Estimating Dioxin/Furan Emissions: The US Dioxin Inventory

Dwain Winters
Director Dioxin Policy Project
Office of Pollution Prevention and Toxics
US EPA
202 566 1977
winters.dwain@epa.gov

The US Has Several Inventories

TRI

- Selected industries
- Multiple pollutants
- All media
- Mandatory Self reporting

Air Toxics Inventory

- Air only
- Composite of state reports
- Dioxin data not used

Dioxin Release Inventory

- All sources
- All media
- EPA generated
- Peer and Stakeholder Review

Highlights of U.S. Dioxin inventory

- The inventory presents estimates of annual releases of dioxin to the land, water and air from known sources in the United States
- Estimates are tied to specific timeframe: 1987 and 1995 (2000, 2002, 2005)
- Includes both quantitative and qualitative review of sources
- Transparent calculations and characterization of uncertainty
- Distinguishes between releases and disposal

Steps in Crafting Dioxin Inventory

- Classify source categories by design, materials processed or manufactured
- Further sub-classify by similarity of pollution control systems
- Collect and screen emissions/release test data
- Develop representative congener-specific emission factors
  - → ng CDD kg
- Develop industry/facility-specific measures of annual activity
  - → kg materials process yr
- Develop national emission estimates and evaluate uncertainty
  - → grams congener yr
  - →grams TEQ yr
- Document supporting analysis and data
- Peer Review and public comment

Dioxin Source Categories

- Combustion and Incineration Sources
- Metal Smelting and Refining/Processing
- Chemical Manufacturing/Processing
- Biological and Photochemical Processes
- Reservoir Sources

Inventory of Sources of Dioxin in the United States- Sept, 2000 draft	1987 Emissions (g TEQdf-WHO98/yr)	1995 Emissions (g TEQdf-WHO98/yr)	*% Total 1995*
Municipal Solid Waste Incineration, air	8877.0	1250.0	38%
Backyard Barrel Burning, air	604.0	628.0	19%
Medical Waste Incineration, air	2590.0	488.0	15%
Secondary Copper Smelting, air	983.0	271.0	8%
Cement Kilns (haz waste), air	117.8	156.1	5%
Sewage Sludge/land applied, land	76.6	76.6	2%
Residential Wood Burning, air	89.6	62.8	2%
Coal-fired Utilities, air	50.8	60.1	2%
Diesel Trucks, air	27.8	35.5	1%
Secondary Aluminum Smelting, air	16.3	29.1	1%
2,4-D, land	33.4	28.9	1%
Iron Ore Sintering, air	32.7	28.0	1%
Industrial Wood Burning, air	26.4	27.6	1%
Bleached Pulp and Paper Mills, water	356.0	19.5	1%
Cement Kilns (non-haz waste), air	13.7	17.8	1%
Sewage Sludge Incineration, air	6.1	14.8	0%
EDC/Vinyl chloride, air	NA	11.2	0%
Oil-fired Utilities, air	17.8	10.7	0%
Crematoria, air	5.5	9.1	0%
Unleaded Gasoline, air	3.6	5.9	0%
Hazardous Waste Incineration, air	5.0	5.8	0%
Lightweight ag kilns, haz waste,air	2.4	3.3	0%
Kraft Black Liquor Boilers, air	2.0	2.3	0%
Petrol Refine Catalyst Reg., air	2.2	2.2	0%
Leaded Gasoline, air	37.5	2.0	0%
Secondary Lead Smelting, air	1.2	1.7	0%
Paper Mill Sludge, land	14.1	1.4	0%
Cigarette Smoke, air	1.0	0.8	0%
EDC/Vinyl chloride, land	NA	0.7	0%
Primary Copper, air	0.5	0.5	0%
EDC/Vinyl chloride, water	NA	0.4	0%
Boilers/industrial furnaces	0.8	0.4	0%
Tire Combustion, air	0.1	0.1	0%
Drum Reclamation, air	0.1	0.1	0%
TOTALS	13,995	3,252	
Percent Reduction from 1987		77%	

