Capacity for meeting food needs with local and regional production: Tales from the Northeast United States

John Glenn Colloquium
Ohio State University, Columbus
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Dr. Christian Peters, Assistant Professor, Tufts University
Agenda

• Context on local and regional food
• Three stories
  – Land requirements of diet
  – Mapping foodsheds
  – Net balance studies
• Closing remarks
What is local food?

“There is no legal or universally accepted definition of local food.”

- Martinez et al. (2010, p.3)

Figure by C.J. Peters
Models of local food production

• Farm to consumer
  – Farmers’ markets
  – Community Supported Agriculture (CSA)
  – Farm stands
  – Pick your own

• Farm to business or institution
  – Restaurants
  – Retail stores
  – Schools

Martinez et al. (2010)
What is a regional food system?

Local v. Regional:
- Volume of food
- Management of natural resources
- Economic efficiency
- Diversity

(Clancy and Ruhf, 2010)
Why does local food matter?

The Claims

• Fresher
• More nutritious
• Tastier
• Safer
• Keeps farmers farming
• Supports local economy
• Less energy use
• Lower emissions
• Connection to food

Photo by Keith Weller (from USDA-ARS Photo Library: http://www.ars.usda.gov/is/graphics/photos/k3839-3.htm)
Avoiding the local trap

Current system:
Less sustainable
Less just

Local food systems

Alternative system:
More sustainable
More just

To what degree can localizing the food supply serve as a vehicle for achieving these goals?*

Born and Purcell (2006)
The big questions

1. What is the place of local and regional production in the U.S. food system?
2. What capacity does a location have for producing local and regional food?
Foodshed analysis
Funding streams

2000-2004
Department of Crop and Soil Sciences, Cornell University; Hatch funding from the Cornell University Agriculture Experiment Station

2005-2008
“Mapping Local Food Systems in New York State” USDA National Research Initiative, grant number 2005-55618-15640

2009-present
“Foodprints and Foodsheds: Tools for Evaluating the Sustainability of Dietary Patterns and the Geography of the Food System” W.K. Kellogg Foundation Grant No. P3008987
## Timeline

<table>
<thead>
<tr>
<th>Early years</th>
<th>Mapping Foodsheds</th>
<th>Foodprints &amp; Foodsheds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net-balance Foodprint prototype</td>
<td>Development of foodshed and foodprint models</td>
<td>Refinement of methodology</td>
</tr>
<tr>
<td>New York focus</td>
<td>New York focus</td>
<td>More locations</td>
</tr>
<tr>
<td>2000 to 2003</td>
<td>2004 to 2008</td>
<td>2009 to present</td>
</tr>
</tbody>
</table>
PROLOGUE
Threat of nationwide railroad strike

July 1, 1921:
U.S. Labor Board authorizes 12.5 percent wage cut

October 15, 1921:
“Big Four” unions authorize strike to begin on October 30

October 27, 1921:
Settlement reached at 11:30PM and strike orders were canceled

Study of New York City food supply


Chapter titles include:

“The revolutionary activities of the refrigerator car”

“The geography of food terminals and food industries”

“Who are the Middlemen?”

“An apple a day costs a lot on the way”

“Watersheds, milksheds, and foodsheds”
FOODSHED
Concept and its origins

FOODSHED: The geographic area which supplies a population with food

A rough history...

1. How Great Cities Are Fed
2. “Coming in to the foodshed”
3. Foodshed analyses

¹Hedden (1929), ²Kloppenburg et al. (1996), ³Thompson et al. (2008), ⁴Peters et al. (2009), ⁵DVRPC (2010)
The basic methodology

Soils
Land cover

Diet
Sub-model

Urban areas
Population

Production zones
Distance
Optimization software

Population centers
Foodshed Matrix

TABLES
MAPS

Peters et al. (2009)
Characterizing land productivity

Area of agricultural land

Relative productivity
Spatial distribution of food needs

Population concentrated in the NYC metropolitan area

SOURCE: Population map from Peters et al. (2009)
Foodshed Optimization: Minimum food miles

**GOAL:** Minimize distance food travels \((\text{DFT})\)

\[
\text{DFT} = \sum (F_{ij} \times D_{ij})
\]

\(F = Q\) of food shipped from \((i)\) to \((j)\)

\(D = \text{distance between } (i) \text{ and } (j)\)

**CONSTRAINTS:**

1) Consumption \(\leq\) food requirement
2) Cultivated production = potential capacity
3) Perennial production = potential capacity
## Capacity to meet food needs, model 1

<table>
<thead>
<tr>
<th>Population center(s)</th>
<th>Food allocated ( \text{HNE}_t )</th>
<th>Food distance ( \text{HNE}_t )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( Tg )</td>
<td>% of need</td>
</tr>
<tr>
<td>NYC</td>
<td>0.33</td>
<td>2.2</td>
</tr>
<tr>
<td>Urbanized areas</td>
<td>4.58</td>
<td>83.7</td>
</tr>
<tr>
<td>Urban clusters</td>
<td>3.22</td>
<td>98.4</td>
</tr>
<tr>
<td>TOTALS</td>
<td>8.13</td>
<td>34.4</td>
</tr>
</tbody>
</table>

\( \text{HNE}_t \) = Human nutritional equivalents (total)

\( Tg \) = teragrams (or million metric tons)

