
Approaches and Assumptions of Risk-based Soil Screening Values

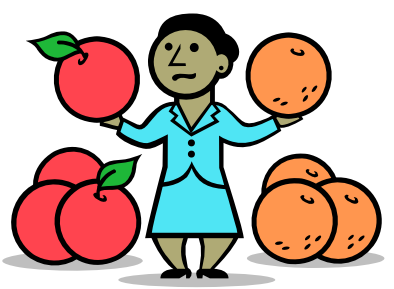
Bennett Kottler, Ph.D.

Interstate Technology Resource Council

Risk Resources Team

Objectives of Survey

- ▶ Document differences in screening levels
- ▶ Determine basis for the development of levels



Survey: Participating States

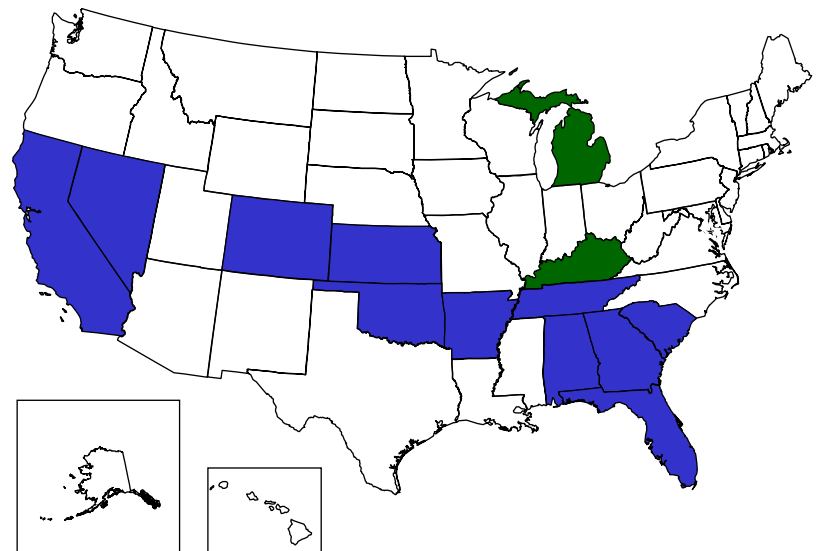
13 States Surveyed

▶ 11 of 13 states

- Regulator is member of ITRC Risk Team
- Alabama, Arkansas, California, Colorado, Florida, Georgia, Kansas, Nevada, Oklahoma, South Carolina, Tennessee

▶ 2 of 13 states

- Unique screening values?
- Kentucky and Michigan



Survey: Chemicals

Chosen by prevalence and regulator interest

- ▶ Trichloroethylene (TCE)
- ▶ Lead
- ▶ Benzo(a)pyrene
- ▶ Arsenic
- ▶ Polychlorinated biphenyls (PCBs)

Survey: Exposure Scenarios

- ▶ Oral, dermal, and inhalation
- ▶ Residential child
Residential adult, industrial adult
- ▶ Soil, ground water, surface water, and leachability



Survey: Risk Level

- ▶ Target excess risk
 - Carcinogens
 - Excess cancer cases
 - 1×10^{-6} to 1×10^{-4}

- ▶ Hazard quotient (HQ)
 - Non carcinogens
 - Reference dose without adverse effect
 - 0.1 to 1.0