updated 3/08/01

Inventory of Sources of Dioxin in the United States-May, 2000	*1987 Emissions (g TEQdf-WHO98/yr)*	*1995 Emissions (g TEQdf-WHO98/yr)*	*2002/4 Emissions (g TEQdf-WHO98/yr)*
Municipal Solid Waste Incineration, air	8877.0	1250.0	*12.0*
Backyard Barrel Burning, air	604.0	628.0	*628.0*
Medical Waste Incineration, air	2590.0	488.0	*7.0*
Secondary Copper Smelting, air	983.0	271.0	*5.0*
Cement Kilns (haz waste), air	117.8	156.1	*7.7*
Sewage Sludge/land applied, land	76.6	76.6	*76.6*
Residential Wood Burning, air	89.6	62.8	*62.8*
Coal-fired Utilities, air	50.8	60.1	*60.1*
Diesel Trucks, air	27.8	35.5	*35.5*
Secondary Aluminum Smelting, air	16.3	29.1	*29.1*
2,4-D, land	33.4	28.9	*28.9*
Iron Ore Sintering, air	32.7	28.0	*28.0*
Industrial Wood Burning, air	26.4	27.6	*27.6*
Bleached Pulp and Paper Mills, water	356.0	19.5	*12.0*
Cement Kilns (non-haz waste), air	13.7	17.8	*17.8*
Sewage Sludge Incineration, air	6.1	14.8	*14.8*
EDC/Vinyl chloride, air	NA	11.2	*11.2*
Oil-fired Utilities, air	17.8	10.7	*10.7*
Crematoria, air	5.5	9.1	*9.1*
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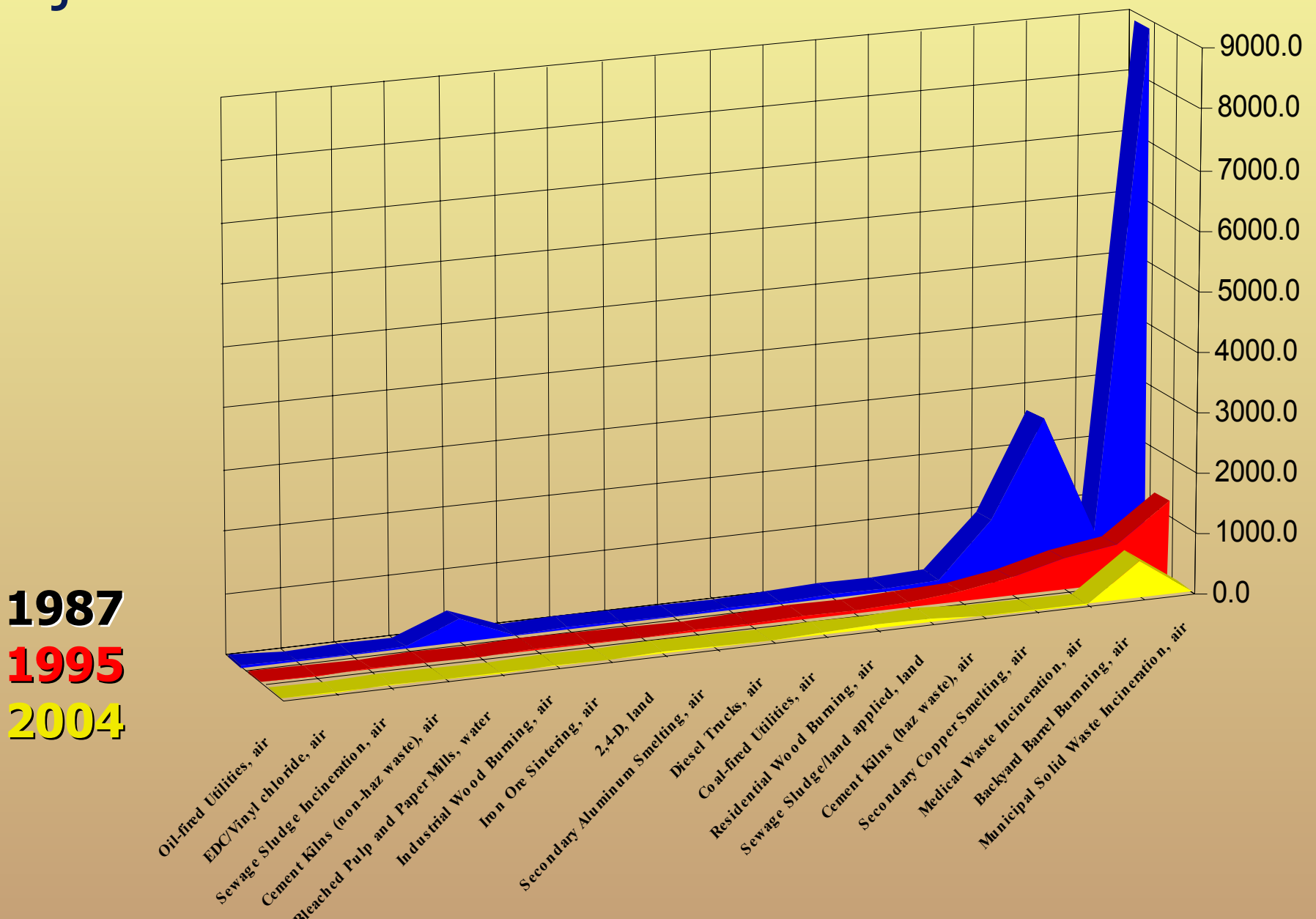
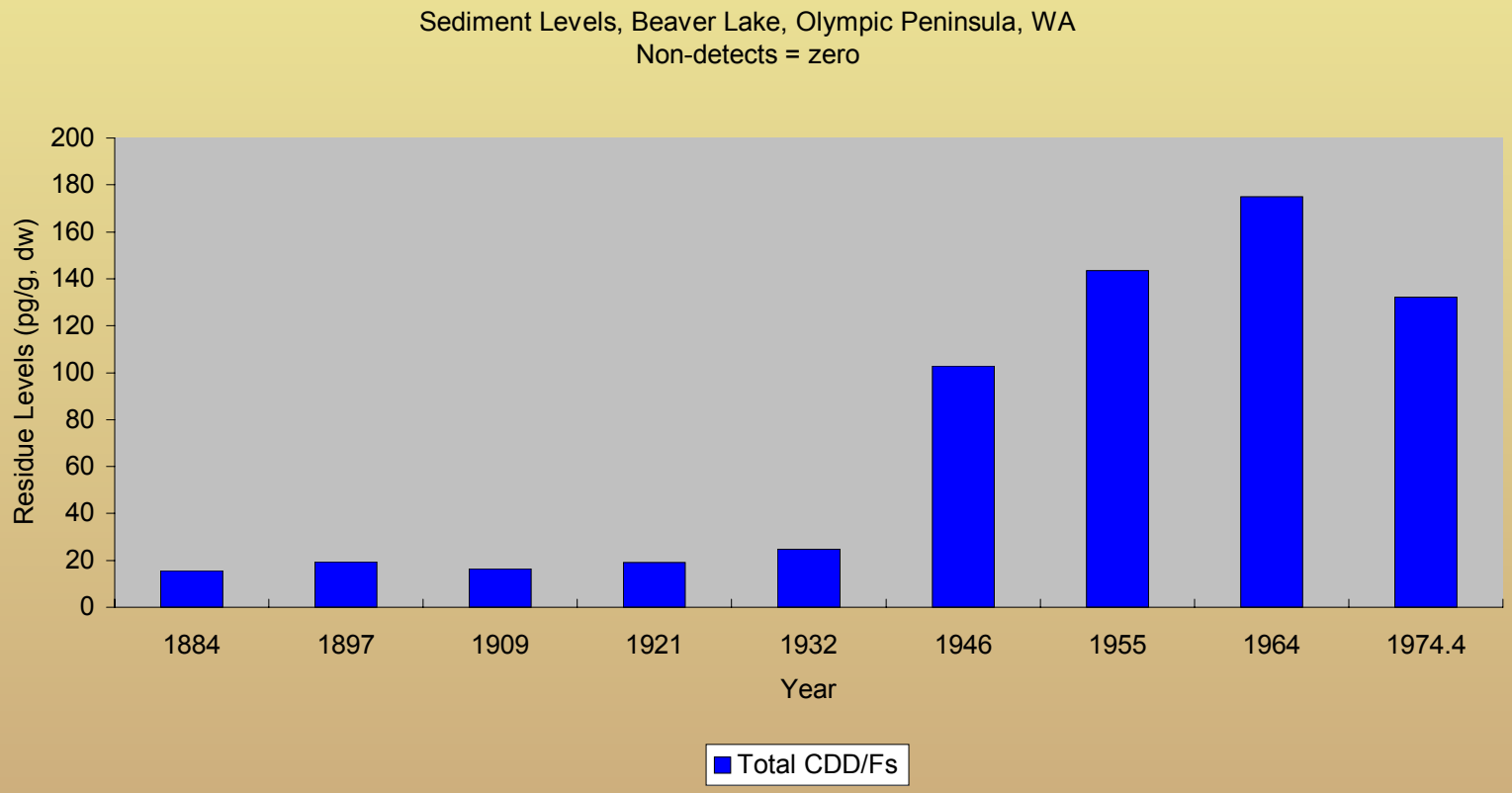
Lightweight ag kilns, haz waste,air	2.4	3.3	*0.4*
Kraft Black Liquor Boilers, air	2.0	2.3	*2.3*
Petrol Refine Catalyst Reg., air	2.2	2.2	*2.2*
Leaded Gasoline, air	37.5	2.0	*2.0*
Secondary Lead Smelting, air	1.2	1.7	*1.7*
Paper Mill Sludge, land	14.1	1.4	*1.4*
Cigarette Smoke, air	1.0	0.8	*0.8*
EDC/Vinyl chloride, land	NA	0.7	*0.7*
EDC/Vinyl chloride, water	NA	0.4	*0.4*
Boilers/industrial furnaces, air	0.8	0.4	*0.4*
Tire Combustion , air	0.1	0.1	*0.1*
Drum Reclamation, air	0.1	0.1	*0.1*
TOTALS	13,995	3,252	*1,106*
Percent Reduction from 1987		77%	92%

