

Merging fishnet and points layer in ArcMap and Calculating PAI*

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Goal

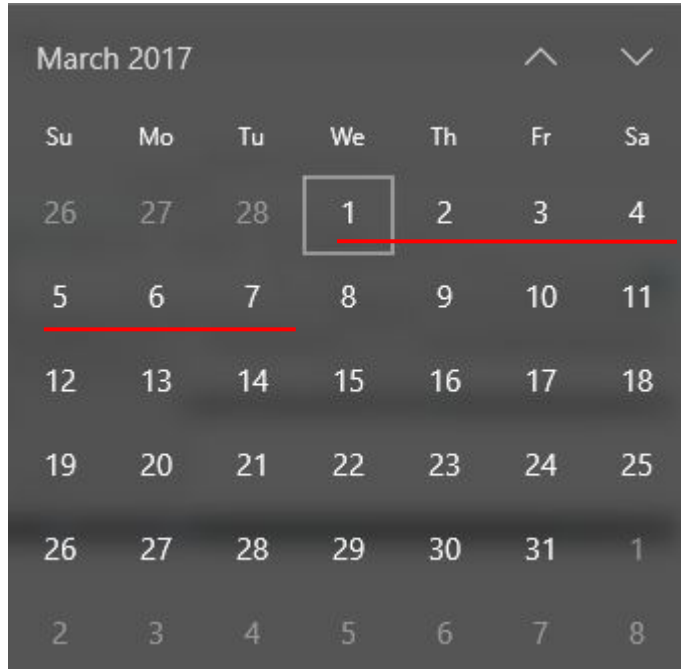
Merging fishnet and points layer in ArcMap. (Here we take the 2013 call for service data as example)

Calculate the PAI* (optimal PAI).

Choose the record of the first week in March

Choose the days in 2013 correspond to the first two weeks of March 2017.

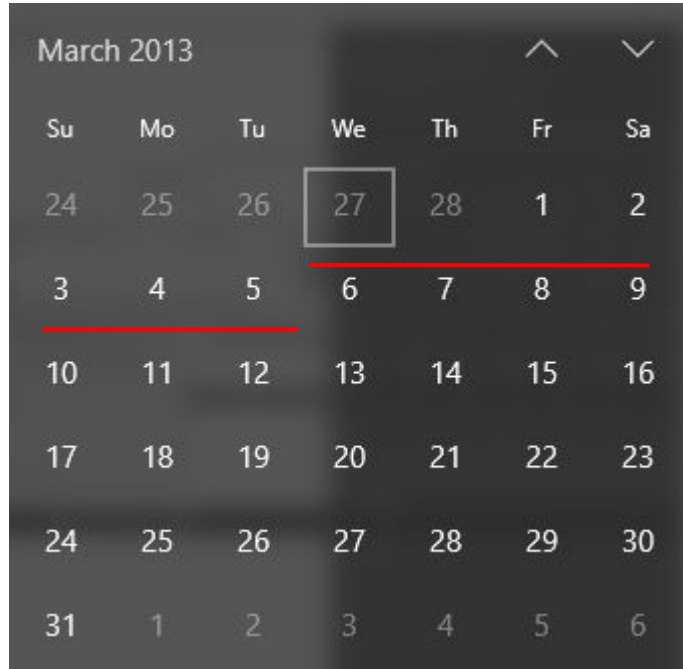
3/1/2017 is a Wednesday



March 2017

Su	Mo	Tu	We	Th	Fr	Sa
26	27	28	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	1
2	3	4	5	6	7	8

2/27/2013 is a Wednesday



March 2013

Su	Mo	Tu	We	Th	Fr	Sa
24	25	26	27	28	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

Choose the record of the first two weeks in March

Choose the days in 2013 correspond to the first two weeks of March 2017.

3/1/2017 is a Wednesday

March 2017						
Su	Mo	Tu	We	Th	Fr	Sa
26	27	28	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	1
2	3	4	5	6	7	8

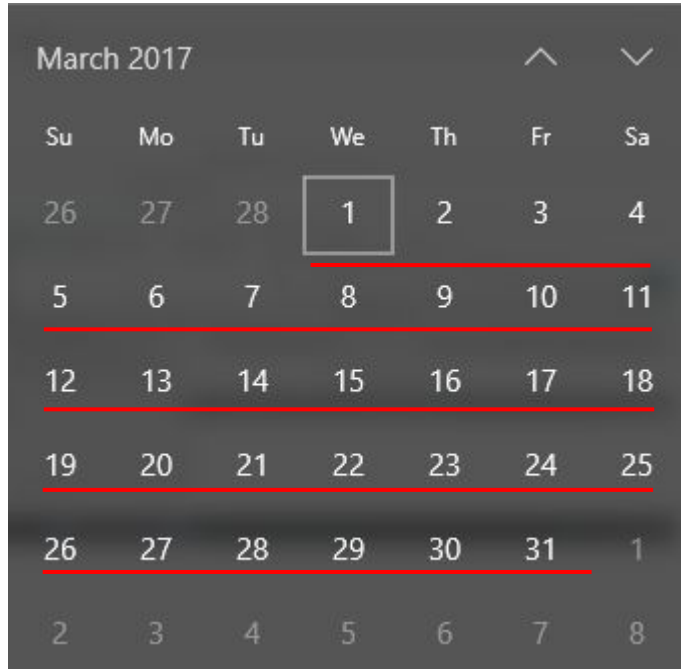
2/27/2013 is a Wednesday

March 2013						
Su	Mo	Tu	We	Th	Fr	Sa
24	25	26	27	28	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

Choose the record of one month in March

Choose the days in 2013 correspond to the first two weeks of March 2017.

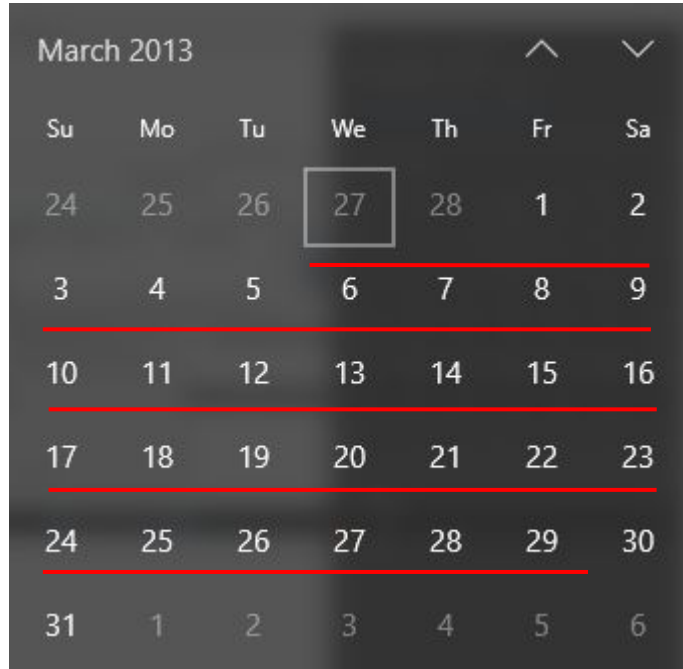
3/1/2017 is a Wednesday



A digital calendar for March 2017. The days of the week are listed at the top: Su, Mo, Tu, We, Th, Fr, Sa. The dates are arranged in a grid. The date 1 is highlighted with a white border and is a Wednesday. Red horizontal lines separate the weeks.

Su	Mo	Tu	We	Th	Fr	Sa
26	27	28	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	1
2	3	4	5	6	7	8

2/27/2013 is a Wednesday



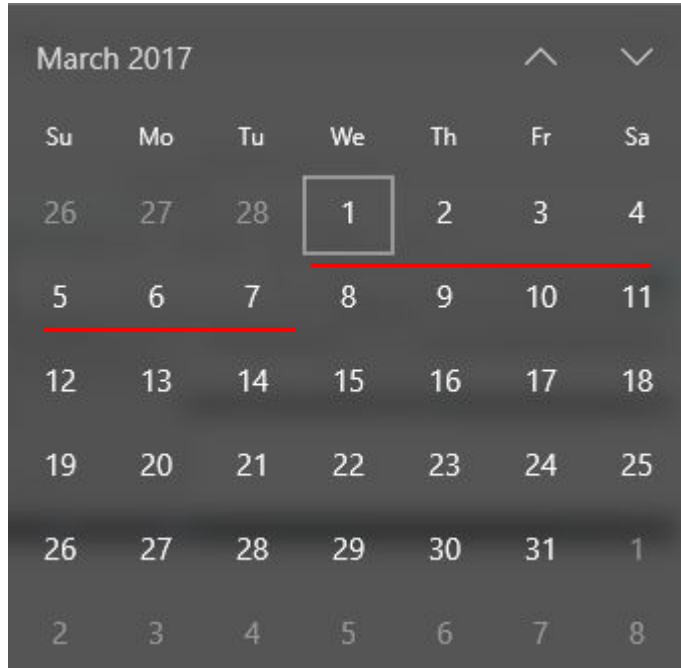
A digital calendar for March 2013. The days of the week are listed at the top: Su, Mo, Tu, We, Th, Fr, Sa. The dates are arranged in a grid. The date 27 is highlighted with a white border and is a Wednesday. Red horizontal lines separate the weeks.

Su	Mo	Tu	We	Th	Fr	Sa
24	25	26	27	28	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

Choose the record of the first week in March

Choose the days in 2014 correspond to the first week of March 2017.

