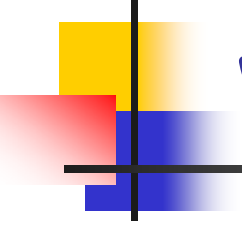


Assessing Garden Crops as an Exposure Route for Soil Mercury

Bill Berti and Dean Cocking
South River Science Team
April 12, 2005

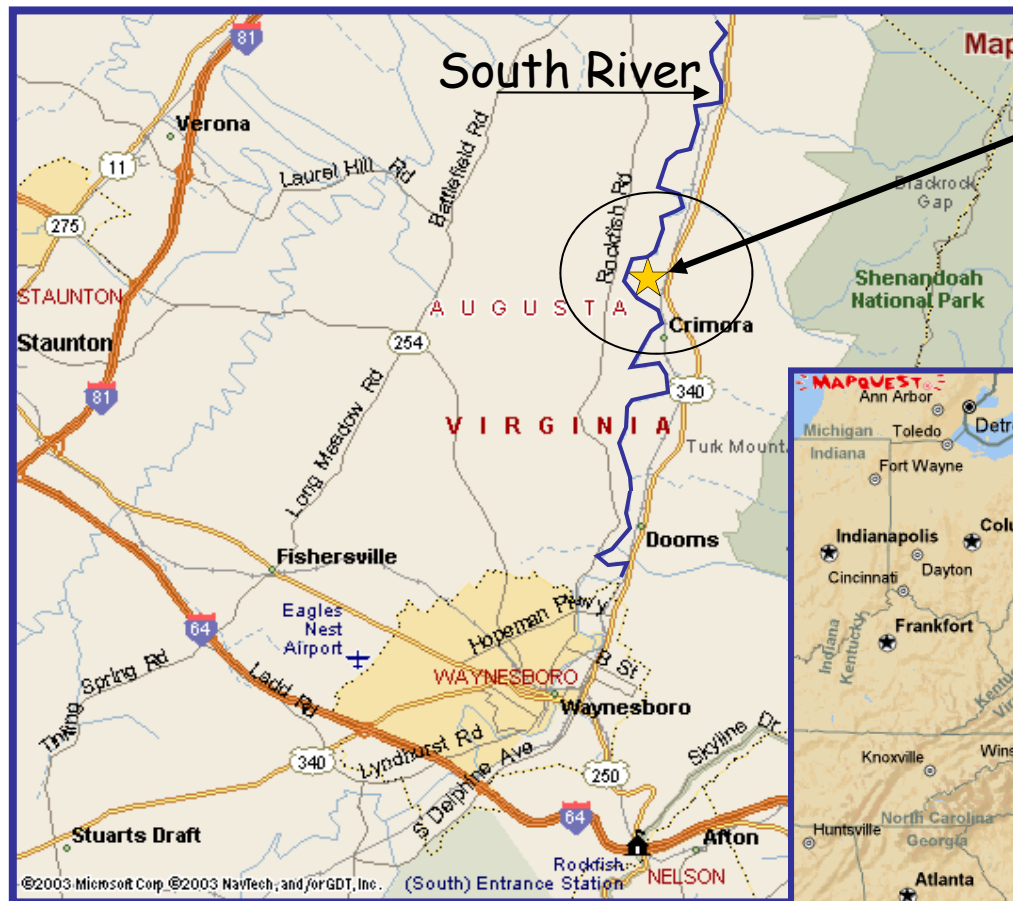


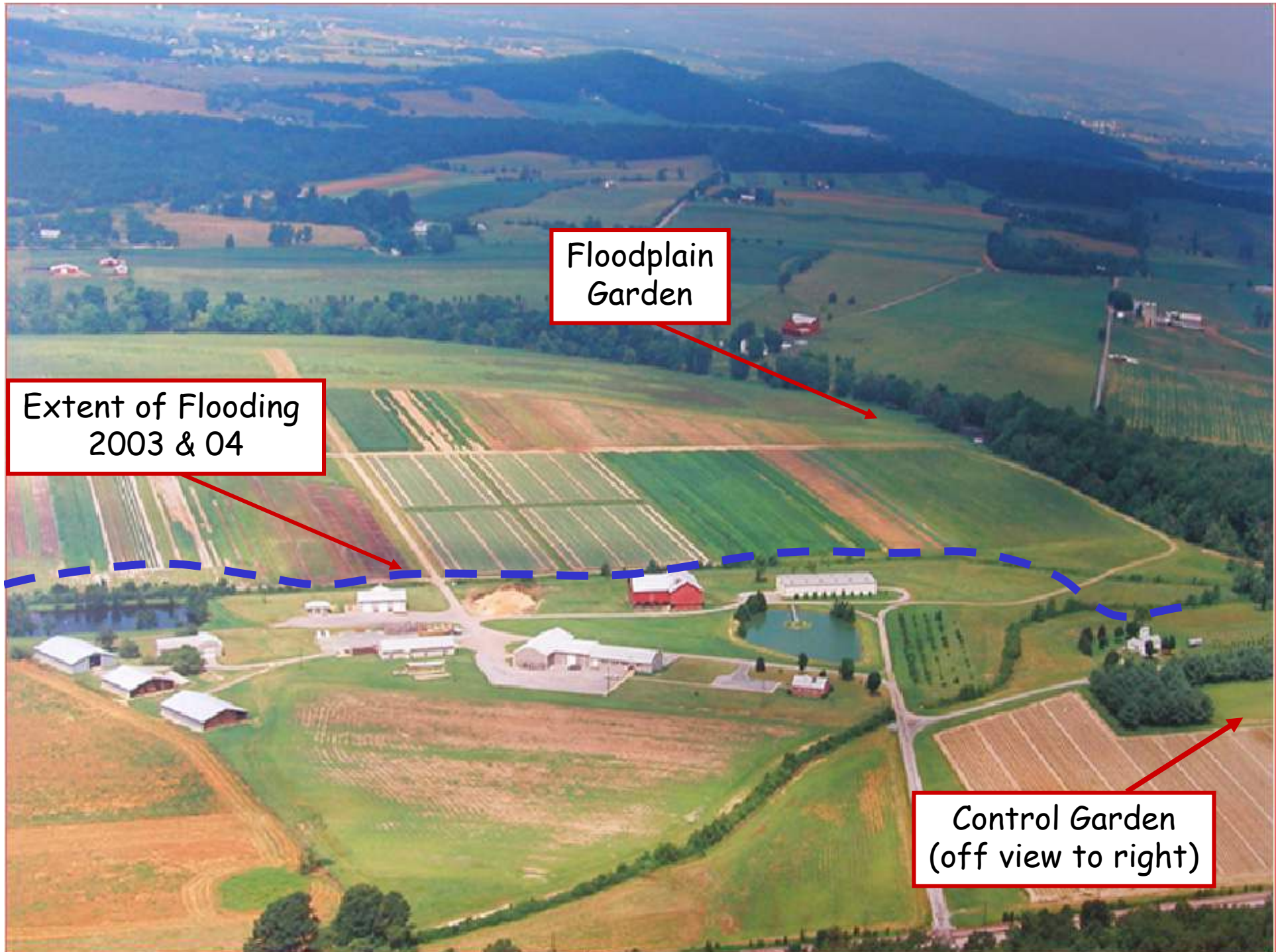
Vegetable Garden Study

Objective -

Determine if soil-Hg is taken-up by vegetables at concentrations sufficient to be a health risk