updated 3/08/01

Major US Dioxin Sources



20th Century Trend



Confidence Rating Scheme

Category	Rating	Activity Level	Emission Factor
A	High	Comprehensive data	Comprehensive data
B	Medium	Based on limited data	Based on limited data
C	Low	Based on expert judgment	Derived from few tested facilities
D	Preliminary Estimate	Inadequate data	Inadequate for more than an order of magnitude estimate
E	Not quantifiable	Insufficient data	Insufficient data

Poorly Characterized Sources

Secondary steel electric arc furnaces

Coke production

Ceramic manufacturing

Clay processing

Ferrous and non-ferrous foundries

Asphalt mixing plants

Primary magnesium

TiO_2

Wood stoves

Forest fires

Brush fires

Range fires

Ag burning

Landfill fires

Structural fires

Landfill flares

Rural soil erosion to water

Urban runoff to surface water

Utility poles and storage yards

Landfill fugitive emissions

Transformer storage yards

POTENTIAL SIGNIFICANCE OF UNCONTROLLED COMBUSTION

- If other uncontrolled combustion sources, either collectively or individually, are of the same magnitude as barrel burning …
- Then for Industrialized countries releases from uncontrolled combustion played a much more important role historically than indicated by current inventories based primarily on industrial sources.
- For non-industrial and developing countries, uncontrolled burning is likely to be much more prevalent and may dominate release for these countries and possibly total global releases.
- Progress in characterizing these sources is of immediate policy relevance for both developed and developing nations.