Survey Results

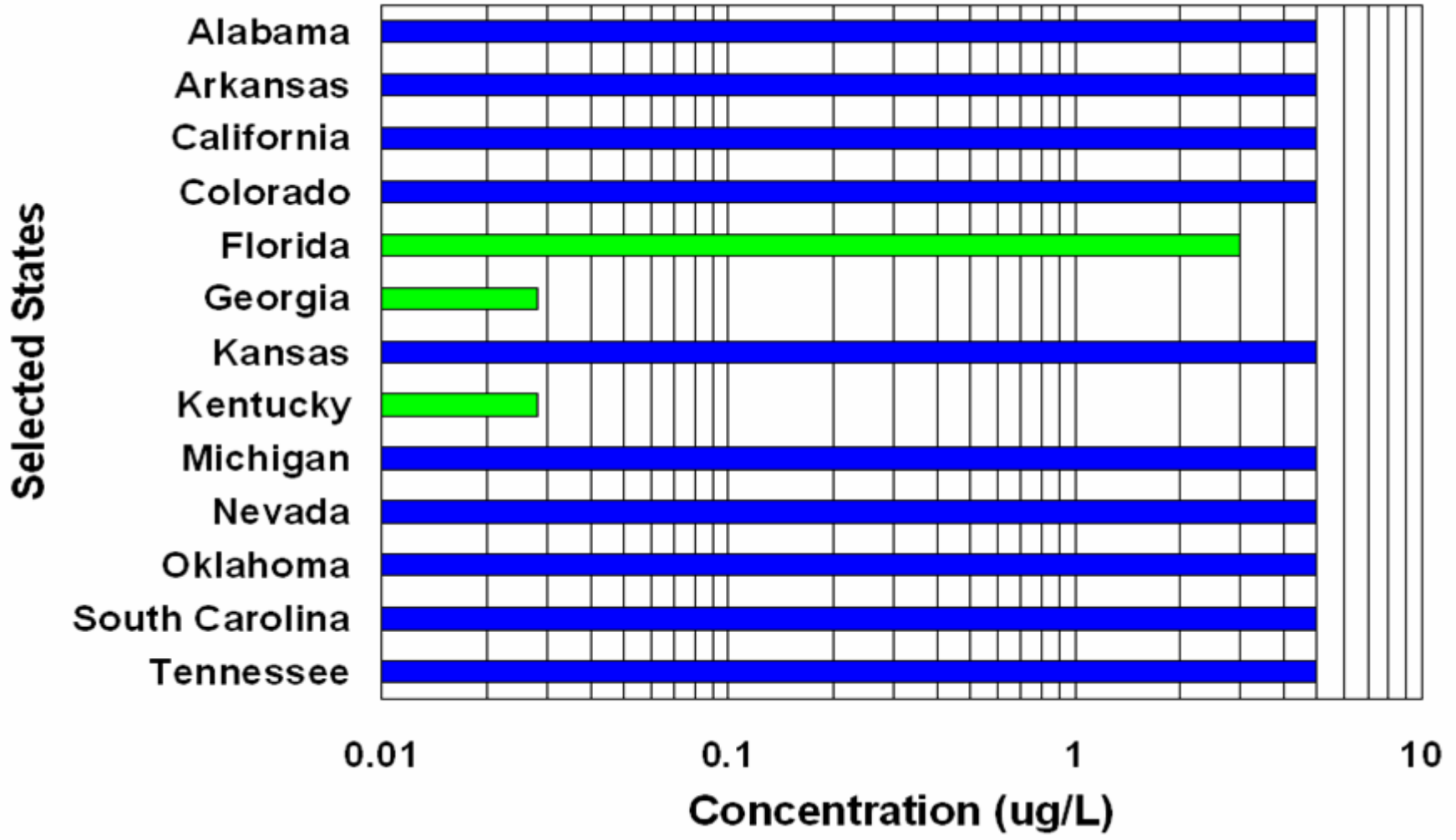


- ▶ Screening levels
 - 650 data points

