EPA METHOD FOR ESTIMATING LIVESTOCK NH_3 AND VOC EMISSIONS FOR VERSION 2 OF THE 2014 NATIONAL EMISSIONS INVENTORY (NEI)

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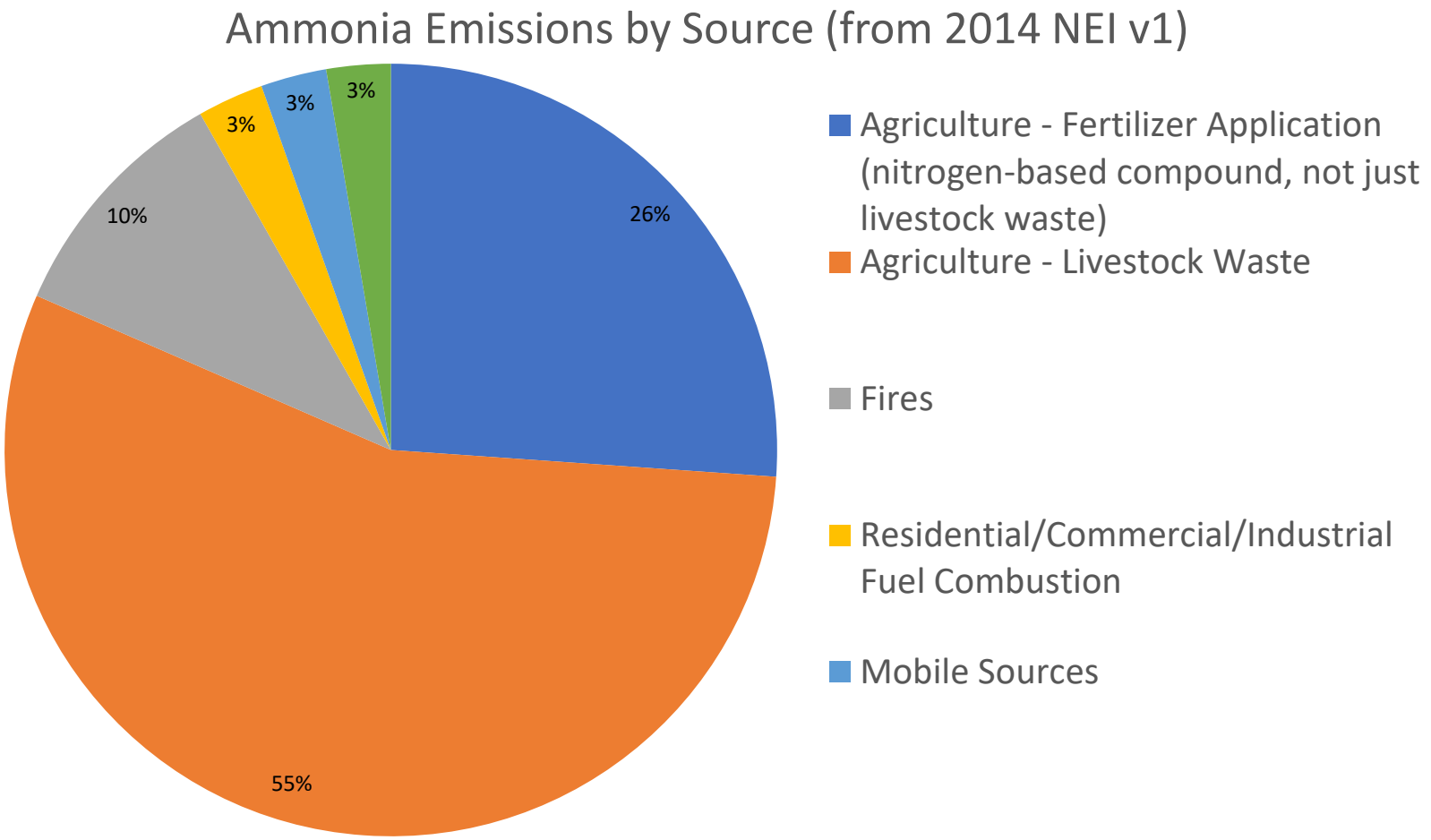
Introduction

- Ammonia (NH_3) emissions attributable to livestock production derive from the manure produced during the grazing/housing of the animals and from the storage and application (as fertilizer) of the livestock manure.

- Volatile Organic Compounds (VOCs) emitted by livestock can be defined as any compound of carbon that can participate in atmospheric photochemical reactions and is emitted by livestock. Note: This excludes carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate.

Introduction



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Background

- Livestock NH_3 NEI estimates for 2011 and 2014 were derived from Carnegie Mellon University's (CMU) livestock ammonia process-based model.
- 2011 NEI estimates were based on an earlier CMU model version, in which 42 dis-aggregated source classification codes (SCCs) were used to describe a comprehensive set of animal types.
- 2014 NEI v1 estimates are based on a newer CMU model, in which only 5 SCCs are used to report emissions from a comprehensive set of major animal types: beef, swine, chickens (layers and broilers separated), and dairy.
  - CMU model produces daily-resolved, county-level NH_3 emissions based on a particular distribution of management practices for each county and animal type.
  - Model emission factors generated from literature-based emission factors and observations from the National Air Emissions Monitoring Study (NAEMS).
  - Population ("head count") data is derived from the county-level 2012 U.S. Department of Agriculture (USDA) Census, adjusted to 2014 using 2014 state data.
- EPA received comments from SLTs regarding the uncertainty in the animal counts used for v1 and some errors were found and corrected in v2 pertaining to how animal counts/emissions were assigned to counties.

General Methodology

2014 NEI V2

- Estimated 2014 county-level animal populations using USDA 2014 Survey and 2012 Census data.
- Used NH_3 emission factors (EFs in kg/head/year) derived from CMU's process-based livestock ammonia emissions model. These EFs are uniform by state and animal type.
- Multiplied the county animal populations by the estimated NH_3 EF for each state and animal type to compute emissions per year.
- Derived VOC emissions by multiplying a ratio of VOC to NH_3 by the NH_3 inventory.
- For every county and animal type, NH_3 emissions are estimated as: animal population * EF (tons of emission/animal/year)

Details – Animal Populations

- Updated animal population/livestock count data were obtained primarily from the USDA National Agricultural Statistics Service (NASS) Quick Stats program:
  - The 2014 USDA Survey was used to obtain the livestock count for as many counties as possible across the United States.
  - Animal populations of a particular type in counties with only one farm of that type are not reported (NR) by USDA due to confidentiality.
  - Because it is not clear if county populations listed as NR in the 2014 Survey are that way for confidentiality or they are 0, the USDA 2012 Census was used to augment the 2014 Survey.
  - For counties with NR in 2014, but not in 2012, a 2014 population was estimated by dividing the state 2014 population by the state 2012 population and applying this factor to the 2012 county population.
  - For counties that did not report (NR) animal populations in 2012 or 2014, a “gap filling” procedure was used. The animal counts from counties in a given state that did report were totaled and subtracted from the 2014 state total. The balance was equally apportioned to the missing counties.

