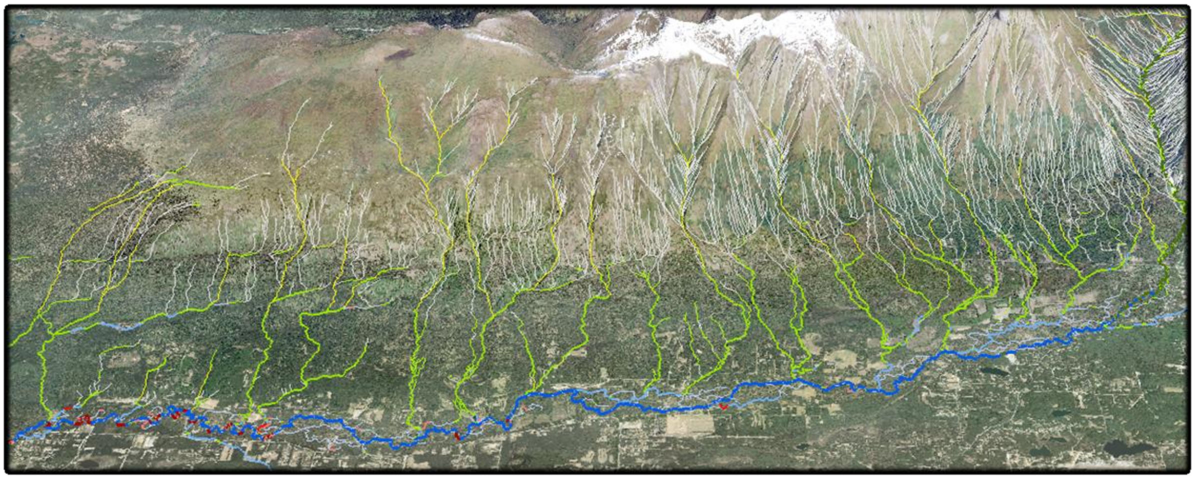
An Introduction to Integrated Hydrography with NetMap Digital Hydroscape:

A mapping and analysis platform for stream and watershed assessment



Background: As a result of ongoing efforts by the Alaska Statewide Digital Mapping Initiative and the Alaska Hydrography Technical Working Group, Alaska is rapidly developing a new generation of hydrographic data products, developed from high-resolution digital elevation models and satellite imagery. These new data provide substantial benefits in accuracy for mapping of Alaska's waters, as well as new functionality to analyze water resources, stream characteristics and stream-terrestrial interactions.

To take advantage of these types of data, a landscape-scale hydrographic mapping and modeling platform called NetMap was developed to analyze landscapes and stream networks (Benda et al 2007), sediment dynamics (Miller and Burnett 2007), fish habitat values (Burnett et al 2007), hydrogeomorphic attributes (Clarke et al 2008), road networks (TerrainWorks 2014) and watershed restoration opportunities (Benda et al. 2011). NetMap has been applied throughout the Pacific NW, and hosts over 80 tools. To learn more about NetMap, go to www.terrainworks.com.

Workshop: The Nature Conservancy, Alaska Department of Fish and Game, the Mat-Su Salmon Habitat Partnership and Alaska Pacific University, with generous support from the Gordon and Betty Moore Foundation and the National Fish and Wildlife Foundation, are pleased to announce a hands-on training opportunity to learn and explore the functionality of NetMap Digital Hydroscape, with applications from the new LiDAR-derived digital hydrography for the Mat-Su Basin.

Date & Location:

***Anchorage**:* *1:30 – 4:30 Thursday, Nov. 20, Alaska Pacific University GIS Lab.*

Contact: David Albert (907-586-2301, dalbert@tnc.org).
Please RSVP, space is limited.

Instructors:

1. Lee Benda PhD, TerrainWorks Inc.
2. Dan Miller PhD, TerrainWorks Inc.
3. David Albert, The Nature Conservancy
4. Jason Geck, Alaska Pacific University

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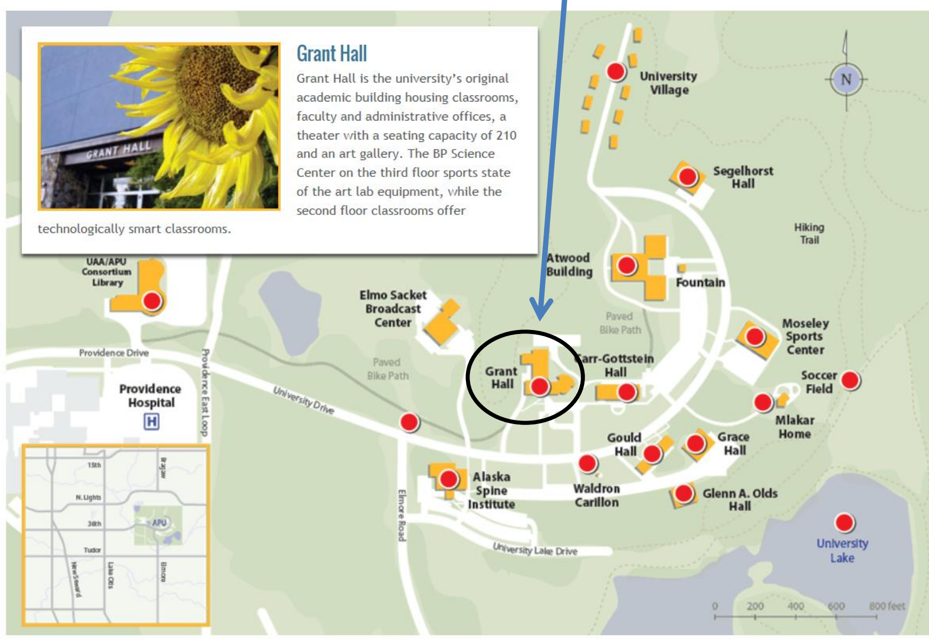
Location: Alaska Pacific University GIS Lab, Grant Hall 3rd Floor

Campus Map



AGENDA

1:30 – 2:00pm, Introduction:

- What is NetMap?
- Under the hood: how does NetMap work?
- How is NetMap used?

2 PM – 2:30 Demonstration exercise in the Goose Bay / Big Lake watershed

- **Culverts and Habitat Connectivity**: Rank culverts based on upstream fish-bearing habitat in the Goose Bay watershed.

2:30 - 4:00pm Hands-on exercises for the Goose Bay / Big Lake watershed.

Data and instructions for the following tasks will be available. Participants may work individually or in groups on these problems or any other tasks they would like to try – given constraints of available data.

- **Impervious surfaces and water quality**: Calculate the density of potential water-quality risk factors upstream all reaches for (a) roads (and/or impervious surfaces) and (b) septic systems. .
- **Proximity of parcels to active river flood plain**: Calculate the mean height of all parcels and/or building footprints above the nearest stream segment in (a) meters and (b) multiples of estimated channel depth.
- **Parcels near spawning streams**: Identify parcels adjacent to the top 20% of stream reaches based on Intrinsic Potential for king salmon spawning.

4:00 – 4:30pm Open Discussion

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List of Participants:

1. **Sara Wilson Doyle,** Planning & Public Involvement, Stantec, formerly USKH
2. **Rebecca Shaftel,** Alaska Natural Heritage Program, University of Alaska Anchorage
3. **Sue Mauger,** *Science Director*, Cook Inletkeeper
4. **Dustin Merrigan,** Research Technician, Alaska Natural Heritage Program
5. **William Rice,** Branch Chief, Habitat Restoration, US Fish and Wildlife Service
6. **Gayle Neufeld,** Research Analyst, ADF&G, Sportfish Division
7. **Jessica Speed**, TNC
8. **Franklin Dekker**, USF&WS
9. **Libby Benolkin**, USF&WS
10. **Louisa Branchflower** , Palmer Soil and Water Conservation District
11. **Matt McMillan**, Alaska Pacific University
13. **Betsy McCracken**, Fish and Wildlife Biologist, USF&WS
14. **Julie Michaelson**, Asst Wetlands Coord R7, U.S. Fish and Wildlife Service
15. **Dustin Murray**, Subsistence Division, ADF&G
16. **Heather Kelley**, Planner, Mat-Su Borough
17. **Kenneth Kleenein**, Mat-Su Borough
18. **Pamela Ness**, Mat-Su Borough
19. **Margaret Cunningham**, ADF&G Subsistence
20. **Joshua Ream**, ADF&G Subsistence
21. **Jon Gerken**, Fisheries Biologist, USFWS
22. **Gayle Martin**, US Environmental Protection Agency

An Introduction to Integrated Hydrography with a NetMap Digital Hydroscape

Instructors: Lee Benda, Dan Miller, David Albert, Jim DePasquale

Overview

To show you how a digital hydroscape can help you with your work, we thought up some typical analyses to work through. Of course, there's a big range to "typical"; our goal is not so much to show how to do any specific thing, but to show how certain types of things are made possible or easier with a digital hydroscape.

We've provided step-by-step procedures for using NetMap within ArcGIS, with the expectation that you may not know much about Arc. We've provided data sets for the Goose Bay watershed, including data files created by NetMap and GIS files to be used with NetMap.

These exercises illustrate the routing capabilities of a digital hydroscape, both through a channel network and overland to channels. In particular, we'll look at how information about channel characteristics, such as fish use and habitat potential, can be summarized over a network and how that information can be translated to the terrestrial zones that both influence the channels they drain to and are influenced by the floods those channels carry.

We'll start by showing the basics: how to get NetMap up and running in ArcGIS. Then we'll work through the first exercise to show how the system works. From there, we'd like you to work on the remaining exercises – or come up with your own. We'll help, and listen for things you'd like to try and suggestions for how to make NetMap easier to understand and more useful.

Goose Bay presents a challenging environment for application of a digital hydroscape. The watershed reflects a legacy of glaciation and huge outburst floods: it is covered with unconsolidated deposits of variable depth and contains many lakes. Over broad areas, water flows largely subsurface. The "stream network" traced from DEMs therefore contains many flow paths that represent subsurface flow rather than surface channels. We are working to differentiate surface and subsurface flow paths so that they can be treated differently by analyses in NetMap, but for now, all flow paths are still treated as surface channels.

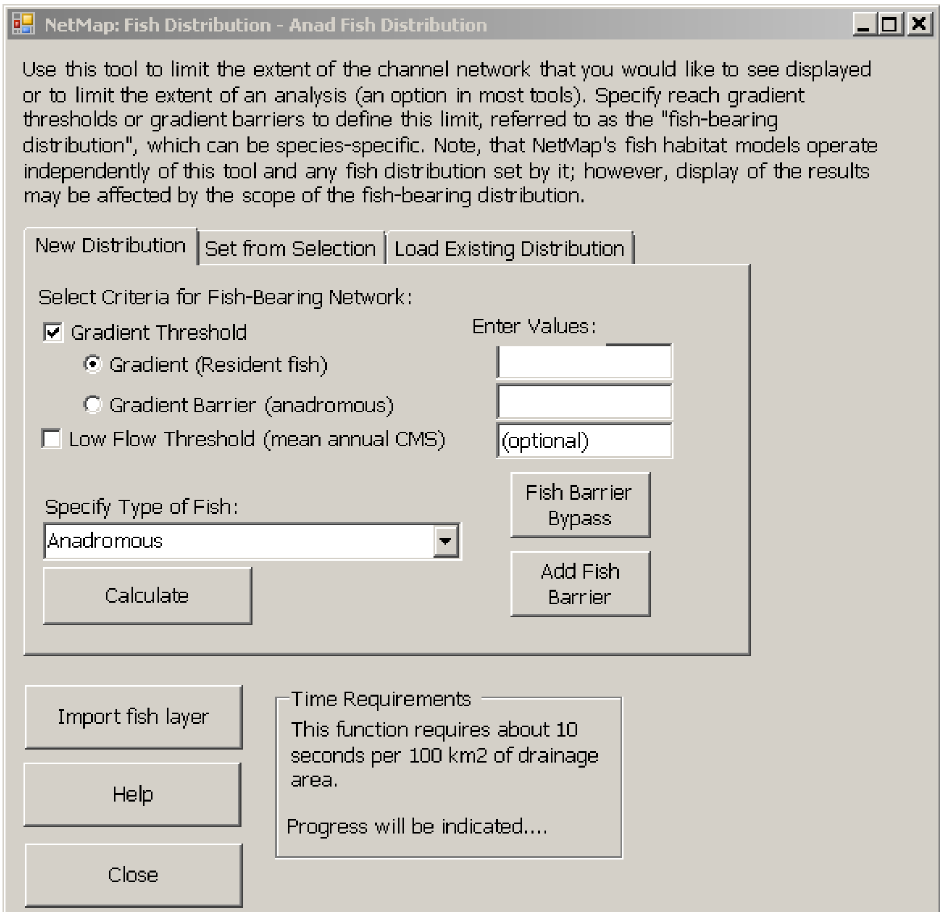
We chose a challenging example for two reasons: First, we want you to see some of the limitations of current methodologies and understand that we intend for you to work with us, and us with you, to overcome those limitations. Second, although challenging for current methods, Goose Bay is a typical landscape for coastal Alaska. We intend to find methods that work for the problems you need to solve.