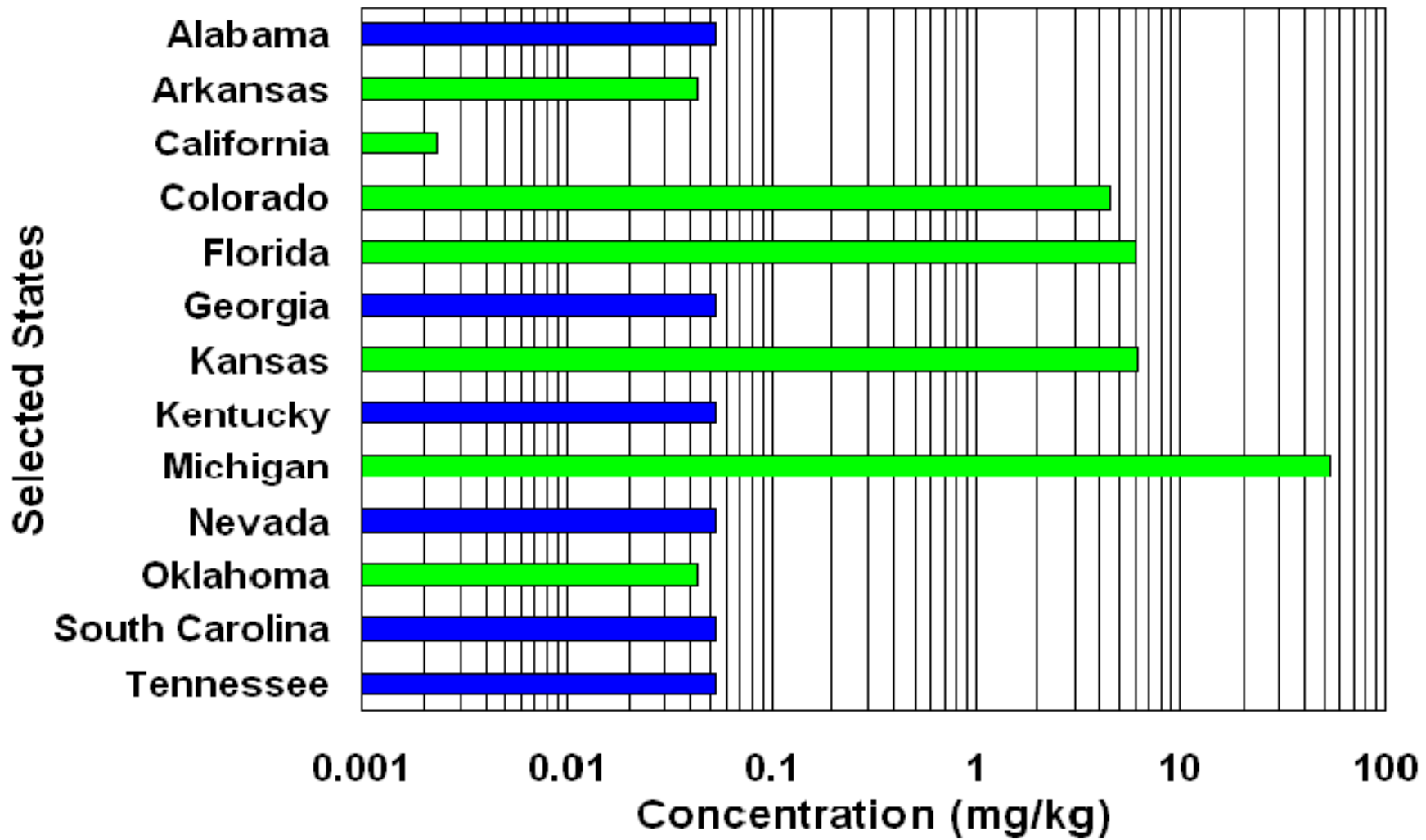
- ▶ Exposure assumptions
 - 169 data points