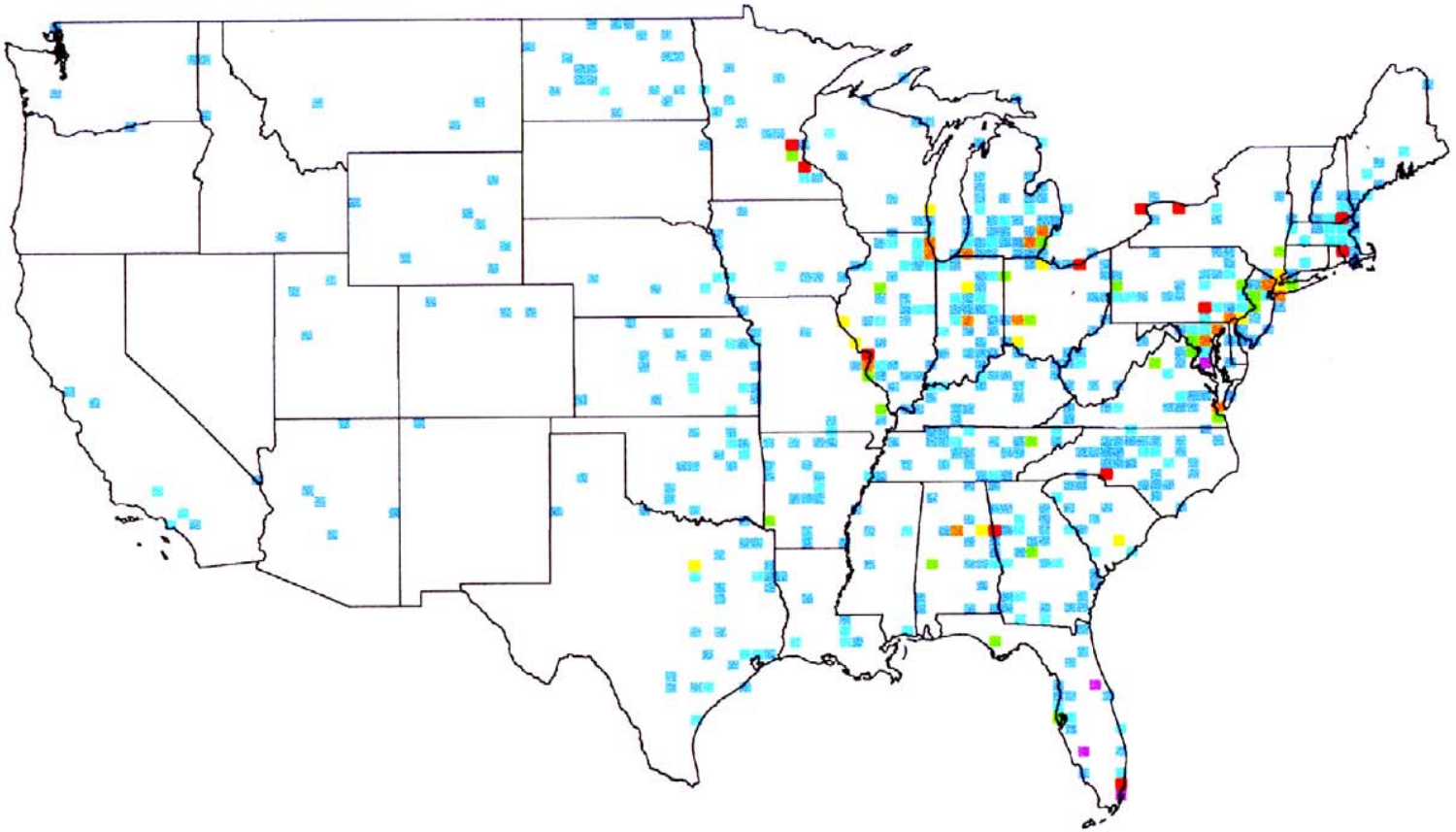
Reservoir Sources

Old releases of dioxins that are temporarily stored in environmental compartments to later be reintroduced into the circulating environment:

- **Soil**
- **Sediment**
- **Biota**
- **Materials**

Reservoirs contribute as much as 50% to general population exposure.

Top 80-percent Emitting Sources, Dioxin/Furan TEQ Emissions



Units of µg/hr; number of cells in each range in ( )

- 1-10 (4)
- 10 - 100 (391)
- 100 - 500 (115)
- 500 -1000 (23)
- 1000 - 2000 (12)
- 2000 - 5000 (15)
- 5000 - 22377 (12)

