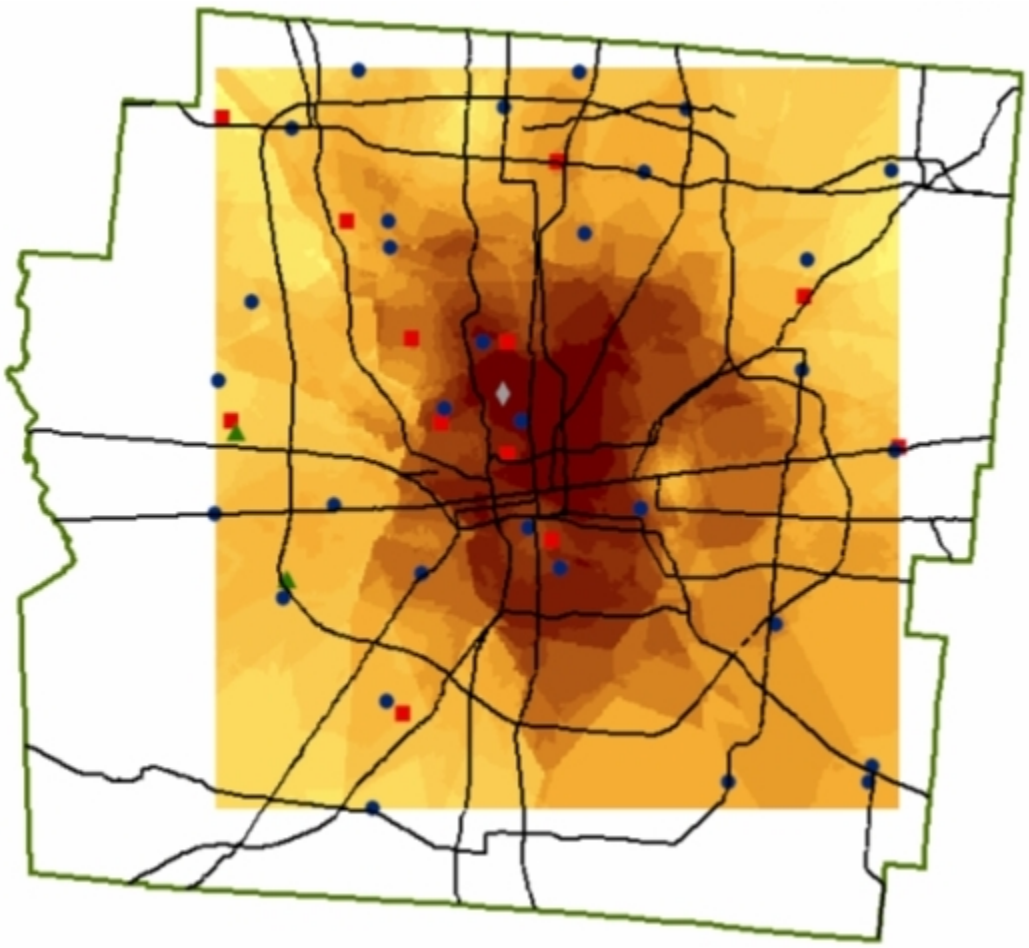
Grocery Gouging of Students
(and Other Vulnerable Populations)



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GEOG 685
Group Project

Introduction

Prior research by one of the group members[1] has shown that grocery prices tend to be high at the stores closest to campus frequented by college students in Tucson, Arizona. Based on this finding, we evaluated whether this holds true for Columbus Ohio. There is a precedent for geospatial market studies[2] using consumer demographic data. However, most models try to optimize the profitability of a location based on market area and suitability; this study reverses the optic to determine if the needs of a population are met by specifically located grocery stores in respect to prices in relation to spending power. Primarily, we desired to assess whether there are price differentials for a given population (OSU's students).

We hypothesized that students at OSU are subject to higher prices at grocery stores in the campus area versus the population of the greater Columbus area. To test this hypothesis, we put together a pricing survey of grocery items (see Table 1) that we believed students might purchase. We then collected data regarding the prices at the two large chain grocery stores serving the campus area and in Franklin County. An initial look at the census data for Franklin County reflected a lower income area around campus (see Map1). This generated a sub-hypothesis: Because the campus area is surrounded by low-income populations, there is a limited market according to traditional analysis, and the competitive options have been reduced by a lack of entry into the market[3].

We planned to test the hypotheses, and if found to be correct we would submit a smaller version for publication to a campus newspaper, disseminating information to the student body so

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[1] Chmara-Huff, Fletcher P., et al. *Tucson Grocery Prices.* Final Project GEOG416a Fall 2004 University of Arizona.

[2]Dramowicz (2005*). Retail Trade Area Analysis Using the Huff Model*. July 02, 2005 access date 10 January 2007, www.locationintelligence.net/articles/printer/php?article_ID=896

[3] Eisenhauer, Elizabeth (2001) *In Poor Health: Supermarket Redlining and Urban Nutrition.* GeoJournal Vol. 53 Number 2. February 2001.

they may make informed decisions regarding their shopping choices.[4]

Our hypothesis that the students at OSU are paying higher prices at grocery stores in part due to their specific geographic location and limited mobility, in tandem with the demographic characteristics of the neighborhoods close to campus is a problem well suited to GIS analysis. In order to test this hypothesis, we examined the specific compositions of grocery store market areas through Voronoi diagrams based on store locations. This is different from ordinary market studies because retail trade analysis is generally used to analyze the competitive fitness of a location, by putting the needs of the retailer first. This is of course appropriate, as the marketability of retail analysis as a skill set depends on the success of retailers who use the theoretical framework and the tools. However, the consumer has little they can resort to in the way of analysis to help them determine where their shopping dollars are best spent in terms of convenience and price. When the optic is reversed on market analysis by evaluating prices, consumers (specifically college students) will be able to make informed decisions as to the location of better shopping values. While this project is campus centered due to our own self-interest, it could easily be applied to other target populations, and in the final analysis, these populations should be indicated by the distribution of the data.

The Data Sources

In order to perform our analysis of pricing distributions in a GIS, we determined that at the minimum we would need a variety of spatial information in addition to the data regarding prices. An initial search for groceries within Franklin county using Google Maps™ turned up hundreds of results. Once we eliminated convenience stores, we decided to focus on the two

[4] Due to unavoidable data quality problems to be described later, this is judged to be an inadvisable course of action at this time.

large grocery chains with retail outlets in the campus area, Kroger and Giant Eagle. Our plan was to georeference each of 53 store locations identified on corporate websites by geocoding addresses in ArcMap™, which required a shapefile of streets within Franklin County. Due to a unique series of circumstances regarding data availability, the most recent data publicly available for this task was determined to be 2000 TIGER/Line files available from the US Census Bureau.[5] In addition, we needed to use a census block group shapefile that could be joined with demographic data for Franklin County also downloaded from the US Census. All other data and shapefiles were to be generated based on data collection. It was discussed how to determine the distribution of the student population, but student housing data proved impossible to collect. Instead, it was decided to show relationships based on the representation of OSU as a point on the map with the geographic coordinates of 83º West, 40º North based on the datum point next to the Main Library.

Regarding the quality of the data, we encountered a few problems. Because of the age of the available street shapefile, geocoding addresses returned only a 38% match. In part, this is because many of the newer stores are in subdivisions built more recently than the shapefile, with addresses within a commercial development rather than on the major roads they face. It was decided to use Google Earth™ to find the locations based on the satellite and DOQQ data used as base maps in the database. Once a store was located, it was identified as point in the user database and the points were exported as .kml files. These files can be opened in a text viewer, and the x,y coordinates based on WGS 84 can be extracted. This was done for each store, and the x,y coordinates were entered into a database that also contained the address, chain affiliation, and two price data sets for each store (see Table 2).

[5] Both the Ohio Department of Transportation and the US Census Bureau had removed more updated versions (2005) of their street shapefiles in anticipation of a new release in 2007. The Census files were updated March 5, 2007, too late for this analysis.

Each team member performed a sample survey, where we captured a full range of pricing data for a general product description, like bread or orange juice looking at the lowest and highest priced item on the shelf. This proved to be too broad a range of prices to compare on a store by store basis. A revised survey was put together to capture a specific list of items that could be found at every store (see Table 1). Primary data was collected for each store at two price levels because of the proliferation of "discount" cards. These cards are used to track the shopping habits of customers, who are encouraged to use them by offering discounts on certain items in exchange. Therefore, each store was treated as two shopping trips, one with no discount card based on the posted everyday price without discounts or sales. An additional column reflected the total price that a customer would pay after receiving discounts or taking advantage of in store sale prices. Pricing surveys were carried out by all team members over a 4-day period (Wed. – Sat.) to insure that sale prices remained consistent. The desire to record both full and discounted price of specific items led to some problems in data collection, in part due to misunderstandings as to how to collect the data. Because of this, and the existence of "phantom" stores on the corporate websites, the original 53 stores were trimmed to 45 stores for analysis.

The Analysis

There was some debate among the group as to what the most precise analysis within the GIS would be, and as stated in the proposal for this project, we felt that an exploratory approach was appropriate in order to allow each team member to explore new visualization approaches. In the initial proposal, a rather ambitious set of data transformations were proposed. Some analyses worked, and others will require further experimentation beyond this class. In addition, problems in the recording of the data based on communication problems with some of the members of the

team made cleanup of the data take more time than the actual analysis.

Numerically, once the prices were collected, it was possible to simply rank the pricing of each location. Because we are interested in the spatial distribution of this ranking, we analyzed the price trends of different grocery store locations in relation to a) the Ohio State University campus, and b) the median income as recorded by the US Census Bureau. The different skill levels and ways of thinking about the data led to a variety of visualizations from the group. The geovisual exploration was significant in that one of the stated goals of this project was to produce a product (in the form of a news article) tailored for public consumption. Each member of the group made different choices about how the data should be presented. While the original intention was to create trend surface analyses as a way of exploring the Huff model[6], our analyses are instead a mixture of both conventional and exploratory visualization.

For overarching trends to be shown as well as quick analysis, typically bar graphs or histograms are employed to illustrate differences. To illustrate the pricing distribution for grocery store prices in Franklin County, bar graphs were used highlighting both the region as a whole and quadrants of that region (Figure 1 through Figure 1.5). These graphs were done in excel using the data we collected. As shown the graph comparing the regions (Figure 1), campus area grocery stores clearly showed higher prices. For our secondary goal of investigating the correlation of high grocery price areas and low income areas the graphs (Figures 1.1-1.5) must be referenced to an income map (Map 1). For each specific region there were found to be one or more stores that charged significantly more than what was the apparent average price for the region. When those high price spikes were compared to the income map of Franklin County (Map 1), there would be a corresponding low income area.

[6] Huff asserted in an article published in ArcUser (October-December 2003, pp34-36) that his model requires data sets that will not be available to us, notably sales data, and therefore while we admire his framework, we use it only as an ontological lens, rather than a methodological framework.

Maps 2 and 3 are less concerned with presenting the relationship between price and median income, rather these two maps are concerned with presenting the viewer with a usable means of determining which store has the best prices and where to shop to make one's money go further. The sidebar graph representation (Map 2) is one way to depict the differences of not only discounted prices against standard prices, but of store prices against other store prices county-wide. This map shows the trend that prices were higher towards the campus region and lower overall the further one moved towards the outer boundaries of the county. The bars side by side are a great way to show how prices varied against each other. The shorter the bar, the better the prices so in order to spend less money, all one would need to do is find the location with the shortest bar. The pie chart representation (Map 3) is meant to provide the viewer with a clear picture of the significant price difference between standard prices and use of a discount card. The visual image created by the pie chart is one of the higher prices devouring the discounted prices, providing a clear sense of where to go for better value. The colors chosen for both these maps are intended to make it clear to the viewer what the relationship is between the standard prices for the selected items vs. the discounted prices for those same items. The varying shades of the same color used for the comparisons in both the sidebar and the pie chart representations are meant to show the relationship between the two figures (prices at the same store location) while at the same time making clear the differences. These maps are intended to highlight for the viewer that, in order to get the best value, they must not only carefully select the location at which they will shop but should also utilize store discounts.

Map 4 is a choropleth map of the median household income overlaid with the price differences in grocery prices for Franklin County. The data for median household income was collected from the US Census Bureau's website. The legend shows that the yellow shading

represents the lowest median household income, and the dark brown shading represents the highest median household income. The areas of Dublin, Worthington, Gahanna, and Upper Arlington are shown to be the highest median household income areas. The lowest median household income appears to be in the areas of Downtown Columbus and Central Columbus. The four classes of proportional symbols represent the price difference between the low discount price and the high price for grocery stores in the Franklin County area. The smallest size of the proportional symbol represents lowest price difference and the largest size of the proportional symbol represents highest price difference. The formula of price difference is equal to the difference between the maximum value and the discount value (Table 2).