Augusta Forestry Center - Crimora, VA



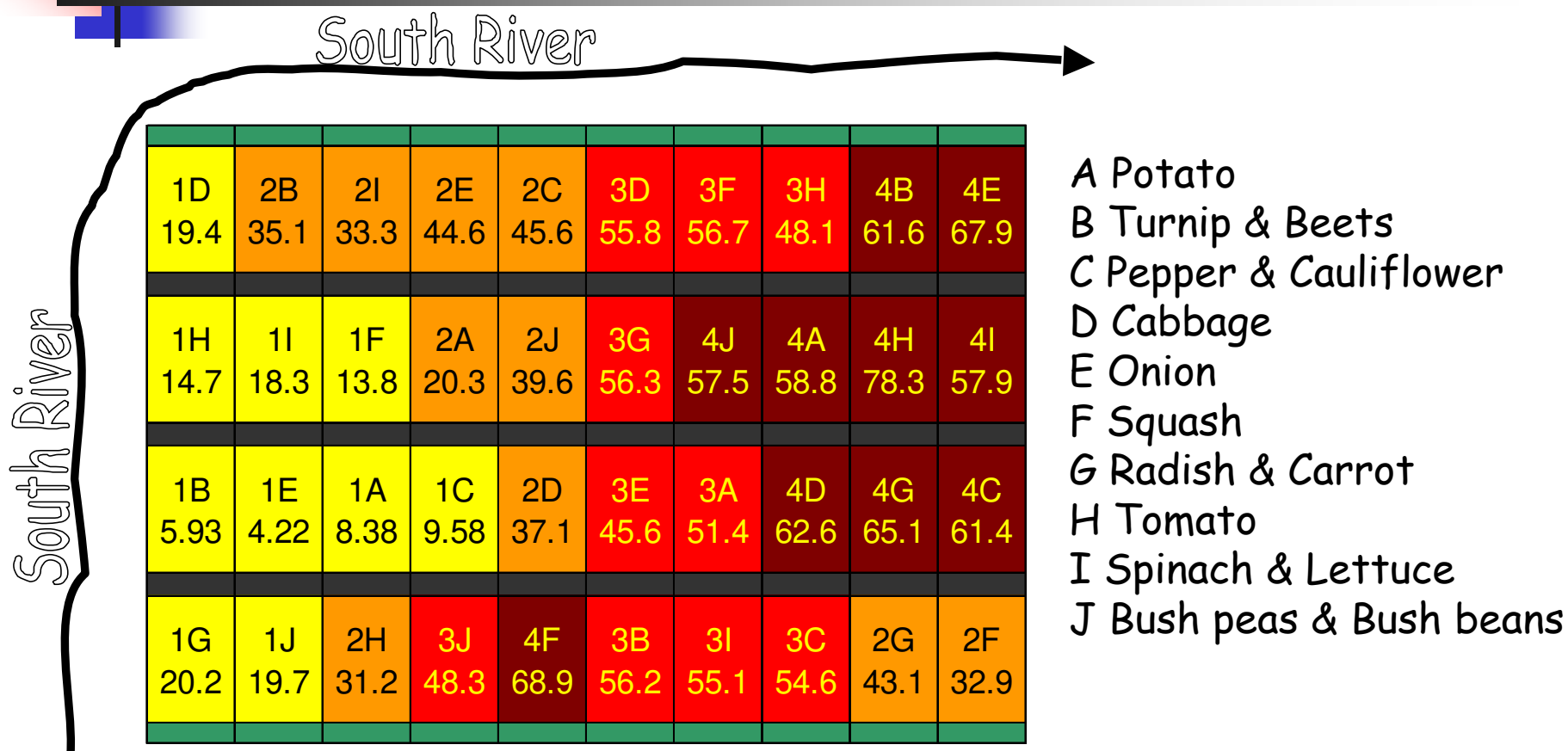


Floodplain
Garden

Extent of Flooding
2003 & 04

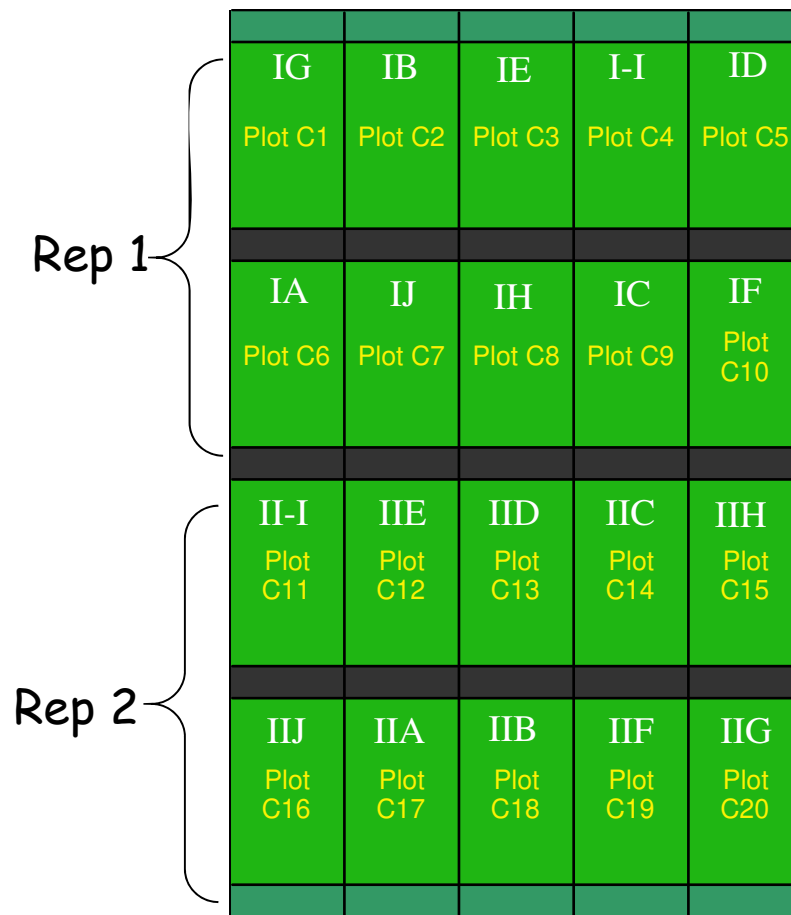
Control Garden
(off view to right)

Floodplain Garden - 2004



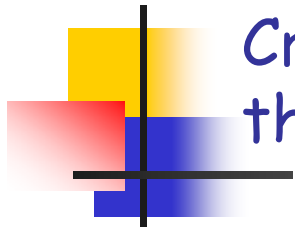
Sampled Nov 23, 2003
mg Hg/kg soil, dry weight basis

Control Garden - 2004



- A Potato
- B Turnip & Beets
- C Pepper & Cauliflower
- D Cabbage
- E Onion
- F Squash
- G Radish & Carrot
- H Tomato
- I Spinach & Lettuce
- J Bush peas & Bush beans

Plots in 2 x 10
Randomized
Complete Block
design with some
plots containing
two crops



Crops were planted much earlier in 2004 than in 2003

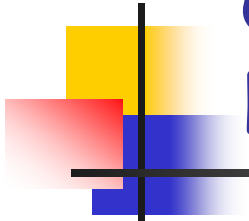
Root Crops

Crop list	Planted as:	Date 2003	Date 2004
Beet	Seed	-----	11-May
Radish	Seed	30-Sept	11-May
Carrot	Seed	25-June	11-May
Turnip	Seed	-----	11-May
Potato	Cut seed potatoes	-----	24-April
Red Onion	Onion sets	25-June	24-April
Scallions (onion)	Seed	-----	14-May
Lettuce	Seed	30-Sept	11-May
Spinach	Seed	30-Sept	11-May
Cabbage	Transplanted	25-June	24-April
Cauliflower	Transplanted	-----	11-May
Bush pea	Seed	-----	11-May
Bush bean	Seed	-----	11-May
Bell Pepper	Transplanted	25-June	11-May
Tomato	Transplanted	25 -June	11-May
Squash	Transplanted	25-June	11-May
Sweet corn	Seed	25-June	-----