- ▶ Additional comments and data collected

Ground Water Screening Value: TCE



Residential Soil Screening Value: TCE



Objectives of Survey

1. Document differences in screening levels
2. Determine basis for the development of levels



Sources of Screening Values

- ▶ Federal Drinking Water Maximum Contaminant Level (MCL)
 - All U.S. States

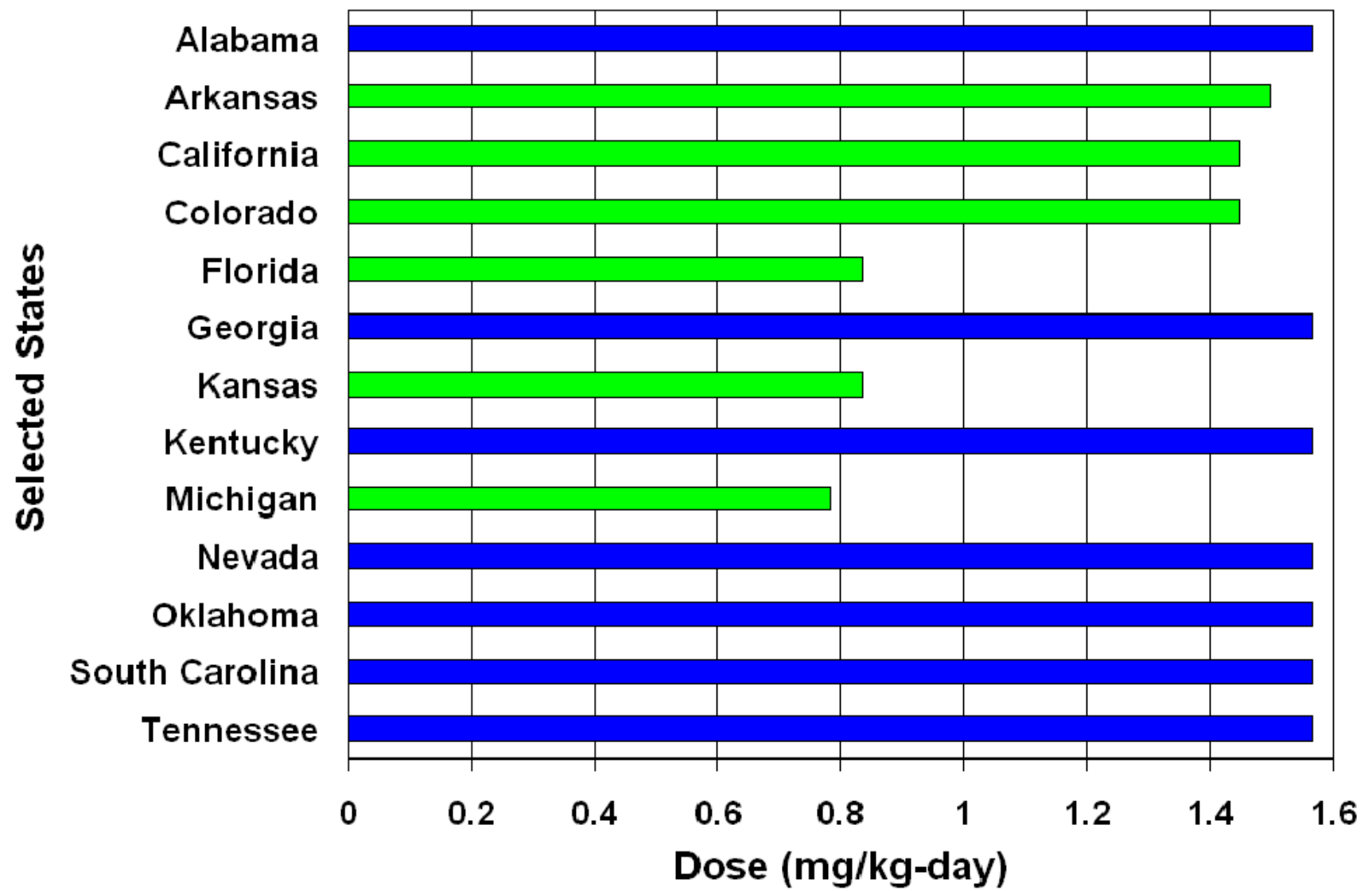
- ▶ U.S. EPA Region 9 Preliminary Remediation Goals (PRGs)
 - AL, GA, KY, NV, SC, and TN

- ▶ U.S. EPA Region 6 Screening Levels
 - AR and OK

- ▶ State derived
 - CA, CO, FL, KS, and MI



Normalized Average Oral Daily Dose (ADD_o) of Selected States



Algorithms for ADD_o

- ▶ US state derived (i.e. Florida)

$$\text{ADD}_o = \frac{\left(\text{Ingestion Rate} \right) \left(\text{Exposure Duration} \right) \left(\text{Soil Absorption Efficiency} \right) \left(\text{Exposure Frequency} \right)}{\left(\text{Body Weight} \right) \left(\text{Averaging Time} \right)}$$



Age-Adjusted Body Weight: Florida (Pre-2005)



