Mapping Violent Crimes

Background

This exercise explores different approaches to mapping violent crimes using Geographic Information Systems (GIS). Additionally, socio-economic characteristics of locations with high crime rates are explored.

ArcGIS online is a platform for sharing maps on the internet. The analysis layers in this application were created using ArcGIS desktop. However, anyone with an ArcGIS online account[1] can use analysis tools similar to the ones described here to study crime patterns.

For this study, a mapping application has been prepared to familiarize you with crime mapping and analysis. To access the map on ArcGIS Portal, click here or copy and paste the url below into your web browser. (**NOTE**: *If accessing this document in BLACKBOARD, right click on link and choose open in a new TAB*.)

https://geographyplanning.buffalostate.edu/geography/home/webmap/viewer.html?webmap=c19eb300a8074d3e80229609e4ef976f&extent=-79.0171,42.8139,-78.6126,42.9714
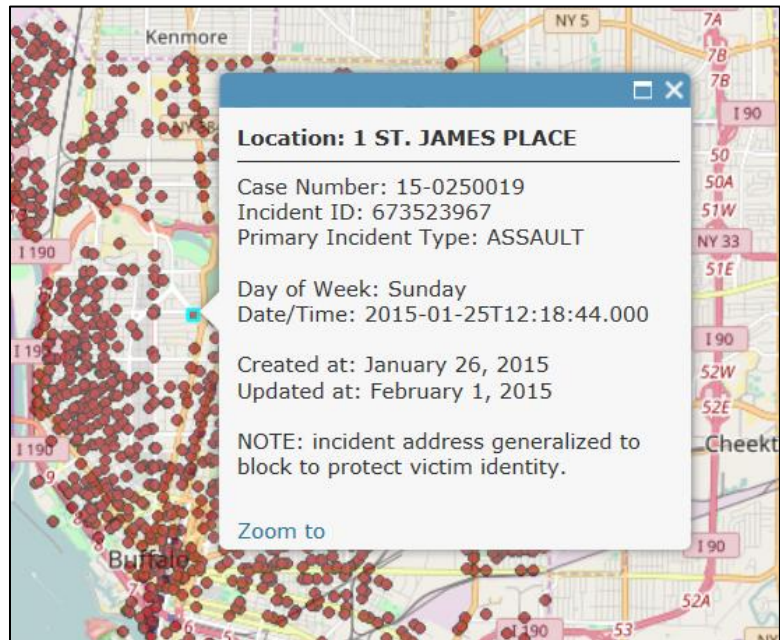
Map Interface

The map will open in a new window in your web browser. The LEGEND for the map is on the left side of the screen. In GIS a map is composed of many layers, each containing information related to the map topic. A "Basemap" gives context to the map layers. When this map opens, the "Violent Crimes 2015" is the only layer shown in the "Violent Crimes in Buffalo, NY" map LEGEND. The default symbology represents every crime with the same red circular symbols.

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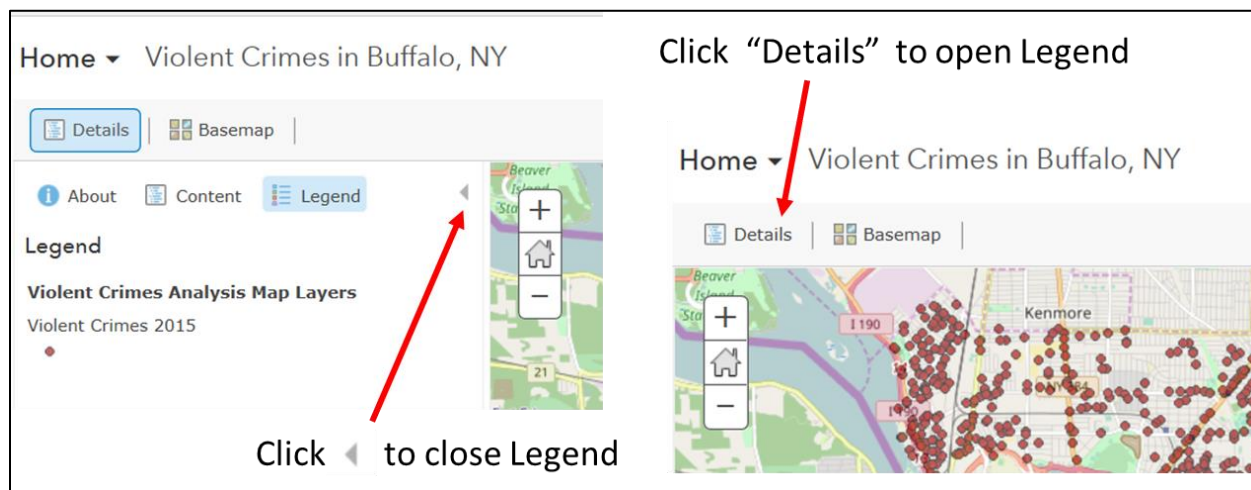
[1] If you are interested in a free ArcGIS online account go to https://www.arcgis.com/home/index.html and click on sign up now. This application provides access to a zipped shapefile of the violent crime data and some basic instruction on how to conduct the analysis in ArcGIS online.

