



## **Welcome to the CLU-IN Internet Seminar**

Understanding Arsenic: From Vasculature to Vegetables  
*Sponsored by:* U.S. EPA Region 9 and National Institute of Environmental Health Sciences, Superfund Research Program

Delivered: May 16, 2012, 1:00 PM - 3:00 PM, EDT (17:00-19:00 GMT)

*Instructors:*

*Mónica D. Ramírez-Andreotta, M.P.A., Ph.D. Candidate, Soil, Water and Environmental Science, The University of Arizona*

*Todd D. Camenisch, PhD, Associate Professor, Pharmacology and Toxicology, The University of Arizona*

*Moderator:*

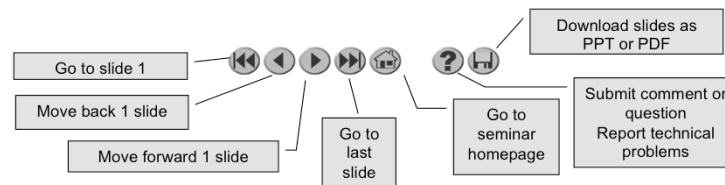
*Sarah T. Wilkinson, Superfund Research Program, University of Arizona (wilkinso@pharmacy.arizona.edu)*

*Visit the Clean Up Information Network online at [www.cluin.org](http://www.cluin.org)*

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# Housekeeping

- Please mute your phone lines, Do NOT put this call on hold
- Q&A
- Turn off any pop-up blockers
- Move through slides using # links on left or buttons



- This event is being recorded
- Archives accessed for free <http://clu.in/live/archive/>

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Although I'm sure that some of you have these rules memorized from previous CLU-IN events, let's run through them quickly for our new participants.

Please mute your phone lines during the seminar to minimize disruption and background noise. If you do not have a mute button, press \*6 to mute #6 to unmute your lines at anytime. Also, please do NOT put this call on hold as this may bring delightful, but unwanted background music over the lines and interrupt the seminar.

You should note that throughout the seminar, we will ask for your feedback. You do not need to wait for Q&A breaks to ask questions or provide comments. To submit comments/questions and report technical problems, please use the ? Icon at the top of your screen. You can move forward/backward in the slides by using the single arrow buttons (left moves back 1 slide, right moves advances 1 slide). The double arrowed buttons will take you to 1<sup>st</sup> and last slides respectively. You may also advance to any slide using the numbered links that appear on the left side of your screen. The button with a house icon will take you back to main seminar page which displays our agenda, speaker information, links to the slides and additional resources. Lastly, the button with a computer disc can be used to download and save today's presentation materials.

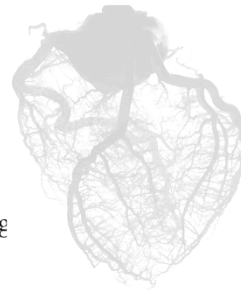
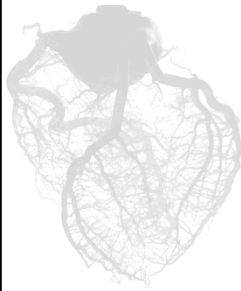
With that, please move to slide 3.

# Arsenic as a cardiovascular toxicant

Todd D. Camenisch, PhD

Camenisch Lab  
University of Arizona  
Department of Pharmacology and Toxicology

3/13/2012



## **Inorganic Arsenic cardiovascular toxicity points**

- Heart as a target of arsenic toxicity
  - Hypertension and hypertrophy
- Altered vascular matrix deposition
  - Loss of key extracellular matrix molecules around vessels
- Disruption of cardiac developmental EMT
  - Key developmental gene programming lost



## Why we study arsenic...

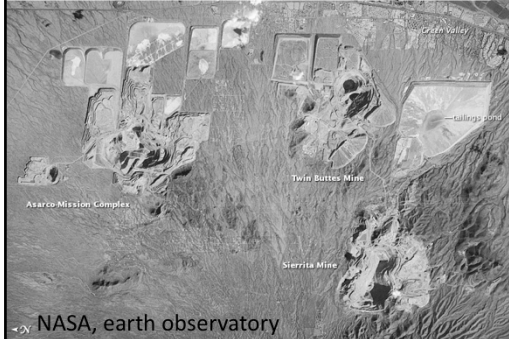
- Chronic arsenic exposure is a worldwide healthcare problem.
- Arsenic has been well studied in relation to multiple cancers, such as skin, liver, and bladder cancers,
- More recent link to diabetes, heart disease and atherosclerosis.



## Southwest region of U.S. has arid environment which creates conditions for unique exposures

Dewey-Humboldt/Iron King site

Green Valley, AZ



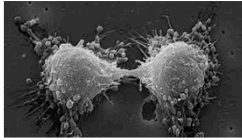
***Arsenic in water and dust a growing concern***

# Arsenic and Disease

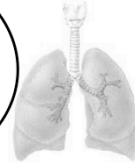
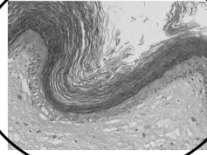
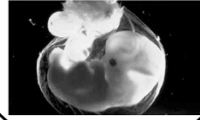
## Cardiovascular



## Cancer

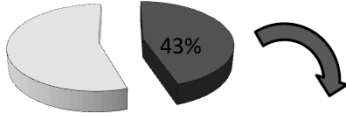


## Many Others

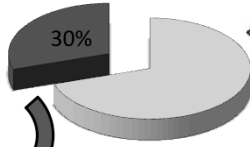


# Overview and Impact

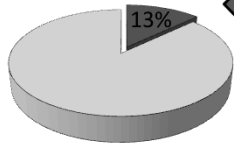
Cardiovascular deaths in Bangladesh



CV deaths attributable to Arsenic



Total Arsenic related CV deaths



**~ one quarter of all deaths in Bangladesh  
Attributed to arsenic exposure (Argos, Ahsan et al., 2010)**



Bangladesh

\*Groundwater Studies of Arsenic Contamination in Bangladesh (GHSAR) (2006)

Chen Y, Graziano JH, et al. (2011)

Projects on  
Deciphering impact of As  
On the heart and vessels\_

- **Does Arsenic impact structural heart development?**
- **What is the mechanism of action of developmental As cardiotoxicity?**
- **Whether exposure to As early in life leads to cardiovascular disease in adulthood**
- ***Whether the impact of As on the cardiovascular system is preventable or reversible?***

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# Epidemiology on Arsenic and Cardiovascular Disease

## **Increased Prevalence of Hypertension and Long-Term Arsenic Exposure.**

Chen CJ, Hsueh YM, Lai MS, et al. (1995)

- Duration, concentration and cumulative exposure correlate with incidence of hypertension

## **Dose-Response Relationship Between Ischemic Heart Disease Mortality and Long-term Arsenic Exposure.**

Chen, Chien-Jen, et al. (1996)

-Increased ischemic heart disease related mortality rate with cumulative arsenic exposure

## **Hypertension and Arsenic Exposure in Bangladesh.**

Rahman M, Tondel M, et al. (1999)

-Dose response relationship significantly related to hypertension

## **Arsenic exposure from drinking water and mortality from cardiovascular disease in Bangladesh: prospective cohort study.**

Chen Y, Graziano JH, et al. (2011)

- 30% of cardiovascular deaths attributable to elevated arsenic content in water (43% of deaths are cardiovascular related)

## Studying arsenic as a cardiovascular toxicant

- **Aim 1**

- Hypothesis

- Chronic arsenic exposure leading to altered vascular integrity promotes hypertension and ventricular hypertrophy

- Our model

- FVB mouse model exposed to 100 ppb NaAsO<sub>2</sub> for 22 wks

- **Aim 2**

- Hypothesis

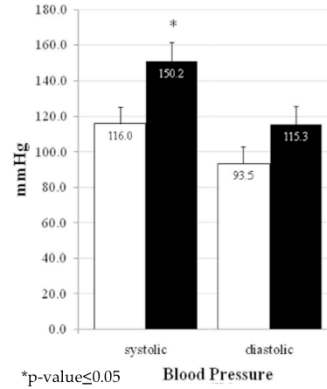
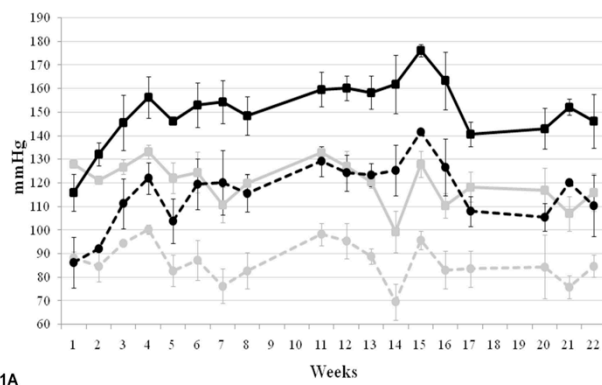
- Arsenic disrupts cardiovascular developmental programming and patterning
      - Developmental epithelial to mesenchymal transition (EMT)
      - Inhibition of key developmental gene programming