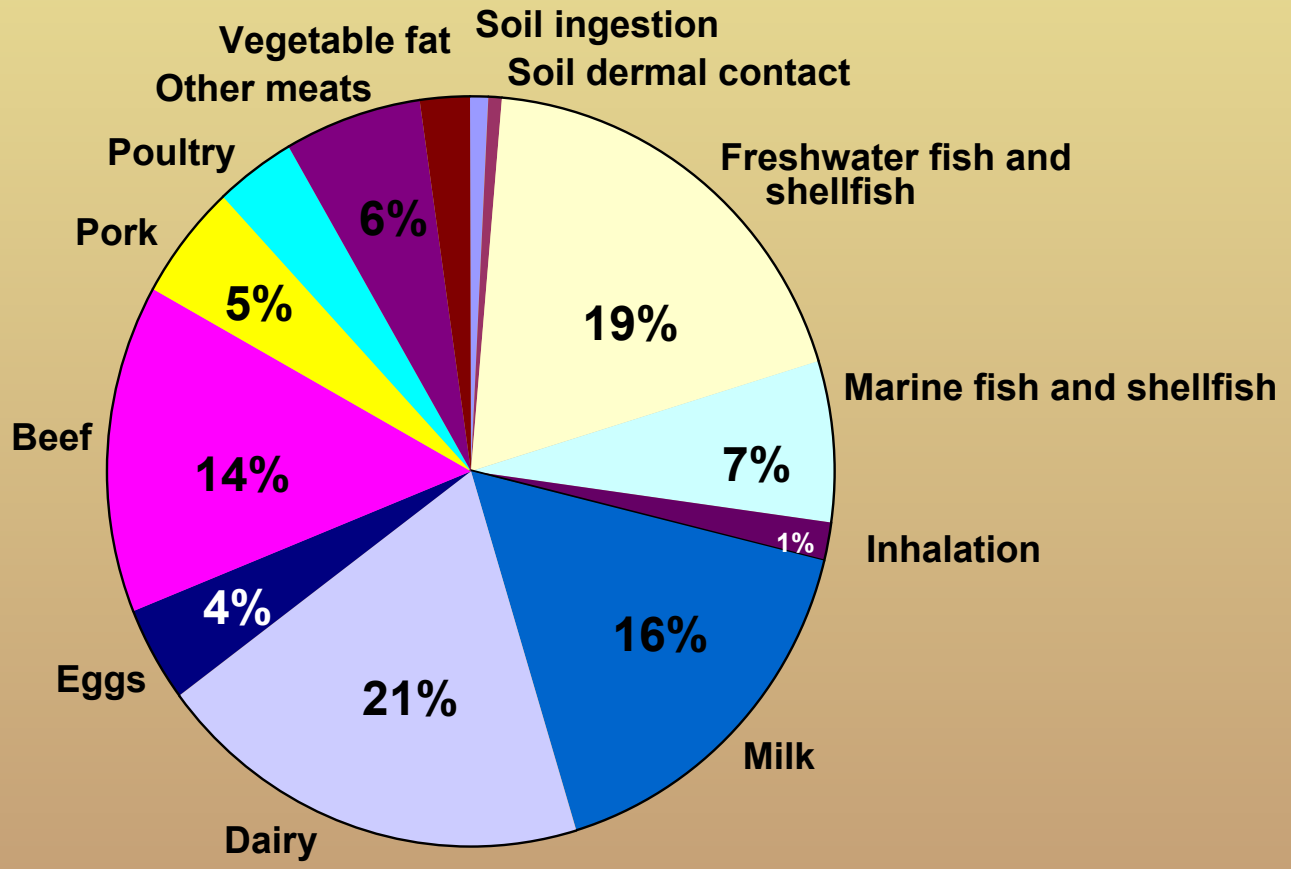
N

KM

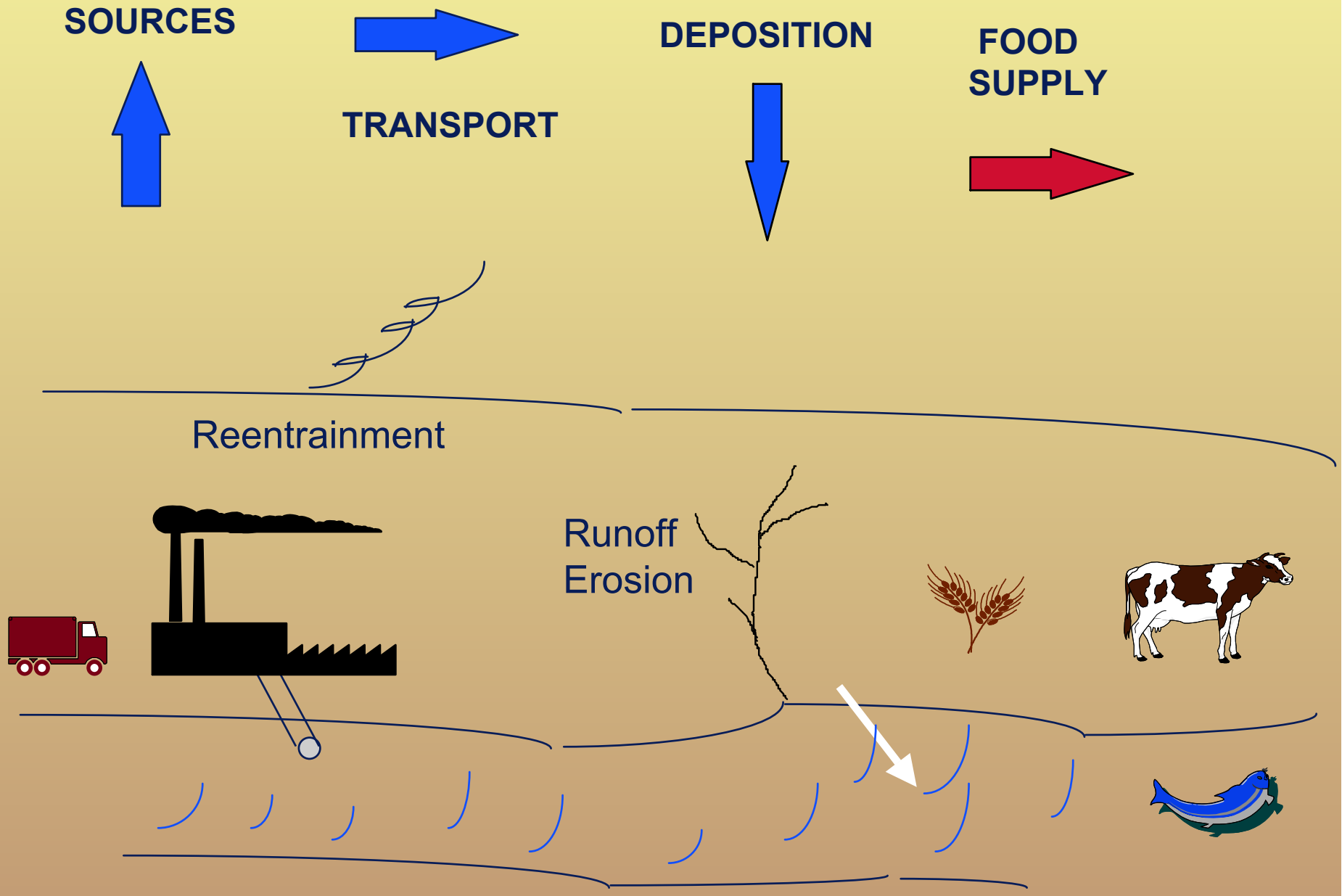
0 500 1000

U.S. Adult Average Daily Intake of CDDs/CDFs/ Dioxin - Like PCBs

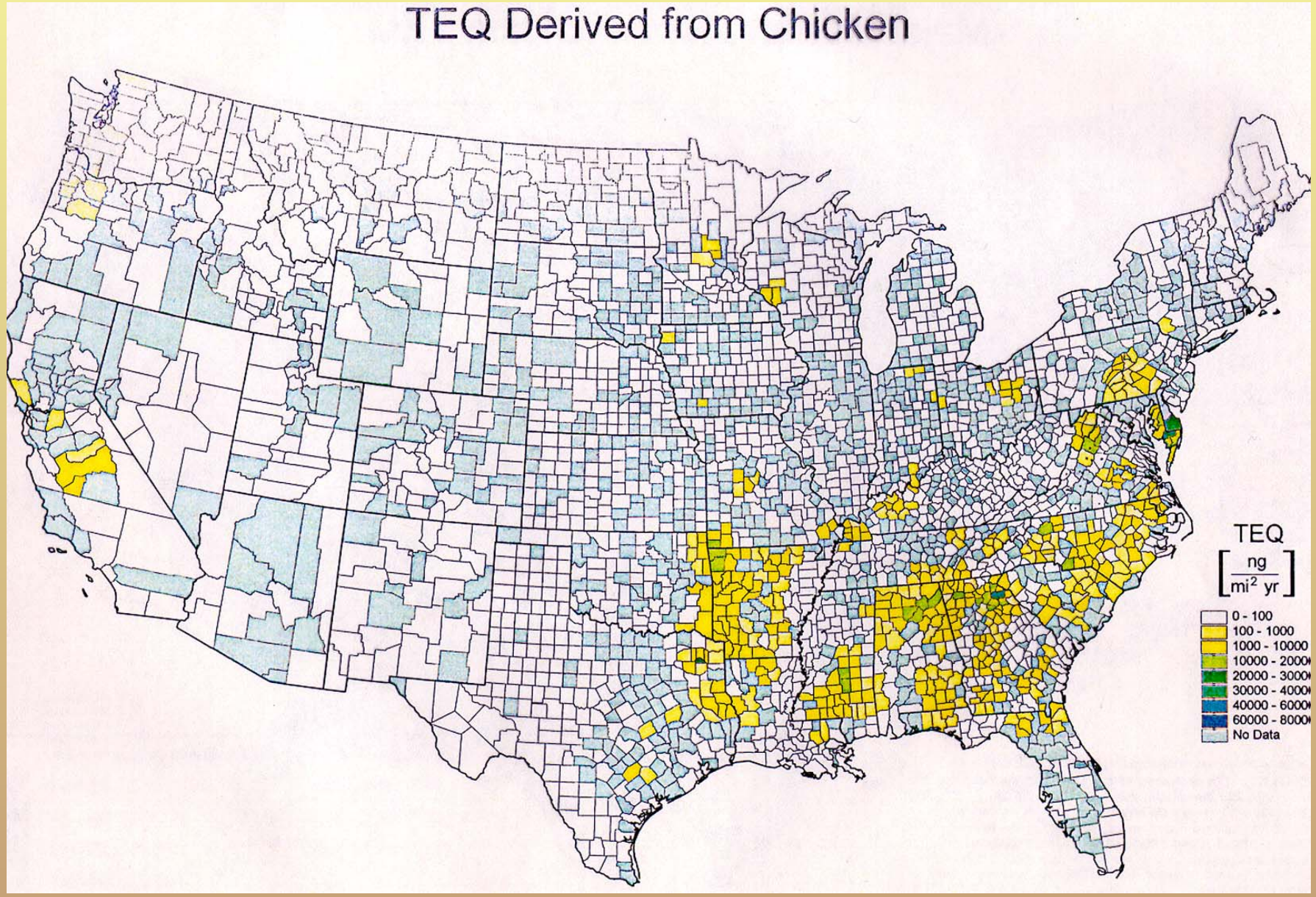
65 pg TEQ_{DFP}-WHO_{98}/day



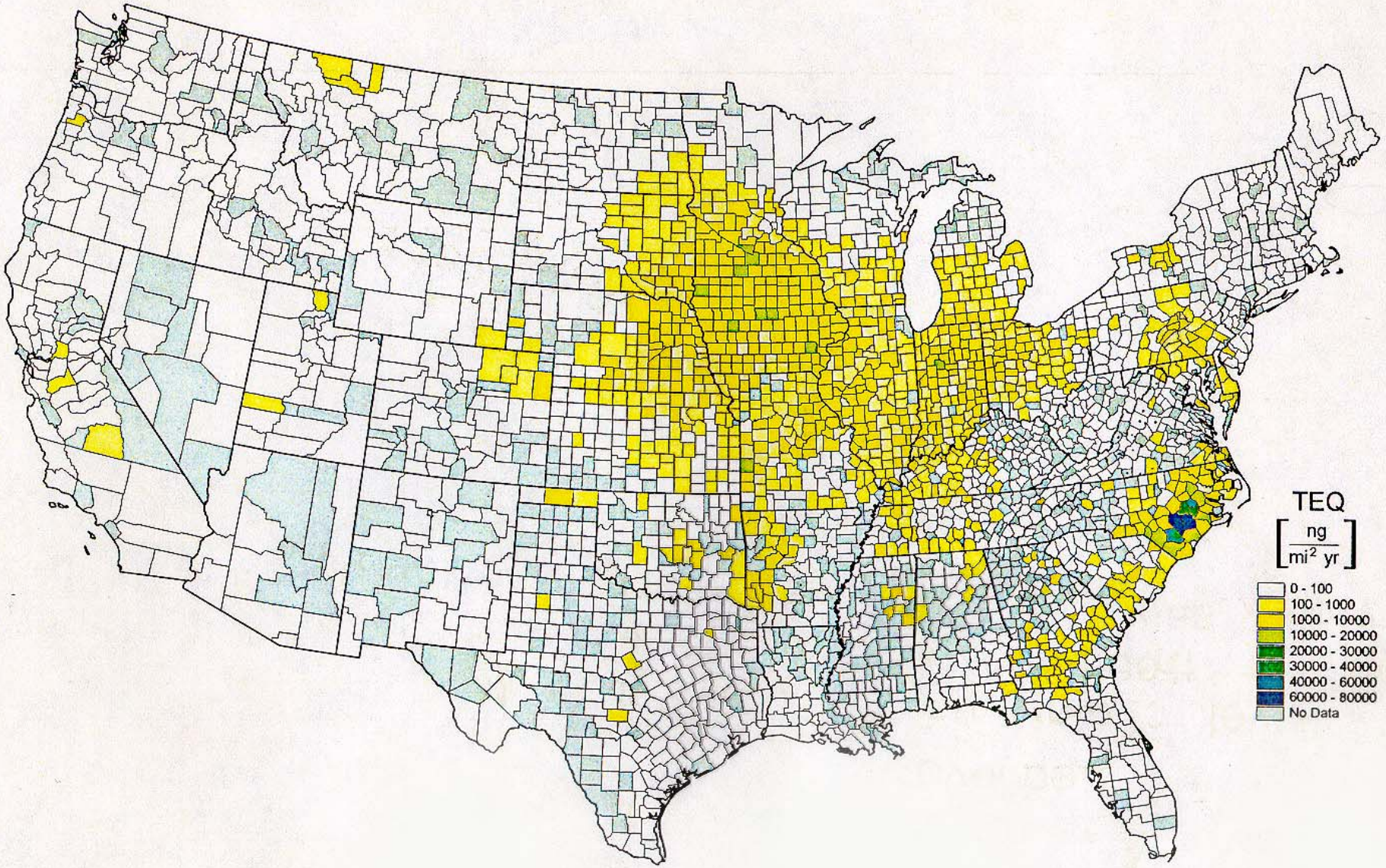
Sources and Pathways to Human Exposures



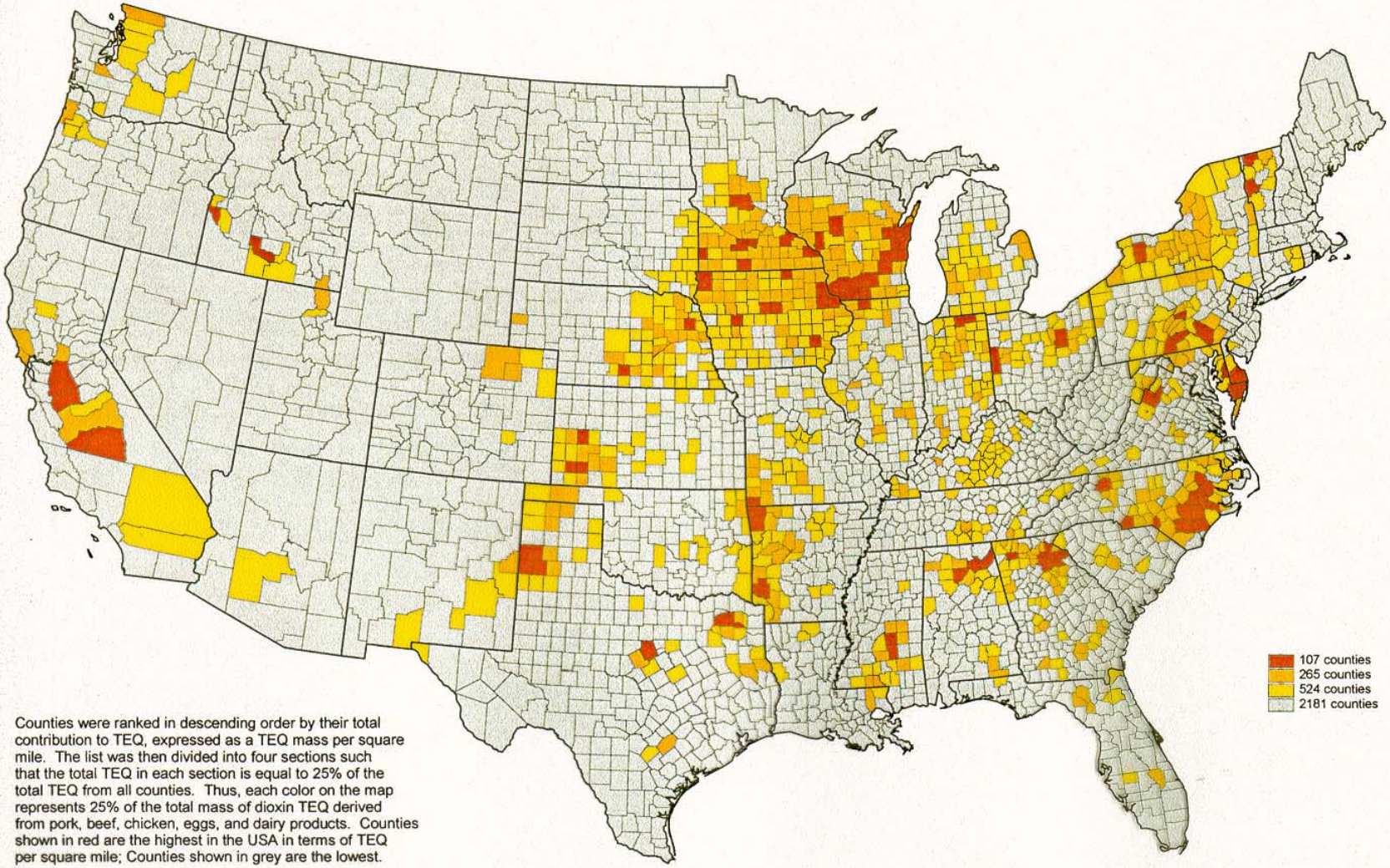
TEQ Derived from Chicken



TEQ Derived from Pork