Table of Contents

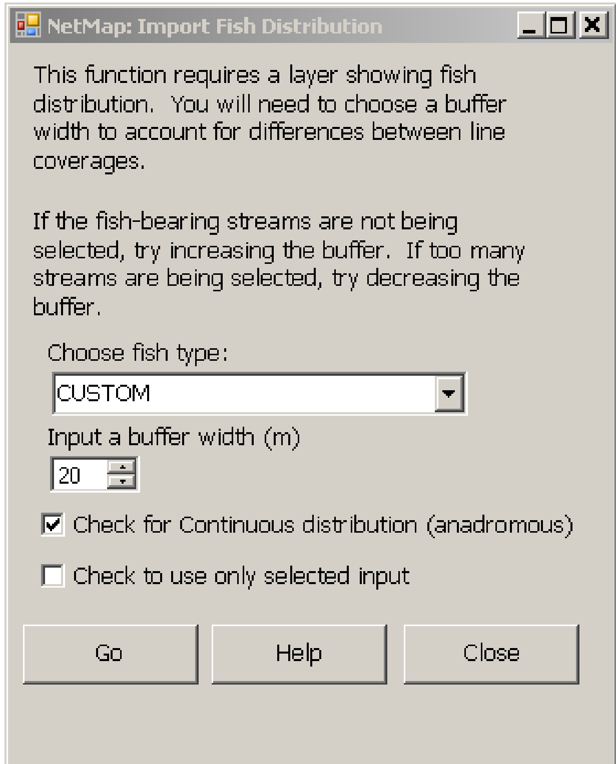
1) **Culverts and Habitat Connectivity**: Our goal is to see what's upstream of all the culverts in the watershed. We want to rank culverts based on the length and quality of upstream fish habitat. Using the Mat-Su Borough culvert database, we'll (a) calculate length of fish-bearing stream above each culvert; (b) weight that length by a measure of habitat quality, c) transfer those values back into the culvert database; and (d) make a map showing locations of culverts, coded in a way to represent relative ranking of upstream fish habitat.

a. **Identify the extent of the fish-bearing network**. First we want to use the Anadromous Waters Catalog to identify fish-bearing channels in the watershed.

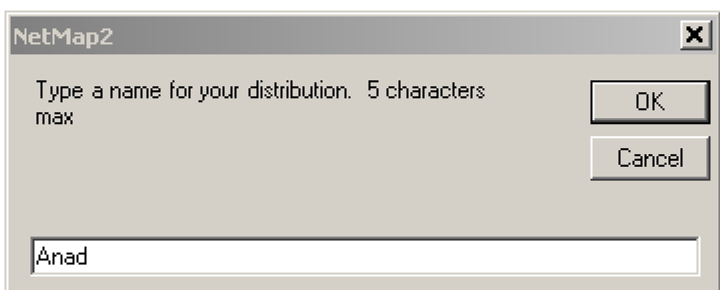
i. In the NetMap menu bar, open the **Define Fish Distribution** dialog box, under *Analysis Tools*. (Note that most NetMap dialog boxes have *Help* buttons, which link to extensive online documentation. If you have internet connectivity, try them out).



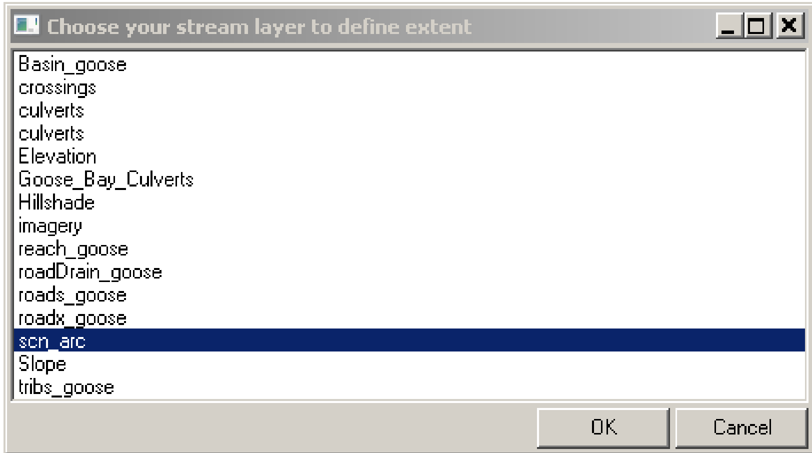
ii. Click on **Import Fish Layer** and set the *Choose fish type:* to CUSTOM. A buffer width of 20 meters works well in this case.



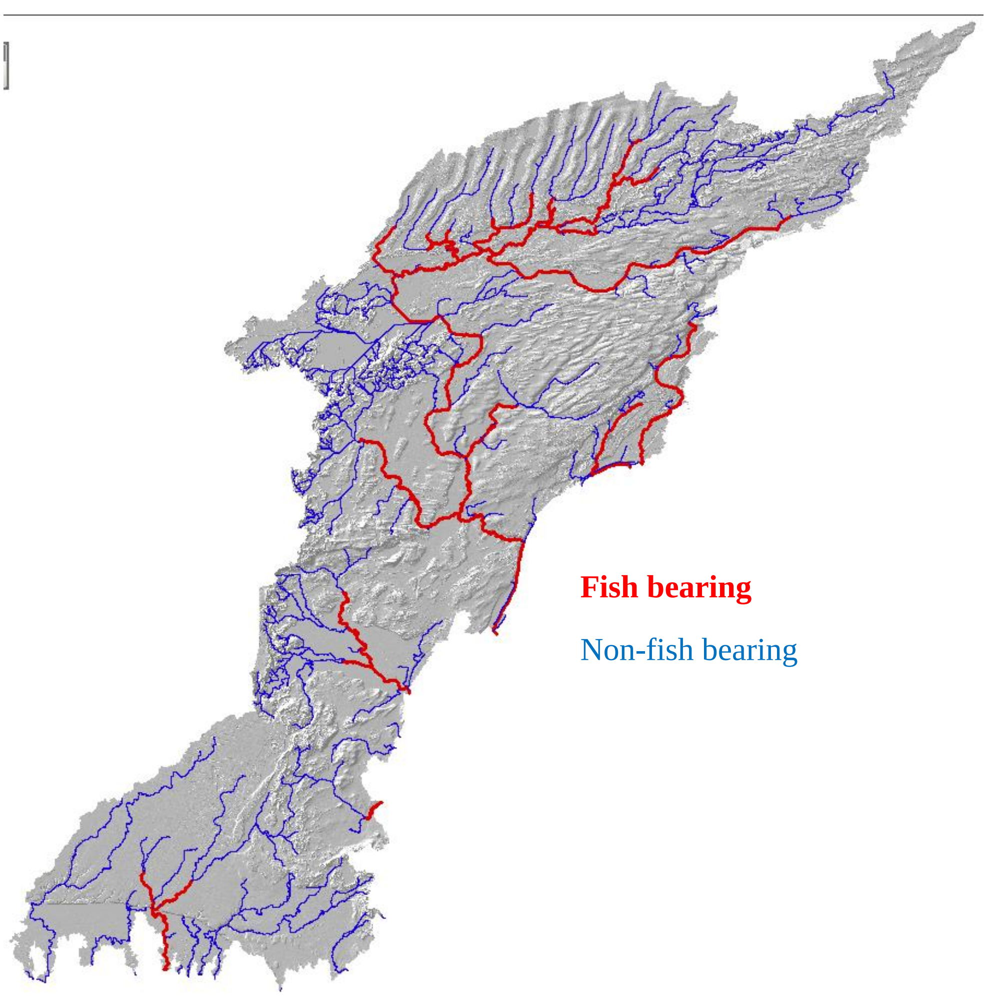
iii. Click on *Go* to bring up a dialog box to give this imported fish distribution a name.



iv. After specifying a name, click *OK* to get a dialog box from which to choose a shapefile (from the table of contents) that is used as the template for fish distribution. In this case, we'll use the Anadromous Waters Catalog data (scr_arc).

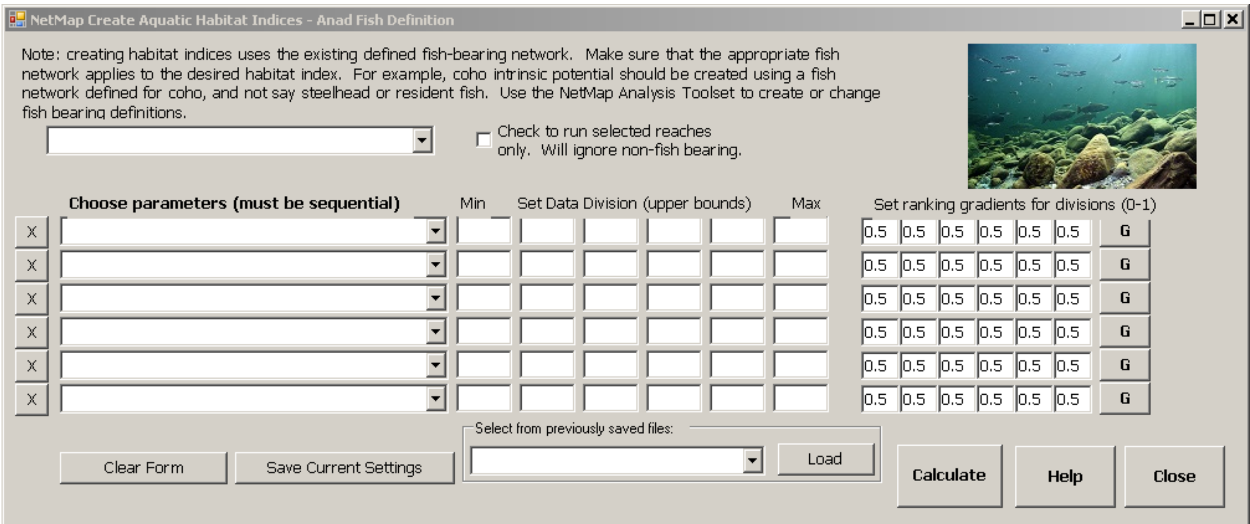


v. Click *OK* again, and wait as NetMap attempts to match the DEM-traced channels to the channel network specified in your chosen shapefile. Upon completion, the reach_goose layer will be displayed with the fish-bearing portion of the network in **red**, and the nonfish bearing in blue.



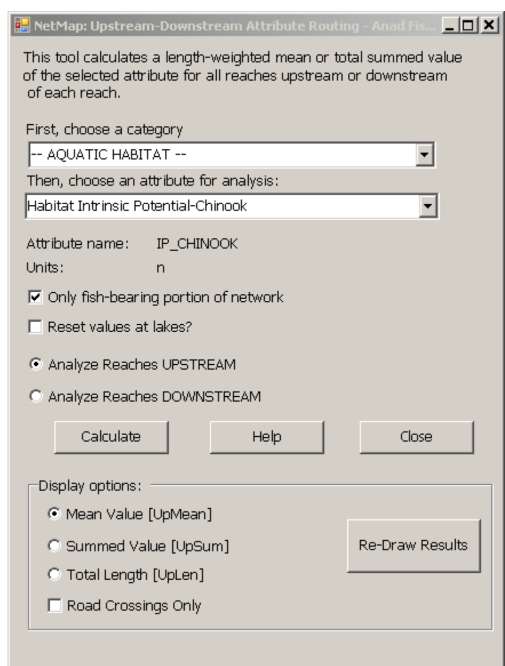
b. **Characterize habitat intrinsic potential**.

i. In the NetMap drop-down menu for **Aquatic Habitats**, select ***Create Aquatic Habitats***, ***Anadromous (Intrinsic Potential)***. This will pull up the dialog box "Create Aquatic Habitat Indices".



ii. From the drop-down menu for *Select from previously saved files* (lower center), select IP_Chinook_Busch_2011.txt and click *Load*. This will bring up an existing habitat Intrinsic Potential (IP) model for Chinook spawning habitat based on work from the Lower Columbia River (Busch et al., 2011, River Research and Applications). Then click *Calculate* to add this data field to the attribute table for the reach_goose shapefile.