The source of the crime data is the Buffalo Police Department on Socrata. Please read "About the Data" to understand how the data were modified for this GIS application.
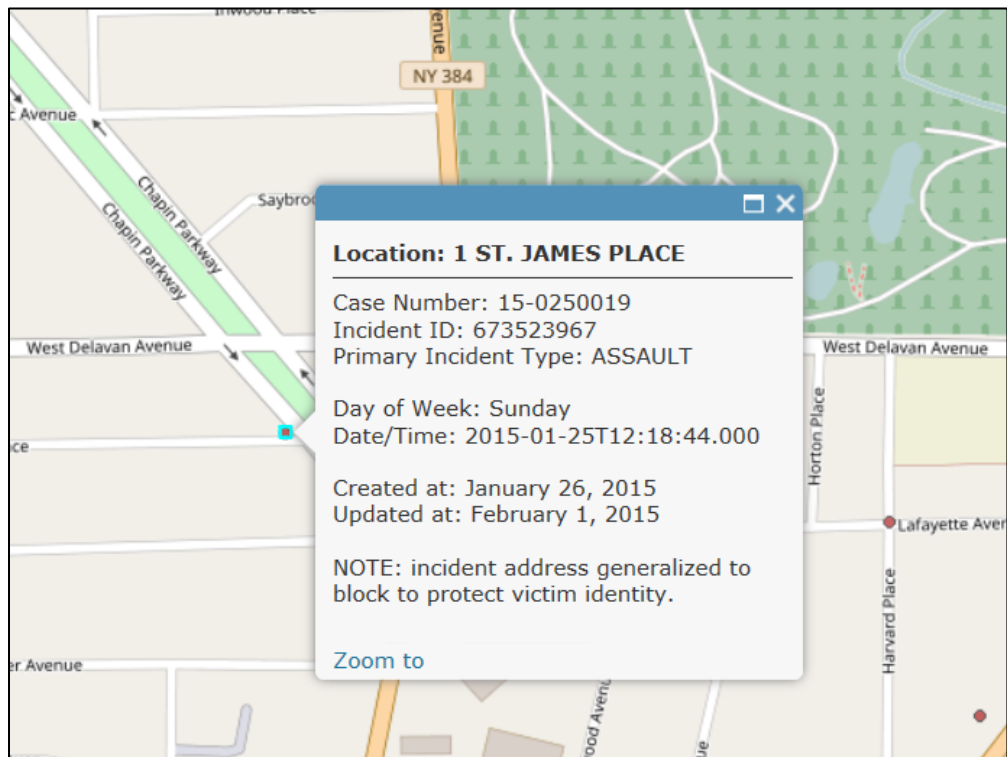
Click on any of the point symbols on the map to open a pop-up for that crime location. The pop-up shows information provided in the downloaded crime dataset. The data provider geocoded (spatially referenced) crimes to city block locations to protect identities. As stated in the "About the Data" document, the incident date and time information contains errors (no crimes after 12: 59 pm information).


Location: 1 ST. JAMES PLACE

Case Number: 15-0250019
Incident ID: 673523967
Primary Incident Type: ASSAULT

Day of Week: Sunday
Date/Time: 2015-01-25T12:18:44.000

Created at: January 26, 2015
Updated at: February 1, 2015

NOTE: incident address generalized to block to protect victim identity.

Zoom to

Click on "Zoom to" at the bottom of the pop-up to see more detail in the area where the incident occurred.

Click [home icon] to return to the original map extent.

If you click in an area where there are a lot of crimes very close to each other the pop-up may contain information for more than one incident. In the example below 9 crimes were found in the vicinity of where the mouse click


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Zoom to

occurred. Page through the incidents by clicking on [▶] which is in the top right header of the pop-up window.
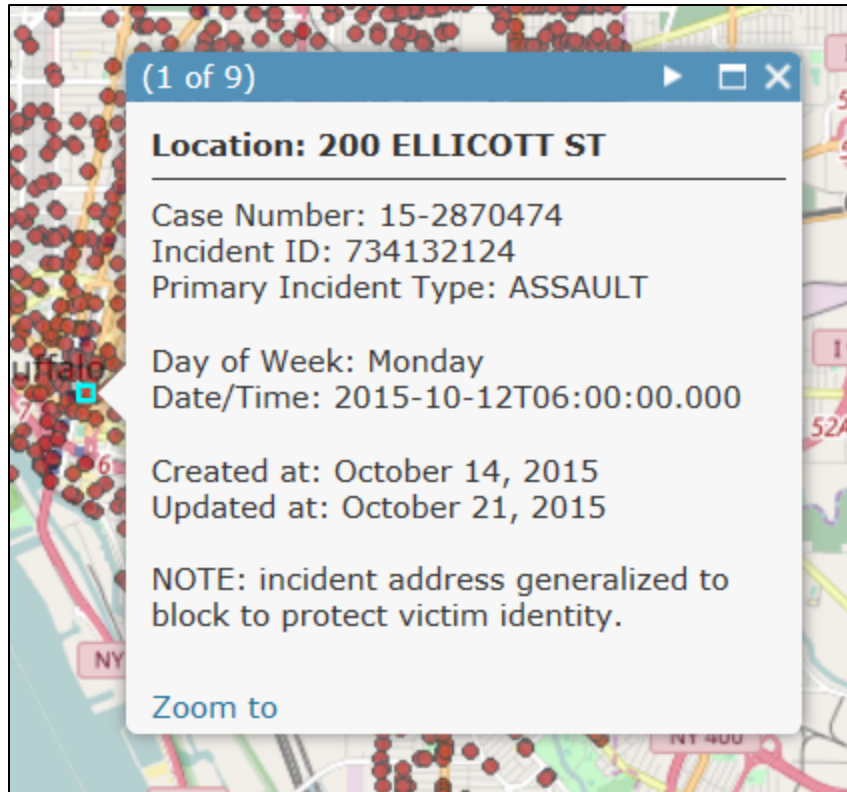
The application is being hosted in ESRI's ArcGIS portal on the Department of Geography and Planning's web server. Portal is identical to ArcGIS online. This site is called a web map (as opposed to a web mapping application) to allow you to explore the data and modify its presentation, to some extent.

To the left of the map screen is an area referred to as the Table of Contents (TOC) for the map. Notice that the word Legend and its icon are highlighted in blue. This is the default view. To see other map layers or investigate the data in the map, you should click on the word Content. (*Note* only icons appear if your web browser is too small to show both icon and text.)
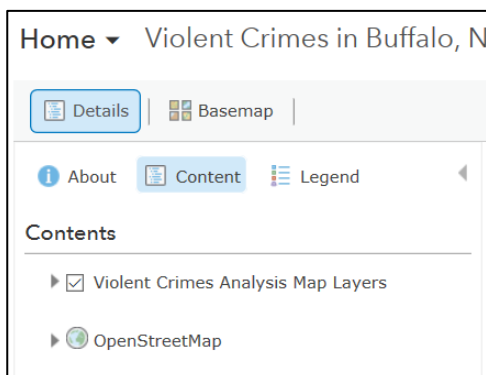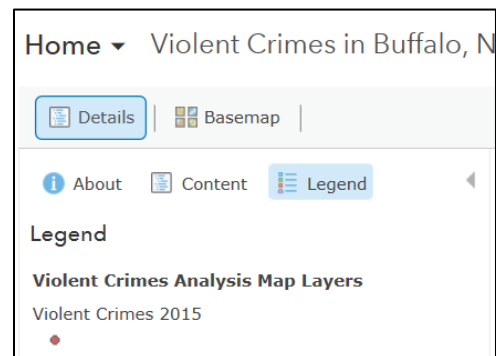
The content of this map consists of a "data frame" containing several data and analysis layers and a base map which is "OpenStreetMap". An analysis layer is a layer that is produced using models for spatial data processing.

