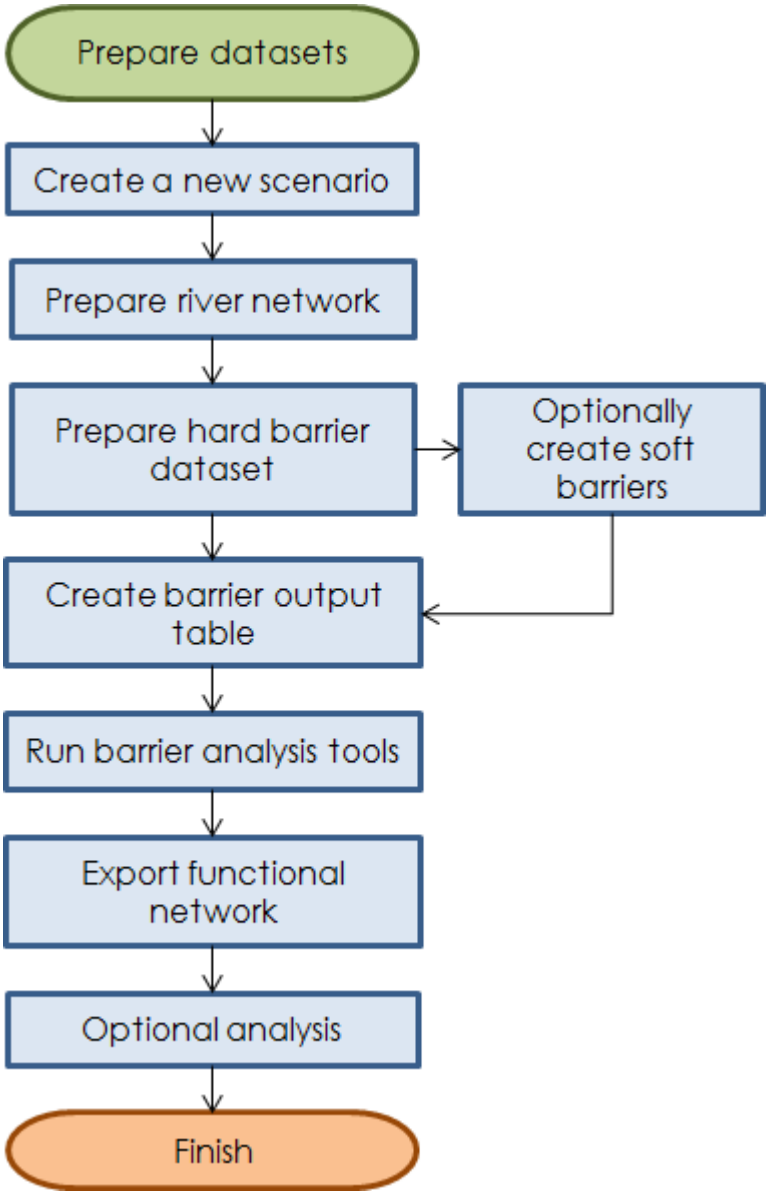
Quick Guide

This is the BAT quick guide. It describes the basic steps for running the tool. It does not seek to explain why you may get some values (e.g. a -1 or -9999), these are explained in the appropriate section of the User Manual.

The basic work flow is shown in the flow diagram below. You essentially create a "scenario", prepare your datasets, run your analysis, create an export of the functional network and run any optional analyses.

This quick guide explains each step in a concise manner to aid you in getting started with BAT.



Once you have finished processing a set of barriers against your network you can use the data generated by BAT in you analysis, examples are discussed in the section *What to do with the output*.

Prepare Datasets

You need to ensure your datasets are in a format that BAT can use. **Do not ignore or skip over these specifications as BAT will either reject the data or fail during processing.**

General requirements

- All datasets must be in **ShapeFile** format, other formats will be rejected by BAT.
- The coordinate system of all your datasets must be in meters and consistent (i.e. all datasets have the same coordinate system as your river network).

River network

- The river network is a single channel network, there are no bifurcations, braiding or loops
- The river network must have the following minimum fields:
    - Unique polyline ID (field type Long)
    - From-node (field type Long)*
    - To-node (field type Long)*
    - Region (field type String and **no more than 25 characters**) ~ This field encodes the network polylines into non-nested hydrological catchments.

* = If these fields do not exist then BAT can build them for you.

Barriers

- A unique ID (field type String and **at least minimum length of 8**)
- Barrier dataset must have a barrier type field, this can be any name (suggested name should be simply *Type*) but it must be of type text, 1 character long and must contain either a capital **H** for hard or a capital **S** for soft. No other values are acceptable.
- If the residual effect of a barrier is to be computed then it must have a numeric field where each barrier has a value greater than zero.

Catchment polygons

- The polygon ID field must contain unique numeric IDs.

Lakes\reservoir polygons

- The polygon ID field must contain unique numeric IDs.

Create a New Scenario

This is a simple task which creates an important file. The scenario file stores for the current network: information about the input layer, barrier data, and any outputs that have been generated under the current scenario. Its what binds all the inputs and outputs within BAT and allows BAT to re-establish links to datasets.

You would create a different scenario every time you change the configuration (add/move/delete) of the barriers.

To create the Scenario:

- Start ArcMap and load a network dataset
- Go to the BAT menu Scenario > New
    - Select the network
    - Set the file name (you only need to change this if you are running multiple scenarios on the same network)
    - Write a short note in the description box to indicate what you intend this scenario to be about
    - Set the fields. In the example below the From/To node fields have been set to ***?*** as these fields don't exist in the network and need to be built.
    - Press create

