GIS Tools for Sharing Health Data and Protecting Patient Confidentiality

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Health data maybe collected at different sub-county scales

- Residential address
- Census blocks
- Census tracts
- ZIP codes
- Towns

Problems using Pre-existing Regions

Unequal populations

Populations are too large. Difficult to see variations in rates between local communities.

or

Populations are too small so data is suppressed to protect confidentiality or rates are unstable due to chance.

The Demand for Community Level Data

- State health departments and federal health agencies such as the CDC often provide county level health indicators.

- Stakeholders want the data at a finer geographic scale.

Environmental Facilities & Cancer Incidence Map Law, 2008 § 3-0317

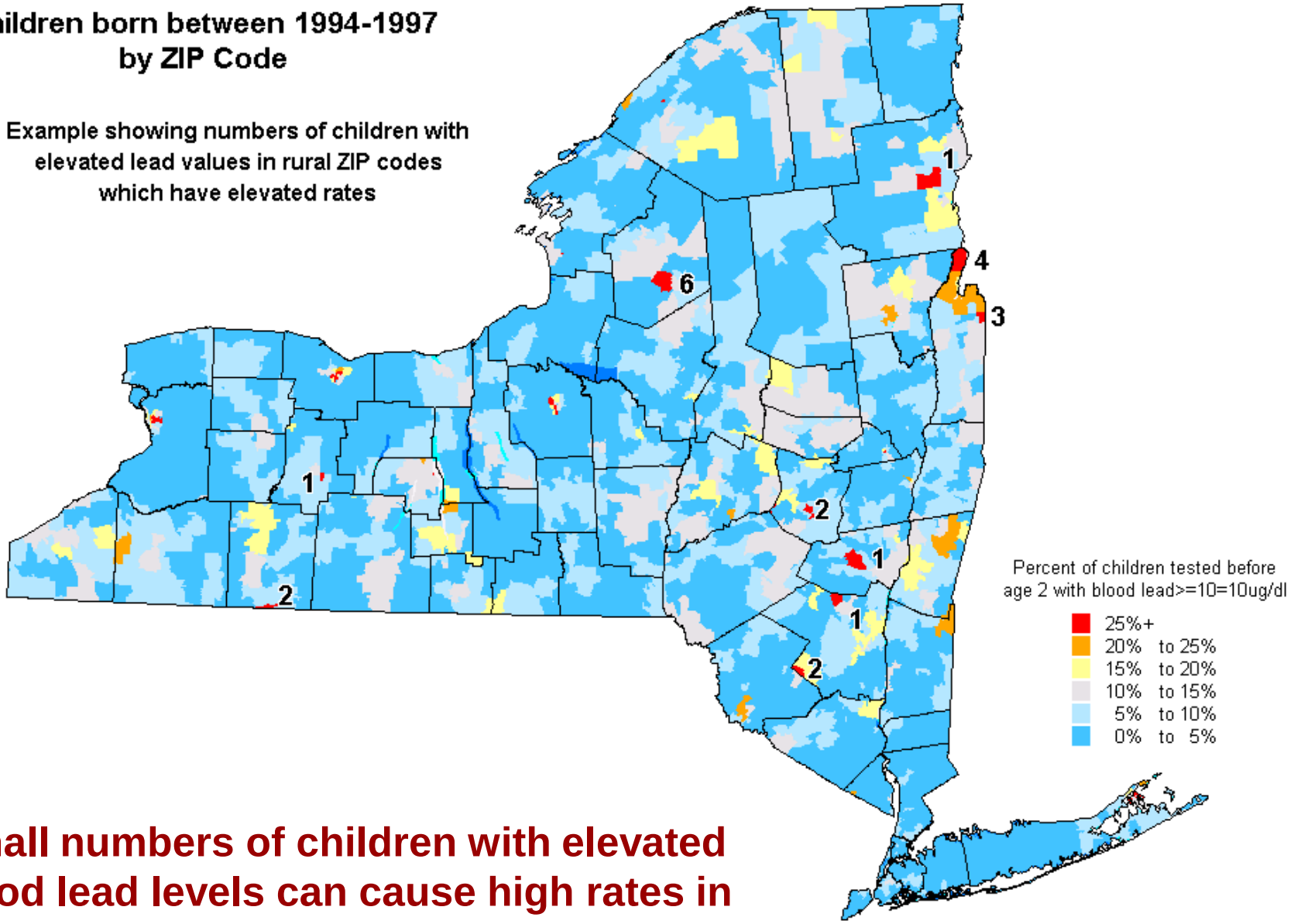
- Plot cancer cases by census block, except in cases where such plotting could make it possible to identify any cancer patient.

- Census blocks shall be aggregated to protect confidentiality.

Geographic Aggregation

Geographic distribution of elevated blood lead levels in New York State children born between 1994-1997 by ZIP Code

Example showing numbers of children with elevated lead values in rural ZIP codes which have elevated rates

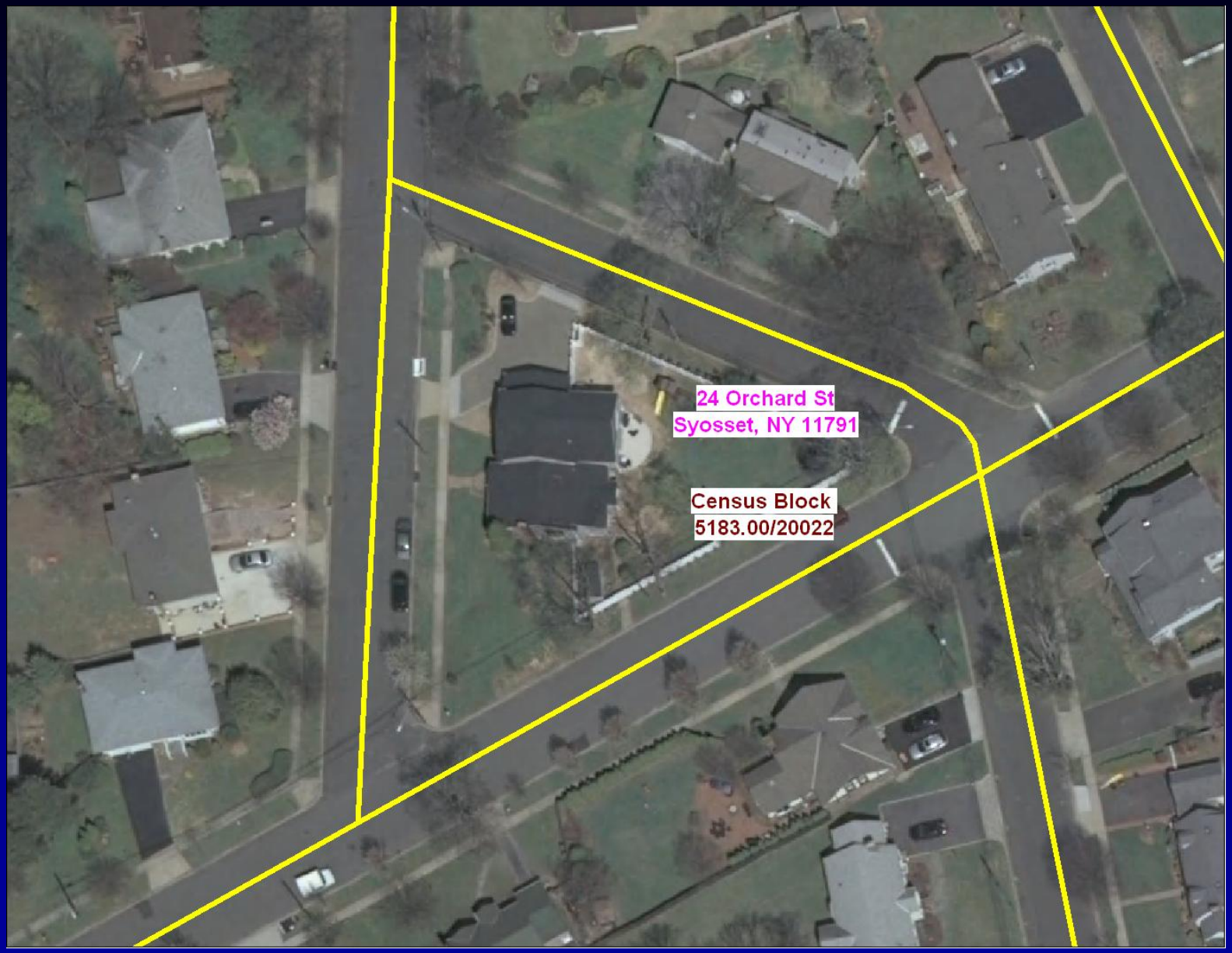


Small numbers of children with elevated blood lead levels can cause high rates in sparsely populated areas due to chance.

Geographic Aggregated Count & Rate Maps

- Protect Confidentiality so data can be shared.
- Reduce random fluctuations in rates due to small numbers.

Disclosure of confidential information



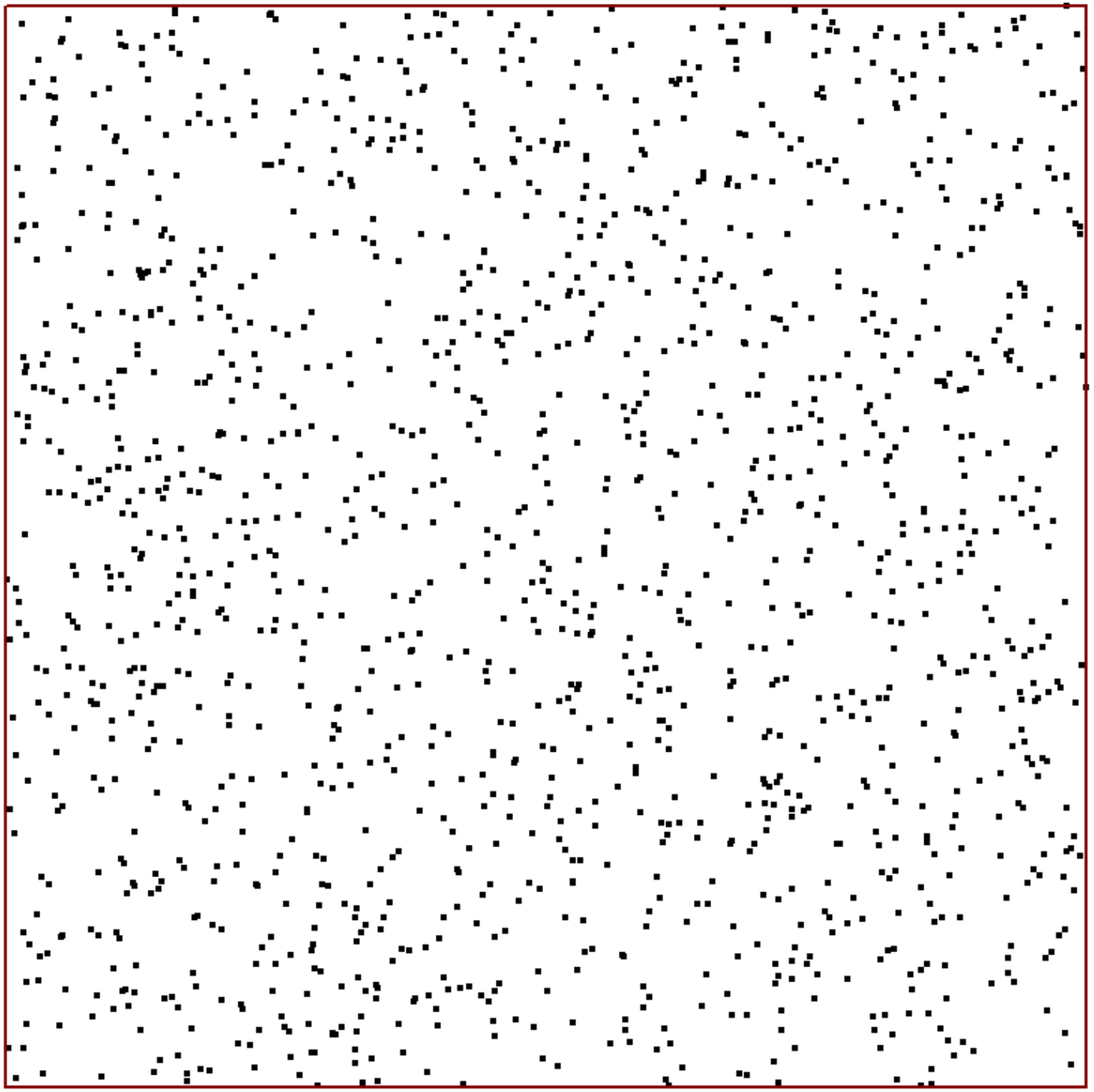
Census Blocks

Some census blocks may contain only one house.

