Health Canada Santé Canada

Canada

Canadian Total Diet Study

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Food Research Division
Bureau of Chemical Safety
Food Directorate
Health Canada

YOUR HEALTH AND SAFETY... OUR PRIORITY.

Federal Food Safety In Canada
Health Canada

Food Directorate

- Sets food safety policies (conducts research, risk assessments, sets regulations, guidelines, recommends risk management measures)

Canadian Food Inspection Agency

- Enforces food safety regulations and conducts food monitoring

Toxic Chemicals In Foods

Food Directorate

Bureau Of Chemical Safety

<u>Food Research Division</u>

Human dietary exposure to chemicals (Canadian total diet study - TDS)

Regulatory Toxicology Research Division

Toxicological research on chemicals

Chemical Health Hazard Assessment Division

Risk assessment and regulations

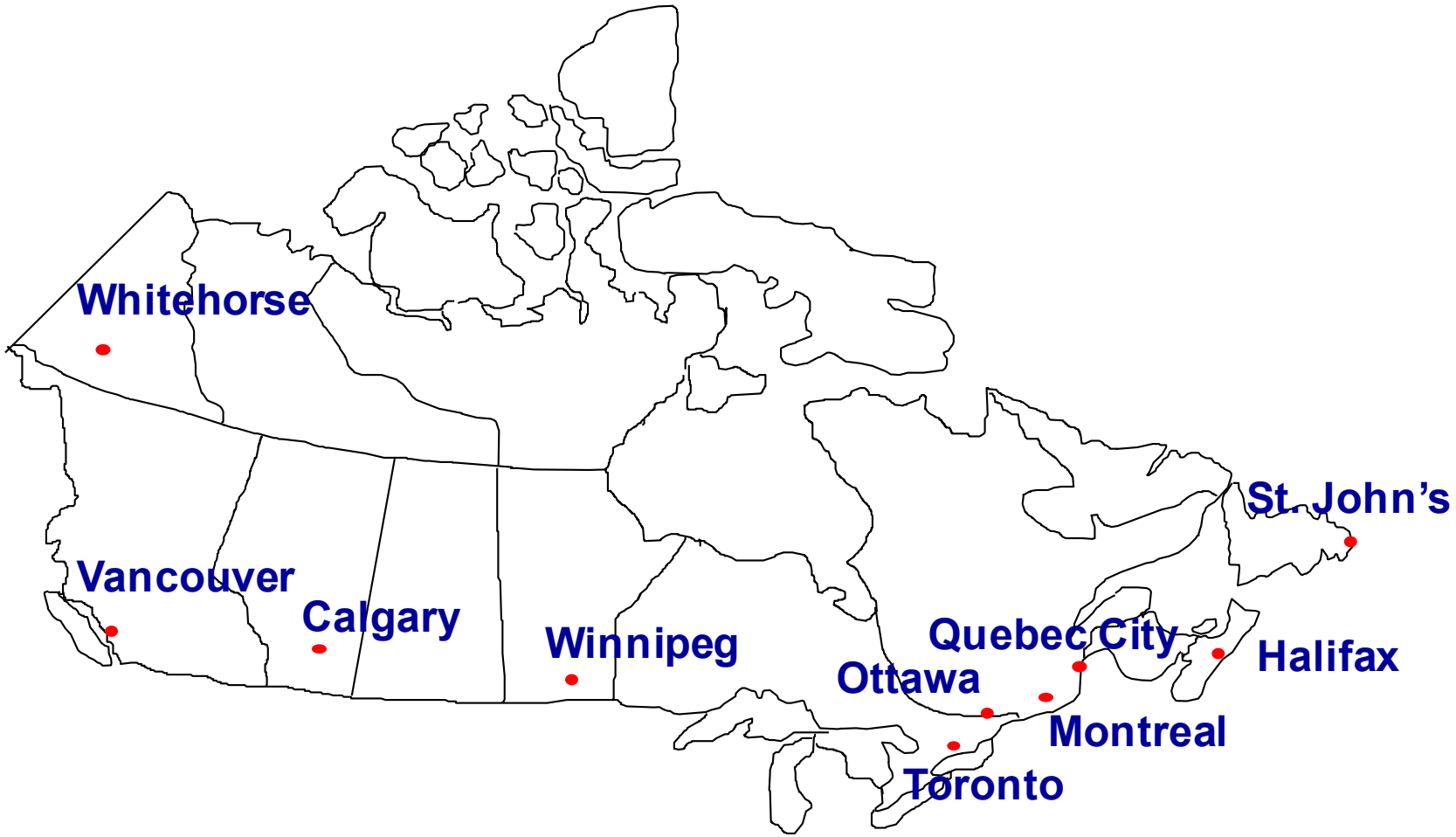
TDS Objectives

Representative background concentrations of priority chemicals in prepared foods

Estimate of the dietary intake of priority chemicals by average Canadians in different age/sex groups

Identify unexpected contamination, and time trends of dietary intakes and chemical concentrations in primary foods.

TDS Sampling Cities



Canadian Statistics

- Population 38.24 million
- Area 9.98 million sq. km
- 5,500 km east-west coast to coast
- 4,600 km north-south
- 22% of the population are immigrants from over 140 different countries
- 5% of the population are indigenous peoples
- 18% of population rural

Canada – Food and Diet Trivia

Food consumption

- **75% of fresh vegetables eaten in Canada are imported**
- **Canada imports food from about 160 countries**

TDS Objectives

Representative background concentrations of priority chemicals in prepared foods

Estimate of the dietary intake of priority chemicals by average Canadians in different age/sex groups

Identify unexpected contamination and time trends of dietary intakes and chemical concentrations in primary foods with time.