## Study design: Aim 1

- Mice were exposed to either 100 ppb NaAsO<sub>2</sub> or 100 ppb NaCl starting at weaning age
- Blood pressure analysis was done weekly and data was collected through a data acquisition software
- Echocardiography analysis was done under anesthesia to assess cardiac remodeling near the end of the study
- Histology on hearts and aortas were performed to confirm echocardiographic analysis



# Arsenic promotes hypertension



1A

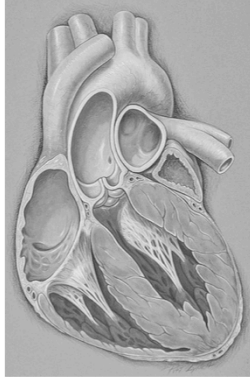


Sanchez-Soria et al. Toxicologic Pathology 2012.

**Chronic hypertension causes a constant stress on the heart**

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## Physiological effects of hypertension



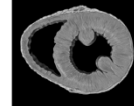
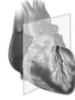
- Systemic pressure is higher
- Left ventricle needs to overcome higher load to eject blood into aorta
- Increased afterload
- Decreased cardiac output

### **In other words:**

**The heart needs to work harder to keep up with the body's oxygen demand. So, the muscle gets bigger and this is what is called cardiac hypertrophy.**

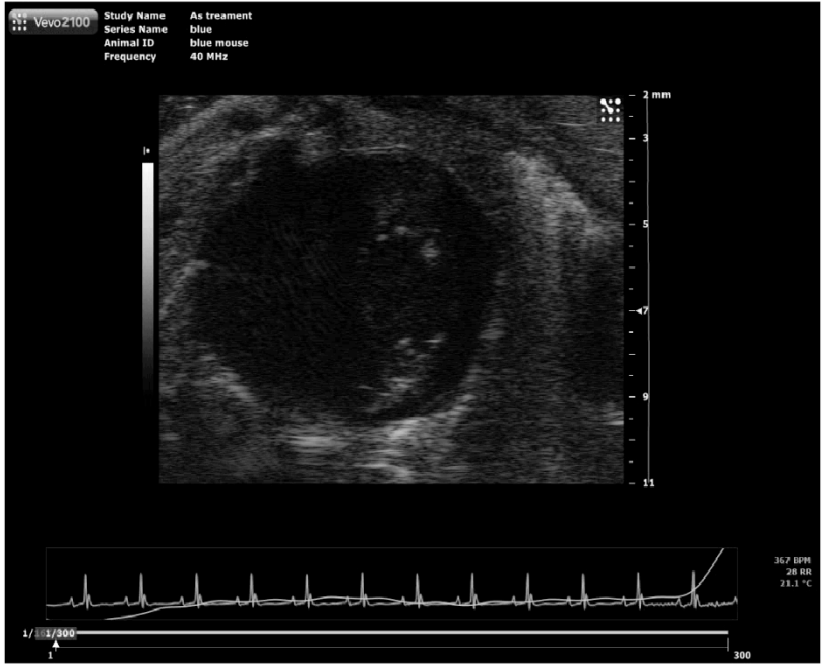


# Physiological effects of hypertension



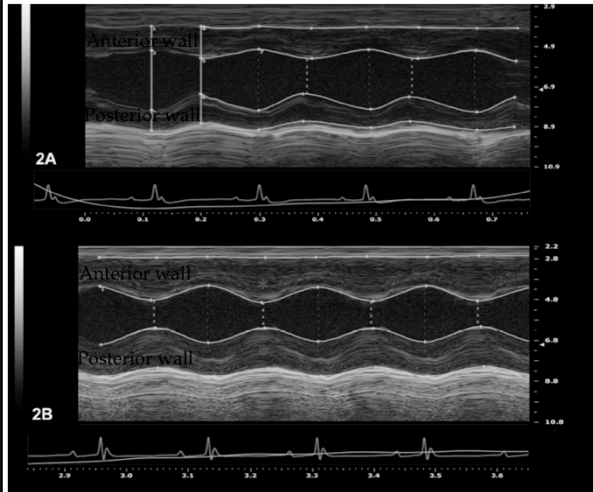
- Real time data acquisition
- Non-invasive
- Short axis (transverse plane)
- M-mode
- Gold Standard method for diagnosis of left ventricular hypertrophy
- Many other physiological parameters can be obtained



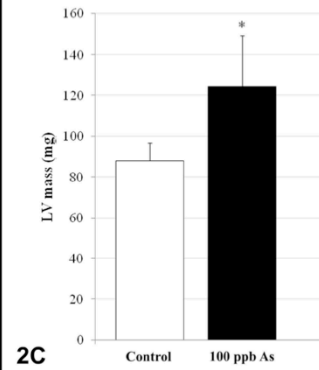


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# Left ventricular hypertrophy



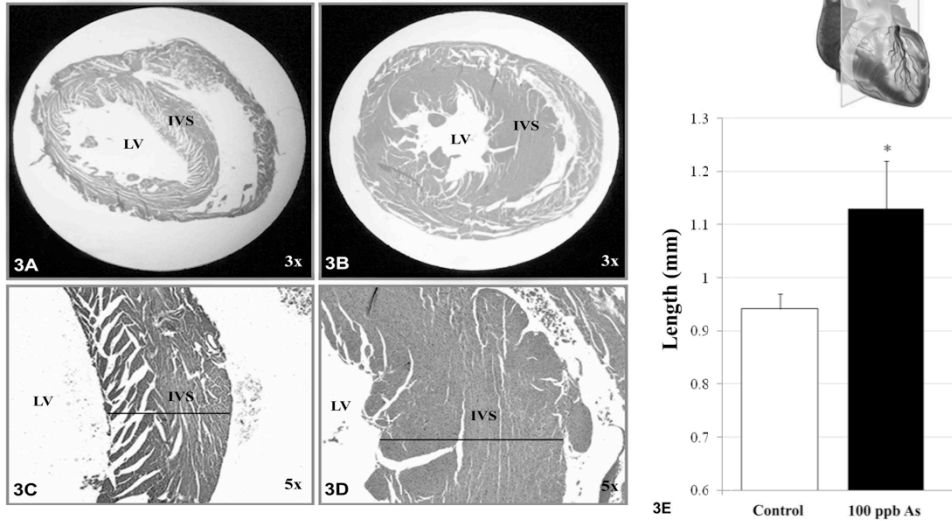
$$LV\ mass = 1.05 \cdot (\text{Avg. Diastolic Diameter at Outer Wall})^3 - (\text{Avg. Diastolic Diameter at Inner Wall})^3$$



Sanchez-Soria et al. Toxicologic Pathology 2012.

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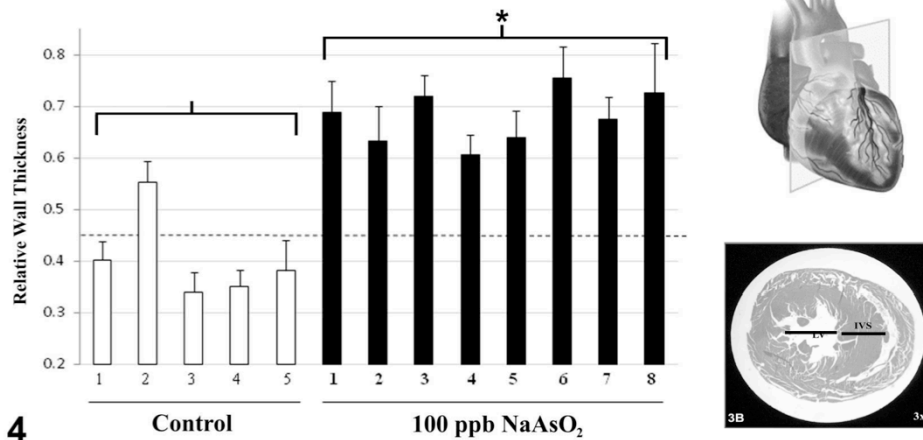
# Left ventricular hypertrophy



Sanchez-Soria et al. Toxicologic Pathology 2012.

