

# **Earthworms and Sludge Contaminated Soils:** The Long Term Effects of Land Applied Waste

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# Field Site




- 🐛 1983 test site run by T. Culliney & D. Pimentel
- 🐛 Short-term effects of sludge etc. application on arthropods growing on collard greens
- 🐛 15' x 15' plots with buffers
- 🐛 5 replicates, randomized block layout
- 🐛 Subsequent site use: no tillage, hay crops

# Treatments

-  Syracuse sludge (industrial)
  -  Groton/Marathon sludge (smaller towns)
  -  Groton + Cd\* (to approach Syr. Cd level)
  -  Groton + Dieldrin\* (to equal Syr. PCB's)
  -  Cow manure
- 
-  100 T/acre dry matter loadings (rototilled)

\*Cd and Dieldrin surface applied *after* sludge

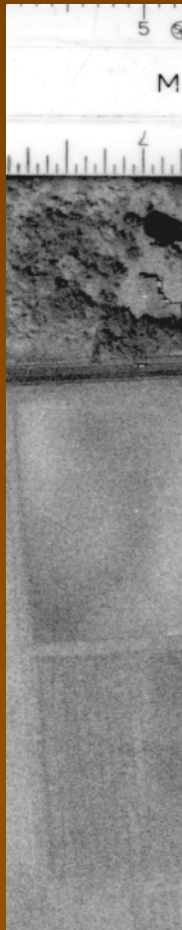
# Objectives

-  Locate the plots
-  Confirm plot geometry with transects
-  Plot-by-plot sampling:
  - Soil characteristics
  - Worm populations/metals





# Find Plot Locations



June



	Cd 1-4
	Manure 2-4
	Groton 3-4
	Manure 4-4
	Groton 5-4
	Cd 6-4



# Confirm Plot Centers

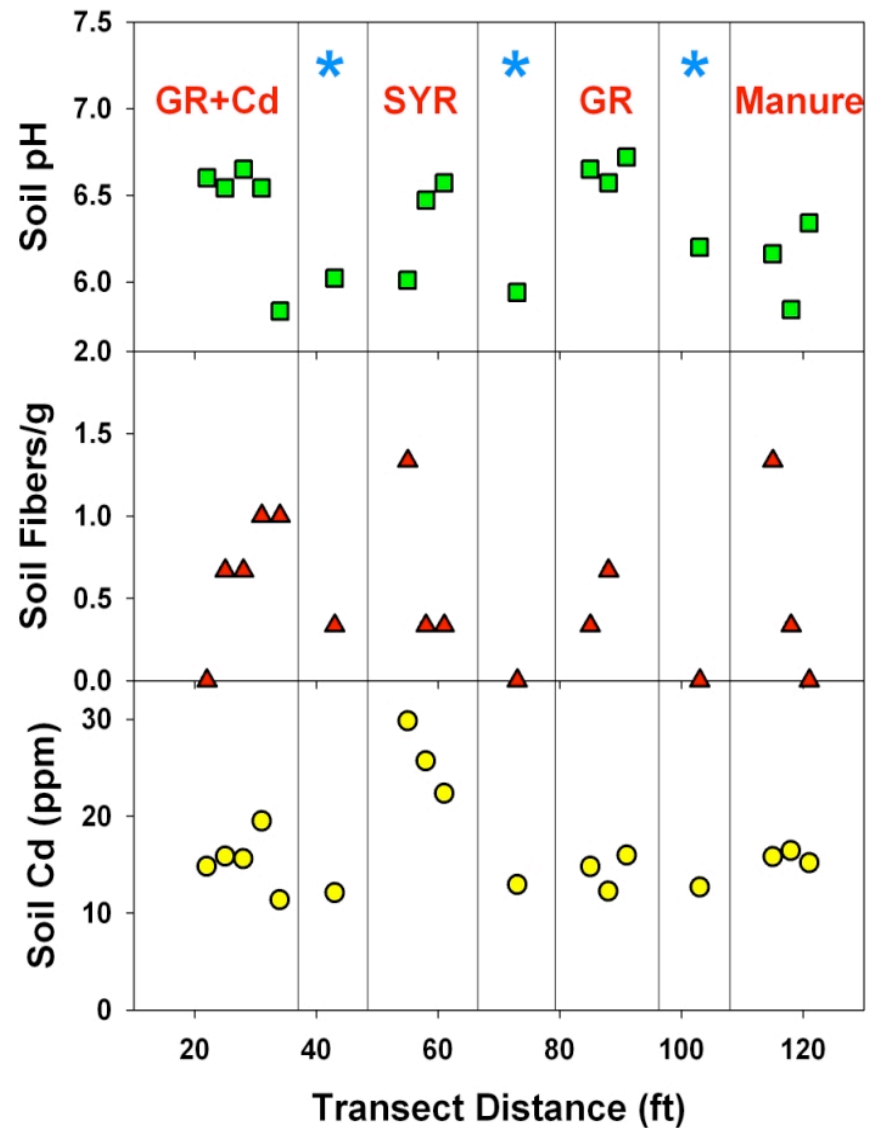
- 🐛 Surveying
- 🐛 Transect Sampling
- 🐛 Soil Analysis:
  - Cd
  - pH
  - fibers



