

# Rural Realities: Food Hub Site Suitability in the Northeast Kingdom of Vermont

## Project Overview

The Northeast Kingdom (NEK) is a rural region in Northeast Vermont, comprised of Caledonia County, Essex County and Orleans County. This area contains several small and medium size farms, and is known for its regional food movement. While the NEK prides itself on offering local food, one critique of small-scale food systems, such as CSAs, farmers markets, and farm food stands, is the increase in driving such models create (Coley et al.). When consumers each drive to a remote farm stand for example, this can increase total miles driven and lead to more carbon emission than purchasing food at a grocery store, even including the store's cold storage and transportation emissions (Coley et al.). Yet regional food hubs present an opportunity to help farmers access markets as well as reduce miles driven for both consumers and producers. This project seeks to create a site suitability analysis model for potential food hub locations in the NEK region.



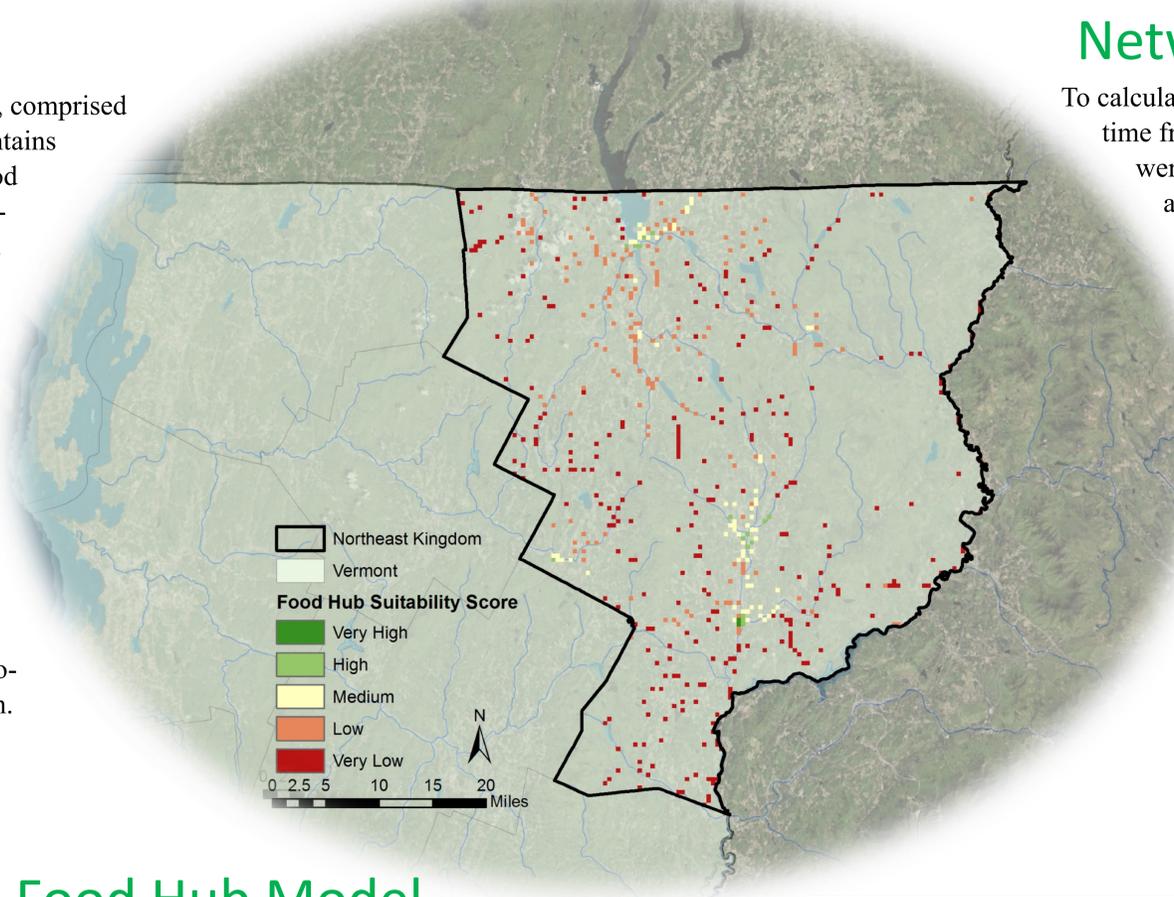
## Food Hubs and VT Data

A food hub is “a business or organization that actively manages the aggregation, distribution, and marketing of source-identified food products primarily from local and regional producers to strengthen their ability to satisfy wholesale, retail, and institutional demand” (Barham et al., 2012). This project’s site-suitability analysis serves as a preliminary model. It seeks to look at how rural areas could begin to determine where to place food hubs, to both reduce carbon emissions and be accessible to residents and consumers. Potential customers are modeled through both population data, as well as school points, as schools present important potential buyers. Emphasis is given to accessibility for those of lower median incomes, as those in poverty are more likely to be food insecure (Wilde).

