Integrating Disease & Environmental Variables: The Case of Cryptosporidiosis & Dairy Farms in Massachusetts

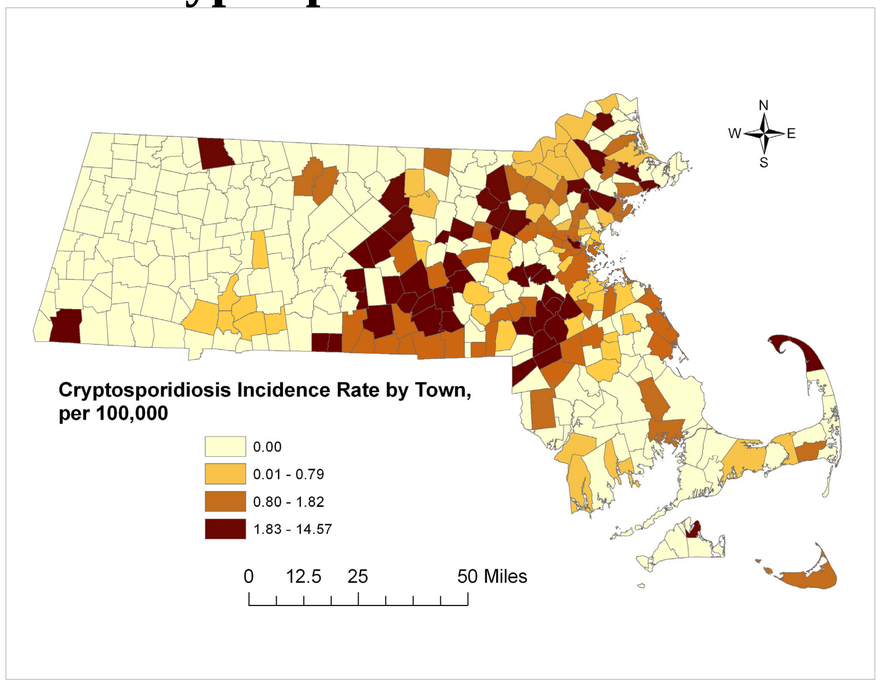
Objective:

Using Massachusetts dairy farm locations and Cryptosporidiosis incidence as examples, this project demonstrates the application of GIS for the integration of environmental variables with incidence of disease. Each of these maps represents a variable which will be useful in future statistical analyses of environmental factors affecting incidence of Cryptosporidiosis.

Background:
Cryptosporidium is present in 60-97% of our surface waters. Many of us have been exposed to the two species affecting humans, either *Cryptosporidium parvum* (CP) or *hominis* (CH), at some point in our lifetime. The result is diarrhea and nausea, ranging from mild to severe. Although healthy people recover easily, Cryptosporidiosis is a life threatening disease for immunocompromised individuals and the elderly. Cryptosporidiosis incidence is vastly underreported throughout the United States, although it is accountable for the largest water supply contamination outbreak in U.S. history, in Milwaukee in 1993.

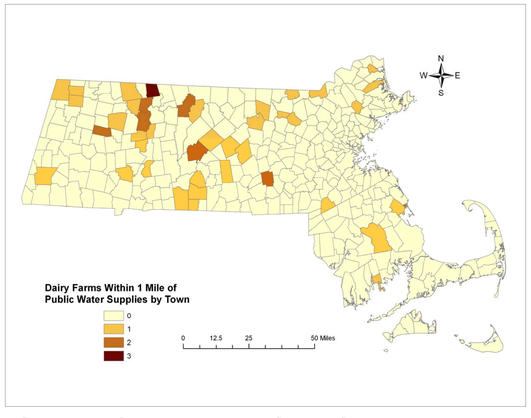
The Massachusetts Department of Public Health passive surveillance data for Cryptosporidiosis incidence from 1993-2003 does not classify by species. Therefore incidence in a town may reflect contamination by *parvum* (carried predominately by cattle) or by *hominis* (carried predominately by people).