# Transect Sampling



pH and Cd  
pinpoint plot  
centers and  
borders



\* buffers between plots



# 3. Sampling for Soil & Worms

Two sampling digs: 6-  
(hot days! Second dig several  
of rain)



ontrols

leep first





Verizon + Time Warner Cable

June = ~~June~~ per person

There's no  
Cd in me!

SAVE THE WORMS!

I did. They were most grateful.  
We're welcome at their place anytime.

Don't hurt me  
I'm cute &  
Cuddly! :3

HELP ME! DON'T  
YOU LOVE ME??

Worm Party Monday...  
whether you like it or not!



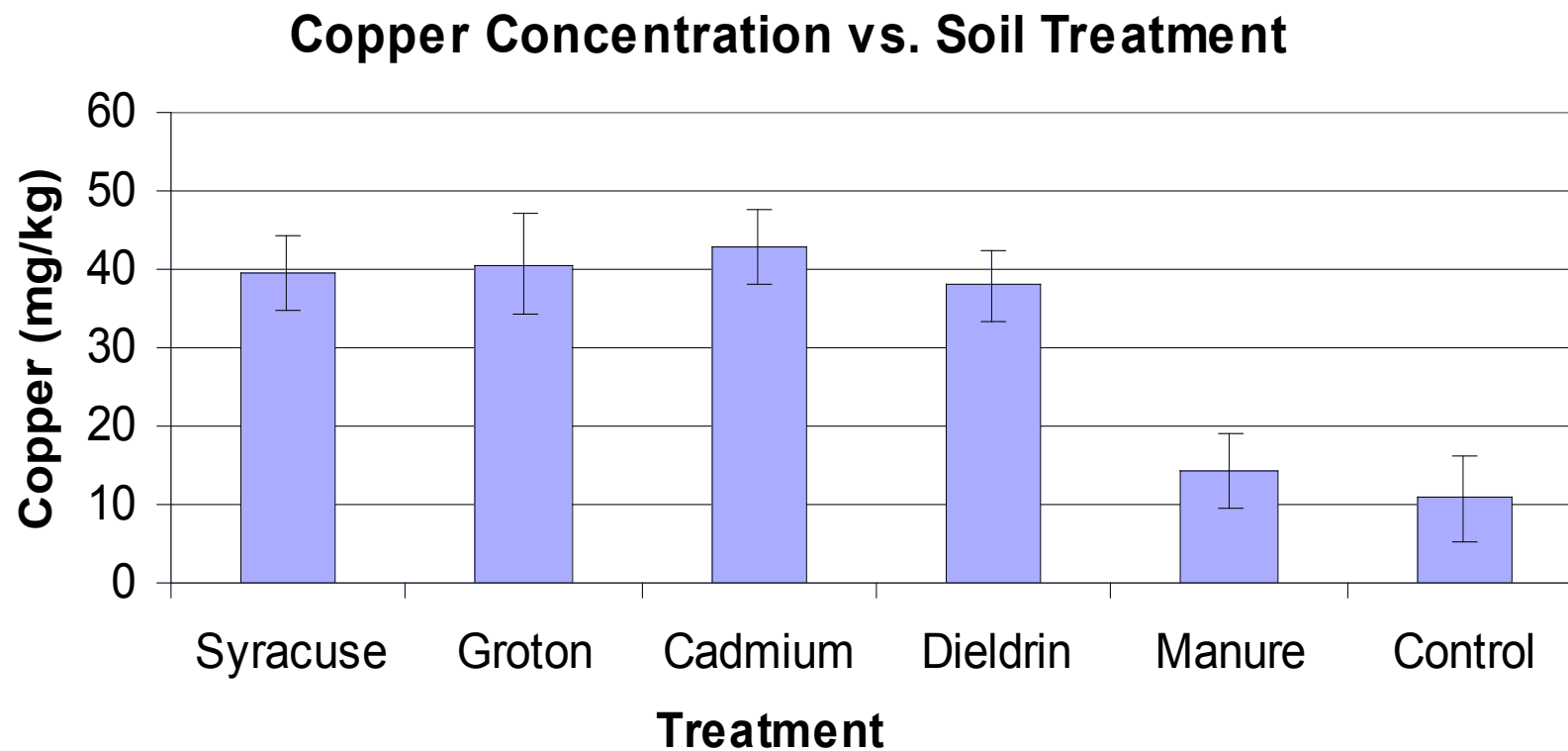
# Soil Analysis - Cadmium

1983

Treatment	Reported Soil Cd (ppm)	2005 Soil Cd (ppm)	Minimum % Loss
Syracuse	55	$3.2 \pm 0.8^*$	54
Groton	1.8	$0.9 \pm 0.2$	50
Cadmium	15	$3.3 \pm 0.6$	78
Dieldrin	1.7	$0.7 \pm 0.2$	59
Manure	0.5	$0.8 \pm 0.3$	0
Control	0.2	$0.8 \pm 0.2$	NA