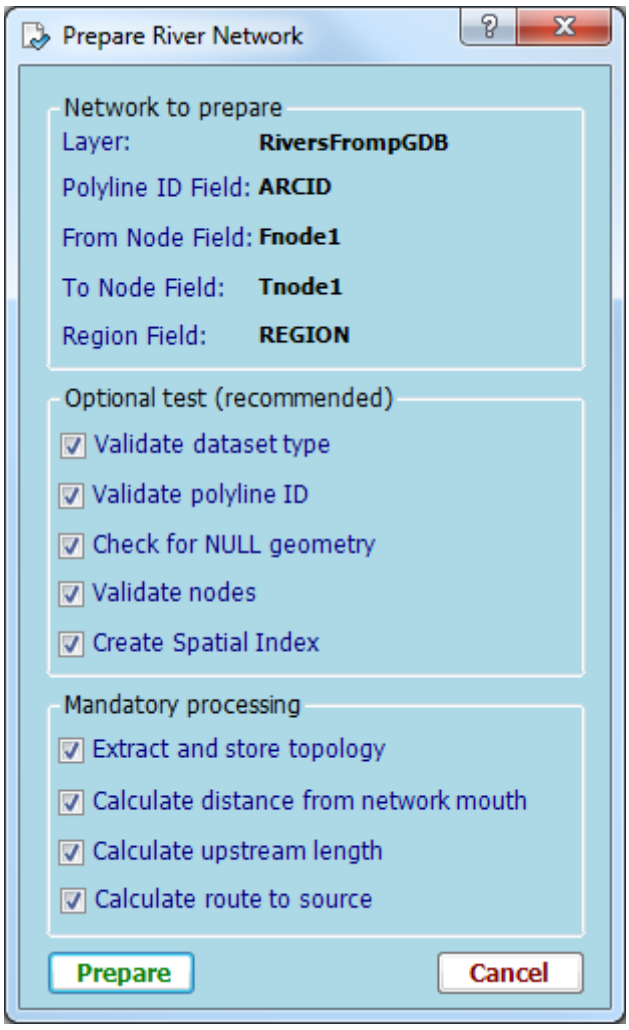
- If you are interested you can see what BAT created by going to Scenario > Display current scenario.

Preparing the River Network

Once you have created a scenario you can then prepare the river network for BAT. This will first run a set of quality controls on the network. If the network passes all the quality control tests it then extracts out the topological information that BAT requires and attributes the network with information BAT requires for efficient processing. Depending upon the size of your network this stage will take a less than a minute to half an hour.

To prepare your river network:

- Go to Data Preparation > Prepare river network
- Accept all quality control tests (if this is the first time you have run the network through BAT)
- Press Prepare



If your network fails any quality control checks the processor log window will turn red and you will see red text, you need to read these. What the errors mean and how to deal with them are discussed in more detail in the User Manual.

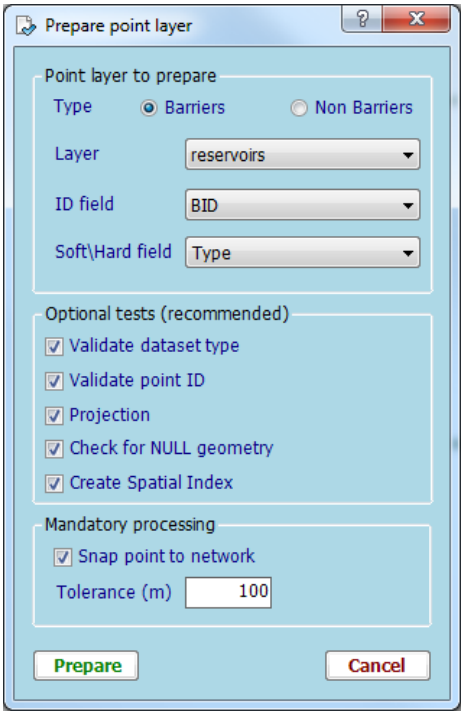
Prepare the Barrier Dataset

BAT now distinguishes between HARD and SOFT barriers. You will have a point dataset that represents barrier structures (weirs and dams) these are your HARD barriers. Soft barriers are the intersection points of rivers as they enter and leave lakes. BAT will create SOFT barriers as an *optional* task.

Your starting point would typically be a point dataset of HARD barriers that need to be prepared to create the "snapped barrier" dataset. It is the snapped dataset that BAT will only ever process.

To create a snapped barrier dataset:

- Go to Data Preparation > Snap points to river network
- As this is a BARRIER datasets set type to Barrier
- Choose your point layer
- Choose your ID field (type must be string)
- Select your type field (this will be a string field containing nothing but "**H**" values)
- Accept all quality control tests (if this is the first time you have run the point dataset through BAT)
- Set tolerance, default is 100m.
- Press prepare



If your barrier dataset fails any quality control checks or snaps to the end of a polyline the processor log window will turn red and you will see red text, you need to read these. What the errors mean and how to deal with them are discussed in more detail in the User Manual.

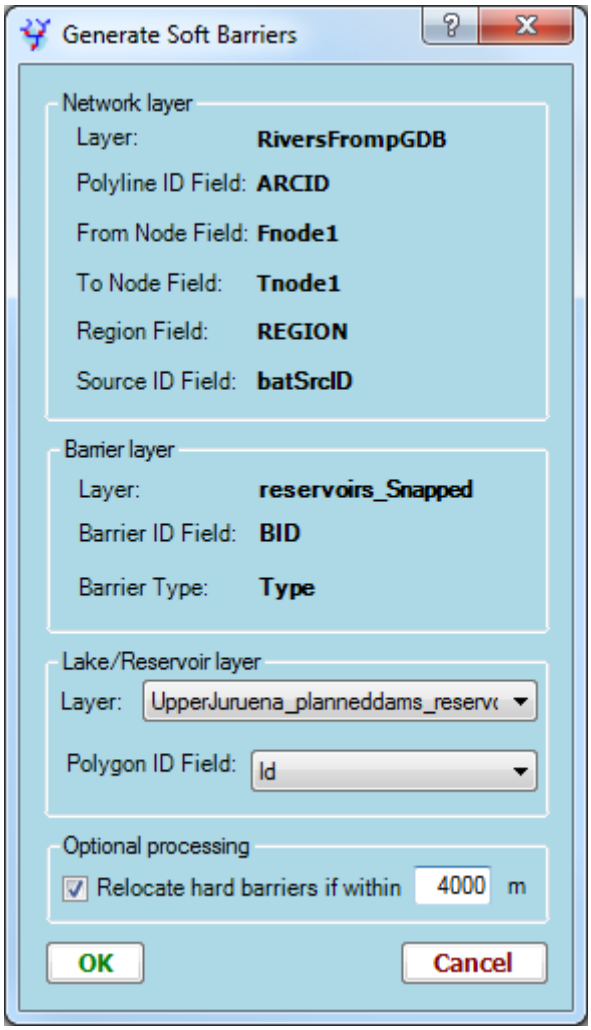
Creating Soft Barriers (Optional)

Soft barriers are the intersection points of rivers as they enter and leave lakes. Soft barriers are inserted into the **snapped** barrier dataset and not the original barrier dataset. This is an optional task and can only be done if you have a polygon lake dataset that intersects the network.

