2024 Local Food Economics Data Visualization Challenge Documentation/Code Files

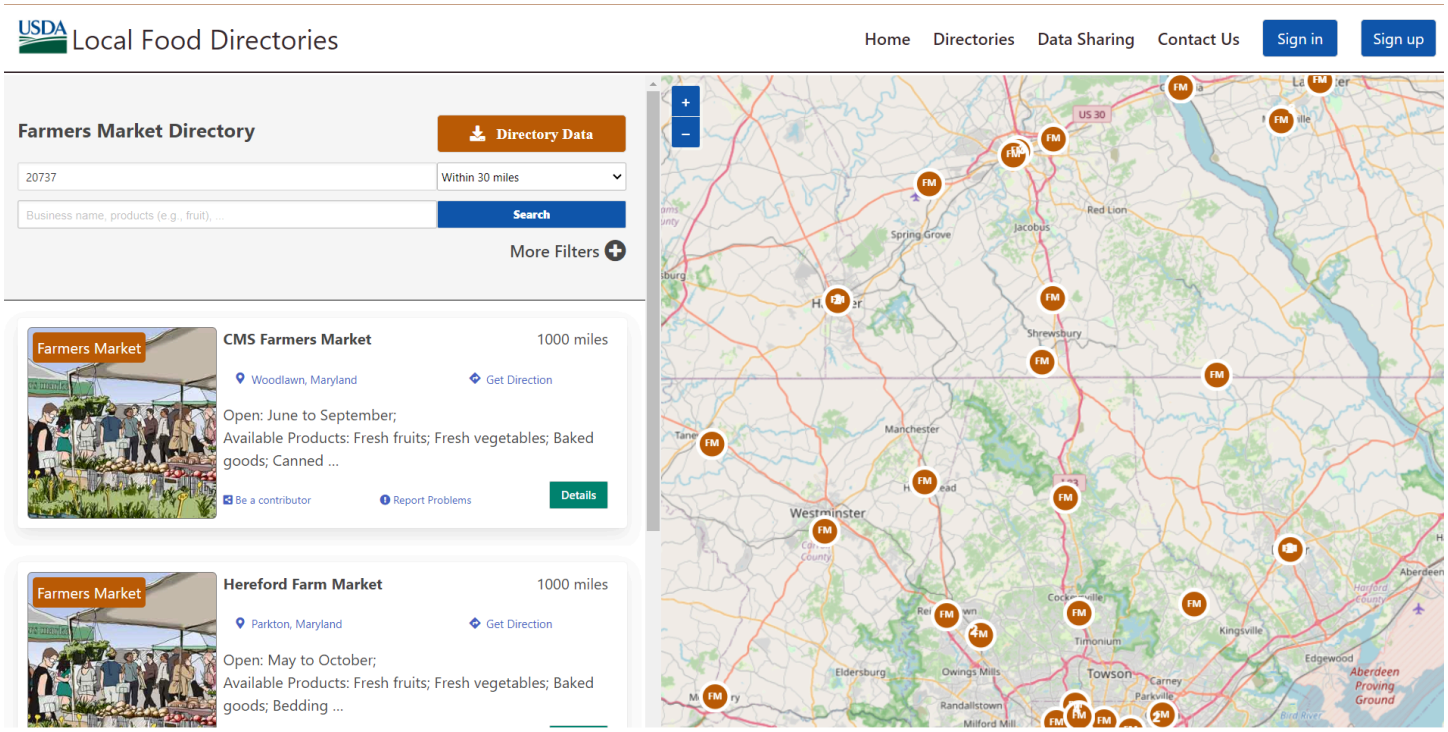
Data Collection & Processing

AMS Local Food Economics Data Warehouse

We retrieved data from the "Local Food Sales" tab within the [AMS Local Food Economics Data Warehouse](https://localfoodeconomics.com/data/access-the-data/)[1] to analyze regional food sales and identify local food-related challenges.

Screenshots from the AMS Local Food Economics Data Warehouse, "Local Food Sales" tab:

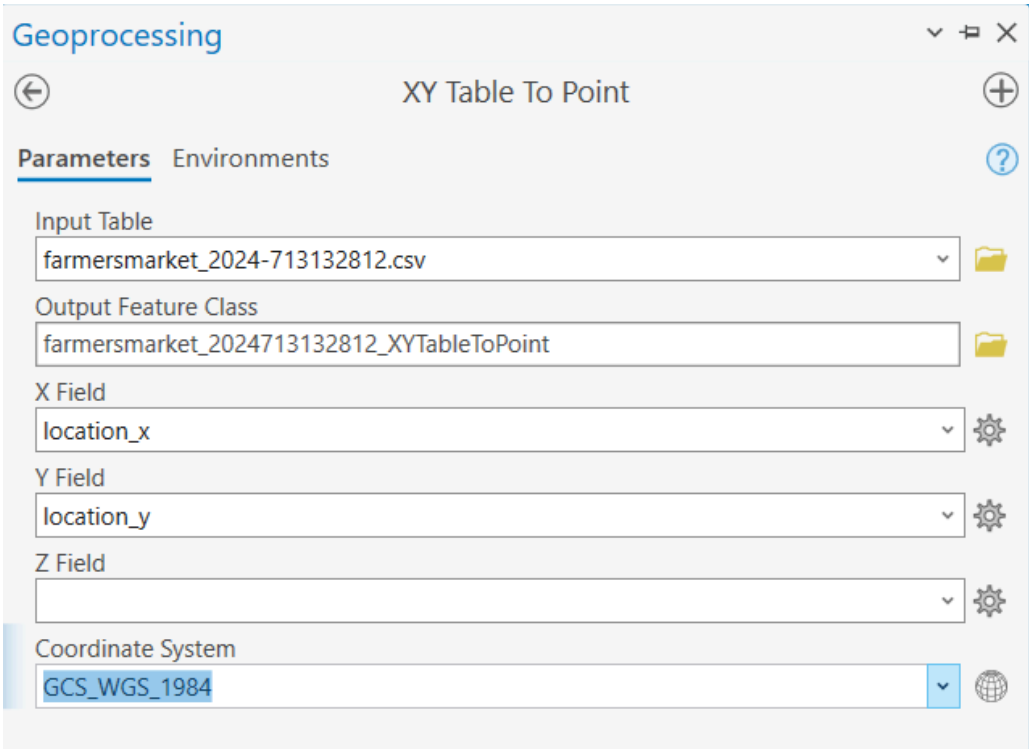
Farmers Market	Farmers markets, Location	USDA Local Food Directories, Farmers Market Directory	https://www.usdalocalfoodportal.com/fe/fdirectory_farmersmarket/?source=fe&directory=farmersmarket&location=&x=&y=



1. **Load Farmers Market Data:**
    a. Load the farmers market data into ArcGIS Pro, ensuring the dataset includes fields for approximate coordinates (location_x and location_y).
2. **Use "XY Table To Point" Tool:**
    a. Use the "XY Table To Point" tool in ArcGIS Pro to convert the location_x and location_y fields into geographic points.

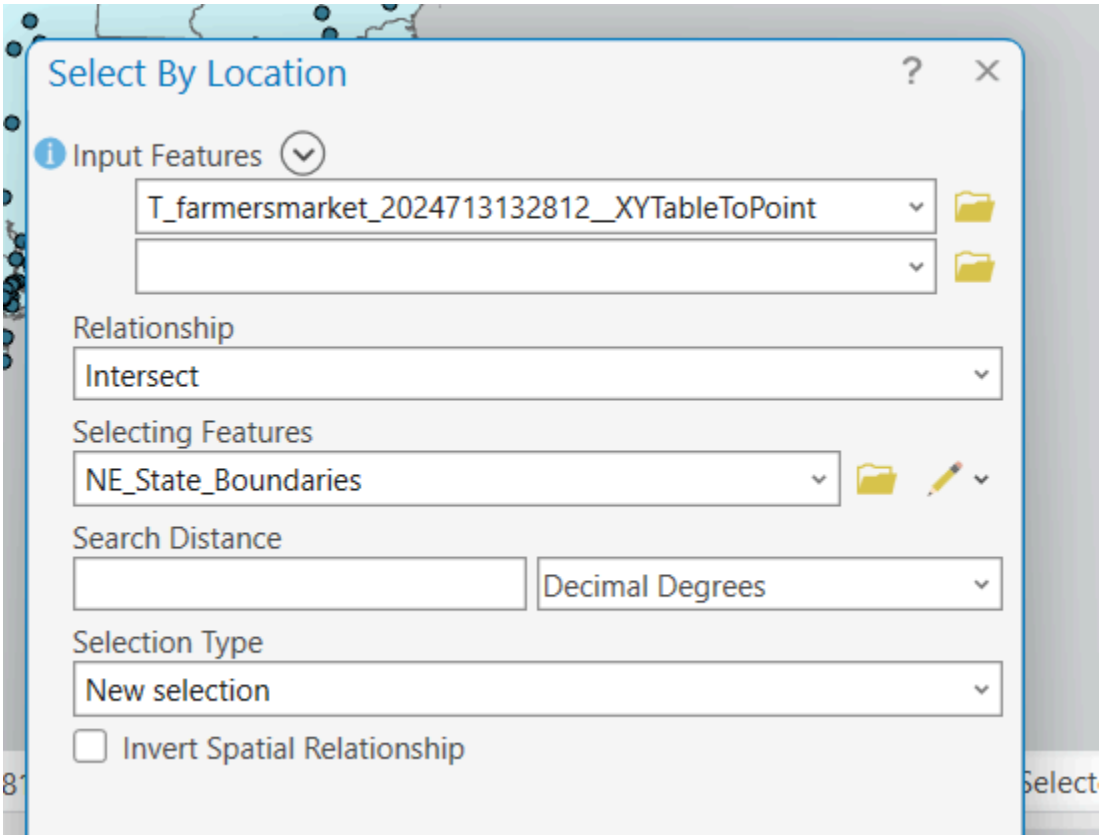
[1] https://localfoodeconomics.com/data/access-the-data/

i. Input Table: Farmers market data table.
ii. X Field: location_x
iii. Y Field: location_y
iv. Coordinate System: WGS 1984