Objective: Representative background concentrations of priority chemicals in prepared foods

Canadian TDS:

1. One city once a year over 7 weeks (representation not seasonal or regional)
2. 244 different foods
3. 4 stores/brands of each food to prepare 1 composite (definitely not statistical?)
4. End up with 159 food composites for analysis
5. Analyse food composites using high-sensitivity methods

Chemicals Included in Canadian TDS

- Pesticides (registered and nonregistered)
- Polychlorinated biphenyls (PCBs)
- Chlorinated dioxins and dibenzofurans (dioxins)
- Polybrominated diphenyl ethers (PBDEs) (flame retardants)
- Trace elements (e.g. Pb, Cd, F, As, Hg)
- Perfluorinated compounds
- Ochratoxin-A
- Chemicals transferred from food contact materials (e.g., phthalates, DEHP, bisphenols)
- Volatile organics (toluene)
- Radionuclides

Analysis

Analyses conducted primarily in Food Research Division by research analysts

Thea Rawn. PCBs, chlorinated dioxins, dibenzofurans, PBDEs, new POPS (perfluorinated organics), legacy and current pesticides
Xu-Liang Cao. Phthalates, bisphenols, VOCs
Robert Dabeka -Trace elements
Stephen Kiser (RPB) Radionuclides

Analysis

Objective

- Achieve sufficiently low LODs to actually measure the background concentrations of the chemicals

Characteristics

- Expensive, sensitive instrumentation, high complexity (preconcentration, separation, contamination control), and high analytical expertise

Rationale

- Can't identify a contaminated sample if you don't know the chemical concentration of an uncontaminated one
- Improve accuracy of dietary intake estimations

Lead results, ng/g, and precision for TDS milk composites – 2017 TDS

	Duplicates		%RSD
Milk, whole	0.15	0.17	8.8
Milk, 2%	0.12	0.11	6.1
Milk, 1%	0.12	0.13	5.7
Milk, skim	0.13	0.23	39.3
Evaporated milk	0.54	0.49	6.9
Milk baby formula	1.31	1.40	4.7

Objective: Estimate of the dietary intake of priority chemicals by average Canadians

Canadian TDS

1. **Average food consumption and body weight data for 16 age/sex groups based on 1970-72 survey. Data are old & available for only 127 composites. (Data being updated).**
2. **Deterministic calculations. For each food composite, multiply the concentration of chemical by the amount of composite consumed. Add these over all composites to give the dietary intake by the age/sex group**

Age/Sex Groups And Body Wts, kg

0-1 Month M & F	3.73		20-39 Years M	71.3
2-3 Months M & F	5.66		40-64 Years M	72.0
4-6 Months M & F	6.81		65+ Years M	70.3
7-9 Months M & F	8.73		12-19 Years F	49.9
10-12 Months M & F	10.26		20-39 Years F	57.2
1-4 Years M & F	14,4		40-64 Years F	61.1
5-11 Years M & F	26.4		65+ Years F	63.1
12-19 Years M	53.8		All Ages M & F	60

Nutrition Canada Survey 1970-72, 24-hour recall

Concentrations <LOD are reported as LOD for dietary intake calculations

Conc. ng/g	Food intake (g)	Dietary intake
0	100	0 ng
<0.3	100	30 ng
<1	100	100 ng
<10	100	1000 ng

2017 Dietary intakes of Pb, µg/kg/day, by average Canadians and effect of analytical limit of detection. LOD used to calculate dietary intakes when Pb<LOD.

	7 - 9 Month	1 - 4 Years	12 - 19 Years	12 - 19 Years	All Ages Cdn.
LOD, ng/g	M & F	M & F	M	F	M & F
0	0.178	0.157	0.083	0.068	0.062
0.1	0.179	0.157	0.083	0.068	0.062
0.5	0.197	0.173	0.089	0.072	0.065
1	0.233	0.204	0.100	0.081	0.075
3	0.429	0.353	0.157	0.125	0.123

Objective: Identify unexpected contamination and time trends of dietary intakes and chemical concentrations in primary foods with time.

Canadian TDS

1. **4 Brands of each food is optimum to identify if one of the brands is badly contaminated**
2. **Time trends in concentrations for each composite – 1 city/4 brands/7 weeks a year**
3. **Time trends in dietary intakes to identify effects of risk management or other factors**

Note: Portion of TDS samples are archived frozen at -25C, and are used for retrospective analyses of new priority chemicals.

Reporting TDS Results

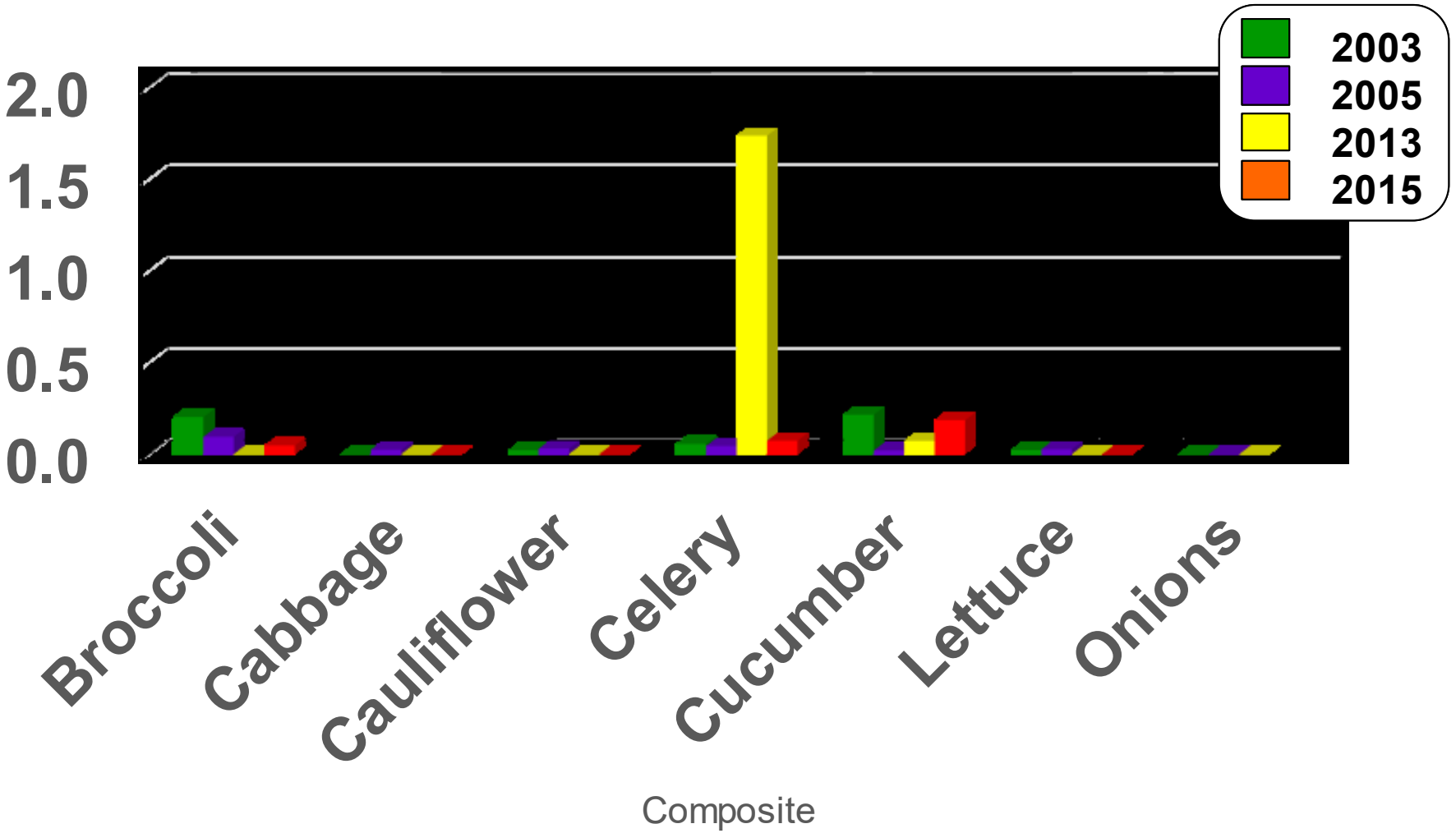
Results are posted on Government of Canada website & science publications