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# Concentric hypertrophy

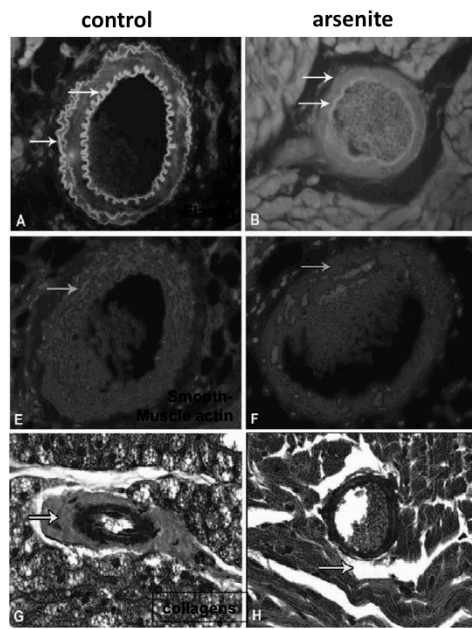


$RWT = (2 * \text{Avg. LV wall thickness}) / \text{End diastolic left ventricular diameter}$

Sanchez-Soria et al. Toxicologic Pathology 2012.

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# Disrupted Vascular Matrix

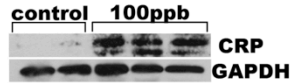


Hays, Camenisch et al.,  
Tox Pathol 20



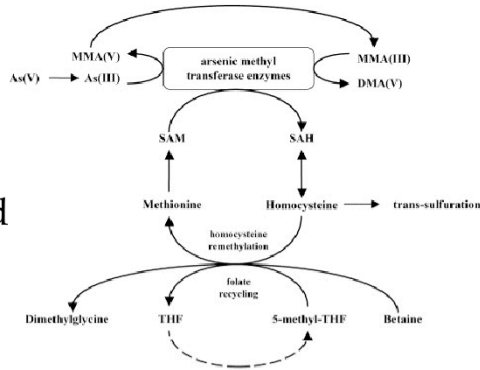
## Future studies for aim 1

- Blood biochemistry study to analyze biomarkers of cardiovascular disease
  - **CRP**
  - HCY
  - BH4/BH2 ratio
  - Total Nitrate
  - Cholesterol, triglycerides, glucose
- Assess effects
- of *in-utero* exposure

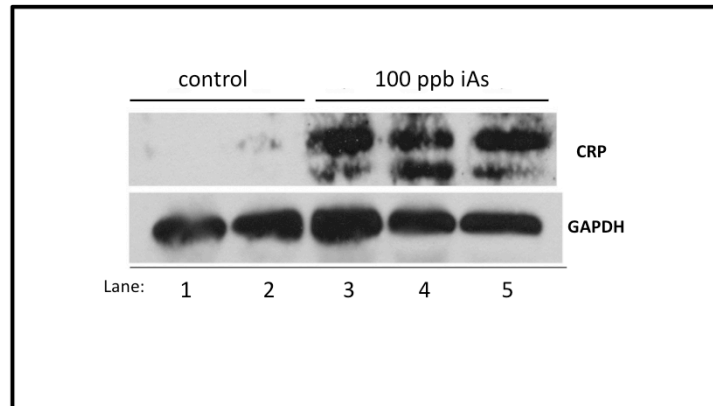


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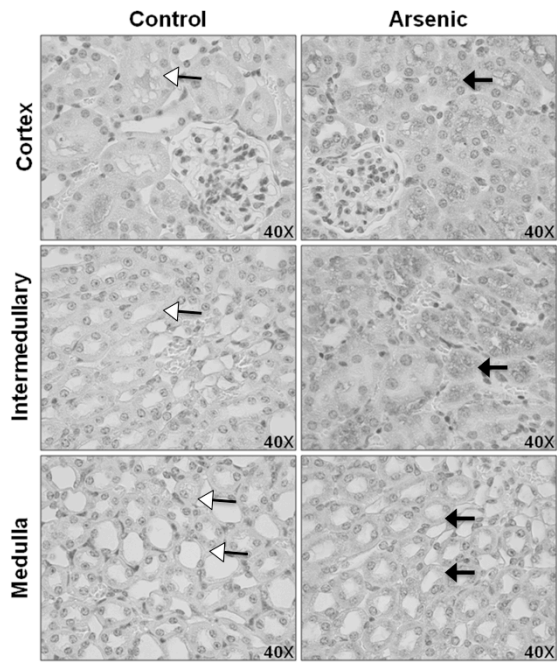
## iAs Exposure induces CRP in Mouse Livers



### Initial CRP Observations

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**Detection of CRP  
in liver sections  
elevated in iAs  
samples**



Druwe, Camenisch, Vaillancourt 2012

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## Aim 1: Conclusions and Implications

- Results from our studies are consistent with epidemiological studies. Provides a strong model to study cardiovascular outcomes of arsenic exposure and use as model for biomarkers of disease
- LVH is an independent cardiovascular risk factor and should be assessed in future epidemiological studies
- Beginning to define potential surrogate markers to gauge health risk from arsenic exposure
  - Consider organ specific serum markers with exposure readouts

## Congenital Heart Defects

- ~occur at 2-5% rate per year in U.S.
- Etiology

Chromosomal anomaly 6-10%

Clinical syndromes 5-10%

Maternal disease 1%

***Teratogen exposure*** ~1%

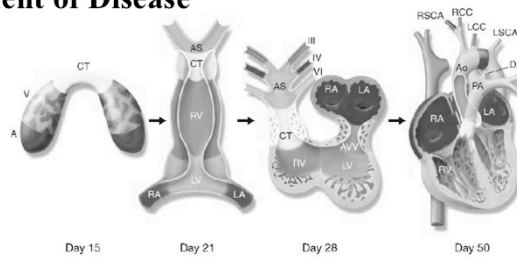
"Other" 75-85%

***What about developmental origins of CV disease in adults?***

# Molecular Aspects of Mammalian Cardiovascular development

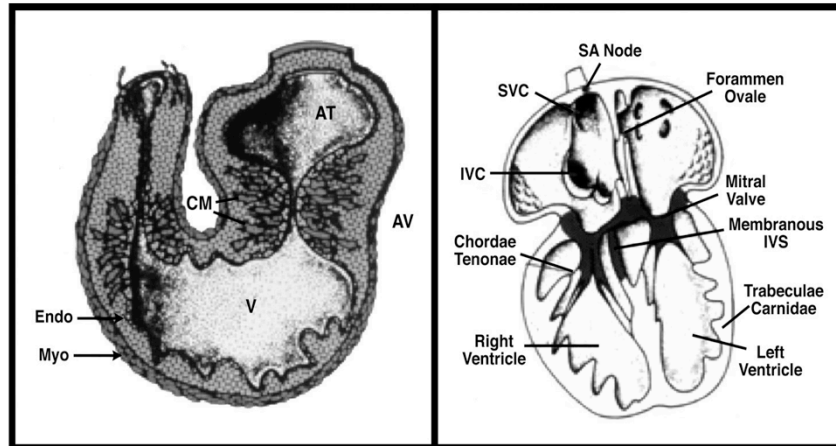
Developmental Biology  
Development of Disease

Overlapping Pathways



Nature Review 2000  
Schroeder & Camenisch J Mol Med 2003 27

## Atrioventricular Endocardial Cushions and the Adult Heart

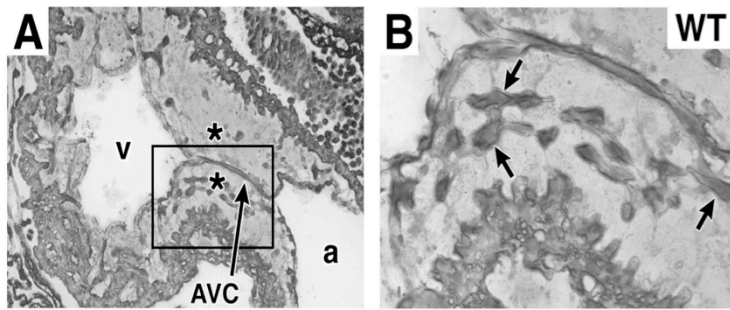


Key Players: TGFb2, TGFb Receptors especially the Type III  
Hyaluronan and Has2 (ECM) ; Periostin and more

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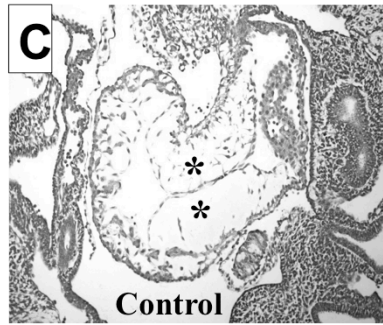