Map 5 is similar to Map 4, with differences in the transformation of the data, and the style of the data. In order to make this map, the choropleth base map was created with 10 classifications using natural breaks, starting at the lowest recorded value in order to eliminate skew towards the lower end of the income spectrum. While the human eye has trouble differentiating between more than seven colors, the choice for more classifications was deliberate in order to emphasize that in general, income levels in the central city are lower. In this case the store prices were classified without consideration of discounts in order to show the spread of everyday shopping prices. Classification involved natural breaks once again, starting with the lowest recorded aggregate price. The data was used in its raw form, rather than as transformed numbers as seen in map 4. Prices were symbolized with proportional symbols, with the size of the higher prices changed to make them visually more prominent. Color was chosen to further emphasize the higher prices by making the lower categories green, the central category yellow, and the two higher categories red. These colors were chosen due to their association with traffic lights, in hopes that the map reader will interpret green as signal to go ahead and shop

there, and red as warning against shopping there due to high prices.

Maps 6 and 7 are in many ways a variation on Map 5. While the number of classifications for the median income data has been changed to five classifications, the visual effect is much the same. The primary difference in these maps is that the grocery chains have been represented on different maps in order to show the distribution of prices varies within chains geographically, a factor that could not be discerned from reading Map 5. The other change was to carry the traffic themed symbolization a step further by changing the symbol for stores with higher prices to a red octagon suggesting a stop sign.

Maps 8 and 9 examined each grocery chain as a separate category again, but the representation was achieved by creating Thiessen polygons and then performing a join to the pricing data. The pricing data was then used to create five color choropleth map using natural breaks as described above. These maps are interesting because stores that are shown to have the highest prices in other representations tend to drop out in this analysis. This appears to be a problem created by the calculation of the Thiessen polygons. Because these polygons are generated by creating boundaries that are closest to each point in relation to all other points, they represent a mathematical relationship rather than capturing a "market area." The problem becomes worse if all stores from both the Kroger and Giant Eagle chains are included as points, creating fragmented market areas with no consideration of even the most basic location analysis.[7] Because of these distortions, these maps poorly represent our data. In fact, they serve better as an example of how to lie with maps at their worst, and bad cartography in the best case.

For Map 10 a Voronoi diagram was created for all grocery stores in the Kroger and Giant

[7] The Hotelling Model, proposed in 1929, suggests that all other things being equal, location is the primary factor to consider in capturing market share. Current forms of location analysis accept that all things are not equal, which is why many of the stores are located close together in direct competition, which is what causes the odd polygons created in the Thiessen calculation.

Eagle chains. A join was performed on the Median Household Income data with the Block Group polygons. A quintile classification was chosen for both median household income and discounted pricing to equally distribute both variables. The map was created using a transparent overlay of the two variables. As an initial exploration of the data this map fails to give the reader a clear legend unless each color in the overlay is extracted and built manually with 25 classes, however this proved too time consuming to complete. The complimentary color scheme worked fairly well for a quick overview of the bivariate analysis. From this map, it is apparent that the Giant Eagle stores are located in areas of the highest prices throughout the county.

The goal for Map 11 was to produce a bivariate map that the reader could better understand and gain knowledge from. To accomplish this, the classification scheme needed to be simplified. All stores were included, even the two Walmart stores because they provided a greater range of pricing data and the students might benefit from knowing that there are alternatives to Kroger and Giant Eagle. A manual classification scheme was used to emphasize and break out the lowest income areas of the county. Each classification was queried independently to allow individual color schemes to be applied. The color scheme was the most difficult design feature of the map. Given more time, this color scheme could be improved. However, this map better communicates the bivariate analysis to the user. It is evident that the low income high price areas are easier to distinguish versus the previous version in Map 10.

Map 12 looks at the data using a raster model. A surface was created for each variable using the Kriging method. Kriging was chosen because it is a predictive method using spatial autocorrelation, which produces what some might call optimal interpolation. In order to use the Kriging method a centroid point was created for the block group polygons joined with the median household income data using a visual basic calculation in the attribute table. The table

was exported to a dbf file and brought back in as x, y coordinates. The surfaces produced were overlaid using transparency. In this case to show the low income high price relationship the income color ramp was reversed, which revealed the low income high price area in the center of the study area in dark purple. This map has the same issue as Map 10, in that it proves almost impossible to develop a clear legend for the overlay, so the added inserts of each layer with their respective legends were supplied for the users.

Map 13 was developed to improve on the raster overlay map. Each surface was reclassified into 10 categories. The pricing data was classified using an equal interval, which provided a good spread for the pricing category. The income data was classified using a defined interval of $10,000 in order to better capture the range of the low income data, which natural breaks did not provide. In addition, the income data reclassification values were reversed so that the lowest income category was classified to a value of 10 and the highest a value of 1. These two reclassified maps were then added together and the resulting raster depicts the high price low income areas with the highest values. The combined values ranged from 4 to 20. The stretched raster using a color ramp provided a clear legend for the combined data that was lacking from map 12. The addition of the stores surveyed, OSU, major roads and the Franklin County outline provide the users with location orientation of the study area.

The model for Map 13 is included in the appendix, however it must be noted that all steps in the process could not be shown in the model. Specifically the centroid points for the income were calculated outside the model using advanced calculations of the new X and Y fields with visual basic. The attribute table was exported. The income point data layer was created and georeferenced and then brought back into the map.

Map 14 focuses Map 13 in on the OSU campus area, as it was our region of interest and the subject of our hypothesis. The results of the raster analysis indicate that the highest combined value for pricing and lowest income do indeed describe the campus area. The insert of the county enables those unfamiliar with the OSU campus area to orient this region within Franklin County. The addition of selected roads enables the users to more easily recognize the store locations in the area. This proves to be very effective in communicating the results of the analysis.

Results

Our data clearly shows that grocery prices at Kroger and Giant Eagle stores do tend to be higher in relation to the campus area. Furthermore, the bivariate analysis in Maps 10, 11 and 12 shows that the secondary hypothesis has not been falsified either. There appears to be a correlation between low levels of income and higher grocery prices. What is unclear from our analysis is whether the campus is surrounded by a low-income area, or whether the students themselves are the cause of the lower income measurements.

The exploration of the data visualization progressed from Maps 1, 2 and 3 which visualize a single variable income or pricing. Map 4 using the proportional symbols shows little variation in pricing differences. The standard point symbols over choropleth maps (5, 6 & 7) proved somewhat effective in visualizing store pricing distribution but did not capture the interplay of the variables. The Voronoi Diagram maps (8 & 9) proved to be of little help in visualizing the data distribution. The overlaid maps (10 & 12) produced excellent visualizations but proved difficult when trying to come up with effective legends. This issue makes them difficult for non-professionals to interpret.

Only the bivariate maps (11 & 13) bring the variables together in a representation that

indicates the linkage between low income and high prices that we were seeking to answer our hypothesis. Data analysis using SPSS indicates that Median Household Income (MHIncome) and Grocery Prices, both Discount (disct) and Non Discount (no_disct), are negatively correlated, -0.117 and -0.271 respectively, which is significant at the 0.01 level (see Data Correlation Tables). The bivariate Voronoi diagram method Map 11 proved inadequate to represent the combined data due to the fragmentation of the market areas.

In the final analysis the raster method provided the best representation of the data. The simplest way to show the negative correlation on the raster image was the transparent overlay. The reverse the color ramp of income under the standard color ramp for pricing with 50% transparency proved effective in showing the negative correlation. To improve upon this, Map 13 employs raster reclassification and map addition, which brings the values together in a single raster that presents a clear legend to the users.

Discussion

We all learned a real world lesson, that communication is a key to success in data collection. A second trial survey using the new list and working as a group would have been beneficial. We could have discovered the problem areas, instead of spending time doing data clean up and resurveys on several stores to validate the revised prices against the store data.

If the revised data set for the Franklin County streets had been available, many hours in geolocating the stores one by one via Google Earth could have been saved. However, by using Google Earth for geolocations, we avoided the errors produced by geocoding from street file data in ArcGIS. We could visually verify site locations against the satellite images even if the store had not been built at the time of the image. Geolocating the stores after the surveys revealed that five of the stores surveyed fell outside Franklin County, which wasted time and gas. Incorrect

store locations from the company web sites sent us on some wild goose chases as well. A clearly defined list of who was to survey which specific store would have been better than the regional division of the city. It would have eliminated store overlap by surveyors and we would have picked up a few more stores that we did not get to survey.

On the visualization side of the project, the few missing stores in Franklin County that we did not get to added some uncertainty to the surface analysis. This uncertainty would have been reduced with the complete data set. Specifically there were a few stores in the Whitehall/Bexley area of the county that did not get visited. As this area has a higher median household income than its surroundings, grocery pricing in that region would have improved the pricing and income raster analysis. The addition of some of the smaller grocery chains found in Franklin County, such as IGA would have made for a more complete analysis.

In addition, another source of uncertainty is evident in the raster surface analysis due to edge effects. This could have been reduced with surveys of additional stores outside the county boundary in all directions, however we only captured data by accident east (Pickerington) and northwest (Westerville) of the county. We would need to add the surrounding county shape files and income data to correct for this issue, as well as additional store surveys. Both of these suggestions combined together would make an interesting follow up project.

Table 1: Revised Grocery Shopping List

Store				
Address				
City				
Surveyor				
Zip				
Date				
#	Item	Measure	Discount $	Regular $
1	Milk, whole	Gallon	1.99	2.60
2	Butter, Land o'Lakes	1 lb	3.65	3.65
3	Orange Juice, Tropicana	1/2 gal	2.99	2.99
4	Eggs, large	1 dozen	1.34	1.34
5	Kraft Am Cheese slices	16 oz	4.59	4.79
6	White Bread, Wonder	24 oz loaf	1.29	2.29
7	Hamburger, 80% Lean	1 lb	2.99	2.99
8	Hot Dogs, Oscar Mayer	1 lb	2.69	3.29
9	Bologna, Oscar Mayer	1 lb	3.49	3.49
10	Coffee, reg Maxwell House	Big Can	5.99	7.49
11	Coke	12 pack cans	3.50	4.69
12	Tuna	6 oz can	0.66	0.66
13	Hamburger Helper	1 box	2.00	2.59
14	Kraft Mac & Cheese	7.5 oz box	0.67	0.77
15	Cam. Chick Noodle Soup	10.75 oz can	0.68	0.68
16	Carrots, whole	1 lb	0.69	0.69
17	Apples, Red Delicious	1 lb	1.69	1.69
18	Lettuce, iceberg	head	1.18	1.18
19	Tomato, reg.	1 lb	2.79	2.79
20	Pizza, Tombstone -Pep	each	3.69	3.69
21	Pot Pie, Banquet	each	0.52	0.52
	Card Discount Total		49.08	
	Regular Total			54.87

Table 2: Store Database

ID	COMPANY	ALT_ADDRES	DIR	TYP	CITY	STATE	ZIP	DISCT	NO_DISCT	X	Y
1	THE KROGER CO.	3588 GENDER		Rd	CANAL WINCHESTER	OH	43110	47.83	53.10	-82.828129490589	39.861083321267
2	THE KROGER CO.	6095 GENDER		Rd	CANAL WINCHESTER	OH	43110	50.31	56.23	-82.830287051691	39.855393461629
3	THE KROGER CO.	1350 HIGH		St	COLUMBUS	OH	43201	51.73	56.38	-83.005484923501	39.989862612380
4	Giant Eagle	777 Neil	N	Ave	Columbus	OH	43201	53.89	57.33	-83.012236820137	39.976972197115
5	THE KROGER CO.	2913 OLENTANGY RIVER			COLUMBUS	OH	43202	50.89	56.11	-83.025107244215	40.019625798683
6	Giant Eagle	2801 High	N	St	Columbus	OH	43202	52.57	55.96	-83.013052953662	40.019648474991
7	THE KROGER CO.	2000 MAIN	E	St	COLUMBUS	OH	43205	50.00	56.37	-82.945053017744	39.957710165740
8	Giant Eagle	280 Whitter	E	St	Columbus	OH	43206	54.62	56.32	-82.989515185640	39.944734163972
9	THE KROGER CO.	1441 PARSONS		Ave	COLUMBUS	OH	43207	48.52	55.30	-82.984291555355	39.934267382810
10	THE KROGER CO.	1375 CHAMBERS		Rd	COLUMBUS	OH	43212	50.53	54.88	-83.043485807246	39.993485172415
11	Giant Eagle	1451 5th	W	Ave	Columbus	OH	43212	56.72	58.42	-83.045154671486	39.988607221758
12	THE KROGER CO.	7000 BROAD	E	St	COLUMBUS	OH	43213	48.49	56.43	-82.820557255307	39.981546651818
13	Giant Eagle	6867 Broad	E	St	Columbus	OH	43213	50.00	54.74	-82.818695483763	39.982502342770
14	THE KROGER CO.	150 SYCAMORE	W	St	COLUMBUS	OH	43215	48.99	55.17	-83.001082074535	39.949233047844
15	Giant Eagle	4747 Sawmill		Rd	Columbus	OH	43220	53.02	56.29	-83.093946842897	40.064007690757
16	Giant Eagle	1798 Kingsdale		ctr	Columbus	OH	43221	51.22	54.70	-83.060921554544	40.020125318340
17	THE KROGER CO.	2161 EAKIN		Rd	COLUMBUS	OH	43223	48.59	54.17	-83.053102999409	39.930993387653
18	THE KROGER CO.	1585 GEORGESVILLE SQ		dr	COLUMBUS	OH	43228	49.34	54.68	-83.120756794782	39.920493176210
19	Walmart	5200 WestPointe Plaza		Dr	Columbus	OH	43228	38.58	38.58	-83.146293381831	39.982997800066
20	THE KROGER CO.	3600 SOLDANO		blvd	COLUMBUS	OH	43228	49.09	54.47	-83.096744402443	39.956165307516
21	Walmart	1221 Georgesville		rd	Columbus	OH	43228	41.13	41.13	-83.119300753619	39.927611202317
22	THE KROGER CO.	1630 MORSE		rd	COLUMBUS	OH	43229	49.41	55.06	-82.975865838760	40.061470227587
23	Giant Eagle	1000 Dublin-Granville	E	rd	Columbus	OH	43229	51.99	55.43	-82.990775000822	40.088623934765
24	Giant Eagle	1250 Hamilton	N	rd	Columbus	OH	43230	51.82	55.76	-82.866820551632	40.039620292855
25	THE KROGER CO.	5727 EMPORIUM		sq	COLUMBUS	OH	43231	49.80	55.18	-82.947448000000	40.085652000000
26	THE KROGER CO.	4485 REFUGEE		rd	COLUMBUS	OH	43232	49.07	55.51	-82.877387903551	39.914694127596
27	THE KROGER CO.	2090 BETHEL		rd	COLUMBUS	OH	43235	48.70	54.30	-83.073472715901	40.064852212714
28	THE KROGER CO.	7625 SAWMILL		rd	DUBLIN	OH	43016	48.70	54.20	-83.090199000000	40.121817000000
29	THE KROGER CO.	299 BRIDGE	W	St	DUBLIN	OH	43017	48.90	54.60	-83.122684491356	40.098687580546
30	Giant Eagle	6700 Perimeter		lp	Dublin	OH	43017	52.80	56.04	-83.156863659547	40.102453921368
31	THE KROGER CO.	1365 STONERIDGE		dr	GAHANNA	OH	43230	48.55	54.20	-82.865748934027	40.053158223152
32	THE KROGER CO.	300 HAMILTON	S	rd	GAHANNA	OH	43230	49.45	55.33	-82.867120000000	40.011565000000
33	THE KROGER CO.	5800 BROAD	W	St	GALLOWAY	OH	43119	49.29	54.97	-83.155469285461	39.951744641232
34	THE KROGER CO.	2474 STRINGTOWN		rd	GROVE CITY	OH	43123	48.84	54.42	-83.068629169701	39.882180292380
35	THE KROGER CO.	5965 HOOVER		Rd	GROVE CITY	OH	43123	49.06	55.14	-83.074353083724	39.841055610266