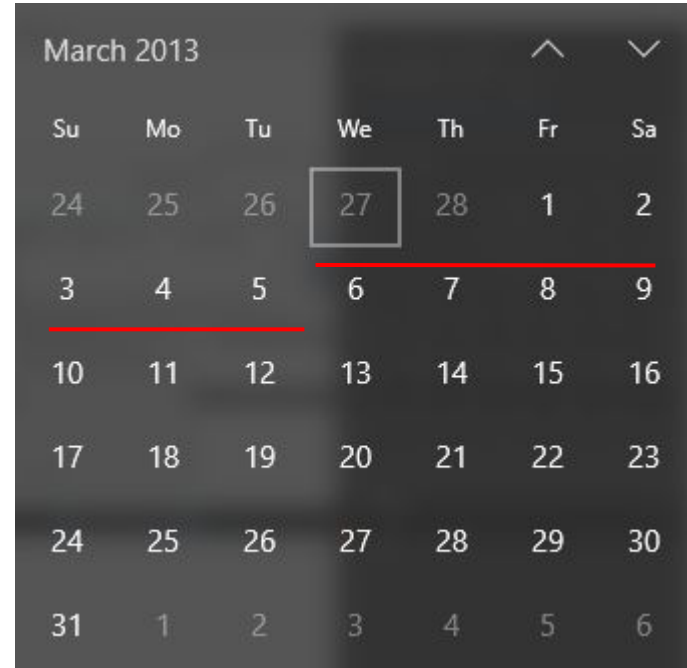
3/1/2017 is a Wednesday



March 2017

Su	Mo	Tu	We	Th	Fr	Sa
26	27	28	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	1
2	3	4	5	6	7	8

2/26/2014 is a Wednesday



March 2013

Su	Mo	Tu	We	Th	Fr	Sa
24	25	26	27	28	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

Choose the record of the first two weeks in March

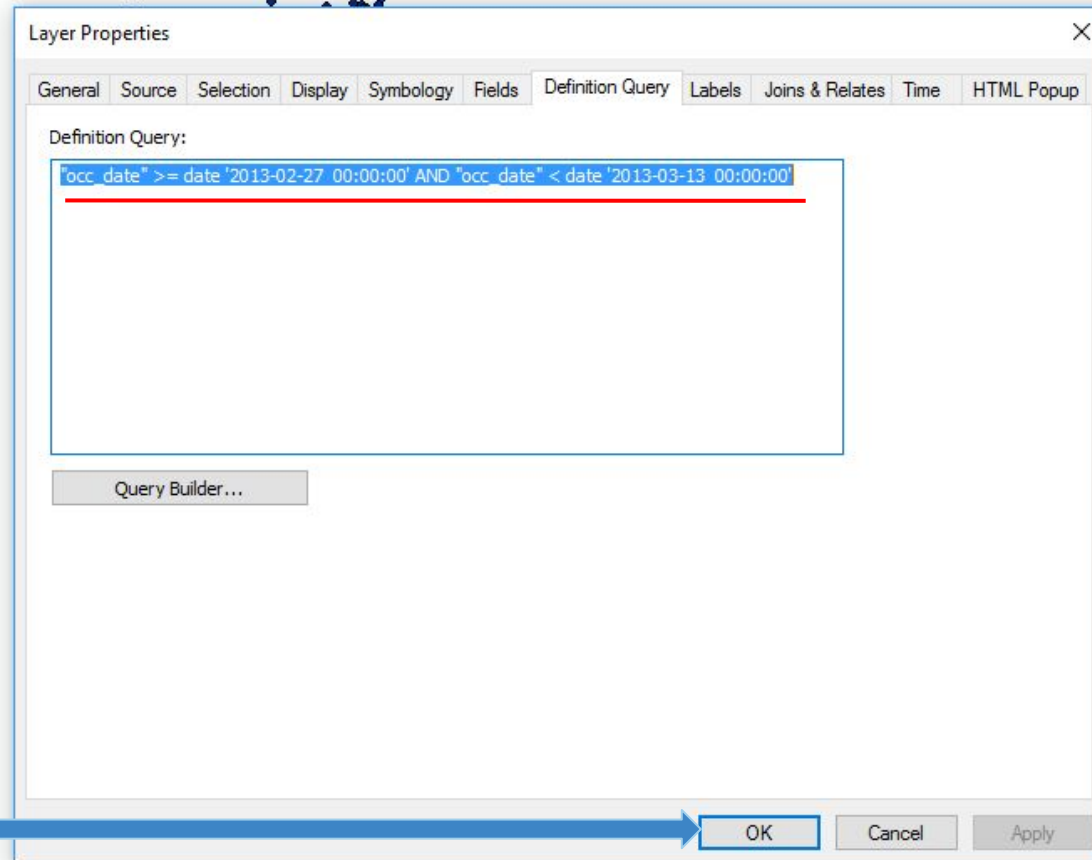
The screenshot displays a GIS application window. On the left, the 'Table Of Contents' panel lists several layers. The layer 'NJ2013_JAN01_DEC31' is selected, and a context menu is open over it. The menu options include: Copy, Remove, Open Attribute Table, Joins and Relates, Zoom To Layer, Zoom To Make Visible, Visible Scale Range, Use Symbol Levels, Selection, Label Features, Edit Features, Convert Labels to Annotation..., Convert Features to Graphics..., Convert Symbolology to Representation..., Data, Save As Layer File..., Create Layer Package..., and Properties... (highlighted). Below the menu, a 'Layer Properties' dialog box is visible with the text 'Display the properties of this layer'. The main map area on the right shows a dense cluster of blue points, likely representing a spatial dataset.

Table Of Contents

- Layers
 - ☒ NJ2013_JAN01_DEC31
 - ☐ portland_fishnet_10
 - ☐ portland_fishnet_10
 - ☐ portland_fishnet_10
 - Join_Count
 - 0 - 25
 - 26 - 50
 - ☐ portland_fishnet_60
 - ☐ portland_fishnet_10
 - ☐ portland_fishnet_60
 - ☐ portland_fishnet_45
 - ☐ portland_fishnet_25
 - ☐ portland_fishnet_25
 - ☐ Portland_Police_Dis
 - ☐ gz_2010_41_140_00_500K

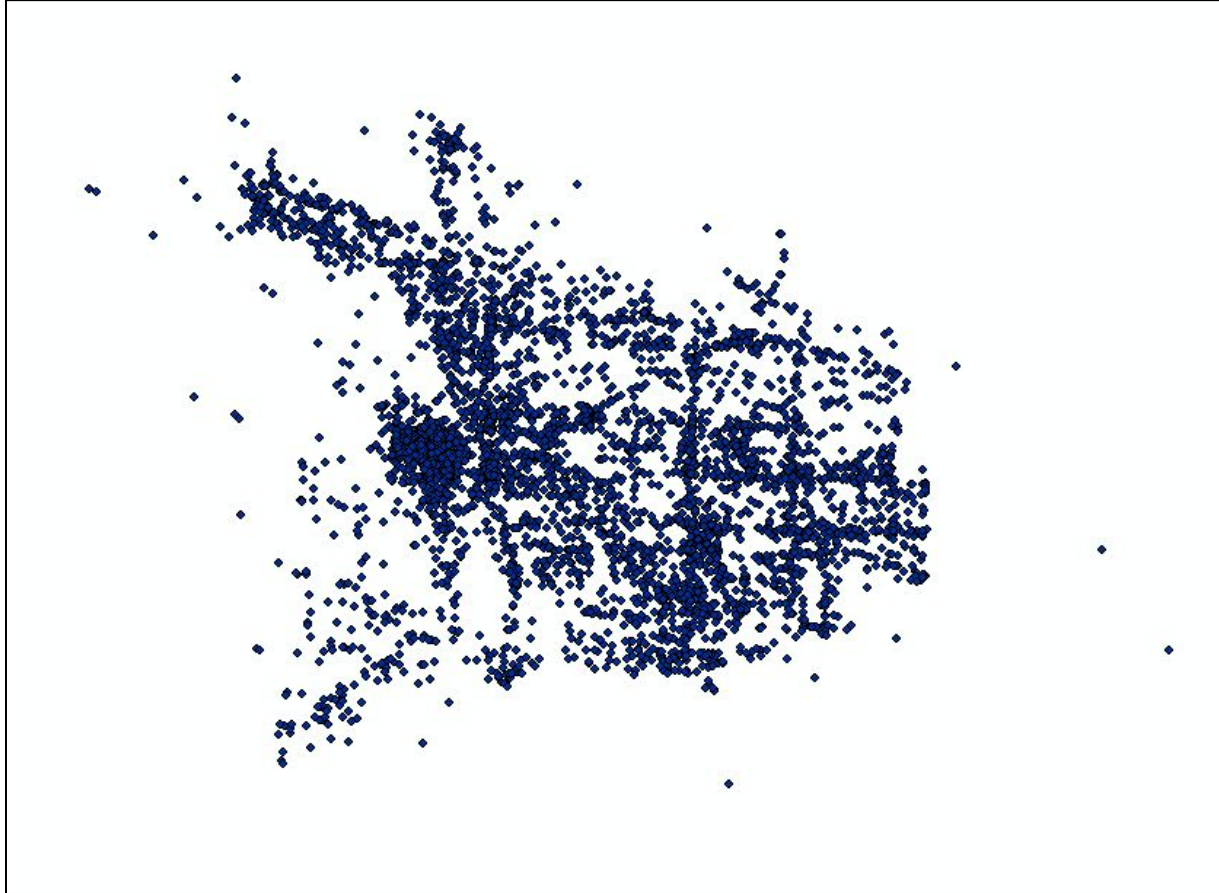
Layer Properties
Display the properties of this layer