## Presence of HA in Forming AV Canals



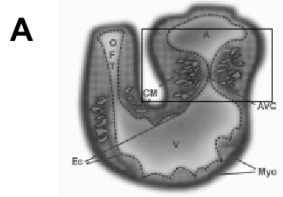
**Wild-type E9.5  
Mouse embryos**

**Detection of HA with  
HABP and DAB  
Substrate (Brown)**

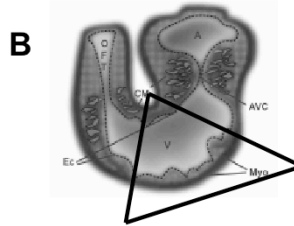
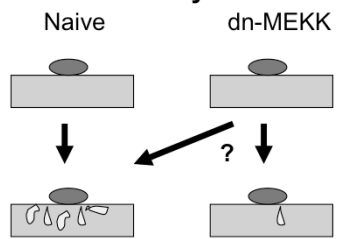


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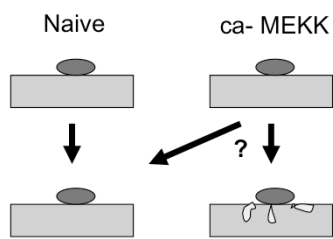
## Collagen Gel Invasion Assay



**Endocardial cushion  
explant/Collagen gel  
assay**

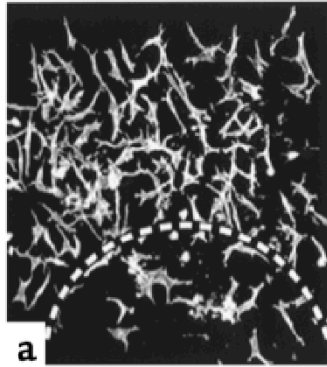


**Ventricular explant/  
Collagen gel assay**



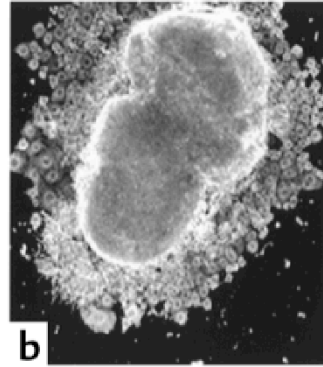
30

***Ex Vivo* Assay recapitulates EMT events *in Vivo***



**a**

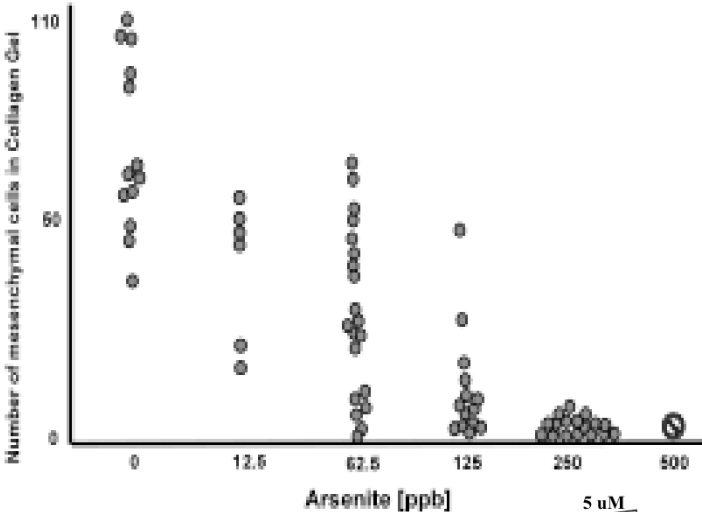
**Normal EMT**  
Cardiac  
mesenchyme



**b**

**Aborted or blocked  
EMT  
with Arsenite**

# Arsenic disrupts EMT

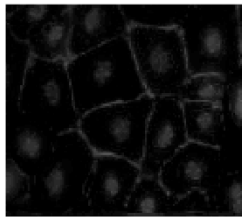
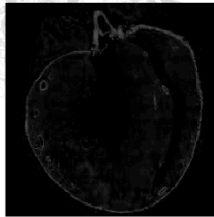


Lucinas & Camenisch et al., Tox Sci. 2010

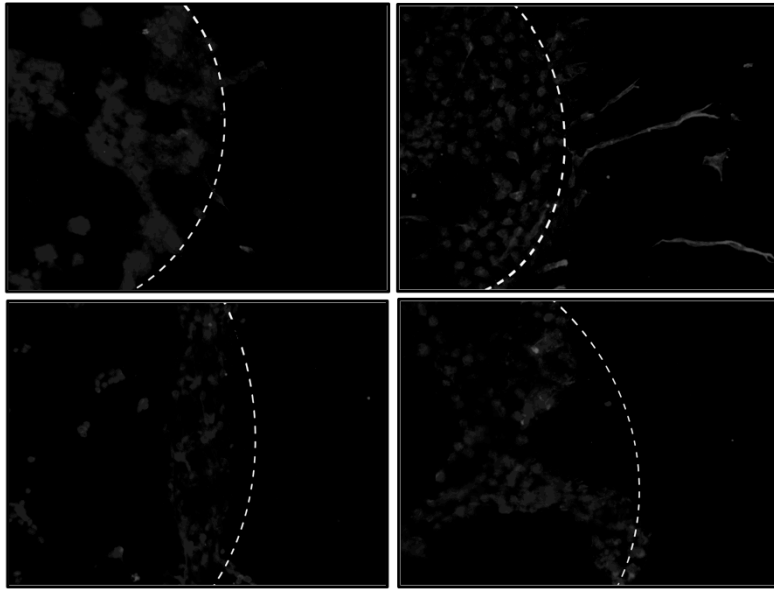


## Coronary Progenitor Cell Line To study Cardiac EMT

- Murine cells that express the simian virus 40 (SV40) large T antigen (Tag)
- This Tag gene is temperature sensitive (not expressed above 33°C)
- Thus, cells are conditionally immortalized at 33°C but behave like primary cells at 37°C.



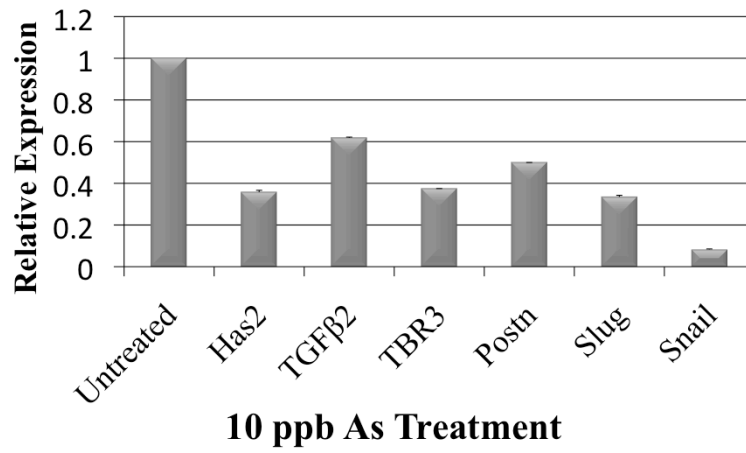
***iAs blocks TGFβ2 induced cardiac EMT***



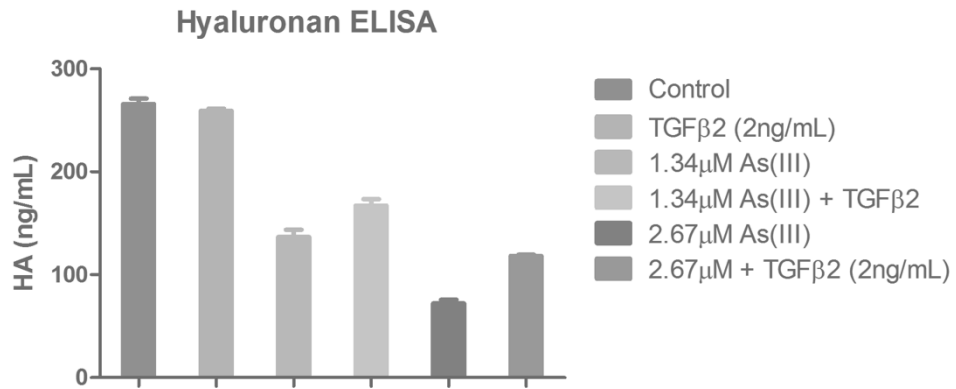
**Coronary Progenitor Cell Line on collagen gel invasion assay**