Sample Preparation

- Harvested and stored cold
- Washed, sliced, and diced
- Shipped to analytical lab for Hg analysis
 - Samples digested and Hg measured





Crop samples all less than Method Detection Limit - MDL

2003

- Cabbage
- Pepper
- Small squash

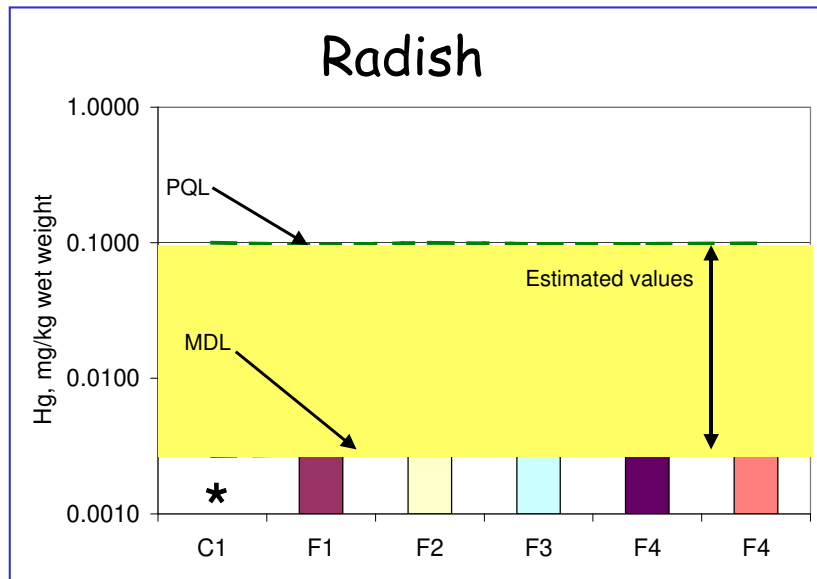
2004

- Bean
- Beet
- Pea
