U.S. Food and Drug Administration

U.S. Department of Health and Human Services

CENTER FOR FOOD SAFETY AND APPLIED NUTRITION

Management and Surveillance of Imported Spinach from Mexico Using GIS

By:

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Agenda

- **Background and Purpose**
- **Prepare and pre-process the data**
- **Visualize spinach imported from Mexico with GIS**
- **Explore the patterns and trends of imported quantities of spinach from Mexico with GIS**
- **Identify areas of greatest concern and speed recall and environmental investigations**
- **Discussion and Conclusion**

Background

- Food safety is a core public health issue
- Millions of foodborne illnesses occur each year in the U.S.
- Foodborne illness hazard can be minimized by maintaining high standards of surveillance during all the stages along the production, distribution, and consumption chain.
- Identify sources of problems and find ways to prevent and/or eliminate them.

Most common foods associated with foodborne outbreaks (why spinach?)

10 Unexpectedly Risky Foods (CDC data1990—2006: http://abcnews.go.com/print?id=8753705):

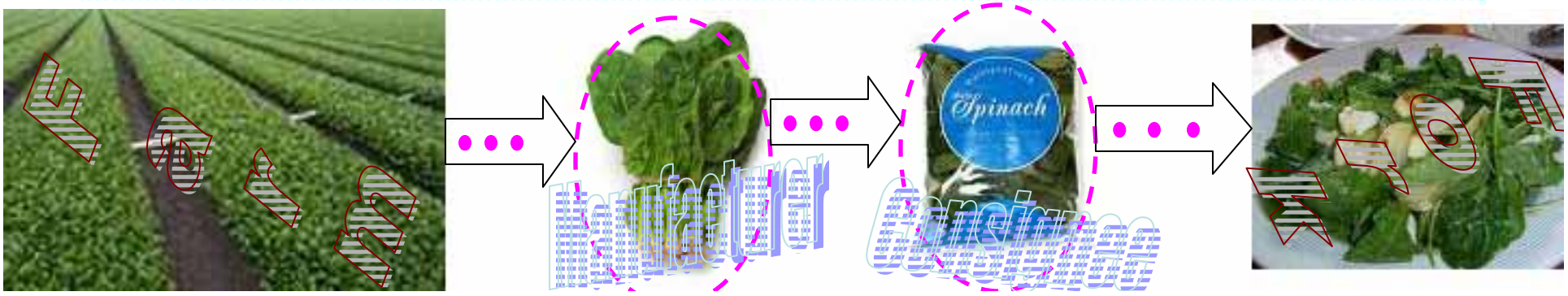
- **Leafy Greens (363 outbreaks)**
- Eggs (352 outbreaks)
- Tuna (268 outbreaks)
- Oysters (132 outbreaks)
- Potatoes (108 outbreaks)
- Cheese (83 outbreaks)
- Ice Cream (74 outbreaks)
- Tomatoes (31 outbreaks)
- Sprouts (31 outbreaks)
- Berries (25 outbreaks)

What a surprise! ***Leafy greens***?

We select spinach as a preliminary case study.

Key Issues of Spinach Supply Chain data

- **Data Gap:** No spinach life-cycle (a.k.a: from farm to fork) data
- **Data Unstructured**: Interpreting the information about the safety of our food supply chain is frequently very difficult
- **Lack of Spatio-temporal Analysis Function:** Decision makers feel they do not have the type of information support to make good decisions



Purpose/Motivations of the study

- *Recent events (such as jalapeno peppers of 2008) have exposed weakness in our produce safety net*
- *International trade in produce will continue to increase*
- Desire to have *technology* support data management and surveillance

This study tailored the specific situations for spinach imported from Mexico.

Typical Life-cycle of Spinach Imported from Mexico

Farms

Locations are typically not included

Manufacturer (MFR)

FDA dataset has clues about the MFRs.

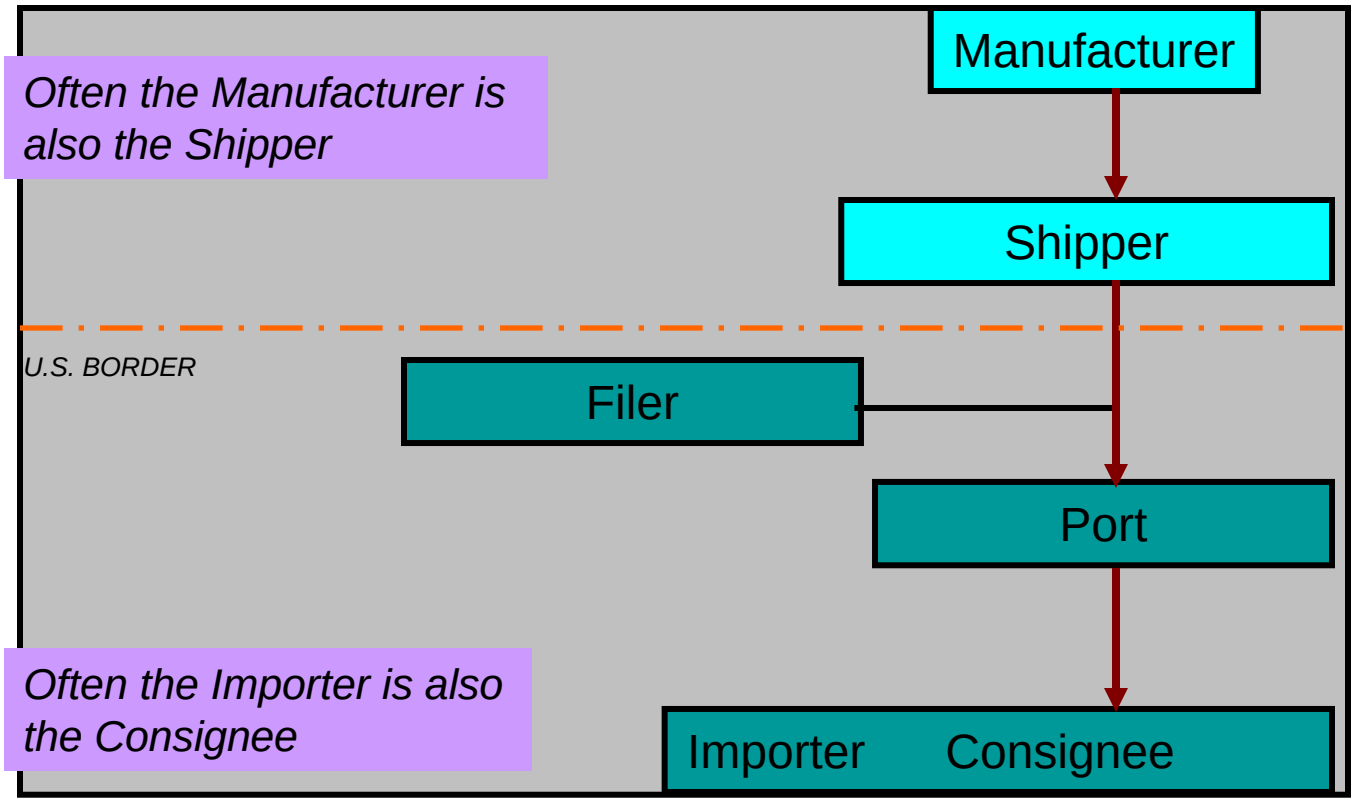
Consignee (CON)