# As disrupts EMT Gene Program

## EMT Related Gene Expression



## iAs blocks HA deposition



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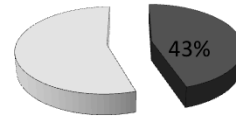
## Aim 2: Conclusions and Implications

- iAs blocks cardiac EMT in both endocardial and epicardial progenitor cells
- iAs disrupts cardiac developmental EMT gene programming
- HA deposition attenuated by exposure to iAs
- Does disrupting developmental process like EMT lead to disease in adults (*developmental origins for disease in adulthood*)

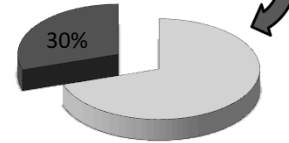
# Significance

- **Powerful model for understanding arsenic-related cardiovascular pathologies**
- **Molecular mechanisms ultimately help us understand and prevent disease**
- **Supplementation to prevent arsenic toxicity could be feasible**
- **Cardiovascular toxicity should be considered when setting EPA standards**

CV deaths



Arsenic related CV events



# Acknowledgements

- **Camenisch Lab:**

- Patrick Allison
- Derrick Broka
- Sherly Huang
- Sarah Monks
- Patti Parker
- Stephanie Quach
- Pablo S. Soria

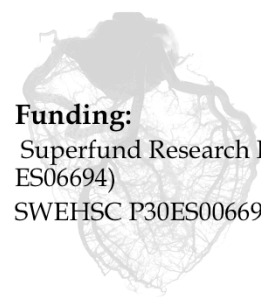


- **Funding:**

- Superfund Research Program (NIEHS 04940; ES06694)
- SWEHSC P30ES006694

- **Vaillancourt Lab:**

- Ingrid Druwe
- James Sollome





## Protecting Communities Neighboring Contamination: A Transdisciplinary Approach to Determine the Accumulation of Arsenic in Vegetables

**Monica Ramirez, PhD Candidate**

**Advisors: Janick Artiola, Mark Brusseau, Raina Maier**  
*Department of Soil, Water and Environmental Science  
College of Agriculture and Life Sciences*

**16 May 2012**

**Webinar via Clu-in, <http://www.clu-in.org/conf/tio/arsenic/>**



# Acknowledgements

## *gardenroots* The Dewey-Humboldt, Arizona Garden Project



# Acknowledgements





*gardenroots*  
The Dewey-Humboldt, Arizona Garden Project

**My Mission Statement:**

Public participation in environmental science research improves the **quality, legitimacy, and capacity** of environmental investigations and decisions.

## **Gardenroots is:**

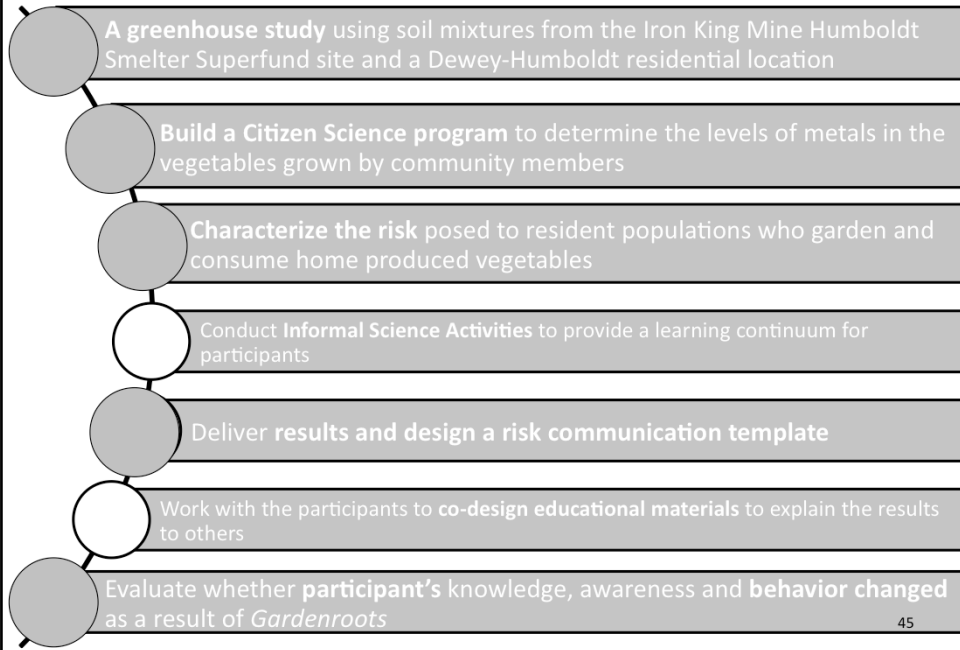
**Community driven**

**A collaborative, co-created  
Citizen Science project**

**A form of public  
participation in scientific  
research and informal  
science education**



## *Gardenroots Project Activities*



# Introduction



# Research Translation Timeline



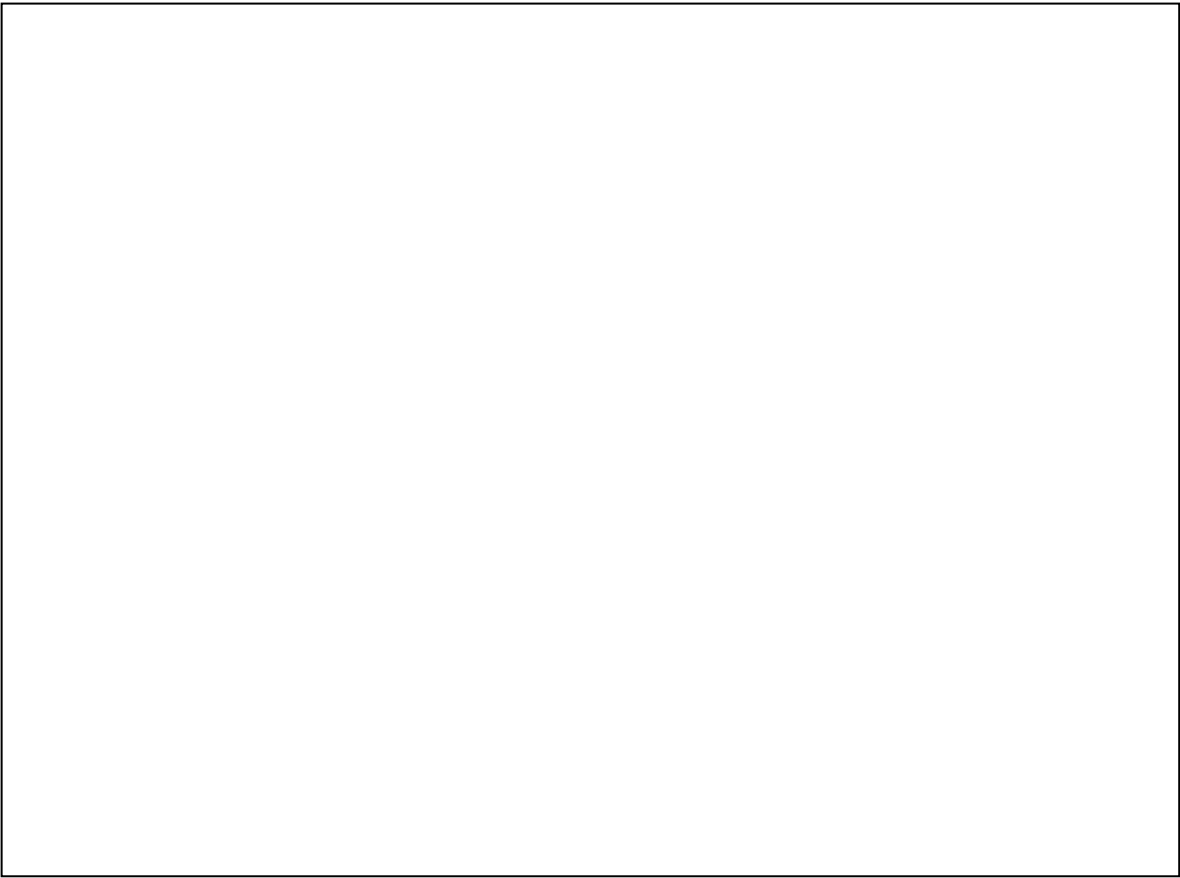
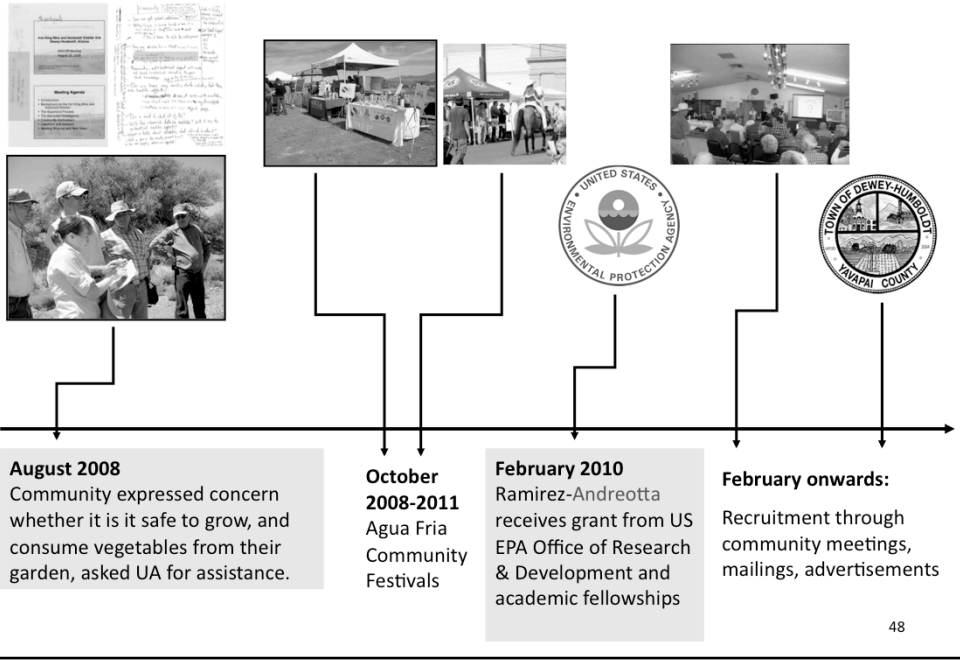
**October 2006**  
UA SRP RT Core  
begins collaborating  
with US EPA R9  
Technical Liaison