### Datasets:

The data utilized in this model includes income, population density, land use, as well as farm and school locations in the Northeast Kingdom analyzed via street speed limits. The income and population data utilized came from the American Community Survey state-wide data, collected in 2015 by the U.S. Census Bureau. This data was in census block groups, the smallest aerial unit available. The land use data was published by the National Land Cover Database, and the farm and school data was provided by the Vermont Farm to Plate organization, and the Vermont Agency of Education, respectively. The street data with speed limits was published by ESRI.

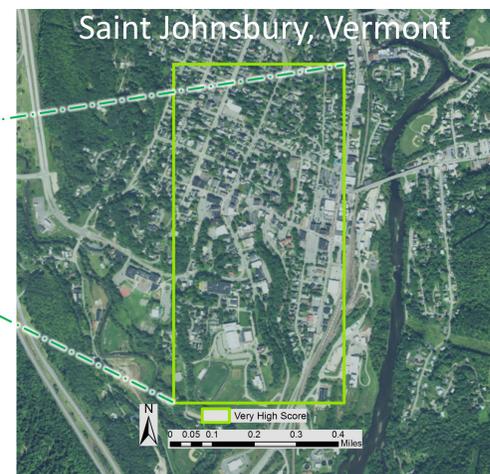
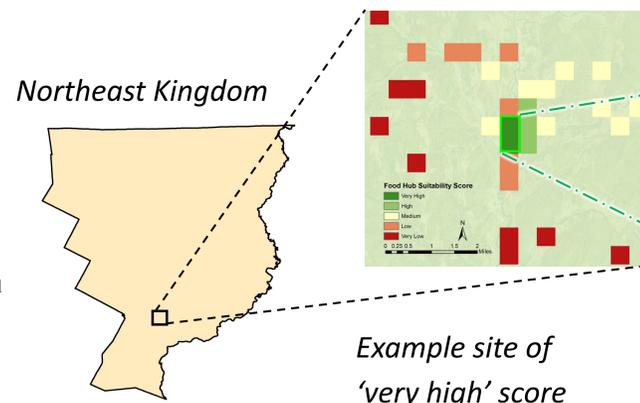
**References:** Barham, J., Tropp, D., Enterline, K., Farbman, J., Fisk, J., & Kiraly, S. (2012). Regional food hub resource guide (No. 145227).  
 Coley, D., Howard, M., & Winter, M. (2009). Local food, food miles and carbon emissions: A comparison of farm shop and mass distribution approaches. *Food policy*, 34(2), 150-155.  
 Conner, D., King, B., Kolodinsky, J., Roche, E., Koliba, C., & Trubek, A. (2012). You can know your school and feed it too: Vermont farmers' motivations and distribution practices in direct sales to school food services. *Agriculture and Human Values*, 29(3), 321-332.  
 Wilde, P. (2013). *Food policy in the United States: An introduction*. Routledge.