Click on the data frame **Violent Crimes Analysis Map Layers**, to see a long list of layers that are included in this web map.
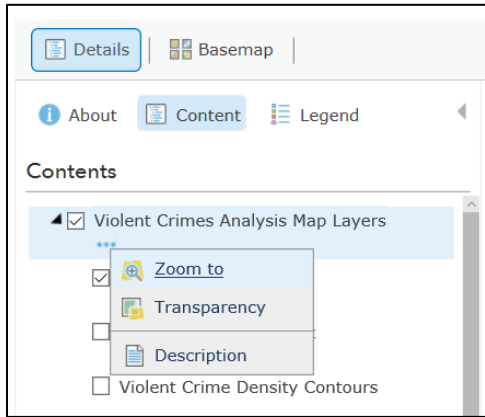
Hover your mouse over the data frame title and three blue dots appear. Click on these dots to

- zoom to the extent of the layers in the data frame,
- change the transparency of the data frame layers, or
- open a new tab with the technical description of the map service.

Notice the check mark next to **Violent Crimes 2015** data layer. A check mark means that you can see the layer in the map; it is visible.

Note, all layers with a check mark will be visible. However, the map is drawn from the bottom up, so the layer closest to the top that is visible will be drawn on top of the other layers. These layers have been arranged to ease exploration of the data.

Make the 1st layer (**Violent Crimes 2015**) invisible and the 3rd layer **Violent Crime Density (per sq. mile)** visible. Change the data frame transparency (decrease the percent transparent) if the density map is too light.

This layer is called a "raster" layer because the density of crimes is calculated for every location in the study area. This is also an "analysis layer" generated by kernel density models in ArcGIS Desktop. The darkest blue color indicates that there are between 235 and 265 crimes per square mile at that location. The darkest location is downtown Buffalo.
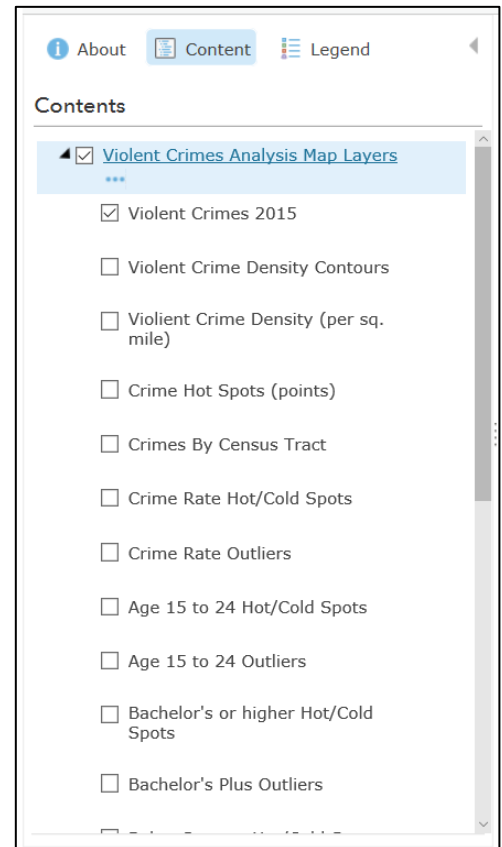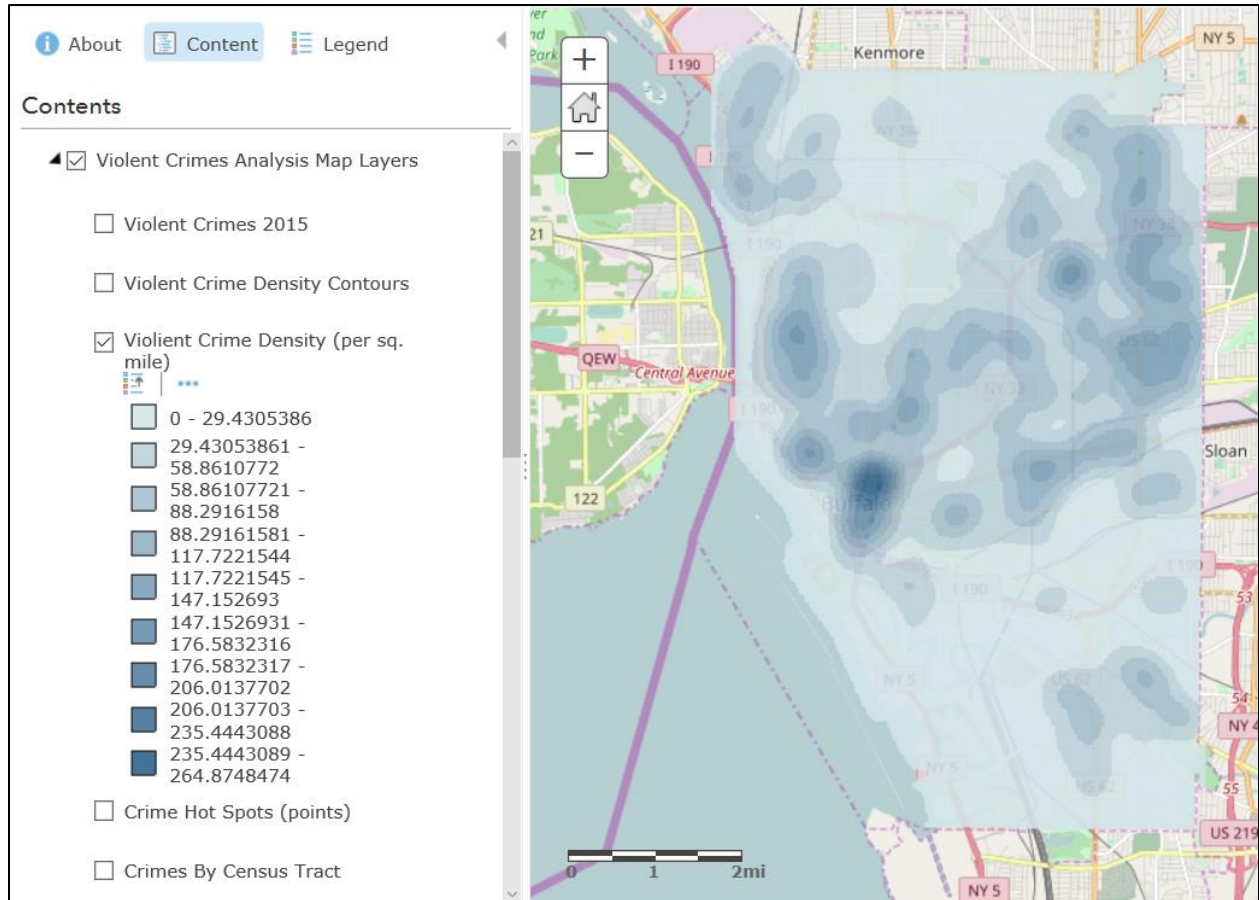
As you hover the mouse over a layer name a set of tools [2] appear below the layer name. Click on the **Show Legend** button to see what the symbolization for the density layer means. The **Show Legend** button is a toggle button that either makes the legend visible or invisible.
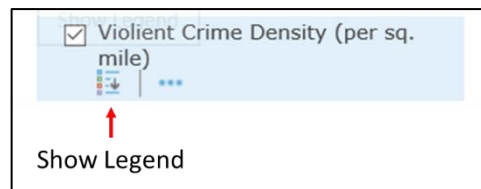