**June 2007**  
"Live at R9" Seminar,  
meet Project Managers –  
learn about upcoming  
National Priorities List  
site

**March 2008**  
Iron King Mine  
Humboldt Smelter  
Superfund Site added  
to National Priorities  
List

**May 2008**  
Teleconference with  
US EPA and ADEQ

# Research Translation Timeline



## Iron King Mine and Humboldt Smelter Superfund Site



- March 2008 added to US EPA National Priority List
- 1906 - 1969 Periodically active gold, silver, copper, lead, and zinc mine

- Contaminants of Concern:
  - Arsenic average 3,100 mg/kg
  - Lead average 2,380 mg/kg
  - Sulfate



## Dewey-Humboldt, Arizona: Selected Social Characteristics

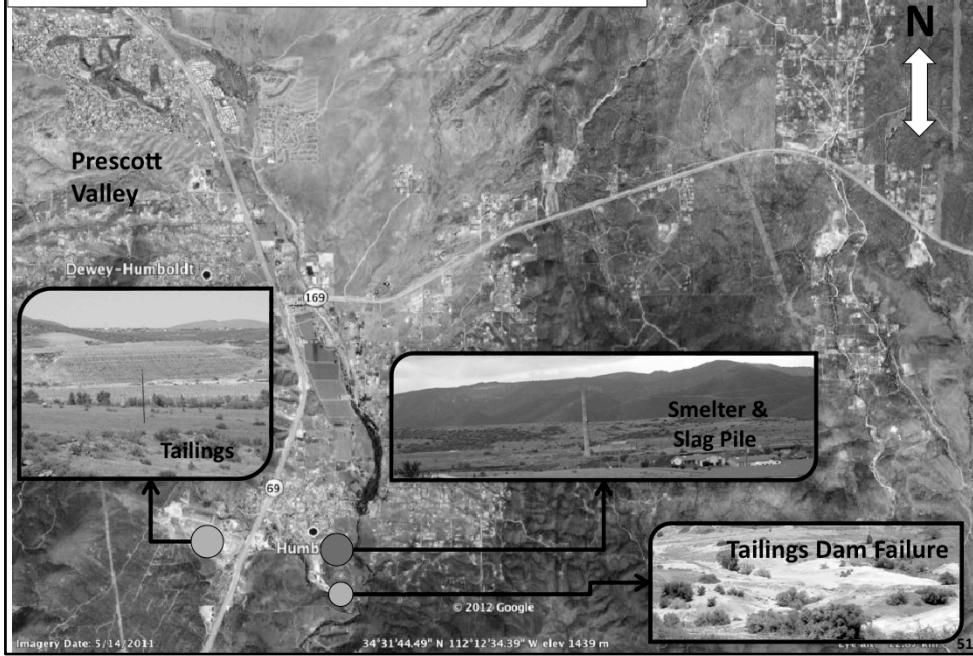
- Population: 3,894
- # Households: 1,589
- 93.3% high school graduate
- 16.7% Bachelor's degree +
- Nonmetropolitan community
- Majority Caucasian



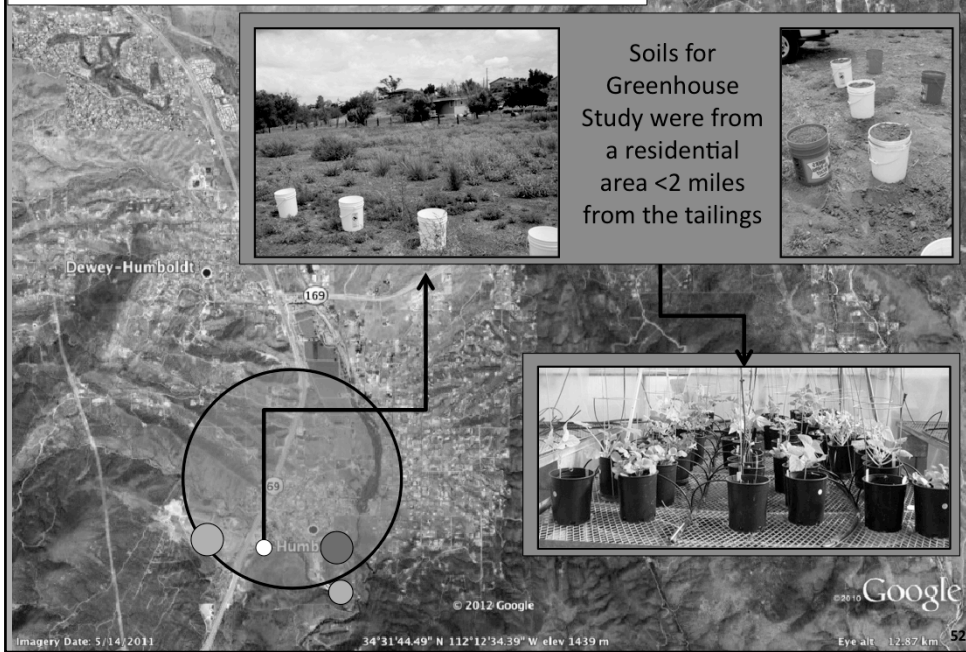
Source: [http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS\\_10\\_5YR\\_DP02](http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_10_5YR_DP02)