36	Giant Eagle	2173 Stringtown		Rd	Grove City	OH	43123	53.49	56.56	-83.061128513772	39.877258845591
37	THE KROGER CO.	6011 GROVEPORT		Rd	GROVEPORT	OH	43125	50.50	55.87	-82.899187015223	39.854144274536
38	THE KROGER CO.	4656 CEMETERY		Rd	HILLIARD	OH	43026	49.08	54.87	-83.140416787637	40.032895806300
39	THE KROGER CO.	2525 HILLIARD ROME		Rd	HILLIARD	OH	43026	49.19	54.87	-83.155376773086	40.002466012705
40	Giant Eagle	1760 Hilliard Rome		Rd	Hilliard	OH	43026	54.42	56.12	-83.149456411175	39.987014922939
41	THE KROGER CO.	5161 HAMPSTED VILLAGE		ctr	NEW ALBANY	OH	43054	49.35	54.73	-82.825348000000	40.088320000000
42	THE KROGER CO.	1955 HENDERSON	W	Rd	UPR ARLINGTON	OH	43221	49.59	54.40	-83.072678049767	40.054735086411
43	KROGER SAV-ON	55 SCHROCK	W	Rd	WESTERVILLE	OH	43081	49.58	54.76	-82.926844700114	40.110055746494
44	THE KROGER CO.	1425 WORTHINGTON		ctr	WORTHINGTON	OH	43085	48.17	53.93	-82.980193000000	40.123122000000
45	THE KROGER CO.	60 WORTHINGTON		ml	WORTHINGTON	OH	43085	48.17	54.05	-83.017775493939	40.108720116581

Table 3: Data Correlation Tables

Correlations

		disct	MHIncome
disct	Pearson Correlation	1	-.117**
	Sig. (2-tailed)		.000
	N	1366	1366
MHIncome	Pearson Correlation	-.117**	1
	Sig. (2-tailed)	.000	
	N	1366	1366

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3.1 Median Household Income and Discount Grocery Price

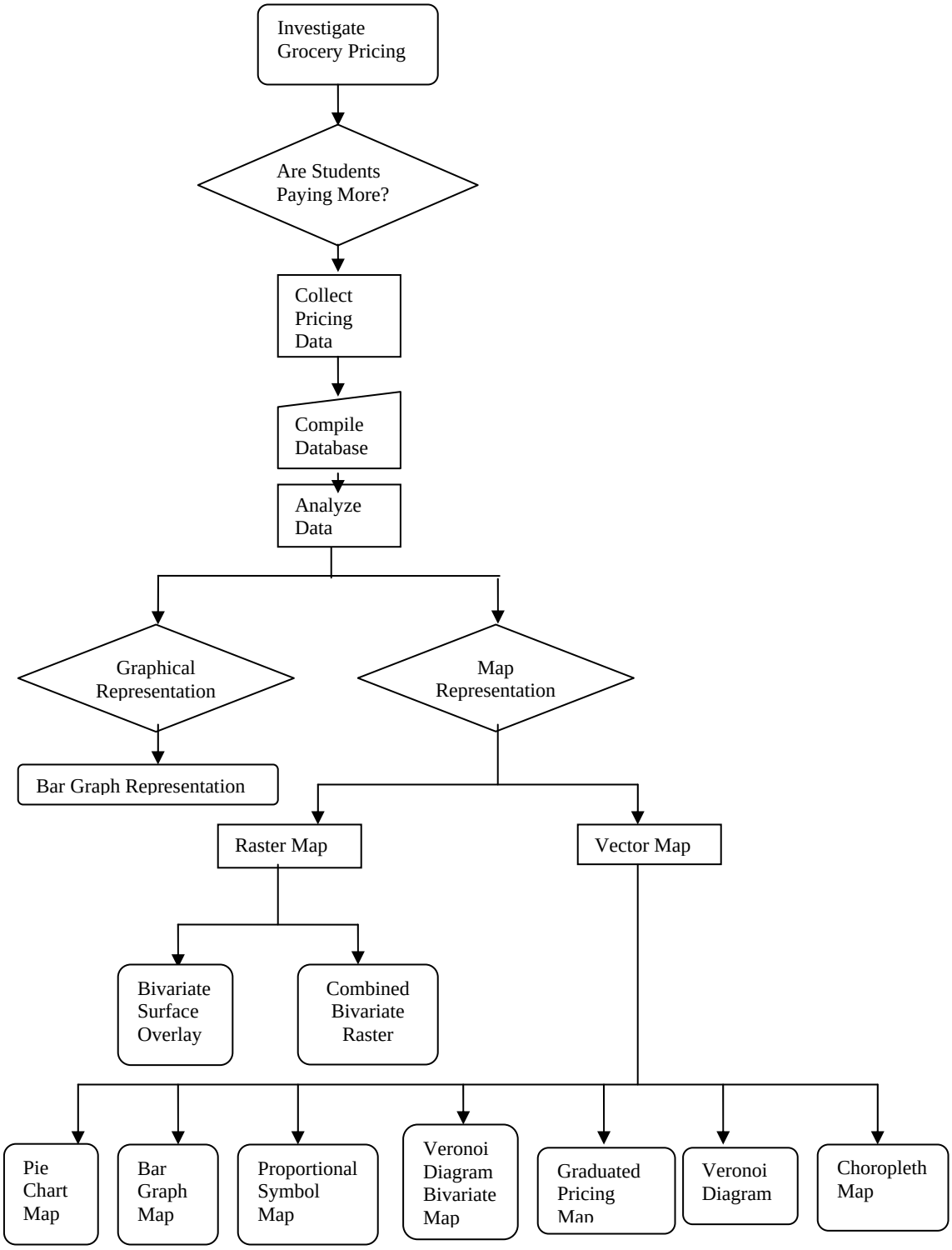
Correlations

		MHIncome	no_disct
MHIncome	Pearson Correlation	1	-.271**
	Sig. (2-tailed)		.000
	N	1366	1366
no_disct	Pearson Correlation	-.271**	1
	Sig. (2-tailed)	.000	
	N	1366	1366

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3.2 Median Household Income and without Discount Grocery Price

Table 4


Investigate Grocery Pricing
Are Students Paying More?
Collect Pricing Data
Compile Database
Analyze Data
Graphical Representation
Map Representation
Bar Graph Representation
Raster Map
Vector Map
Bivariate Surface Overlay
Combined Bivariate Raster
Pie Chart Map
Bar Graph Map
Proportional Symbol Map
Veronoi Diagram Bivariate Map
Graduated Pricing Map
Veronoi Diagram
Choropleth Map