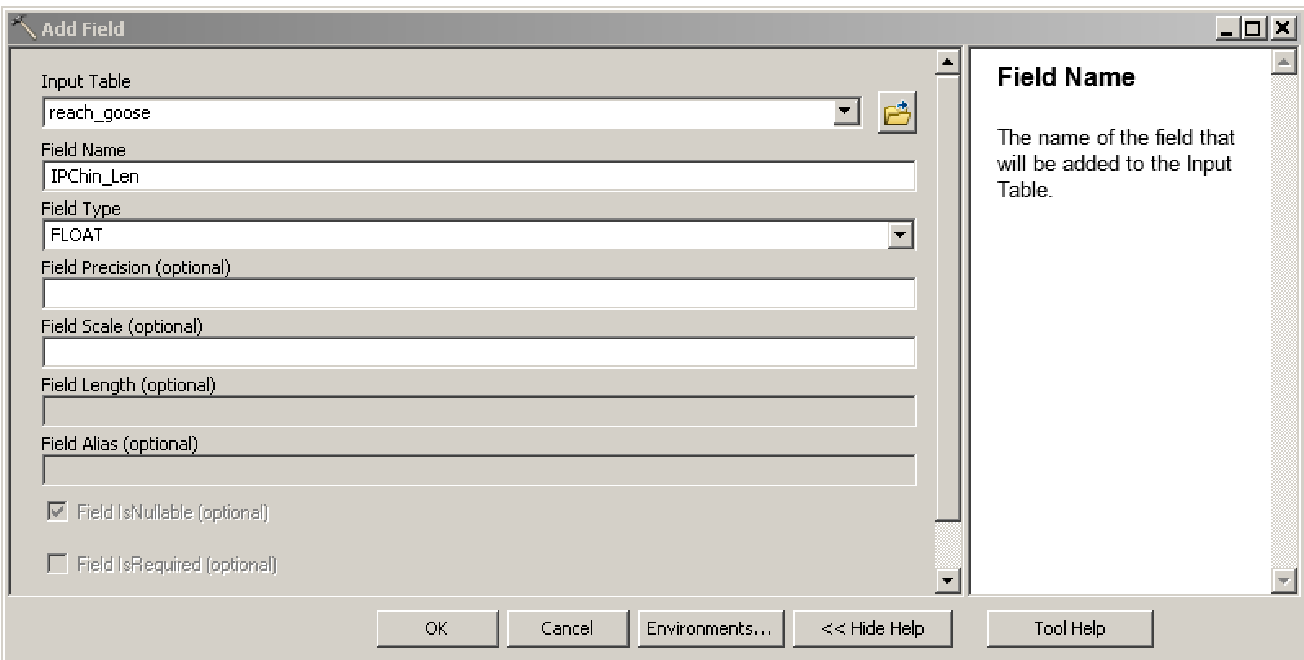
c. **Sum upstream channel length and get mean upstream Chinook Spawning IP value**. From the NetMap drop-down menu *Analysis Tools*, select *Attribute Aggregation*, *Upstream-Downstream Routing*. This brings up a dialog box with several options. Within this dialog box, from the drop-down menu for *choose a category*, select "-- AQUATIC HABITAT – ". Then, from the drop-down menu for *choose an attribute for analysis*, select "Habitat Intrinsic Potential-Chinook". Also check the boxes for "Only fish-bearing portion of network" and "Analyze Reaches UPSTREAM". Then click *Calculate*.



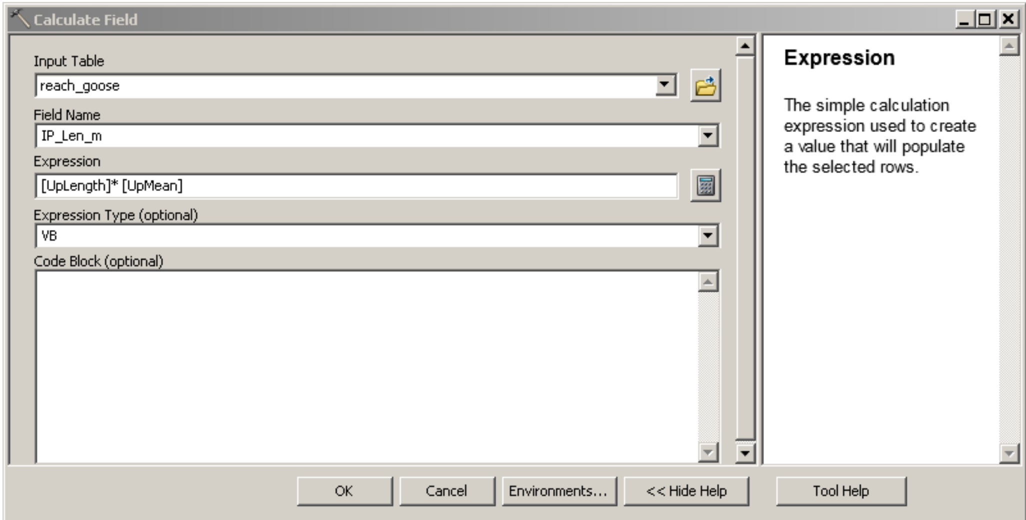
You now have several new data fields in the reach_goose layer attribute table: UpMean (channel-length-weighted mean IP_CHINOOK value of all upstream reaches), UpSum (sum of IP value of all upstream reaches – this is not a useful quantity in this case, but included by default), and UpLen (total upstream length of fish-bearing channels).

d. **Calculate the upstream "IP Length"**: a measure of upstream habitat potential as the product of UpMean (mean upstream IP value) and UpLen (total upstream length of fish-bearing channels). This gives upstream fish-bearing channel length weighted by a measure of intrinsic habitat potential.

i. Using the ArcToolbox, under *Data Management Tools*, *Fields*, select the **AddField** option. In the new dialog box, for *Input Table* select the reach_goose layer. Type in a field name of your choosing, use *Field Type* "Float" (or Double), and hit *OK* to add this field to the attribute table.



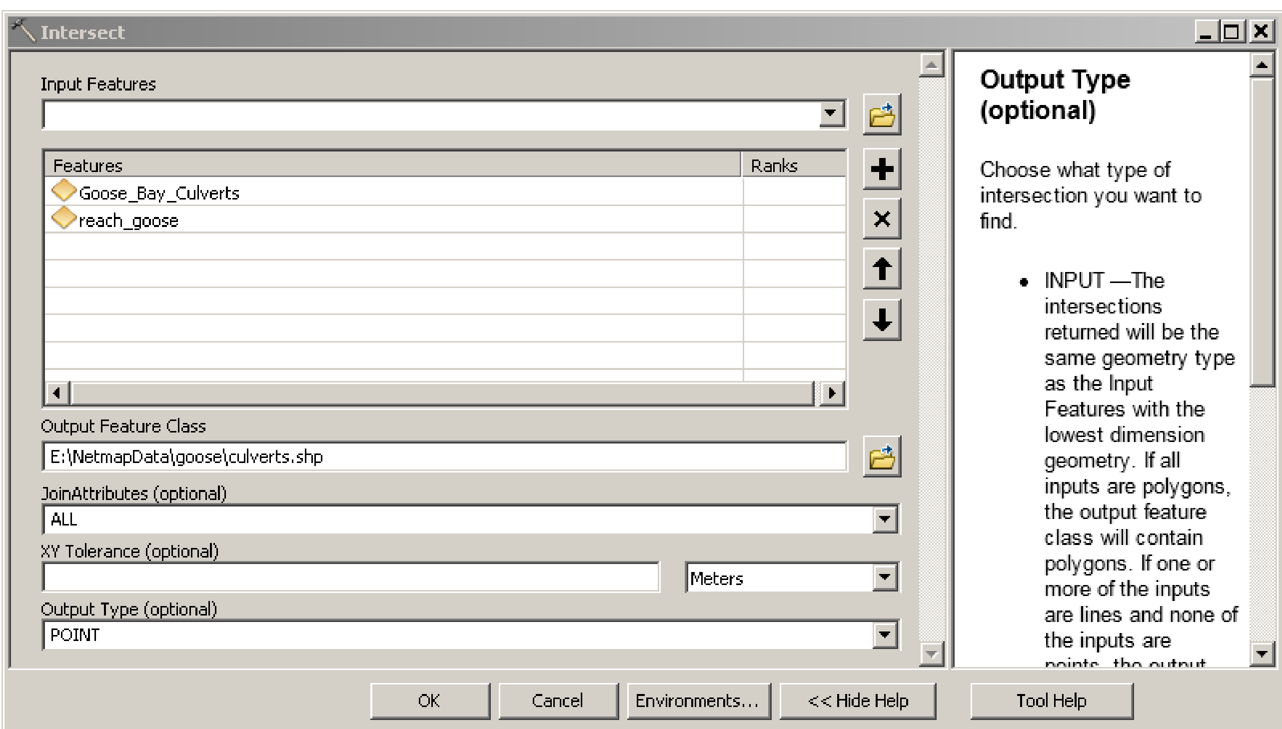
ii. Using ArcToolbox again, under *Data Management Tools*, *Fields*, select **Calculate Field**. For *Input Table*, select the channel reach layer (reach_goose), for *Field Name*, select the name of the field you just added, then for *Expression*, multiply the UpLength field by the UpMean field (you can use the Field Calculator, started by clicking on the calculator icon to the right of the text box). Click *OK*, and wait for Arc to update the attribute table with these new values.



e. **Intersect the Culvert Layer with the Stream Layer**.

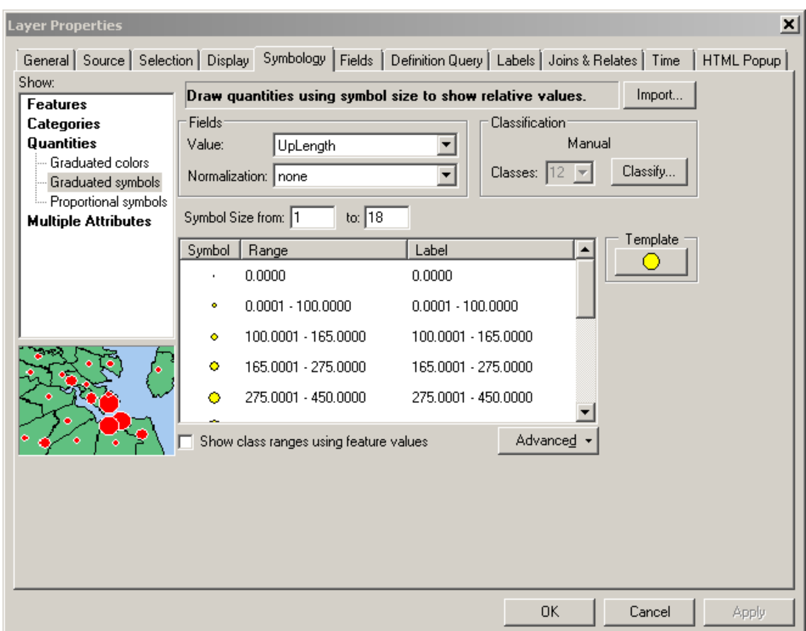
First, make sure that the Goose_Bay_Culverts layer has been added to your workspace and is visible in the Table of Contents in Arc. Then, in the ArcToolbox, under **Analysis Tools**, *Overlay*, select ***Intersect***.

For *Input Features*, select the Goose_Bay_Culverts and the reach_goose layers. Keep all data fields (ALL in JoinAttributes). I've chosen a point layer as the output, so that we can use graduated sizing to display the results. Click *OK* and wait for the new point layer (here named culverts.shp) to be created.