Details – Animal Populations

Animal Type	Source
Chicken Broilers	The inventory reflects the 2012 state level totals, because no 2014 data is available in the Survey at either the county or state level. County level populations were adjusted to ensure that the county totals match the 2012 state level totals.
Chicken Layers	The inventory is based primarily on the 2012 Census. There were 30 states with 2014 state level population data, and the 2012 county level populations for those states were adjusted to reflect the change in population between 2012 and 2014 state level totals.

Details – Animal Populations

Animal Type	Source
Swine	The NEI 2014 v1 inventory had four states with 2014 county level data (MT, NC, ND, OK). These states were not changed for v2. The other 46 states were updated to reflect the 2014 state level total. The county populations were adjusted to reflect the change in population between 2012 and 2014 state level totals.

Details – Animal Populations

Animal Type	Source
Dairy Cattle	Counts are based on 2014 Survey data where available, and counties with missing data are “gap filled” using the algorithm described on the bottom of slide 6. Data for each state matches the 2014 NASS state inventory totals.
Beef Cattle	Counts are based on 2014 Survey data where available, and counties with missing data are “gap filled” using the algorithm described on the bottom of slide 6. Data for each state matches the 2014 NASS state inventory totals.

Details – Population Gap Filling

	Beet Cattle	Dairy Cattle	Swine	Chicken Layers	Chicken Broilers
Number of Counties with Gap Filling (3,071 counties in database)	776 (25%)	973 (32%)	643 (21%)	433 (14%)	621 (20%)
Number of States with no Gap Filling	5	4	9	6	3

Details – Emission Factors

- NH_3 Emission Factors:
  - Back-calculated from CMU's 2014 NEI v1 inventory (emissions/animal counts) for each county and animal type.

- VOC Emission Factors:
  - Calculated using the ratio of VOC to NH_3 emissions from livestock waste.
  - Since EPA estimates do not include VOC, state-submitted VOC emissions were used to estimate this ratio.

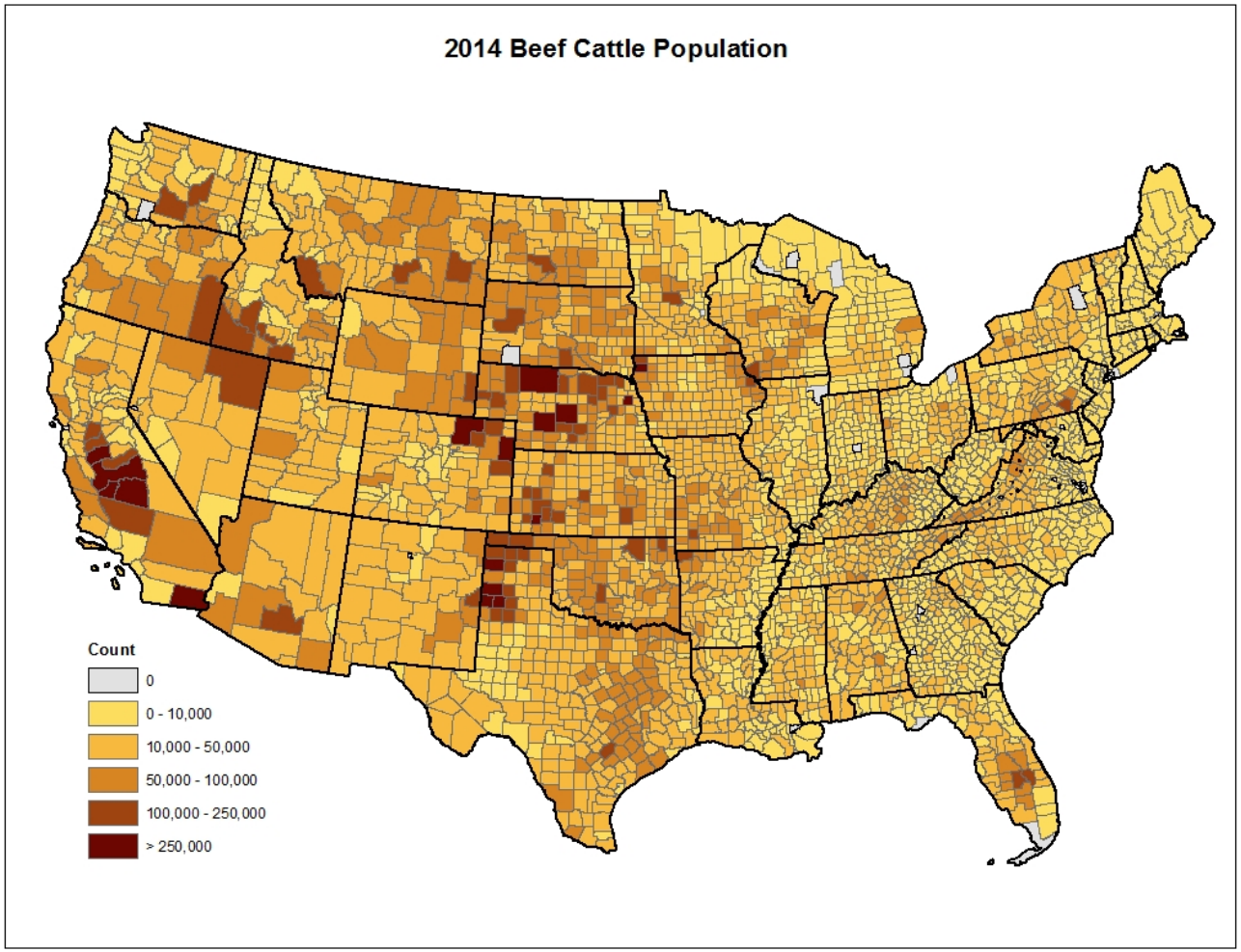
VOC Emissions

- VOC emissions had not previously been estimated by EPA for the livestock sector.
- VOC emissions are from two primary sources on a farm: livestock and silage. The EPA method for the 2014 NEI v2 does not include silage. Silage VOCs are expected to be much higher than livestock VOCs.
- Calculated VOC emissions using the ratio of VOC to NH_3 emissions from livestock waste.
- Calculated an average VOC/NH_3 ratio of 0.08 using data at the county level where both VOC and NH_3 were reported in 2014 NEI v1 by SLTs (from 3 states)
- Applied this ratio to the 2014 NEI v2 NH_3 livestock inventory to develop the county and animal type specific VOC inventory.