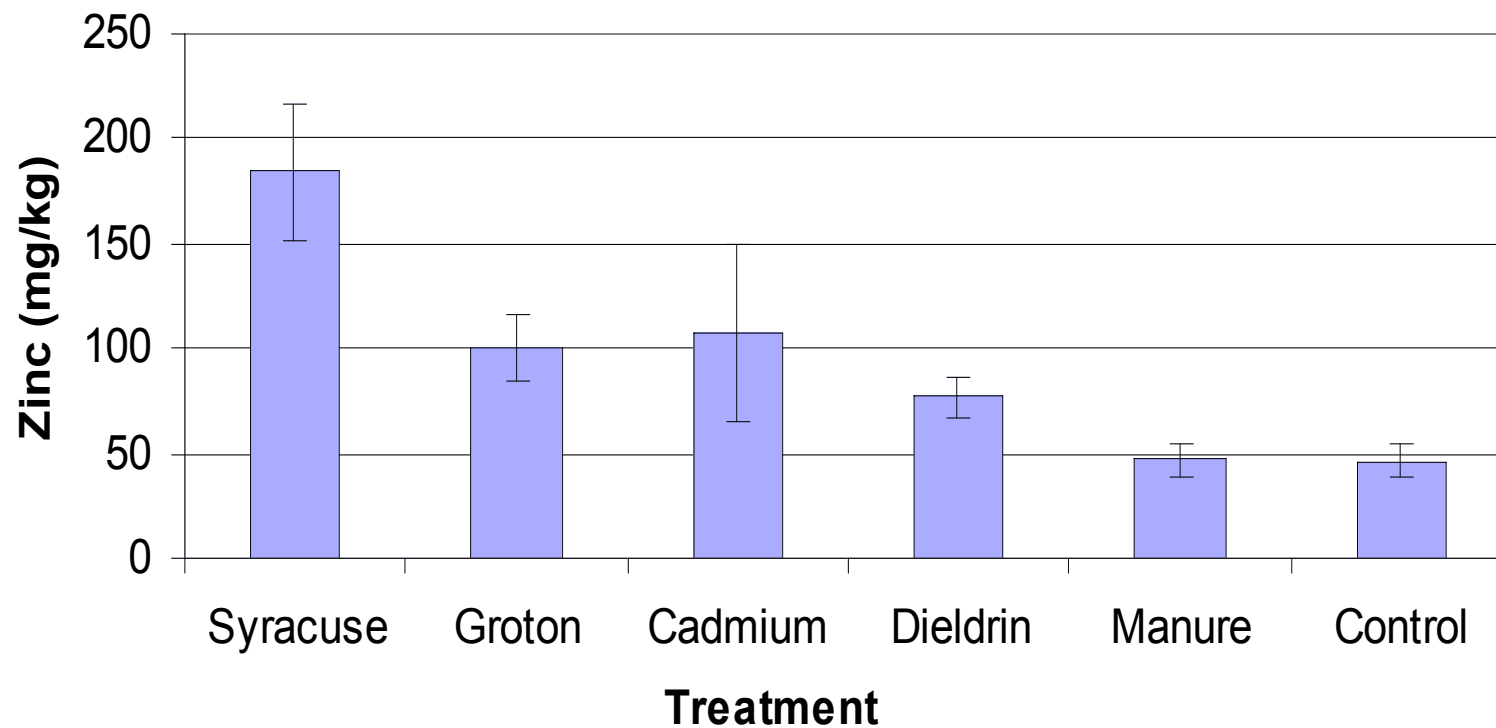
**\* All of the 2005 cadmium concentrations are averages of all five plots of the same treatment except for Syracuse, which uses four of the five.**