- **Open Data:** https://www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-surveillance/canadian-total-diet-study.html
- **CANLINE:**
- https://clin-rcil.hc-sc.gc.ca/clin-rcil/home.do

Interpretation of Results

- Tap water from target city and kitchen preparation area are collected and analysed
- Water consumed as water is not included in the calculation of dietary intakes
- Tap water from the lab kitchen in Ottawa is used to prepare the composites (2017, 2018 both tap and deionized water were used)
- Foods prepared in the lab are not seasoned or salted
- To improve statistical power of some chemicals, dietary intakes over several cities (years) should be averaged

Chlorpyrifos in Vegetables, ng/g



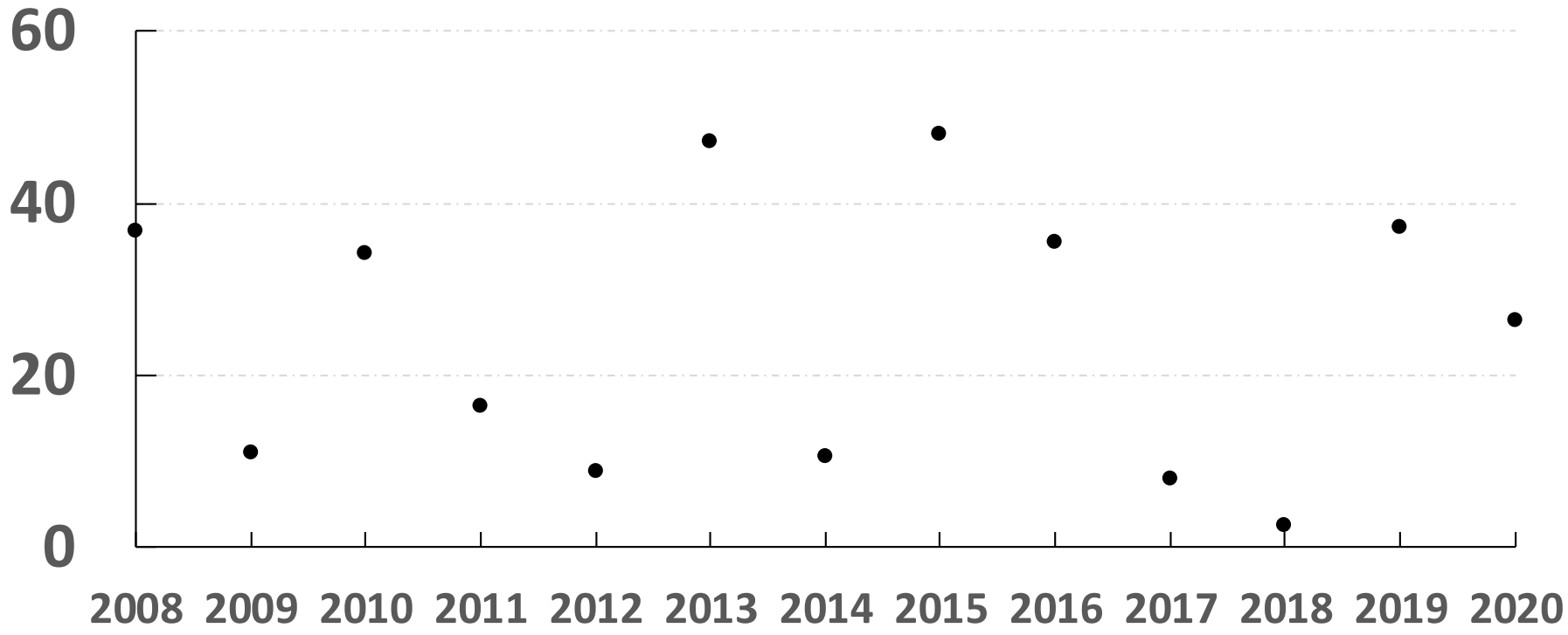
Concentrations (ng/g) of toluene in selected 2014 TDS samples

Composite	ng/g
BEEF STEAK	670
VEAL CUTLETS	323
FISH, CANNED	132
BREAD, WHITE	175
BREAD, WHOLE WHEAT	1974
BREAD, RYE	635
CRACKERS	4655
PASTA, PLAIN	190
HOT DOG	100
POTATO CHIPS	130
COOKIES	269