## Food Hub Model

Each dataset was reclassified in ArcGIS, as well as the distance times from farms and schools, which were calculated utilizing a network analysis, further explained on the right. Population data (normalized as people per hectare) was reclassified to give a more favorable ranking for areas estimated to have a higher population density, while the median income spatial data was reclassified to give a more favorable ranking to areas which were estimated to have populations with lower median incomes. Land use data was reclassified as either possible for use, such as developed land (with areas of higher density development receiving a more favorable ranking), or not possible for use as a food hub site, such as open water, forest, pasture, etc. The travel times to both farms and schools were given a higher ranking for less total travel time (highest = under 5 mins), and a lower ranking for longer travel times (lowest = over 30 mins). These reclassified datasets were then combined for a final ‘site-suitability score’ utilizing Map Algebra in ArcGIS and the weights in the figure to the right.

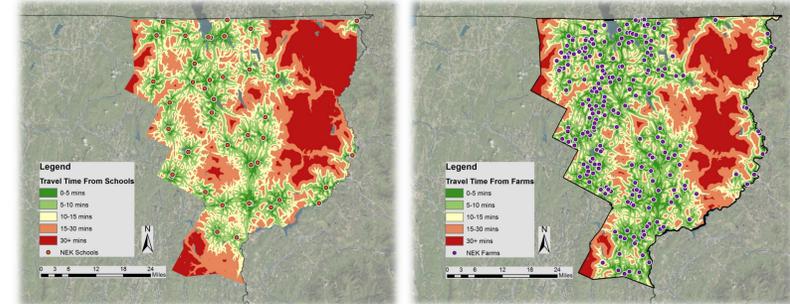
Model Component	Weight
Median Income	28.6%
Population Density	28.6%
Land Use	14.3%
School Travel Time	14.3%
Farm Travel Time	14.3%



## Network Analysis

To calculate site suitability, a network analysis was completed to determine travel time from both schools and farms to rank potential food hub locations. Schools were included as they are key purchaser of local food in Vermont (Conner et al.), and thus reducing travel time to these large consumers is of key importance. Travel time to farms were also included to thus optimize distance traveled for both consumers and producers. A network analysis was completed using both driving time, and walking time, which enabled the connection of farms and schools to the road network. Road travel speeds were estimated using street speed limits, while walking speeds were estimated through average human walk speeds and the Land Use Data layer. These two travel times were combined for a total travel time from each cell to either the closest farm or school.

### School Network Analysis Farm Network Analysis



## Discussion

This model was intended as a preliminary evaluation of how one could assess potential food hub site-suitability. To the left is one example of a site with a high suitability score, and was the only area that received a ‘very high’ score. It is the town of St. Johnsbury, which is considered the commercial center of the Northeast Kingdom. While the model’s assessment appears promising, the level of confidence ascribed to the areas identified as ‘suitable’ should be low, as there are several other important criteria not included in this model. Such criteria include farm productivity and sales, the purchasing volume of different consumers, as well as the financing capabilities of towns to implement a food hub. Another flaw is the U.S. Census population and income data, as the block groups in Vermont are very large, meaning much of the variation within these areas is not taken into consideration in this model. The network analysis is also likely to misrepresent travel times, as it does not take into account road conditions. Future steps to improve this model include adding additional important criteria and more granular data.

Cartographer: Hannah Kitchel; Project Date: December 2017  
 Projection: NAD 1983 State Plane Vermont FIPS 4400 (Meters)  
 Data Sources:  
 ACS data: American Community Survey, Census Block Groups, 2015, U.S. Bureau of the Census  
 VT Farms: Vermont Food Systems Atlas, Food Production, 2017, Farm to Plate  
 VT Schools: VT School Locations K-12, February 2003 (Update 2014), Vermont Agency of Education  
 VT Roads: North America Detailed Streets, 2014, ESRI  
 Land Use: 2001 National Land Cover Database – Vermont, September 2003, U.S. Geological Survey