- Pepper
- Radish
- Red onion
- Potato

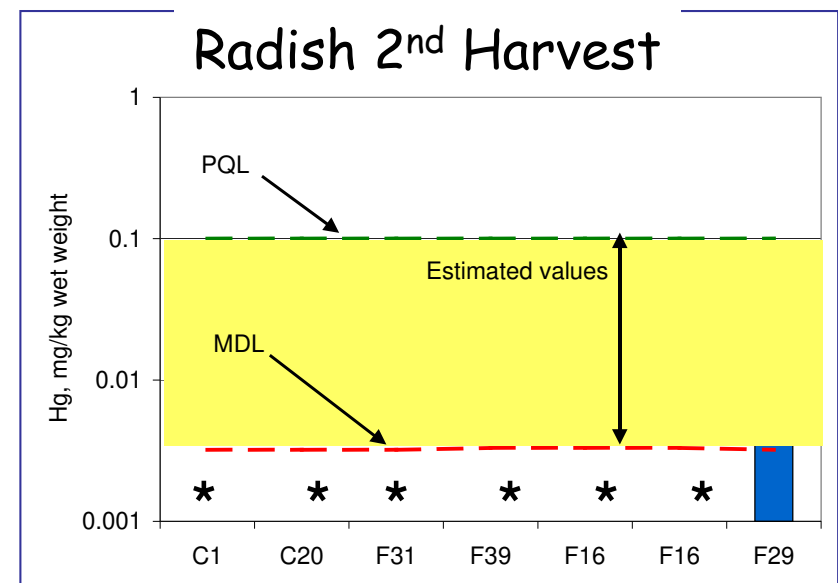
MDL < 0.003 mg Hg kg⁻¹ wet weight

Radish Crop Harvest

2003



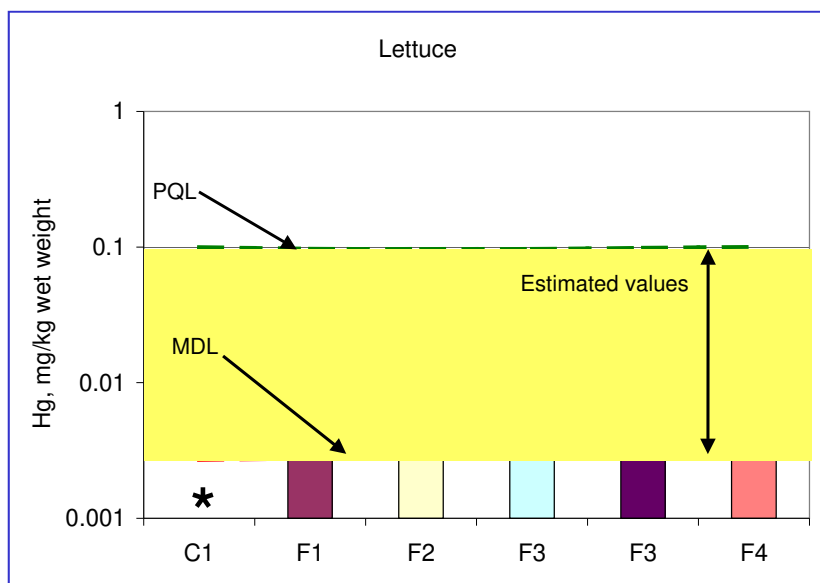
2004



* = less than the MDL

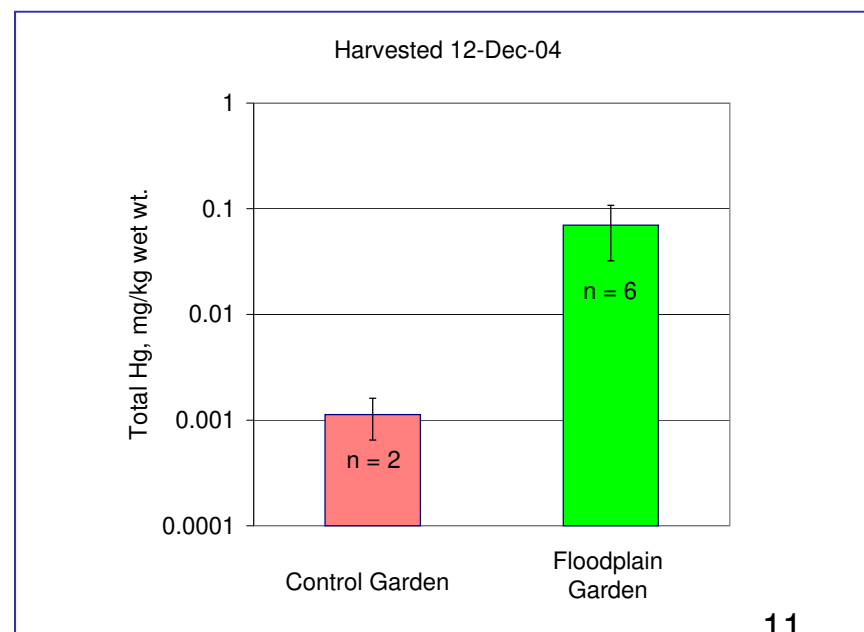
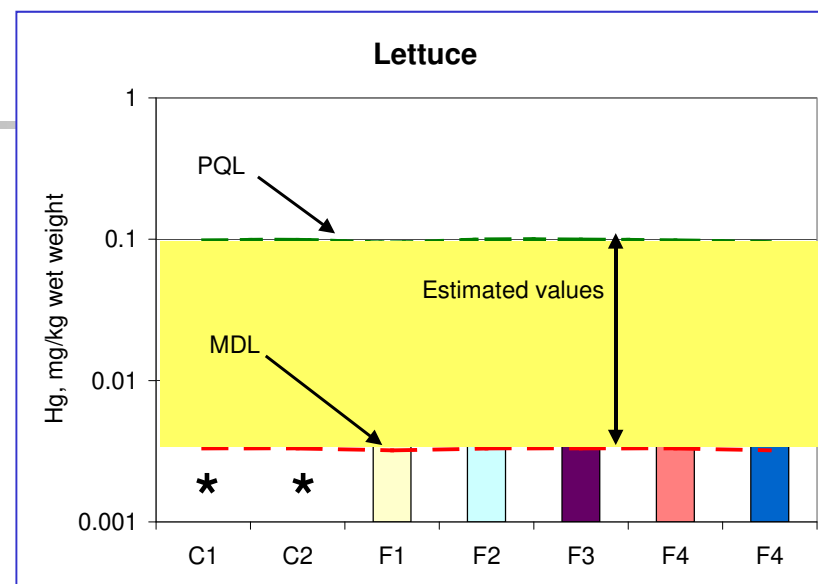
Crop Harvest: Lettuce