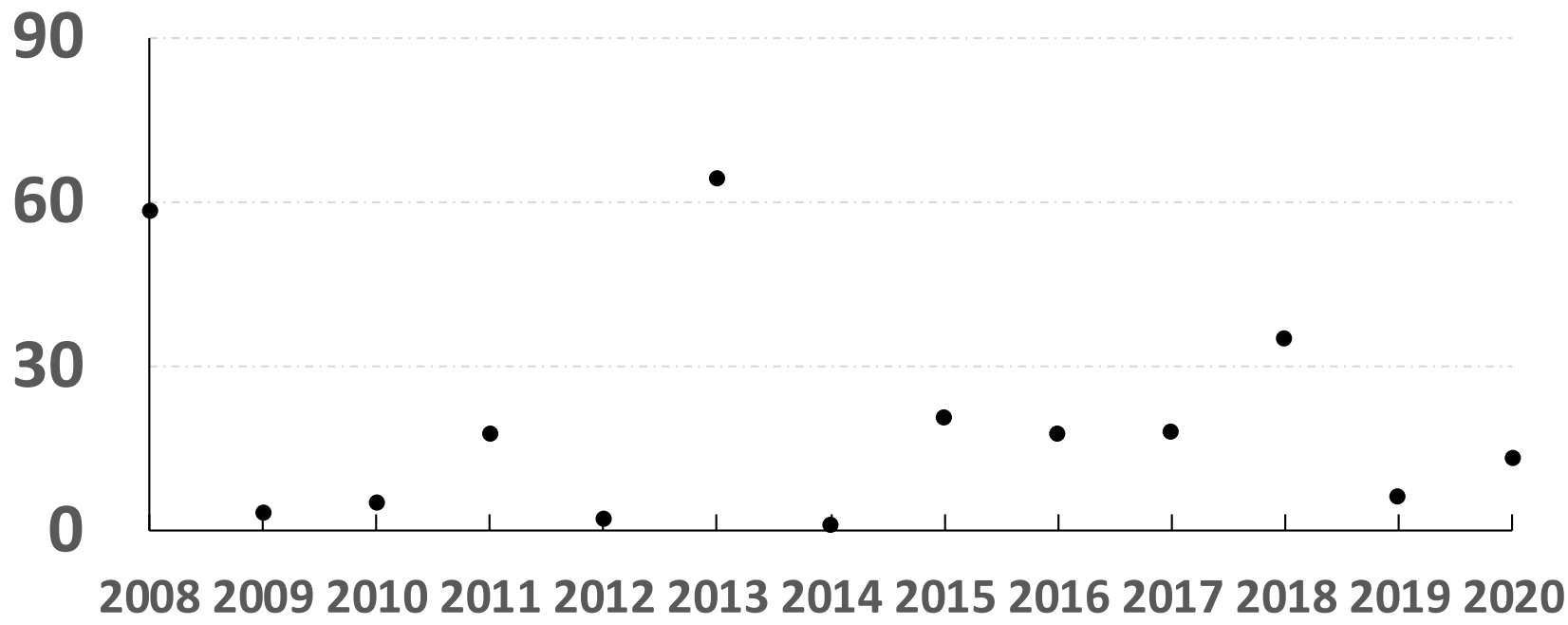
Concentrations of Di(2-ethylhexyl) phthalate (DEHP) in selected vegetable samples from 2013 TDS

COMPOSITE	NG/G
CAULIFLOWER, COOKED & RAW	305
CORN, FROZEN AND CANNED	287
CUCUMBER, RAW AND PICKLED	675
LETTUCE, RAW	657
PEAS, FROZEN AND CANNED	613
PEPPERS, RAW	502
VEGETABLE JUICE, CANNED	682
ASPARAGUS, COOKED	409
POTATO, BAKED WITH SKIN	222
TOMATOES, COOKED AND RAW	405

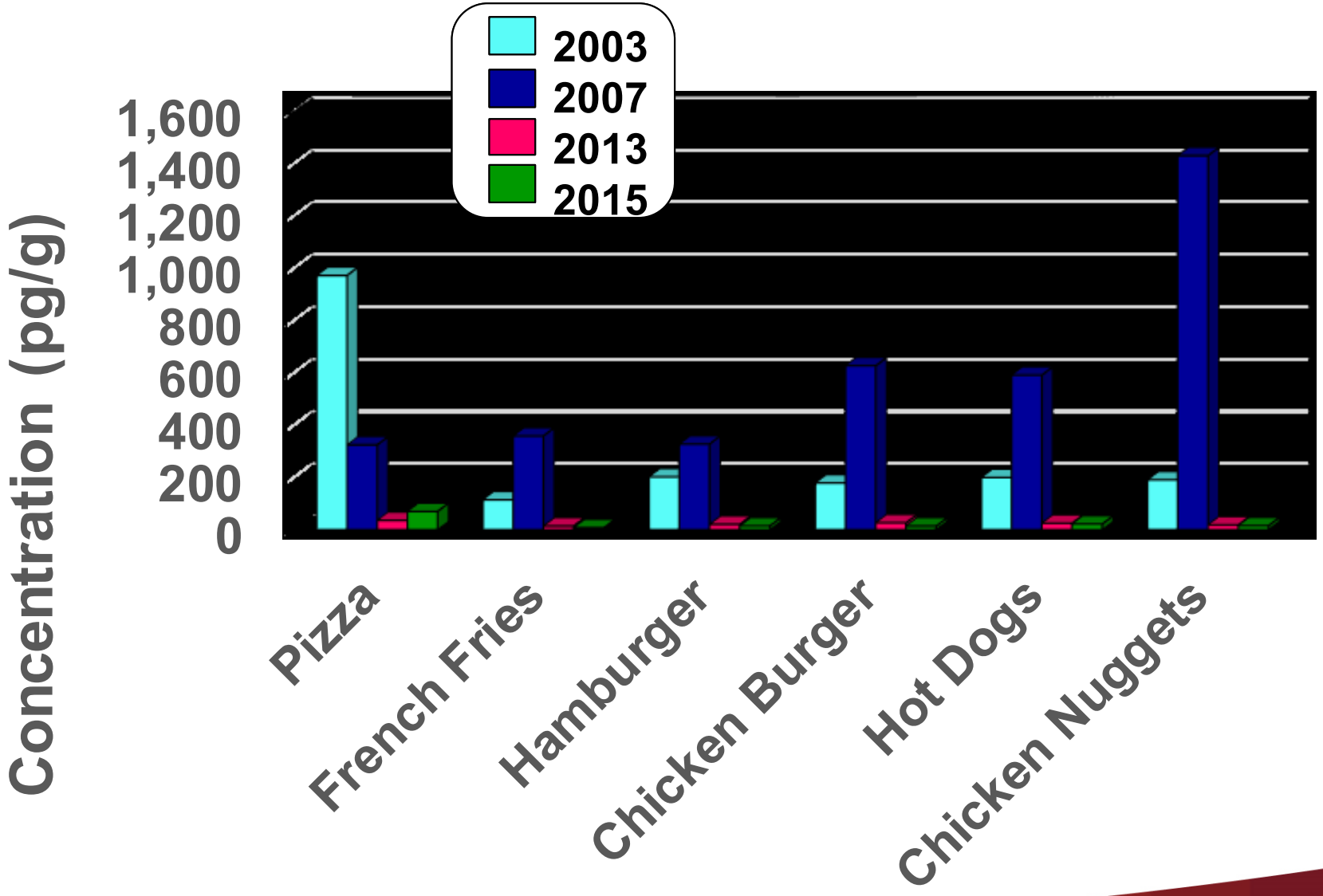
BPS, ng/g, in Ground Beef from 2008-2020 TDS