Contour lines represent lines of equal density and help clarify the density map. The contours layer for this density map is directly above the density layer. Contours are an "analysis layer" generated from the contour model in ArcGIS Desktop. Contours are lines so you will see more tools appear when you hover over this layer's name.

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[2] The tools that appear are based on the type of layer. Point, line, and polygon layers have more tools than raster layers.
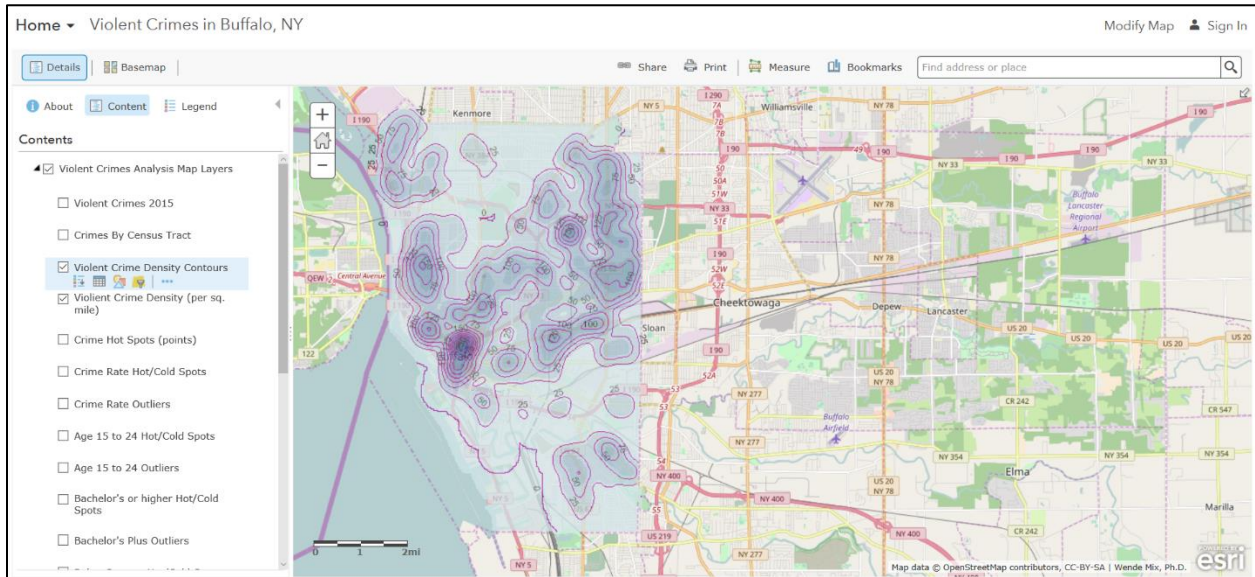
DATA TABLES AND FILTERING DATA

For vector data layers (points, lines, or polygons) the toolbar contains four tools useful for exploring the data.
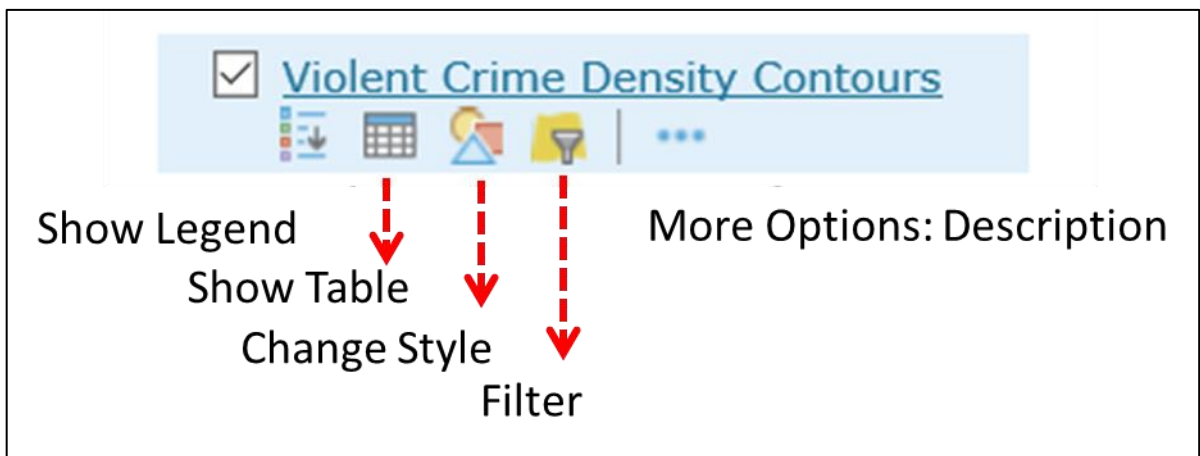
The first tool is the Show/Hide Legend tool. The second button, **Show Table,** opens the attribute table of a layer. Attributes are characteristics associated with a feature. For instance, an attribute of an incident is the type of incident. You can sort the data in the table by clicking on an attribute field name and choosing ascending or descending order. For numeric attributes, you can also generate some summary statistics.

Tables are useful for answering the basic question; How many violent crimes occurred in Buffalo in 2015? Make the *Violent Crimes in 2015* layer visible. Click on the **Show Table** button. At the top left side of the table is the data frame name followed by the layer name followed by a count of the number of features. There are 3,405 point features in this database. The **Show Table** button is a toggle button like

the **Show Legend** button. Close a table by clicking on the x in the top right corner of the table or by clicking on the **Show Table** button.

The third button from the left is the **Change Style Button**. This button will be explained in detail later in this document.

The fourth button from the left is the **Filter Button**. This allows you to set a filter for the current layer based on values of attributes associated with the layer. In the example below the filter is set to show only contours where violent crime density is greater than 150 crimes per square mile. The result of the filter is to show only the contours in downtown Buffalo.