NH_3 Emissions Summary

Animal Type	2014 NEI v2 NH_3 Emissions (tons/year)
Beef Cattle	590,424
Dairy Cattle	225,919
Swine	722,621
Layers	73,492
Broilers	228,723

Map of Population – 2014 NEI V2



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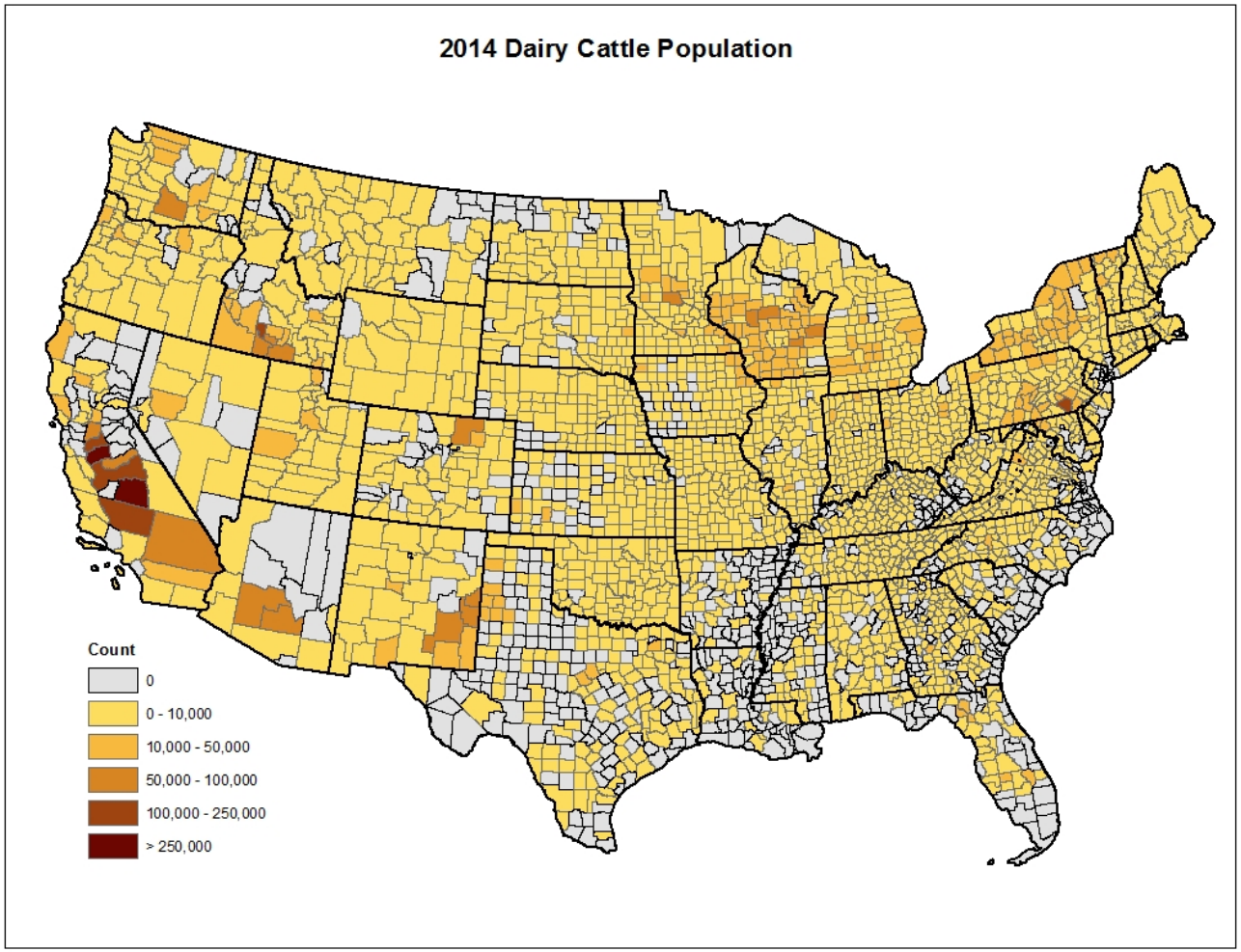

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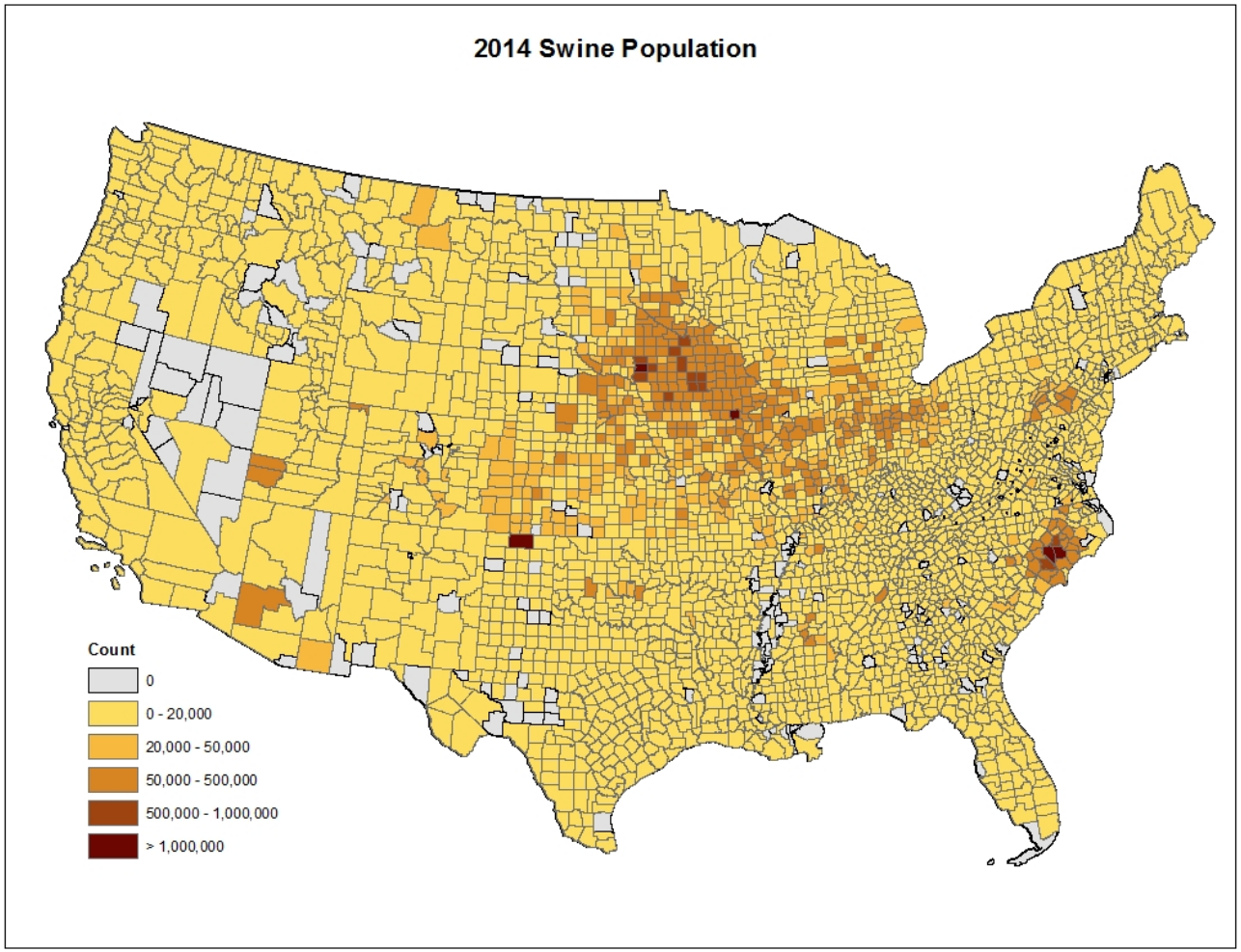