3. Select Farmers Markets in the Northeast:

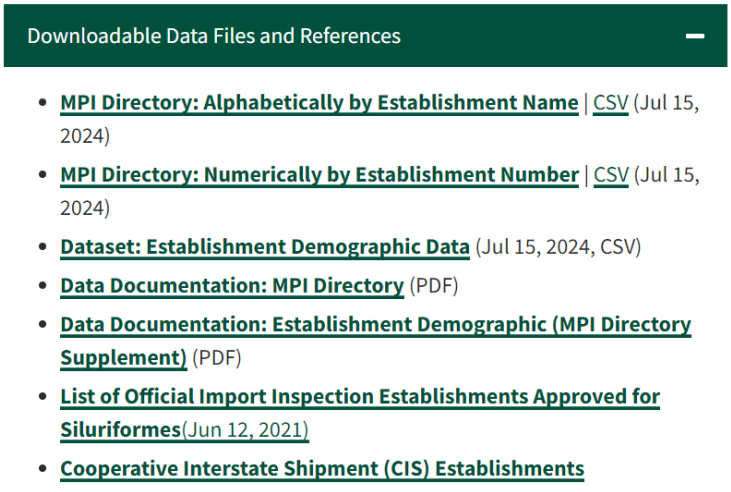
a. Use the "Select by Location" tool to select farmers markets within the Northeast region.
   i. Target Layer: Farmers markets points layer.
   ii. Source Layer: Polygon layer of the Northeast region (CT, DE, DC, ME, MD, MA, NJ, NY, PA, RI, VT, NH).
   iii. Spatial Relationship: Intersect



4. Export the selected features to a new layer for analysis.

Steps for Processing [Food Safety and Inspection Service (FSIS): Meat, Poultry and Egg Product Inspection (MPI) Directory[2] Data] and Geocoding in ArcGIS Pro

1. **Download the MPI Directory data from FSIS**



2. **Filter FSIS Dataset**
    - Retain only facilities categorized as Processing Volume Category 1 and Slaughter Volume Category 1, identified as niche/small livestock processors.

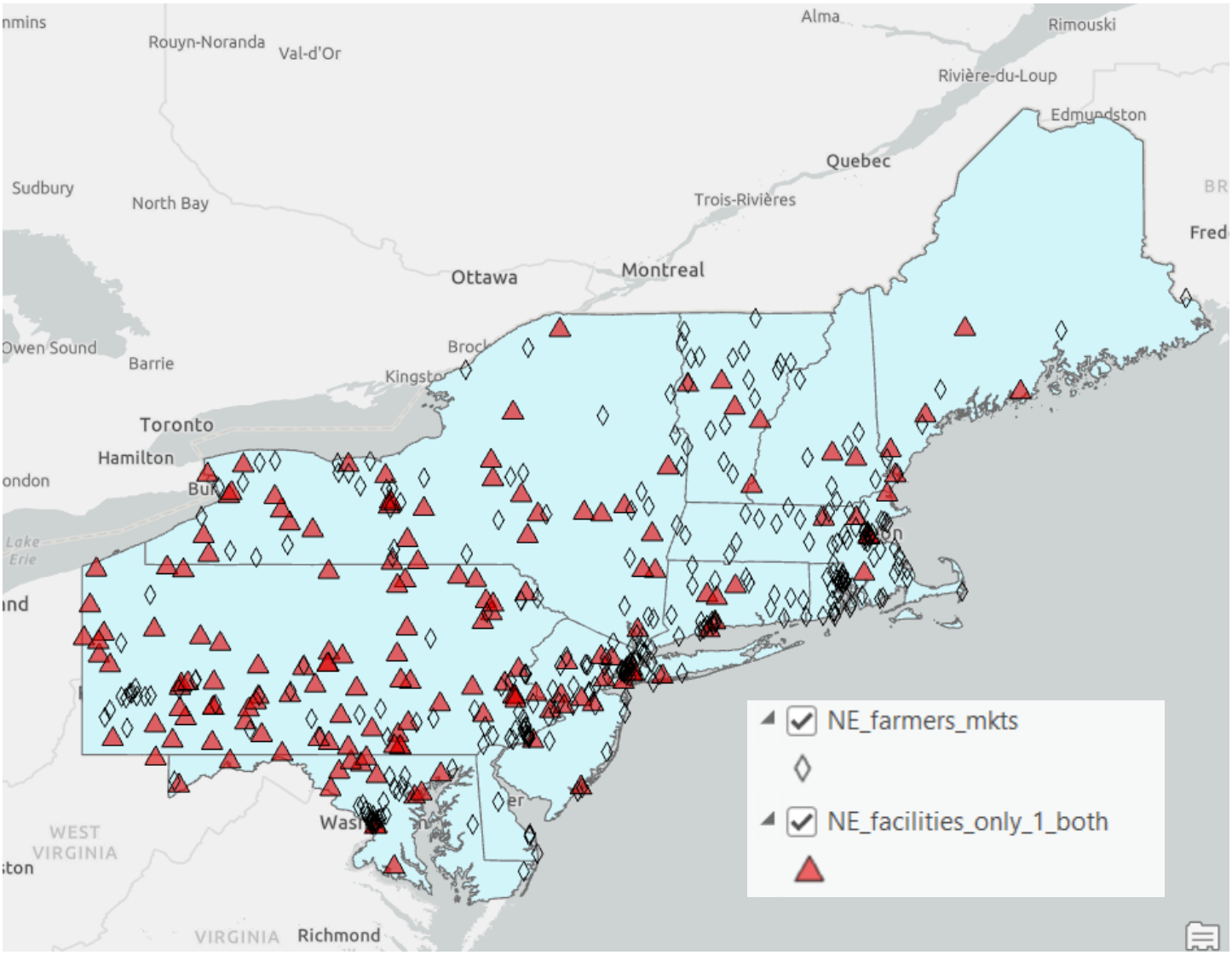
[2] https://www.fsis.usda.gov/inspection/establishments/meat-poultry-and-egg-product-inspection-directory