FDA dataset has address of CONs.

Fork/Table

Could be traced by the info of membership card and/or credit card

Availability of data of FDA's datasets



Often the Manufacturer is also the Shipper

Often the Importer is also the Consignee

Manufacturer's address is available, but it may not be where the raw materials are packaged. ***We do not have street maps of Mexico… For incorporating into spatial database, the coordinates were assigned to the city-level they belong.***

Consignee or Importer's address is available, but it may not be where product is sold. ***For incorporating into spatial database, we geocode them based on their addresses.***

The current FDA's dataset is far from complete, but we could still **initialize** a geodatabase for monitoring movement of spinach from Mexico to USA .

Prepare and pre-process the data

We requested three years data, the raw imported spinach data are three **EXCEL files**:

- FY08 (10/2007-09/2008) 1685 shipments; 507.8 million kilograms
- FY07 (10/2006-09/2007) 2157 shipments; 130.7 million kilograms
- FY06 (10/2005-09/2006) 3291 shipments; 48.7million kilograms

FY06—FY08: number of shipments decreased while the quantity increased sharply.

Overview of the data

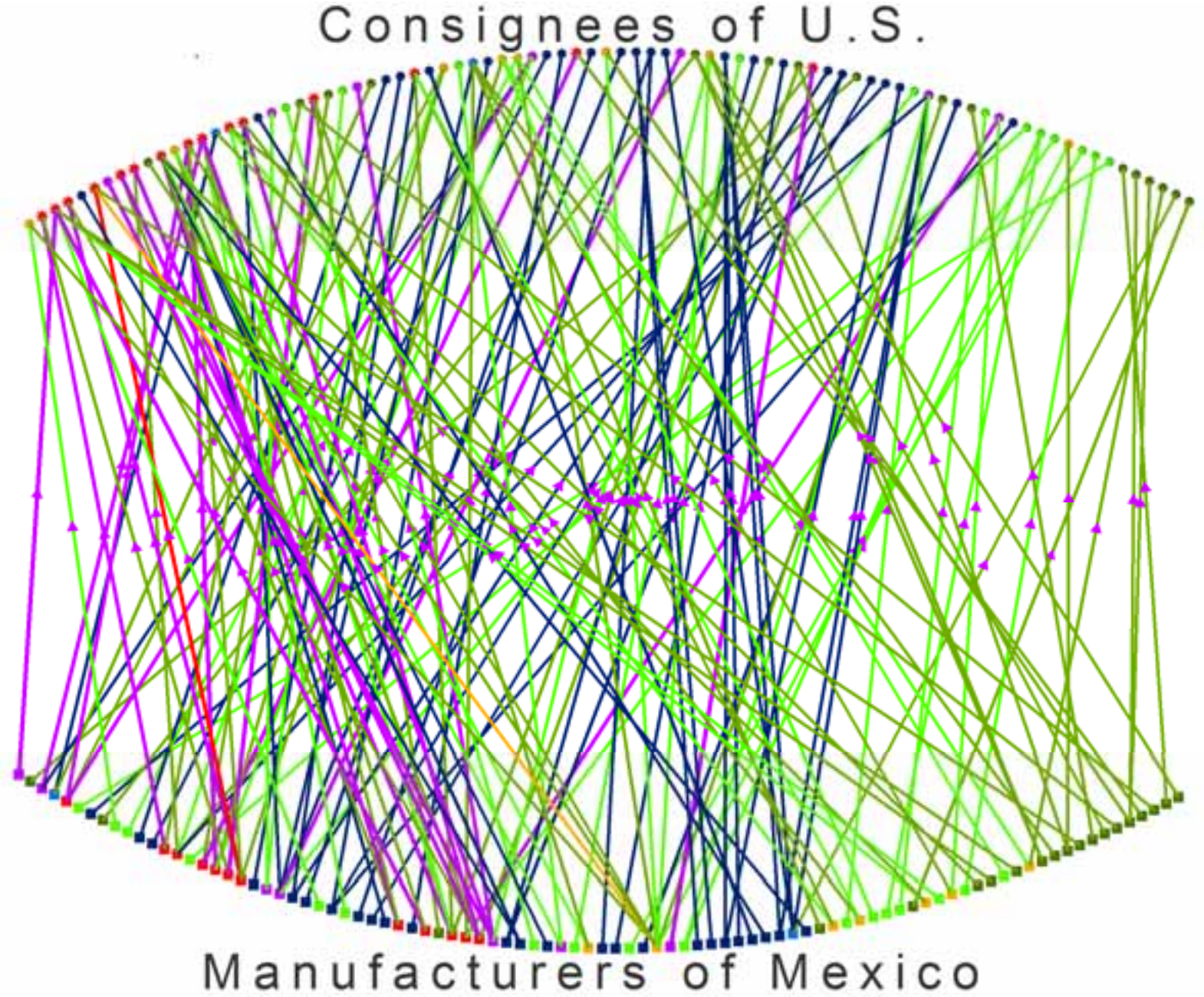
	FY06	FY07	FY08	Total (Unique)
#Manufacturer	46	43	41	90*
#Consignee	47	42	41	83**
#Activated trade-relationship	65	60	57	159***
#Port	7	8	8	9#