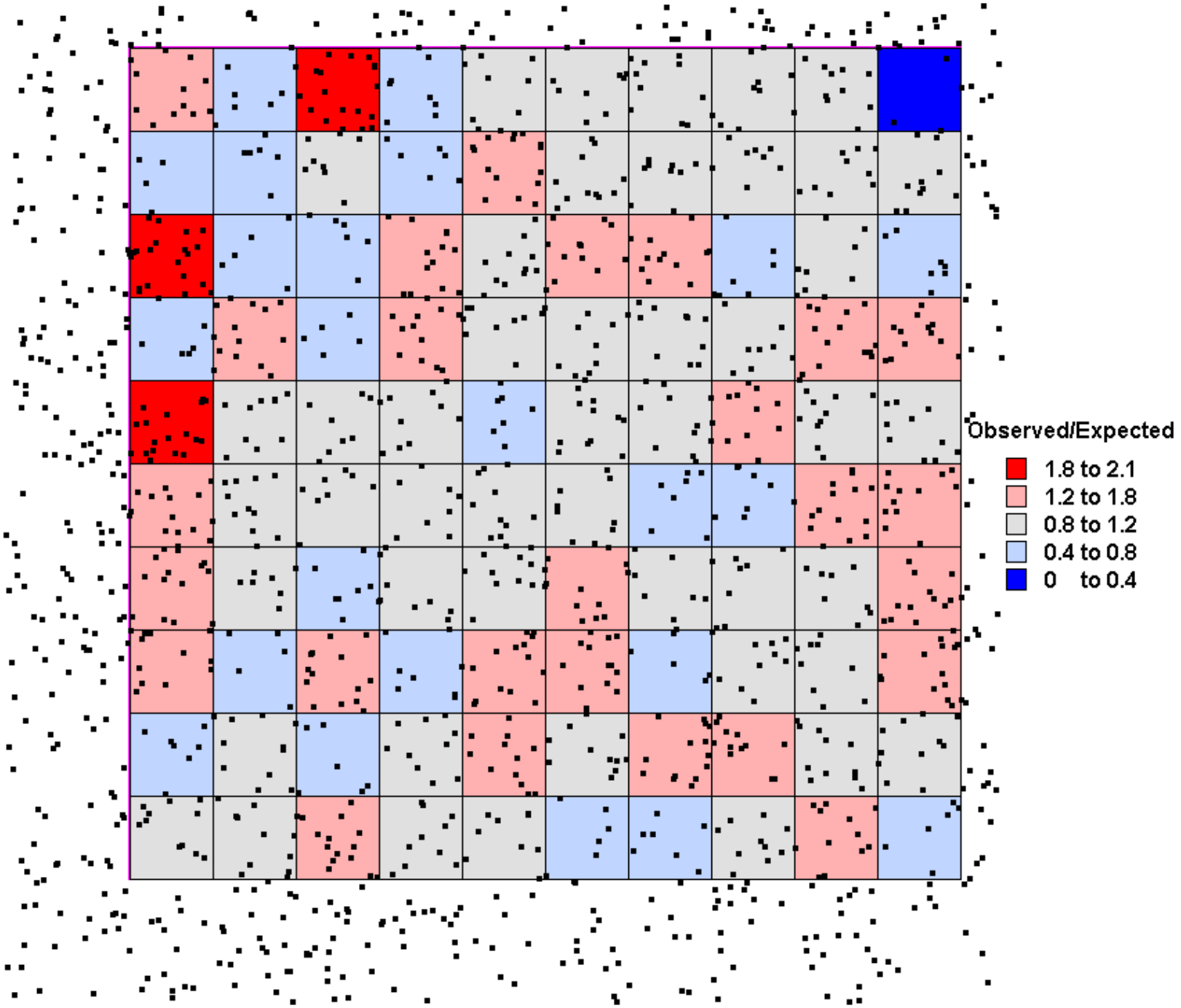
Small Numbers and Unstable Disease Rates

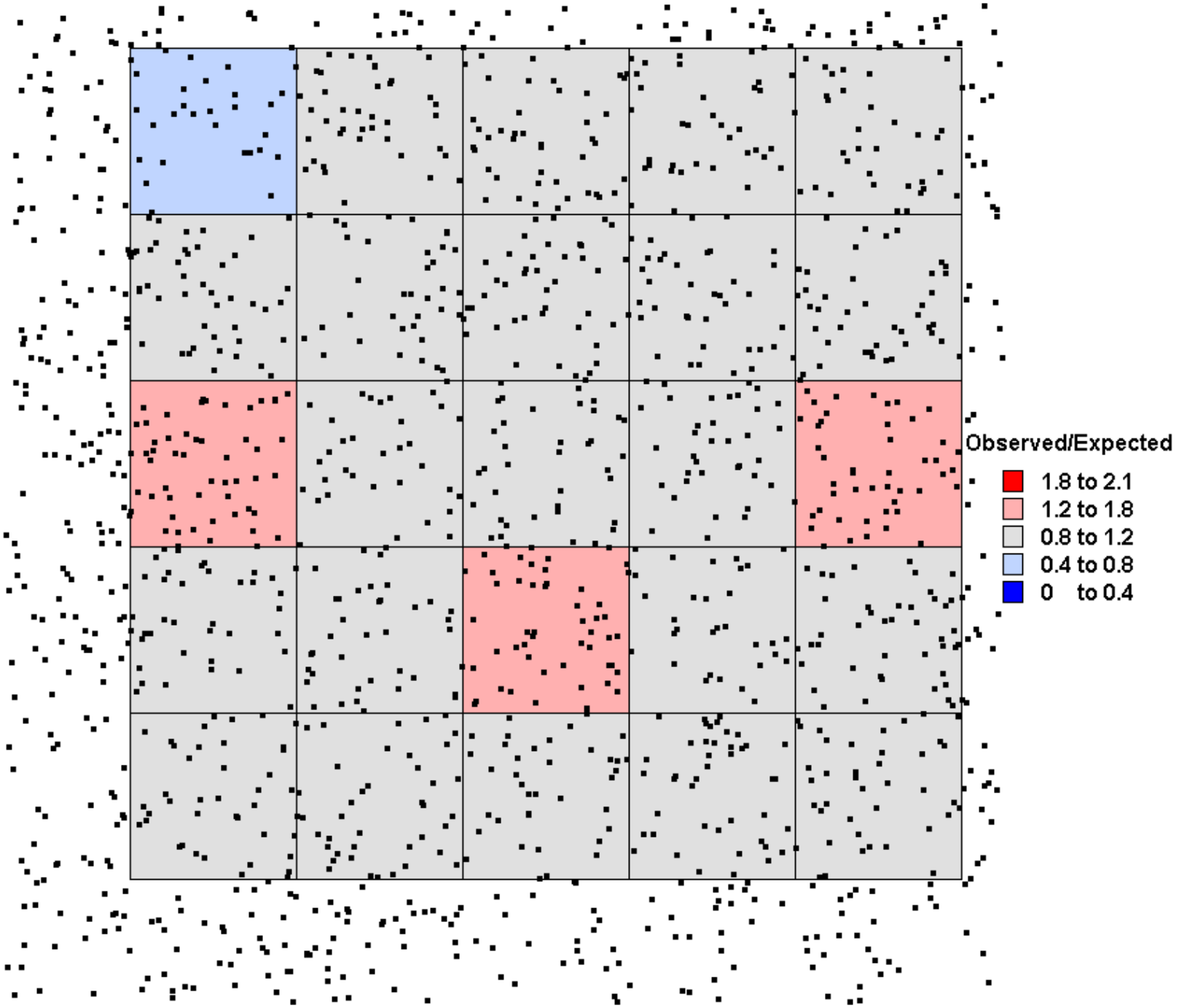
- In the following example points are randomly placed on a map with an average of 10 points in each grid cell.

- The observed number of points vs. the expected number of points changes as we move the grid or if we change the scale by combining grids.



Random
Distribution
of points


Observed/Expected
1.8 to 2.1
1.2 to 1.8
0.8 to 1.2
0.4 to 0.8
0 to 0.4


Observed/Expected
1.8 to 2.1
1.2 to 1.8
0.8 to 1.2
0.4 to 0.8
0 to 0.4

Need for an Aggregation Tool

- Merge small areas with neighboring areas to provide more stable rates of disease and/or protect confidentiality.
  - Aggregation can be done manually.
  - Existing automated tools were difficult to use or did not fulfill requirements.

NYSDOH Geographic Aggregation Tool Requirements

- Aggregate small areas into larger ones.
- User decides how much aggregation is needed.
  Based on cases and/or underlying population
- Works with various levels of geography.
- Can nest one level of geography in another
  Example: Census tracts are aggregated. Aggregated areas do not cross county borders
- Uses open source free software (R).
- Outputs results for use in mapping programs.

Geographic Aggregation Tool

Original Census Block Data

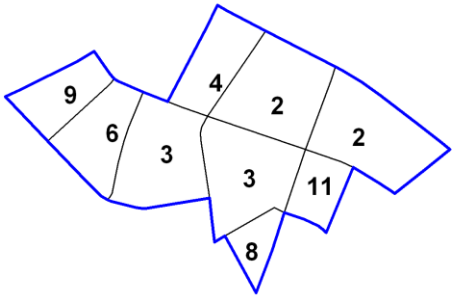
Census Block	Cases
2004	2
2005	11
3005	2
3007	3
3008	8
3009	3
3010	4
12001	9
2002	6

R Tool

Regions

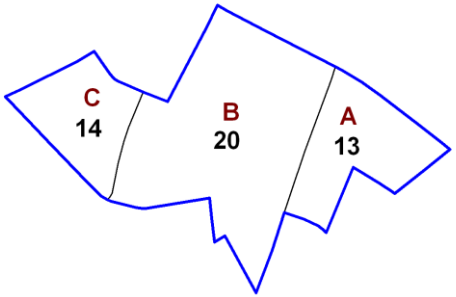
Census Block	Cases	Region
2004	2	A
2005	11	A
3005	2	B
3007	3	B
3008	8	B
3009	3	B
3010	4	B
2001	9	C
2002	6	C

Cases & Block Boundaries



Cases	Region
13	A
20	B
14	C

Aggregated Block Boundaries



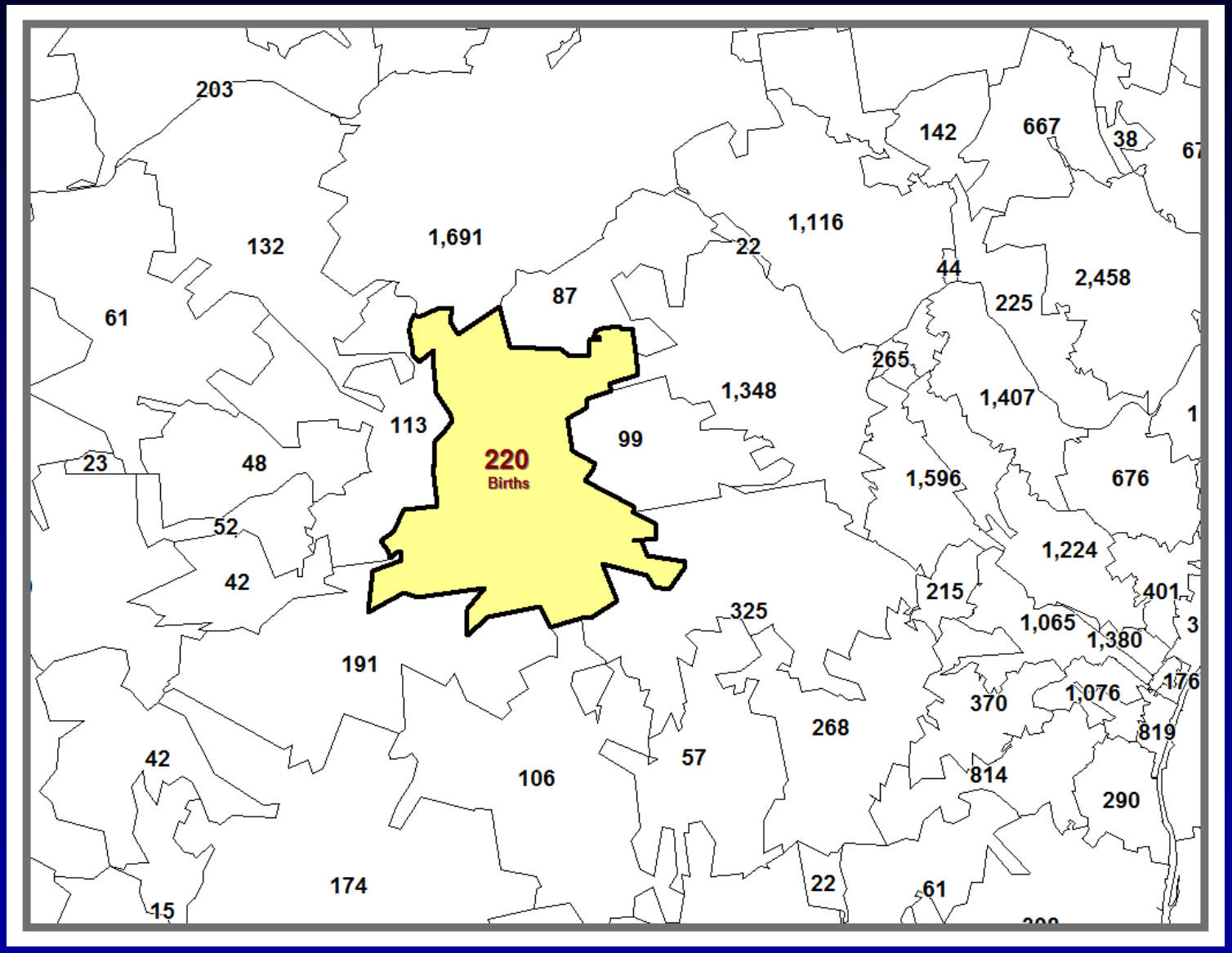
How does the GAT Determine which areas to Merge?