Choose the record of the first two weeks in March

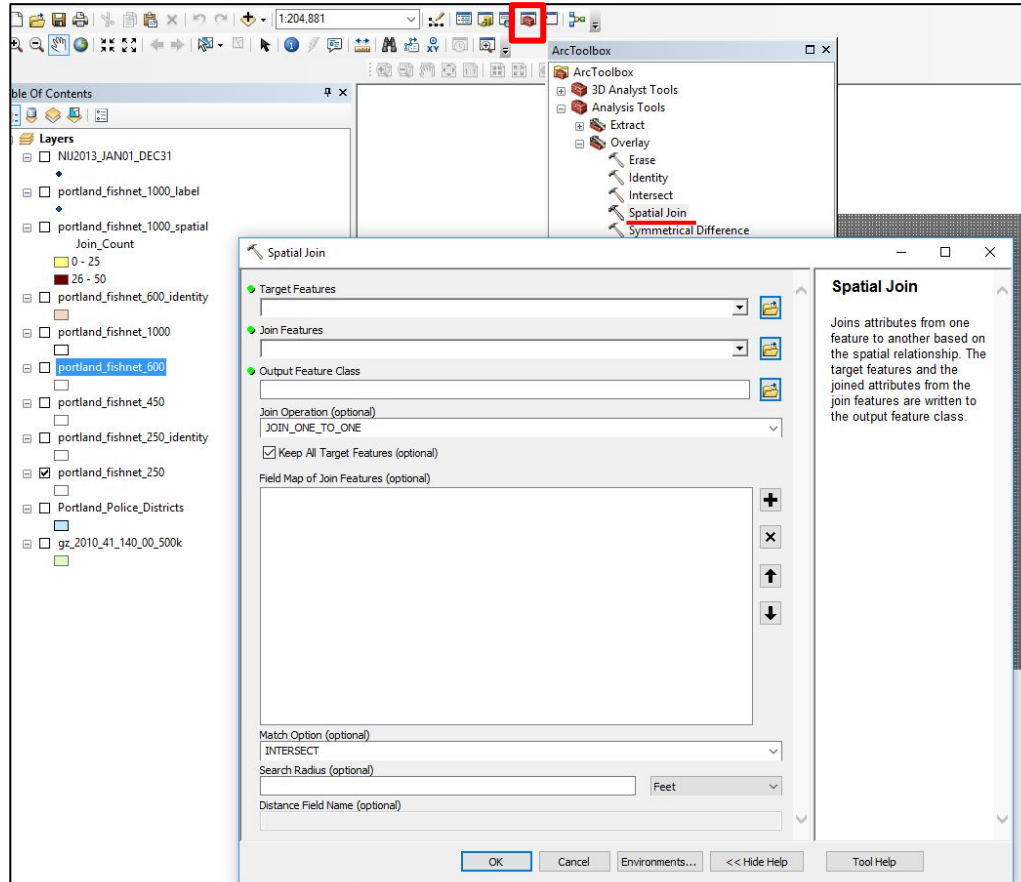


Click OK

Choose the record of the first two weeks in March



Open the Spatial join tool

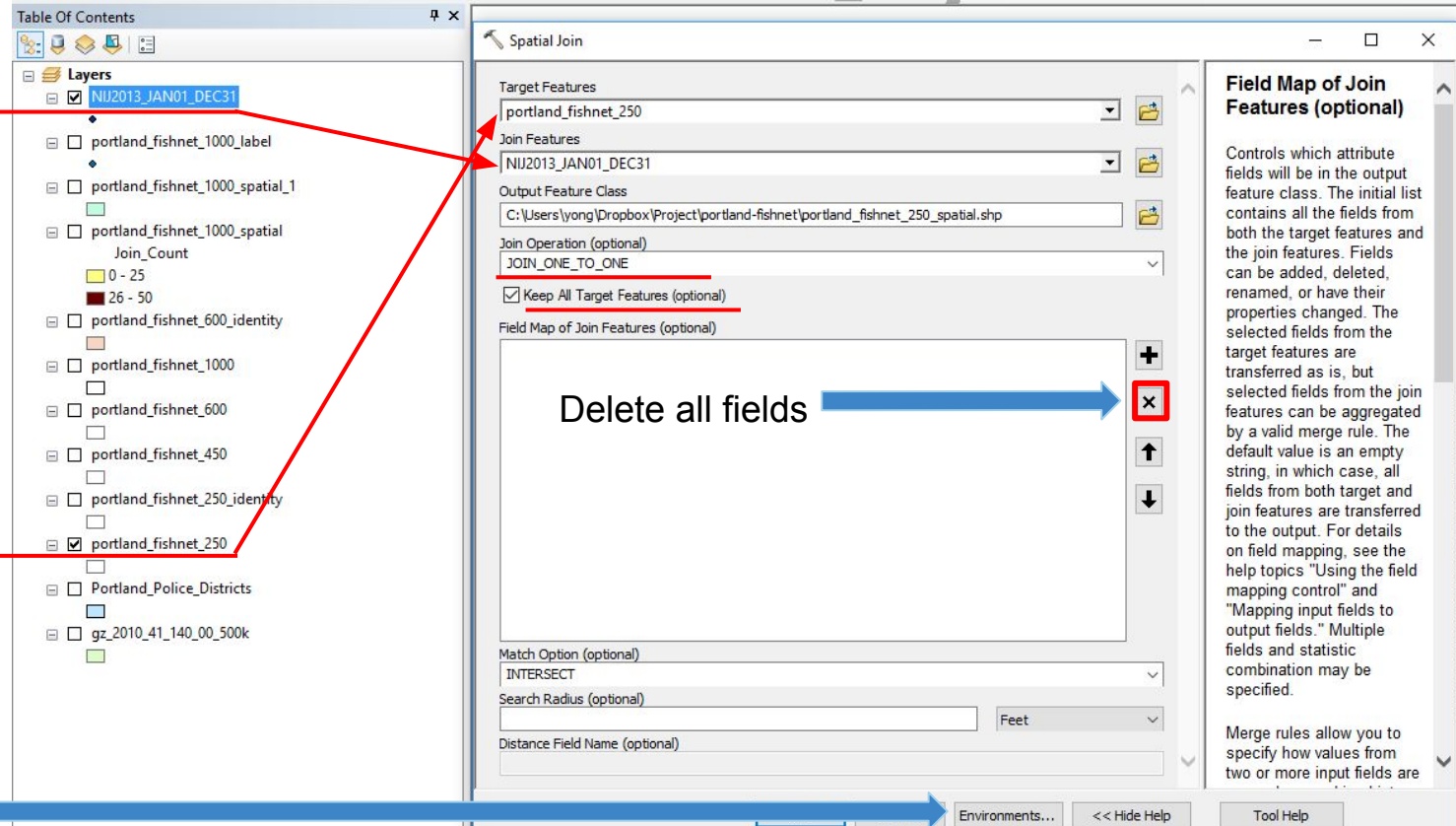


Fill in the form

Choose the points layer as Join features (Make sure you save the NIJ2013_Jan01_Dec31 layer file after querying and upload that file)

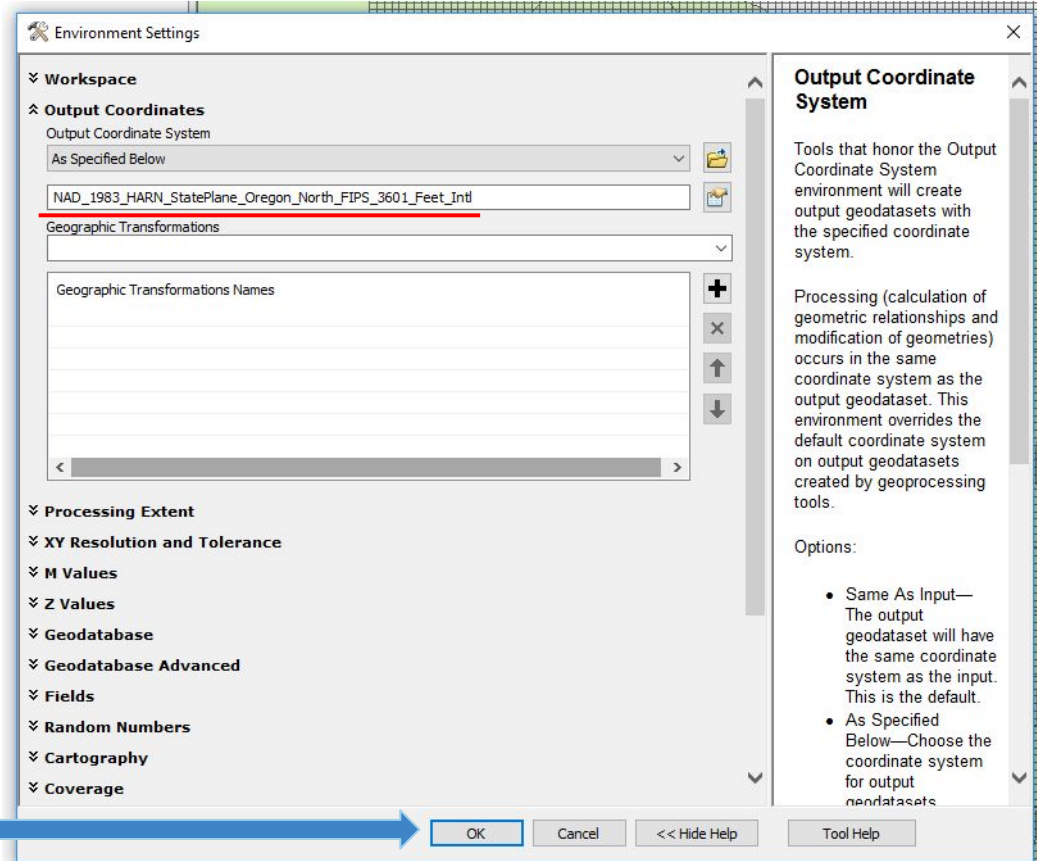
Choose the fishnet layer as Target features