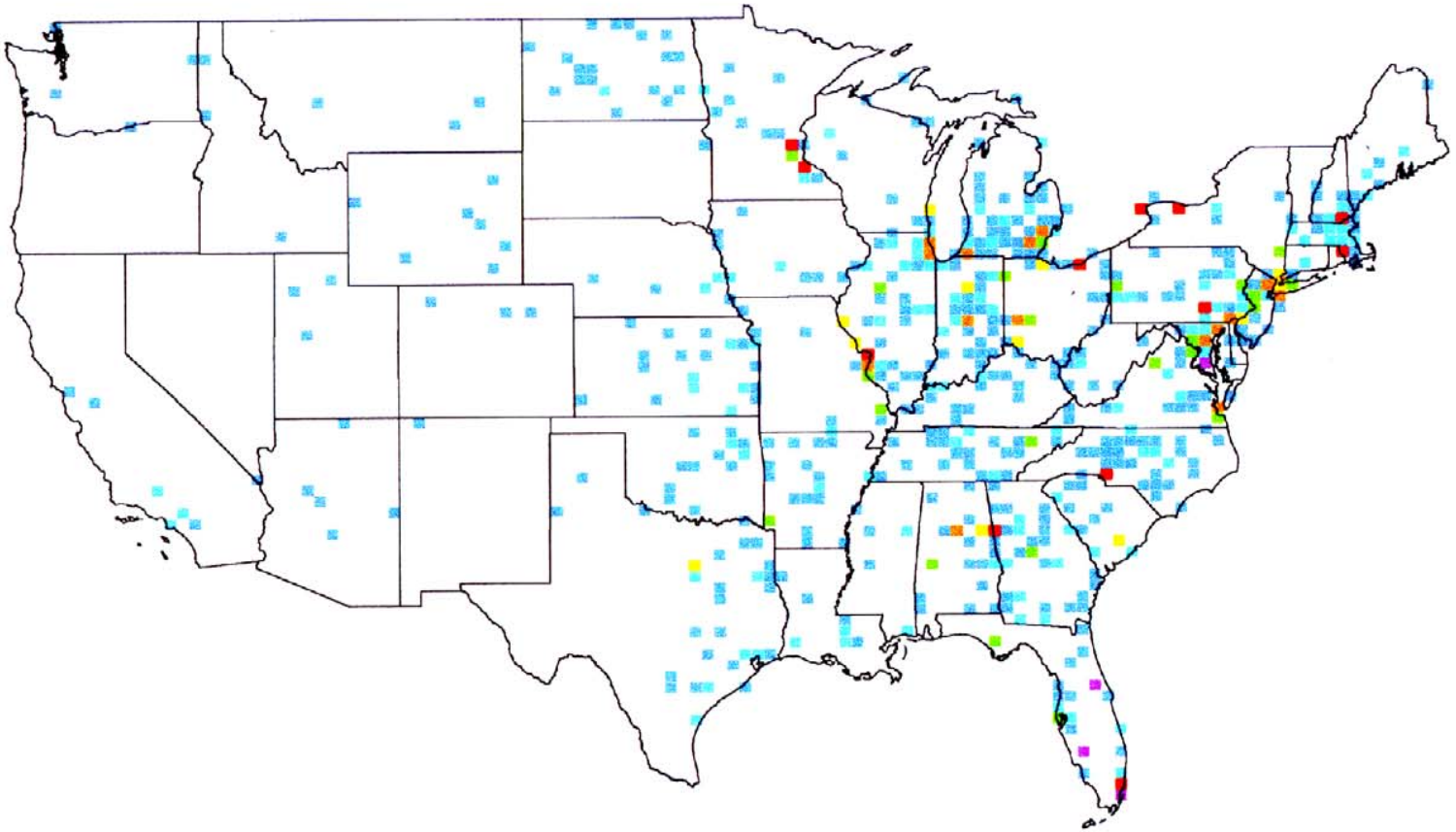


Dioxin Uptake Into Meat And Dairy



Counties were ranked in descending order by their total contribution to TEQ, expressed as a TEQ mass per square mile. The list was then divided into four sections such that the total TEQ in each section is equal to 25% of the total TEQ from all counties. Thus, each color on the map represents 25% of the total mass of dioxin TEQ derived