- Example: Merge areas in a series of pairwise merges until all areas have at least 250 births.

- Areas with 250 births will on average have about 15 low birth weight births.

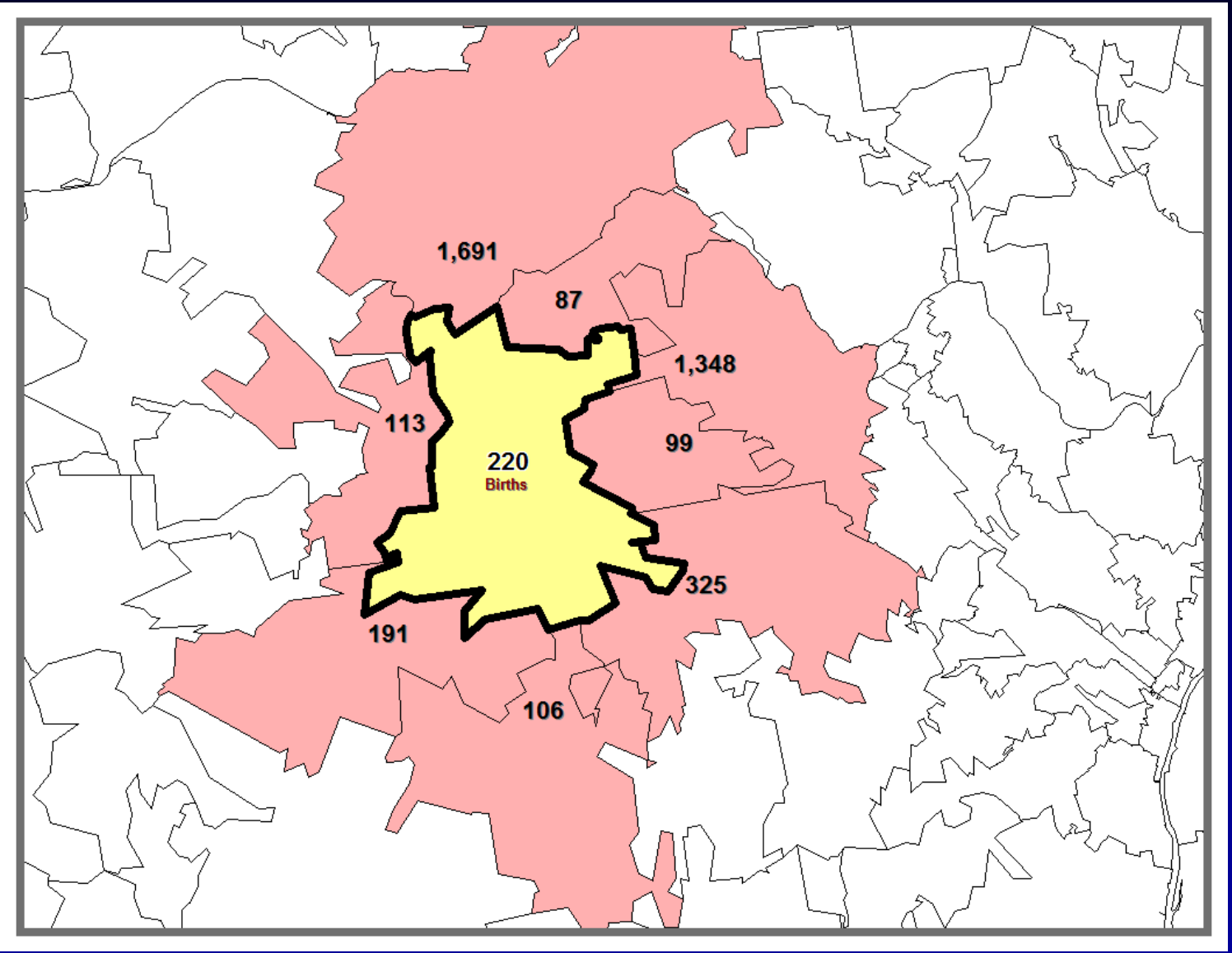
1st Area to Merge

Select areas with less then 250 births
of those areas select the area with a count closest to 250



Select Neighbors

Tool can be set so neighbors need to be in same region (e.g. county)

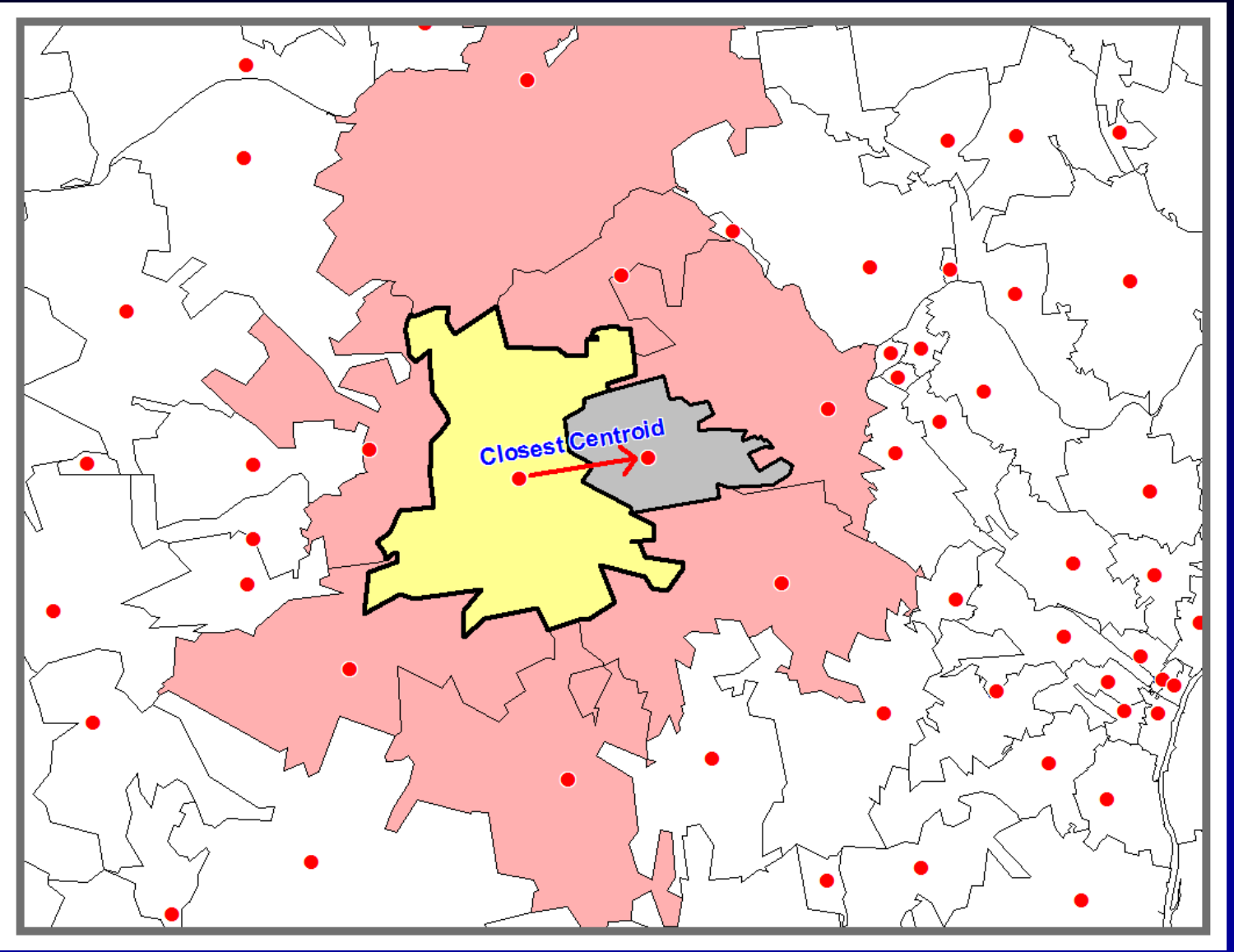


Three methods used to select neighbors to merge

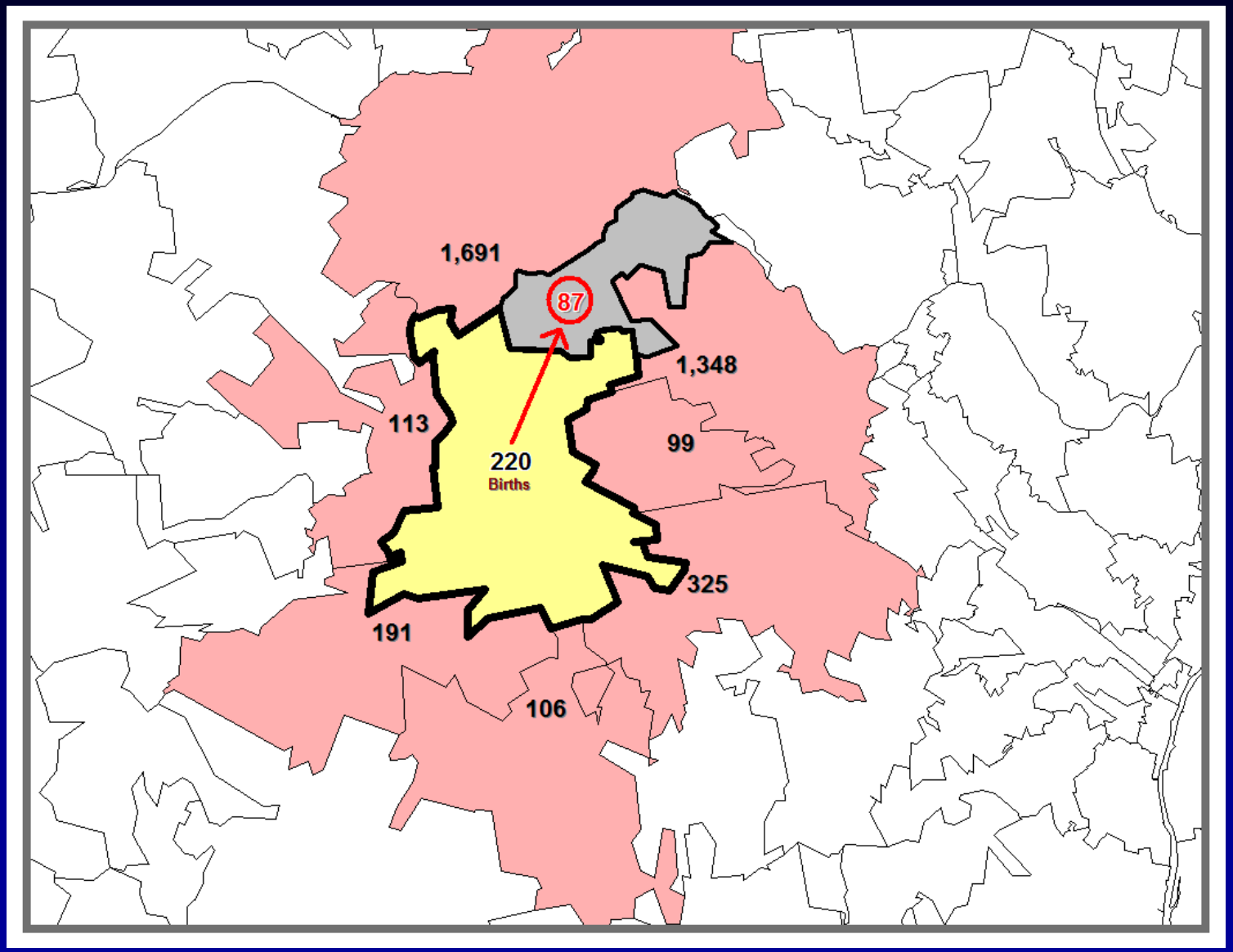
- Nearest neighbor (closest centroid)
- Smallest population

  (e.g. number of births)
- Most similar characteristic.