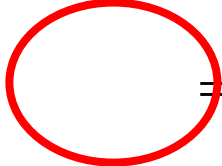
$$\text{Age Adjusted Body Weight} = \frac{\left[\begin{matrix} \text{(Body} \\ \text{Weight)} \end{matrix} \text{(Years)} \right]_{\text{Child}} + \left[\begin{matrix} \text{(Body} \\ \text{Weight)} \end{matrix} \text{(Years)} \right]_{\text{Adult}}}{\text{Exposure Duration}}$$



Age-Adjusted Body Weight: Florida (Pre-2005) – Example Calculation



$$\text{Age Adjusted Body Weight} = \frac{\left[\begin{matrix} \text{Body} \\ \text{Weight} \end{matrix} \right] (\text{Years})_{\text{Child}} + \left[\begin{matrix} \text{Body} \\ \text{Weight} \end{matrix} \right] (\text{Years})_{\text{Adult}}}{\text{Exposure Duration}}$$

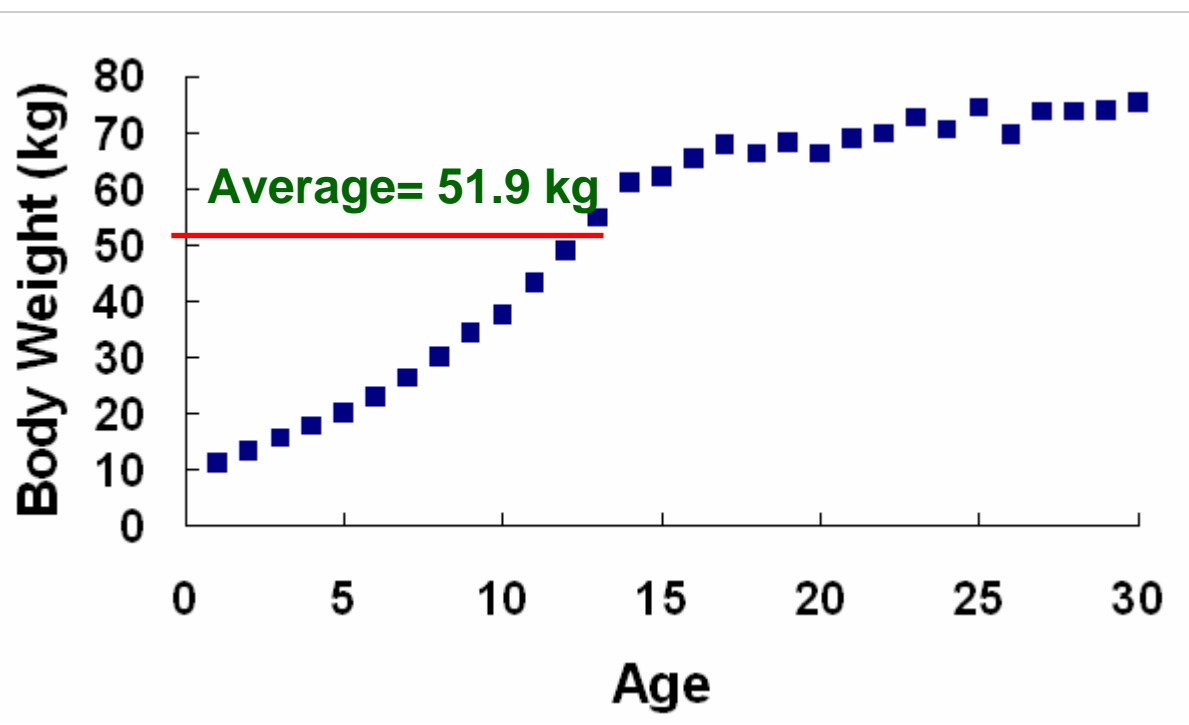
 = $\frac{(\quad)(\quad) + (\quad)(\quad)}{\quad}$

Age-Adjusted Body Weight: Florida 2005



- ▶ Final Technical Report: Development of Cleanup Target Levels (2005) Division of Waste Management, Florida Department of Environmental Protection

<http://www.floridatox.org/TechnicalFeb05.pdf>



Body Weight in Exposure Algorithm

Different age adjustment?