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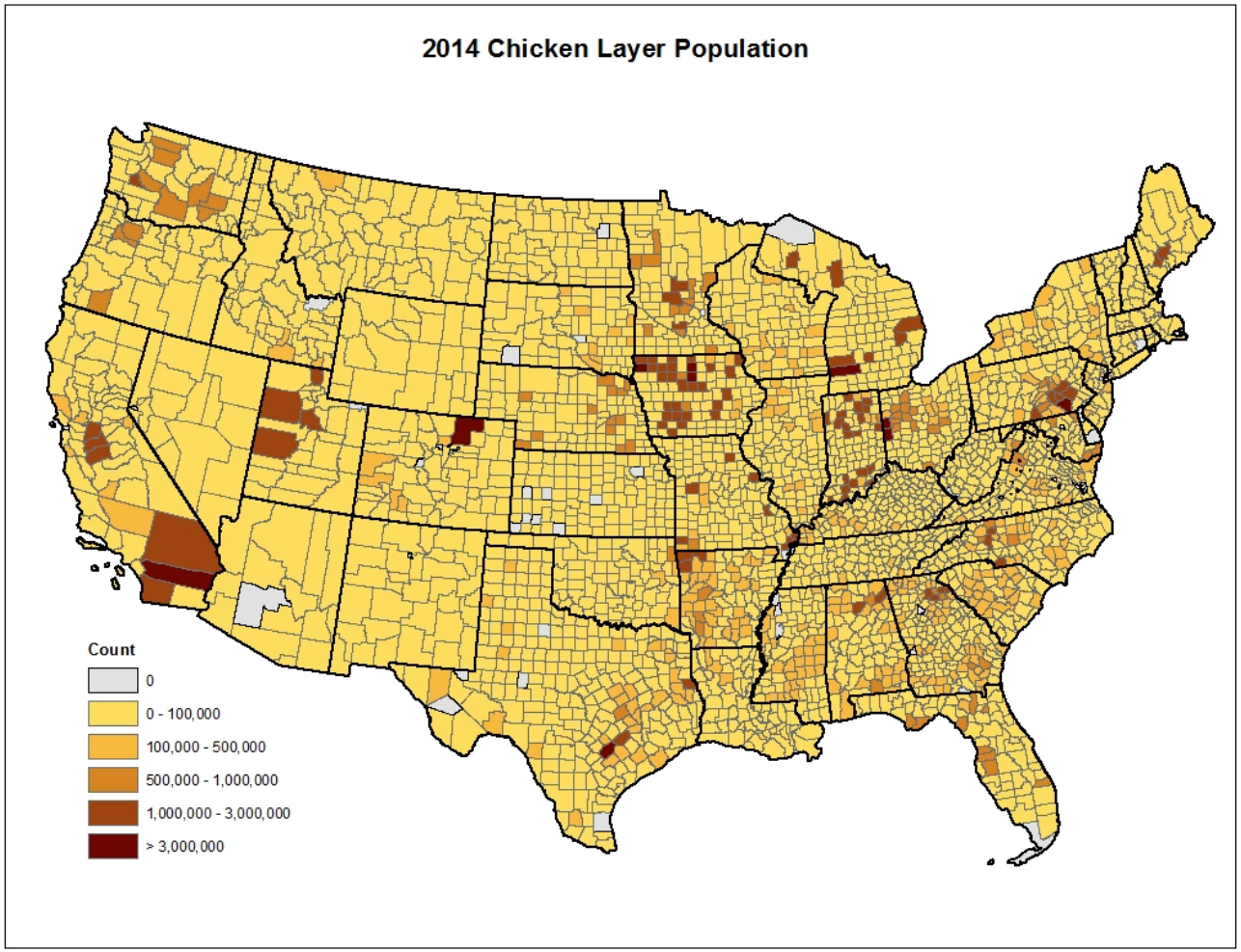