Data Analysis

Figure 1: Pricing By Region

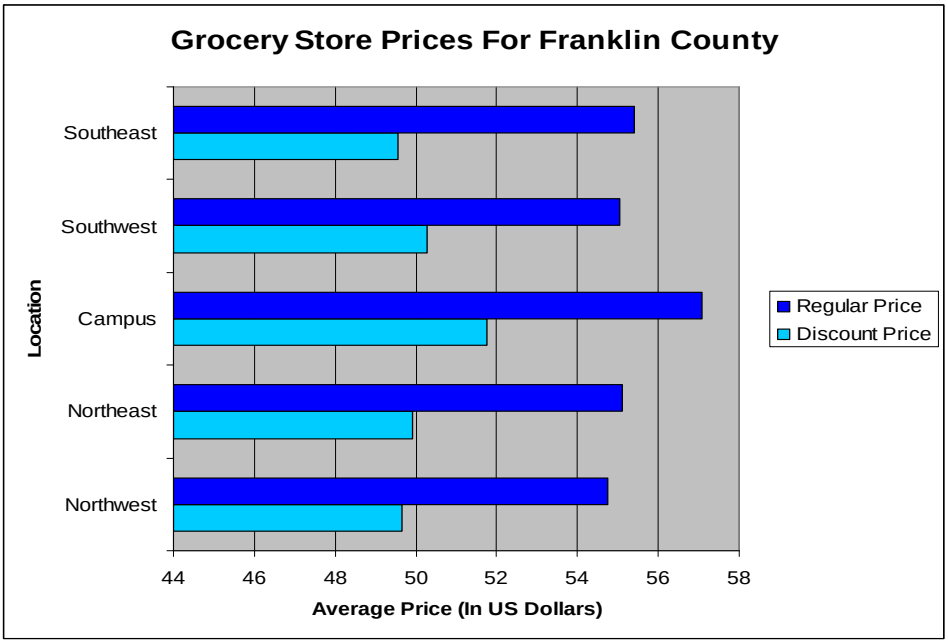


Figure 1.1

Figure 1.2

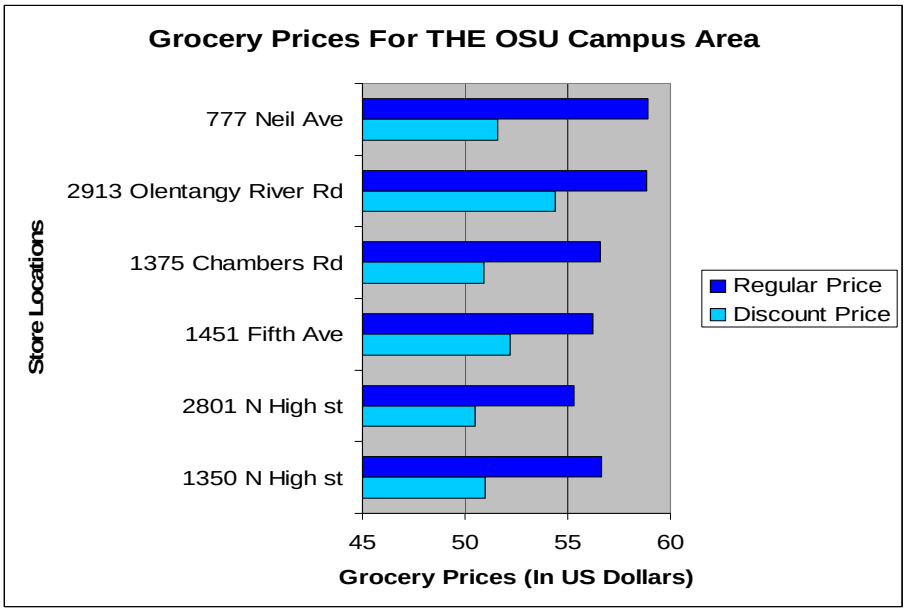


Figure 1.3

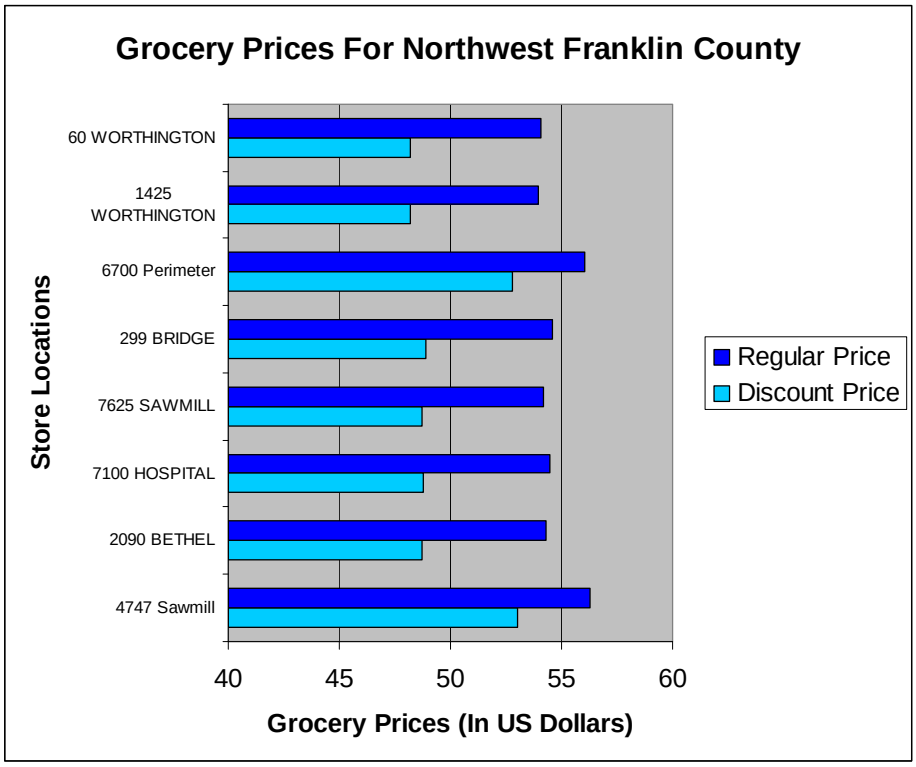


Figure 1.4

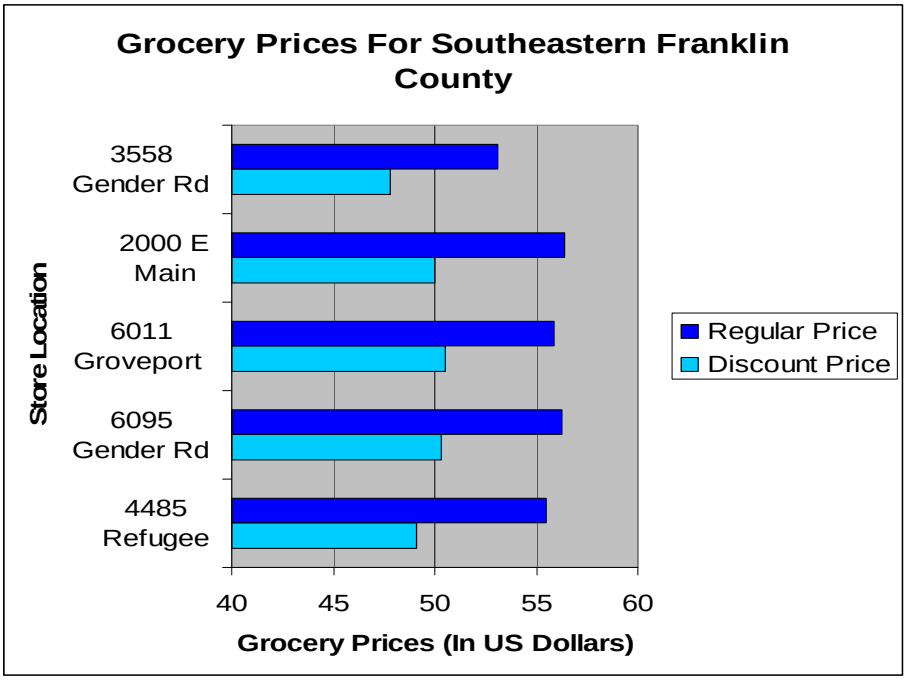

Grocery Prices For Southeastern Franklin County
3558 Gender Rd
2000 E Main
6011 Groveport
6095 Gender Rd
4485 Refugee
Store Location
40
45
50
55
60
Grocery Prices (In US Dollars)
Regular Price
Discount Price

Figure 2: Histograms

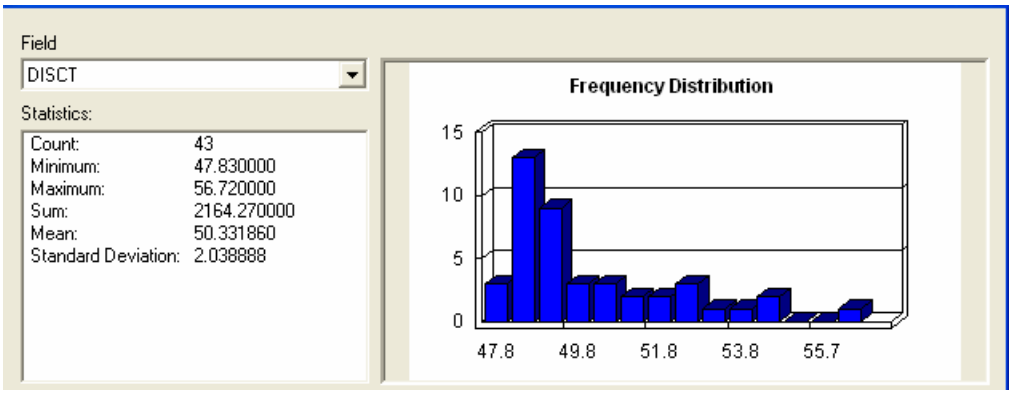


Figure 2.1: Pricing with discount

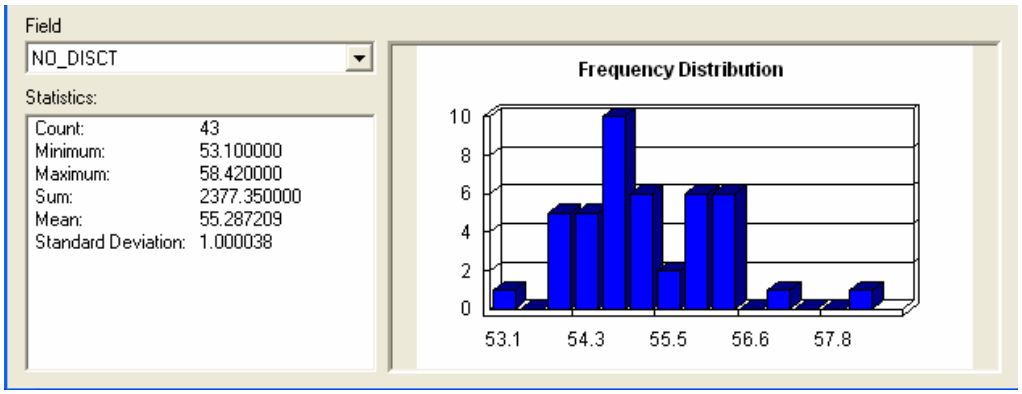


Figure 2.2: Pricing without discount

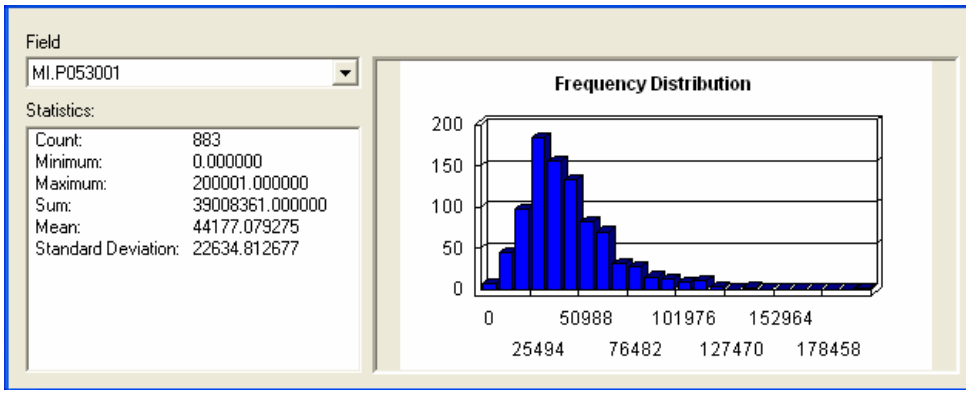
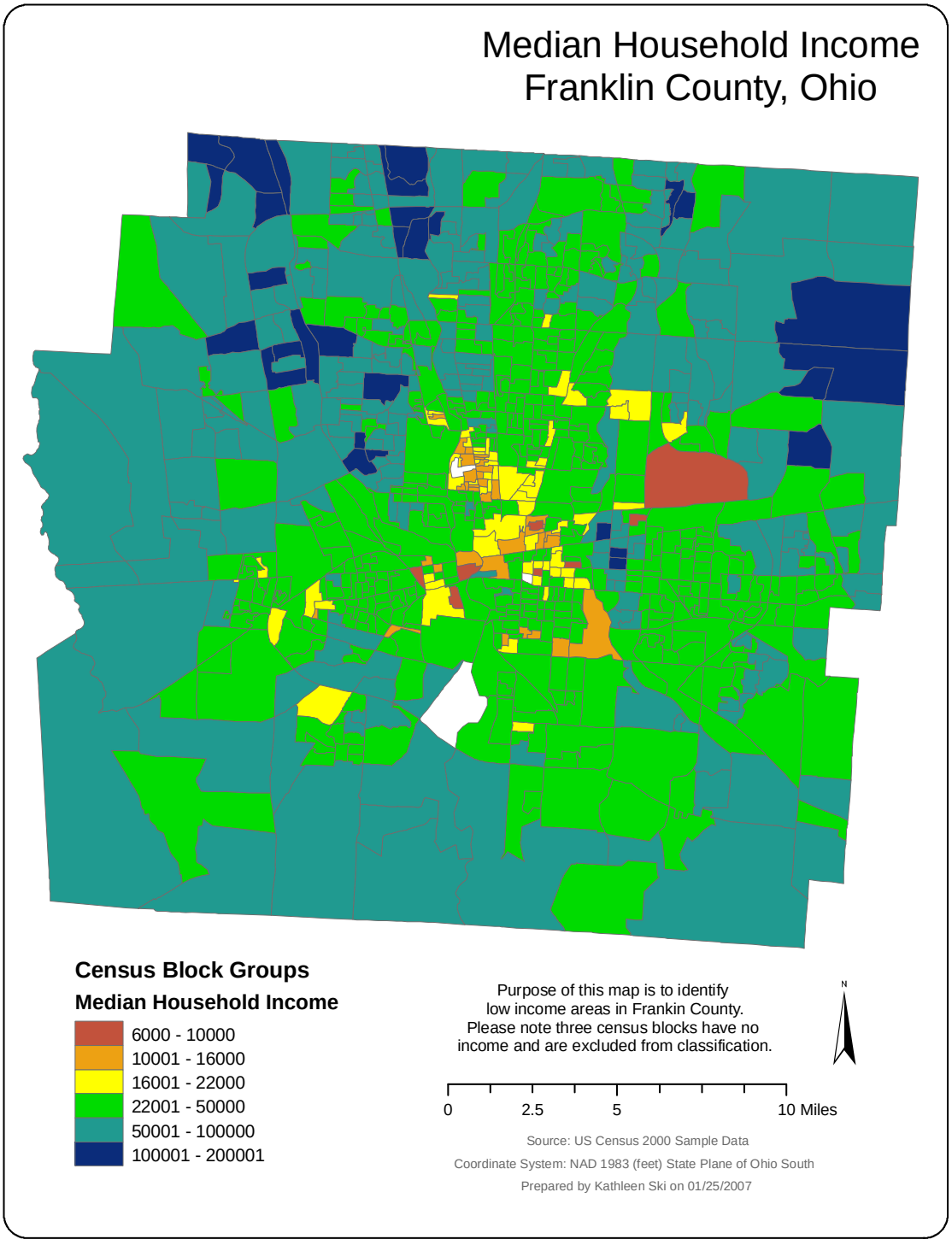
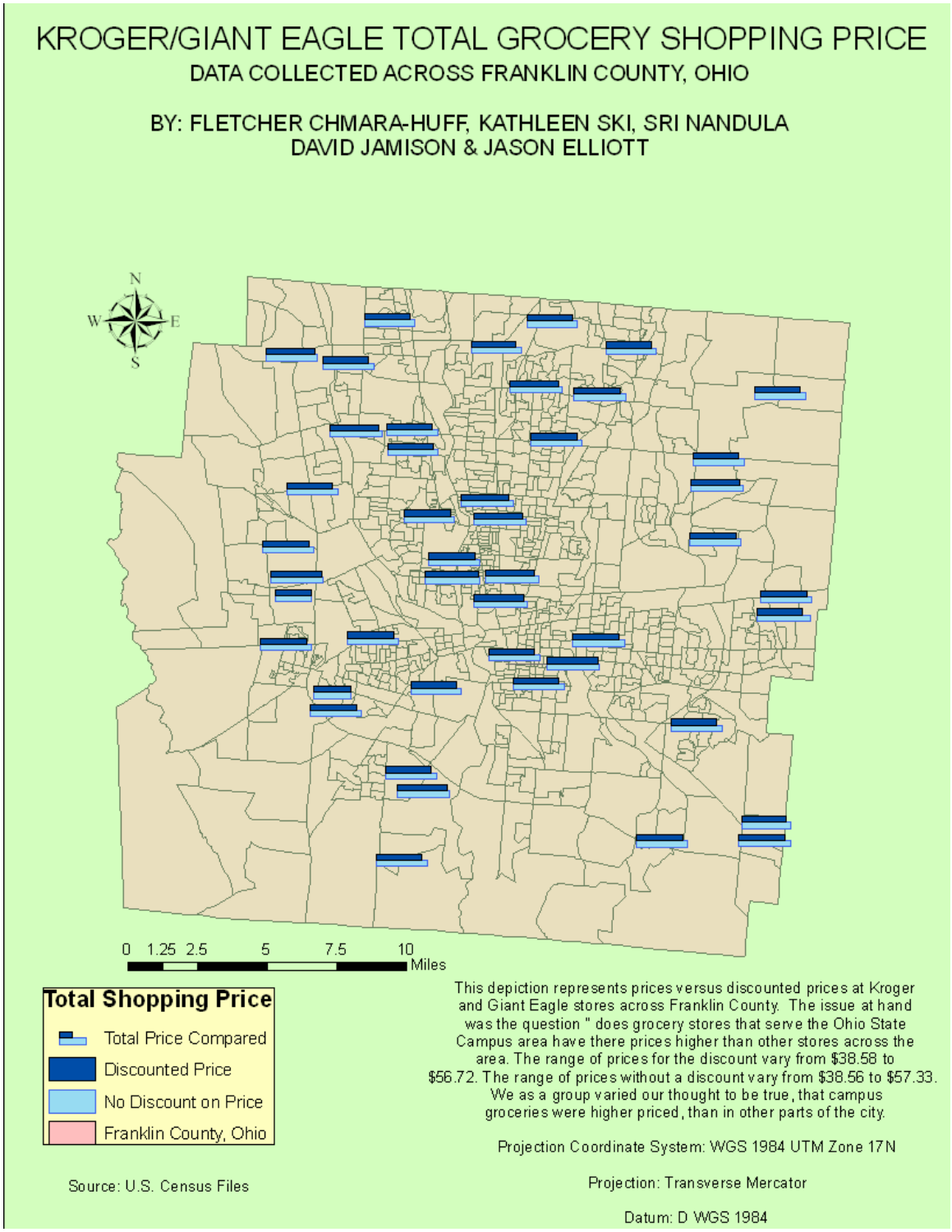