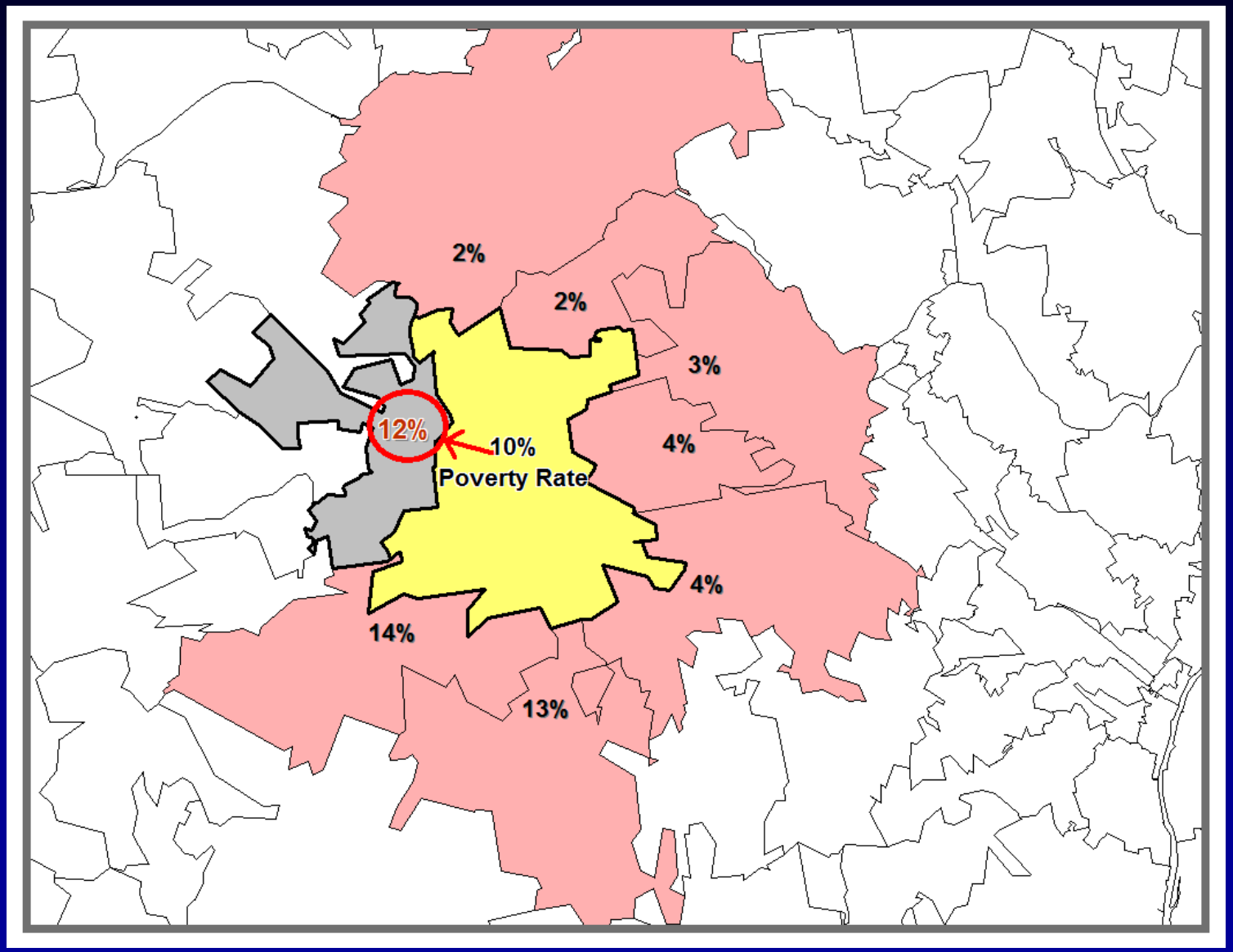
Select Nearest Neighbor



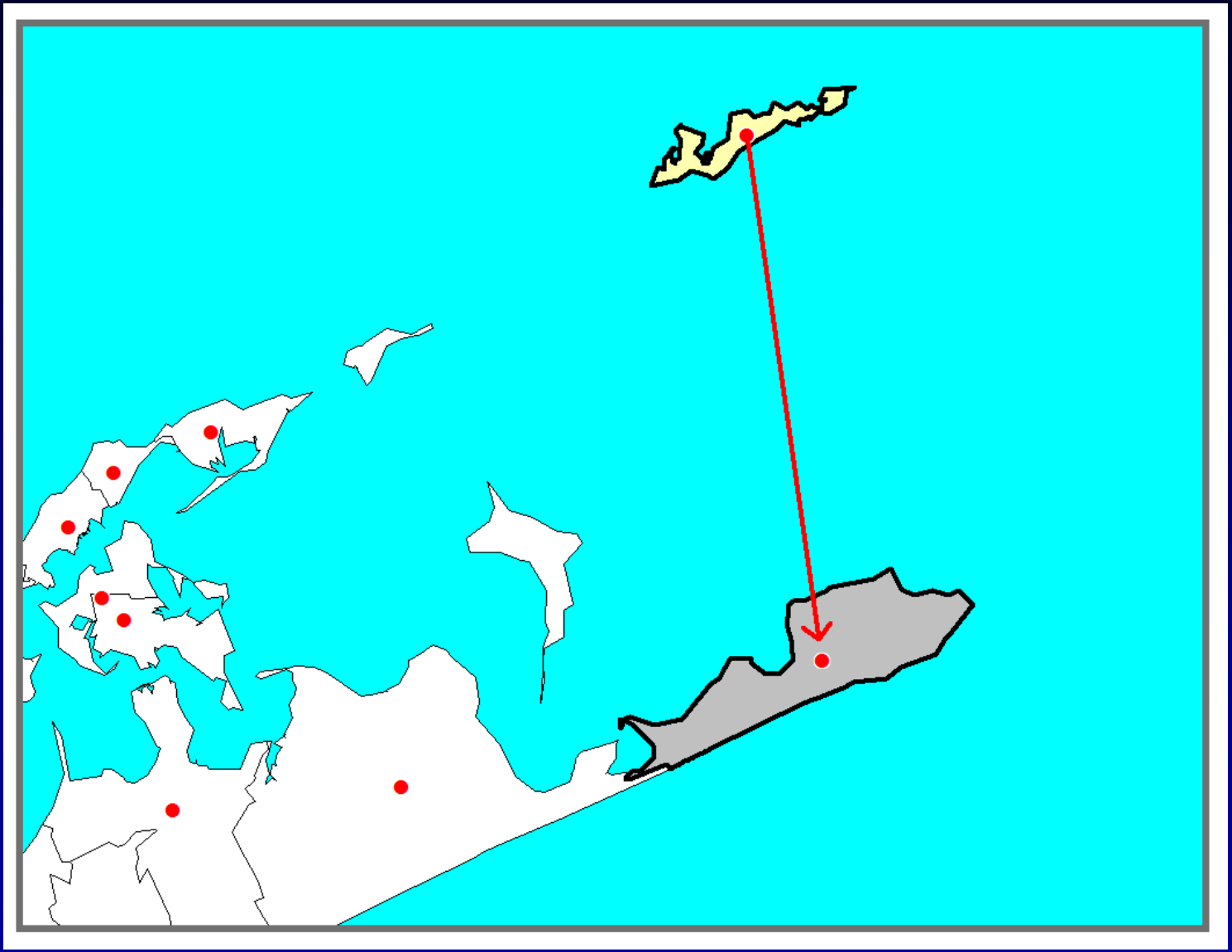
Select Area with the Fewest Births



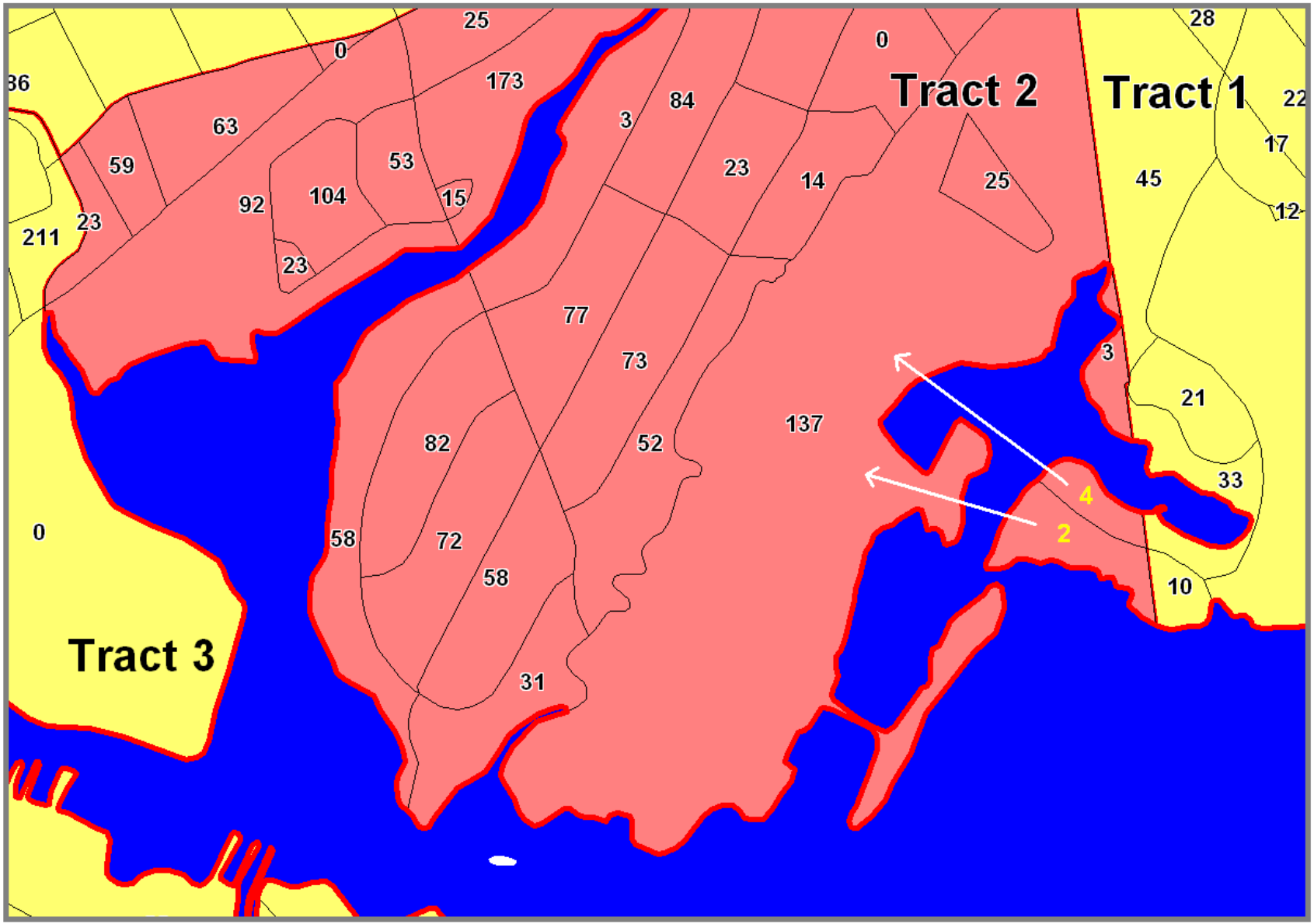
Select Area with Most Similar Poverty Level