*90 Manufacturers: 12 (3-year); 7(FY06 &FY07); 7(FY07 &FY08); 2(FY06 &FY08); 25 (FY06 only); 17 (FY07 only); 20 (FY08 only)
**83 Consignees: 15 (3-year); 7(FY06 &FY07); 8(FY07 &FY08); 2(FY06 &FY08); 23 (FY06 only); 12 (FY07 only); 16 (FY08 only)
***159 Activated trade-relationships: 1 (3-year); 20(FY06 &FY07); 1(FY07 &FY08); 44 (FY06 only); 38 (FY07 only); 55 (FY08 only)
#9 Ports: 7 (3-year); 1 (FY07 only); 1 (FY08 only)

Visualize spinach imported from Mexico with GIS

- Create **demo** pictures: Demonstrate the spinach supply chain regardless of the real locations
- Geocode consignees and manufacturers into GIS point files
- Represent the spinach supply chain with the GIS polyline file
- Put the GIS files into a food-safety-focused geodatabase

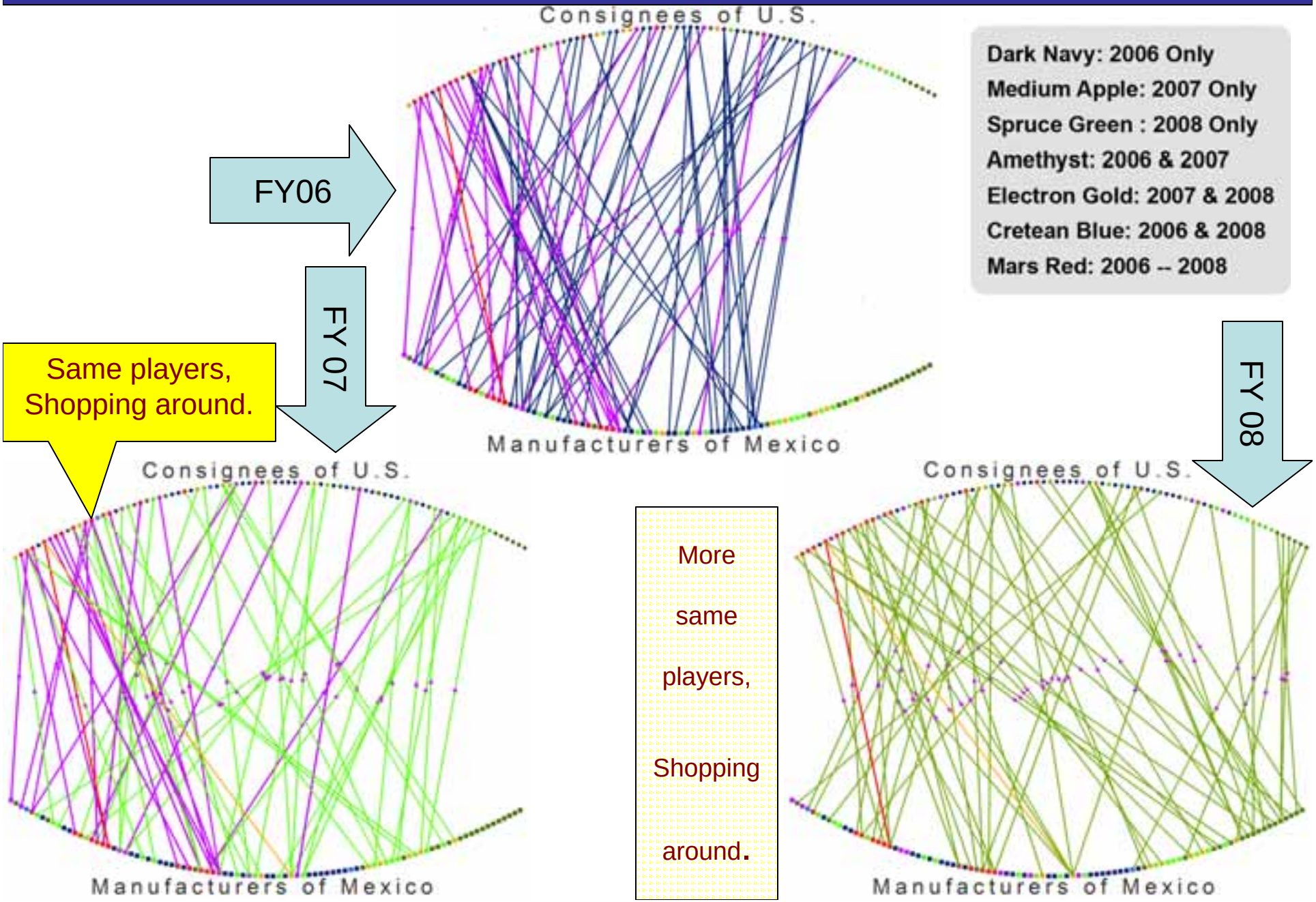
All activated manufacturer-consignee trade relationships



Big-picture 1:
83 CONs,
90 MFRs
159 supply chains.

Dark Navy: 2006 only;
Medium Apple: 2007 only;
Spruce Green: 2008 only;
Amethyst: 06 & 07;
Electron Gold: 07 & 08;
Cretean Blue: 06 & 08;
Mars Red: 06—08.