To create soft barriers:

- Add to the map you lakes dataset
- Go to Data Preparation > Generate Soft Barriers
- Select the polygon layer and ID field
- If your original HARD barrier dataset has poor spatial alignment such that the

point representing the HARD barrier is not at the intersection of the lake and network then consider ticking on *relocating hard barriers* and setting the maximum distance a barrier will move along the network to snap to a lake outlet. In the example below any HARD barriers that are within 4000m of the lake outlet will be snapped to the outlet location.



Create Barrier Output Table

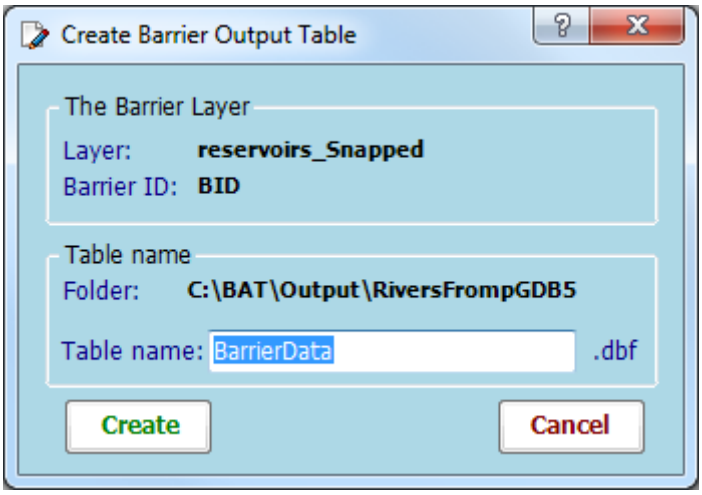
This is a simple task which creates the Output table where much of your analysis is stored. This table must exist as most tools will write to it. As each tool processes, more fields are added to it. The field names created by BAT always start with "bat". This means they can become quite cryptic due to the limitations of the dBase format.

Help has a useful table listing all the fields that BAT creates, what they are and where you expect to find them. The table is on the page called *What and where is the output?*

During the creation of the Barrier Output Table the table is populated with the ID's of the **snapped** barriers as these are the only barriers it can use. If you have left un-snapped barriers in your dataset these are filtered out.

To create the Barrier Output Table:

- Go to Barrier Analysis > Create barrier output table
- Typically you would accept the default file name
- Press Create



Running the Barrier Analysis Tools

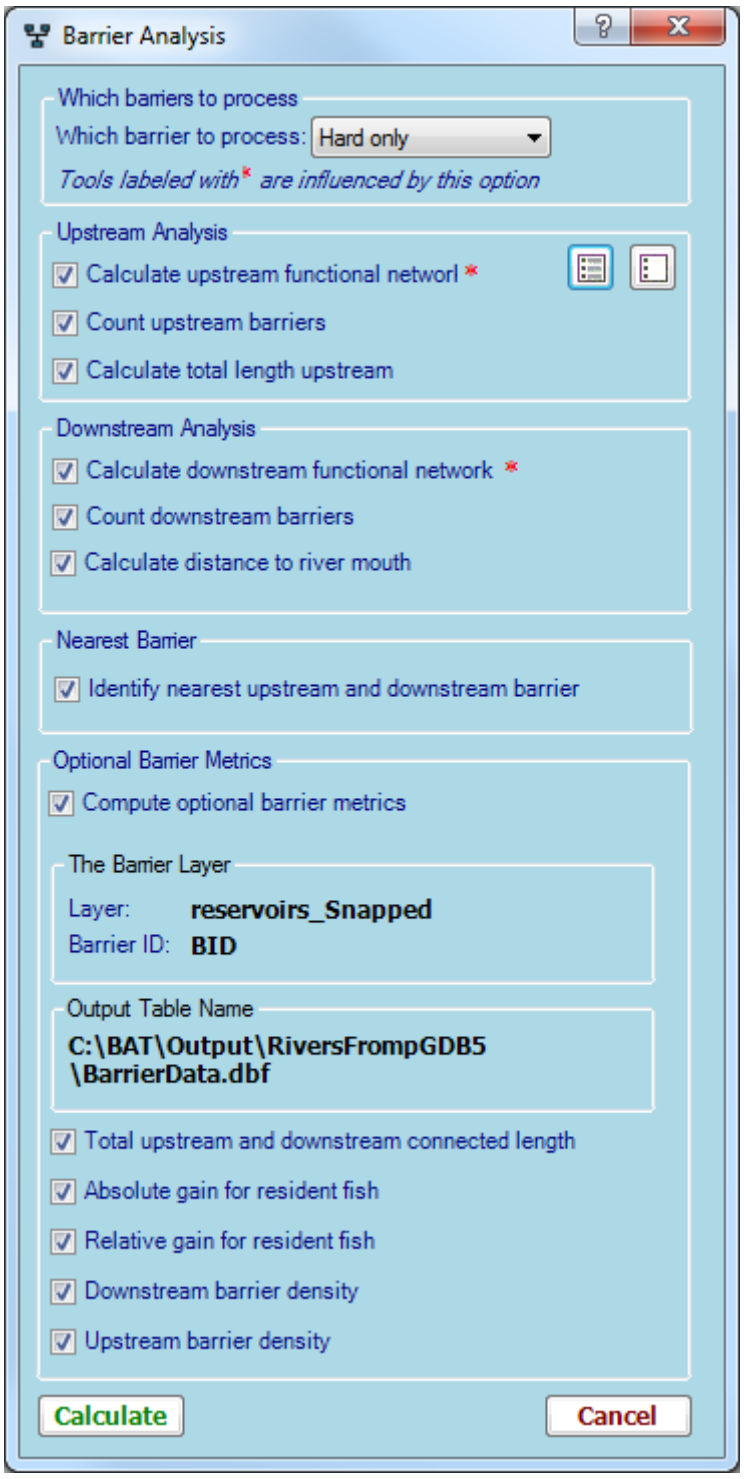
The Barrier Analysis dialogue is the main interface for computing the Key and Optional metrics, this information is written to the Barrier Output Table.