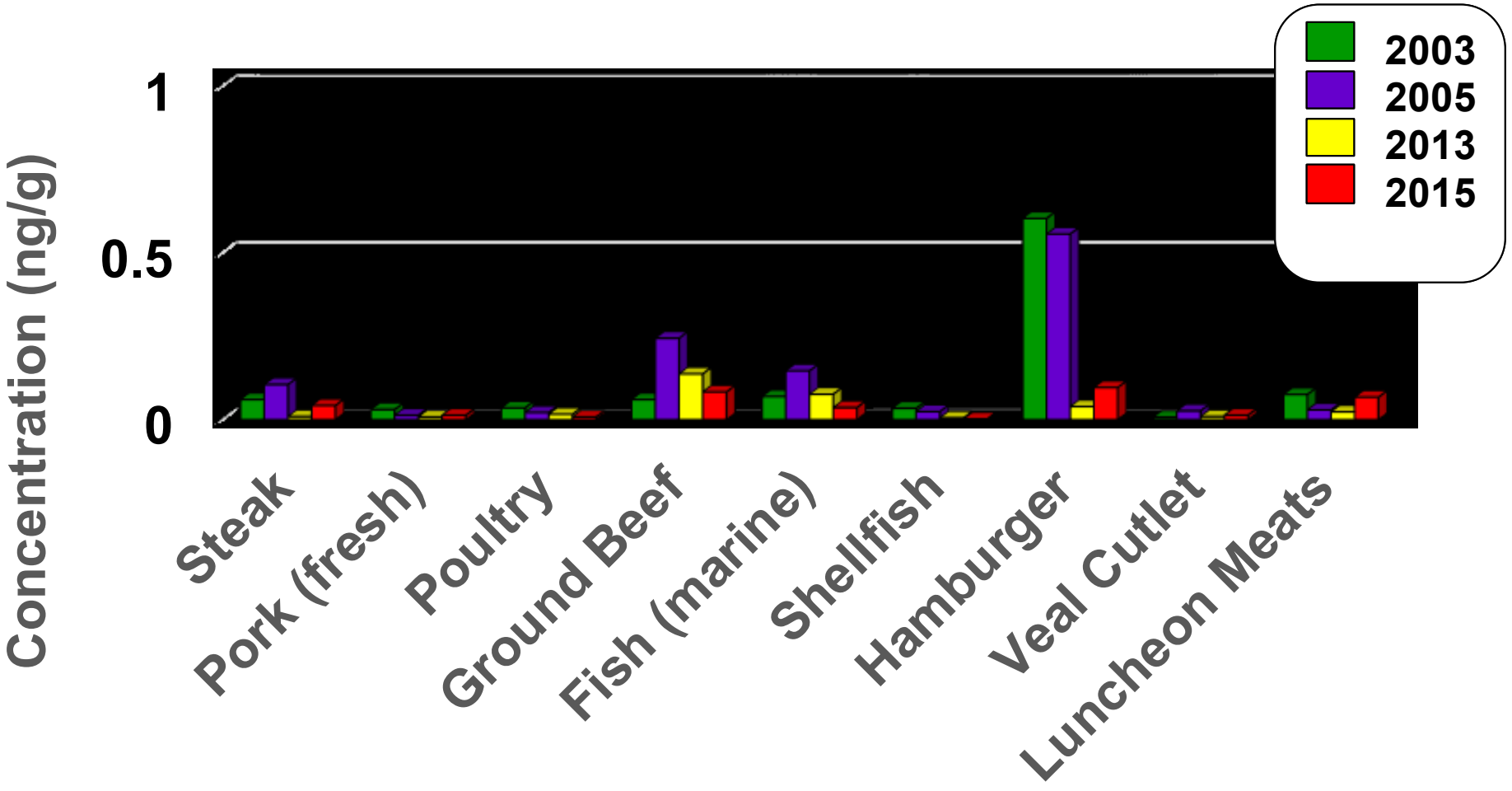
BPS, ng/g in Beef Steak from 2008-2020 TDS