Click Environments

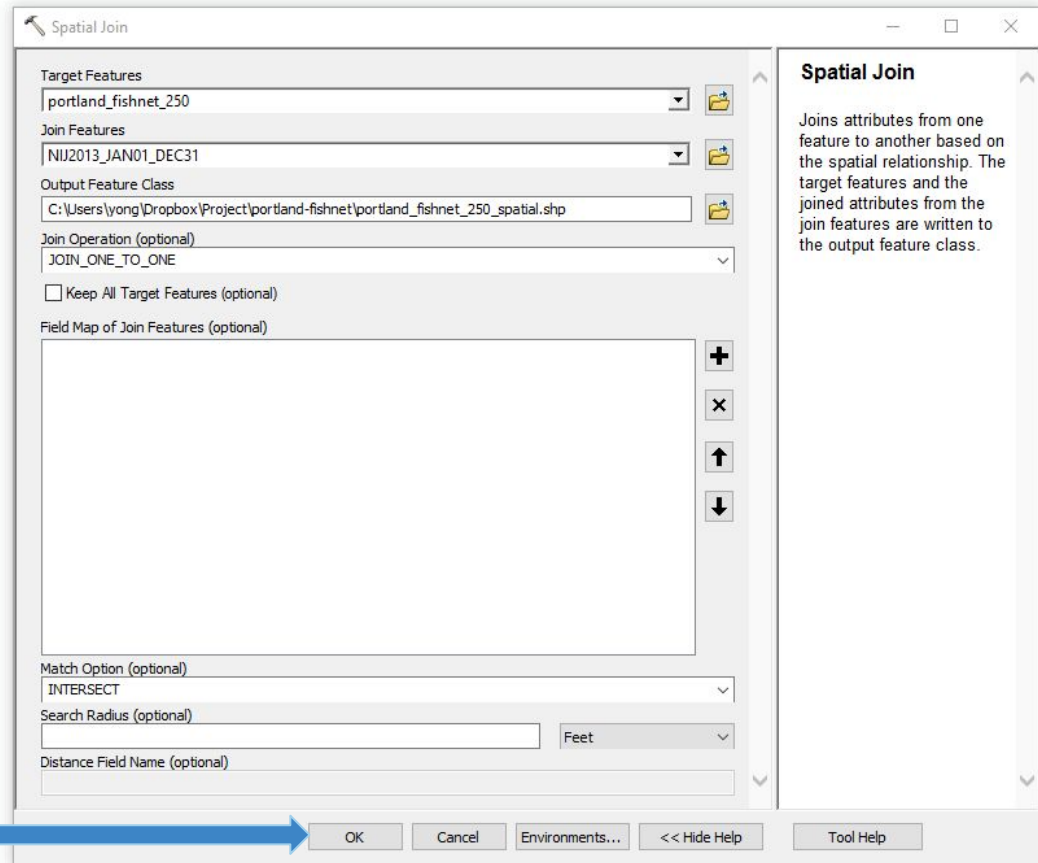
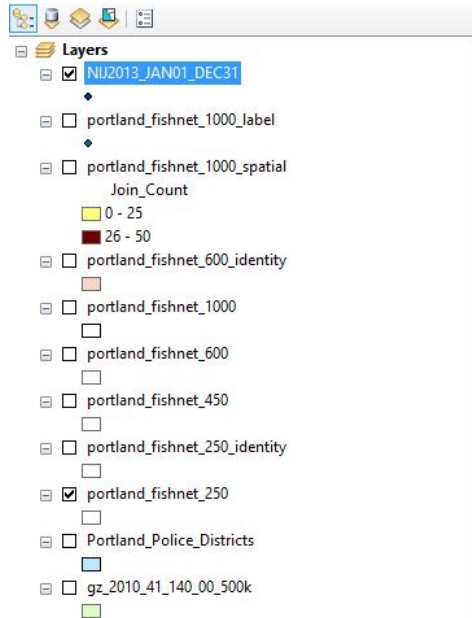


Choose the coordinate system

Choose the coordinate system of output layer, in this example, we choose NAD_1983_HARN

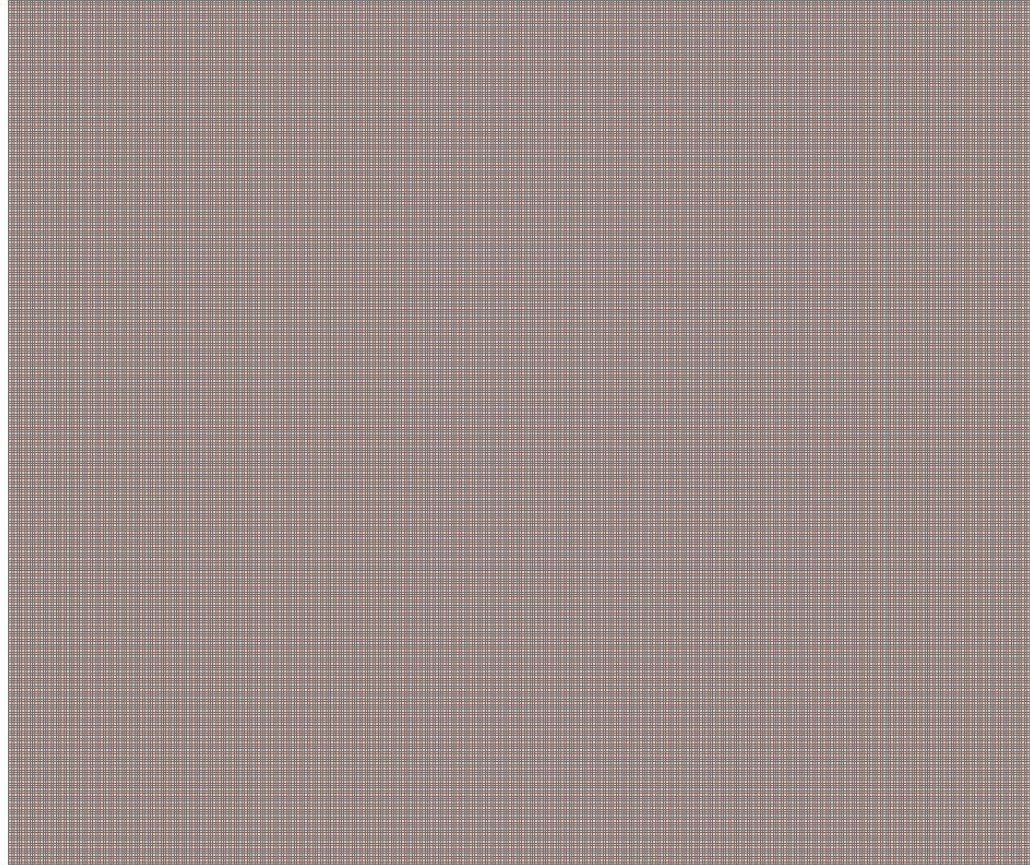
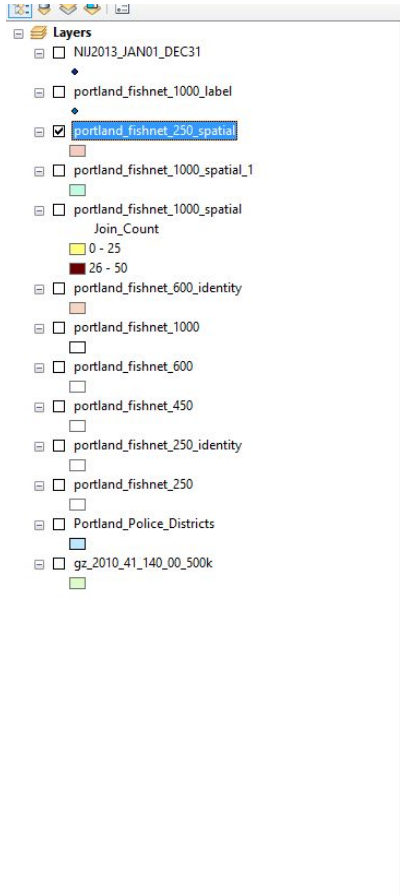