You must select which type of barriers you are going to process as this changes the behaviour of the processing algorithms. The default is to process HARD only, but you can select SOFT only or All. Your initial un-snapped barrier dataset will contain hard barriers by default and you will have created a text field and set all rows to "**H**". If you have created soft barriers then your dataset will contain barriers coded as "**H**" or "**S**", this is why you have to make a choice.

Depending upon the size of your network this stage will take a few minutes to half an hour.

To compute the metrics:

- Go to Barrier Analysis > Barrier Analysis Tools
- Select which barrier type you want to process.
- Select 1 or more Key metrics
- Only when all upstream and downstream tools are selected will the optional tools enable, this guarantees that the right fields are available for generating the optional metrics.
- Press calculate



Export Functional Network

When you have run the barrier analysis tools you will then be able to run the export functional network tool. This creates a copy of your river network cut up into the functional networks defined by your barrier dataset.

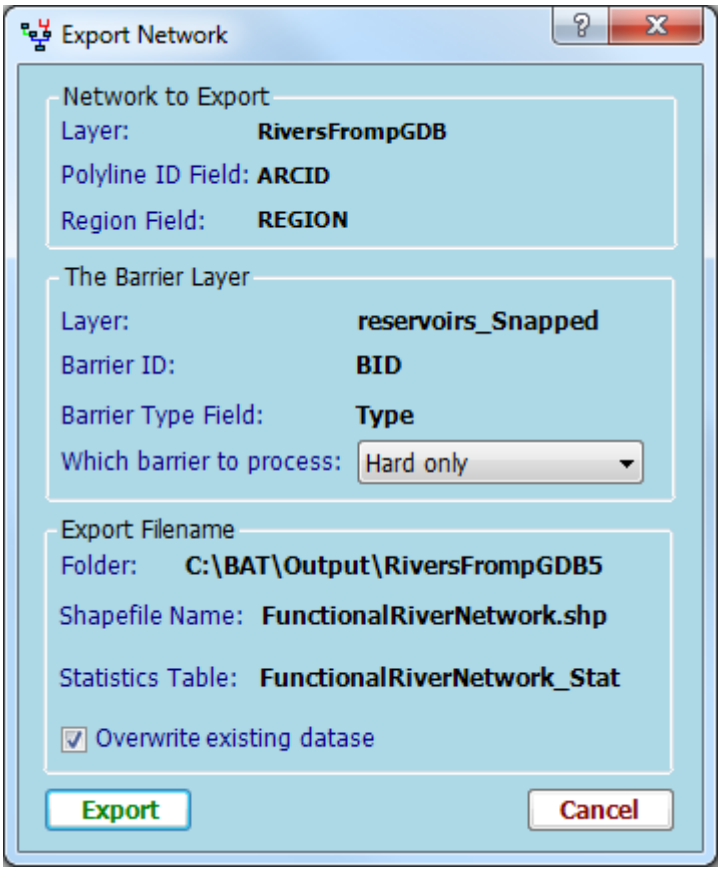
During the export all the fields are copied over from the network but some fields will become out of sync by virtue of the fact you have used the barriers to cut up the network. An important field created is the **batNetID** which encodes the network into separate functional networks. The tool also creates a table summarizing the lengths of the functional networks this is called

FunctionalRiverNetwork_Stats.

Depending upon the size of your network this stage will take a few minutes to half an hour.

To create a functional network:

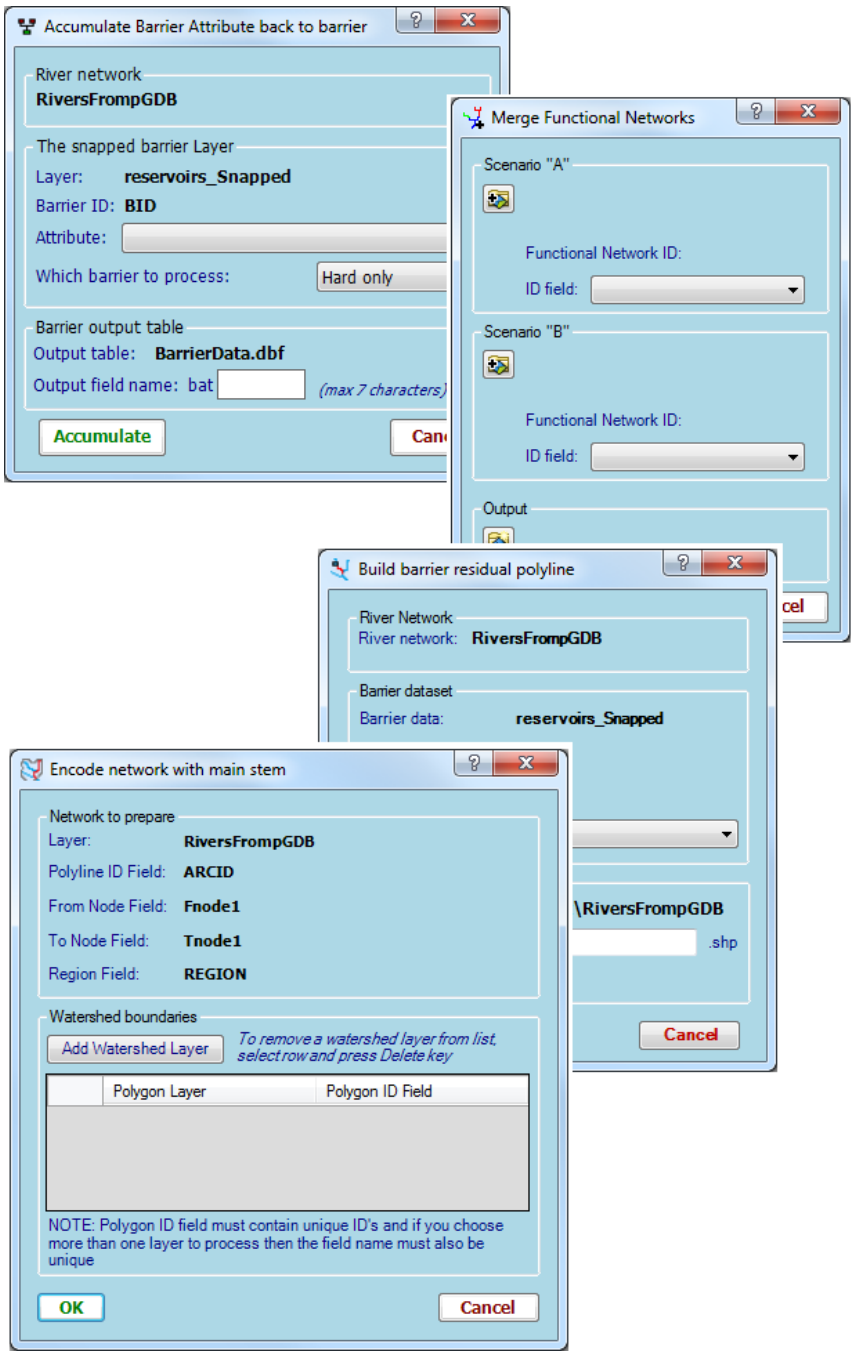
- Go to Barrier Analysis > Export functional networks
- Select the barriers that will cut up your network into the functional networks
- Press export