The attribute used to filter the data is entered in the first drop- down box. To see a list of attributes click on the drop-down arrow.
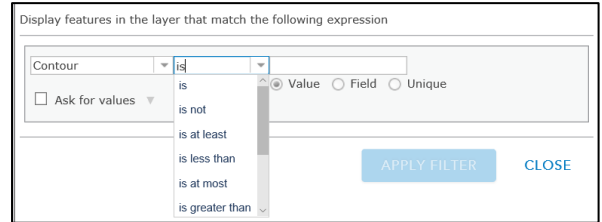
The operators, in the middle drop-down box, are different for text attributes and number attributes. To see the operators that may be used in a filter for the numeric attribute "contour" click on the drop-down arrow.

In the last box enter any value that makes sense in the context of your analysis. The legend for the density layer indicates that any value between 0 and 265 makes sense. However, the *contour interval* is 25 crimes per square mile so a filter like "is greater than 90" will show contours 100, 125, 150, ...250.
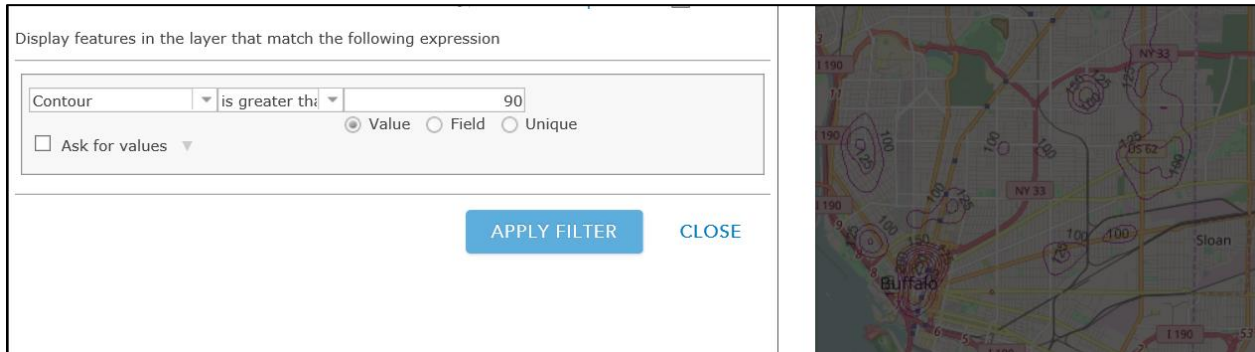
Click the APPLY FILTER button.

The filter will persist until you remove it. Click on the **Filter Button** again to either remove the filter or modify (EDIT) it. The filter is a very powerful way to compare information across layers. In this example there was only one filter statement. You can add multiple expressions to explore coincidence across layers.

When a filter is set, the number of features will change, indicating the number of features that satisfy the filter query.

The last button   ⋯   in the tools will take you to the "metadata" for the layer. The metadata is a description of the data stored in the feature layer. This information is not going to be meaningful to you and is not relevant to this exercise.

Exploration 1:

Use the filter tool to explore the **Violent Crimes 2015** layer. Click the Filter button to open the Filter window. The attribute to filter is the type of crime. Select "parent_incident_type" from the first drop down.
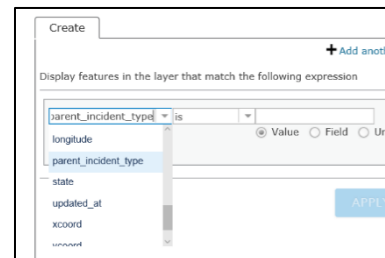
This is a text attribute field so the operator list will be different from the previous example. Select "contains" from the operator drop down. In the last box, enter "Sexual". Click on APPLY FILTER.
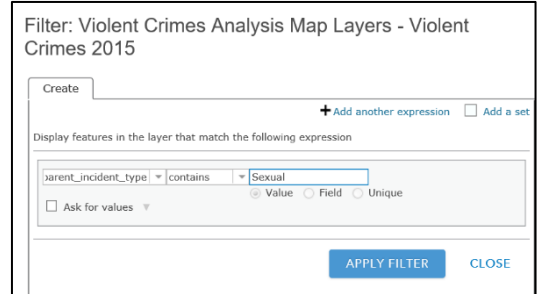
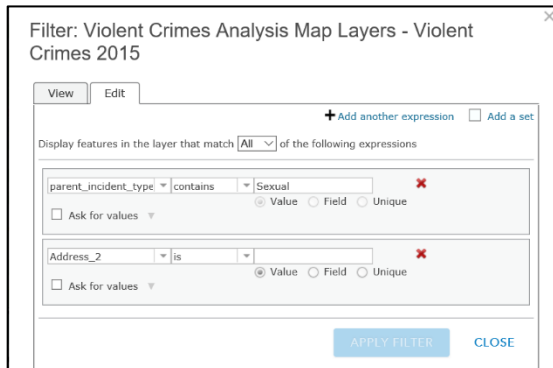**Q1.1** How many sexual assault crimes occurred in Buffalo in 2015?

Use [+] to zoom in closer to the downtown area.

Q1.2 How many rapes occurred within the highest density contour? (HINT: Use the pop-up tool)
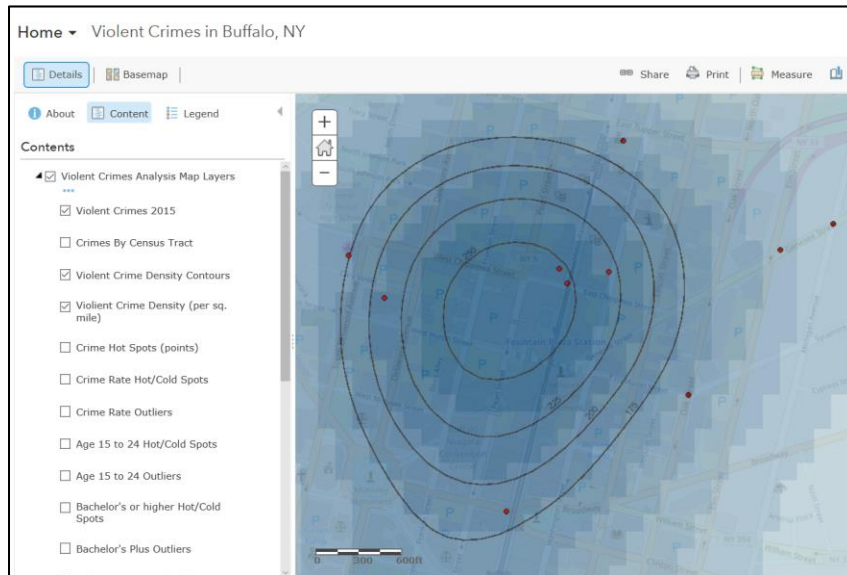
Open the Filter Tool again and click on the Edit tab.