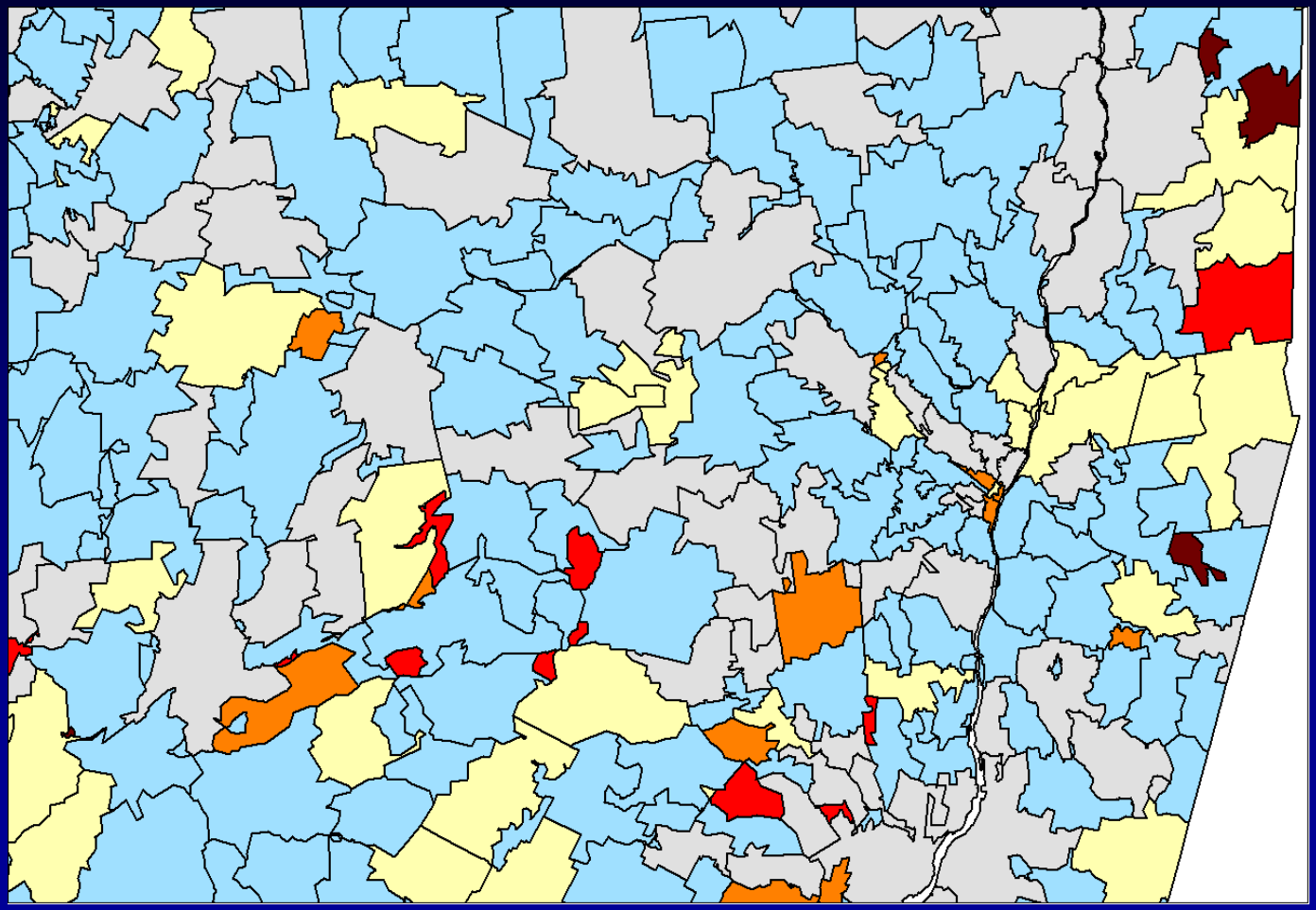
In the case of islands, GAT chooses the closest area if there are no adjacent neighbors.



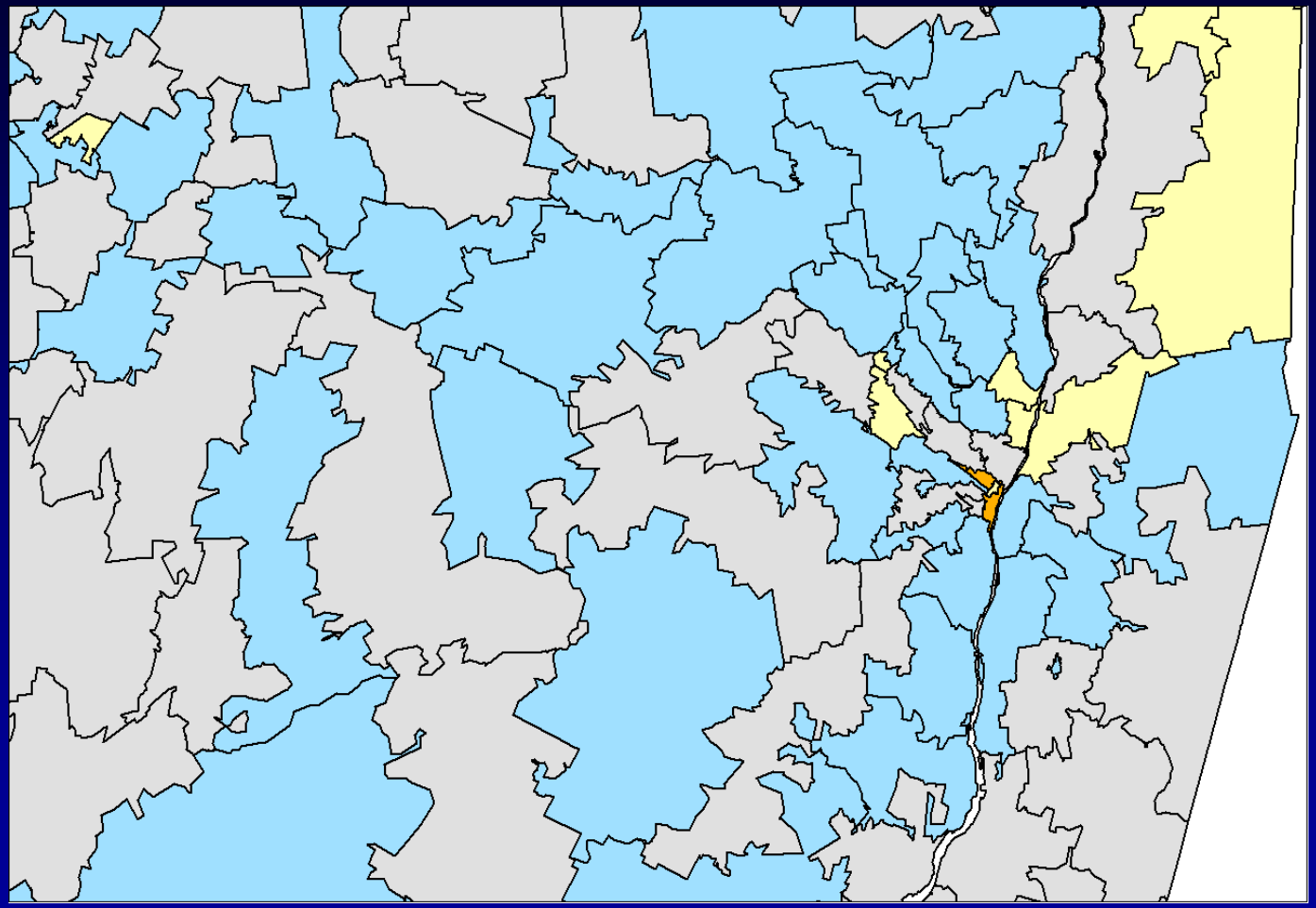
Merging blocks with noncontigous blocks in same tract.



Original ZIP Codes
3 Years Low Birth Weight Incidence Ratios



Aggregated to 250 Births per ZIP Code Group



Performance Measures

- Compactness
- Similar population sizes.
- Number of aggregated areas.
- Aggregated zones are contained within larger areas.
- Tool can handle large numbers of polygons
- Speed

New York State Descriptive Statistics

Year 2000 populated census blocks

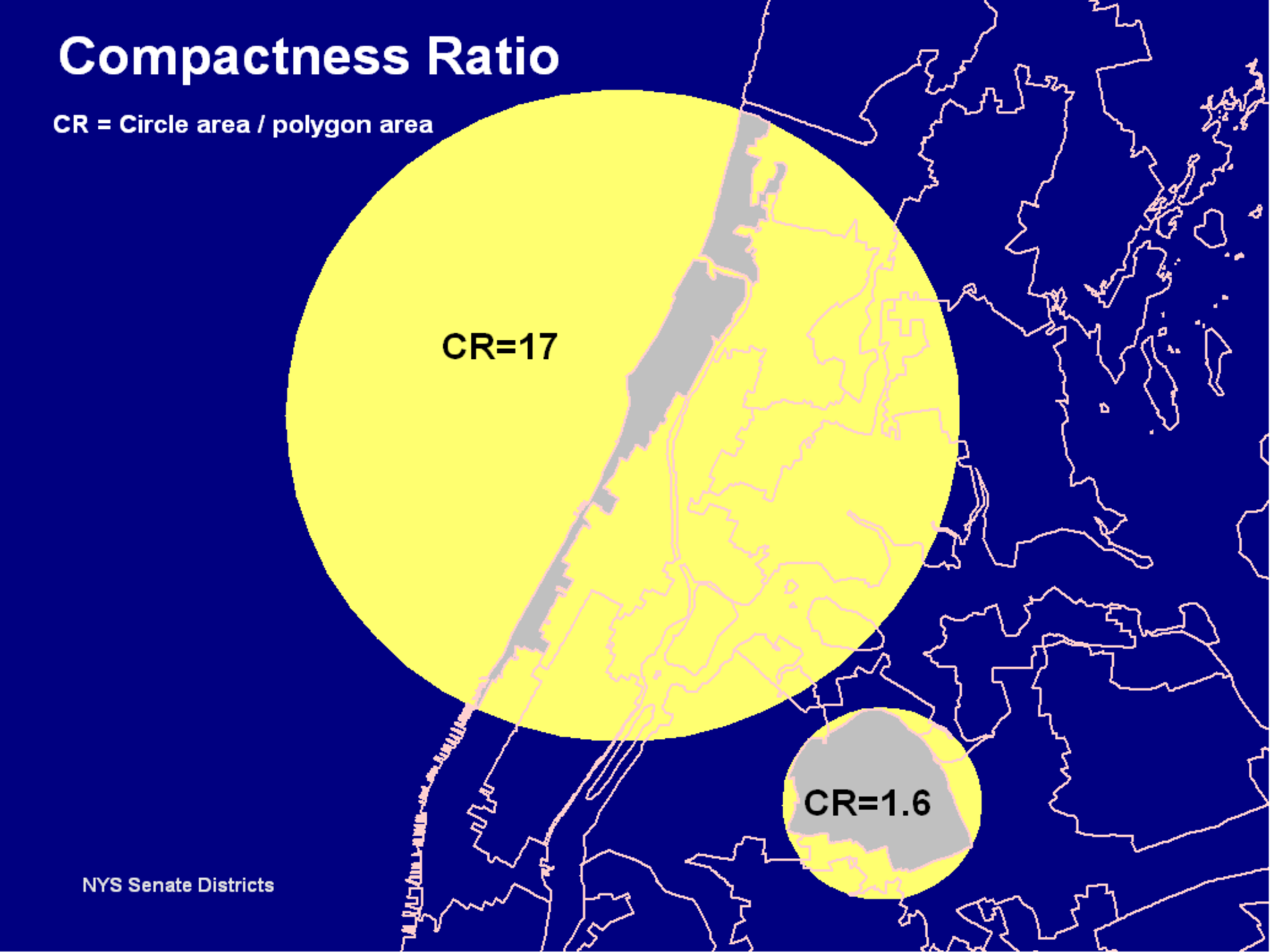
Statistic (calculated using populated regions only)	Original Census Blocks	New Regions: Level of Aggregation		
		6 cases	12 cases	24 cases
Number of regions	225,167	39,748	21,525	11,381
Median Population	39	385	770	1,467
Median number of cases	1	10	20	38
Median number of blocks	1	4	7	14