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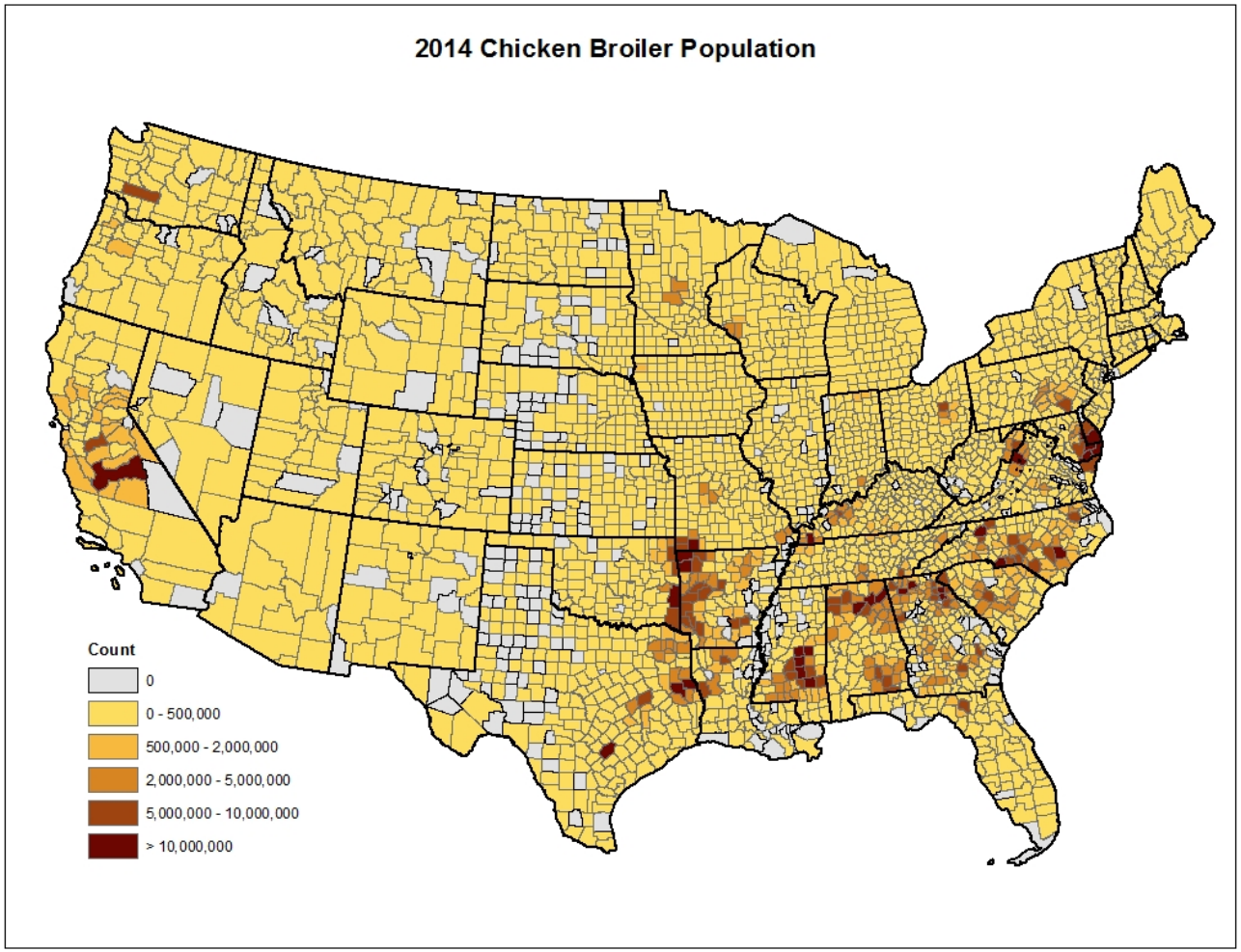
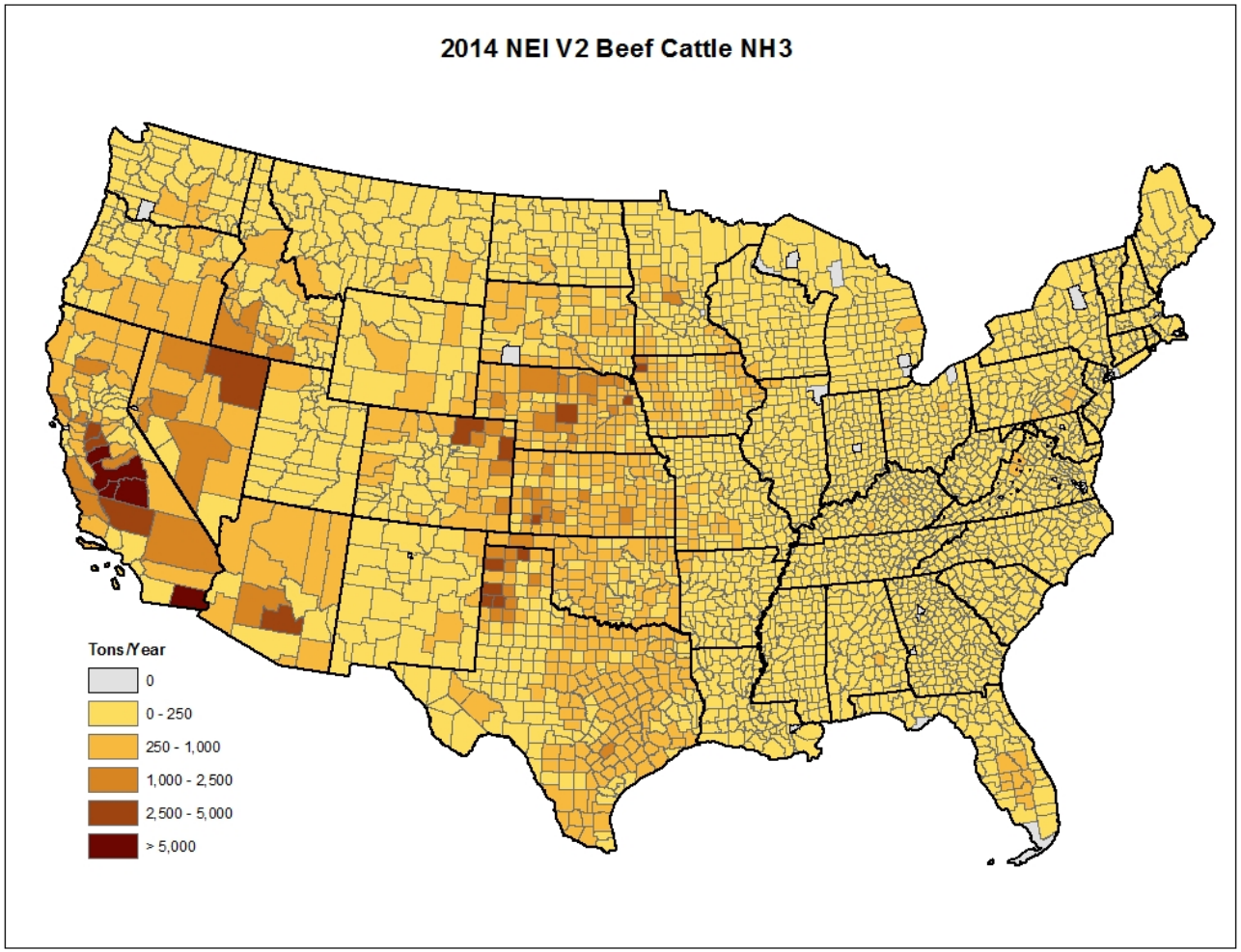


Map of Emissions – 2014 NEI V2



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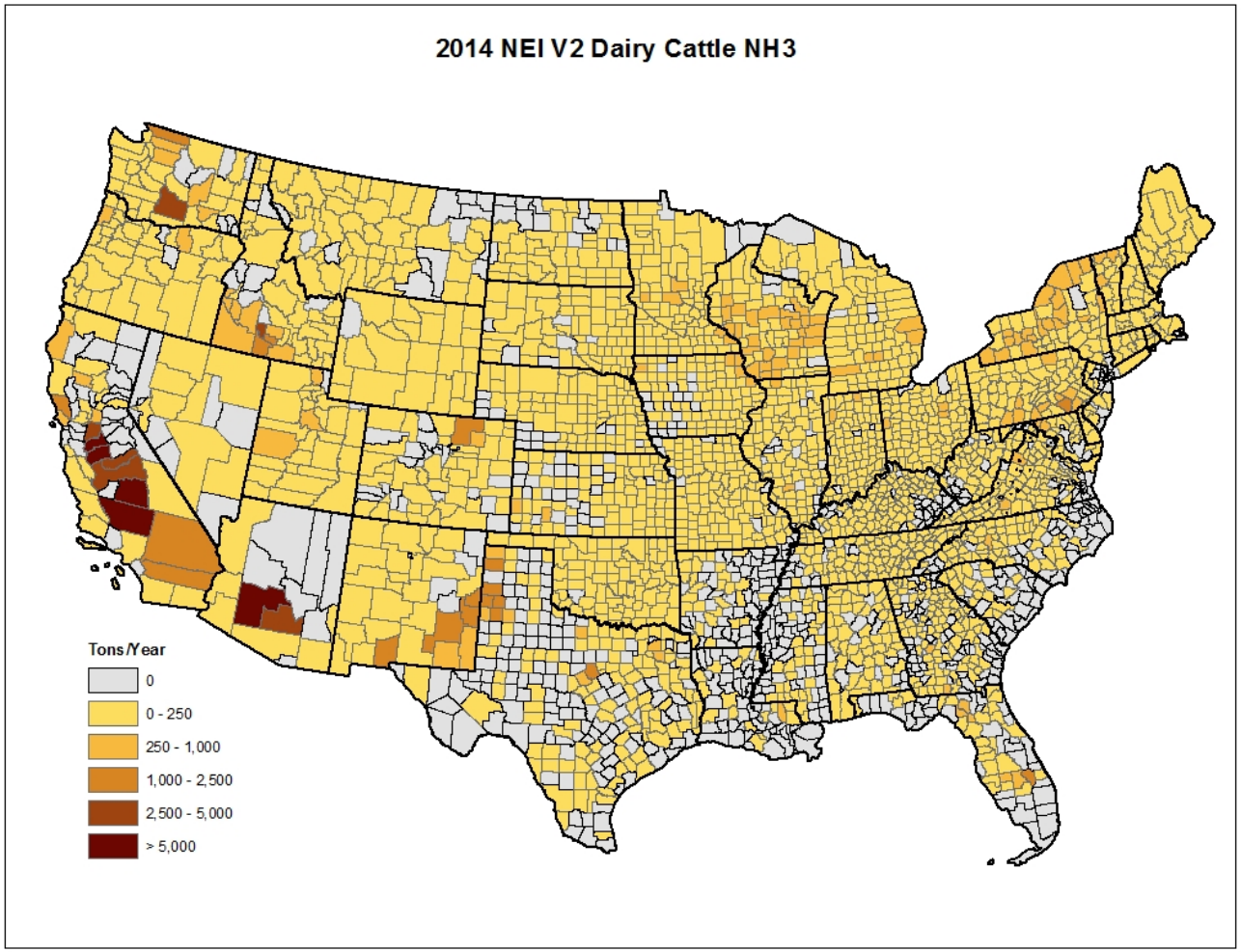