Click on **+** Add another expression

Create a filter to retrieve only the sexual assaults that occur in the summer (June = Month 6 to August = Month 8).

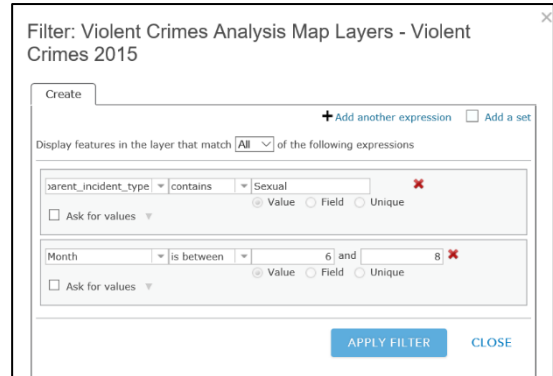**Q1.3** How many rapes occurred in the summer months?

Table and Map Relationship

Every row in a table represents one feature on the map. If you open the table and click on a row, the corresponding feature is highlighted on the map.

Keeping the filters set above, open the attribute table for the **Violent Crimes 2015** layer. Click on the field name "longitude" and select sort in ascending order.
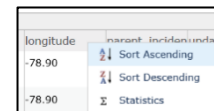
Click on the first row to select it. Scroll down in the table to where the longitude changes from -78.89 to -78.88. <u>Hold the Shift key down</u> and click on the row containing the value -78.89. You will see that 14 rapes during the summer of 2015 occurred on the West Side and Blackrock/Riverside areas in Buffalo.

Look at the Table Options dropdown to center the map on the selected set of records. Notice that the Table Options provide filtering capabilities similar to those in the Table of Contents.
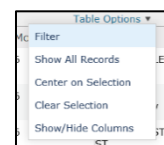
CRIME RATE

Clear the selection and remove the filter on the Violent Crimes 2015 layer. Turn off all visible layers.

The data that you have worked with so far is the number of violent crimes that occur. Another important statistic is the crime rate in an area. In this application the number of crimes within each Census Tract is counted. This number is divided by the population within a tract to provide a crime rate for a tract. In this application, the crime rate is per 100 people. So, a crime rate of 2.0 is interpreted as 2 crimes per 100 residents.

Why are we interested in crime rates? Suppose you have two neighborhoods, one with 100 residents that had 2 crimes and the other with 2000 residents that had 10 crimes. The crime rate per 100 people is 2.0 for the first area and 0.05 for the second area. The crime rate indicates that the first area has higher personal exposure to crime than the second area even though the second area had more crimes.

Make the "Crimes by Census Tract" layer visible and Show the Legend.
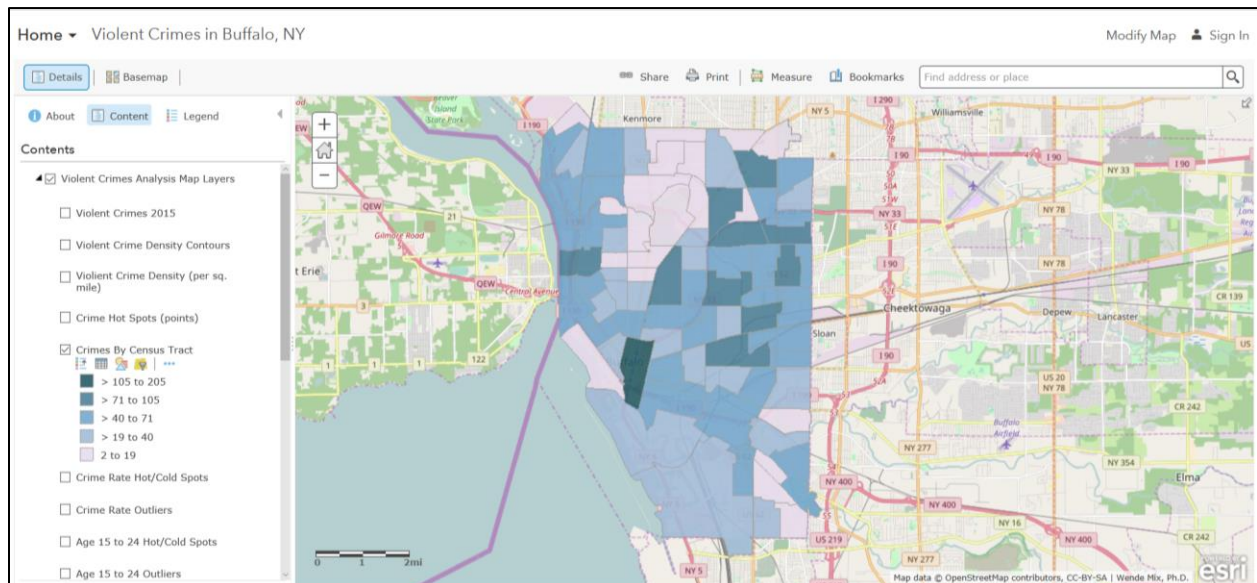
Changing Symbolization

When you hover over a layer name in Table of Contents, the third button allows you to change the way the layer is symbolized in the map. This means that you can explore different ways to display the same data to gain insight on patterns and coincidences that you may not see otherwise.

The default shading for this data is the number of crimes within a tract. The darker the color, the more violent crimes occurred. Similar to the density map presented above, the downtown Buffalo tract has the highest number of violent crimes. To create this symbology the default number of classes (5) and the default method (natural breaks) to determine the range of each class were used.