# Soil Analysis - Copper



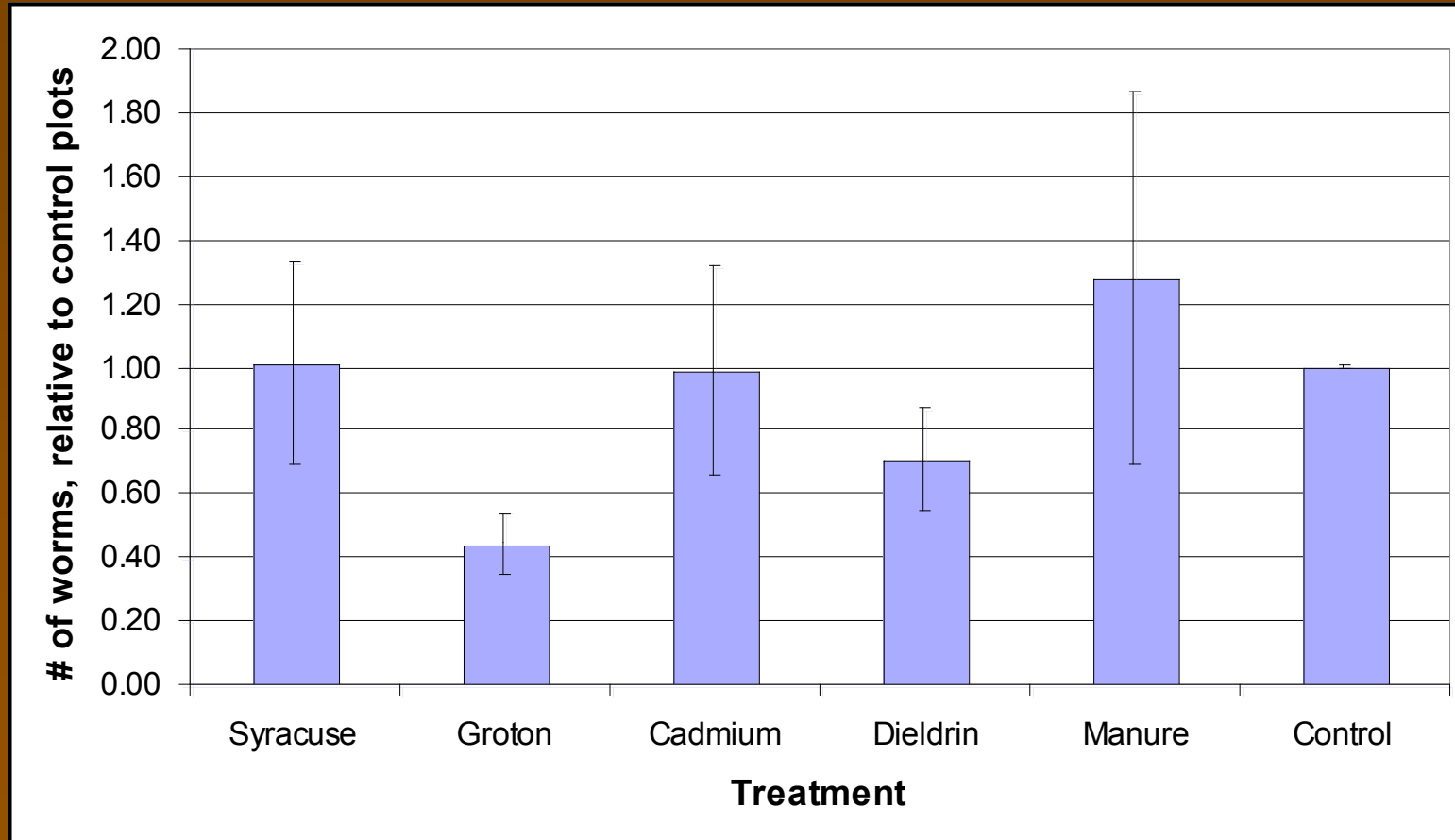
# Soil Analysis - Zinc

**Zinc Concentration vs. Soil Treatment**

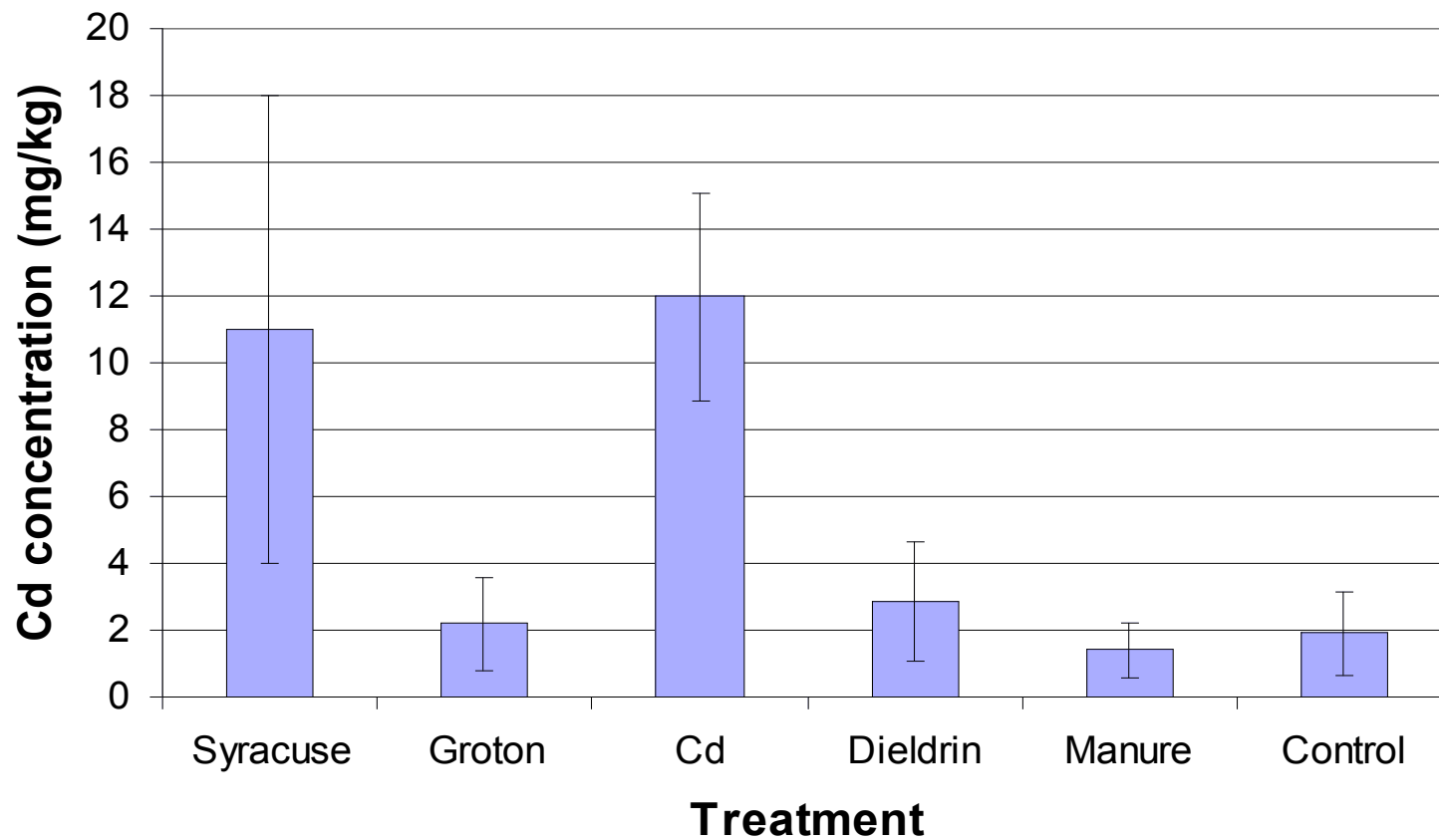




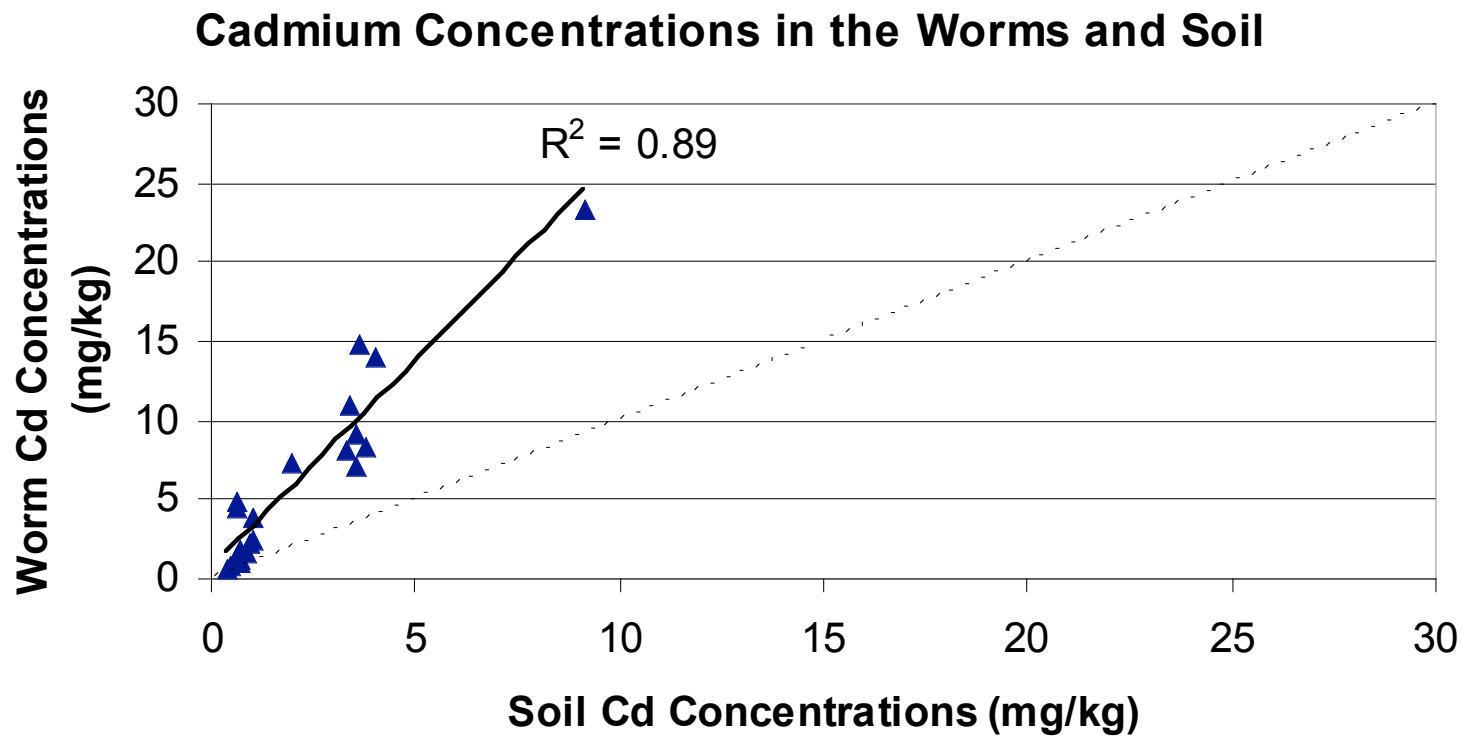
# Worm Counts



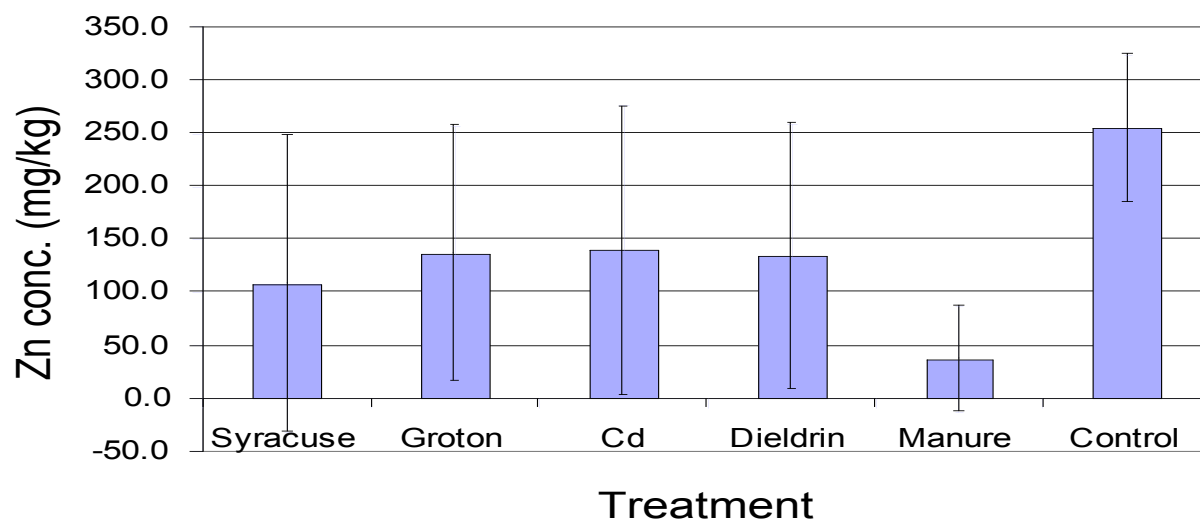