Yes!



Different exposure algorithm(s)?

Yes!

Compare Florida to USEPA Region 9

Preliminary Remediation Goals

Different Algorithms for ADD_o

- ▶ US state derived (i.e. Florida)

$$\text{ADD}_o = \frac{\left(\text{Ingestion Rate} \right) \left(\text{Exposure Duration} \right) \left(\text{Soil Absorption Efficiency} \right) \left(\text{Exposure Frequency} \right)}{\left(\text{Body Weight} \right) \left(\text{Averaging Time} \right)}$$

- ▶ USEPA Region 9 PRGs

$$\text{ADD}_o = \frac{\left(\text{Age Adjusted Soil Ingestion Factor} \right) \left(\text{Soil Absorption Efficiency} \right) \left(\text{Exposure Frequency} \right)}{\left(\text{Averaging Time} \right)}$$

Selected Exposure Assumption: Age-Adjusted Soil Ingestion Factor



$$\text{Age Adjusted Soil Ingestion Factor} = \left[\frac{\left(\begin{matrix} \text{Ingestion} \\ \text{Rate} \end{matrix} \right) \left(\begin{matrix} \text{Exposure} \\ \text{Duration} \end{matrix} \right)}{\left(\begin{matrix} \text{Body} \\ \text{Weight} \end{matrix} \right)} \right]_{\text{Child}} + \left[\frac{\left(\begin{matrix} \text{Ingestion} \\ \text{Rate} \end{matrix} \right) \left(\begin{matrix} \text{Exposure} \\ \text{Duration} \end{matrix} \right)}{\left(\begin{matrix} \text{Body} \\ \text{Weight} \end{matrix} \right)} \right]_{\text{Adult}}$$



Similar Exposure Algorithm Parameters: Average Oral Daily Dose (ADD_o)



- ▶ US State Derived (i.e. Florida)

$$ADD_o = \frac{\left(\text{Ingestion Rate} \right) \left(\text{Exposure Duration} \right) \left(\text{Soil Absorption Efficiency} \right) \left(\text{Exposure Frequency} \right)}{\left(\text{Body Weight} \right) \left(\text{Averaging Time} \right)}$$

- ▶ USEPA Region 9 PRGs

$$ADD_o = \frac{\left(\text{Age Adjusted Soil Ingestion Factor} \right) \left(\text{Soil Absorption Efficiency} \right) \left(\text{Exposure Frequency} \right)}{\left(\text{Averaging Time} \right)}$$

Exposure Algorithm Parameters: Average Oral Daily Dose (ADD_o)