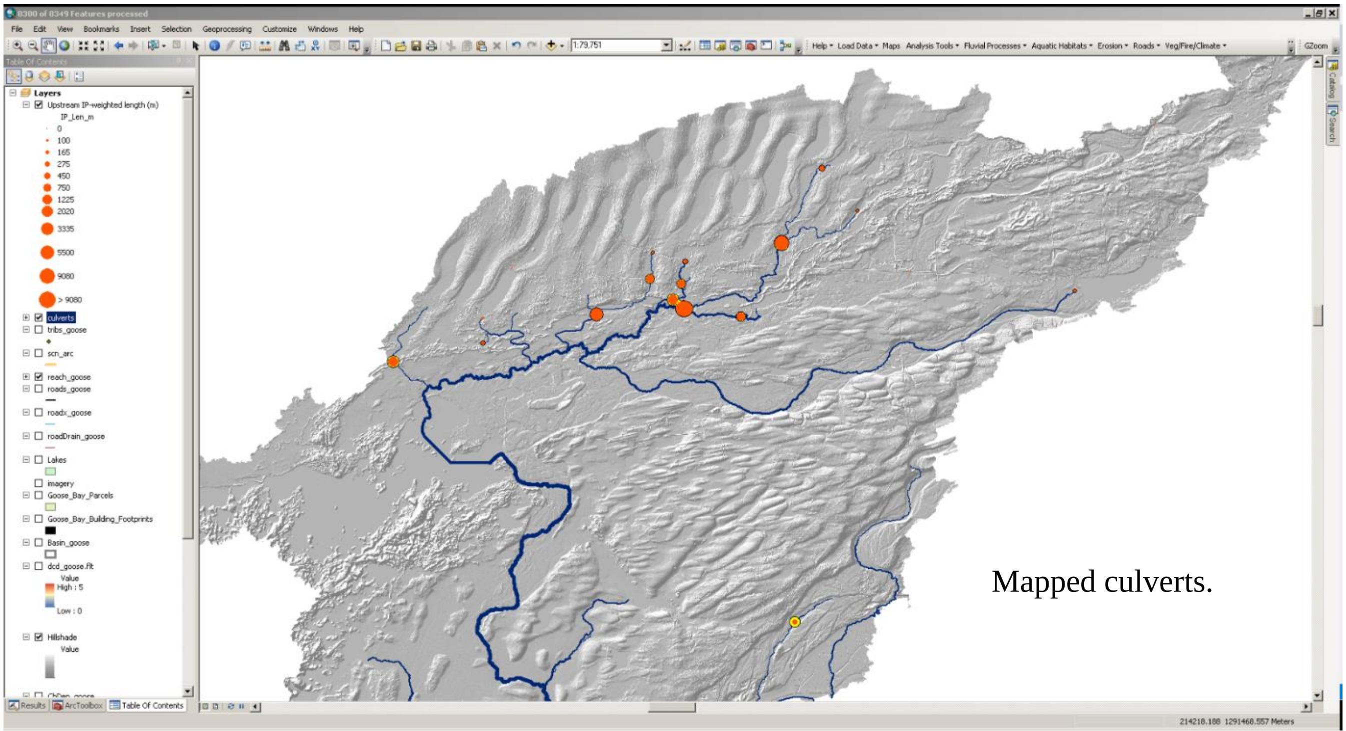


f. **Map the results**. It is useful to look at both the total length of fish-bearing channel upstream of each mapped culvert and to compare this to the length weighted by modeled Chinook spawning intrinsic potential. A convenient way to show this is with graduated symbols. Double click the culverts layer in the Table of Contents in the ArcGIS window to bring up the *Layer Properties* dialog box. Open the **Symbology** tab; in the *Show* window, select ***Quantities – Graduated symbols***. For *Fields – Value*: select the UpLength field, which gives the length (m) of fish-bearing channel upstream of each culvert. For *Classification*, select the number of classes you'd like to use, and then click on *Classify* to bring up a dialog box from which to set class breaks.

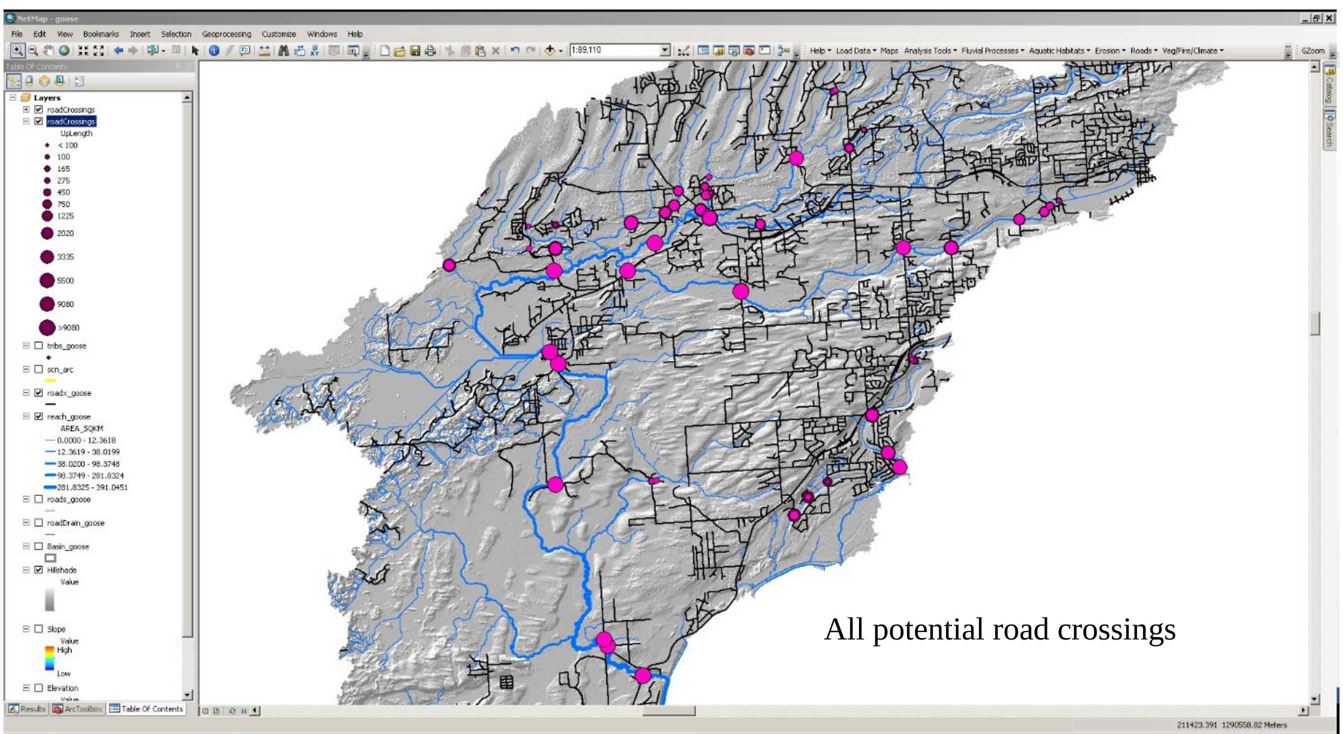
How to decide on meaningful class breaks? Right click on the culverts layer in the Table of Contents and then select *Open Attribute Table*. Scroll to the right through the table until you find the UpLength column. Right click on the column heading and select *Sort Descending*. Now you can see the range of values, and compare them to the corresponding values in the IP_Len_m values (a few columns to the right), which shows the upstream length weighted by habitat intrinsic potential. I chose a logarithmic variation (set manually). I also then added the culverts layer to the Table of Contents a second time and displayed the IP_Len_m values, using the same class breaks and graduated symbol sizes as used for the UpLength values. By overlaying the UpLength symbols with the IP_Len_m symbols, I can see both which culverts have the most upstream fish-bearing length, and how a measure of potential habitat quality modifies those values.



It is also worthwhile to try something similar by intersecting the road layer with the channel-network layer and creating a point layer of the intersections. These can then be displayed using graduated symbols to show the length of fish-bearing channel upstream of each crossing and the IP-weighted upstream length (see figure on the next page).



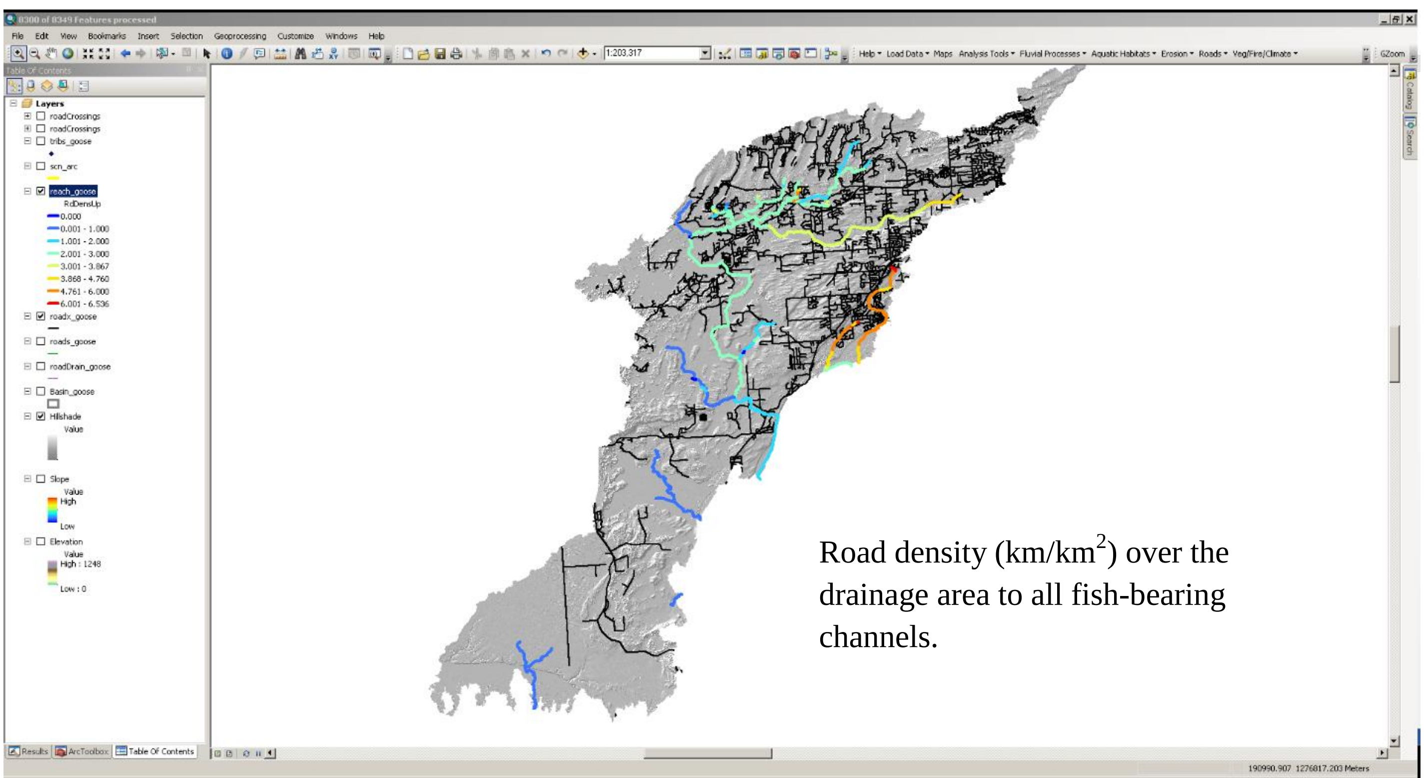
Mapped culverts.



All potential road crossings

2) **Impervious surfaces and water quality**. Now we're interested in seeing how features on land might be influencing channel characteristics. Our goal is to find meaningful ways to describe and summarize features within the area contributing flow to each channel reach.