NYS number of cases (5 yrs)	470,000
NYS population 2000	18,976,457

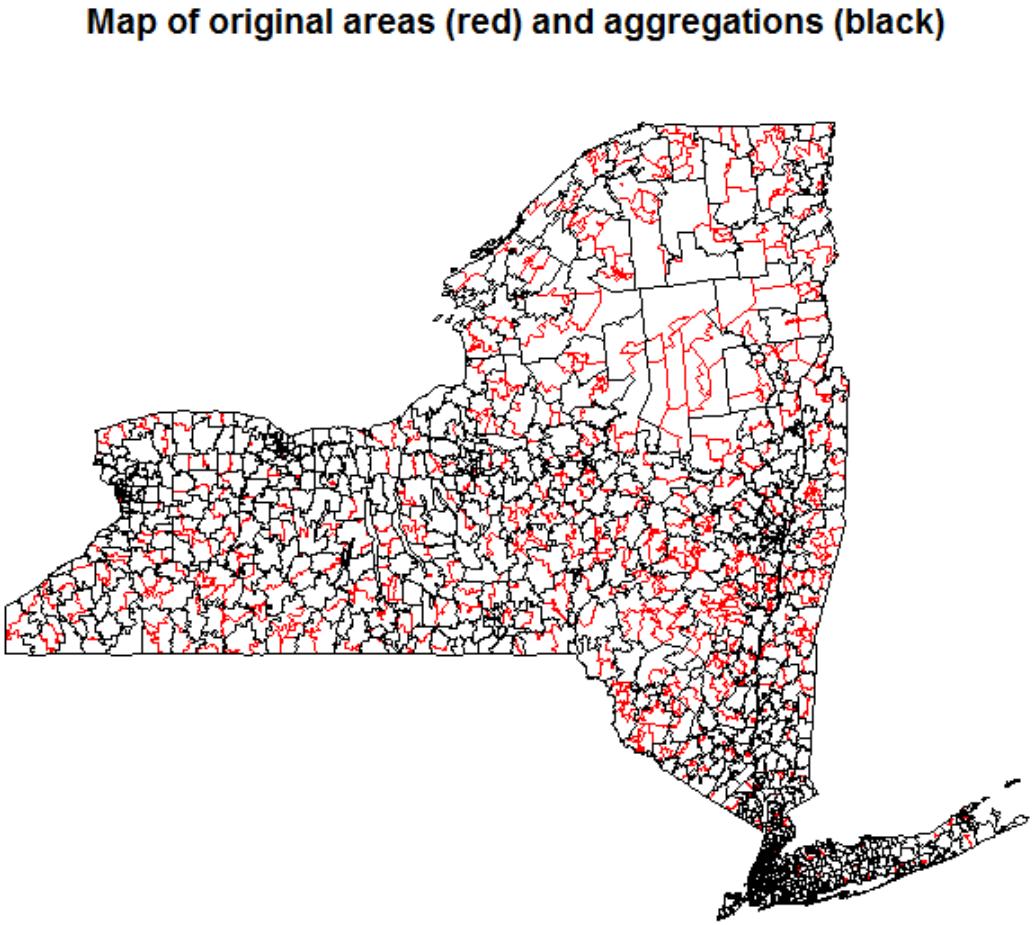
Note: The range in the census block populations is 0 - 23,373 Persons

Compactness Ratio

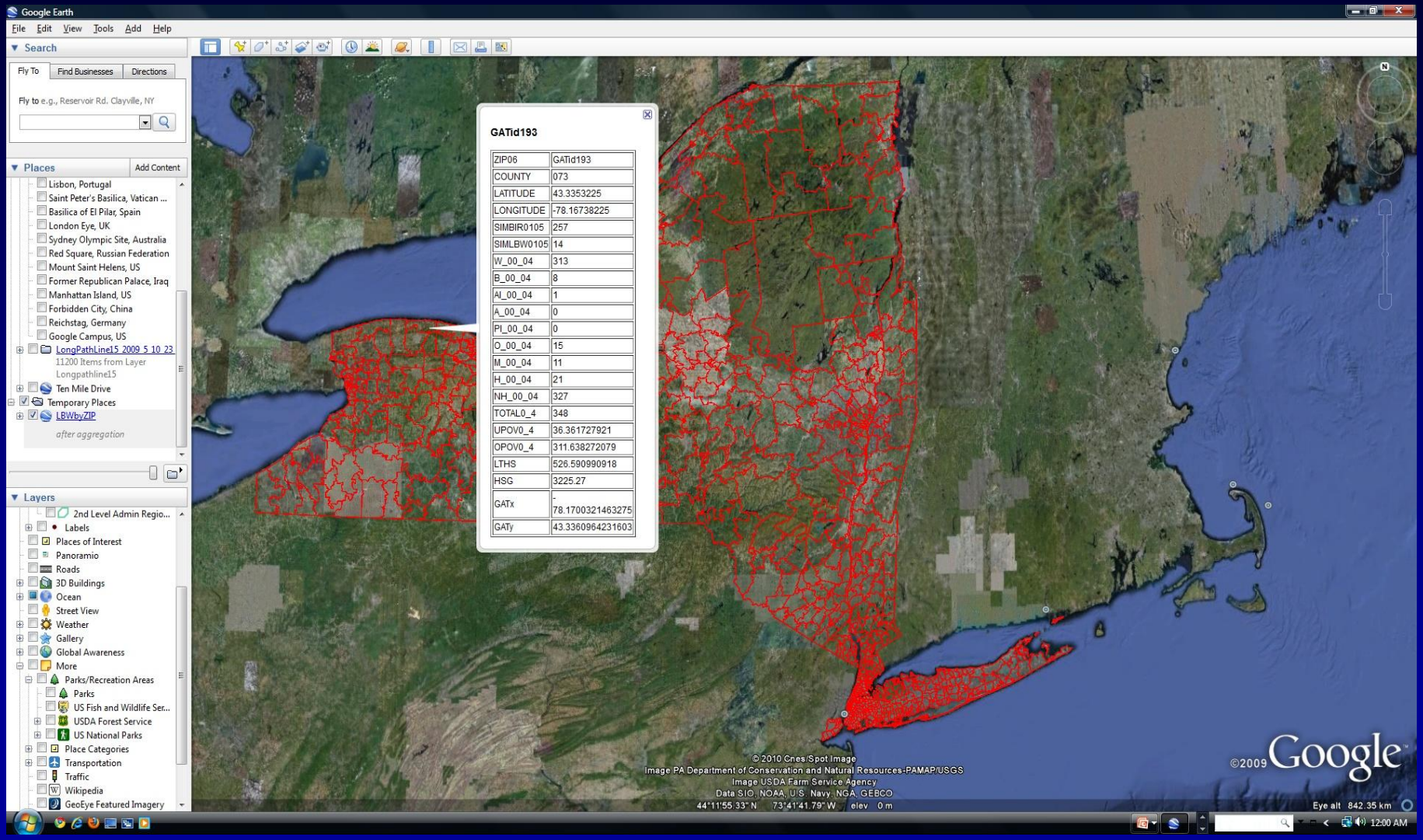
CR = Circle area / polygon area



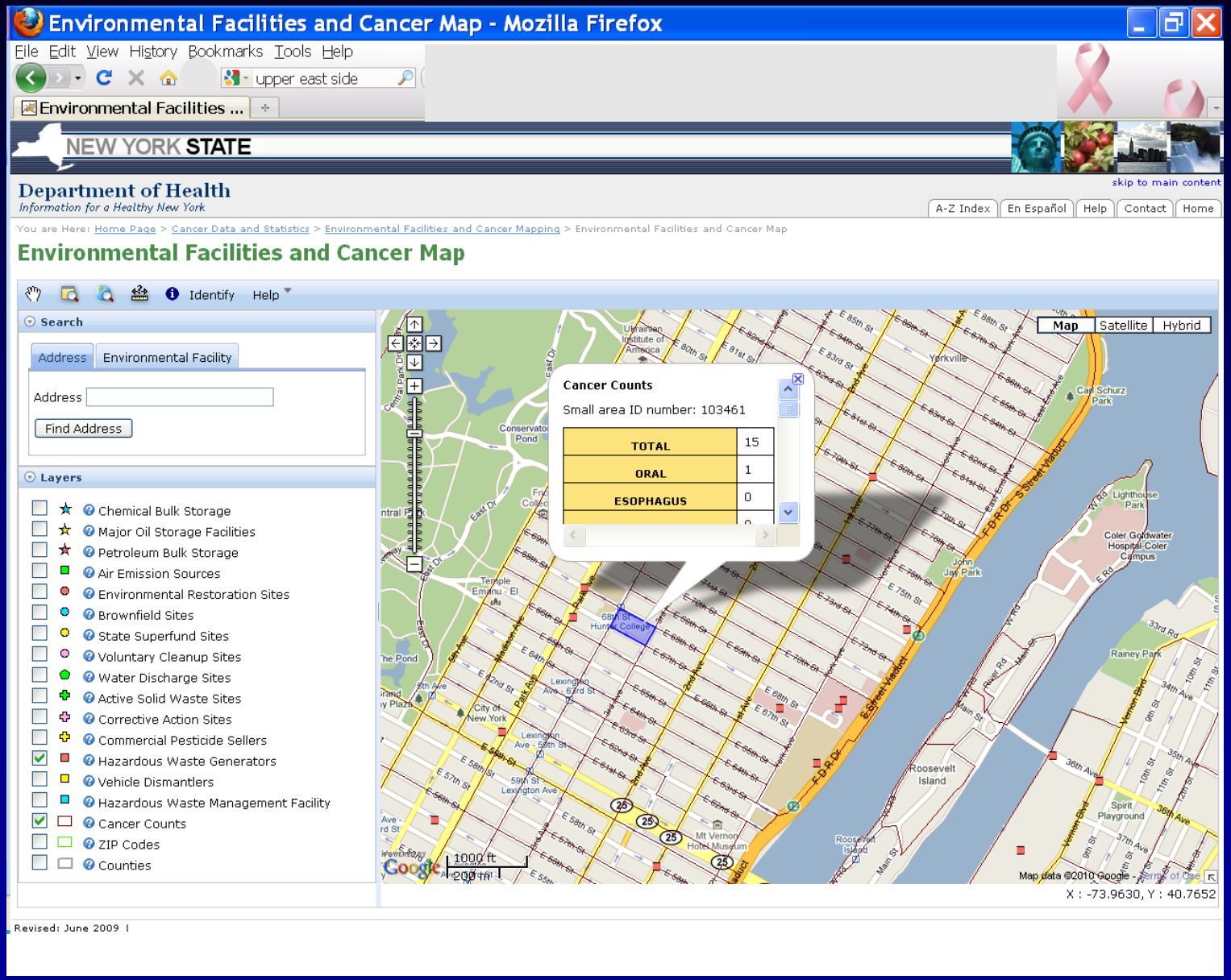
Compactness



GAT Outputs both KML & SHP Files



The Geographic Aggregation Tool helped us provide fine scale cancer data to the public.