Optional analyses

BAT has other optional tools which are all discussed in the help file.

- Accumulating a numeric value encoded into your barrier dataset
- Merging the functional network IDs of two scenarios into a single dataset
- Generate polylines that are the downstream residual effect of a barrier
- Encode back into the network the main stem as defined by a separate shapefile of catchment polygons.
- Accumulate a numeric value in a point dataset that is not a barrier



How to create a new scenario

So you've run through your first lot of analysis with BAT and you now want to remove\add\move barriers and see what sort of affect this has on the functional networks?

You need to create a new scenario and prepare your barrier dataset. It is not as simple as just running the barrier dataset through the prepare barrier dataset tool you need to remove the fields inserted by BAT as BAT is expecting your dataset to be a clean dataset. The steps for running a new scenario on the same network with a different barrier configuration are described in the page *Removing or adding barriers* in the help file.

What to do with the output

If you have run a set of barriers through BAT will you have generated multiple outputs in the form of tables, Shapefiles and attribution to existing datasets. These can all be used in your analysis. The values generated by BAT could be used to summarized various statistics for the functional networks but can also be used to link existing data your organisation may have or offer new avenues of spatial analysis that were previously not available as the data did not exist.

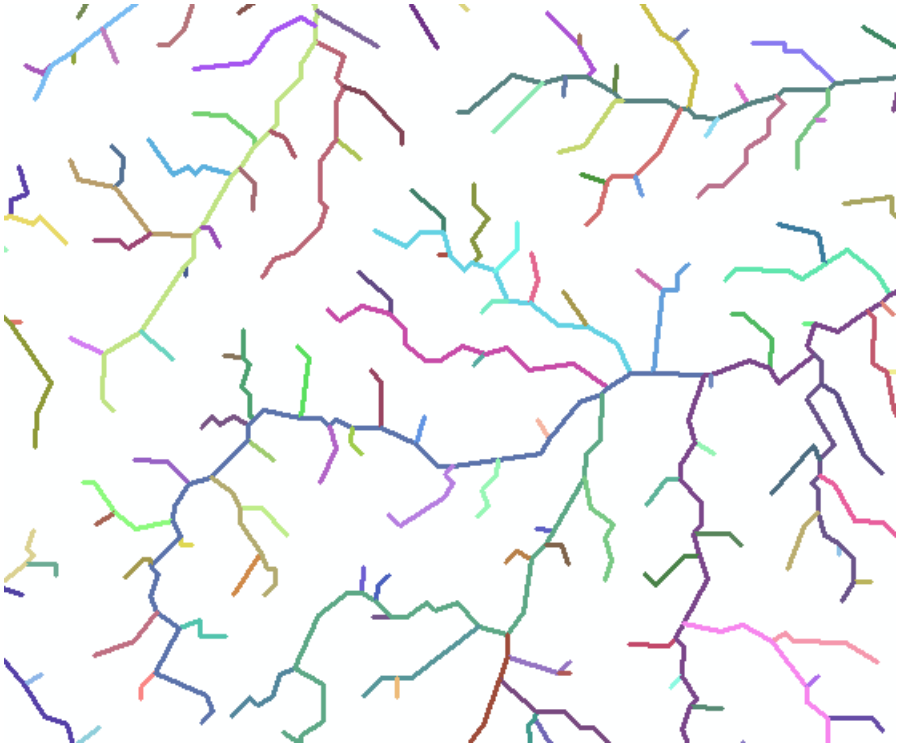
The river network

During the preparation stage the network had 3 new fields added to it: **batDis2Mth**, **batUSLen** and **batSrcID**. These were used by BAT to optimize its network searching but can be very useful in any future analysis.

- **batDis2Mth** is the distance from network mouth for the polyline's FROM node. So simply clicking on this polyline with the identify tool gives you a good approximation of how far up the network you are.

- **batUSLen** is the sum of all polyline lengths upstream flowing into that polyline. With the catchment area you easily calculate the drainage density.

- **batSrcID** is the node ID of the furthest point upstream or the "source". This code could allow you to filter and aggregate sites on the same route to source.



Network encoded by batSrcID

Snapped barriers

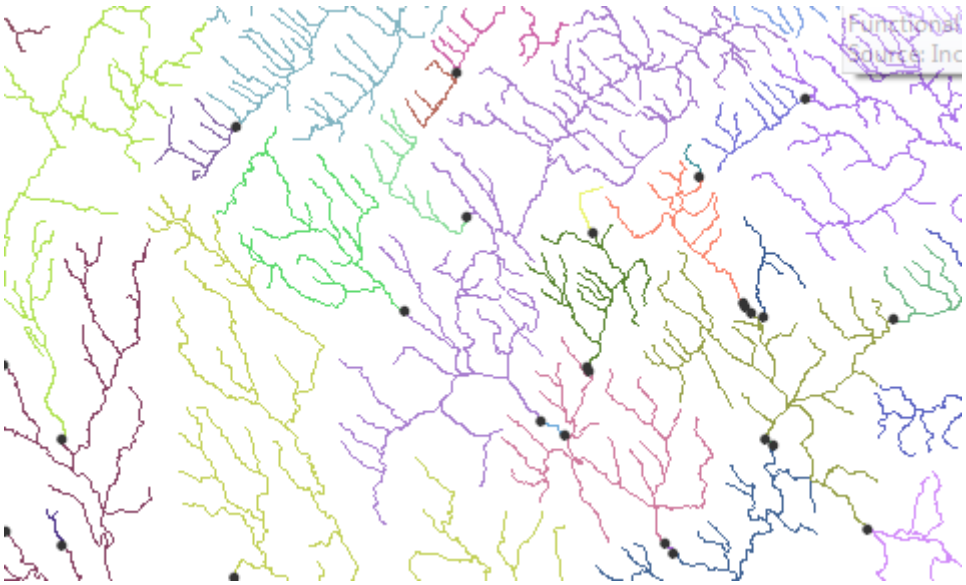
The data preparation step for the barriers generates the snapped barrier dataset, it is this dataset that BAT can only use. This dataset is a copy of the original barrier dataset with the points snapped to the network within the defined search tolerance. This dataset contains more than just moved points it has several fields that can help in future analysis.