Create your output layer

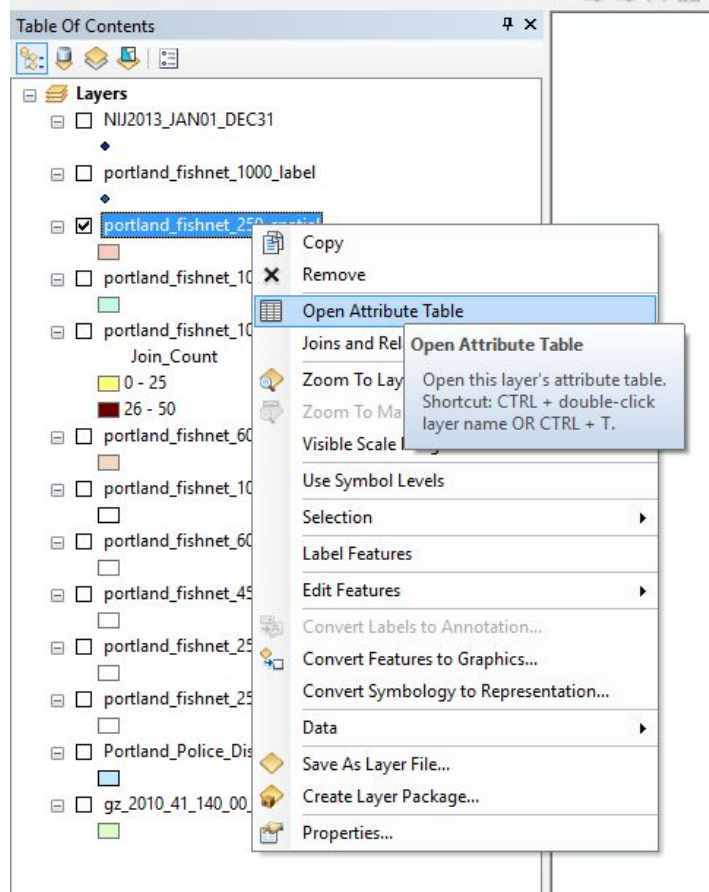


Click OK

Create your output layer



Check the number of points in each cell



The number of points in each cell

Table

portland_fishnet_250_spatial

FID	Shape *	Join Count	TARGET_FID
56735	Polygon	28	56735
33804	Polygon	23	33804
54371	Polygon	19	54371
55663	Polygon	18	55663
55269	Polygon	14	55269
36140	Polygon	13	36140
51646	Polygon	12	51646
56441	Polygon	11	56441
36149	Polygon	10	36149
51393	Polygon	10	51393
52425	Polygon	10	52425
54878	Polygon	10	54878
55553	Polygon	10	55553
58282	Polygon	10	58282
43068	Polygon	9	43068
51245	Polygon	9	51245
53982	Polygon	9	53982
81669	Polygon	9	81669
82059	Polygon	9	82059
46690	Polygon	8	46690
46949	Polygon	8	46949
47326	Polygon	8	47326
48147	Polygon	8	48147
49317	Polygon	8	49317
51315	Polygon	8	51315
52010	Polygon	8	52010
53592	Polygon	8	53592
87499	Polygon	8	87499
29120	Polygon	7	29120
29500	Polygon	7	29500
32337	Polygon	7	32337
38546	Polygon	7	38546
38939	Polygon	7	38939
43077	Polygon	7	43077
45020	Polygon	7	45020
47339	Polygon	7	47339
47726	Polygon	7	47726
47732	Polygon	7	47732
47921	Polygon	7	47921

(0 out of 129090 Selected)

Judging Criteria

- Prediction Accuracy Index (PAI)

$$PAI = \frac{\frac{n}{N}}{\frac{a}{A}} = \frac{n}{a} * \frac{A}{N} \propto \frac{n}{a} = \frac{\sum_{i=1}^k n_{c_i}}{k * a_{cell}} \propto \frac{\sum_{i=1}^k n_{c_i}}{k} = Mean(n_c)$$

where n is the number of crimes in areas where crimes are predicted to occur (e.g. hotspots), N the number of crimes in study area, a the area of areas where crimes are predicted to occur (e.g. area of hotspots), and A the area of the study area (e.g. the area of Portland). k is the number of hotspots. n_c the number of crimes occur in hotspot c . a_{cell} is the area of one hotspot (e.g. $250 * 250 ft^2$). \propto means proportional to.

Because PAI is proportional to average number of crimes in a cell, to get the a higher PAI score, we should not only choose the valuable cells, but also should choose as fewer hotspots as possible.

Evaluation example

1 week (3/1-3/7) evaluation

	2	3	6
	1	0	7
1	2	5	1
1			

One hotspot

2	3	6
0	0	9
2	5	0

$$PAI^* = \frac{\frac{9}{27}}{\frac{1}{9}} = \frac{9}{1} * \frac{9}{27} \propto \frac{9}{1} = 9$$

For PAI score, one hotspot is better than two hotspots.

Two hotspots

2	3	6
0	0	9
2	5	0

$$PAI^* = \frac{\frac{(9+6)}{27}}{\frac{2}{9}} = \frac{(9+6)}{2} * \frac{9}{27} \propto \frac{(9+6)}{2} = 7.5$$

Check the requirements of submission

The smallest cell size is
250*250 sq.ft

The Biggest cell size is
600*600 sq.ft

Suppose the cell size is
250*250 sq.ft, the
range of number of
hotspots is:

$$0.25 \text{ mi}^2 / 62500 \text{ ft}^2 = 112$$

$$0.75 \text{ mi}^2 / 62500 \text{ ft}^2 = 335$$

Table 2: Requirements for Entries

Requirement	Description of Requirement
Required files	.dbf .prj .sbn .sbx .shp .shx
Projection of files	NAD_1983_HARN_StatePlane_Oregon_North_FIPS_3601_Feet_Intl
Required variables	Unique ID for each cell A binary variable (1 – hot spot, 0 – not) Area for each cell measured in square feet to 4 decimal places
Cell shape	Any shape
Individual cell area*	62,500 ft ² – 360,000 ft ²
Total forecasted area	0.25 mi ² – .75 mi ²

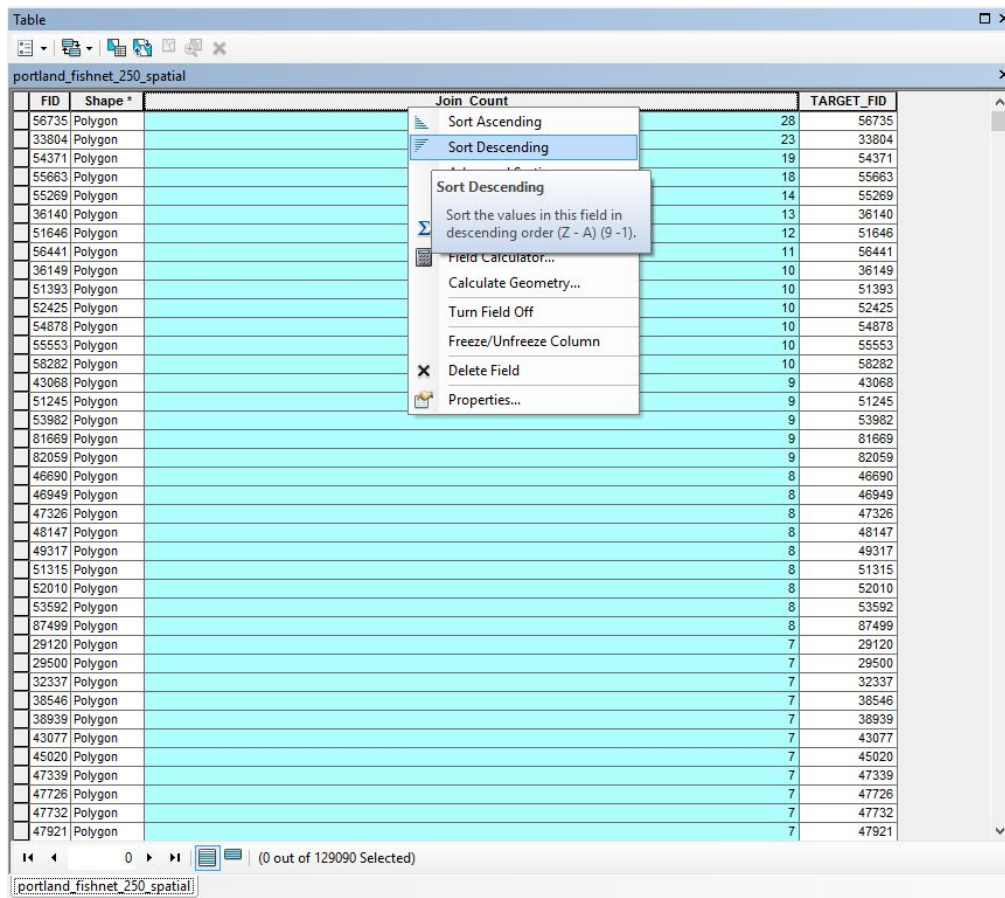
*Cells forming the outer boundary of the study area (Portland Police Districts, [see file in Section X.](#)) must be trimmed so that the total area of all cells equals 147.71 square miles (+/-0.02 square miles). The area of each interior cell must be equal to one another.

Check the requirements of submission

Based on our analysis of PAI score, for different size of cell, we should choose as fewer hotspots as possible.