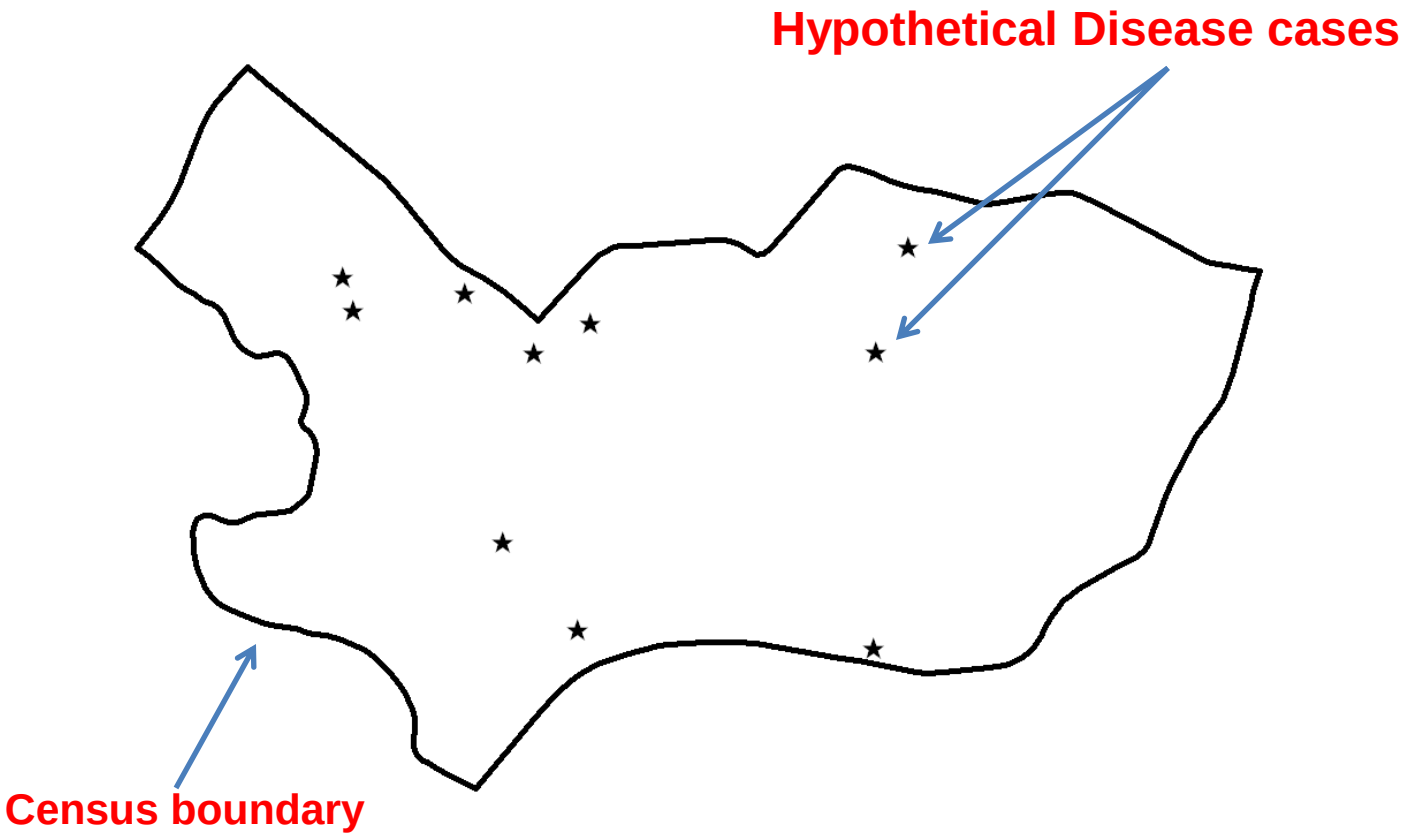
GeoMasking

- Masking: Obscure specific data elements by replacing sensitive data with realistic but not real data.

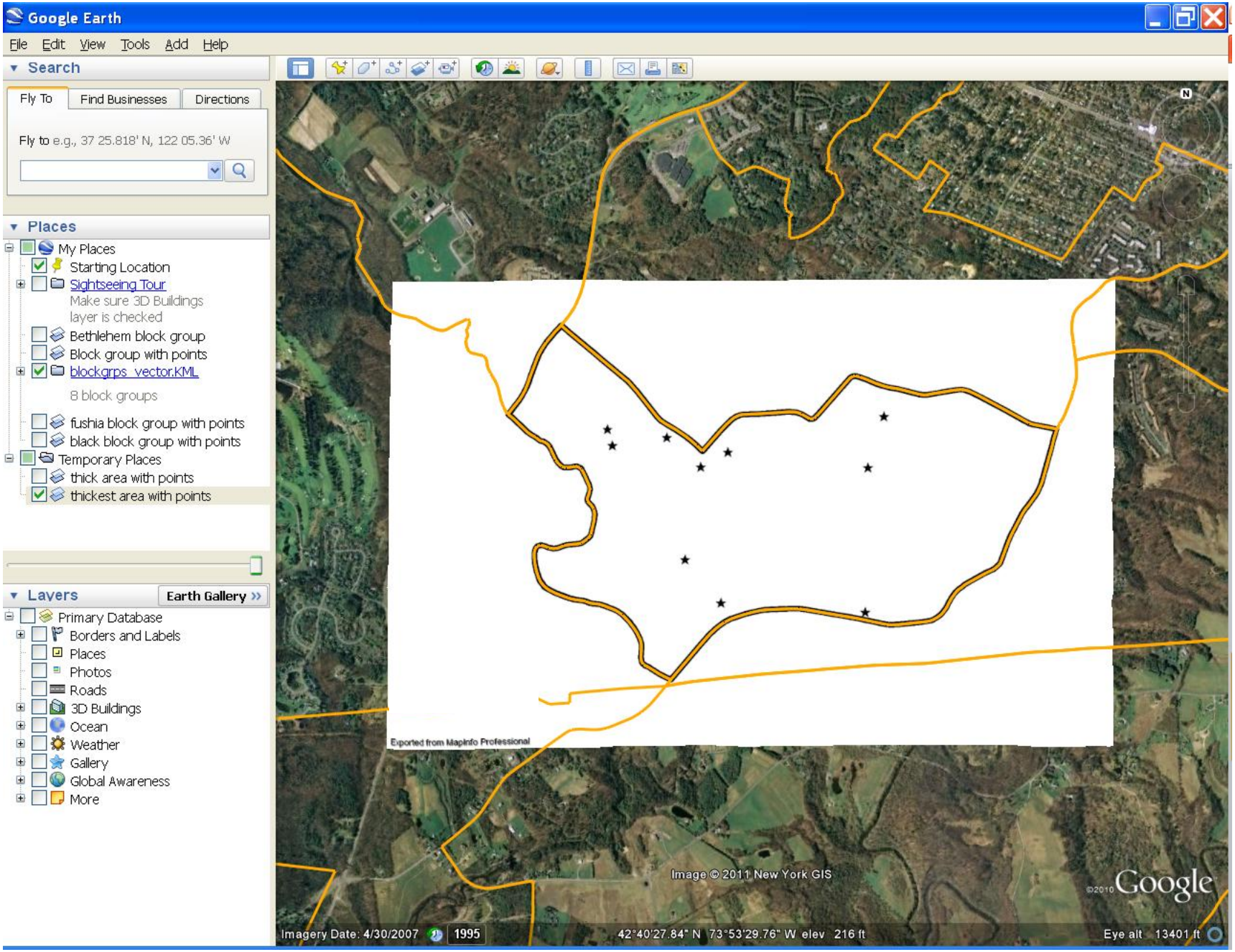
- Geomasking: The elements being replaced are the geographic coordinates.

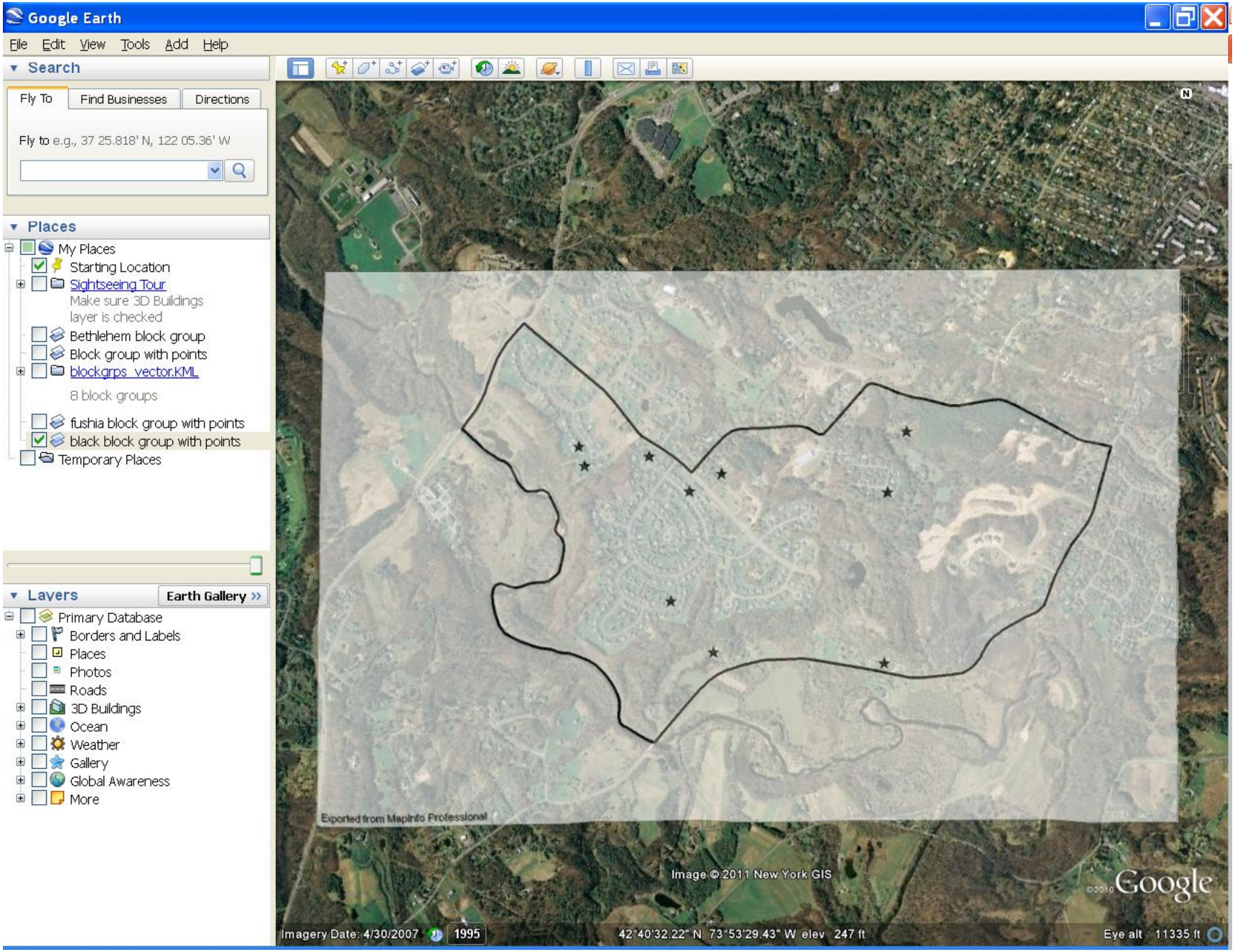
Why do we need to do this?

Maps can be registered to real-world coordinate systems.



Example: Registering a Map In Google Earth




Google Earth
File Edit View Tools Add Help
Search
Fly To
Find Businesses
Directions
Fly to e.g., 37 25.818' N, 122 05.36' W
Places
My Places
Starting Location
Sightseeing Tour
Make sure 3D Buildings layer is checked
Bethlehem block group
Block group with points
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Temporary Places
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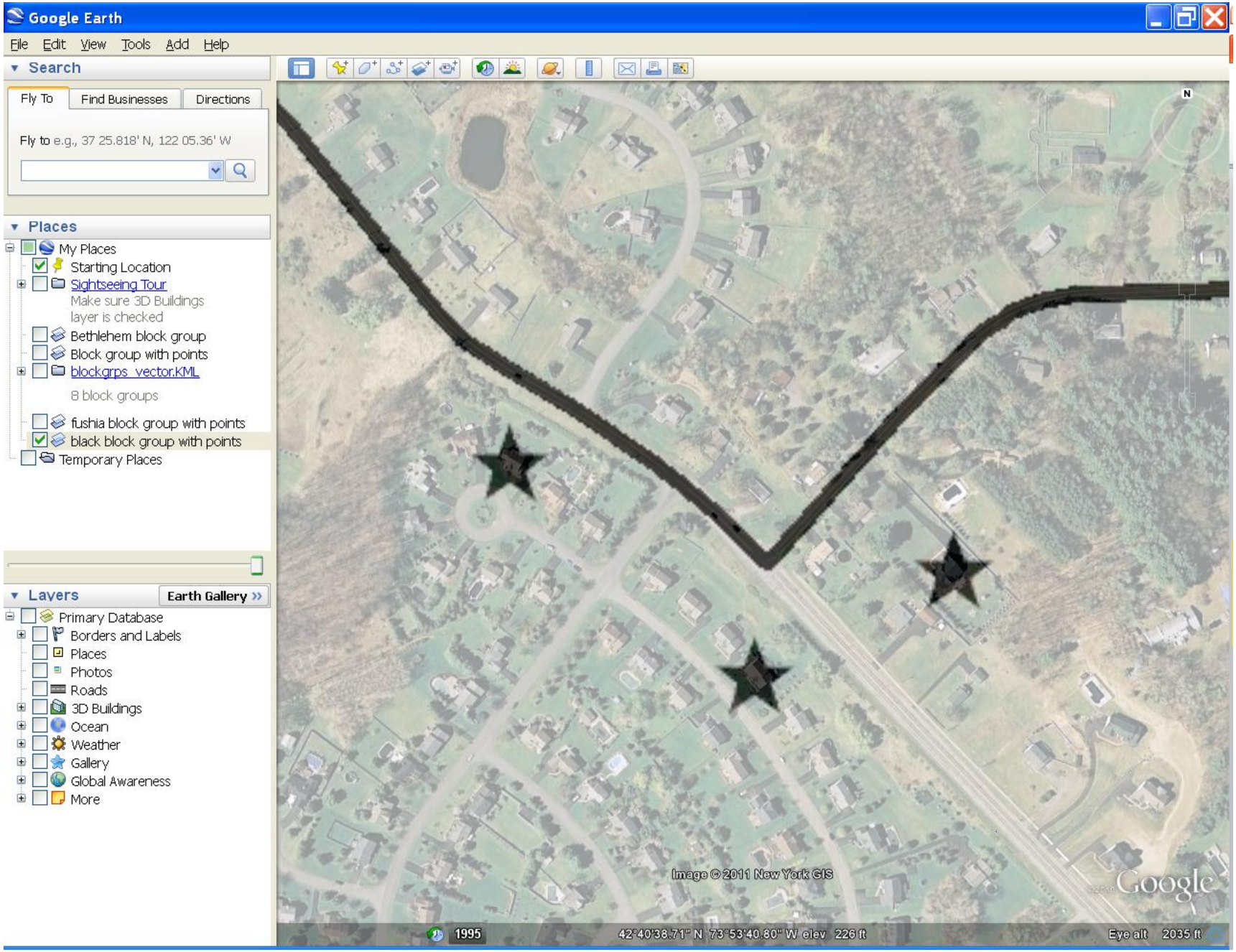
Places
Photos
Roads
3D Buildings
Ocean
Weather
Gallery
Global Awareness
More
Exported from MapInfo Professional
Image © 2011 New York GIS
©2010 Google
Imagery Date: 4/30/2007
1995
42°40'32.22" N 73°53'29.43" W elev 247 ft
Eye alt 11335 ft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Starting Location
Sightseeing Tour
Make sure 3D Buildings layer is checked
Bethlehem block group
Block group with points
blockgrps_vector.KML
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Temporary Places
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Primary Database
Borders and Labels
Places
Photos
Roads
3D Buildings
Ocean
Weather
Gallery
Global Awareness
More
N
Image © 2011 New York GIS
Google
1995
42°40'38.71" N 73°53'40.80" W elev 226 ft
Eye alt 2035 ft