Peters et al. (2009)
Potential local foodsheds

Annual crops and fruits

Perennial forages

Peters et al. (2009)
Foodshed optimization: Maximum returns to land

**GOAL:** Maximize total land use value (LUV)

\[
\text{LUV}_{\text{total}} = \sum (A_{ij} \times \text{LUV}_{ij})
\]

\( A = Q \) of food shipped from \((i)\) to \((j)\)

\( \text{LUV} = \) distance between \((i)\) and \((j)\)

**CONSTRAINTS:**

1) Consumption \( \leq \) food requirement
2) Area in annuals \( \leq \) area available for annuals
3) Area in perennials \( \leq \) area limited to perennials
Prioritizing what is produced locally

Could meet up to **69%** of food requirements

Total NYS requirements = **13.8 Tg**

Peters et al. (2011)
Potential foodsheds by food group

A (vegetables)  
Vegetables only

C (dairy)  
Dairy only

Peters et al. (2012)
Summary of foodshed analyses

• Not all food can be local
• Some cities better positioned than others
• Optimizing for returns to land favors different foods rather than different locations
• Potential “localness” influenced by location and population size

*What should be grown locally? Regionally? What role do these systems play in the larger food system?
Northeast Baseline
Enhancing the Food Security of the Northeast with Sustainable Regional Food Systems
Systems Approach to Food

Distribution

Consumption

Production

Actual supply chains (9 study sites)

Modeling (throughout region)

Integrated project (Outreach & Education)
Net balance approach

\[
\frac{\text{Production}}{\text{Consumption}} = \text{Self-sufficiency ratio}
\]

Examples:
Messing et al. (1981)
Herrin and Gussow (1989)
Cowell and Parkinson (2003)
The basic methodology

<table>
<thead>
<tr>
<th>Production</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>= Area × Yield</td>
<td>= Food availability × population</td>
</tr>
<tr>
<td>No. of animals × output</td>
<td>Food availability × conversion to farm weight × population</td>
</tr>
<tr>
<td>Seafood landings</td>
<td></td>
</tr>
</tbody>
</table>
What does the Northeast grow?

Land in farms: 24 million acres

Northeast region: CT, DE, MA, ME, MD, NH, NJ, NY, PA, RI, VT, and WV

Derived from Griffin et al., in review.
## Self-reliance in plant foods

### Northeast regional self-reliance, 2001-2009

<table>
<thead>
<tr>
<th>Self-reliance category</th>
<th>Mean regional production ($10^6$ kg)</th>
<th>Mean regional consumption ($10^6$ kg)</th>
<th>Mean regional self-reliance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
<td>1,389</td>
<td>7,622</td>
<td>18</td>
</tr>
<tr>
<td>Vegetables</td>
<td>2,953</td>
<td>11,387</td>
<td>26</td>
</tr>
<tr>
<td>Grains</td>
<td>1,150</td>
<td>14,627</td>
<td>7.9</td>
</tr>
<tr>
<td>Pulses</td>
<td>15</td>
<td>212</td>
<td>7.2</td>
</tr>
<tr>
<td>Oils</td>
<td>1,396</td>
<td>14,398</td>
<td>9.7</td>
</tr>
<tr>
<td>Sweeteners</td>
<td>290</td>
<td>3,752</td>
<td>7.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7,193</strong></td>
<td><strong>47,199</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

Derived from Griffin et al., in review.
## Self-reliance in animal products

### Northeast regional self-reliance, 2001-2009

<table>
<thead>
<tr>
<th>Self-reliance category</th>
<th>Mean regional production (10^6 kg live weight)</th>
<th>Mean regional consumption (10^6 kg live weight)</th>
<th>Mean regional self-reliance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy^b</td>
<td>13,043</td>
<td>17,297</td>
<td>75</td>
</tr>
<tr>
<td>Eggs^c</td>
<td>692</td>
<td>954</td>
<td>72</td>
</tr>
<tr>
<td>Shellfish</td>
<td>169</td>
<td>375</td>
<td>45</td>
</tr>
<tr>
<td>Chicken</td>
<td>1,549</td>
<td>3,869</td>
<td>40</td>
</tr>
<tr>
<td>Turkey</td>
<td>187</td>
<td>626</td>
<td>30</td>
</tr>
<tr>
<td>Fish</td>
<td>224</td>
<td>997</td>
<td>22</td>
</tr>
<tr>
<td>Lamb</td>
<td>12</td>
<td>68</td>
<td>17</td>
</tr>
<tr>
<td>Beef</td>
<td>696</td>
<td>4,437</td>
<td>16</td>
</tr>
<tr>
<td>Pork</td>
<td>390</td>
<td>2,565</td>
<td>15</td>
</tr>
</tbody>
</table>

Derived from Griffin et al., in review.
Lessons from the net-balance study

Conclusions
• Animal agriculture dominates land base
• Wide range in self-reliance ratios
• Net food importer

Caveats
• Seasonality of production
• Effect of aggregation
• Livestock feed not necessarily regional
Closing comments
Placing the work in context

Midwest relative to Northeast:

• Climate is similar
• Population density is lower
• Area in agriculture is much greater
• Expect greater biological capacity to meet food needs
Directions for future work

• Foodprints and Foodsheds Project:
  – Complete models for states of interest
  – Complete models for conterminous U.S.
  – Dissemination through papers

• Enhancing Food Security of the Northeast:
  – Foodprint of Northeast
  – Interdisciplinary team of modelers