Figure 2.3: Median Household Income

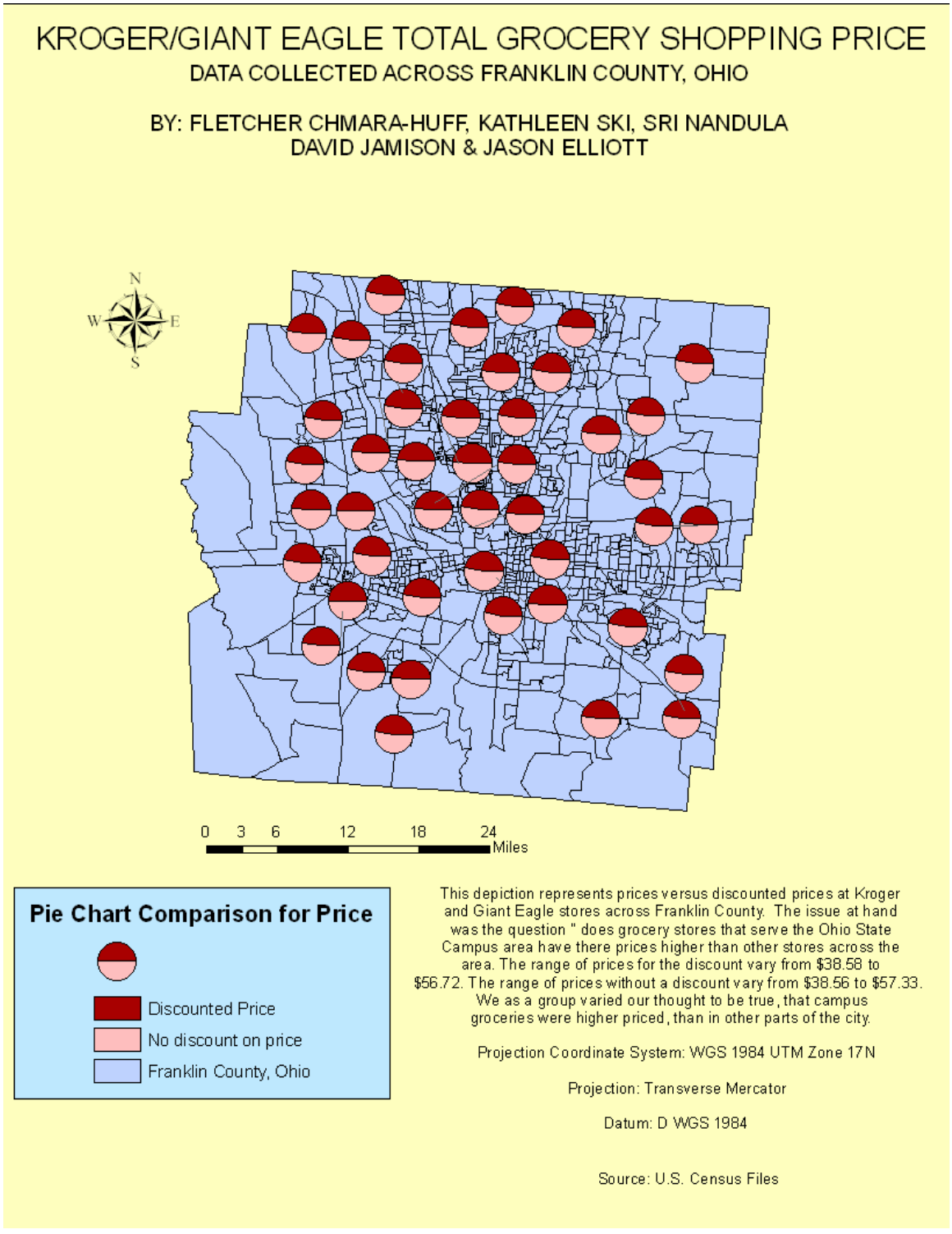
Map 1: Exploratory Map



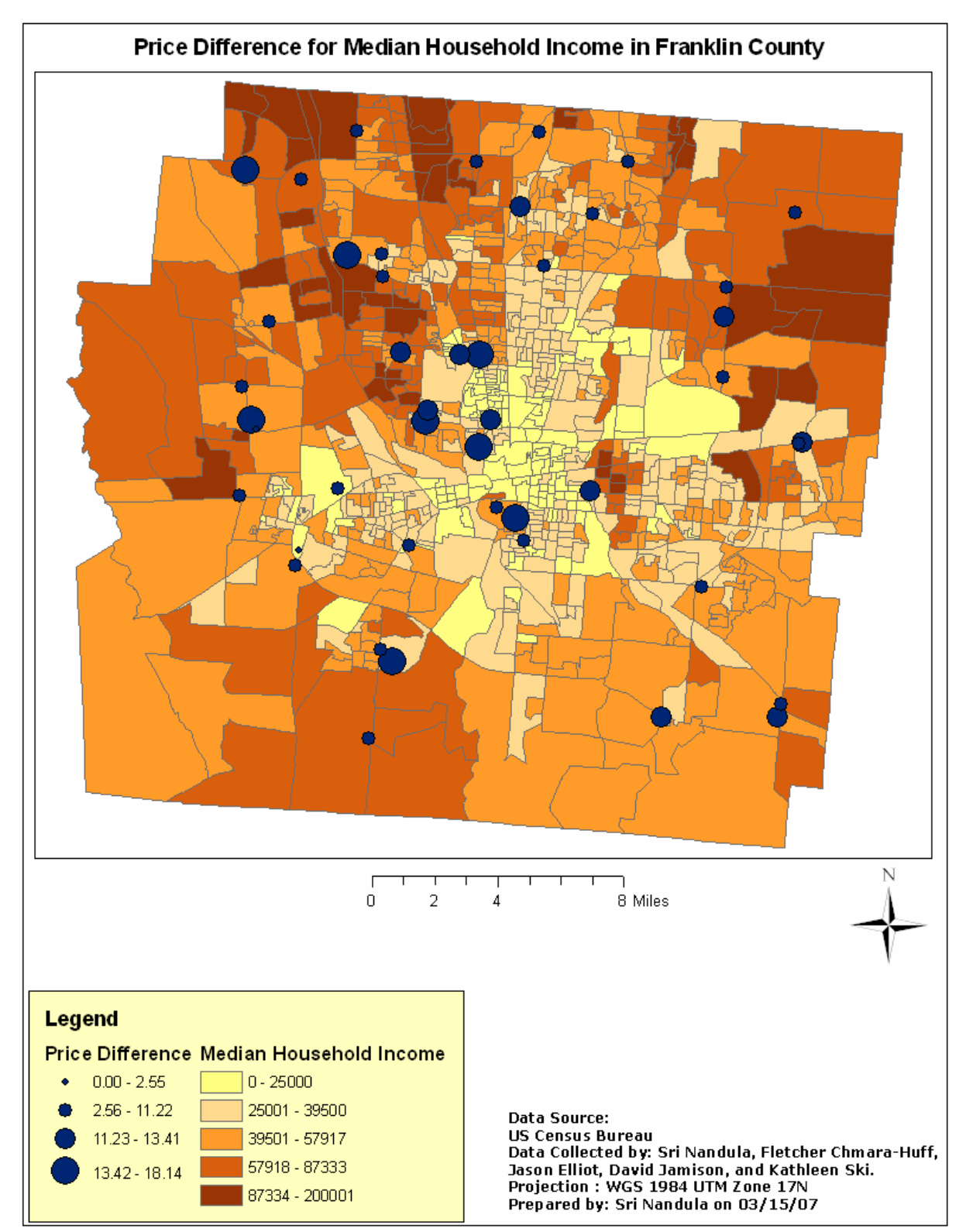
Map 2: Bar Chart (prepared by Jason Elliott)



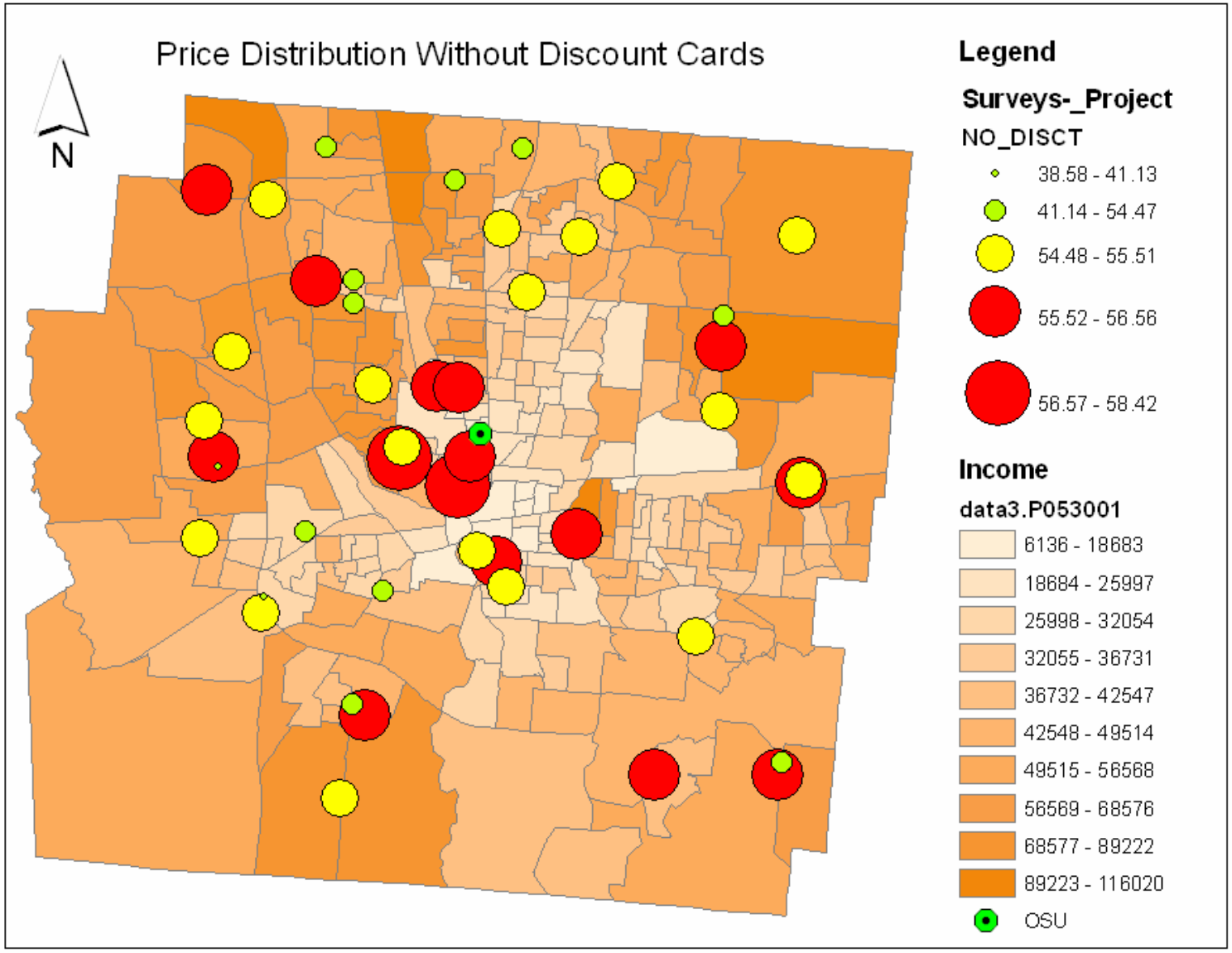
Map 3: Pie Chart (prepared by Jason Elliott)