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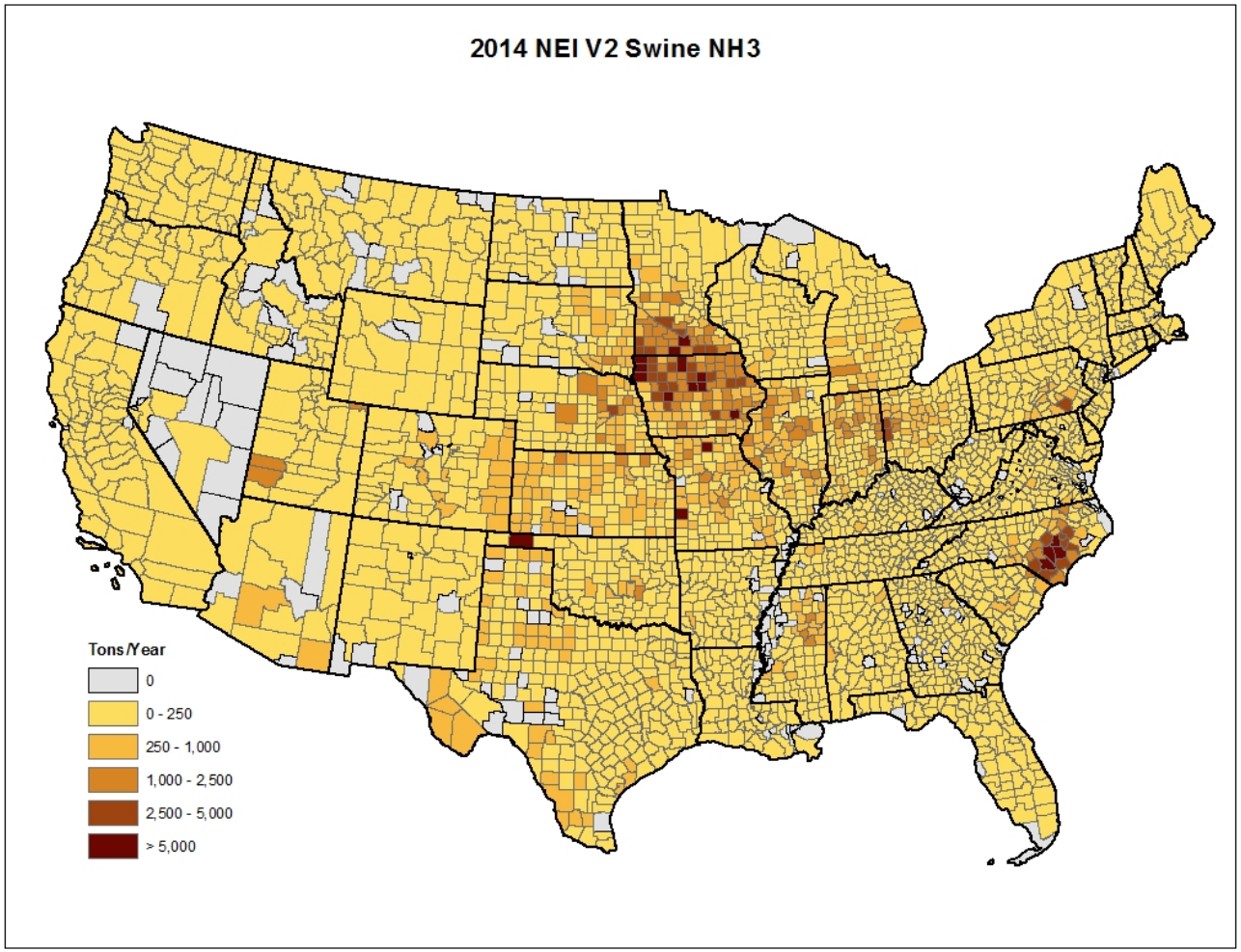

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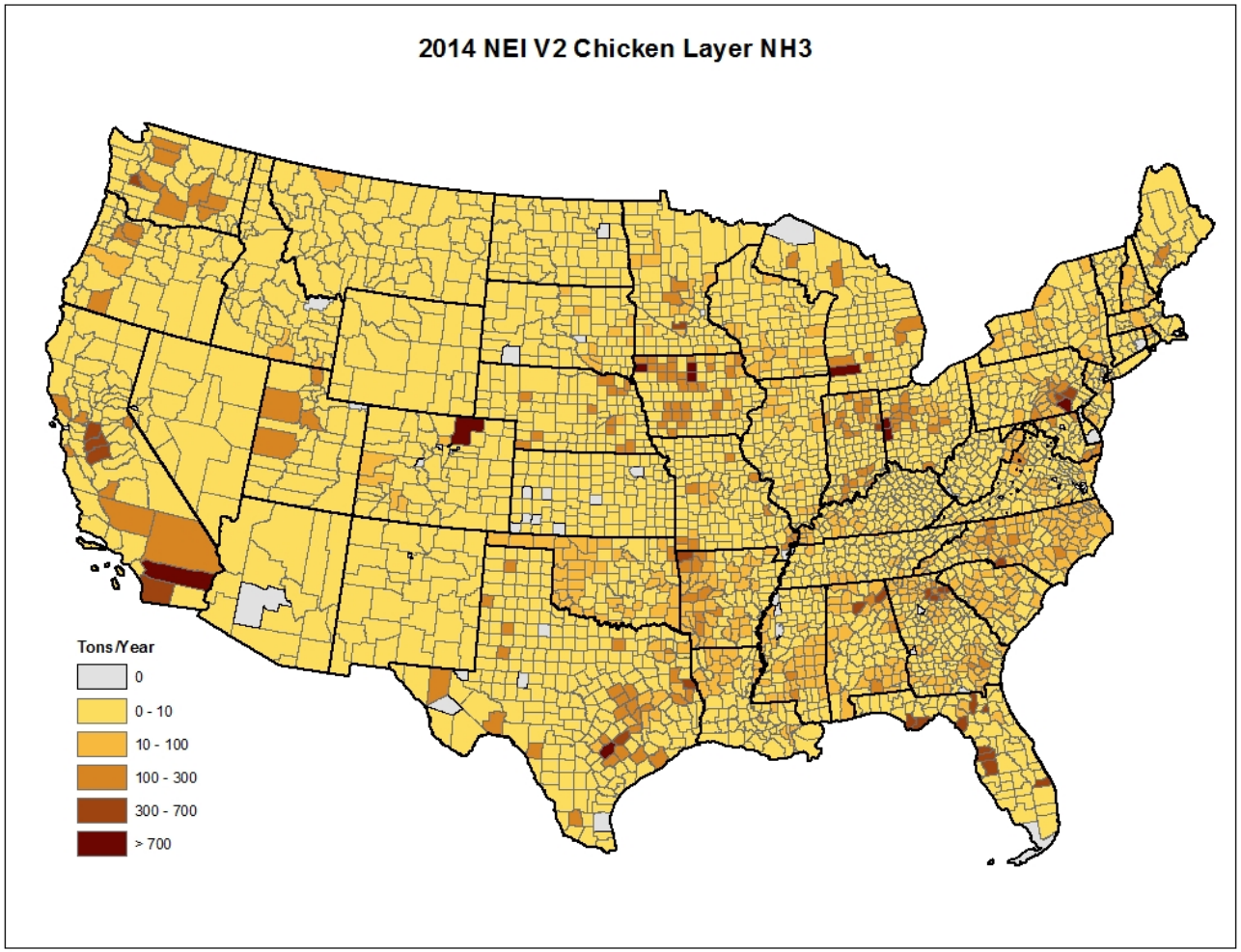