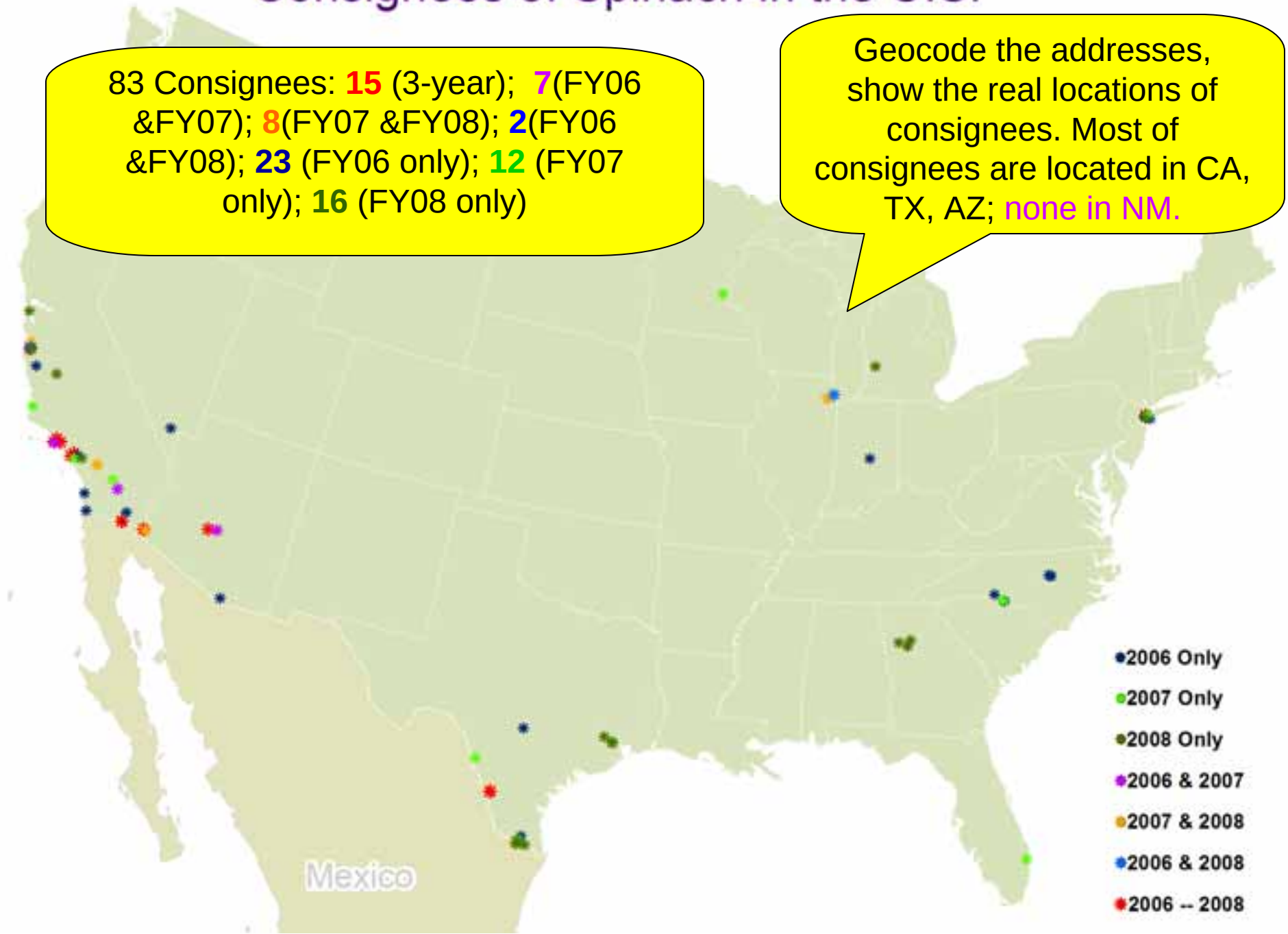
Activated manufacturer-consignee trade relationships By Year

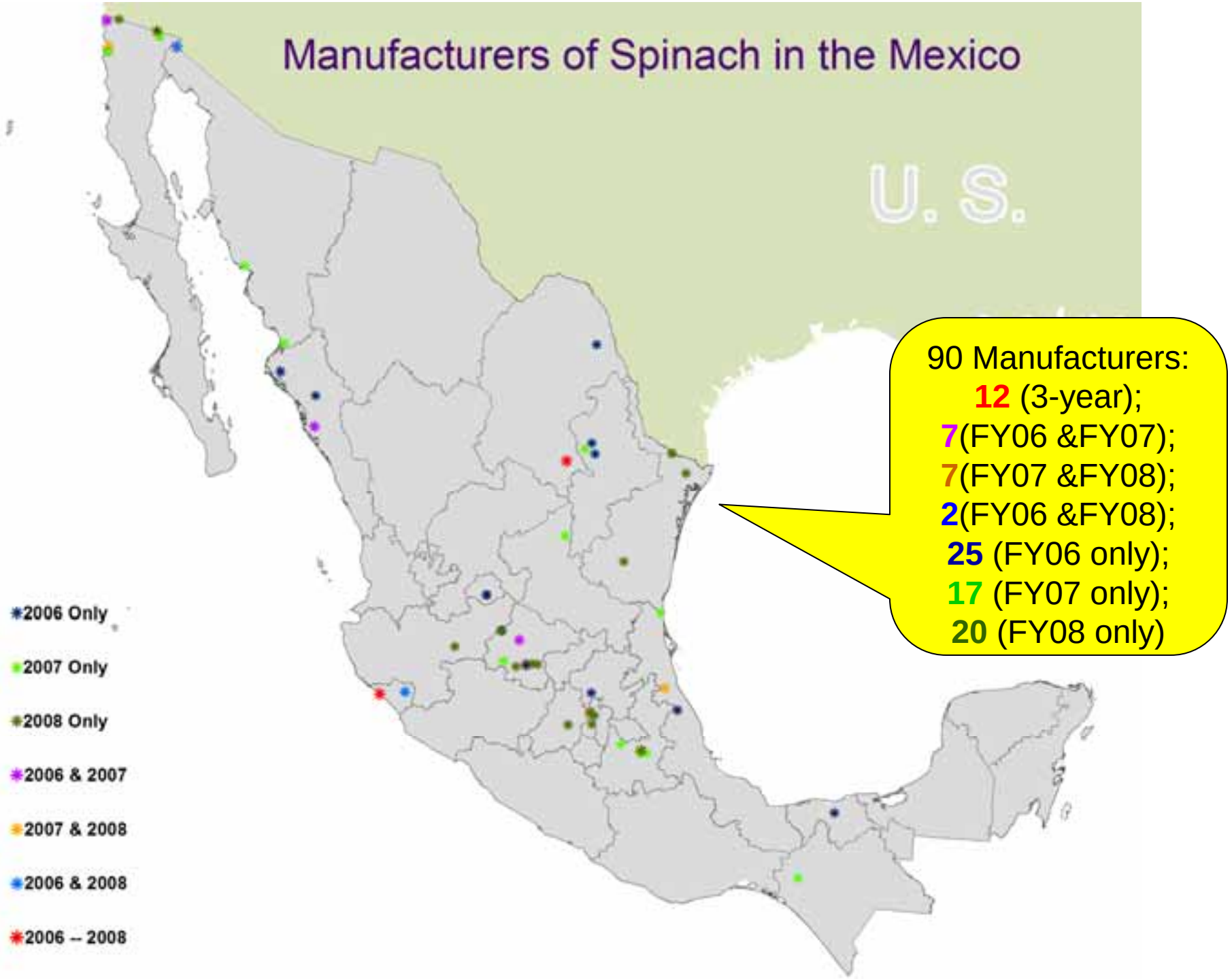


Consignees of Spinach in the U.S.