- **batSnapped** is a flag field that indicates is the point was snapped or not. A "N" value would indicate that the barrier failed to snap and is ignored by BAT. A "Y" value indicates the barrier has been moved from its original location so it intersects the river network.
- **batLineID** is the polyline ID that the snapped point intersects, set to -1 if not snapped.
- **batRegion** is the region that the snapped barrier lies within, this value is encoded into the river network and is transferred to the snapped barrier, set to "X" if not snapped.
- **batSnapDis** is the distance the point was moved to be snapped, set to -1 if not snapped.
- **batDisAlng** is the distance (as a ratio) along the polyline length the snapped point is at, set to -1 if not snapped.
- **batDis2Mth** is the distance from network mouth, set to -1 if not snapped.
- **batSrcID** is the source node ID for the barrier, set to -1 if not snapped.

With these fields alone you could generate statistics like number of barriers per region, average distance from network mouth, most number of barriers along same route to source (pass-ability) or aggregate any information associated with the barrier link by its ID.

The functional network

The functional network is the river network cut up by the barriers. Each functional network is given a unique ID (**batNetID**) and has all the fields in the river network copied into it. Be aware that some fields that are topological in nature become redundant because they refer to the original network before being cut up by the barriers.



Functional Network encoded by batNetID

If your network contained ID's (e.g. the NHD has COMID) then these could be used to join or relate other information that your organisation maintain and aggregate by functional network ID. For example your organisation may maintain habitat quality as a separate table that links to your original network by COMID. By joining that information to the Functional Network (remember the functional network has all the fields of the original network) you could summarize that information by functional network ID.

During the generation of the functional network a separate table is created called *FunctionalRiverNetwork_Stats*. This lists for each functional network the total length of network. This table could be used to attribute the individual functional network as a whole (e.g. you give it a quality class (A-F) based upon some other analysis).

Soft barriers

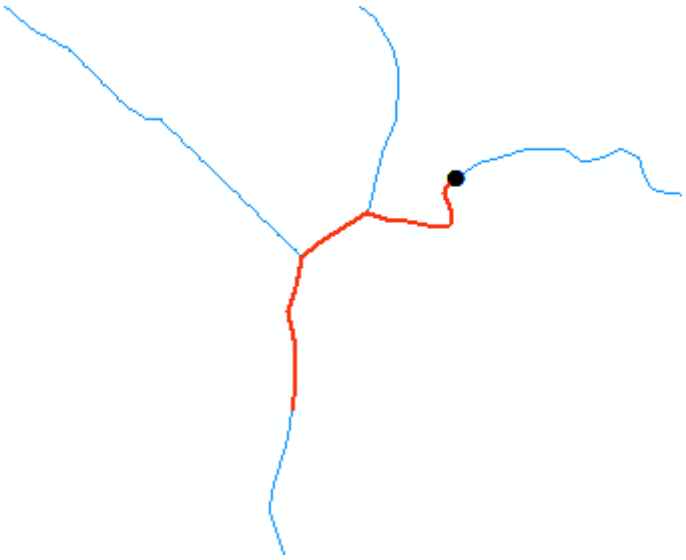
If you have a polygon layer representing on-line lakes for the river network then you may have used that to generate soft barriers. These are inserted into the snapped barrier dataset. During their generation a separate table is created called *SoftBarrierIntersection*.

This lists for each soft barrier the ID of the polygon it was generated from and the polyline it was created on. This could be useful for aggregating statistics for each lake polygon.

Barrier residual effect

If your HARD barrier dataset contains a field that is a distance (meters) which is the residual effect downstream then BAT can generate a separate polyline dataset to help you visualize this. The residual effect could represent some

environmental or geomorphological influence the structure has on the section of river immediately downstream. The distance value in your HARD barrier dataset could have been generated by a model outside the GIS system or computed by a calculation on other fields in the barrier dataset, so it is completely flexible.



A residual effect polyline for a hard barrier

With the residual polylines created these could participate in some form of buffering and clipping or spatial selection to find out how many tributaries feed into this residual zone.

The Barrier Output Table

This is the main table where BAT writes much of its output. It can contain as many as 25 fields of data depending upon what you have selected. The field names can become quite cryptic in their naming (due to the limitation of dBase format). BAT has a very useful table listing all the fields that BAT creates, what they are and where you expect to find them. The table is in the Help manual on the page called *What and where is the output?*

During your analysis you will have created Key and Optional metrics. These can be linked as a join or relate back to the barrier dataset via your barrier ID. The relate is a powerful way of passing a selection from one table to another.