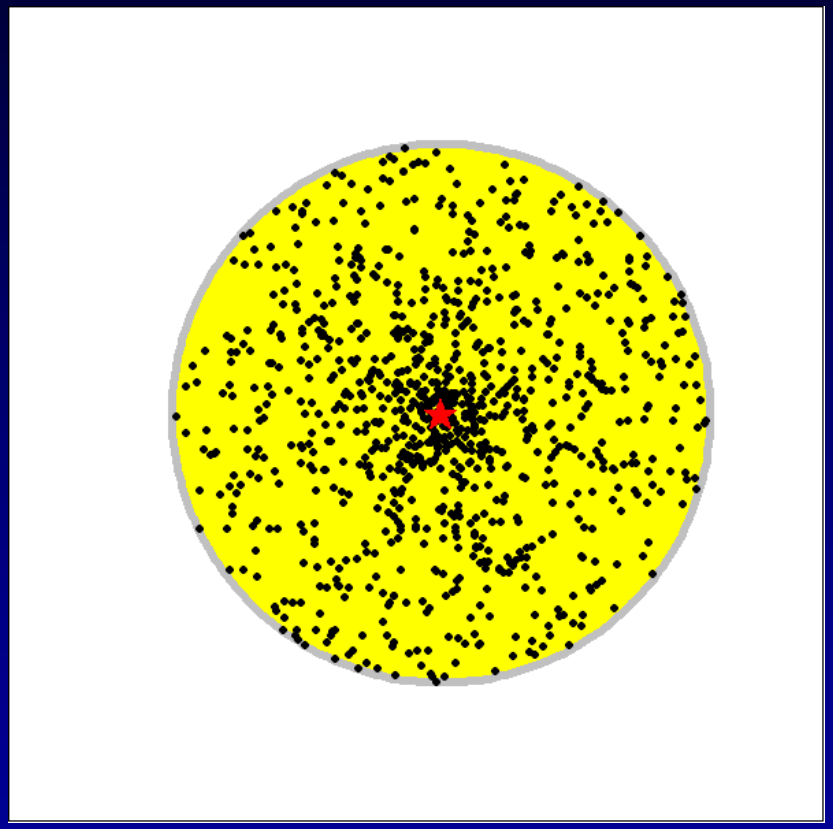
NYSDOH GeoMasking Tool
Randomly Moves Points within User Defined Area

Other residential addresses

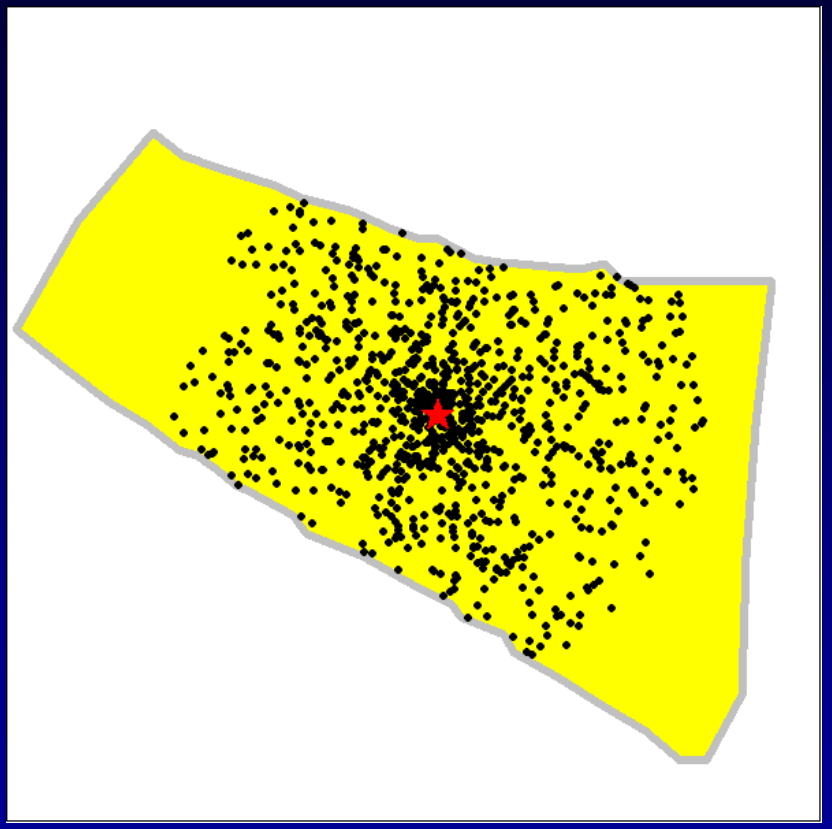
Original location

New location

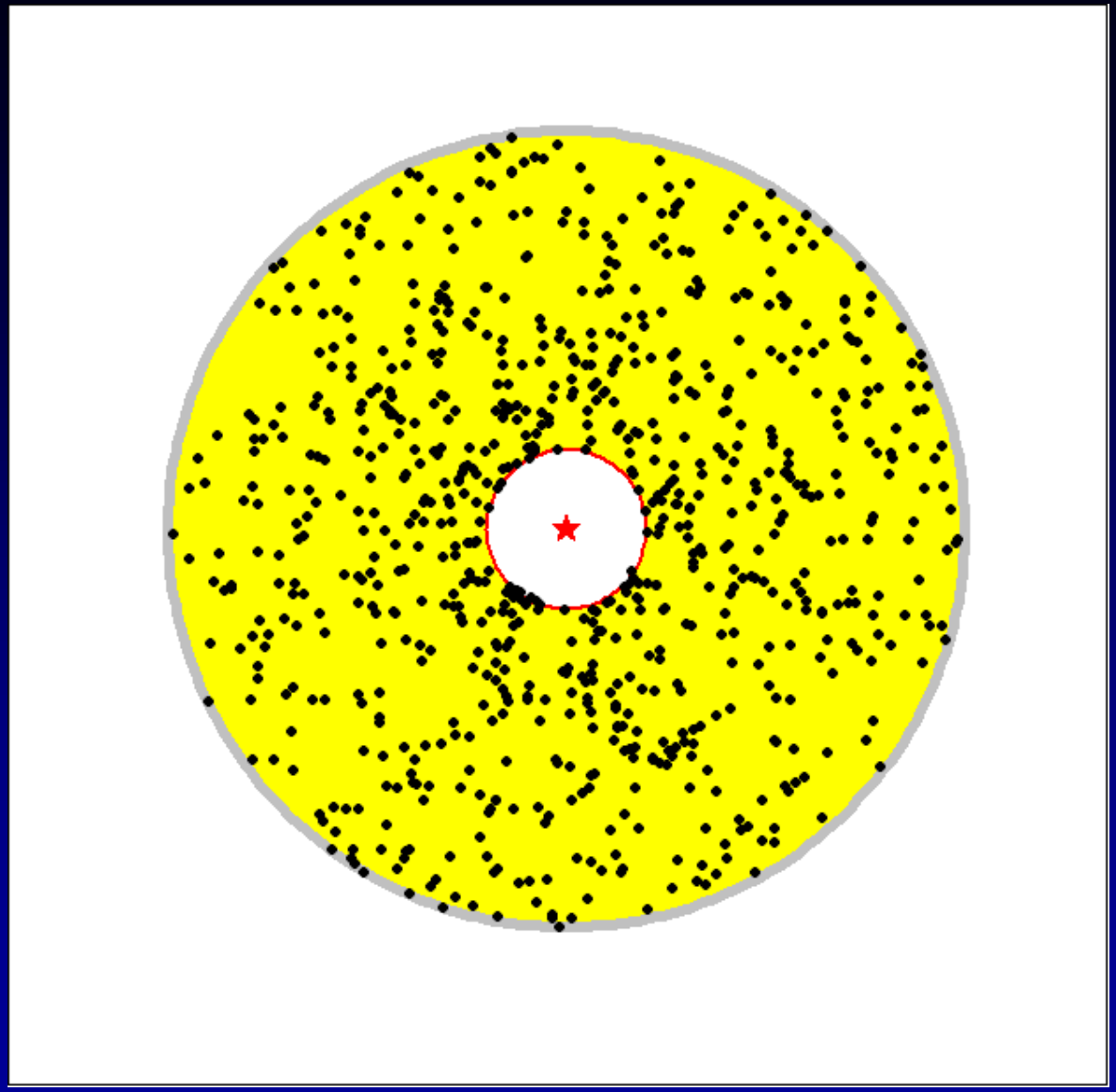
Tool can be set to prevent new point locations from moving into a different exposure area.



1000 possible point locations within 500 meters



1000 Possible point locations within 500 meters. Restricted to a study area or exposure zone.



Points are moved at least 100 meters but less then 500 meters

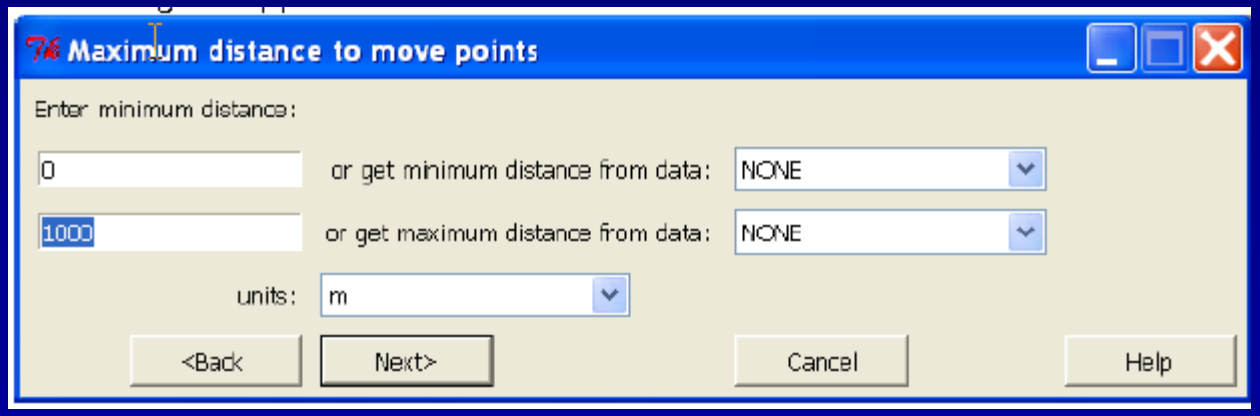
Options for Determining Move Distances

1. Min. & max distances points moved are fixed for all points.

   or

2. User set distances as a function of population density.

   – For example in densely populated areas points are moved less then in sparsely populated areas.



Our Tools are easy to use, have GUI Interfaces and User Guides

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