For more information on classification methods (Equal Interval, Natural Breaks, Standard Deviation, Quantile, and Manual) click on any of the links below.

https://doc.arcgis.com/en/maps-for-office/design-and-use/classification-methods.htm

http://indiemapper.com/app/learnmore.php?l=classification

http://individual.utoronto.ca/lackner/ggr272/DataClassificationMethods.pdf
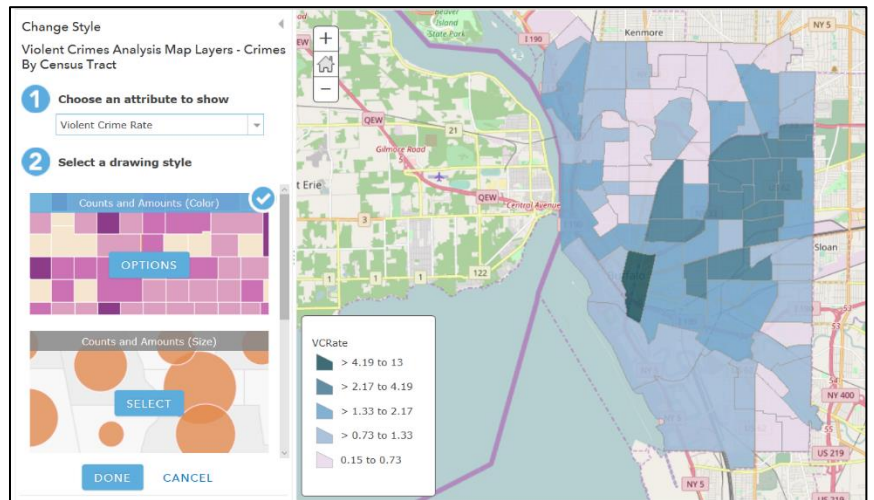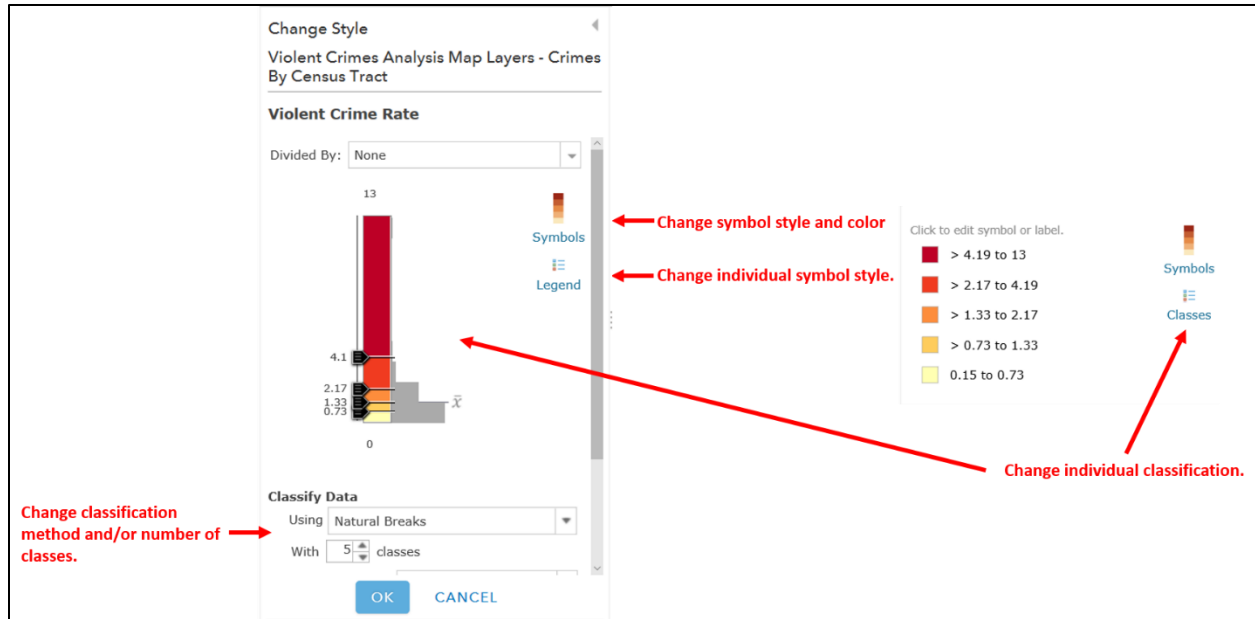
When you click on the Change Style button,   the information in the table of contents will change.
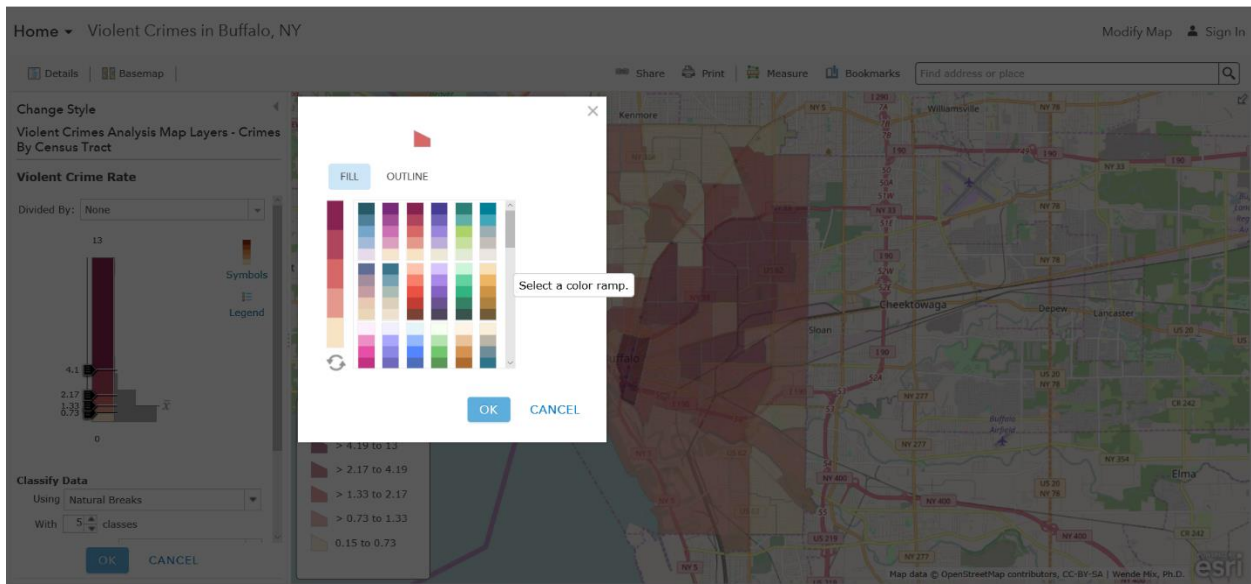
Change the attribute to show to Violent Crime Rate.
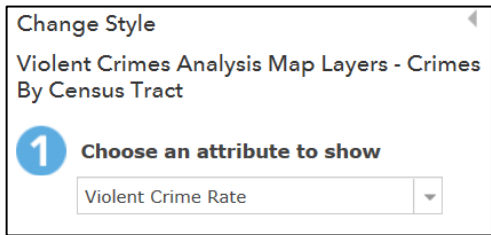
Click on OPTIONS, Counts and Amounts (Color).