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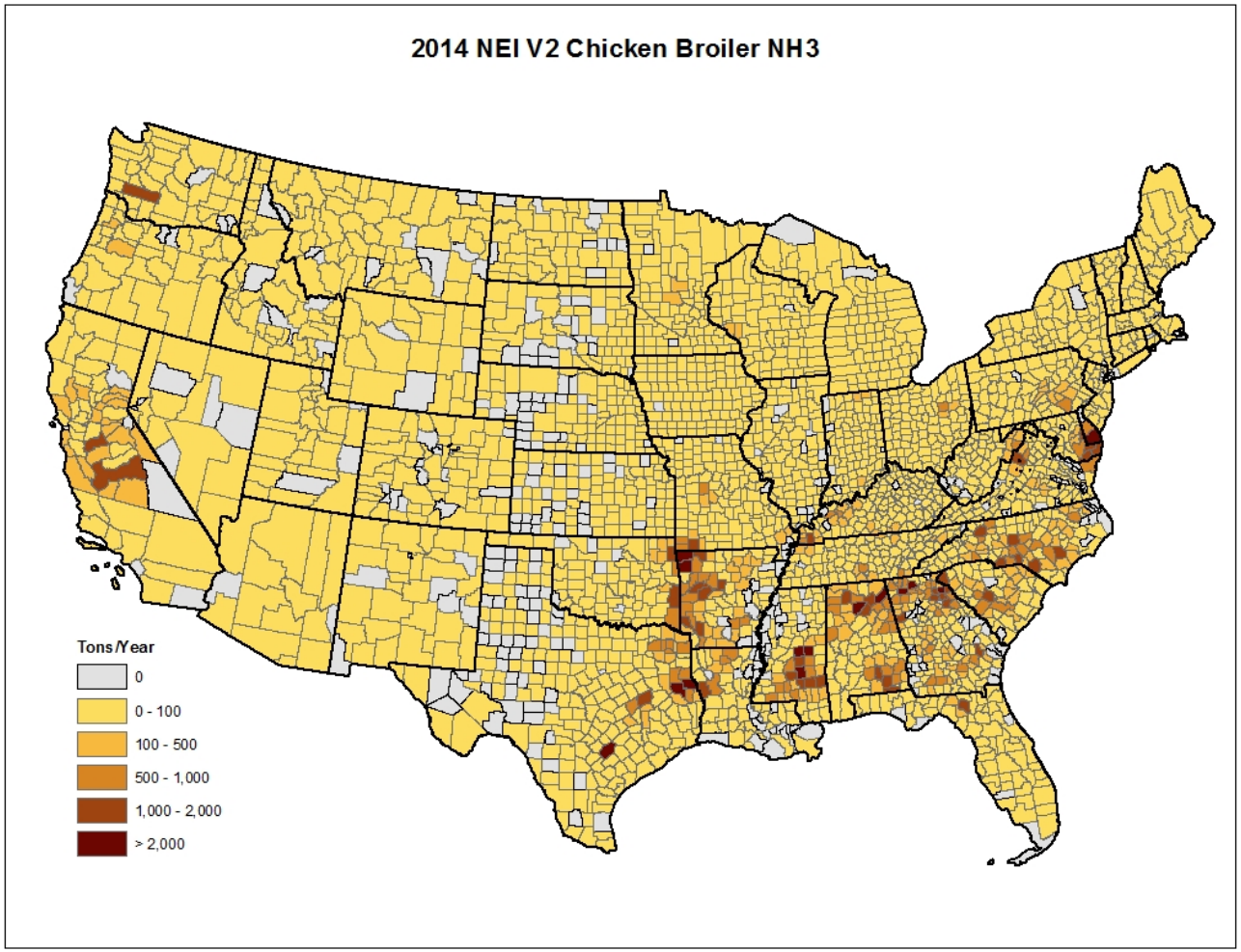