83 Consignees: **15** (3-year); **7**(FY06 &FY07); **8**(FY07 &FY08); **2**(FY06 &FY08); **23** (FY06 only); **12** (FY07 only); **16** (FY08 only)

Geocode the addresses, show the real locations of consignees. Most of consignees are located in CA, TX, AZ; none in NM.




Manufacturers of Spinach in the Mexico
U. S.
2006 Only
2007 Only
2008 Only
2006 & 2007
2007 & 2008
2006 & 2008
2006 -- 2008
90 Manufacturers:
12 (3-year);
7(FY06 &FY07);
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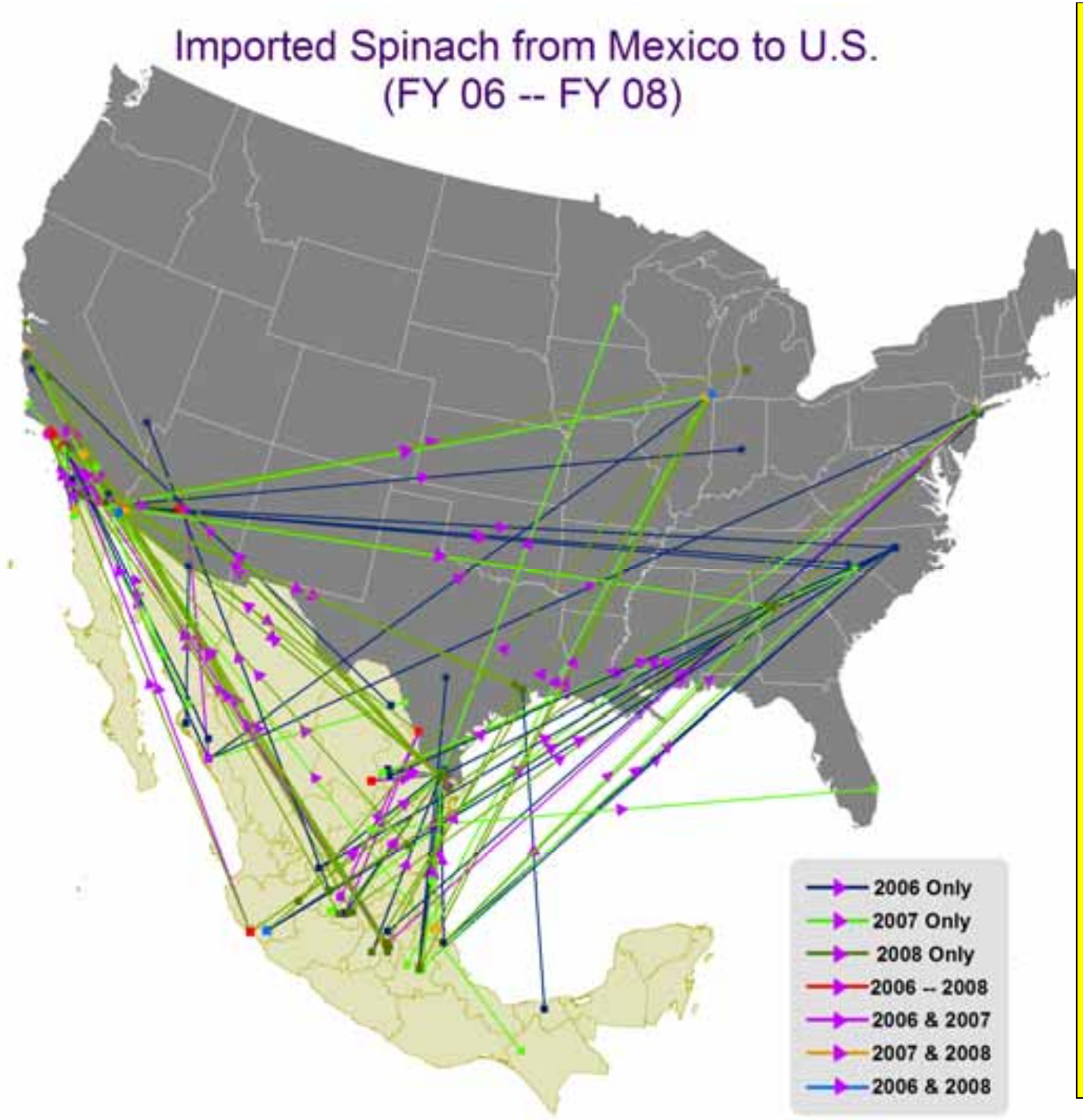


Geovisualize:

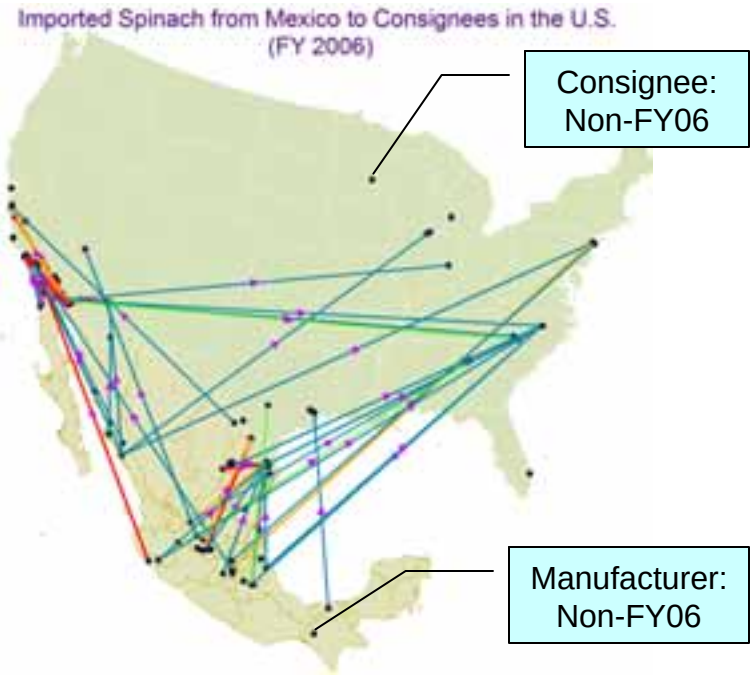
83 CONs,

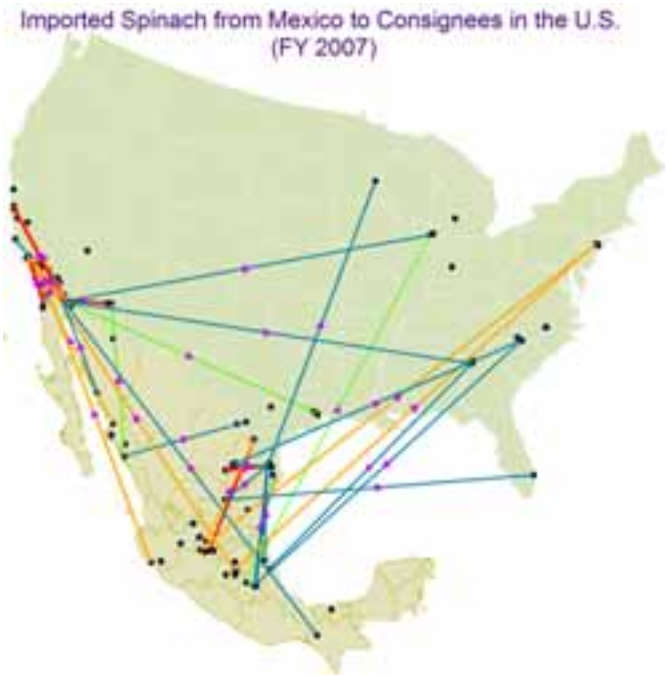
90 MFRs, and

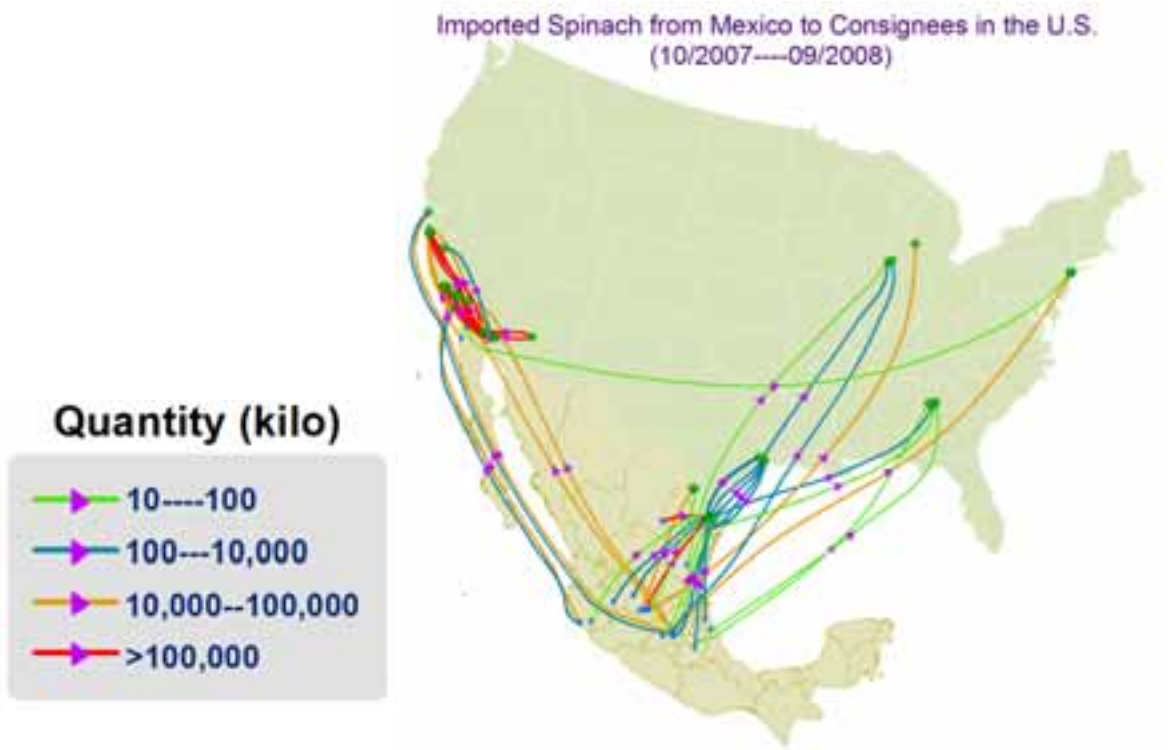
159 supply chains.

Explore the patterns and trends of imported quantities of spinach from Mexico

- Time frame: yearly -- the changes between different years;
- Time frame: monthly (FY06, FY07 and FY08 share the similar pattern, we use FY08 as an example).
- Time frame: daily (April of 2008 as an example)