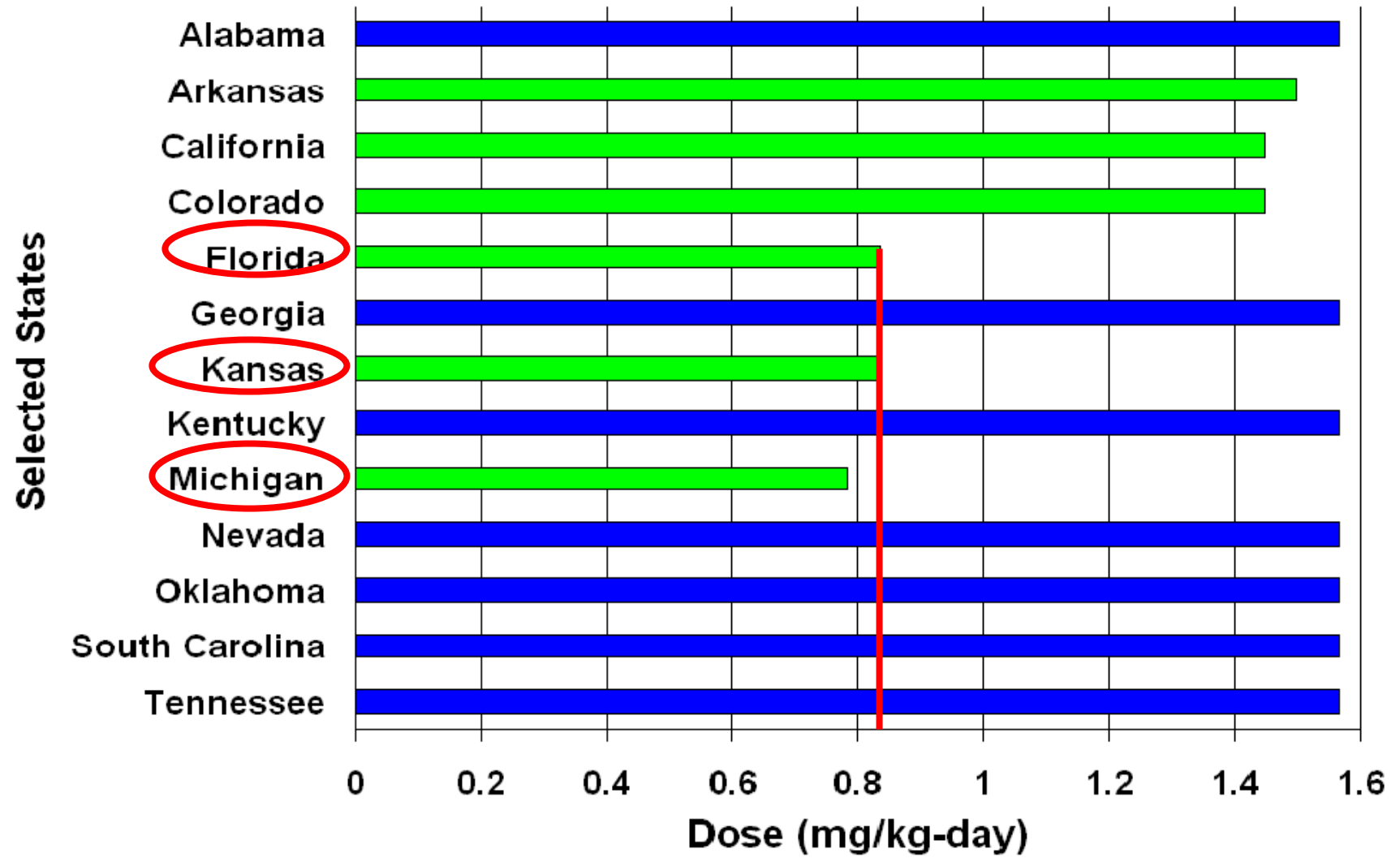
- ▶ US State Derived (i.e. Florida)

$$= \frac{\left(\frac{\text{Concentration}}{\text{Volume}} \right) \left(\frac{\text{Inhalation Rate}}{\text{Body Weight}} \right) \left(\frac{\text{Exposure Time}}{\text{Days}} \right)}{\left(\frac{\text{Concentration}}{\text{Volume}} \right) \left(\frac{\text{Inhalation Rate}}{\text{Body Weight}} \right) \left(\frac{\text{Exposure Time}}{\text{Days}} \right)}$$