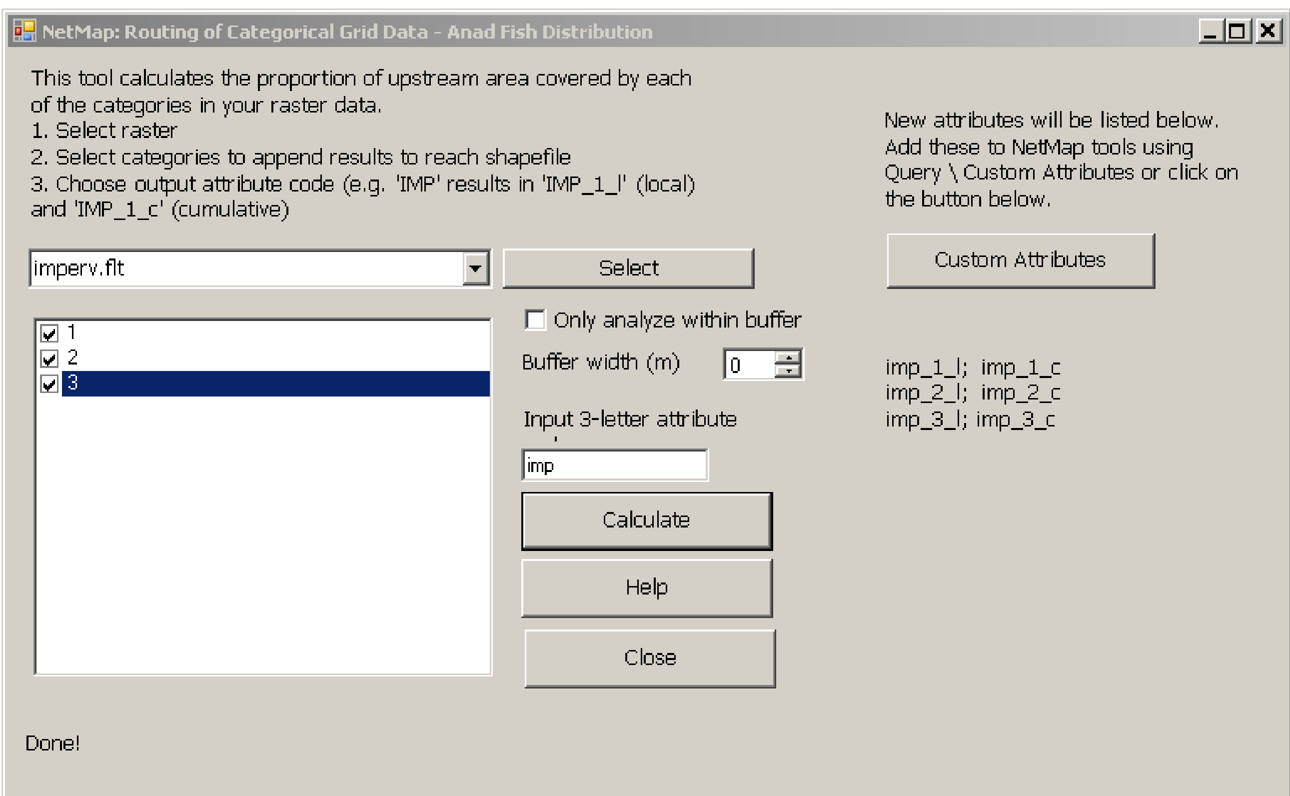
a. **Road density within the contributing area to each reach**. Road density is expressed as unit length of road per unit area. A channel cross section with a contributing area of 10 square kilometers and with 15 kilometers of roads within that contributing area has a road density of 15/10 = 1.5 km/km^2. NetMap has tools for importing a GIS road layer and using it for a variety of analyses, including calculations of road density. For our example, a road shapefile has already been imported (roads_goose). To get road density for the contributing area to each channel segment for the fish-bearing portion of the channel network, left-click on the *Roads* item in the NetMap menu, and then click on *Road Density* in the drop-down menu. This brings up the *Road-Density* dialog box. Within this box, select the tab for *Segment Scale/Routed*, select **Road Density Upstream**, *Fish-bearing only*, and click *Calculate*. It takes awhile for this program to run. When completed, the road network will be plotted in colors corresponding to variable road density within the contributing area to each reach. You can adjust the legend and color scheme to display the results to your liking.



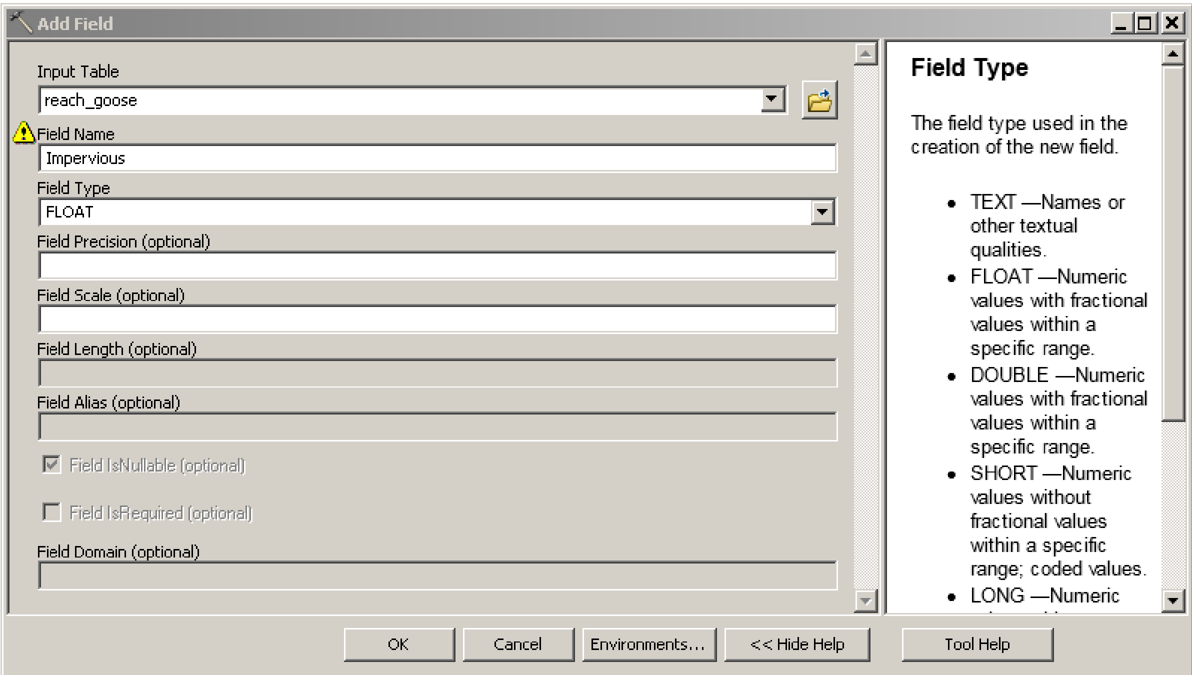
Road density (km/km^2) over the drainage area to all fish-bearing channels.

b. **Impervious area**. Included in the Goose Bay directory is a raster file (impervious.flt) showing approximate impervious areas ranked from low (1) to high (3) impermeability. Use this file with the *Attribute Aggradation* tool in NetMap to calculate the proportion of contributing area to each channel reach covered by impervious surfaces.

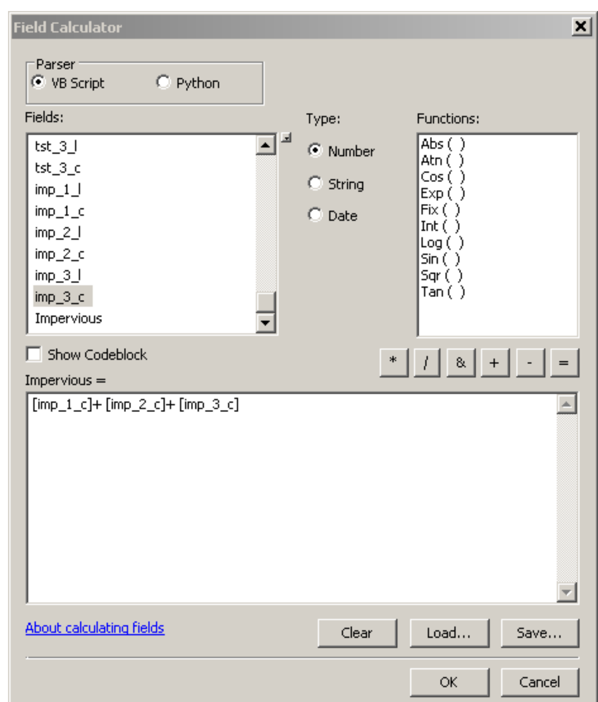
i. **Attribute Aggregation**: From the NetMap *Analysis Tools* drop-down menu, select Attribute Aggradation, *Routing of Categorical Hillslope (grid) Data*. Within the new dialog box, first use the drop-down list to select the impervious.flt raster file and click on the *Select* box. The unique values found within the raster are displayed in the large text box (1 = low, 2 = moderate, 3 = high impermeability). Check the box next to each number (only those values checked will be included in output data files). Then type a 3-letter text string in the "Input 3-letter attribute" text box. This is the name that will be used for the resulting data fields in the reach_goose attribute table. Click on *Calculate*, and wait for the program to work its way through all the data. When it finishes, a set of new attribute field names will be displayed. Click on the *Custom Attributes* box to add these to the set of NetMap data fields.



ii. The "_1_l" and "_1_c" portions of the new field names indicate the value referred to (1) and the "l" indicates "local" – that proportion of the local drainage area (the drainage wings) to the reach in impervious class 1 – and the "c" indicates "cumulative" – the proportion of the entire contributing area to the reach in impervious class 1. Let's sum the proportions in each class to get a single value representing proportion of the total contributing area covered by impervious surfaces. To do that, bring up the Arc ToolBox and go to *Data Management Tools*. Expand the *Fields* tool and select *Add Field*. This brings up a new dialog box. From the drop-down list for *Input Table*, select reach_goose. Type a new *Field Name*, e.g., Impervious, and specify *Field Type* Float (a floating point number, rather than an integer). Then click OK.

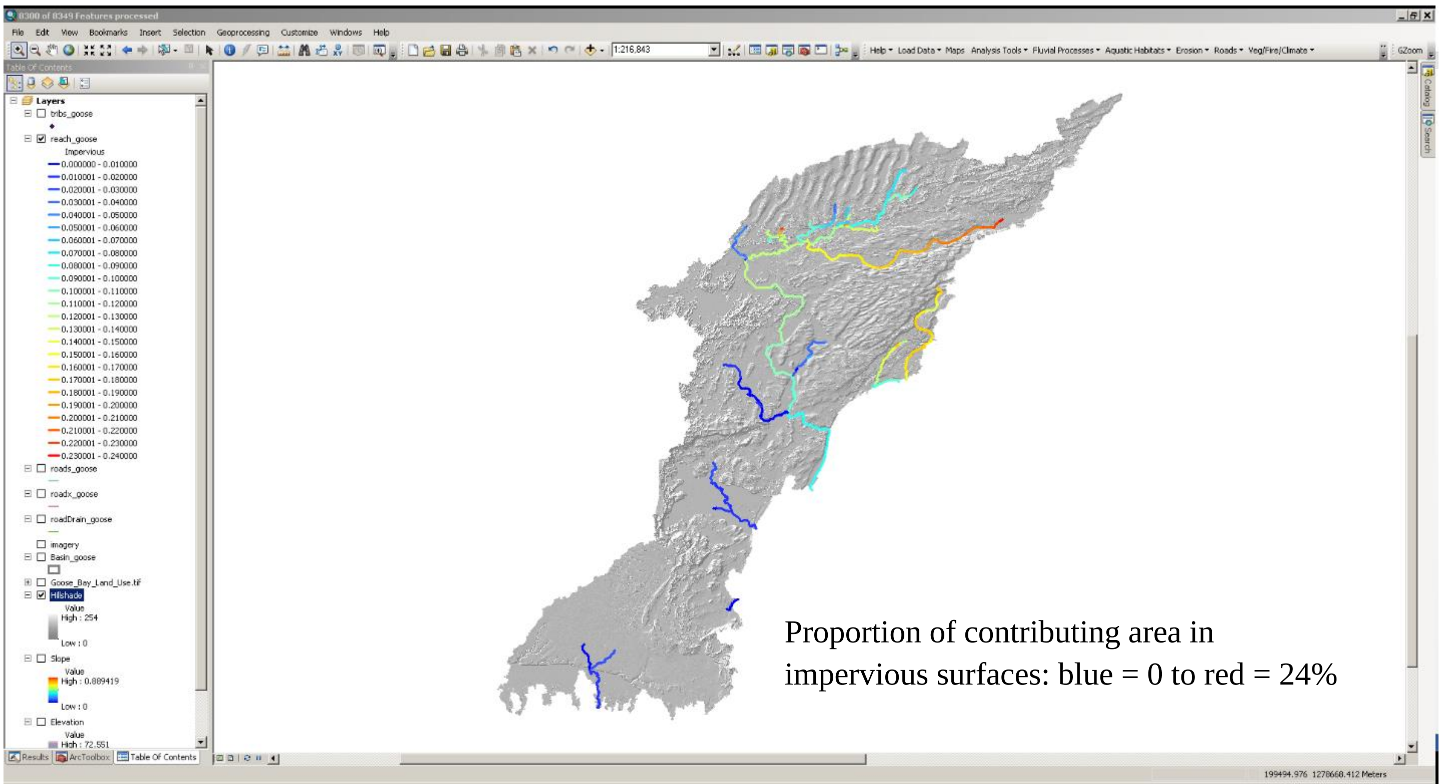


iii. Once Arc has added this field to the attribute table, you need to fill it with values. For this, from the *Fields* tool in Data Management Tools, select *Calculate Field*. This brings up another dialog box. Again, specify reach_goose as the *Input Table*, select the new field you just added, and then fill in the *Expression* text box. To do this, click on the little calculator icon to the right of the *Expression* text box to bring up the *Field Calculator*.



iv. To get the total proportion of the area covered by impervious surfaces, add the cumulative components for each class (imp_1_c + imp_2_c + imp_3_c). Click *OK*, and Arc will fill in the attribute-table values.