2003



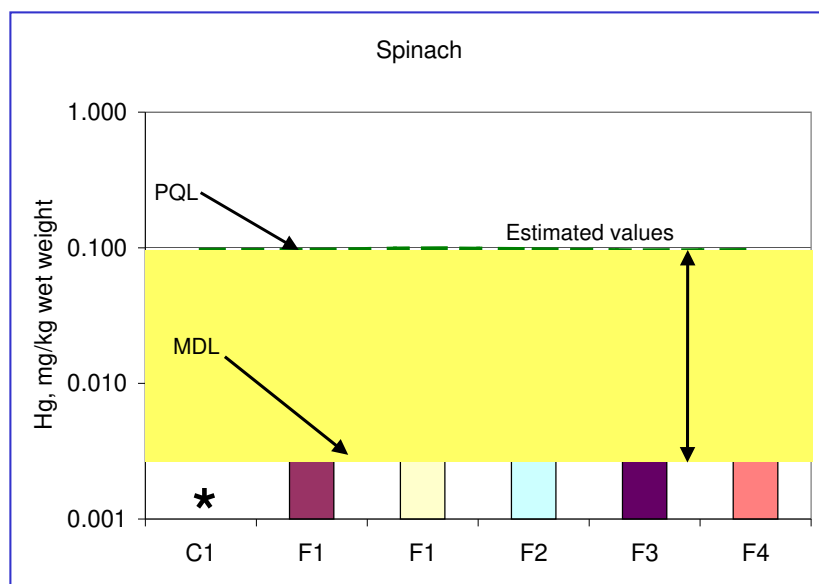
* = less than the MDL

2004



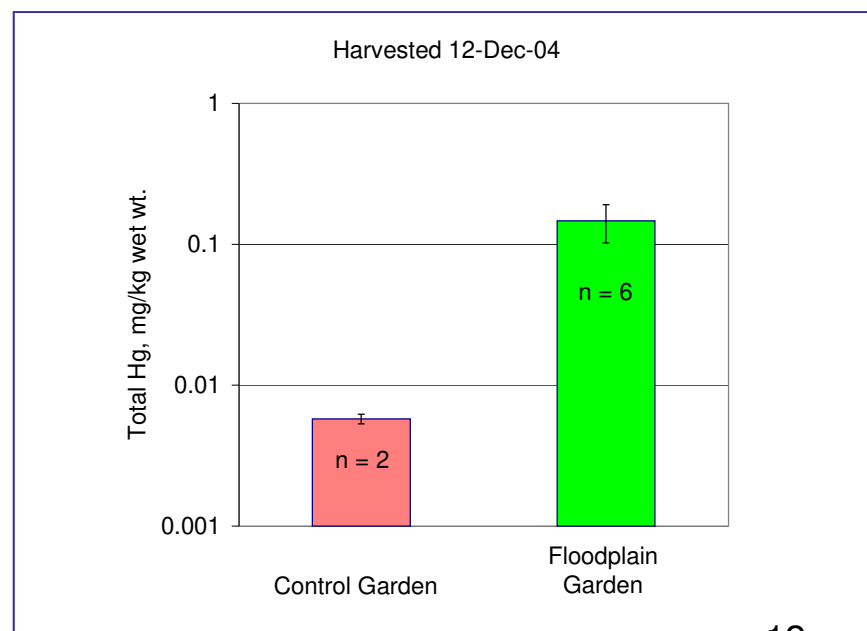
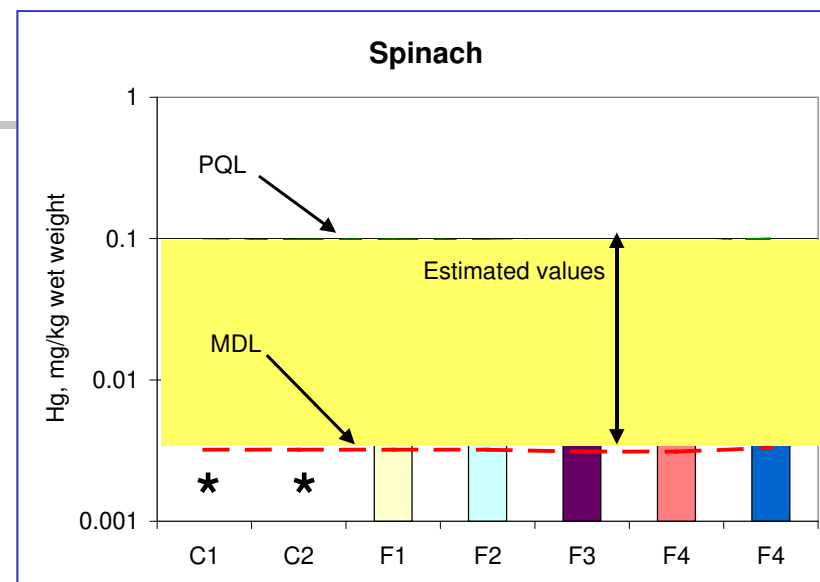
Crop Harvest: Spinach