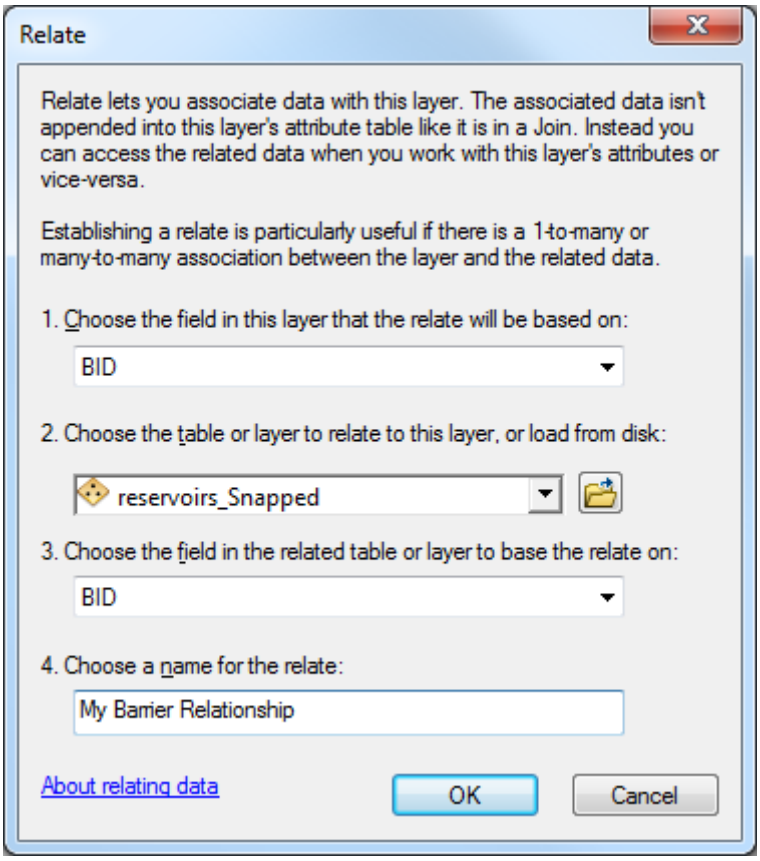
An example of using RELATE

In the example below the barrier dataset has an ID field called **BID** and a type field called **Type** these are copied into the barrier output table for the snapped barriers when the table is created.

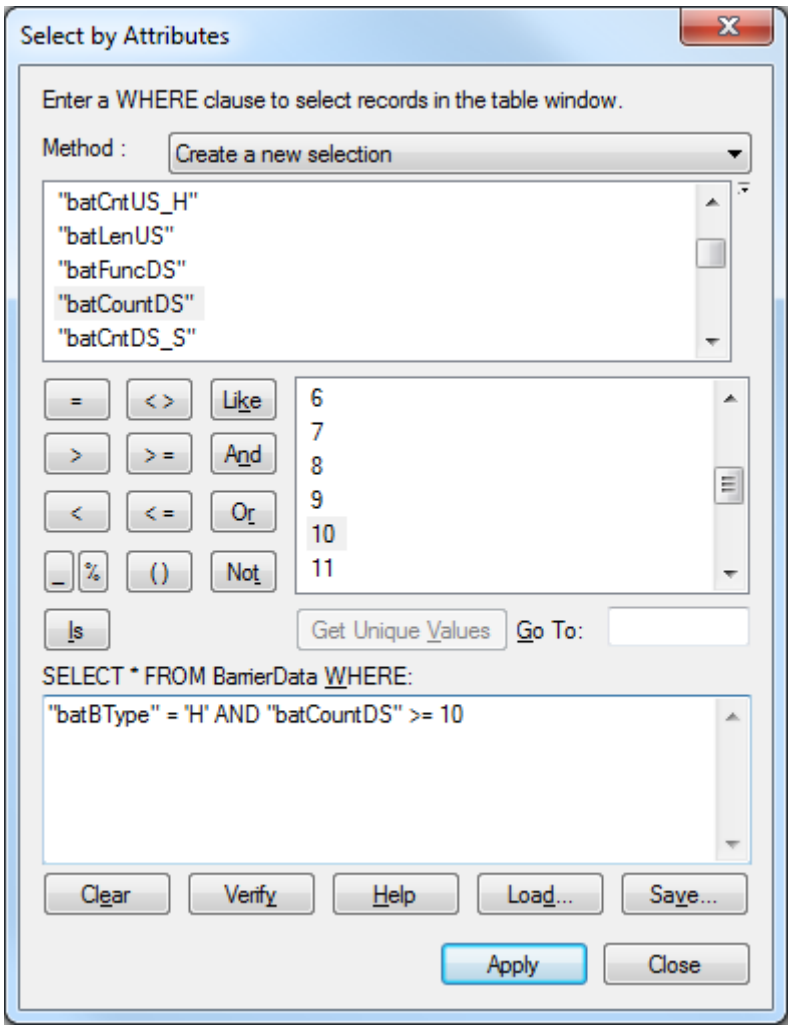
- Right click on Barrier Output Table and go to menu option Joins and Relates > Relate...

- Complete the dialogue as below. This creates a relationship between the non-spatial Barrier Output Table and the spatial dataset snapped barriers

based upon the **BID** field.



- Open the attribute table of the Barrier Output Table.
- Create a selection in your Barrier Output Table (not the snapped barrier shapefile), in this example I am selecting barriers that are HARD barriers and have at least 10 barriers downstream.



- Once the query has run you will have selected ***X*** rows in your non-spatial table. You now need to pass this selection back to the snapped barrier dataset.