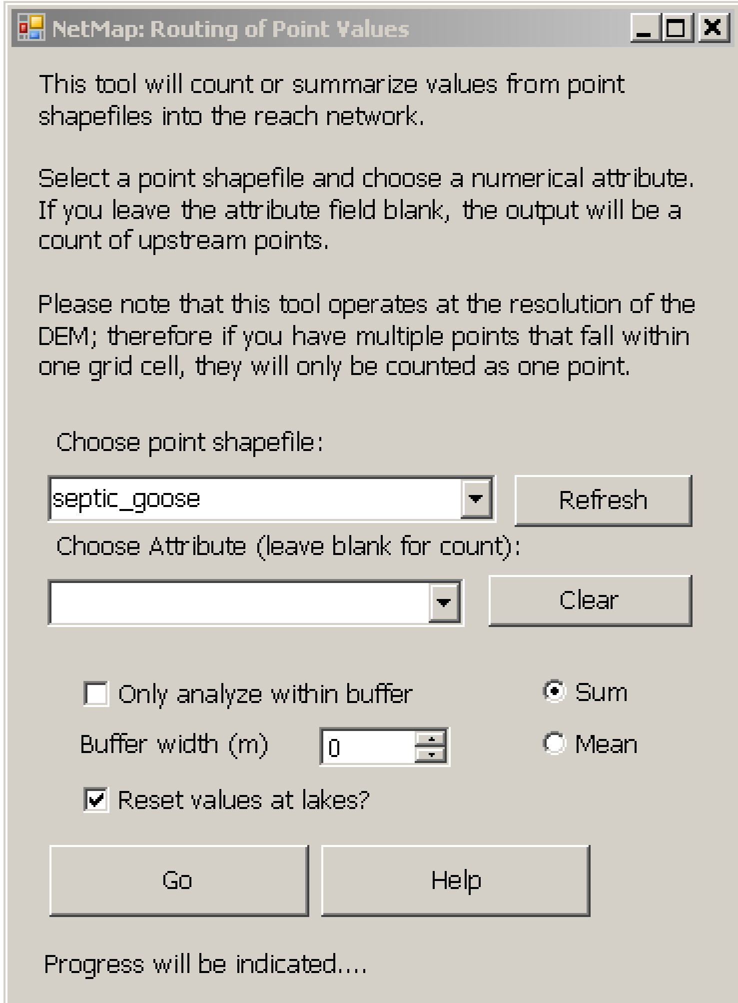
v. Plot the results. In the Table of Contents, double click on reach_goose. This brings up the *Layer Properties* dialog box with many tabs. First, let's restrict map output to only fish-bearing channels. Click the *Definition Query* tab and use the *Query Builder* to build the "Fish" = 1 expression. Click *OK*, and then select the *Symbology* tab. From the left box, select *Quantities*, *Graduated colors*. For *Fields*, from the drop-down list select the data field you just added (Impervious), select a color ramp, and then click the *Classify* box to bring up the *Classification* dialog box. Here I used a "Defined Interval" with *Interval Size* of 0.01 (1%), which gives 24 values (the maximum value for this data field was 0.239). This gives a map showing, for each 100-m channel reach, the proportion of its contributing area covered by impervious surfaces.



c. **Spatial density of septic systems**.

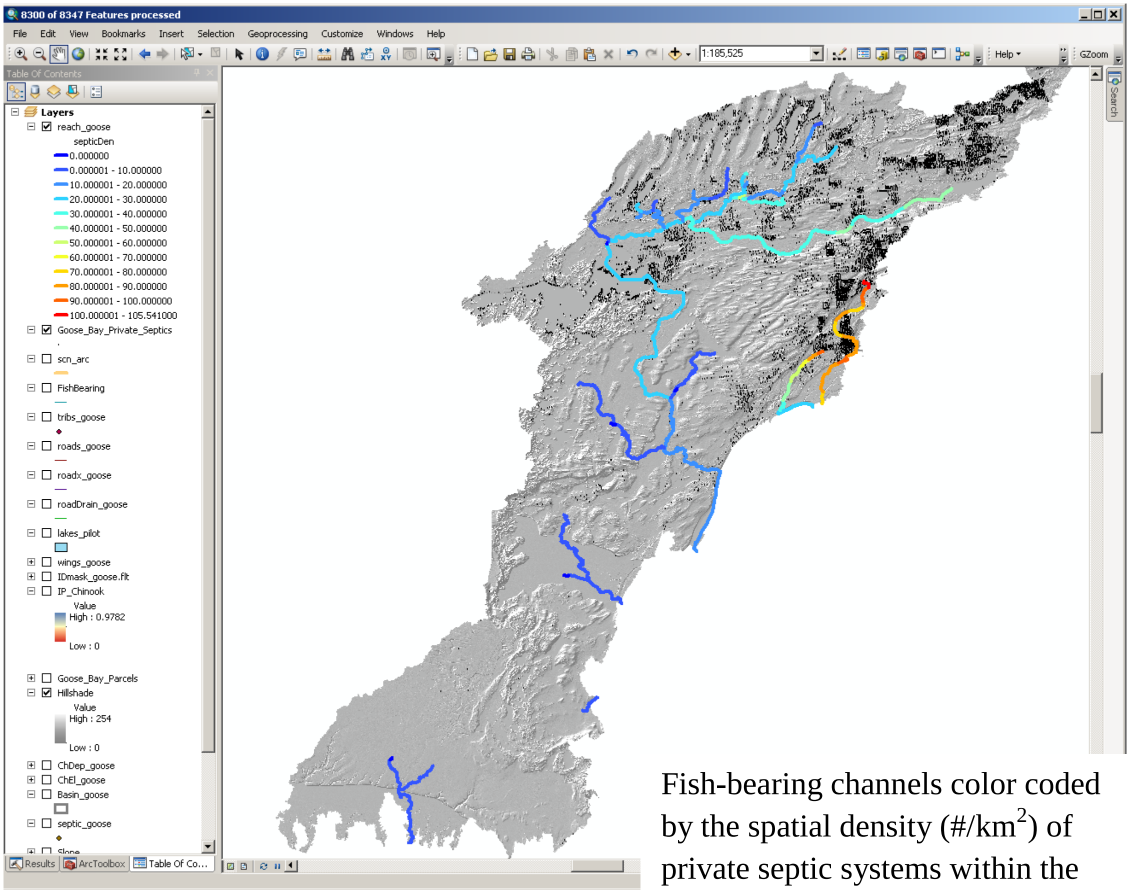
i. Included with the Goose Bay files is a point layer called Goose Bay Private Septics. Add this to your table of contents and then from the *Analysis Tools* in the NetMap menu, select *Data Management*, *Import Data*. This brings up the *Import Data* dialog box. Click on the *Import* button, and follow the instructions in the subsequent dialogs. For example, I named my imported layer "septic" and selected the Goose Bay Private Septics layer for import.

ii. **Routing of Point Values**: Next, from the *Analysis Tools* item in the NetMap menu, select *Attribute Aggradation*, Routing of Point Values. This brings up the *Routing of Point Values* dialog box. Chose the point shapefile you just imported (septic_goose), leave the *Choose Attribute* box blank, select *Sum* (rather than mean), and click *Go*.



iii. You've now created two new data fields in the reach_goose attribute table: UpPointLoc and UpPointCum. UpPointLoc gives the number of private septic systems draining to each reach and UpPointCum gives the total number within the contributing area to each reach. We'd like to translate UpPointCum to a measure of number of points per square kilometer. To do this, use the ArcTool Box and under *Data Management Tools*, expand the *Fields* menu and select *Add Field*. Select the reach_goose *Input Table*, specify a name for the new field (e.g., septicDen), set the *Field Type* to Float, and click *OK*. After Arc has added this field to the attribute table, you need to fill it with values. To do that, in the *Data Management Tools*, *Fields* menu, select *Calculate Field*, select the reach_goose Input Table, the new field name you just created (septicDen), and enter the *Expression* (using the Field Calculator invoked by clicking on the calculator icon to the right of the Expression text box) [UpPointCum]/[AREA_SQKM]. Click *OK* and wait for Arc to calculate the values.

iv. To display the values, I double-clicked reach_goose in the Table of Contents to bring up the *Layer Properties* dialog box, used the *Definition Query* tab to select only fish-bearing channels (“Fish” = 1), and then used the *Symbology* tab to display the data field septicDen with a blue-green-yellow-red color ramp and manually-set ranges, including zero, in steps of 10.



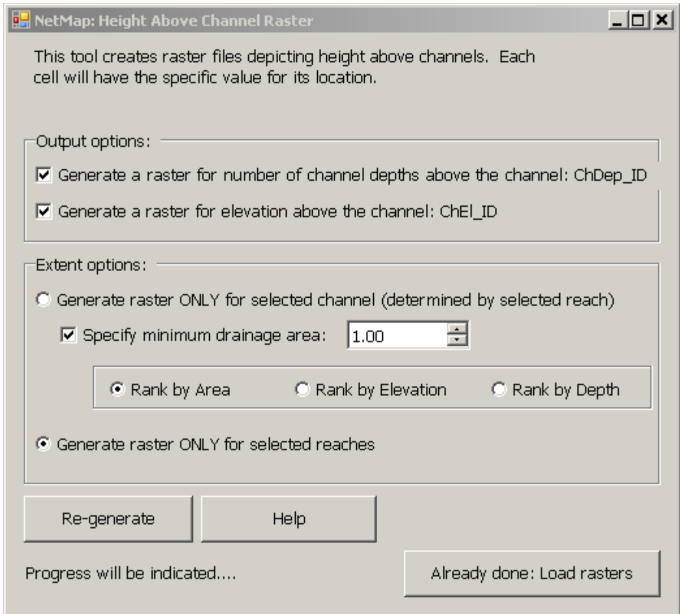
Fish-bearing channels color coded by the spatial density (#/km^2) of private septic systems within the drainage area.

3) **Proximity to active river flood plain**. NetMap includes analyses to estimate elevation above the channel for valley-floor and flood-plain zones. We’ll use these now with other ArcGIS capabilities to identify locations potentially within active floodplains.

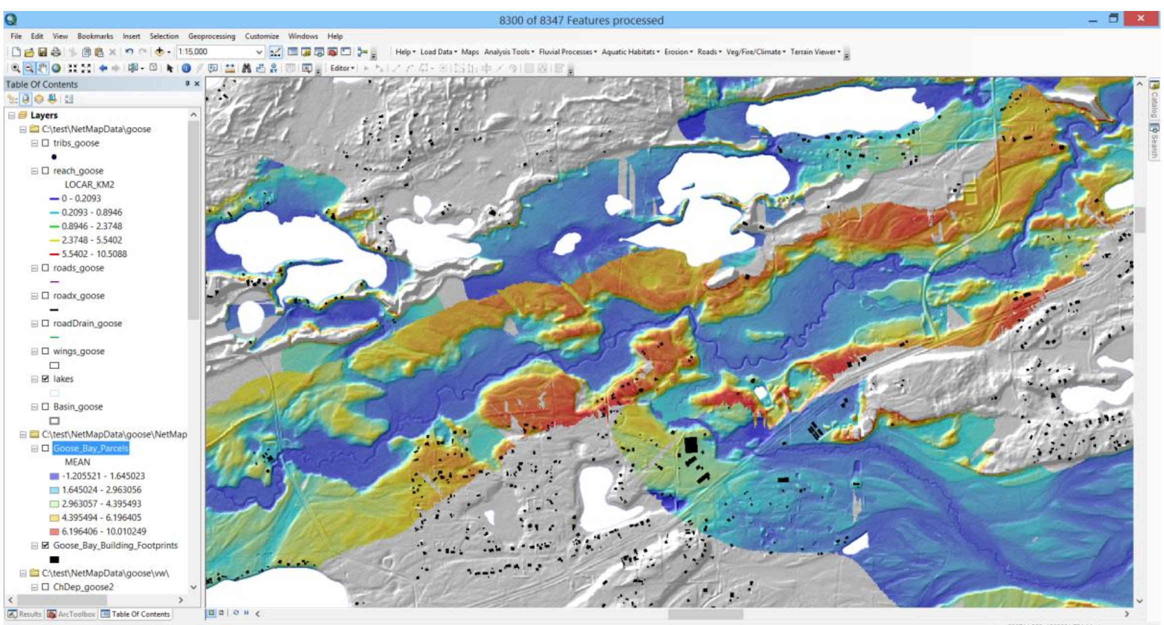
a. **Identify parcels potentially within active floodplain zones**.

i. **Height Above River Channel**: Create a map showing elevation above the channel for potential floodplain areas. In the NetMap menu, click on *Fluvial Processes* and select *Floodplain Mapping*, Height Above Channel. This brings up the *Height Above Channel Raster* dialog box. This tool creates raster files showing the estimated elevation above the channel. Elevation can be reported in meters or in terms of the number of bank-full depths above the channel. (Normalizing by bank-full depths provides a rough estimate of the probability for inundation, because flood stage for a given recurrence interval can be expressed in terms of bank-full depths.) Select both output options, and then under *Extent options*, select “Generate raster ONLY for selected reaches”. Before clicking the

Re-generate button, open the attribute table for reach_goose and use the *Select by Attributes* box  (shown in the ribbon above the table) to select only fish-bearing channels ("Fish" = 1). Then in the *Height-Above-Channel-Raster* dialog box, click *Re-generate*.