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# Gardenroots Study Area



# Gardenroots Study Area

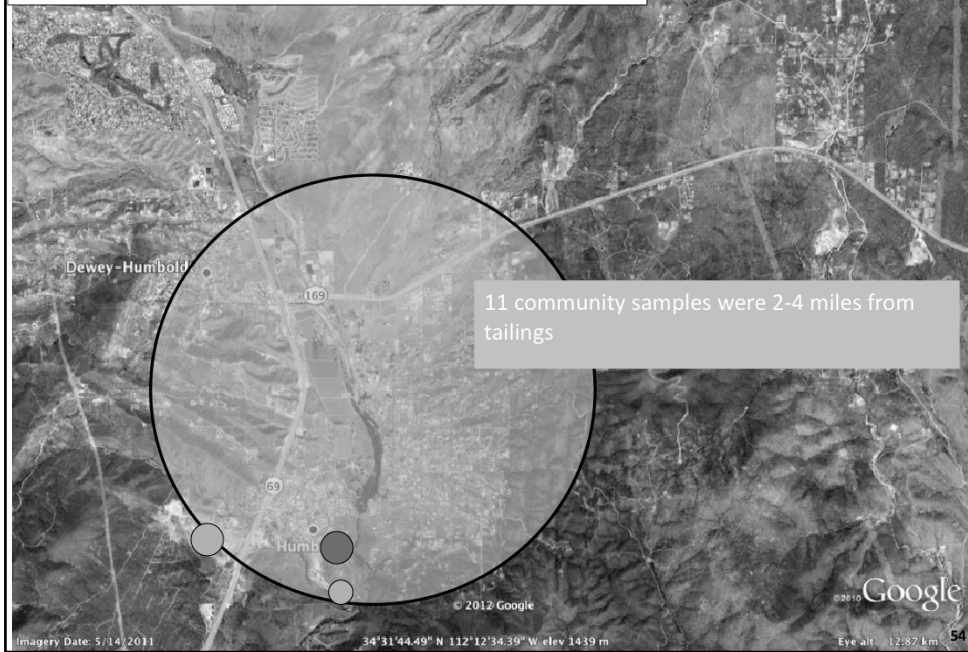




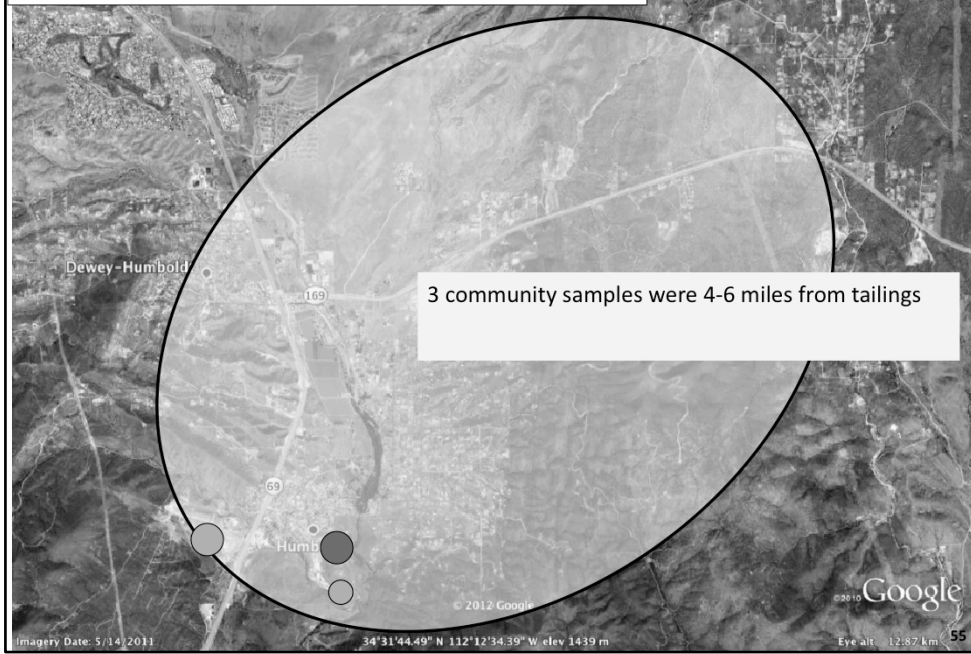
## Gardenroots Study Area



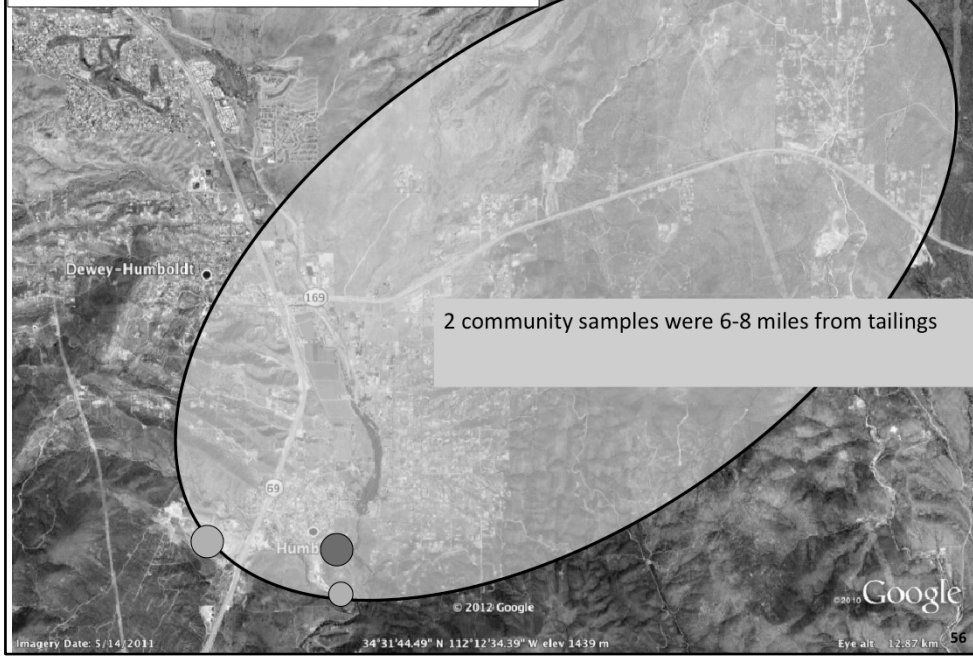
## Gardenroots Study Area



## Gardenroots Study Area



# Gardenroots Study Area



# Citizen Science Program



## Citizen Science Program

*Hypothesis: D-H community participation in an environmental science project will increase their:*

- Understanding of environmental science and the scientific method
- Ability to discuss environmental issues, make informed decisions
- Motivation to take action
- Participation in community advisory boards and volunteering

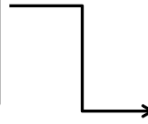


## As a Citizen Scientist, they:

1. Completed pre-survey, participated in training, and took kit home
2. Collected yard and garden soil, water, and vegetable samples from their home garden for analysis
3. Will receive individual and community sample results
4. Take a post-survey to determine *Gardenroots* impact



Community trainings, distribution of collection kits



Community Samples

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# Recruitment Materials

Want to learn more about your garden and soil quality? Join real world research and foster connections for sharing ideas and resources



The Dewey-Humboldt, Arizona Garden Project


Join Gardenroots! As a Citizen Scientist, you will:

- Be the first to have a soil water test & a vegetable sample from your garden for micronutrient and nutrient analysis
- Diagnose the quality of your soil & the vegetables you grow
- Be recognized as an ambassador for the micronutrient program community

Citizen Science Program website: [www.gardenroots.org/citizen-science](http://www.gardenroots.org/citizen-science)

For more information or to sign up, please contact:  
Melissa Sanchez  
1225 E. Green Valley Road  
Phoenix, AZ 85042  
Phone: (602) 955-8500  
Email: [msanchez@gardenroots.org](mailto:msanchez@gardenroots.org)

Promotional Bookmark that was distributed at all community events and meetings



HOME NEWS TO ABOUT CONTACT HELP BLOG

## The Dewey-Humboldt, Arizona Garden Project

Have a garden? Want to learn whether your soil is healthy for vegetable gardening? Join Gardenroots!

### Website

Visit my site about Citizen Science | Sign Up

**GARDENROOTS + CITIZEN SCIENCE = EDUCATIONIZATION OF SOCIETY**

RECENT BLOG UPCOMING EVENTS

**POSTS**

- [Citizen Science: The Dewey-Humboldt, Arizona Garden Project](#)
- [The Importance of Soil Quality](#)
- [Soil Health and Vegetable Production](#)
- [Join Gardenroots!](#)
- [Citizen Science: The Dewey-Humboldt, Arizona Garden Project](#)

**UPCOMING EVENTS**

- [Citizen Science: The Dewey-Humboldt, Arizona Garden Project](#)
- [The Importance of Soil Quality](#)
- [Soil Health and Vegetable Production](#)
- [Join Gardenroots!](#)
- [Citizen Science: The Dewey-Humboldt, Arizona Garden Project](#)



140 Public Drive, W. Phoenix, AZ 85043-2000 | (602) 944-5511 | FAX: 602-944-5515

February 9, 2011

### For Immediate Release

March 12, 2011, 10:00AM - 11:30AM at the Lanesona Valley Wagon at 4th Childhouse, 2774 S. Central Street, Phoenix, AZ 85042



**gardenroots**  
The Dewey-Humboldt, Arizona Garden Project

Have a garden? Want to learn whether your soil is healthy for vegetable gardening?

Be the first to have a soil water test & a vegetable sample from your garden for micronutrient and nutrient analysis. Diagnose the quality of your soil & the vegetables you grow. Be recognized as an ambassador for the micronutrient program community.