- ❖ Cell size **250*250 sq.ft** : $0.25 \text{ mi}^2 / 62500 \text{ ft}^2 = 112$
- ❖ Cell size **450*450 sq.ft** : $0.25 \text{ mi}^2 / 202500 \text{ ft}^2 = 35$
- ❖ Cell size **600*600 sq.ft** : $0.25 \text{ mi}^2 / 360000 \text{ ft}^2 = 20$

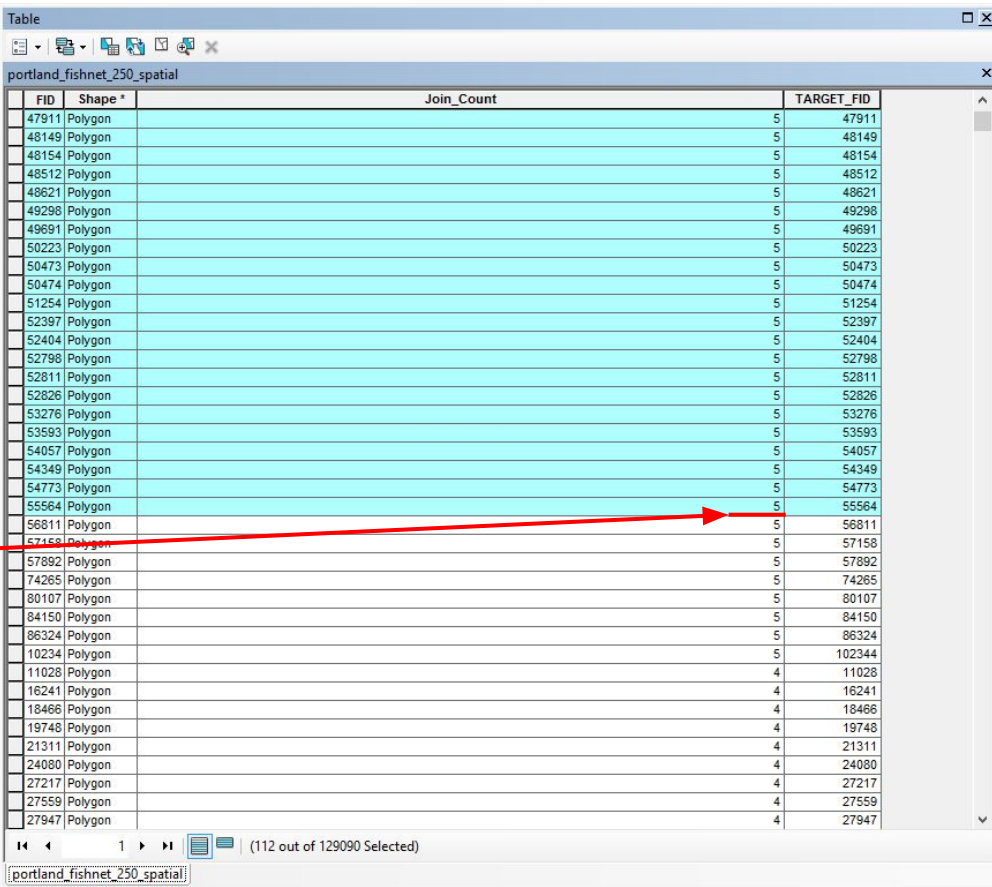
Sorting “Join Count” field



The screenshot shows a software window titled "Table" with a sub-window "portland_fishnet_250_spatial". It displays a table with four columns: FID, Shape *, Join Count, and TARGET_FID. A context menu is open over the "Join Count" column, showing options like "Sort Ascending", "Sort Descending", "Sort Descending" (highlighted), "Sort the values in this field in descending order (Z - A) (9 - 1).", "Field Calculator...", "Calculate Geometry...", "Turn Field Off", "Freeze/Unfreeze Column", "Delete Field", and "Properties...". The status bar at the bottom indicates "(0 out of 129090 Selected)".

FID	Shape *	Join Count	TARGET_FID
56735	Polygon	28	56735
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48147	Polygon	8	48147
49317	Polygon	8	49317
51315	Polygon	8	51315
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53592	Polygon	8	53592
87499	Polygon	8	87499
29120	Polygon	7	29120
29500	Polygon	7	29500
32337	Polygon	7	32337
38546	Polygon	7	38546
38939	Polygon	7	38939
43077	Polygon	7	43077
45020	Polygon	7	45020
47339	Polygon	7	47339
47726	Polygon	7	47726
47732	Polygon	7	47732
47921	Polygon	7	47921

Choose the first 112 rows



Table

portland_fishnet_250_spatial

FID	Shape *	Join_Count	TARGET_FID
47911	Polygon	5	47911
48149	Polygon	5	48149
48154	Polygon	5	48154
48512	Polygon	5	48512
48621	Polygon	5	48621
49298	Polygon	5	49298
49691	Polygon	5	49691
50223	Polygon	5	50223
50473	Polygon	5	50473
50474	Polygon	5	50474
51254	Polygon	5	51254
52397	Polygon	5	52397
52404	Polygon	5	52404
52798	Polygon	5	52798
52811	Polygon	5	52811
52826	Polygon	5	52826
53276	Polygon	5	53276
53593	Polygon	5	53593
54057	Polygon	5	54057
54349	Polygon	5	54349
54773	Polygon	5	54773
55564	Polygon	5	55564
56811	Polygon	5	56811
57158	Polygon	5	57158
57892	Polygon	5	57892
74265	Polygon	5	74265
80107	Polygon	5	80107
84150	Polygon	5	84150
86324	Polygon	5	86324
10234	Polygon	5	102344
11028	Polygon	4	11028
16241	Polygon	4	16241
18466	Polygon	4	18466
19748	Polygon	4	19748
21311	Polygon	4	21311
24080	Polygon	4	24080
27217	Polygon	4	27217
27559	Polygon	4	27559
27947	Polygon	4	27947

112 out of 129090 Selected

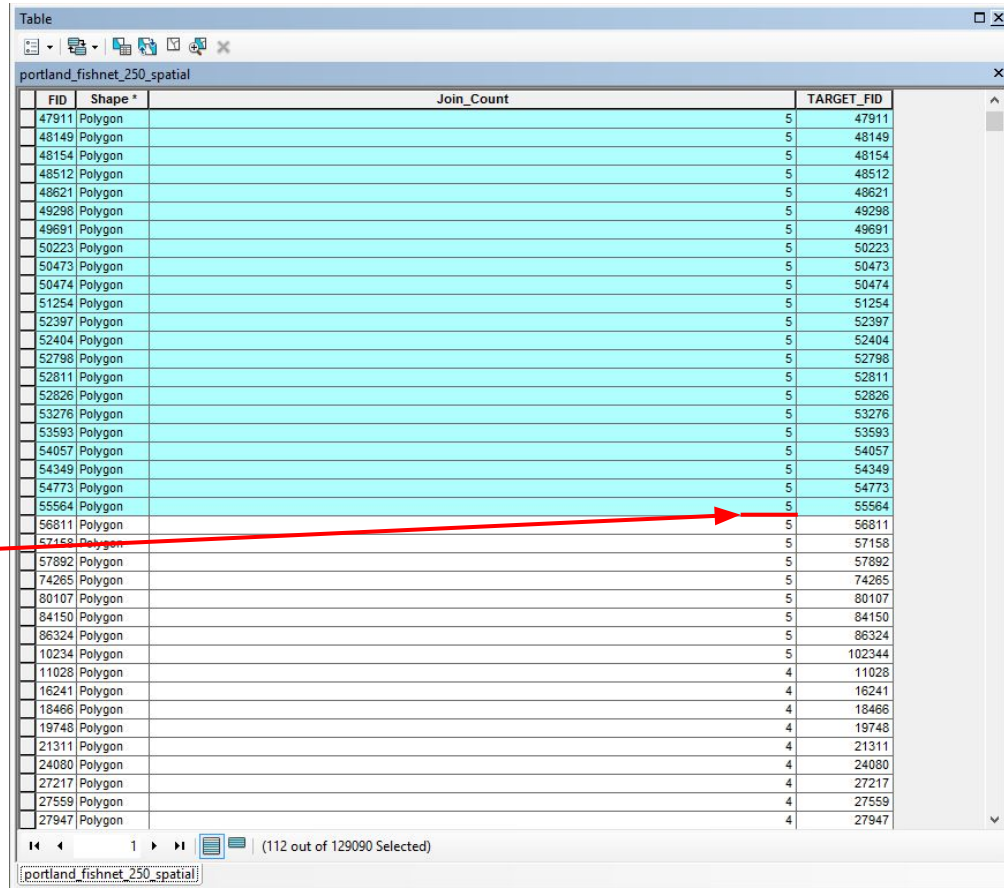
portland_fishnet_250_spatial

The number of crimes
is 5.

Choose the first 112 rows

Copy the value
of the field “FID”
of the rows
which
“Join_Count” >=
5, and export it
as a csv file.

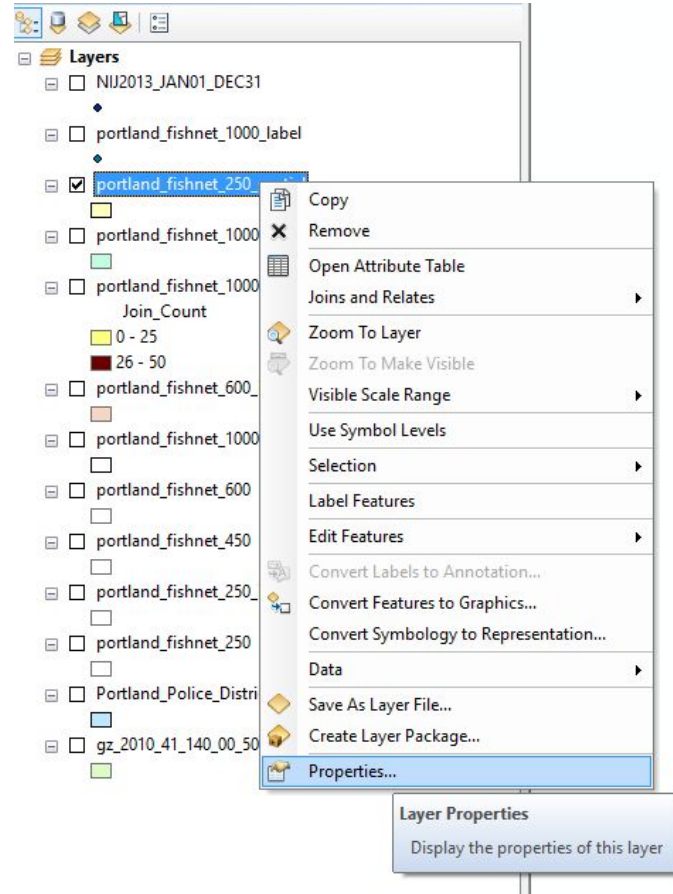
The number of crimes
is 5.