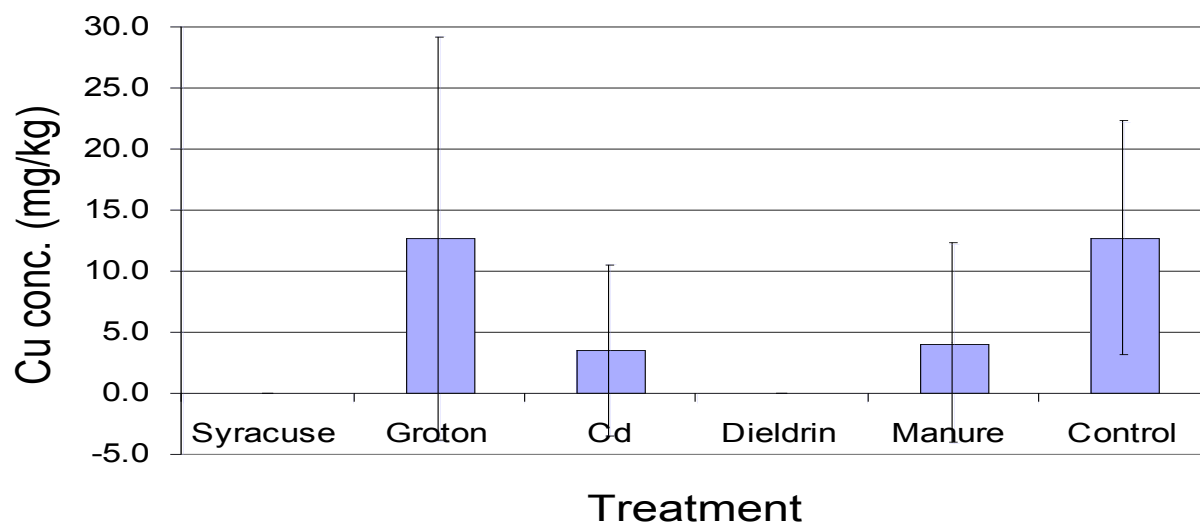
# Worm Analysis – Cadmium

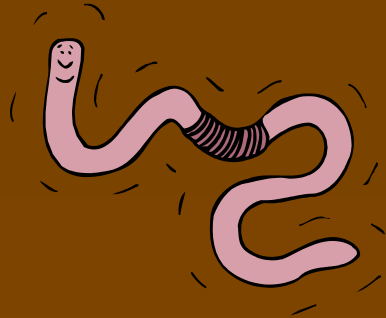


# Cadmium Correlation



# Worm Analysis – Copper & Zinc

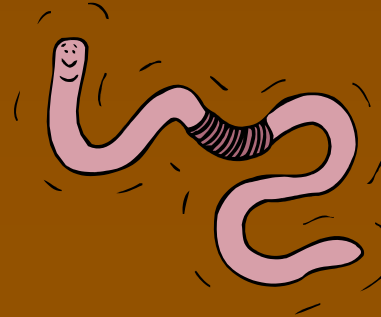




# Conclusion









Sludge is bad and  
worms are gross!!!



# Conclusions & Speculations

- ❧ Cadmium concentrations dropped substantially from the original concentrations
- ❧ Even after 22 years heavy metal concentrations remain elevated in the soil
- ❧ There is a significant correlation between Cd soil concentrations and Cd uptake in the worms ( $R^2 = 0.89$ )
- ❧ Weather conditions (record high temperatures!) may have heavily influenced worm sampling, overwhelming the impact of the heavy metals

# Acknowledgements

-  Brian Richards – for everything
-  Todd Walter – for letting us spread dirt all over his new lab
-  Anthony Hay – for inventing a dieldrin analysis procedure
-  Ellen Harrison – for helping dig for worms
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-  Shree Giri – for patience and assistance with the ICP

# Questions?