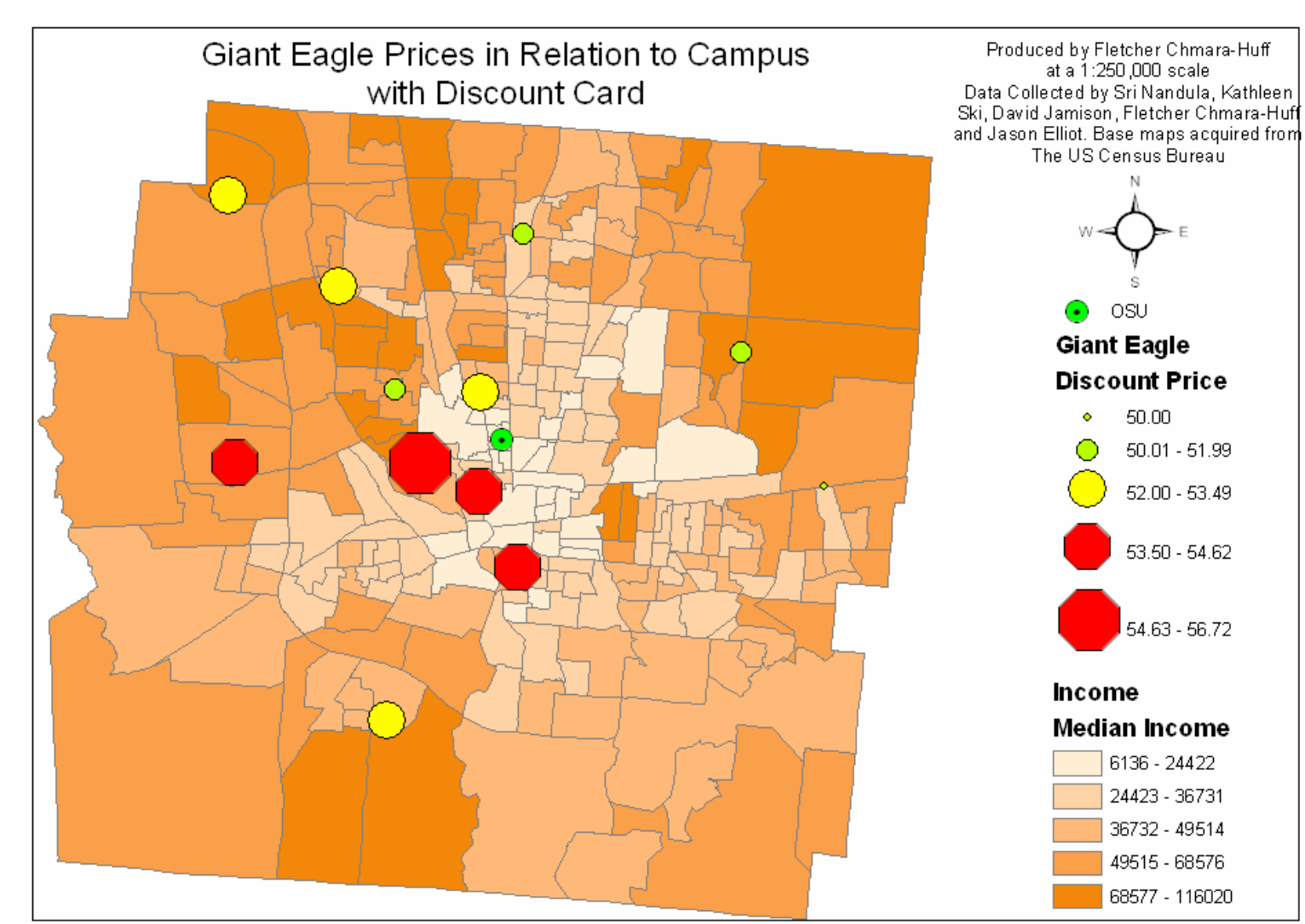
Map 4: Proportional Symbols over Choropleth



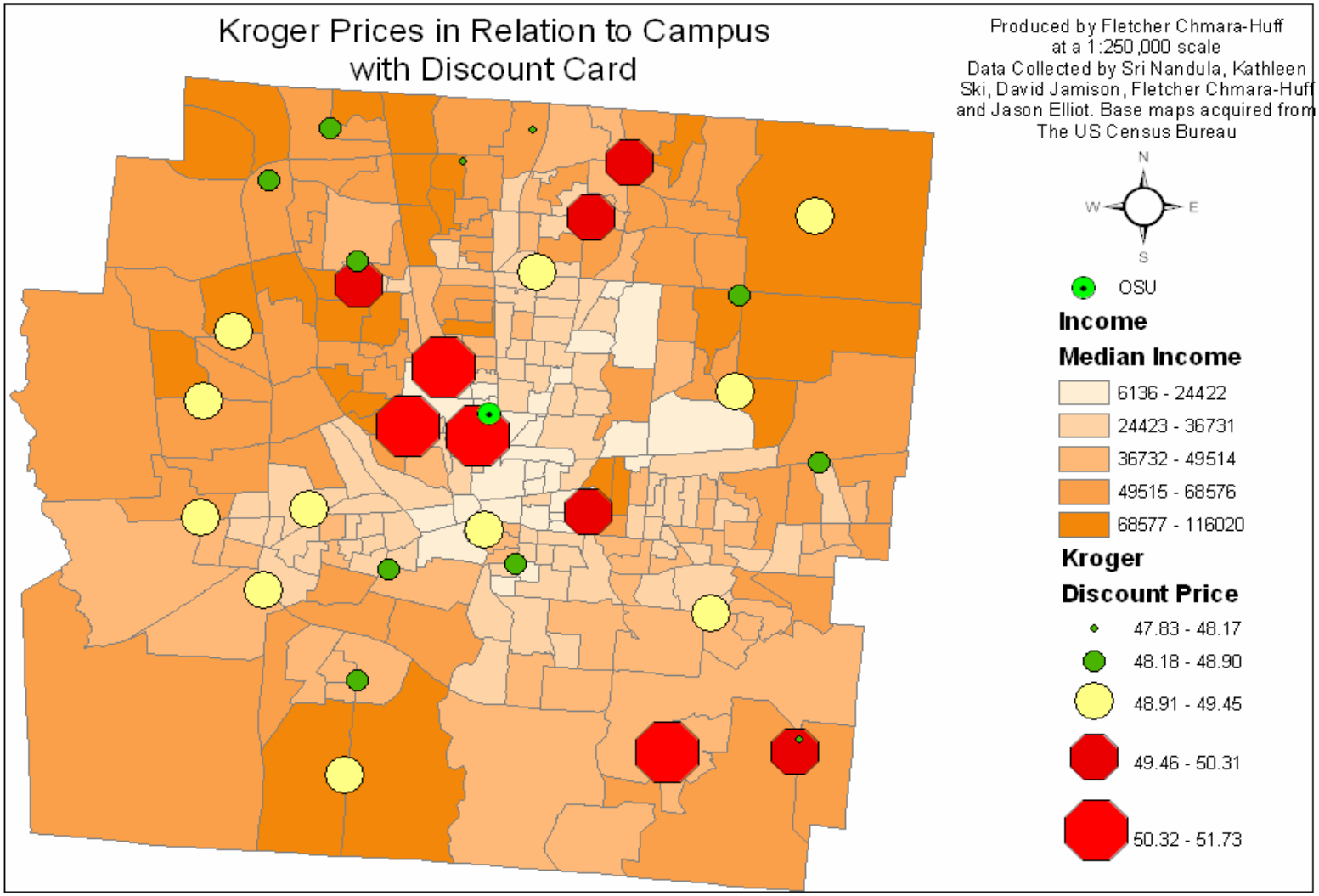
Map 5: Proportional Symbols over Income Data: All Stores, no Discount



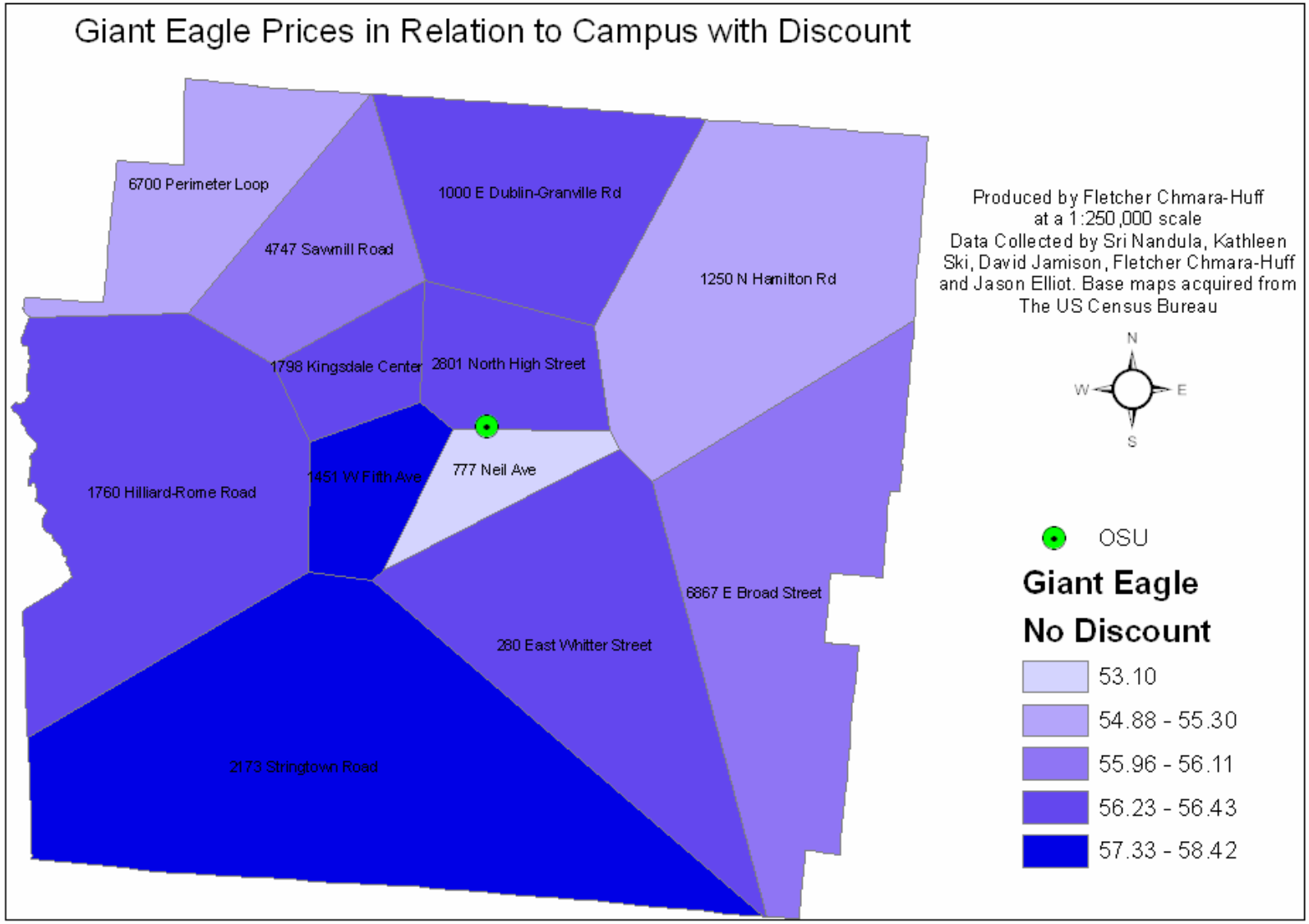
Map 6: Proportional Symbols and Stop Signs over Income Data: Giant Eagle Discounted