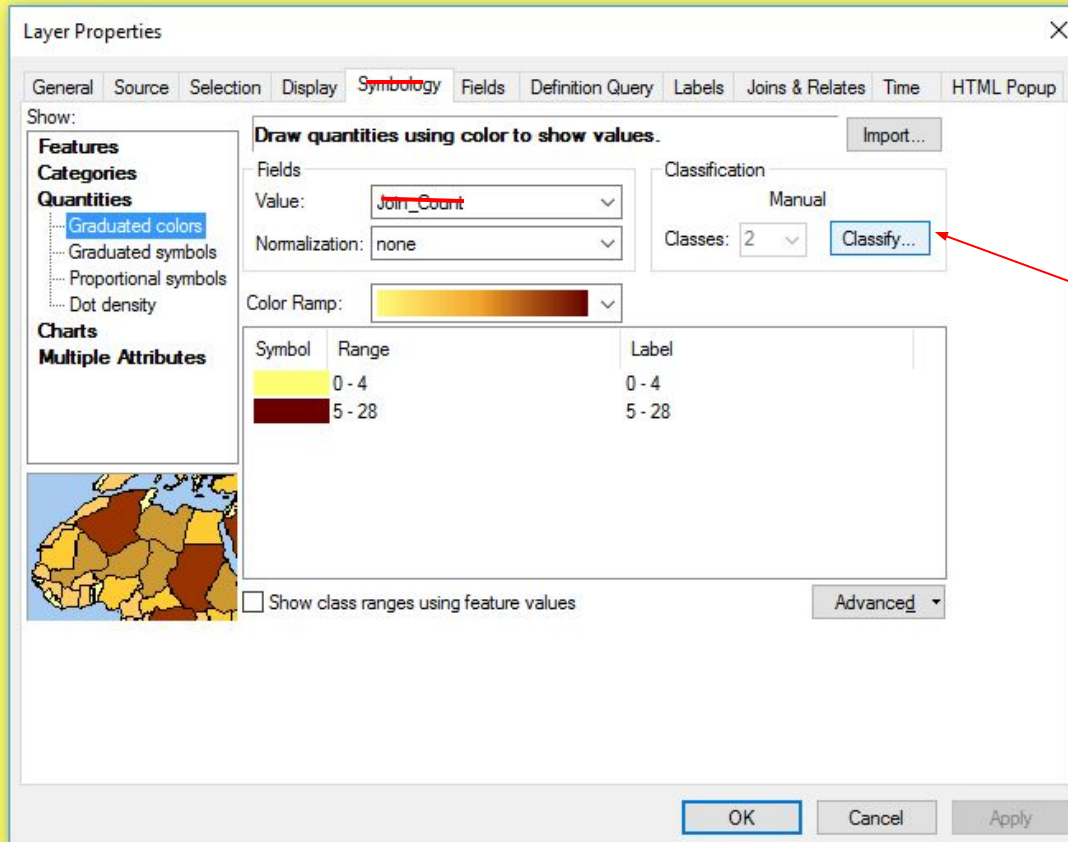
FID	Shape *	Join_Count	TARGET_FID
47911	Polygon	5	47911
48149	Polygon	5	48149
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48621	Polygon	5	48621
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49691	Polygon	5	49691
50223	Polygon	5	50223
50473	Polygon	5	50473
50474	Polygon	5	50474
51254	Polygon	5	51254
52397	Polygon	5	52397
52404	Polygon	5	52404
52798	Polygon	5	52798
52811	Polygon	5	52811
52826	Polygon	5	52826
53276	Polygon	5	53276
53593	Polygon	5	53593
54057	Polygon	5	54057
54349	Polygon	5	54349
54773	Polygon	5	54773
55564	Polygon	5	55564
56811	Polygon	5	56811
57158	Polygon	5	57158
57892	Polygon	5	57892
74265	Polygon	5	74265
80107	Polygon	5	80107
84150	Polygon	5	84150
86324	Polygon	5	86324
10234	Polygon	5	102344
11028	Polygon	4	11028
16241	Polygon	4	16241
18466	Polygon	4	18466
19748	Polygon	4	19748
21311	Polygon	4	21311
24080	Polygon	4	24080
27217	Polygon	4	27217
27559	Polygon	4	27559
27947	Polygon	4	27947

(112 out of 129090 Selected)

Open the properties window



Choose symbology

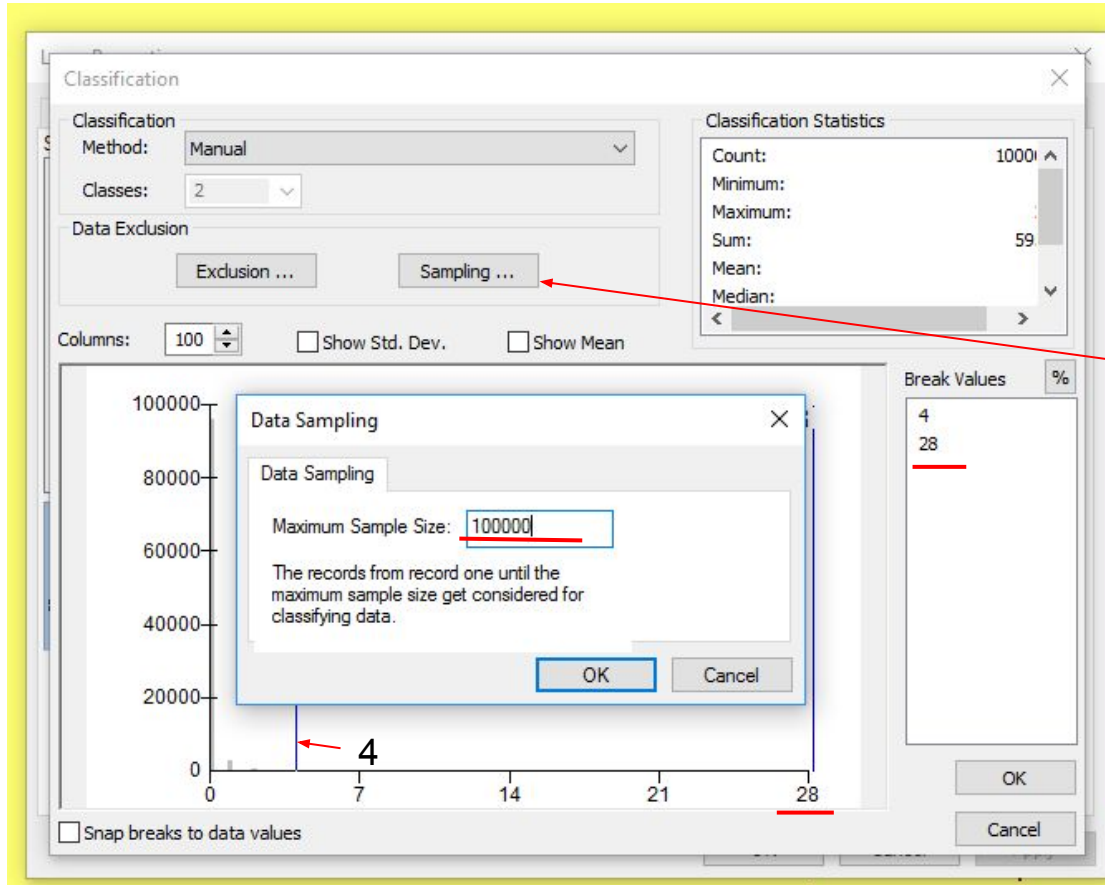


Click here

Choose symbology

Divide all the cells into two classes by number of crimes (“Join_Count”)

1. 0 ~ 4
2. 5 ~ 28



Click here

Create hotspot map

Layer Properties

General Source Selection Display Symbology Fields Definition Query Labels Joins & Relates Time HTML Popup

Show:

- Features
- Categories
- Quantities
 - Graduated colors
 - Graduated symbols
 - Proportional symbols
 - Dot density
- Charts
- Multiple Attributes

Draw quantities using color to show values. Import...