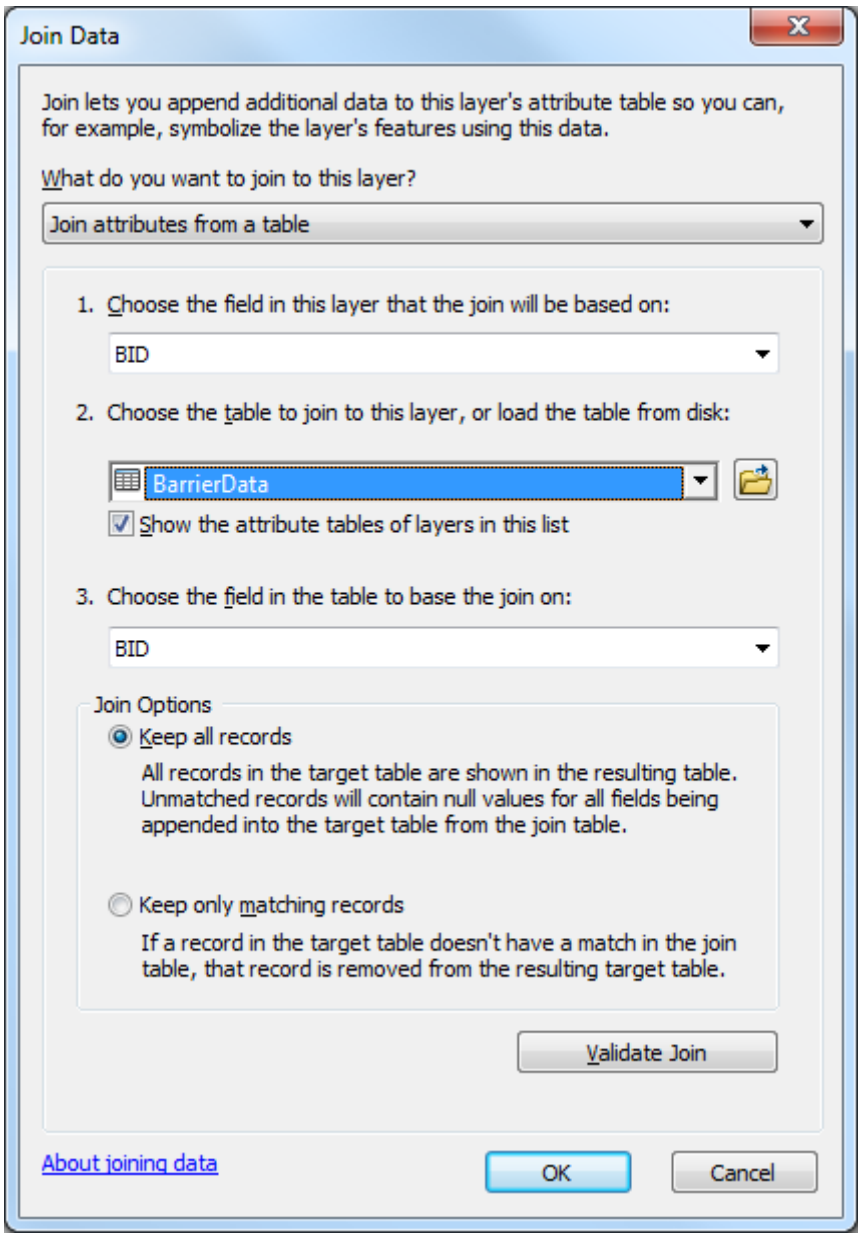
- Go to the options button (top left) on the attribute table and select Related Tables and select the relationship. This passes the selection back to the spatial dataset. You can now zoom to the selection and even use that selection is subsequent geo-processing.

An example of using a JOIN

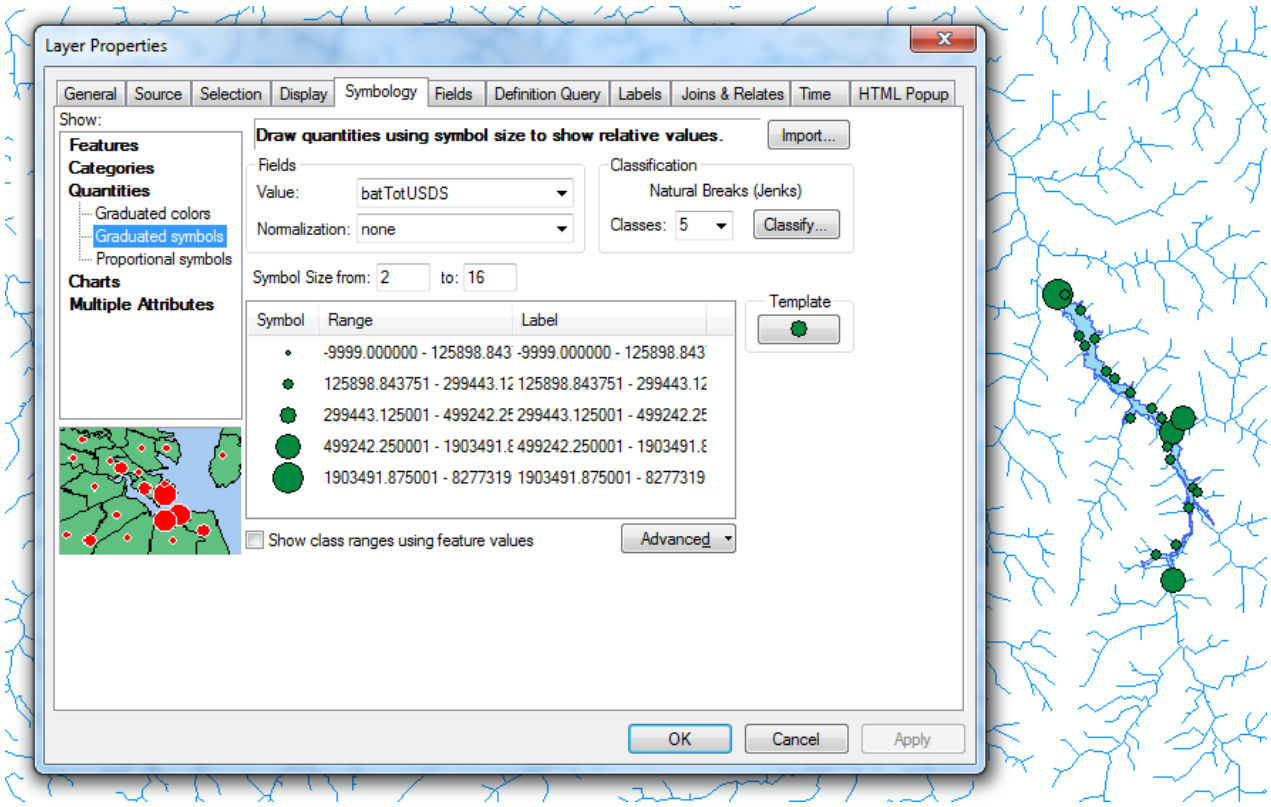
The RELATE is for passing selections but if you wanted to symbolize your barriers based upon an optional metric you will need to join the dataset.

- RIght click on the snapped barrier dataset and go to menu option Joins and Relates > Join...

- Complete the dialogue as shown below. This is joining the non-spatial Barrier Output Table to the snapped barrier dataset. Accept any indexing if ArcMap suggests it.



- You can now open the layer properties of you snapped barrier dataset and change the symbology based upon a value generated by BAT. The example below shows the optional metric total functional network length (**batTotUSDS**)) being used to create a graduated symbol size along a reservoir.



Quick Tips

1. When you load an existing scenario BAT will re-establish links to the input layers and any outputs you created. The default colour schemes are not great so use the Symbolize > Quick Symbolize tool to colour code you datasets in a standard manner.

2. Don't understand what the dialogue is about? Click on the small "?" in the form's title bar an then click on the control on the form and press F1. This will direct you to the relevant page in Help.