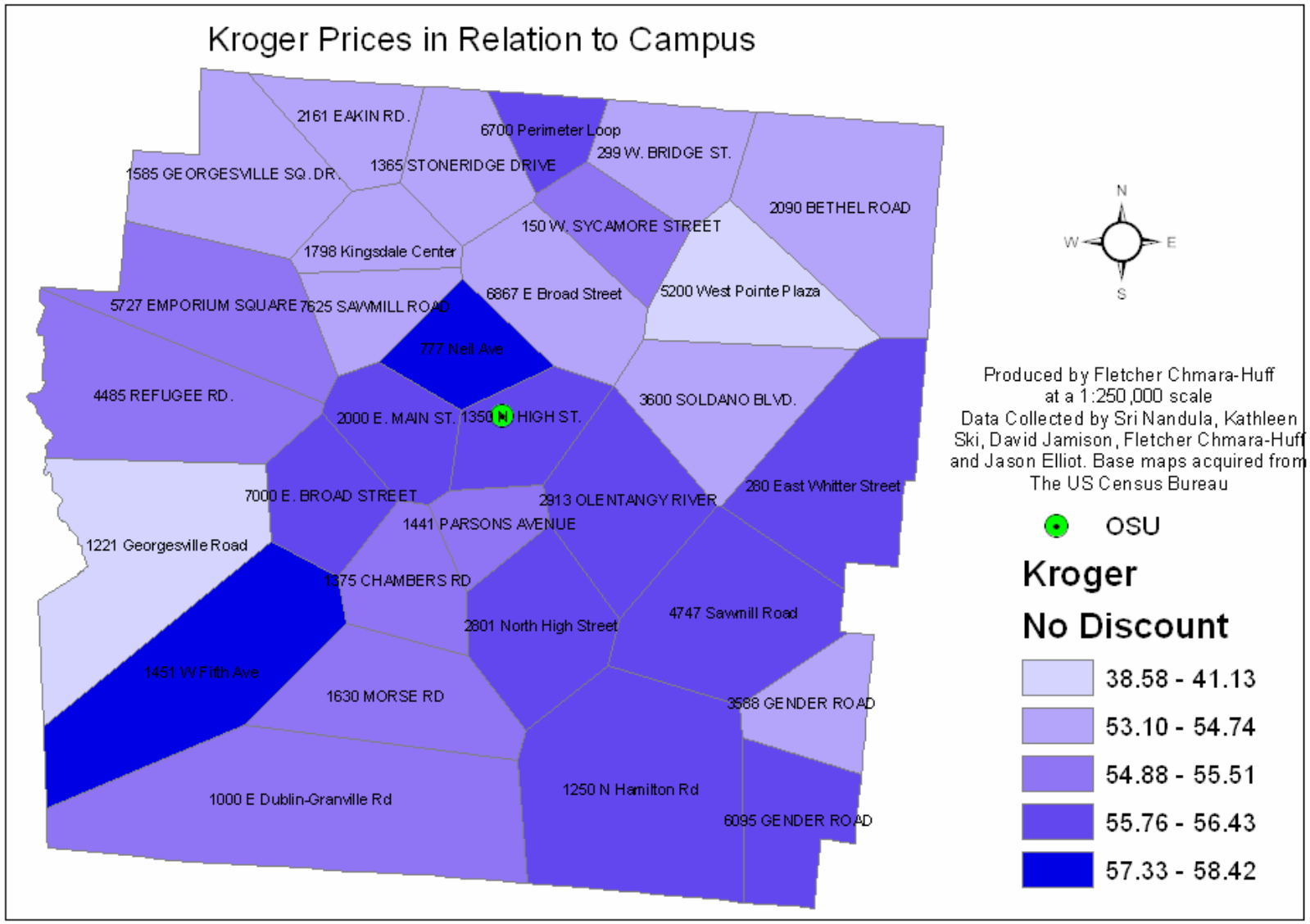
Map 7: Proportional Symbols and Stop Signs over Income Data: Kroger Discounted



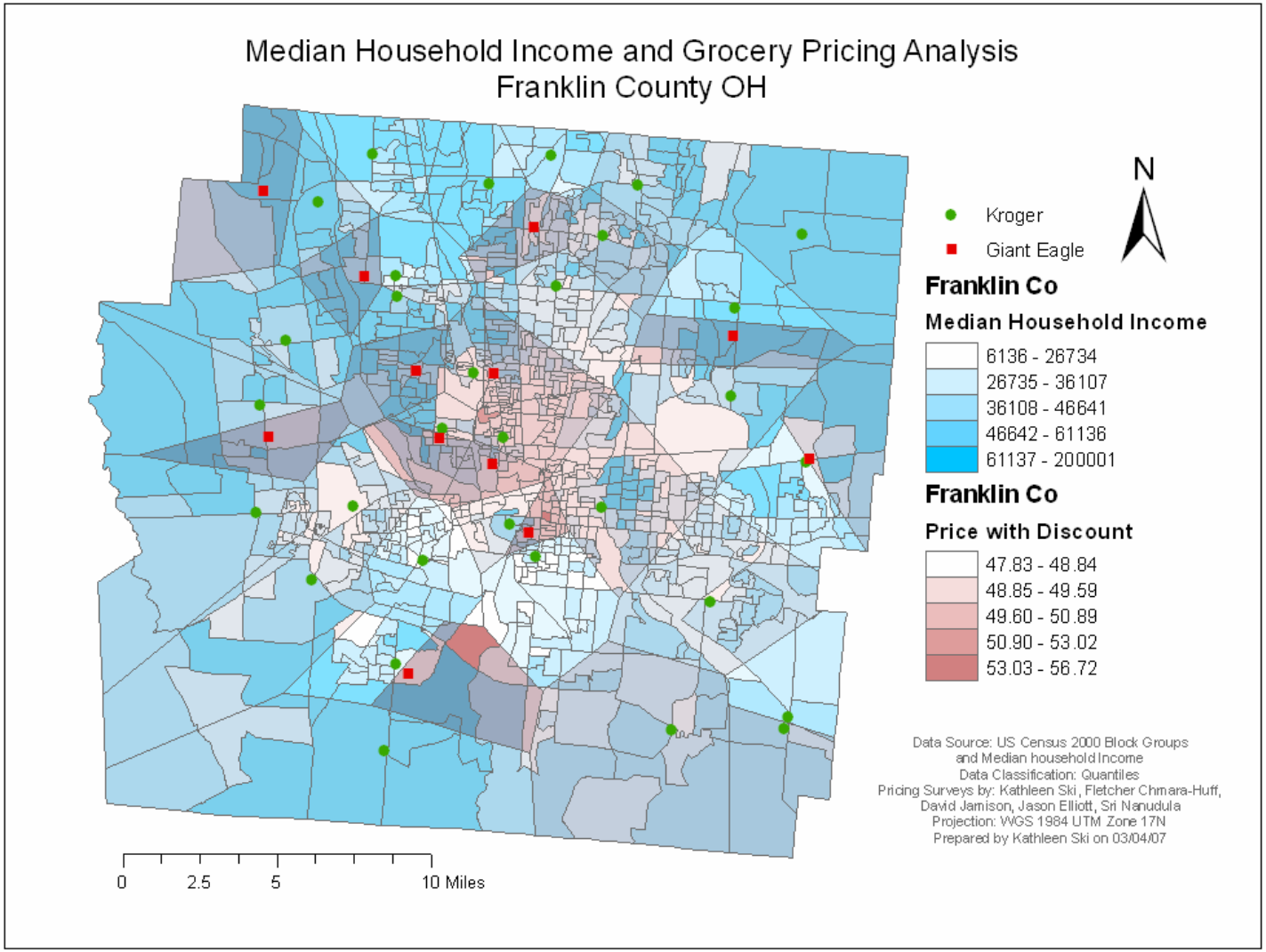
Map 8: Voronoi Diagrams: Giant Eagle No Discount



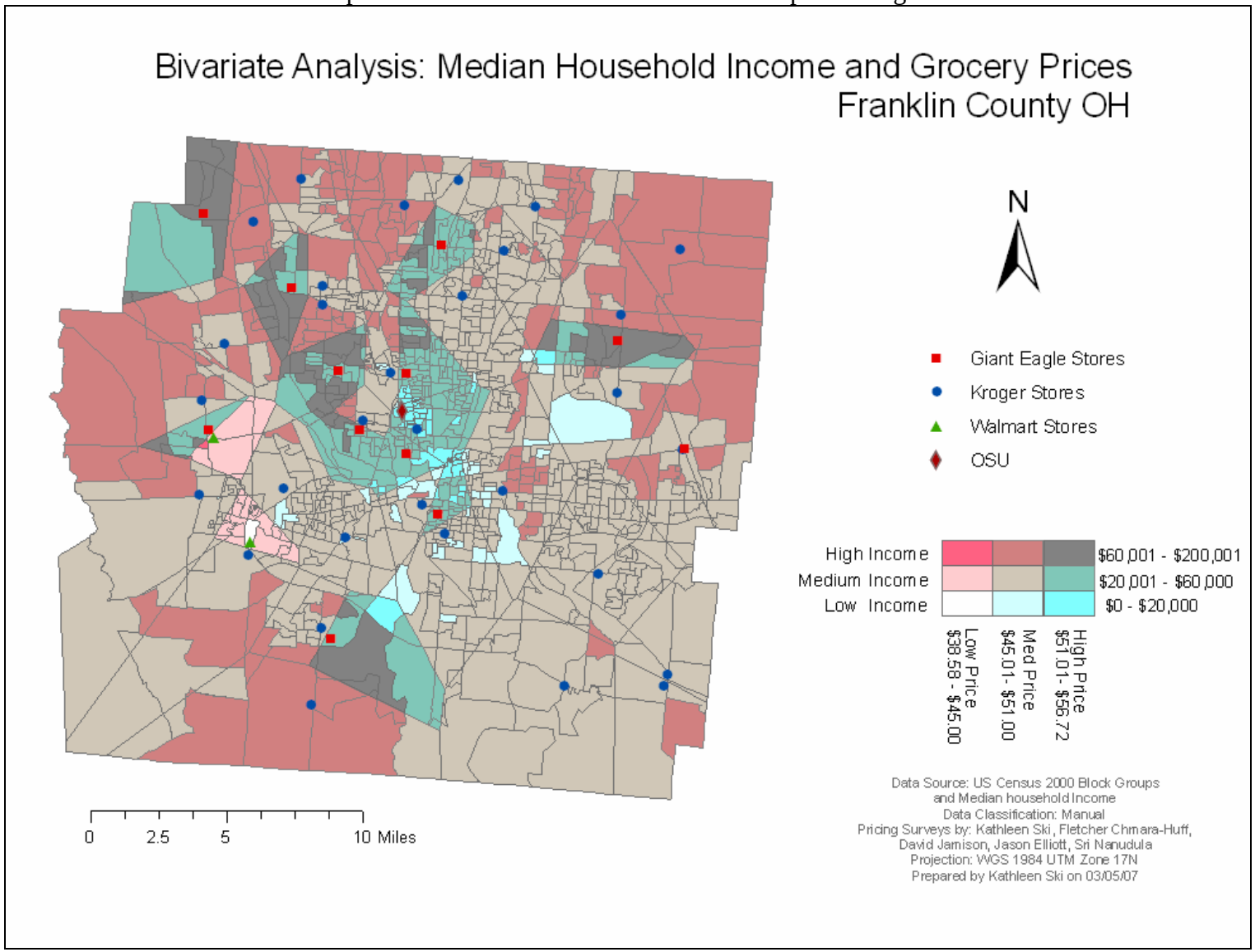
Map 9: Voronoi Diagrams: Kroger, No Discount