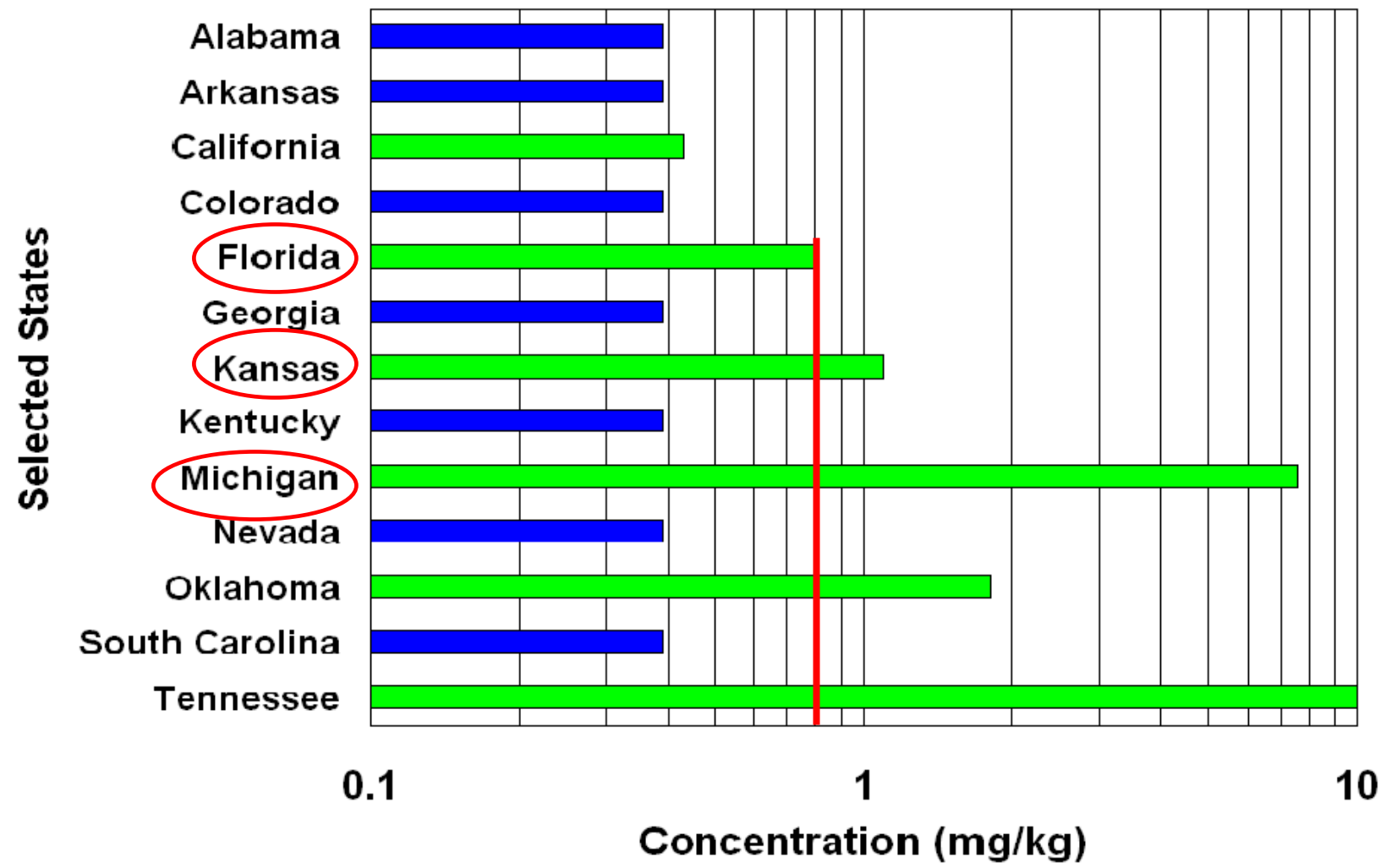
- ▶ USEPA Region 9 PRGs

$$= \frac{\left(\frac{\text{Concentration}}{\text{Volume}} \right) \left(\frac{\text{Inhalation Rate}}{\text{Body Weight}} \right) \left(\frac{\text{Exposure Time}}{\text{Days}} \right)}{\left(\frac{\text{Concentration}}{\text{Volume}} \right) \left(\frac{\text{Inhalation Rate}}{\text{Body Weight}} \right) \left(\frac{\text{Exposure Time}}{\text{Days}} \right)}$$

Normalized Average Oral Daily Dose (ADD_o) of Selected States



Residential Soil Screening Value: Arsenic



Discussion and Conclusions



- ▶ Mostly minimal differences
- ▶ Many U.S. states rely on U.S. EPA values
- ▶ U.S. EPA values vary between regional offices
- ▶ States refine default values
- ▶ Different applications of screening values
 - Legislation or policy
 - Technical
- ▶ Transparency easily lost
 - Values are not enough

Recommendations

- ▶ No one approach advocated
- ▶ Publish basis of criteria and assumptions
- ▶ Publish intended application
- ▶ Provide training and communication tools



Survey Results Available



Examination of Risk-Based Screening Values and Approaches of Selected States. December 2005.
(RISK-1)

http://www.itrcweb.org/gd_Risk.asp