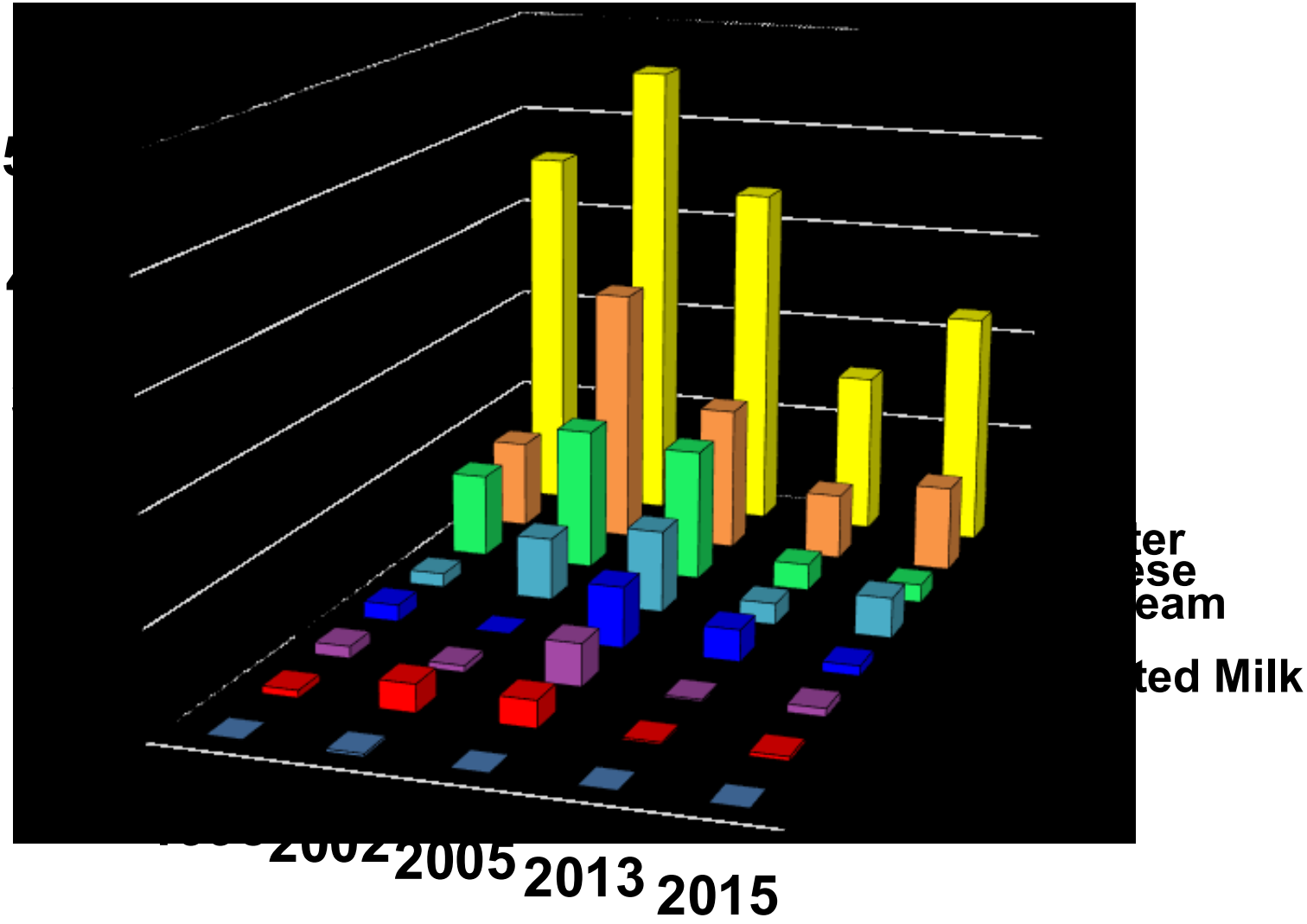
ΣPolybrominated Diphenyl Ethers (PBDE) (Σ17 Congeners) – Flame Retardants in Fast Foods



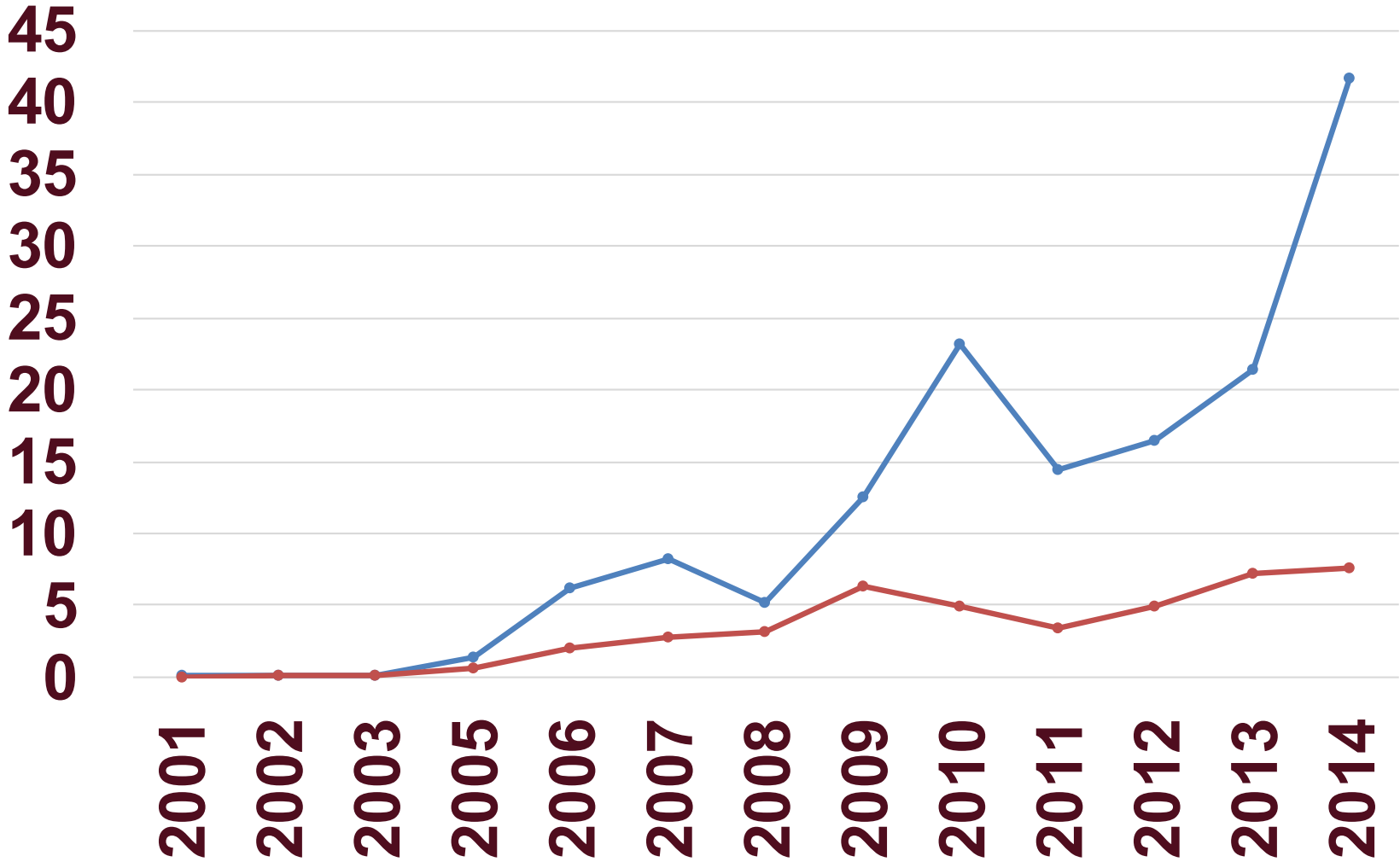
Dieldrin in Meat/Poultry/Fish TDS Composites