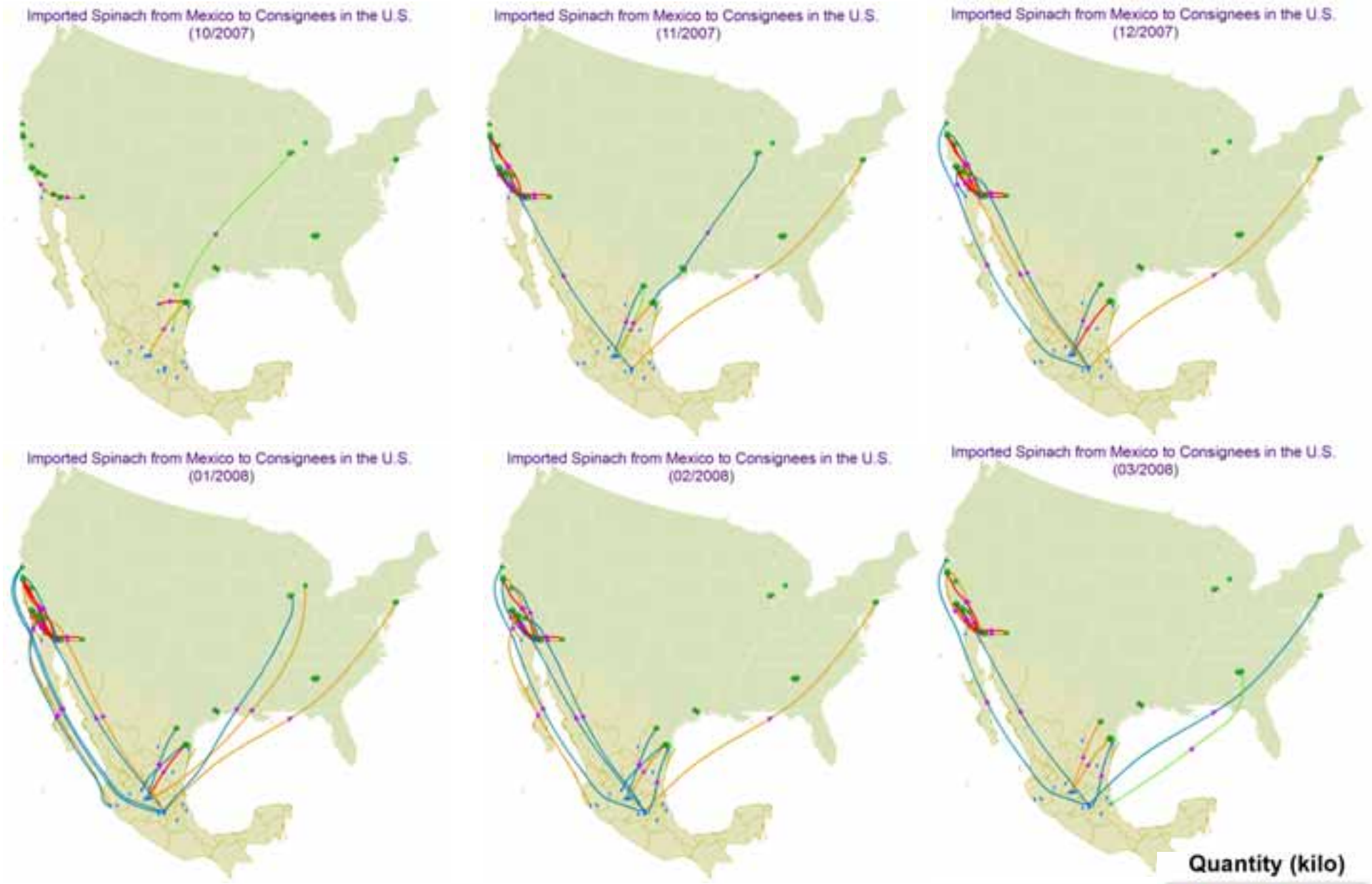
Represent all of the active relationships between the MFRs and CONs in a year as well as the relative shipment quantities associated with these relationships.

FY06: fewer orange lines and red lines than navy lines;
FY07: more orange lines than FY06;
FY08: there are lots of red lines, quantities have sharply increased.

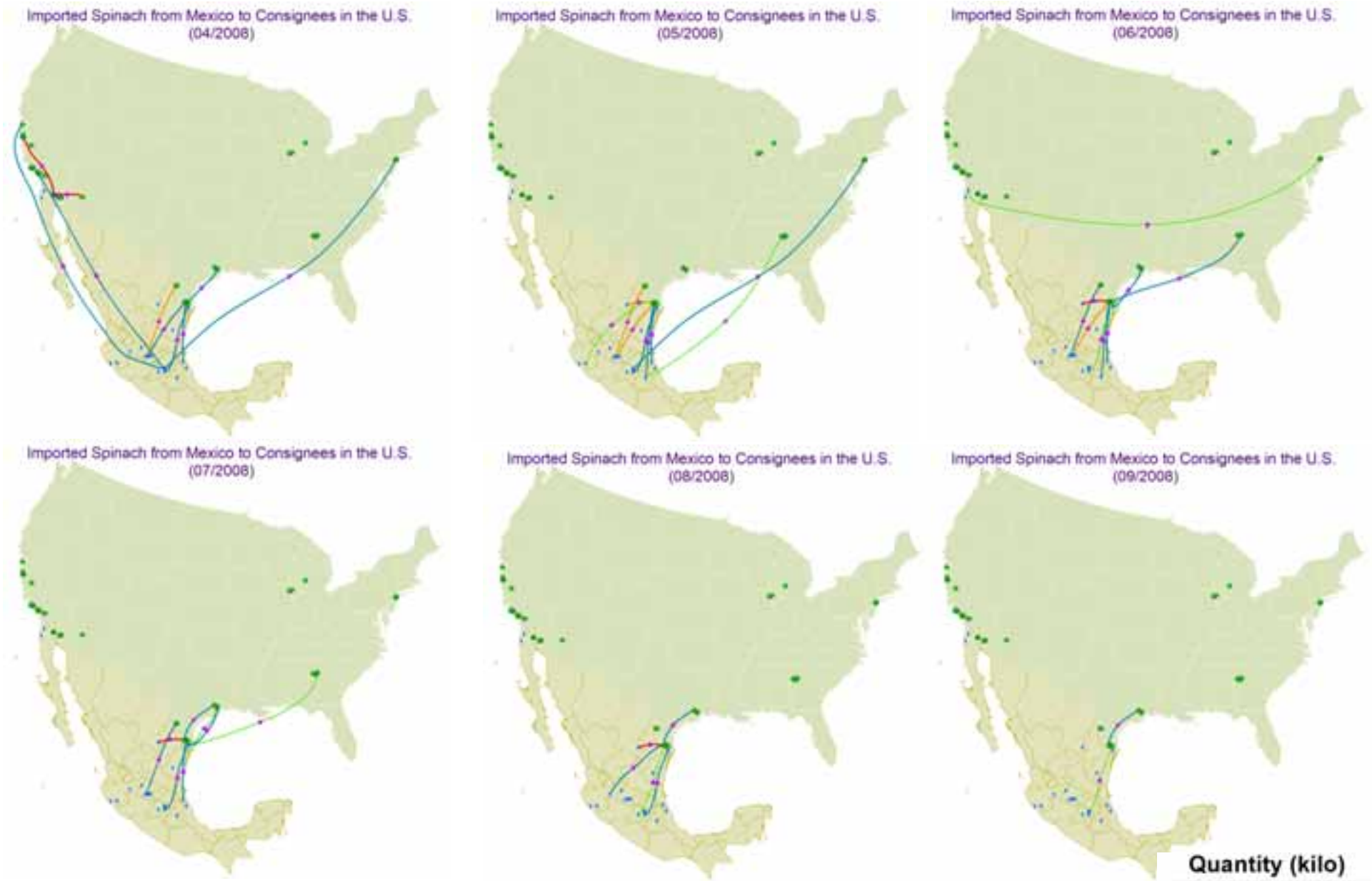
Monthly GIS Map

- Spatial patterns of both manufacturers (Area border on CA and central Mexico) and consignees (CA and others)

- Timeline: Dramatic change between April and May of 2008



Each figure represents all of the active relationships in a month as well as the relative shipment quantities associated with these relationships. From November, the importation sharply increased.