2003

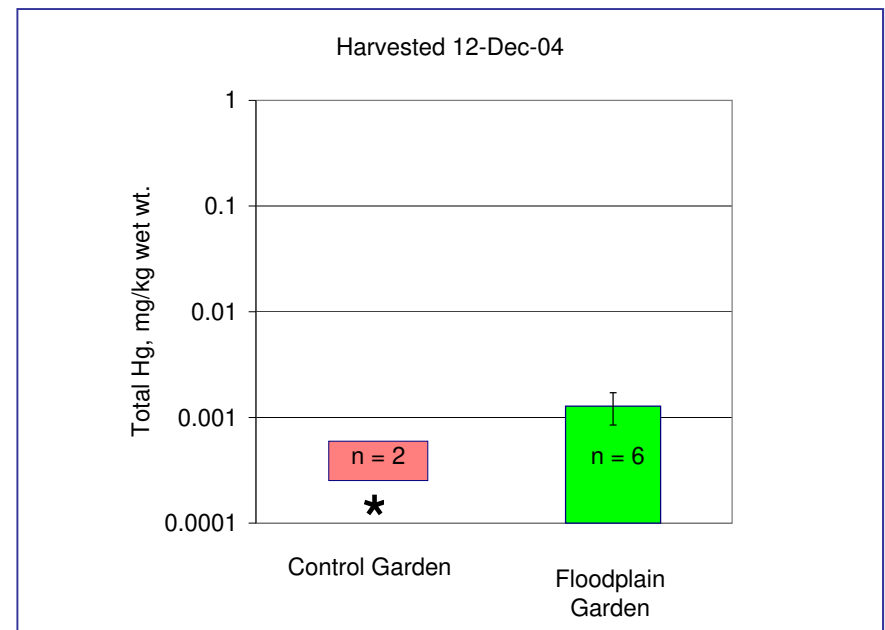
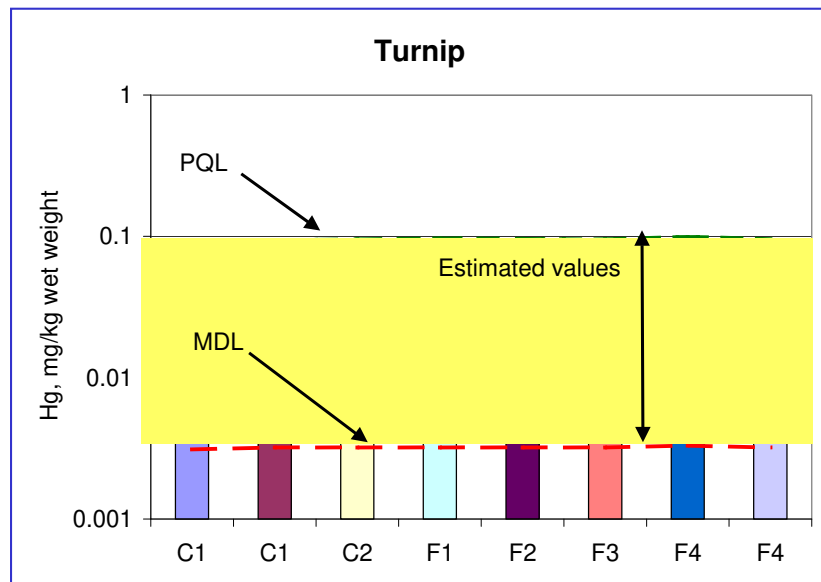


* = less than the MDL

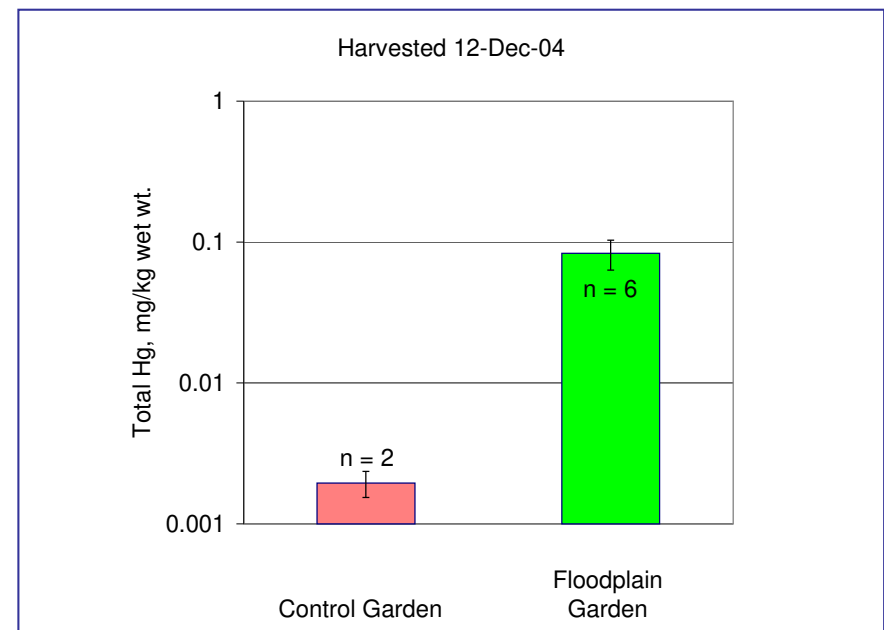
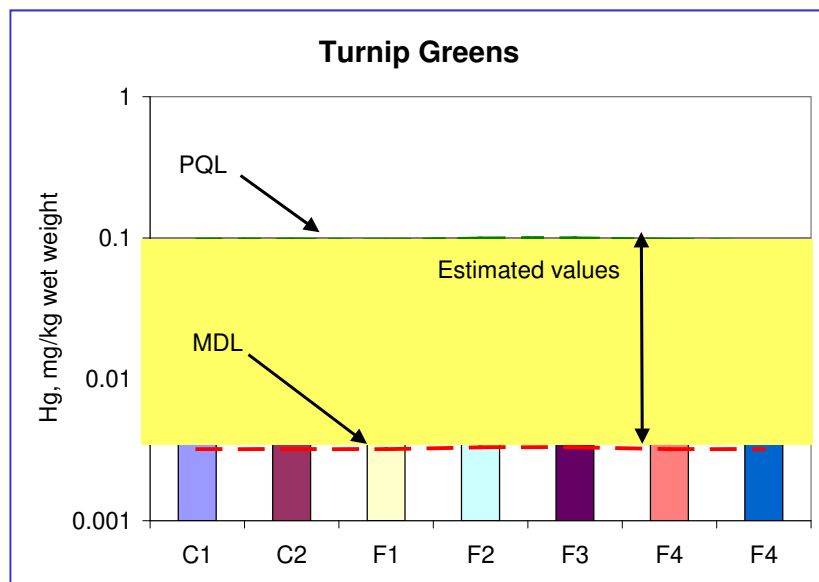
2004