from pork, beef, chicken, eggs, and dairy products. Counties shown in red are the highest in the USA in terms of TEQ per square mile; Counties shown in grey are the lowest.

Top 80-percent Emitting Sources, Dioxin/Furan TEQ Emissions



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N

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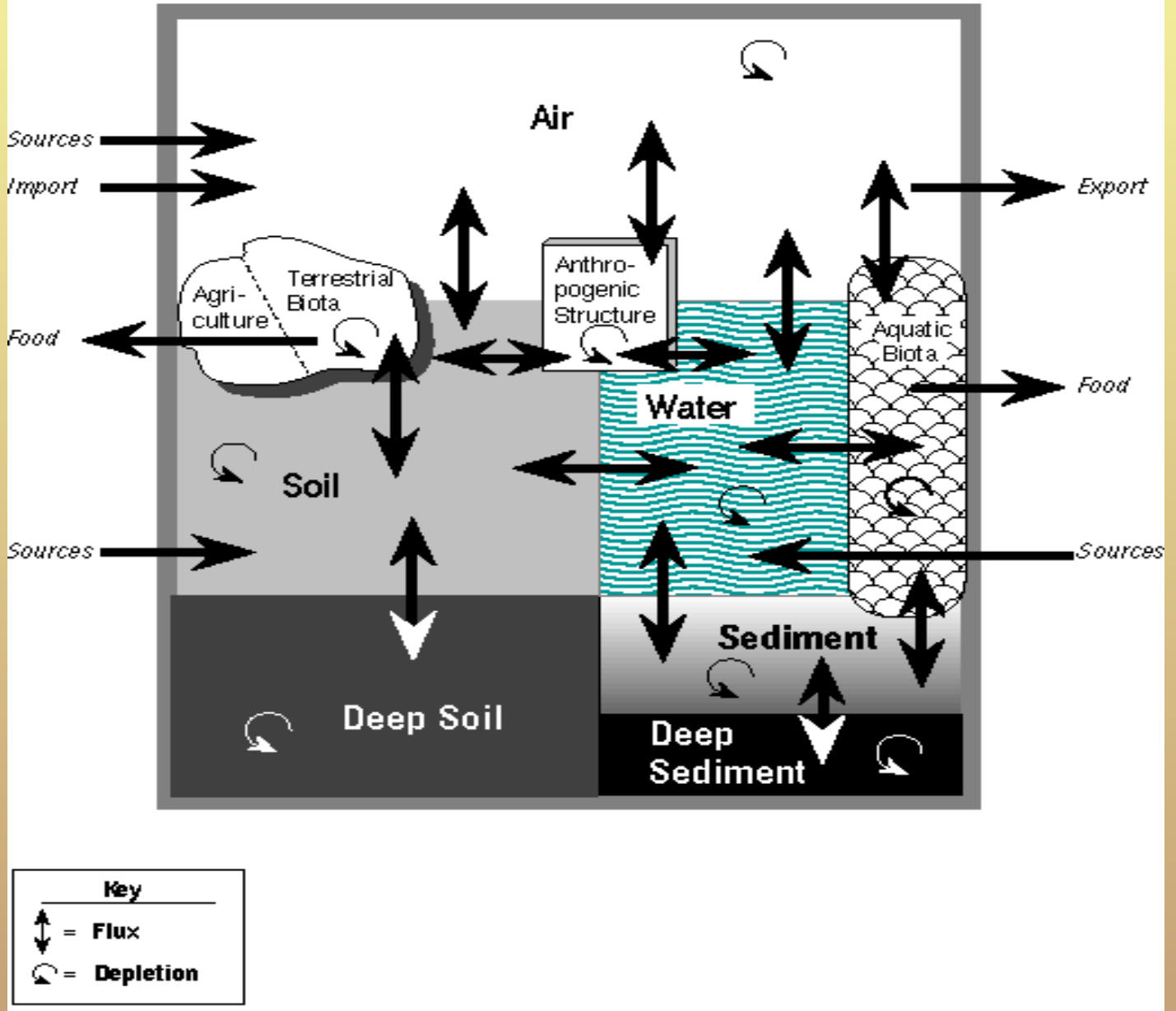
Fluxes Among Dioxin Reservoirs



Conclusions

National Inventories provide a quantitative basis for ranking sources by environmental releases but should not be equated with exposure

Inventories will always be incomplete and must rely on a high degree of indirect estimation methods

Comparisons of multiple years yields a framework for time-trends analysis

Inventories need to be transparent with all sources of data and data analysis well displayed