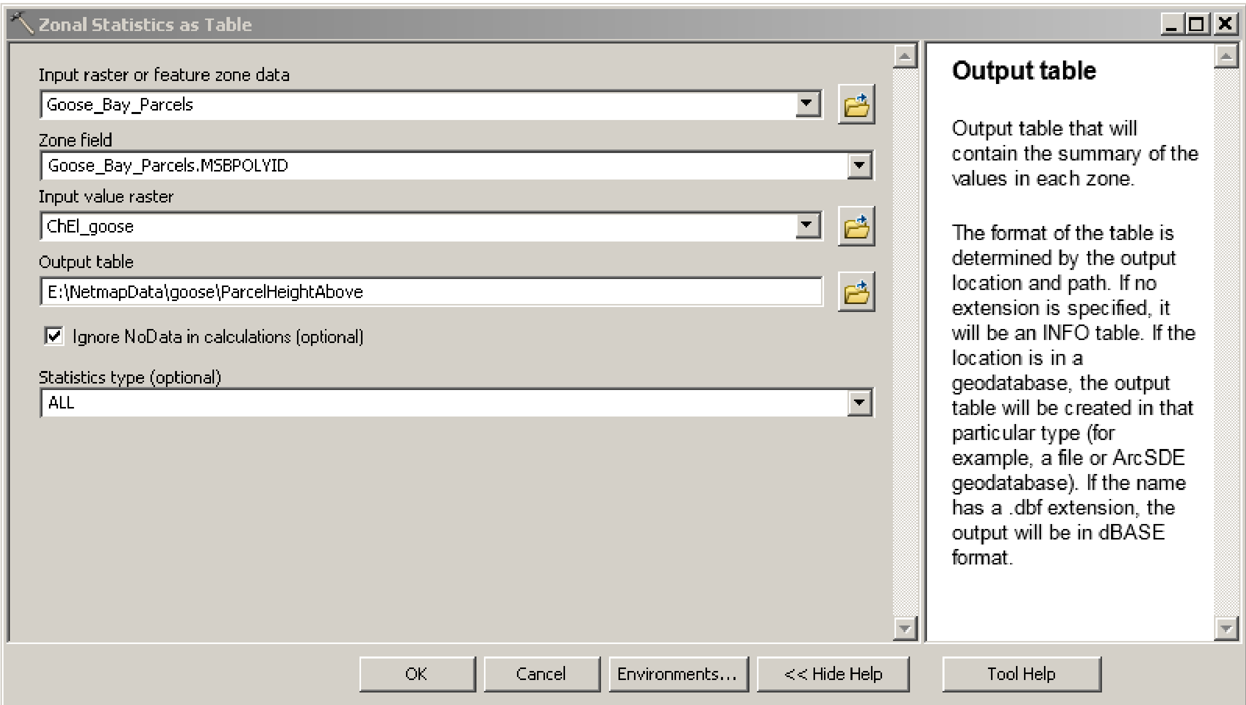


This results in the creation of two floating point raster files: ChEl_goose (elevation above channel in meters) and ChDep_goose (elevation above channel in number of channel depths). We'll use these with a polygon layer for parcel boundaries and the Focal Statistics tools in Arc.

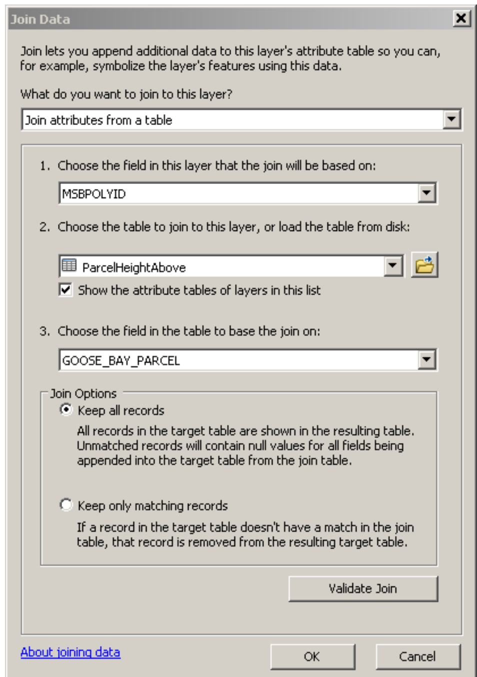


ii. Add the Goose Bay Parcels polygon layer to your table of contents.

iii. **Zonal Statistics**: In the ArcToolbox, under *Spatial Analyst Tools*, expand the *Zonal* tools and select Zonal Statistics *as Table*. Select Goose_Bay_Parcels as the *Input feature zone* data, MSBPOLYID as the *Zone field*, ChEl_goose as the *Input value raster*, and specify a name for the output table. We can ignore NoData, and keep ALL statistics. Click *OK* to create the table. If you list the Table of Contents using List By Source (using the icons in the little ribbon above the table of contents), you can see the table listed and open it up to see the values calculated – such as the minimum, maximum, and mean elevation above channel within each parcel.

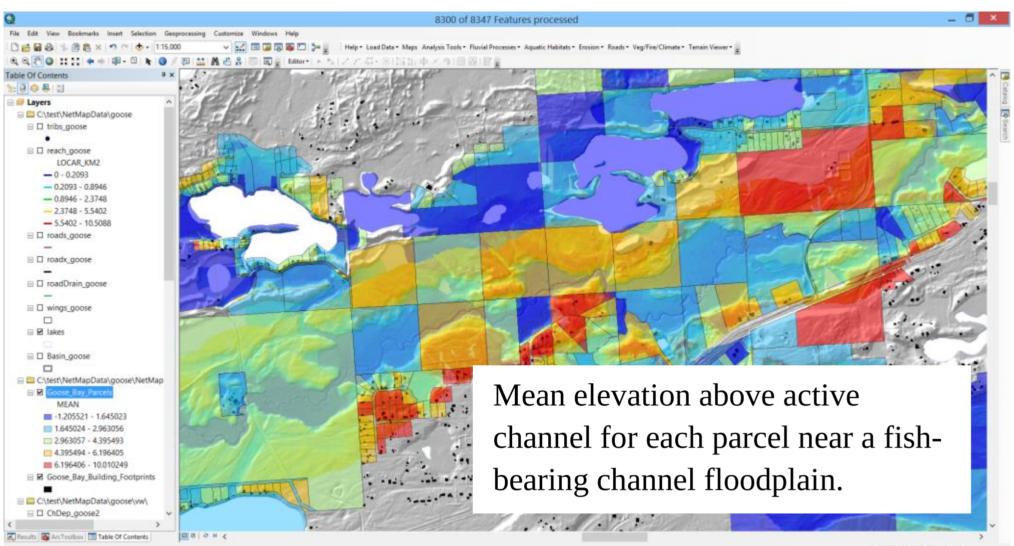


iv. **Join the table** to the Goose_Bay_Parcels polygon layer. In the Table of Contents, right click on the Goose_Bay_Parcels layer, then in the drop-down menu, select *Joins and Relates*, *Join*. This brings up the *Join Data* dialog box. Fill it in as shown in the following figure. Arc will ask if you want to create an index – click Yes.



v. Once the table is joined to the polygon layer, you can display the results as a map. For example, I displayed the MEAN value (mean elevation of each parcel above a channel) using a defined interval of 1 meter for the color division.

vi. You can repeat this exercise using the Goose_Bay_Building_Footprints polygon layer to get an estimate of how far above the active channel each building is located.



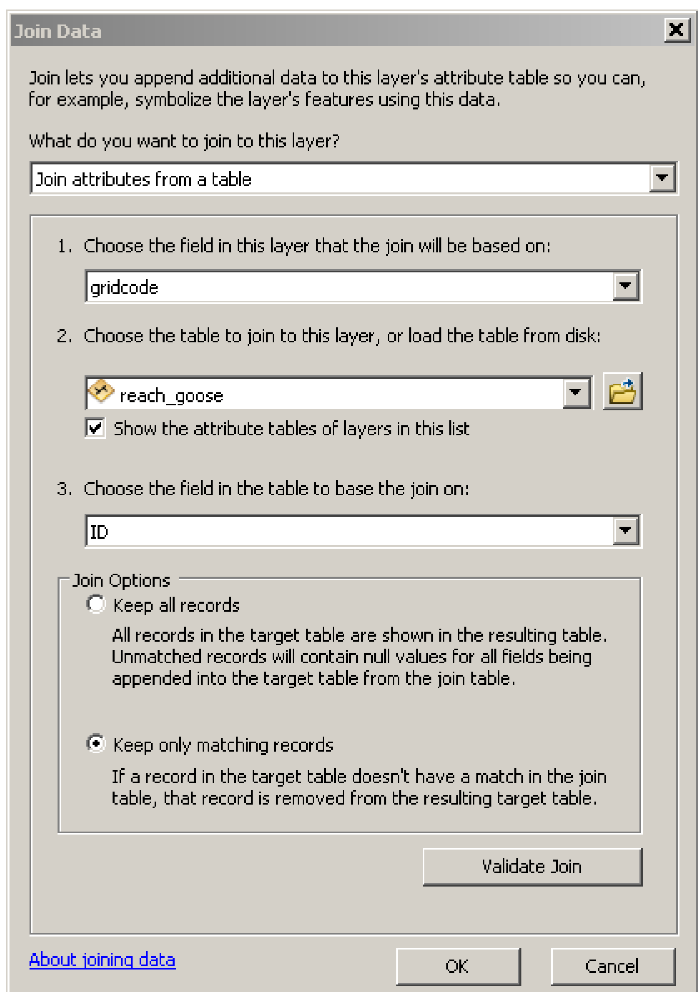
4) **Proximity to spawning streams**. We'll use the estimates of habitat intrinsic potential to identify streams likely to provide spawning habitat. Stream reaches can be linked to adjacent floodplain and hillslope areas either using the DEM-estimated flow paths or using the associations established by the floodplain mapping tool. We'll use the flow paths now.

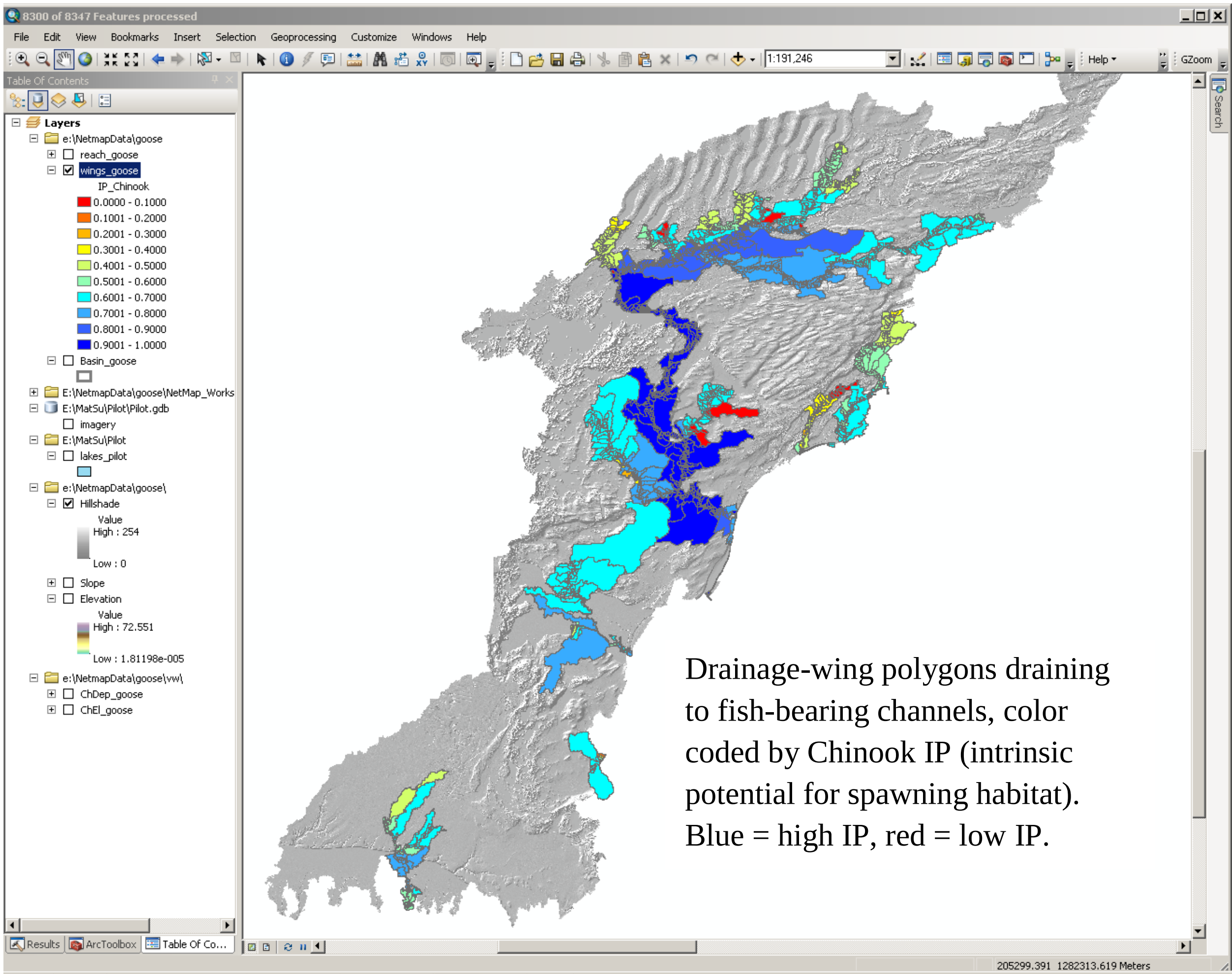
a. **Identify parcels adjacent to the top 20% of stream reaches** based on Intrinsic Potential for king salmon spawning.

i. **Generate Drainage Wing** polygons. These delineate the approximate contributing area to each channel reach. In the NetMap menu, *Analysis Tools*, select *Drainage Wings*. This brings up the *Drainage Wing Polygons* dialog box. Click *Go*, and wait for the "Done!" prompt to appear. You should now see a new polygon layer, wings_goose, in the Table of Contents.