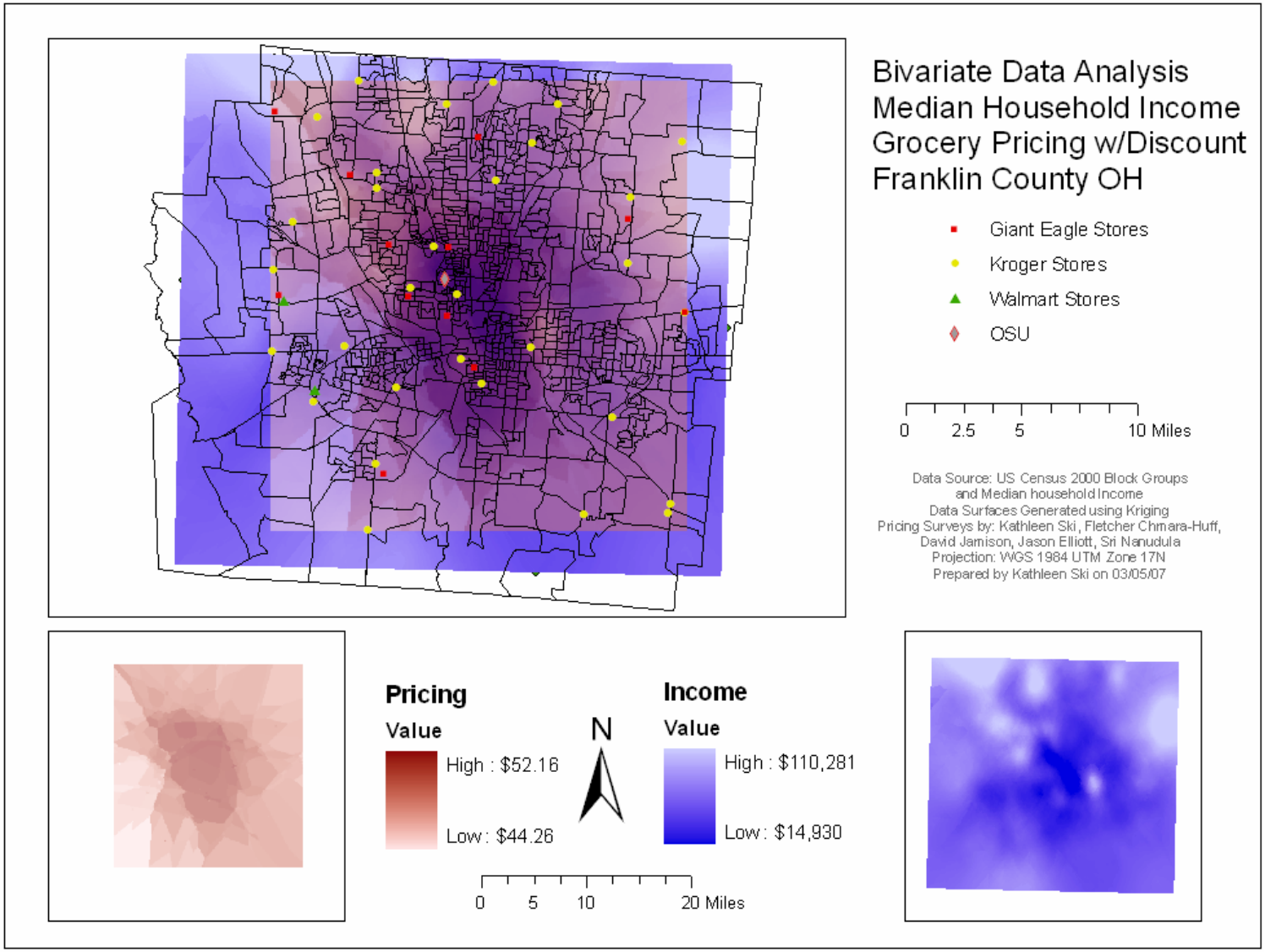
Map 10: Bivariate Overlay All Stores



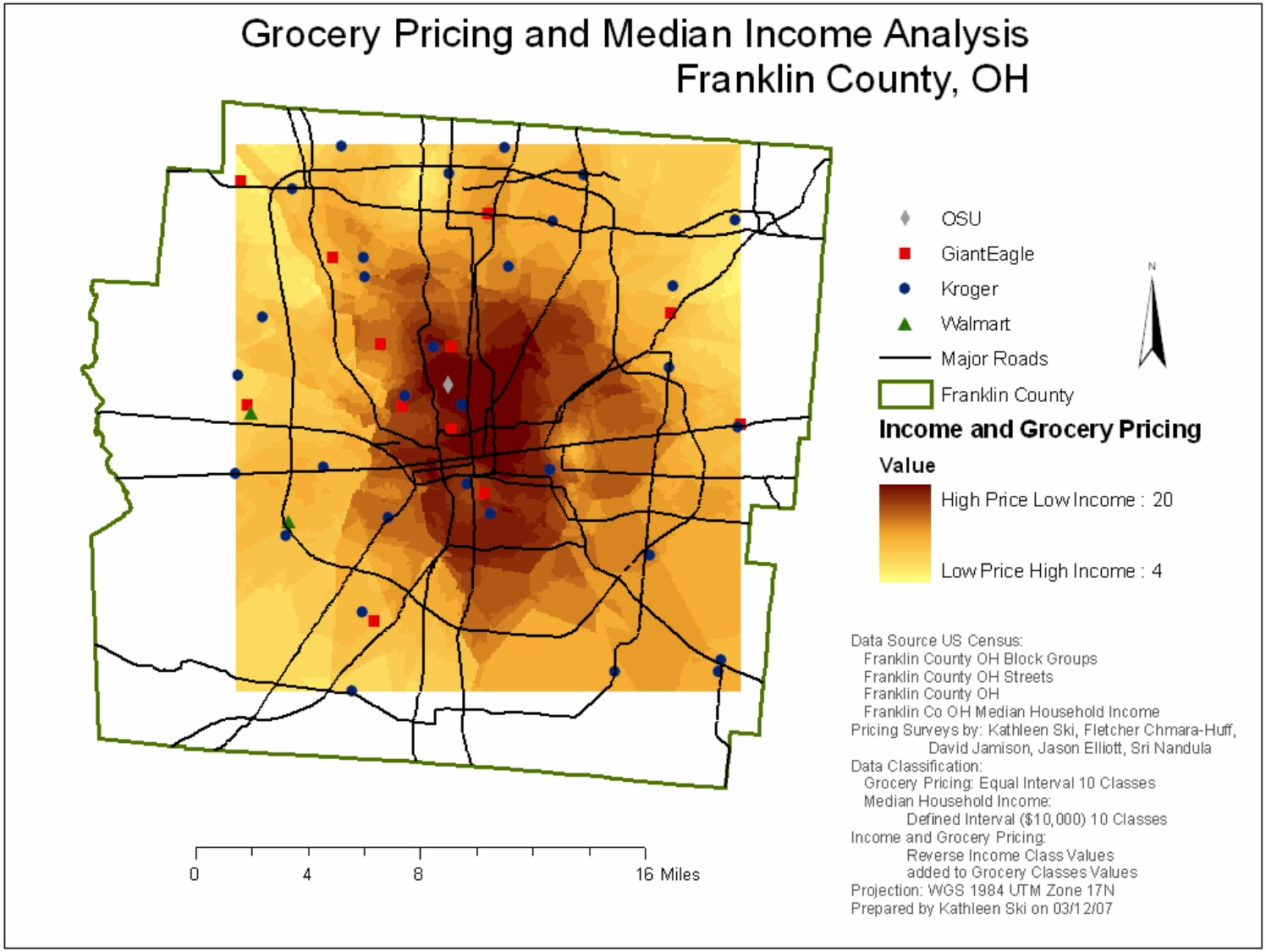
Map 11: Bivariate Manual Classification Simplified Legend



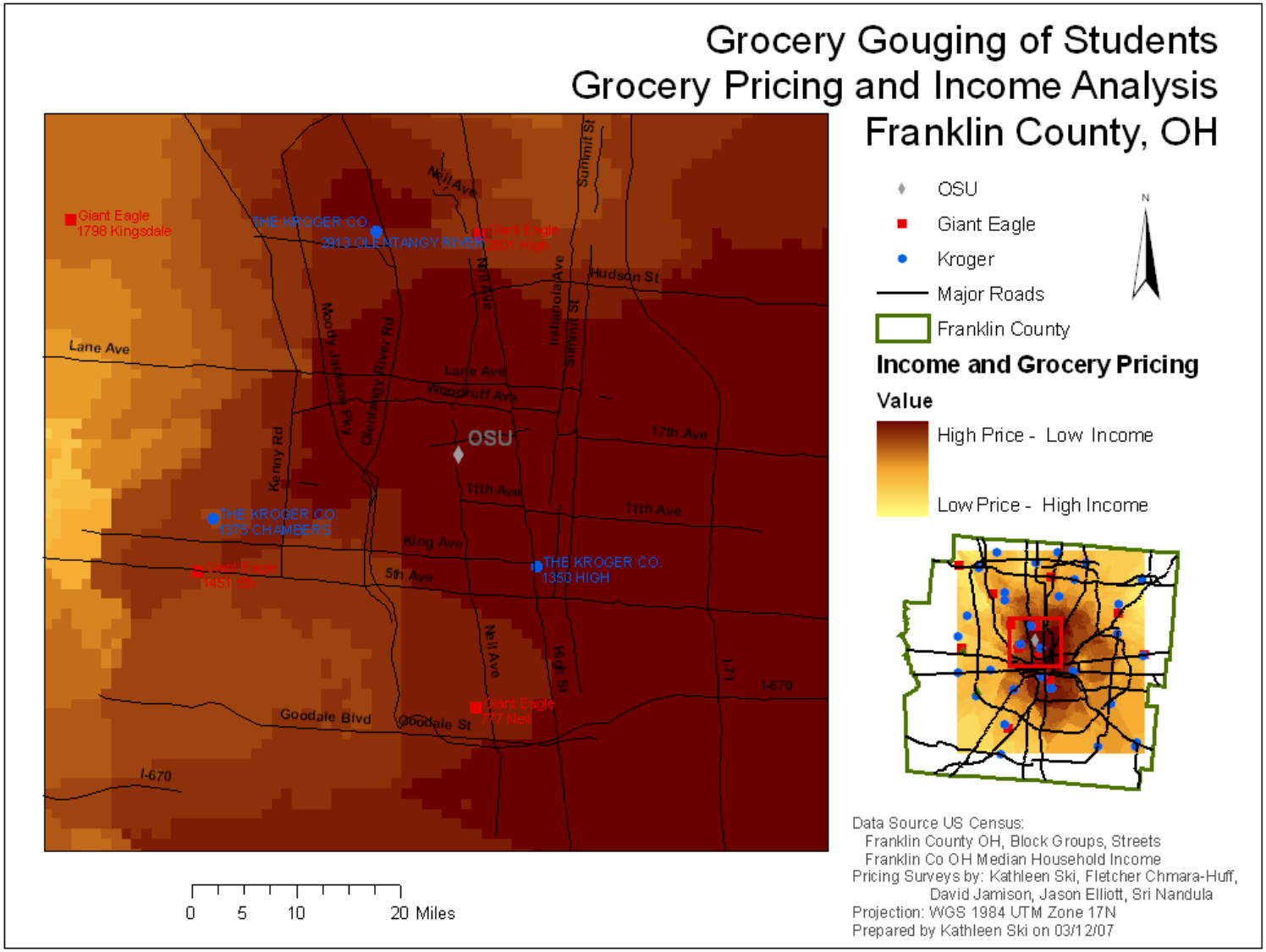
Map 12 Bivariate Raster Overlay



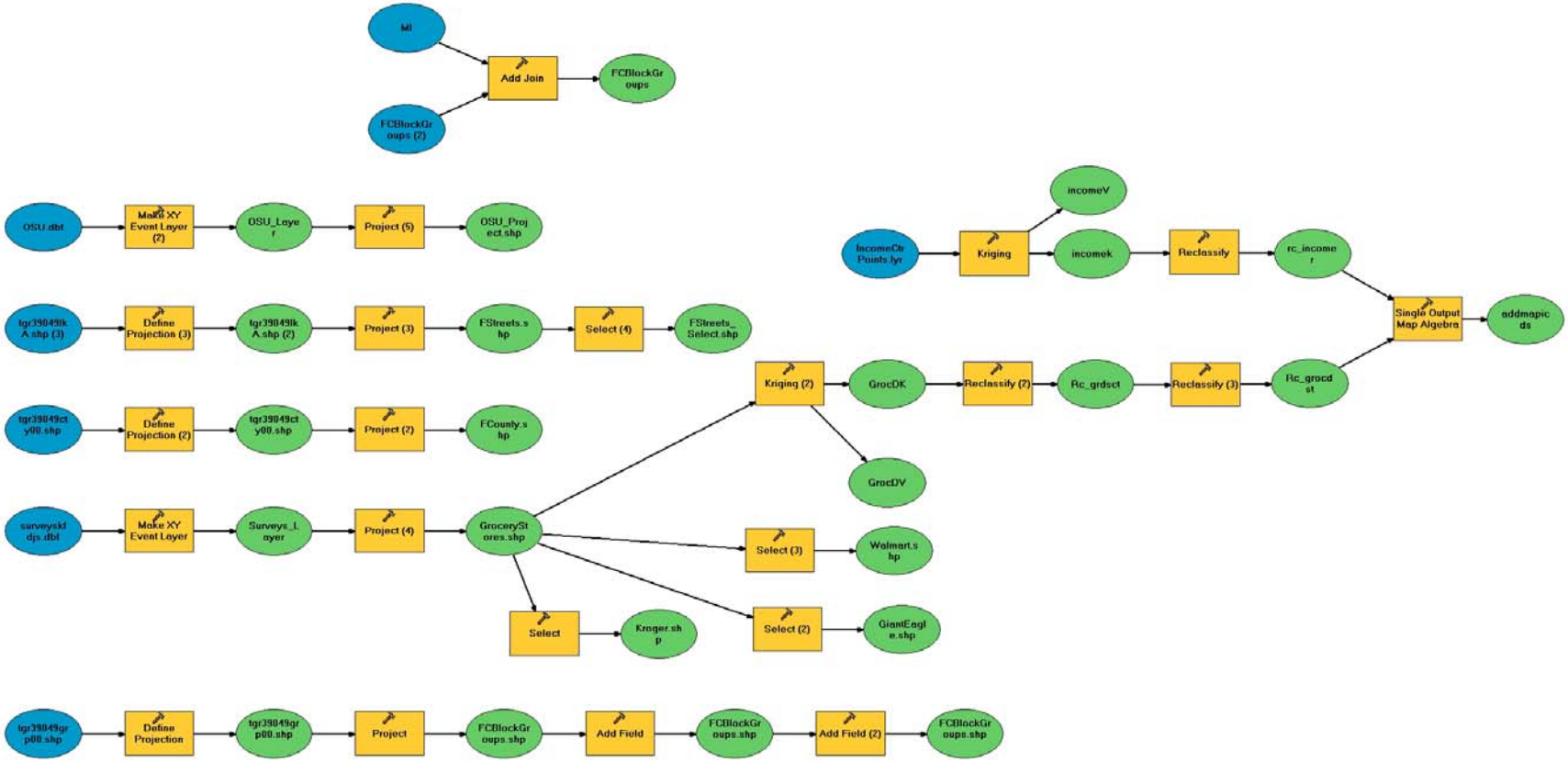
Map 13 Combined Bivariate Raster



Map 14 Focus on the OSU Campus



Model for Map 13



Resources

Tigerline 2000 Census Block Group and Streets Shape File

Tigerline 2000 Census Median Household Income Data

Google Earth for Franklin County, OH geolocation data Version 4.0.2737

Grocery Store Pricing Surveys Primary Data Collected on 2/21/07 to 2/23/07

Kroger Web Site for Store Locations accessed 2/20/07

http://www.kroger.com/homepage/index.htm

Giant Eagle Web Site for Store Locations accessed 2/20/07

http://www.gianteagle.com/main/home.jsp

Mapquest route planning

http://www.mapquest.com/maps-directions/