Size of processing and/or slaughter capcities of facilities			
Processing Volume	lbs/month	Slaughter Volume Categories	head slaughter in last 360 days aggregated
NULL	no processed products produced	NULL	No slaughtering of animals in the last 360 days
1	(0, 10,000)	1	(1, 1,000)
2	(10,000, 100,000)	2	(1,000, 10,000)
3	(100,000, 1,000,000)	3	(10,000, 100,000)
4	(1M, 10M)	4	(100,000, 10M)
5	10M +	5	10M+

- Join tables using establishmentID to consolidate address information.
- Exclude null entries in columns slaughter and process to remove non-processing facilities.

3. **Further Narrow Down the Data in Excel**
   - In Excel, duplicate the table and create a helper column with the equation =OR(SDF>,SDFA>0) to identify non-null processing or slaughter volumes.
   - Filter the helper column by TRUE, delete the helper column, and clear filters.
   - Save the refined dataset for use in ArcGIS.
4. **Geocode in ArcGIS Pro**
   - Import the refined Excel files into ArcGIS Pro.
   - Use the ArcGIS geocoding service to convert address data to geographic coordinates.
   - To reduce processing time, we geocode only within our target region (CT, DE, DC, ME, MD, MA, NJ, NY, PA, RI, VT, NH).
   - Choose geocoding settings that approximate addresses at the building's mailbox or by the road for accurate drive time calculations.
5. **Verification and Mapping**
   - Verify the accuracy of the geocoded locations using the imagery map in the ArcGIS basemap.
   - Right-click on locations and select "What's Here" to double-check the information against visual data.

Screenshot of farmers market and FSIS processing facilities volume 1 and slaughtering volume 1 loaded into ArcGIS Pro:



Sourcing County Boundaries and Selecting Northeast Region:

1. Download County Boundaries:
    - Access and download county boundary files from the U.S. Census Bureau's website: Census Cartographic Boundary Files.
2. Import and Filter County Boundaries in SQL:
    - Import the county boundaries shapefile into your spatial database.
    - Use the following SQL query to select counties within the Northeast region:

SQL code to extract only counties within NE states (inputted into ArcGIS Pro's "Extract by Attributes" tool)