Each figure represents all of the active relationships in a month as well as the relative shipment quantities associated with these relationships. The importation pattern sharply changed between April and May.

Quantity (kilo)

10----100

100---10,000

10,000--100,000

>100,000

Let's focus on the April and May. There is a sharp pattern change, but when? May 1st?

Daily GIS Map: This could also serve as a real-time alarm system to report anomaly imported quantities

Dramatic change after **April 07, 2008**!

To play the movie, please click the blue box!

This *movie* represents the daily activities in April of 2008 as well as the relative shipment quantities associated with these relationships.

Identify areas of greatest concern and speed recall and environmental investigations

- Targeted Consignee → Manufacturers
- Targeted Manufacturer → Consignees

Case 1: there are illnesses caused from eating spinach distributed by the consignee.

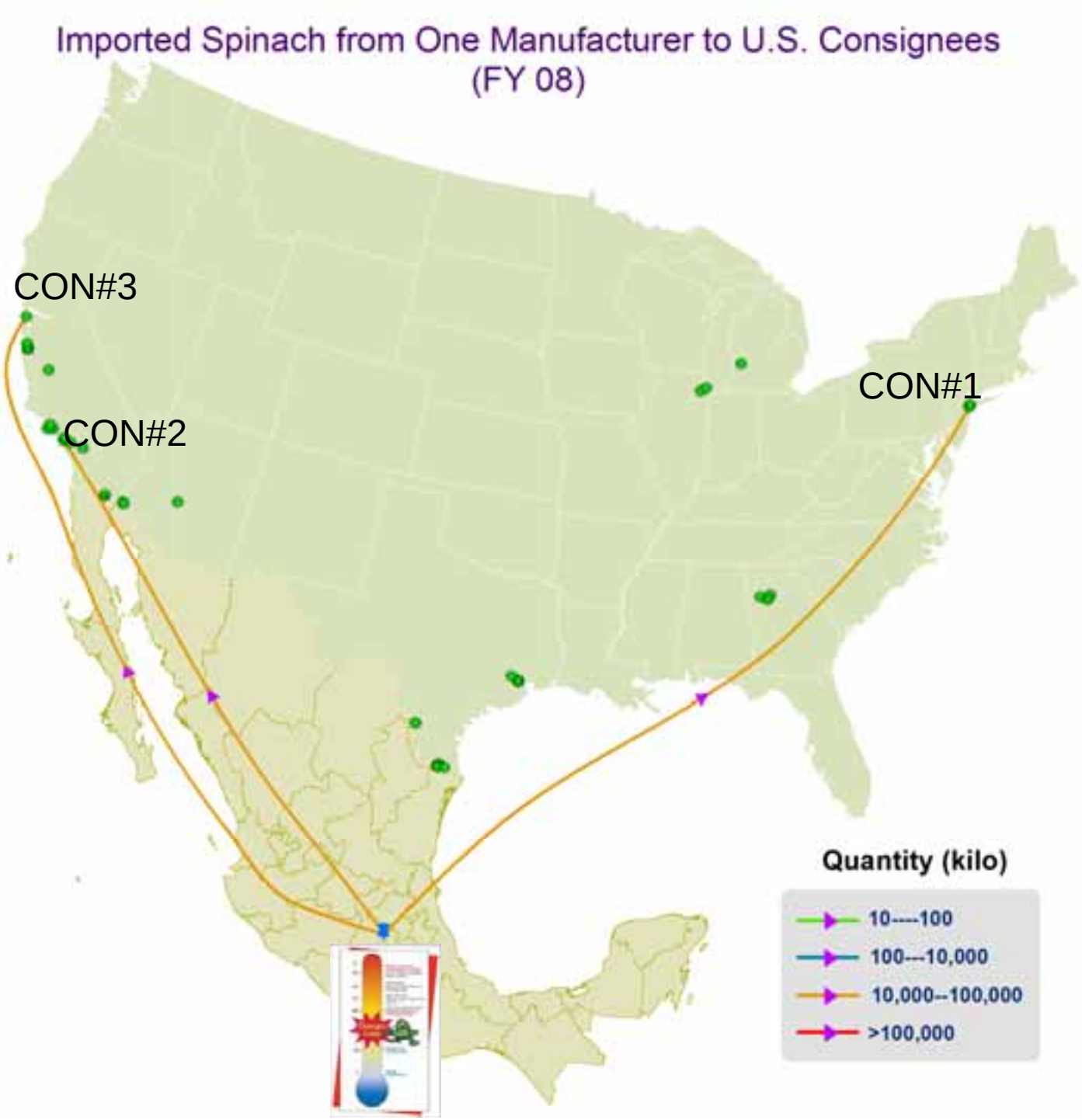
Query geodatabase:

1) Timeline of supply: 12/2007 to 03/2008.

2) MFR#1 supplied: 03/2008;

3) MFR#2 supplied: 12/2007 to 02/2008.

The above information will narrow geographical areas for further actions.



Case 2: the potentially hazardous spinach are found at the manufacturer.

Query geodatabase:

1) Timeline of supply: 11/2007 to 05/2008.

2) Supplied to CON#1: 11/2007 to 05/2008;

3) Supplied to CON#2: 11/2007 to 04/2008;

4) Supplied to CON#1: 12/2007 to 04/2008.

The above information will speed recall and communication…

Discussion and Conclusions

- Identify movement/quantity trends in space and time
  - Times of peak quantities/number of shipments
  - Seasonal patterns in movement/quantity
  - Spatial variation of suppliers
  - Identify when/ where to step up surveillance efforts
- Visualize/track all of the ‘players’ and relationships
  - Manufacturers / Consignees relationships
  - Develop GIS tool to look at relationships by Month, Week, and Day
  - Quickly evaluate data and identify all shipments possibly associated with an outbreak

Imports - Obstacles

- Incomplete product lifecycle tracked in current dataset / Address information may not follow path of commodity movement
  - Difficulty with traceback and trace forward
- Cannot geo-code data to find locations at street level in many countries
- Spatial information that can be used to perform an environmental risk assessment may be limited
  - Issues: Scale, accuracy, accessibility, how often updated etc.

References

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- Bill Davenhall, “The role of GIS in national health reform—Making better decisions through place-based intelligence”, Federal GIS Connections, ESRI Winter 2009/2010, pp9.

Questions?

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Thanks!