Fields

Value: Join_Count

Normalization: none

Classification

Manual

Classes: 2 **Classify...**

Color Ramp:

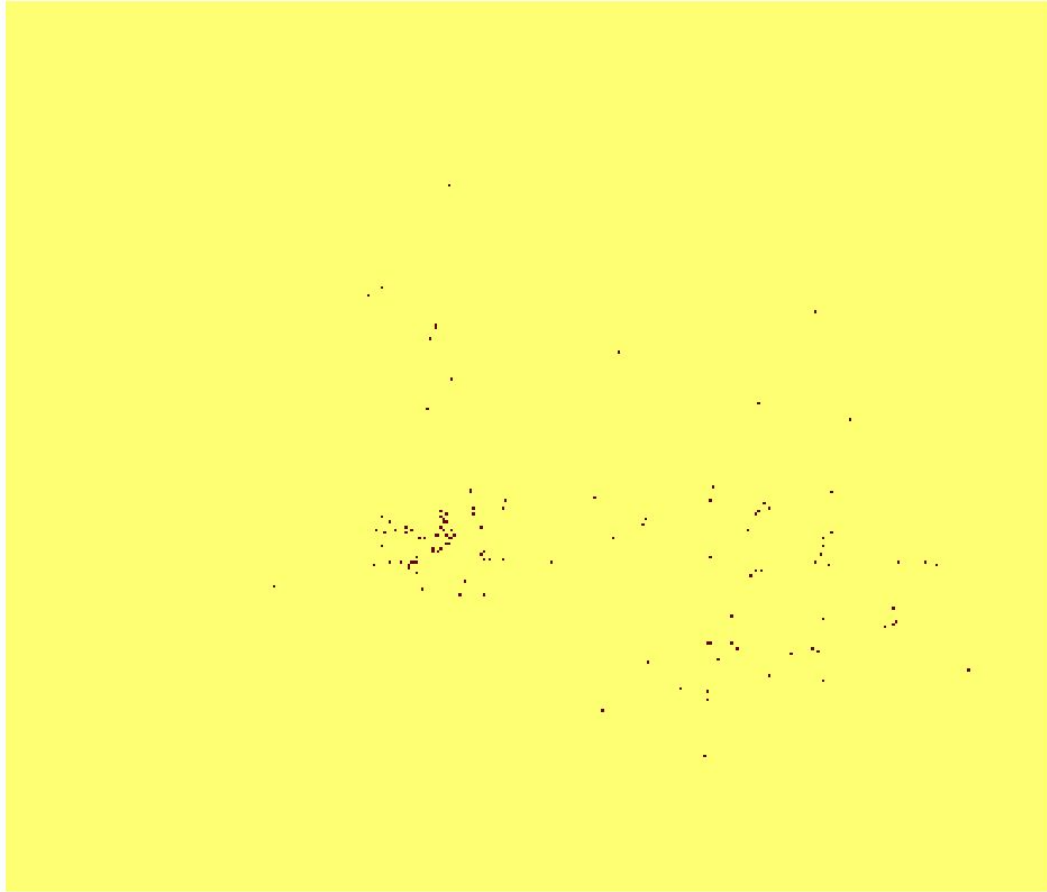
Symbol	Range	Label
	0 - 4	0 - 4
	5 - 28	5 - 28

☐ Show class ranges using feature values **Advanced**

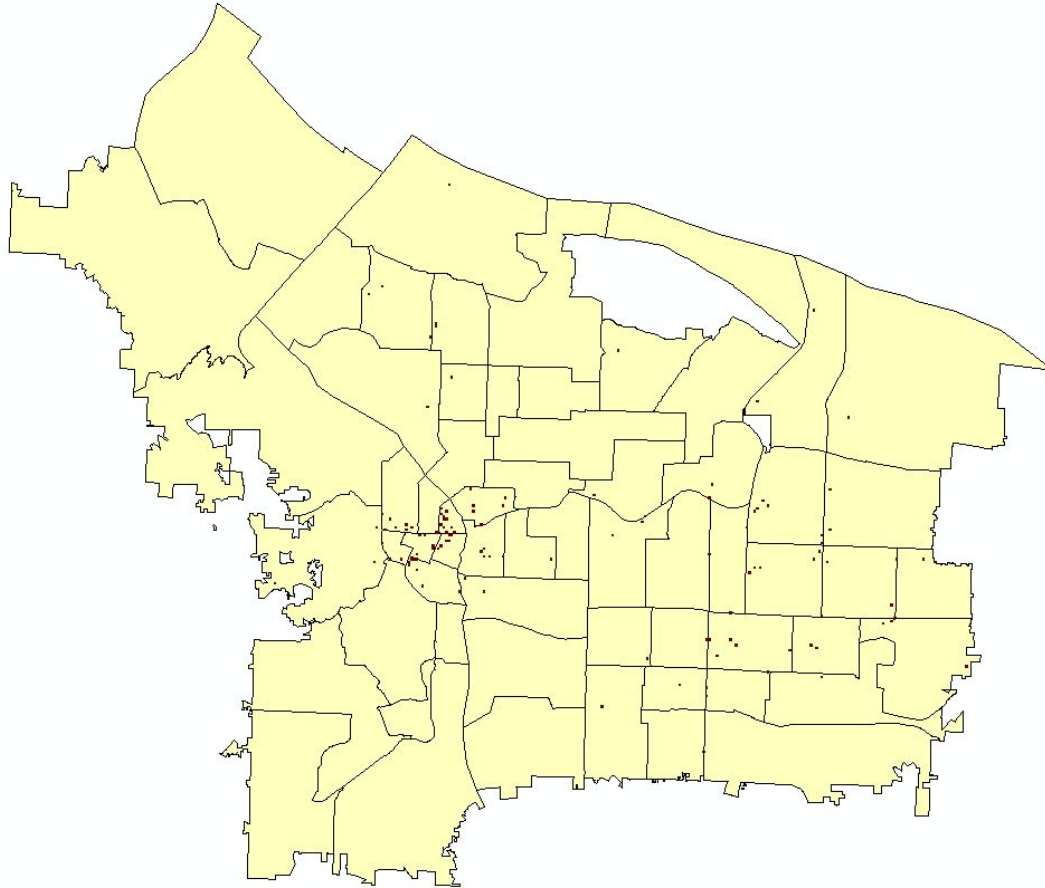
Click OK

OK Cancel Apply

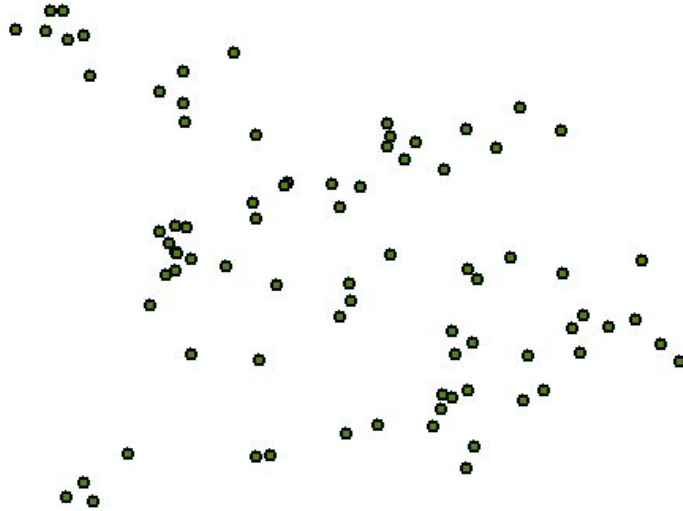
Hotspot map



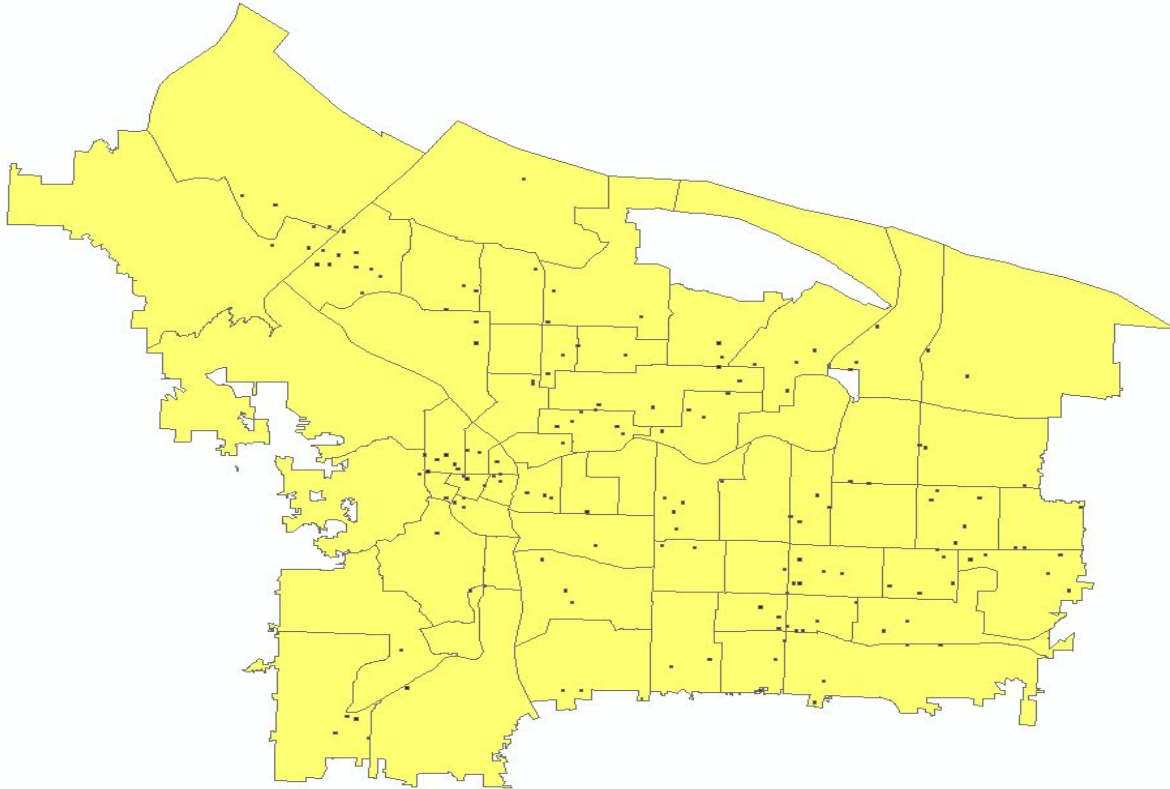
Hotspot map overlay Portland police map



The record of the first week in March 2013 [2/27/2013-3/5/2013]



The record of the first week in March 2013



Thank You!