SELECT * FROM county_boundaries

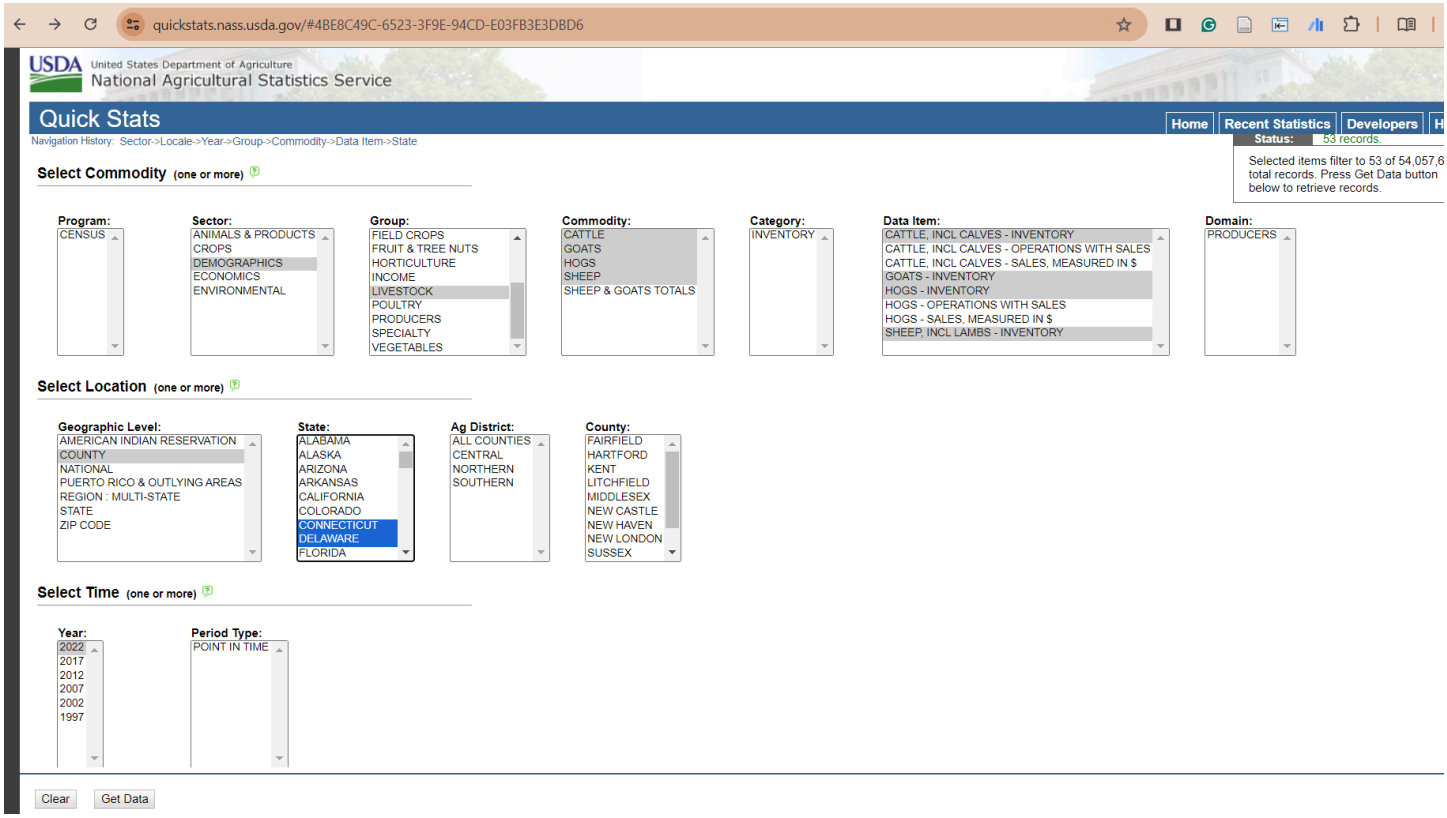
```
WHERE state_code IN ('09', '10', '11', '23', '24', '25', '33', '34', '36', '42', '44', '50');
```

- The state_code values correspond to the FIPS codes for Connecticut (09), Delaware (10), District of Columbia (11), Maine (23), Maryland (24), Massachusetts (25), New Hampshire (33), New Jersey (34), New York (36), Pennsylvania (42), Rhode Island (44), and Vermont (50).

USDA NASS Quick Stats Data

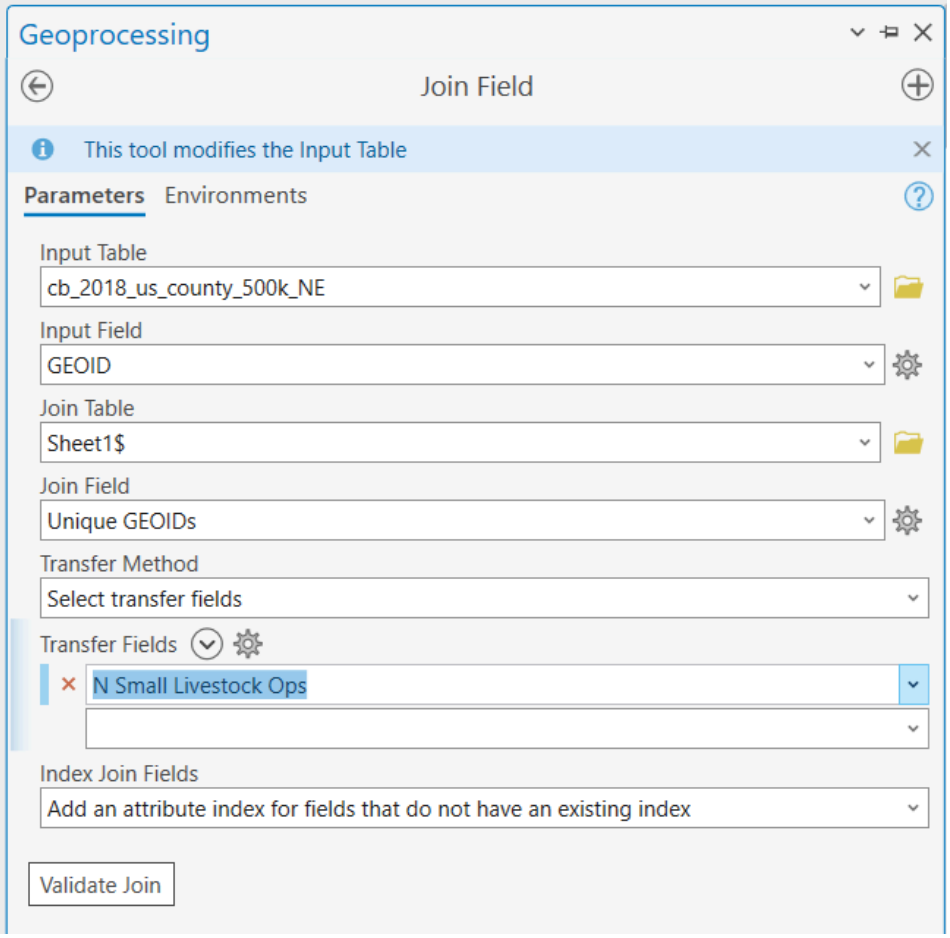
Pulling and Processing NASS Data:

1. **Retrieve Data Using NASS Quick Stats:**
    - Access USDA's National Agricultural Statistics Service (NASS) Quick Stats tool.
    - Pull data on livestock operation counts by county from the 2022 census.



2. **Initial Data Cleaning in MS Excel:**
    - Load the downloaded data into the MS Excel file named "final_nass_census_county_data".
    - Filter and clean the data to include only relevant operations:
        - Operations with beef cows, between 1 and 19 head.
        - Operations with hogs, between 1 and 49 head.
        - Operations with sheep, including lambs, between 1 and 99 head.

        - Operations with goats, any amount of goats.
3. **Prepare Data for ArcGIS Pro:**
    - Use table functions in Excel to format and clean the data.
    - Save the cleaned data for import into ArcGIS Pro.
4. **Integrating Data into ArcGIS Pro:**
    - Complete a "Join" operation to link the NASS county-level data on the number of livestock operations.



Cost Per Mile Analysis

Calculation Methodology:

To calculate the cost per mile for transporting livestock or poultry in the Northeast region of the U.S., we followed Leslie and Murray (2023) formulas from the American Transportation Research Institute (ATRI). Thus, we included a comprehensive set of expenses: fuel, insurance, tire costs, driver benefits, lease or purchase costs, maintenance, and driver wages. Fuel cost per mile was determined using the average

fuel price in June 2024 by state, with a truck fuel efficiency of 6.68 miles per gallon. Fuel data came from the American Automobile Association. In addition, according to ATRI, insurance, and tire costs were averaged per mile. Driver benefits and maintenance costs, excluding tire maintenance, were derived from industry standards and best practices. Lease or purchase costs per mile accounted for the amortized value of the vehicle over its useful life, without including depreciation tax benefits. Driver wage per mile was calculated based on the average wage in June 2024 by state, assuming a driver can drive 40.33 miles per hour. Wages data came from recruiter websites such as Ziprecruiter, Glassdoor, and Salaries.com. We derived a cost per mile for each state by summing these costs, ensuring a realistic and practical evaluation of total truck driving expenses. For additional details, see the table below. The formula used to calculate the cost per mile was:

$$Cost\ per\ mile\ by\ state: Driver\ wage\ per\ mile + Fuel\ cost\ per\ mile + insurance\ cost + insurance\ cost -$$

Since our model included all Northeast states (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, Washington D.C.), we divided by 14 to obtain the average cost per mile in the region:

Cost per mile by region = (Σ cost per mile by state/ 14)

Reference

Leslie, A., & Murray, D. (2023). An analysis of the operational costs of trucking: 2023 update. American Transportation Research Institute.

Copy of the Cost Per Mile calculation by State, computed in an MS Excel file "Cost per mile NE.xlsx"

State	Avg wage/hour	Fuel	Insurance	Tires	Driver Benefits	Lease or Purchase	Maintenance	Driver wage	Fuel	Cost per mile
Connecticut	$37.00	$4.021	$0.088	$0.045	$0.207	$0.366	$0.217	$0.82	$0.67	$2.44
Delaware	$36.00	$3.711	$0.088	$0.045	$0.207	$0.366	$0.217	$0.82	$0.62	$2.37
Maine	$32.00	$4.069	$0.088	$0.045	$0.207	$0.366	$0.217	$0.00	$0.68	$2.33
Maryland	$27.42	$3.832	$0.088	$0.045	$0.207	$0.366	$0.217	$0.82	$0.64	$2.18
Massachusetts	$28.00	$4.056	$0.088	$0.045	$0.207	$0.366	$0.217	$0.82	$0.68	$2.22
New Hampshire	$35.00	$4.039	$0.088	$0.045	$0.207	$0.366	$0.217	$0.82	$0.67	$2.40
New Jersey	$28.38	$3.729	$0.088	$0.045	$0.207	$0.366	$0.217	$0.82	$0.62	$2.18
New York	$38.46	$4.248	$0.088	$0.045	$0.207	$0.366	$0.217	$0.82	$0.71	$2.51
Pennsylvania	$29.47	$4.260	$0.088	$0.045	$0.207	$0.366	$0.217	$0.82	$0.71	$2.29
Rhode Island	$37.00	$4.132	$0.088	$0.045	$0.207	$0.366	$0.217	$0.82	$0.69	$2.46
Vermont	$26.00	$3.951	$0.088	$0.045	$0.207	$0.366	$0.217	$0.82	$0.66	$2.16
Virginia	$47.00	$3.814	$0.088	$0.045	$0.207	$0.366	$0.217	$0.82	$0.64	$2.66
West Virginia	$26.61	$3.847	$0.088	$0.045	$0.207	$0.366	$0.217	$0.82	$0.64	$2.16
Washington D.C.	$28.03	$3.709	$0.088	$0.045	$0.207	$0.366	$0.217	$0.82	$0.62	$2.17
Avg NE	$32.60	$3.96	$0.09	$0.05	$0.21	$0.37	$0.22	$0.76	$0.66	$2.32