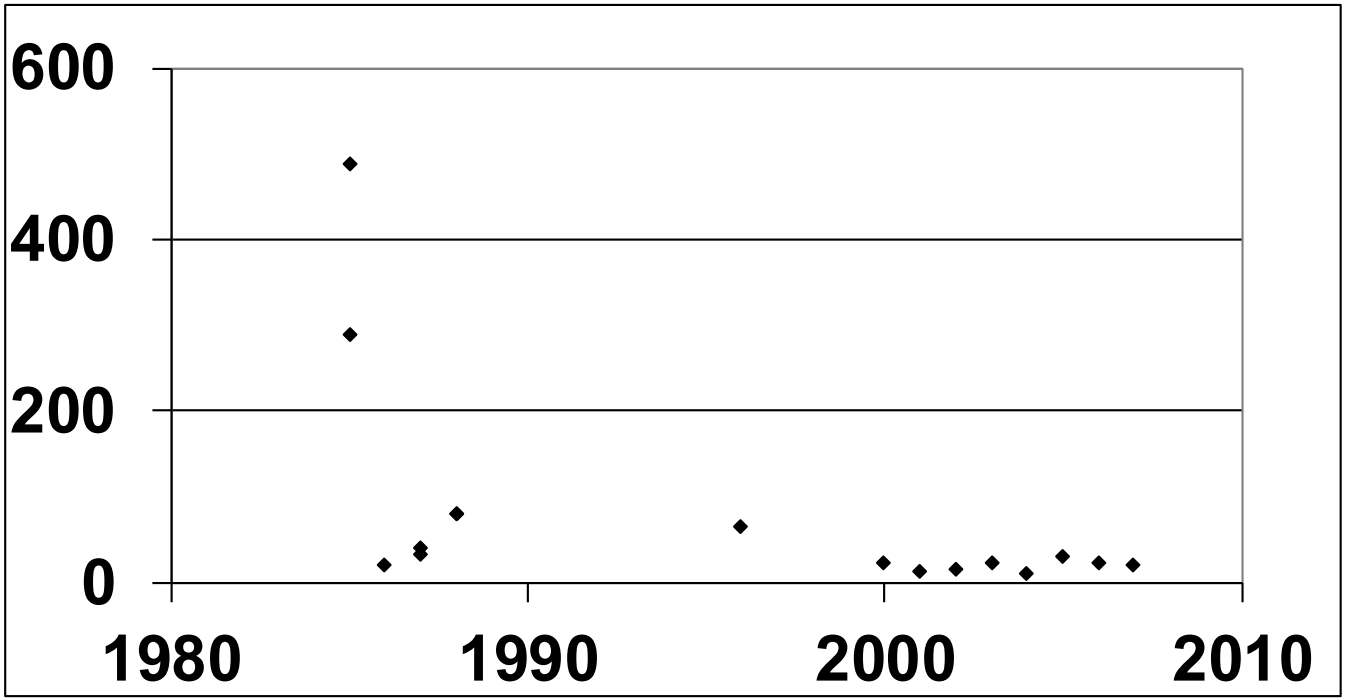
ΣDDT, ng/g, in TDS Dairy Products Over Time



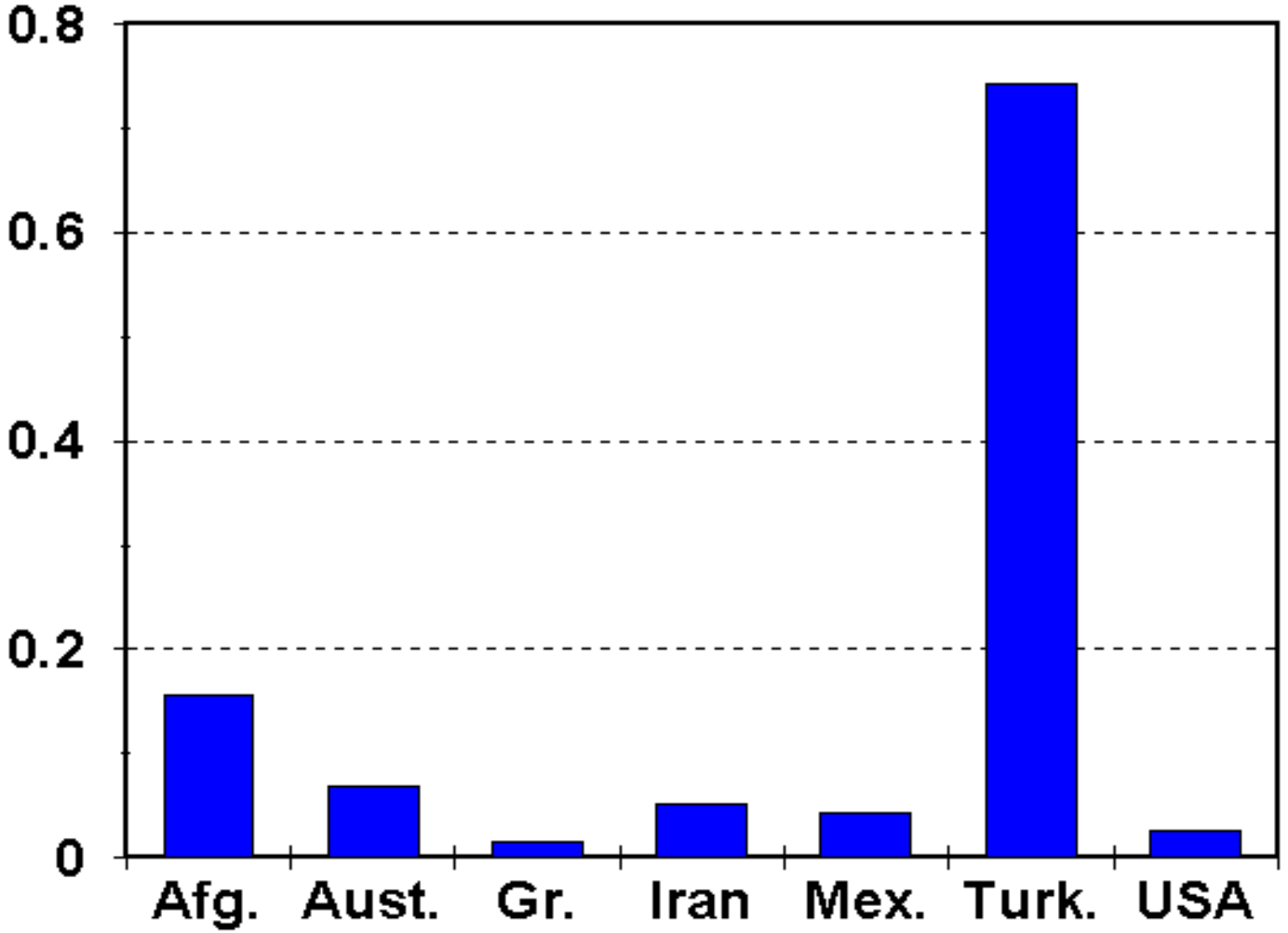
Bismuth, ng/g, in TDS Cheese (blue line) and Cottage Cheese (red line)