Cryptosporidiosis Incidence



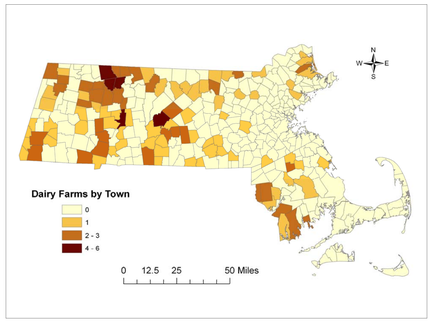
Cryptosporidiosis rates are highest on average in urban areas, possibly indicating presence of *C. hominis* (the species passed between humans). Two western Mass towns show high rates of Cryptosporidiosis.

Proximity of Dairy to Water Supply Intake

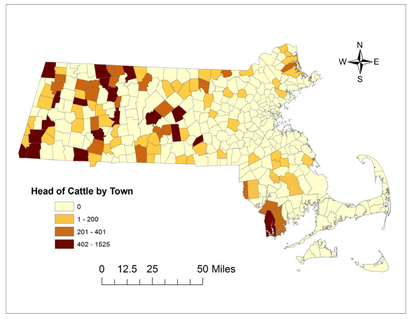


For this map, three water supply attributes were grouped for buffering purposes: surface, ground, and emergency surface. The three grouped attributes represent public water supply sources susceptible to contamination by dairy cow manure. A town may not have any dairies within its' boundaries, but if it has a water supply intake within 1 mile of a dairy farm, it is accounted for by this map. This is useful because water contamination transcends town boundaries.

Number of Dairy Farms by Town



Number of Dairy Cows by Town



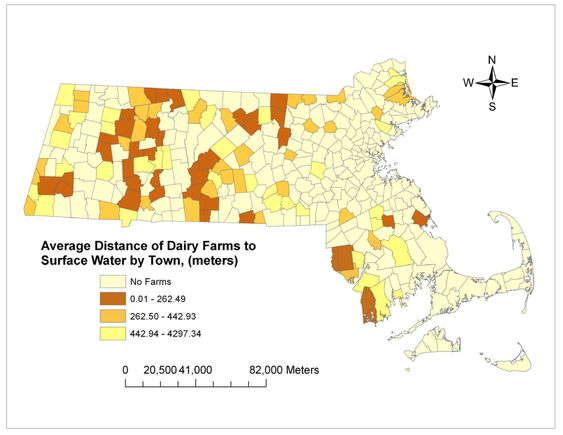
TOWN_ID	TOWN	POP2000	Dairy Farms	Number of Cattle	Farms w/in 1 mile of Public Water Supplies	Avg. Distance to Rivers	COUNTY	LANDAREA of Town (sq. miles)	POP.DENSITY	Number of Crypto Cases	Rate of Crypto Cases
66	COLRAIN	1813	6	825	3	272.19	F	43.38	41.80	1	5.56
67	CONCORD	16993	0	0	6	0.00	M	24.92	682.00	9	5.30
68	CONWAY	1809	3	0	2	387.13	F	37.71	48.00	0	0.00
69	CUMMINGTON	978	3	600	2	88.66	HS	23.05	42.40	0	0.00

The table above represents an example of how dairy farm attributes are integrated with incidence data.

The Dairy Cattle Factor:

Several forms of *Cryptosporidium* are carried by livestock and wild animals. Dairy farms have often been identified as one possible culprit in outbreaks, due to high rates of infection in calves. In Massachusetts there are approximately 189 dairy farms, and 9,000 head of cattle. Unfenced and heavily fertilized farm-land (with manure) bordering rivers is common. Due to manure run-off caused by intensive rain events common in Massachusetts, dairies near rivers and surface water supply intakes can be considered potential sources of contamination of water supplies.

Dairy Farms Near Surface Waters



The near tool defined the proximity of the closest surface water source to each dairy farm by town. These distances were averaged by town to generate this map.

Caveats:
Because water is a transboundary resource, waste from one town may affect another town or several towns downstream. This study does not include water flow variables or elevation, both of which could significantly change the potential for a town's water supply to be impacted by a neighboring dairy farm. Positions of dairy farms were georeferenced to the Masschusetts State Outline using a scanned map. Therefore, a high potential for error exists when measuring distance between farms and other points, such as water variables.

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Map Projection: Massachusetts State Plane 1983
Resources: MassGIS
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Centers For Disease Control