1. **Cost Per Mile Geography Integration:**
    - Integrate cost per mile data into the spatial analysis using ArcGIS Pro.

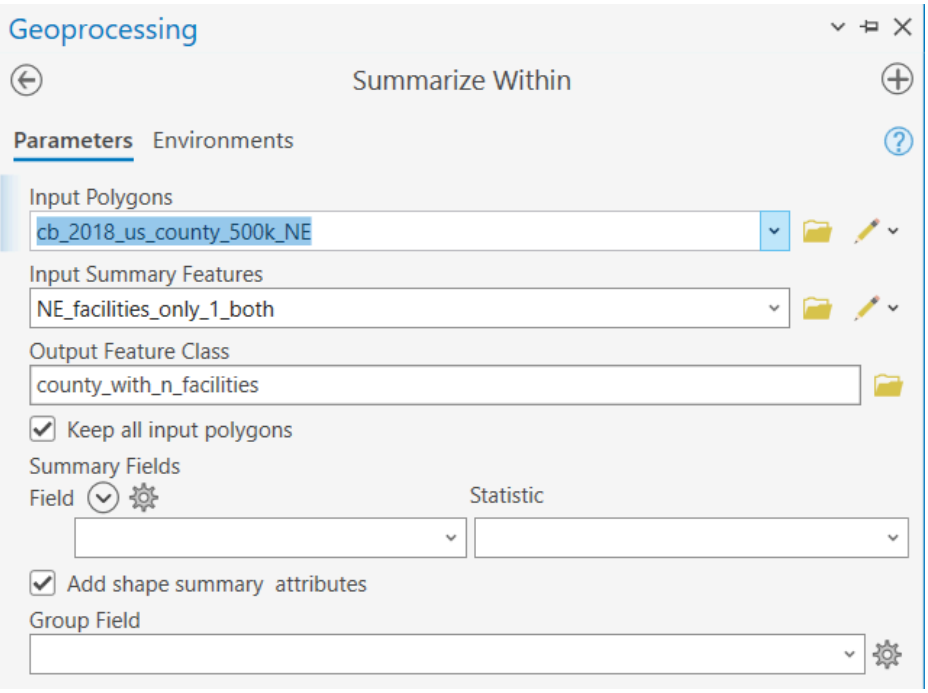
Data Analysis in ArcGIS Pro

Integrating and Analyzing Data:

1. **Import Cleaned Data:**

- Import the cleaned farmers market data, FSIS data, and NASS data into ArcGIS Pro.

2. **Join County-Level Data:**
   - Join the county-level data on operations participating in smaller livestock husbandry (as estimated by NASS in 2022) with the geocoded facility data.
3. **Spatial Join for Analysis:**
   - Perform a spatial join to count the number of processing facilities within each county.



   - Analyze the relationship between the location of processing/slaughtering facilities and the number of smaller/multi-livestock operations within a county.
   - Repeat the spatial join process for farmers markets.