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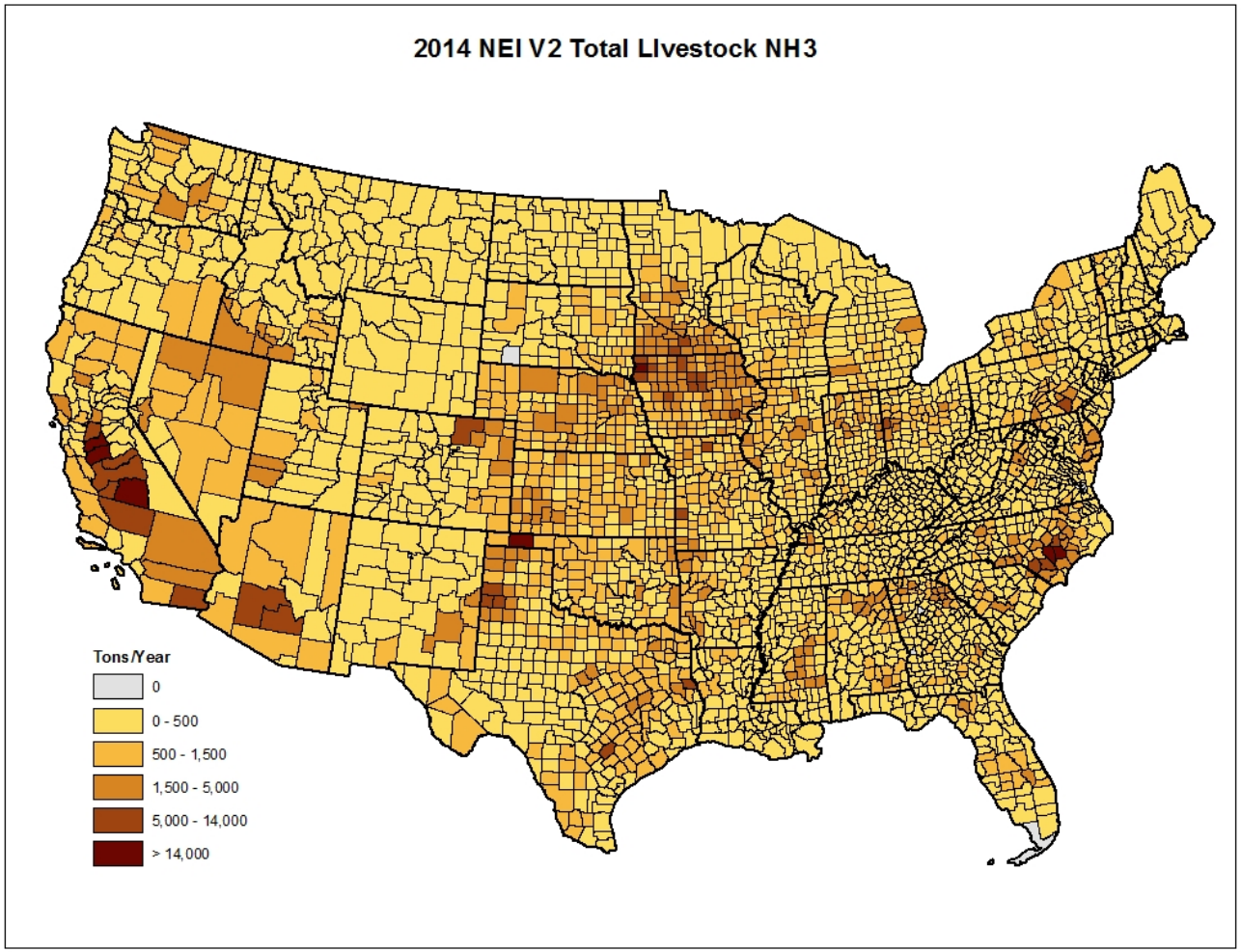

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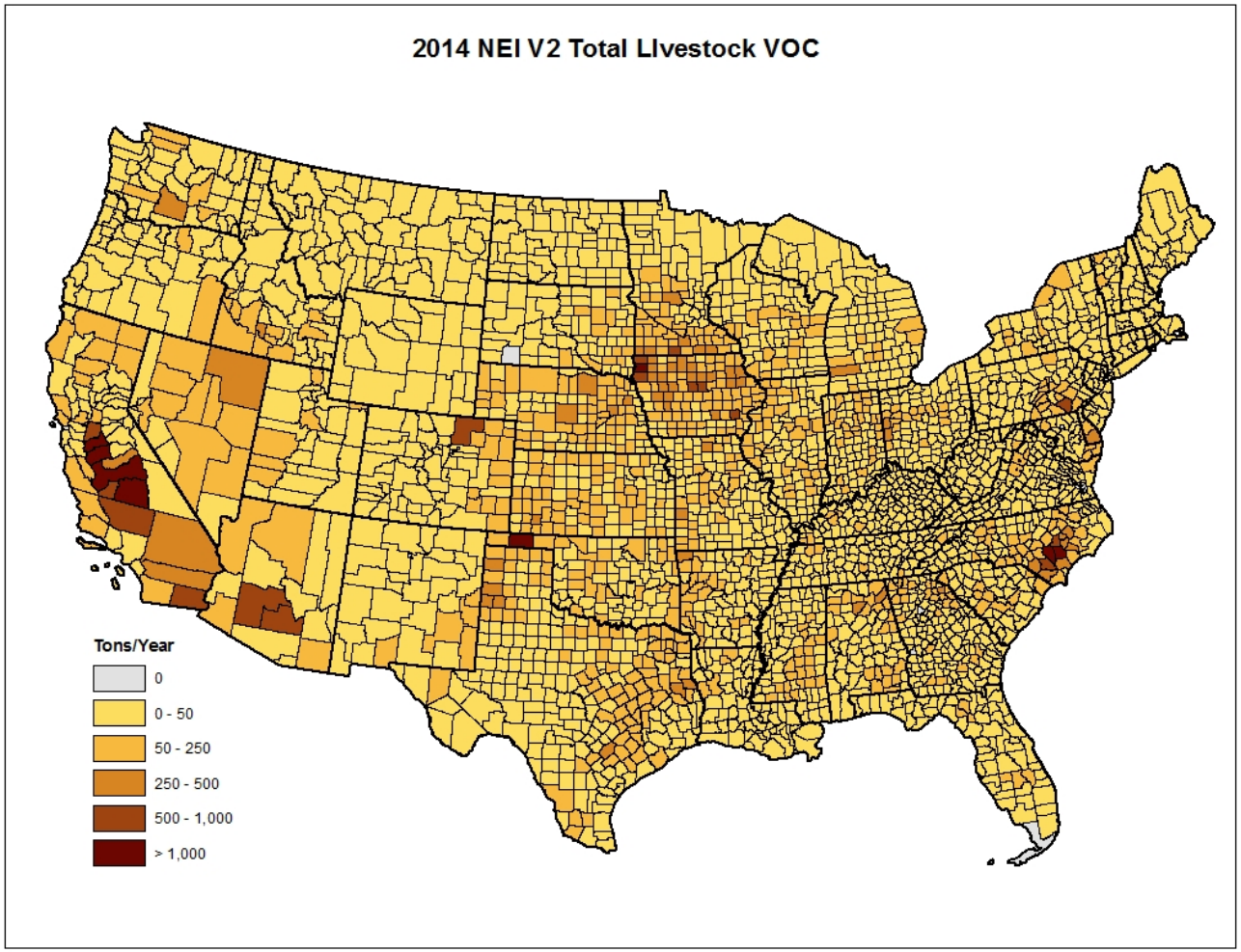

Next Steps/Future Actions

- For 2017 NEI:
  - Acquire CMU model code
  - Increase collaboration and science for this sector
  - Clean up SCCs as appropriate
  - Rethink and revise methods for VOC estimates (resources permitting)
  - Include silage VOC emissions as appropriate (resources permitting)
  - Update non-CMU model animal types, as possible (resources permitting)
  - Develop method for AK, HI, PR and VI

NH_3 Emissions

Animal Type	States Submitting NH_3 Emissions	2014 State NH_3 (tons/year)	2014 v2 EPA NH_3 in these States (tons/year)
Beef Cattle	CA, GA, ID, IL	110,107	102,717
Dairy Cattle	GA, ID, IL	38,400	14,116
Swine	CA, GA, ID, IL	35,154	50,227
Chicken Layers	CA, GA, ID	12,424	8,804
Chicken Broilers	CA, GA, ID	56,240	45,559