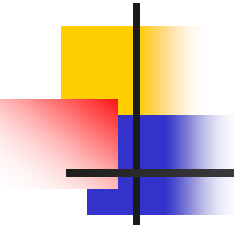


Turnip Harvest 2004



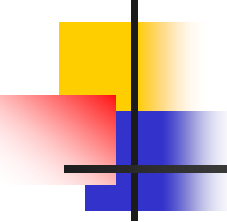
Turnip Greens 2004





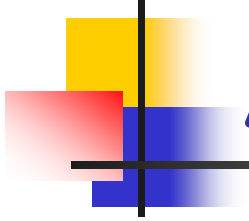
Summary - Garden Soils

- Floodplain garden, 2003
 - Soil mercury from 4.2 to 78 mg Hg·kg⁻¹ dry weight in the surface 15 cm
- Control garden, 2003
 - Total soil mercury from 0.16 mg Hg·kg⁻¹ to less than the LOQ (<0.12 mg Hg·kg⁻¹ dry wt)



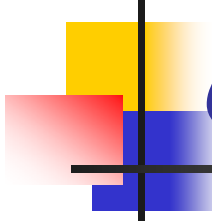
Path Forward

- Collect floodplain and control garden soils and analyze for total mercury
- As many as 3 publications planned
 - Collection and analysis of soil samples
 - Crop data
 - Crop evaluation



Acknowledgements

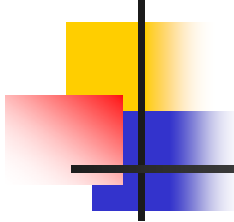
- Barry Wolstenholme
- Dick Jensen
- Annette Guiseppi-Elie
- Mike Liberati
- John Greene
- Sharon Nordstrom
- Allison Kelley
- Susie Temple
- Folks at the Augusta Forestry Center
 - Larry Estes
 - Thomas Frazier



Crop Study Evaluation (Guisseppi-Elie)

General Approach:

- Calculate Potential Average Daily Dose, ADD_{POT}
- Compare to the Reference Dose RfD ,
 - Safe level over a lifetime of exposure
- Ratio of ADD_{POT} to RfD = Hazard Quotient
- $HQ < 1$, exposure not expected to cause harm



Crop Study Evaluation (cont)

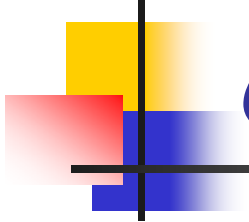
Simplified ADD_{POT} Calculation

$$ADD_{POT} = C \times IR$$

Where				
	ADD_{pot}	=	$\frac{mg \text{ Constituent}}{Kg \text{ Body Weight} - day}$	
	C	=	$\frac{mg \text{ constituent}}{kg \text{ vegetable}}$	
	IR	=	$\frac{Kg \text{ Vegetable}}{Kg \text{ Body Weight} - day}$	

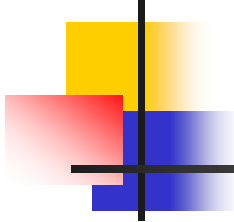
Conservative Assumptions:

- 100% Methylmercury in vegetables
 - Reference Dose (RfD) = 1E-4 mg/kg-day
- 100% bioavailable
- Use maximum detected concentration or $\frac{1}{2}$ method detection limit, if not detected



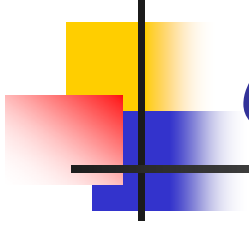
Crop Study Evaluation (Cont.)

- Ingestion Rate from USEPA Exposure Factors Handbook, Homegrown produced
 - Individual Crops (19)
 - Total vegetables (153 floodplain and 74 control garden measurements):
 - all,
 - exposed, protected, root,
 - dark green, deep yellow, other
 - Central tendency estimate
 - 50% (or mean) of homegrown > 90% of general population
 - High end estimate
 - 90% of homegrown > 98% of general population



Crop Study Evaluation (Cont.)

- Results for seasonally adjusted IR for all (geometric mean) vegetables for the South
 - Seasonal to account for potential long-term exposure
 - All to account for potential cumulative effect
 - Geometric mean to account for variation in concentration
 - South to account for regional effects
- $HQ = 0.06$ for 50%
- $HQ = 0.39$ for 90%



Crop Study Evaluation (Cont.)

Workgroup agrees that no additional crop plantings are warranted