Click on Symbols. Select the 3rd color ramp in the top row then click on OK.

Change the **Classify Data** Using *Natural Breaks* to Equal Interval.

Click OK and DONE to see the redrawn map showing crime rate per 100 persons in a red color scheme. The resulting map shows that exposure to violent crimes is very high in downtown Buffalo. The East side has several areas where exposure to violent crimes is higher compared to the rest of the city.

Exploration 2:

Q2.1 Change the number of classes to 8. Write about the impact of this change on what you previously observed.

Q2.2 Change the number of classes to 10. Write about the impact of this change on what you previously observed.

Exploration 3:

Relate Crime to Population Characteristics

One of the most noted capabilities of GIS is the ability to overlay a variety of characteristics from different data sources. The Census Bureau produces numerous data tables that summarize characteristics of the population living in census tracts. Some of these characteristics have been incorporated into the table associated with the "Crimes by Census Tract" layer. These include estimates and the margin of error for:

The percent of the population of a tract

- Between 15 and 24 years old
- With a Bachelor's degree or higher
- Below the poverty level
- Receiving Public Assistance
- Speak English Only

The proportion of housing units in a tract that are

- Renter occupied
- Owner occupied

Q3.1 Write down your expectations about how locations with violent crimes locations may relate to these characteristics. For example, do you expect a lot of violent crimes to occur in areas with a lot of renters?

Q3.2 Use your knowledge of filtering and changing symbology to explore the relationship between high and low crime and these characteristics. Is there evidence in the map to support your assumptions? Be specific.

If you re-symbolize the "Crimes by Census Tract" layer use the EST field for each characteristic not the MOE field. Also, you should read the information below to make use of additional analysis layers that have been provided.
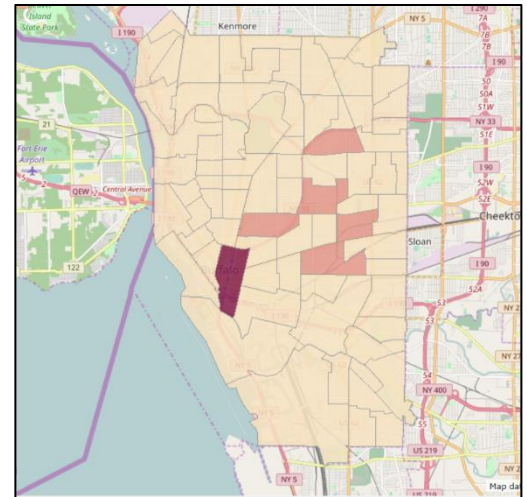
Hot and Cold Spots and Outliers

Crime analysis usually involves identifying locations where there are clusters of high values, clusters of low values, as well as locations where a neighborhood with a high value is surrounded by low values or vice versa. These are called hot spots, cold spots, and outliers, respectively.

Special statistical models are used to generate map layers showing hot and cold spots and outliers. In this application a hot/cold spot layers were generated for the number of crimes (points) and the crime rate (by census tract).

As shown below, North Buffalo and parts of South Buffalo near I-190 are cold spots for the number of crimes. Downtown and the upper east side are hot spots for violent crimes.
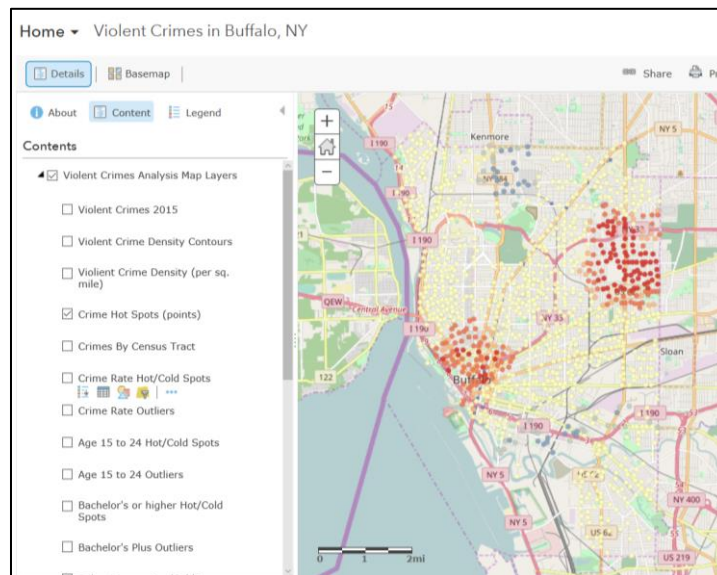

Somewhat similar results are found using crime rate. The cold spots in North Buffalo shift slightly downward (south) to neighborhoods between Delaware Park and Elmwood Avenue and between Amherst St and Lafayette Avenue.

There are hot spot and outlier maps for the Census characteristics incorporated into this web map. All of these layers are polygon layers so you cannot see their content if another polygon or raster layer is visible above them.
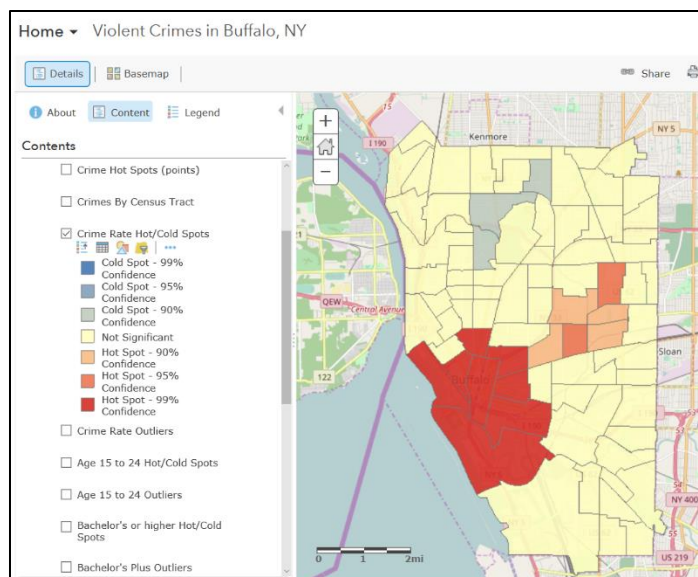
To learn more about the web map, click the **About** button at the top of the table of contents. Then click on More Details….
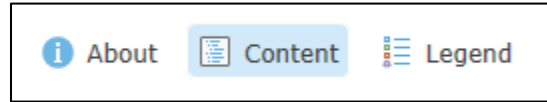
to open a new tab with descriptive information about the web map. In the map DESCRIPTION is a link to a document that provides more detail on the source of the data.