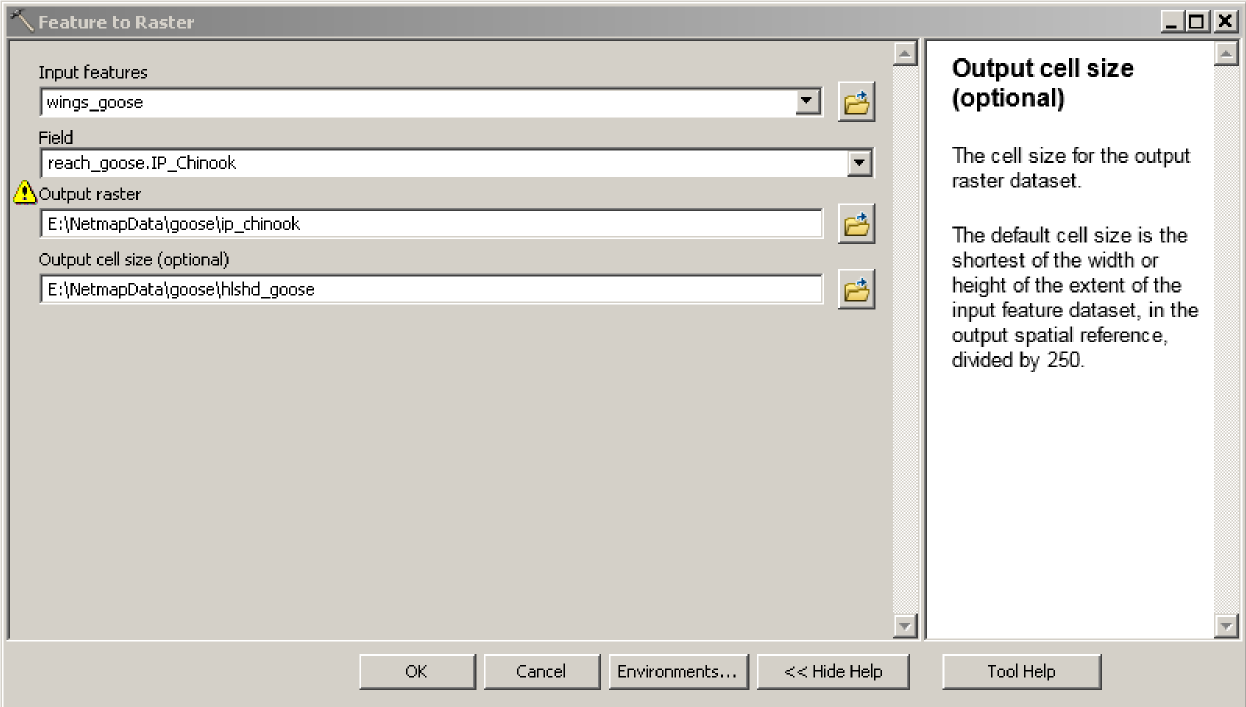
ii. Join the reach_goose stream layer to the wings_goose. This will allow you to associate any reach attribute, such as habitat intrinsic potential, to the drainage-wing polygons. In the Table of Contents, right click on the wings_goose layer, and select the *Joins and Relates*, *Join* item. This brings up the **Join Data** dialog box. Select gridcode as the *field the join will be based on* (gridcode contains the associated reach_goose ID). Select reach_goose as the *table to join*, and choose ID as the *field to base the join on*.

iii. To create a map of your results, double click the wings_goose layer to bring up the *Layer Properties* dialog box. To simplify the resulting map, it is helpful to use the *Definition Query* tab to limit the display only to drainage wings corresponding to fish-bearing channels ("reach_goose.Fish" = 1). Then in the *Symbology* tab, under *Fields* chose IP_Chinook for the *Value* (and *Normalization* "none"), select a color ramp and click the *Classify* button to view the statistics and set a classification method. I used a "Defined Interval" of 0.1.





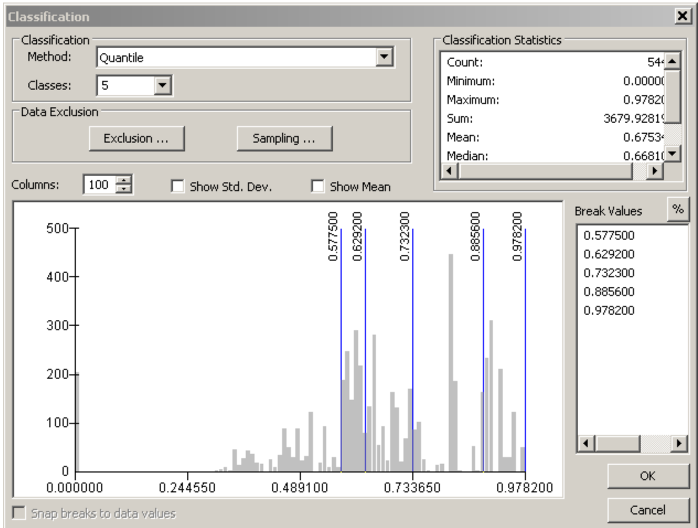
iv. **Feature to Raster**: To relate these results to the Goose Bay Parcels polygons, I converted these drainage-wing polygons to a raster file. In the Arc Toolbox, under *Conversion Tools*, *To Raster*, select *Feature to Raster*. This brings up the Feature to Raster dialog box. Set the *Input features* to wings_goose, the *Field* to reach_goose.IP_Chinook, provide a name for the output raster (I used IP_Chinook), and use one of the existing NetMap grids (e.g., hlshd_goose) to specify the cellsize. Click *OK* to create a new raster file.

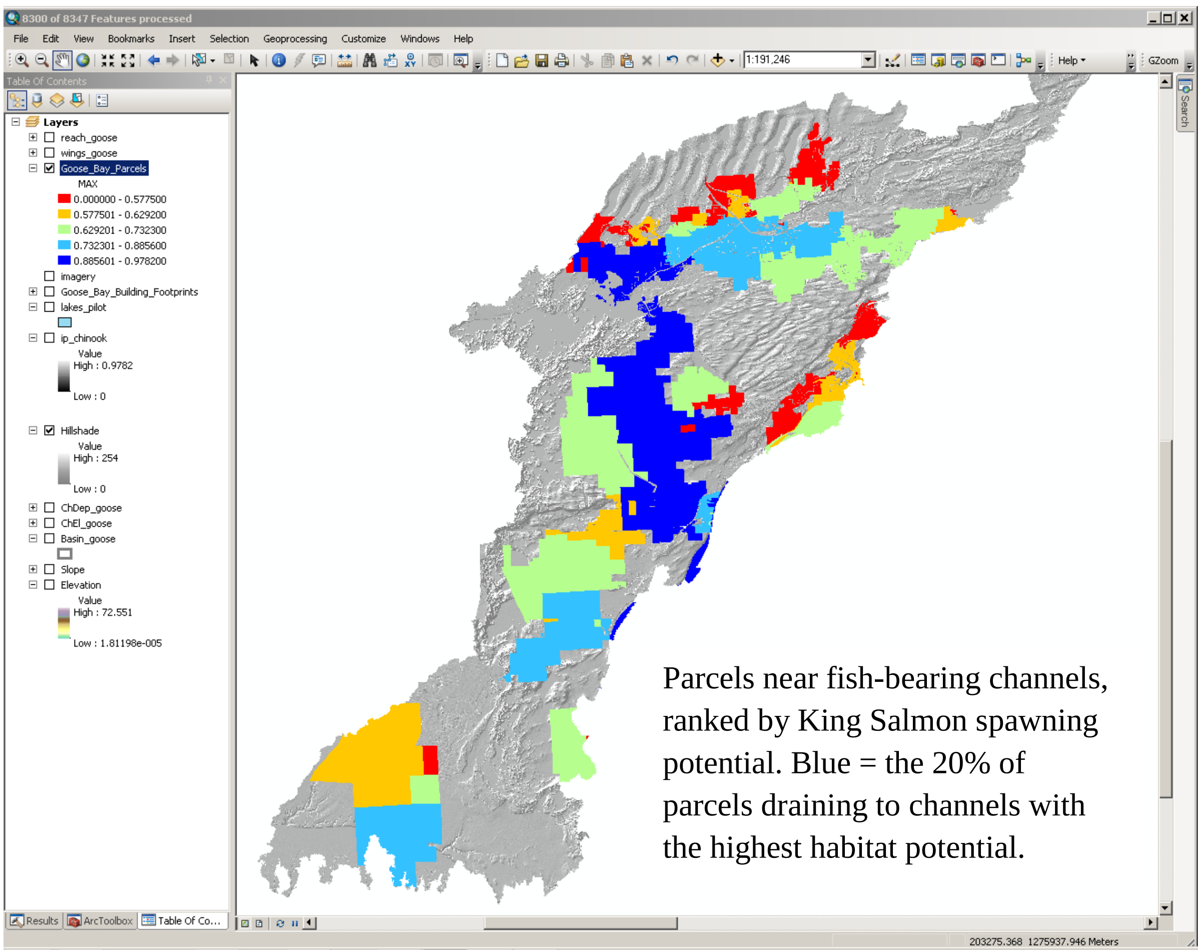


v. **Zonal Statistics**: Now use the Zonal Statistic *as Table* tool (Arc Toolbox, *Spatial Analyst Tools*, *Zonal*) to get information about the habitat potential of the stream reaches that each parcel drains to. Select Goose_Bay_Parcels as the *input feature zone data*, use the MSPOLYID for the *Zone field*, IP_Chinook as the *input value raster*, specify an output table name (I used Parcel_IP), keep all statistics, and click *OK*.

vi. Join your newly created table to the Goose_Bay_Parcels polygon layer.

vii. **Display intrinsic potential (IP) values** in terms of 20% quantiles. Bring up the *Layer Properties* dialog box for the Goose_Bay_Parcels layer (double click in the Table of Contents), select the *Symbology* Tab, for *Fields – Value*, select MAX (the maximum IP_Chinook value encountered in each parcel polygon), and click on *Classify*. In the *Classification* dialog box, set Classes to 5 and select "Quantile" for *Method*. The values are then divided into classes that each contain 20% of the values. You can see where these values fall in the *Break Values* text box: the top 20% fall between values of 0.9782 and 0.8856. (Check my logic – do the same for the IP_Chinook values in the reach_goose layer to see if you get the same values. Since channel-segment lengths are all about 100m in reach_goose, the quantiles will differentiate values in terms of channel length: with 5 divisions, each quantile will contain 20% of the channel length).





Now that you've seen how to use NetMap with ArcGIS to address the questions we came up with, perhaps you have questions of your own. There are other data sets in the Goose Bay directory to experiment with: land cover, building footprints. NetMap provides other geomorphic attributes to map, other habitat models to try – or an interface to build your own.