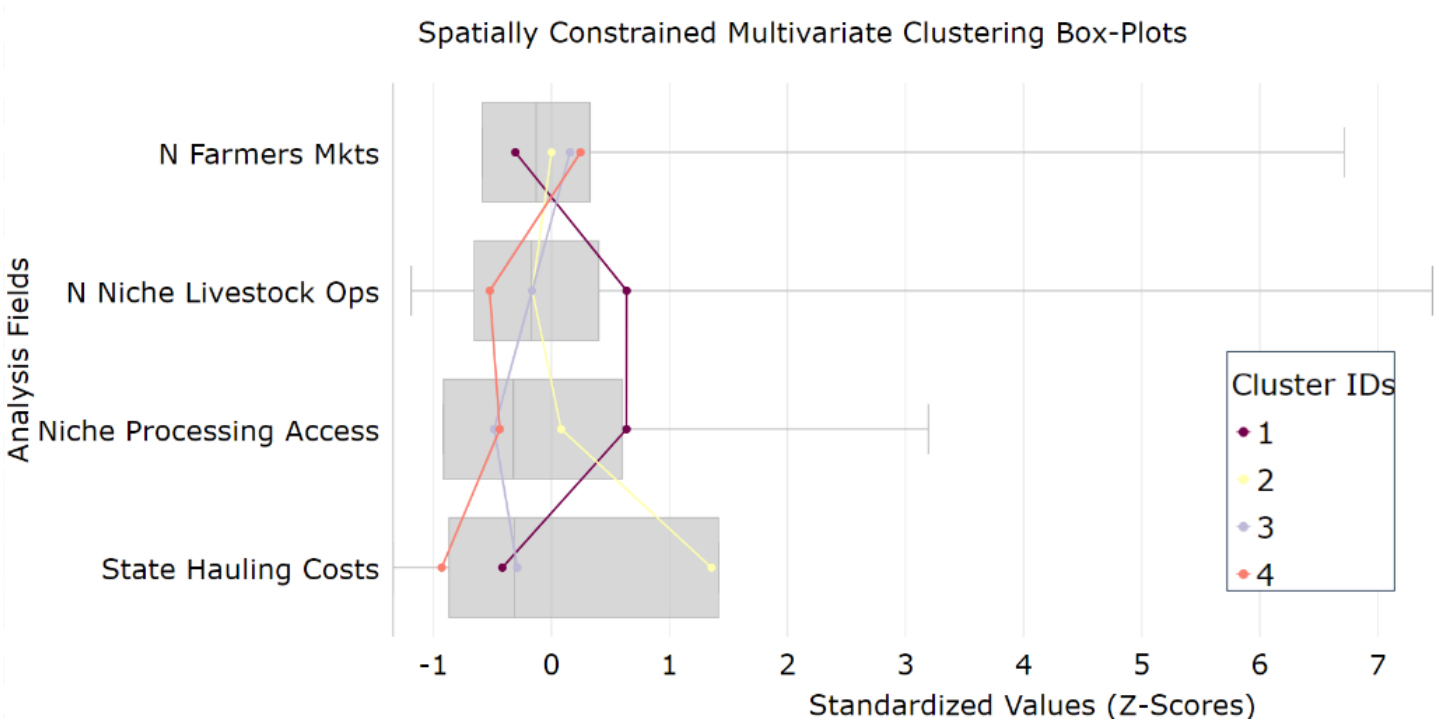
Spatial Analysis and Visualization

Spatially Constrained Multivariate Clustering Analysis:

1. **Preparing Data for Clustering:**
   - Ensure that each county-level feature includes attributes for:
     - State hauling cost
     - Number of farmers markets
     - Overlap with processing facilities
   - These attributes provide the basis for clustering analysis by representing key factors affecting local food systems.

2. **Conduct Spatially Constrained Multivariate Clustering:**
    - Open ArcGIS Pro and load the county-level dataset with the prepared attributes.
    - Navigate to the "Analysis" tab and select "Spatial Statistics Tools."
    - Choose "Multivariate Clustering" and configure the parameters:
        - Input Features: County-level dataset
        - Fields to Cluster: State hauling cost, number of farmers markets, overlap with processing facilities
        - Spatial Constraints: Contiguity (edges only)
3. **Interpreting Results:**
    - Upon completion, the tool will generate clusters based on the specified attributes.
    - Each cluster will represent counties with similar characteristics in terms of state hauling costs, the number of farmers markets, and the overlap with processing facilities.
    - Visualize the clusters on a map to identify spatial patterns and regional differences.

Spatially Constrained Multivariate Clustering Analysis:



1. **Conduct Spatially Constrained Multivariate Clustering:**
    - Perform spatially constrained multivariate clustering in ArcGIS Pro to identify distinct clusters within the Northeast region.
2. **Cluster Descriptions and Analysis:**
    - **Cluster 1 (Dark Purple):**
        - Most niche processing facilities and specialty livestock farmers in the NE.

        - Least access to farmers' markets.
        - Needs additional farmers markets and direct market channels for livestock producers.
    - **Cluster 2 (Yellow):**
        - Highest hauling costs but benefits from access to farmers markets and niche processing facilities.
        - Needs reduced economic costs for livestock hauling.
    - **Cluster 3 (Light Purple):**
        - Sufficient access to farmers' markets with average regional hauling costs and specialty livestock operations.
        - Needs general support for small-scale slaughtering and processing infrastructure.
    - **Cluster 4 (Salmon):**
        - Lowest hauling costs and most access to farmers markets, yet fewest niche livestock operations.
        - Needs support for niche livestock producers and additional slaughtering and processing infrastructure.

Findings and Takeaways

- **Clear Regional Differences:** Regional differences exist in access to markets, hauling costs, and processing infrastructure.
- **Targeted Interventions Needed:** Targeted interventions, such as reducing hauling costs and increasing market access, are needed to improve local food systems.
- **Support for Niche Livestock Producers:** Enhanced support is needed for niche livestock producers and processing facilities.

Limitations

- **Processing and Slaughtering Capacity Unknown:** The capacity and lead/wait time for processing and slaughtering facilities are unknown.
- **Demand Points Limited to Farmers Markets:** The analysis only considers farmers' markets as demand points. Future analysis should include other regional, direct market channels.