Lead, ng/g, in TDS Raisin Pie Composite



Lead Levels, µg/g, in Raisins by Country of Origin



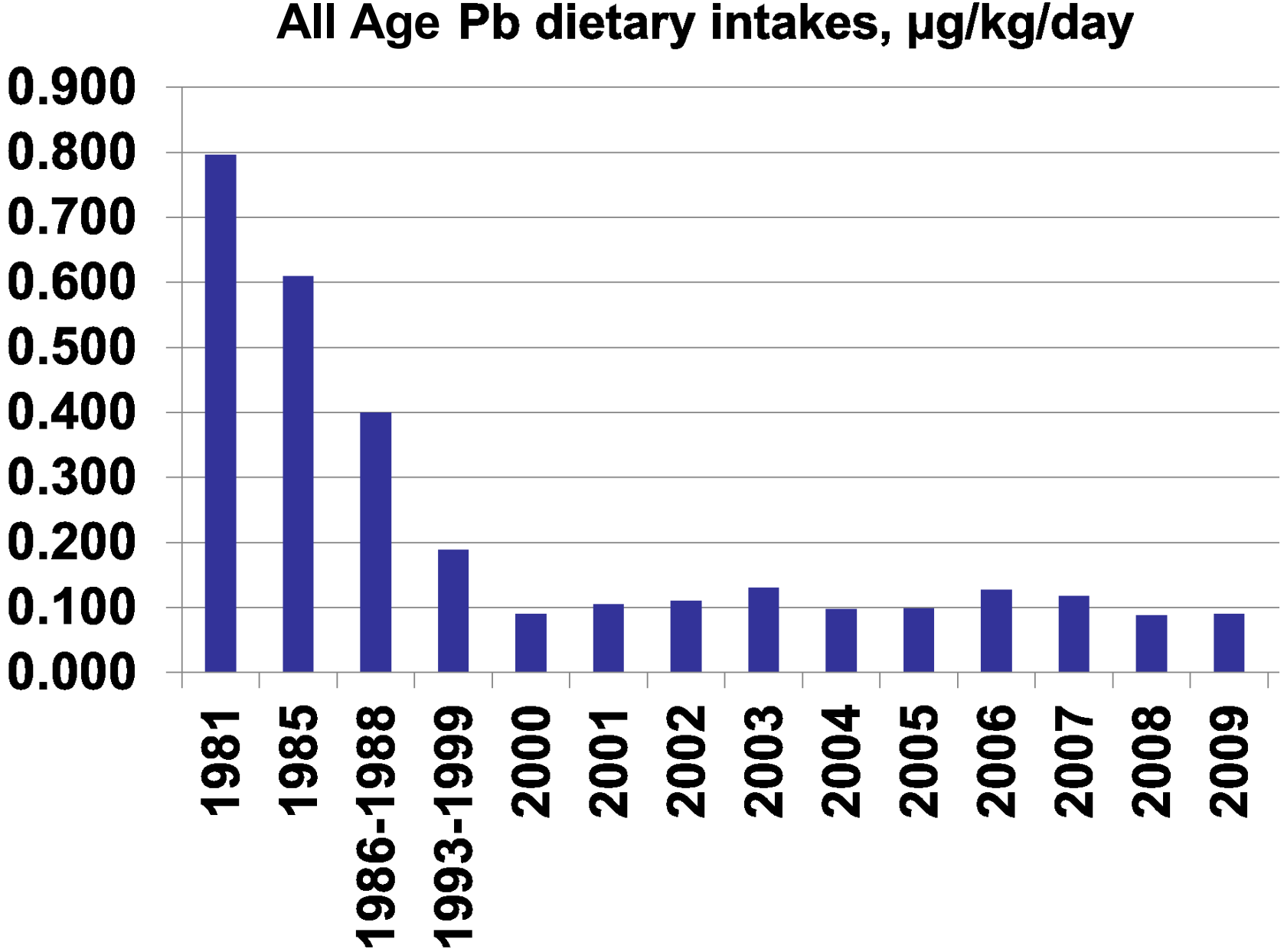
Lead in Raisins

Pb levels in TDS raisin pie traced to raisins from Turkey containing up to 3000 ng/g Pb

Importation of raisins containing >500 ng/g Pb stopped

Meetings with raisin exporters in Turkey traced Pb contamination to copper sulfate fungicide sprayed on grapes. Fungicide contaminated with % levels of Pb

Problems with Pb analytical methods in Turkey identified and solved. Importation resumed with verification.


All Age Pb dietary intakes, µg/kg/day
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
1981
1985
1986-1988
1993-1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

Dietary Intake of Lead, µg/kg/day, Deterministic vs Probabilistic Calculation

Deterministic	Probabilistic	
Average and Age	Median and Age	95TH Percentile
0.157 1-4 Years	0.195 0.5-4 Years	0.363 0.5-4 Years
0.062 All Ages	0.069 12+ Years	0.148 12+ Years

Deterministic – 1970-72 food consumption, and body wt. , & Pb concentrations from 2017 TDS

Probabilistic – uses 2005 food consumption and body weights and Pb concentrations from TDS and targeted surveys

Conclusions

TDS chemical concentration data:

1. **Reliable representation of background concentrations in uncontaminated foods**
2. **Can still identify contaminated samples and time trends**

TDS dietary intake data:

1. **Provide accurate core data for risk assessments**
2. **Can identify time trends and monitor impact of risk management steps**

Hidden Benefits of the TDS

1. Analysis of archived samples found useful in looking at concentrations of emerging chemicals, such as fluorinated organics.
2. The analysis of priority chemicals every year or 2 years ensures availability of analytical expertise to deal with emergencies

Future Design Factors

1. Ethnic / regional diets – no food consumption surveys available
2. Mapping TDS composites to current (2015) food consumption results
3. Add drinking water consumed as water
4. Incorporating new composites to represent thousands of new products for sale and dietary changes, and balancing this with analytical resources

Photo by Adam Becalski – Ottawa, Halloween