**Thursday March 12, 2011, 10:00AM - 11:30AM at the Lanesona Valley Wagon at 4th Childhouse, 2774 S. Central Street, Phoenix, AZ 85042**

Registration fee: \$10.00. Registration fee includes a soil water test kit and a vegetable sample kit. Registration fee also includes a copy of the research report and a copy of the research report.

Reserve your kit and sign up in the training!

### Press Release



February 2011

Dear

Thank you for your continuous interest in Gardenroots! I'm delighted to personally invite you to the gardenroots training. This is a great opportunity to learn about the micronutrient program and how to collect, test, and analyze soil samples from your garden. Training includes a soil water test kit and a vegetable sample kit from your garden for micronutrient and nutrient analysis, and a booklet filled with all the necessary supplies you will need to sample your vegetable garden.

Please RSVP by phone or email for ONE of the training dates below:

- **Thursday March 10, 2011 10:00AM - 12:00PM** Dewey-Humboldt Town Library 2242 S. Central Street, Phoenix, AZ 85042
- **Thursday March 10, 2011 10:00AM - 12:00PM** Lanesona Valley Wagon at 4th Childhouse 2774 S. Central Street, Phoenix, AZ 85042

Reservations to the Lanesona Valley Wagon at 4th Childhouse: Please be prepared to pay for the parking fee. You will be required to pay for the parking fee. You will be required to pay for the parking fee. You will be required to pay for the parking fee.

This is a really exciting project and I am generally looking forward to working with you. This will be part of a real world research project that will advance the state of gardening knowledge, considered important to a Citizen Scientist. Please feel free to contact me for more information or to sign up in the training!

Best,

### Letter to community members

## 2. THE DEWEY-HUMBOLDT NEWSLETTER

### TOWN NEWS

GRASSROOTS

### ARIZONA RANGERS

MEETING TALK

### NEED A RIDE?

Meet your new favorite Tucson...

### Newsletter Announcement



# Communication and Design Challenge: Instructional Manual on how to collect soil, water and vegetable samples

March 2011

## Drop Samples off at UA Yavapai Cooperative Extension Office

Address: 840 Rodeo Dr, Bldg C, Prescott, AZ 86305  
 Hours: Monday - Friday, 9AM - 4PM, closed from 12 - 1PM daily  
 Telephone: 928-445-6590  
 website: <http://extension.arizona.edu/yavapai>

### Gardenroots Contacts

General and Sample Collection Questions:  
 - Monica Ramirez, [mdramire@email.arizona.edu](mailto:mdramire@email.arizona.edu), 520-260-6620  
 - Janick Artiola, [jartiola@cals.arizona.edu](mailto:jartiola@cals.arizona.edu), 520-621-3516

Sample Drop-Off Concerns or Questions:  
 - Jeff Schalau, [jschalau@ag.arizona.edu](mailto:jschalau@ag.arizona.edu), 928-445-6590 ext. 224

### Vegetable Gardening Resources

Arizona Master Gardener Manual  
<http://cals.arizona.edu/pubs/garden/mg/>  
 Backyard Gardener  
<http://cals.arizona.edu/yavapai/anr/hort/byg/>

Want to learn whether your soil is healthy for vegetable gardening?

## gardenroots

The Dewey-Humboldt, Arizona Garden Project

Gardenroots was designed in response to your research interests.

### What is Citizen Science?

Citizen Science is a way for you to learn about soil, water, and plant science by participating in scientific studies.

This is a partnership between the community of Dewey-Humboldt, Arizona and scientists at the University of Arizona.

The work you do, and the samples you collect will be used in a scientific study to determine if your proximity to the Iron King Mine and Humboldt Smelter Site affects the quality of your vegetables.

This manual provides step-by-step instructions on how to collect water, soil & vegetable samples from your garden for analysis by University of Arizona laboratories.



Gardenroots was made possible by:



Gardenroots Instructional Manual

Back

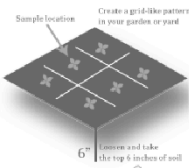
Front

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# Communication and Design Challenge: Instructional Manual on how to collect soil, water and vegetable samples

## 1. Collecting Soil Samples from your Garden

1. Select (mark) six locations (spots) in a roughly grid-like pattern to sample in your garden.
2. Using a hand trowel provided, loosen the top 6" of each of the six soil spots.
3. At each location take one full scoop of soil and place it into a 5-gallon bucket labeled A.
4. Mix the six soil samples thoroughly inside the bucket. This process is called sample bulking.
5. Place about 1-2 pounds of the bulked soil sample into a brown paper bag and attach the label provided.
6. Place the soil paper bag into a 1-gallon Ziploc bag making sure that the label on the brown paper bag is clearly visible.
7. Soil should now be air-dried or kept cold until you are ready to drop-off at the Yavapai County Extension Office.



## 2. Collecting Soil Samples from your Yard

You will do the same soil sampling process as you did above for your garden soil, but now for your yard soil. Complete steps 1-7 above, note for step 3 now use the 5-gallon bucket labeled B.

### Drop-Off Checklist:

- 1) Garden soil sample in paper bag and then 1-gallon Ziploc bag
- 2) Yard soil sample in paper bag and then 1-gallon Ziploc bag
- 3) 3 water sample bottles in a 1-gallon Ziploc bag
- 4) Vegetable samples individually bagged, and then in a 1-gallon Ziploc bag

Drop off all samples at the UA Yavapai Cooperative Extension Office, 840 Rodeo Dr, Bldg C, Prescott, AZ 86305

## 3. Collecting Water Samples (preferably in the late afternoon)

Using the water source you use to irrigate your garden:

1. Turn on the water (hose) and allow to flow for 2-3 minutes. During this you may fill out the labels of the bottles with all the information requested.
2. Slow the flow to a small trickle and carefully fill each bottle until water overflows.
3. Once full quickly cap each bottle and seal.
4. Place the 3 bottles in a 1-gallon Ziploc bag, seal and store in a refrigerator (do NOT freeze water samples) until you are ready to drop off at the Yavapai County Extension Office.



## 4. Collecting Vegetable Samples

1. Collect a minimum of 4-5 ounces of 4 different vegetables (leaf, root, or fruit) from your garden and place it temporarily into a brown bag. Take the vegetable sample(s) to the washing area, which should have the following (see diagram below):  
Tub 1 filled with tap water. Use brush to clean all soil off the vegetable sample and rinse.  
Tub 2 filled with provided distilled water and 1 tablespoon of bleach. Dip your sample several times in the solution.
3. Place each sample on clean paper towels and if possible allow to air dry indoors, away from dust for 30+ minutes. Additionally, clean paper towel may be used to soak up excess water as necessary. (note: plant tissue does not need to be fully dried before next step)
4. Place each vegetable sample in separate Ziploc bag(s) that have been pre-labeled, and remove all air from bag before sealing. Then place all your bagged vegetable samples in a 1-gallon Ziploc bag.
5. Promptly place the bag in the refrigerator till you are ready to drop off at the Yavapai County Extension Office.



Inside

## Outcomes: Numbers

- Over 300 people were contacted via educational outreach events and recruitment products
- 43 community members signed up, and received kits
- 25 kits were returned



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## Outcomes: Numbers

- Over 300 people were contacted via educational outreach events and recruitment products
- 43 community members signed up, and received kits
- 25 kits returned

1 – Nothing grew

3 – I'm sick, can't garden

1 – Grasshoppers ate my garden

7 – No Time

1 – We're too old

2 – Forgot

1 – Disgruntled

? Never heard from the rest

***What happen to remaining Kits?***

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I maintained ongoing communication via phone/email/mail, and informal science educational experiences throughout the project to manage community expectation and involvement

*Upcoming Gardening Seminars - May 3, 2011*

APR 22 2011 Dear Gardenroots Participants,  
Jeff Schalaus, University of Arizona Cooperative Extension Agent, will be offering 2 two-hour gardening seminars for beginning vegetable gardeners on May 3 between 3-5 pm and 7-9 pm at Lonesome Valley Wranglers 4-H Clubhouse, 13911 Quail Run, Dewey, Arizona\*.  
Both seminars will be identical and will cover: soil amendment/preparation, fencing, irrigation, warm vs. cool season crops, season extending strategies, pest management/crop protection, and more.

Tags: Upcoming Gardening Seminars      Login or register to post comments      read more



*gardenroots presents:*

**A Community Health Talk**

Thursday June 2, 2011, from 6:00PM to 8:00PM  
Dewey-Humboldt Town Library  
2735 S. Corral Street  
Humboldt, AZ 86329

Please join us for an informational Q&A session with researchers from the University of Arizona to discuss the contaminants of concern found at the Iron King Mine and Humboldt Smelter Superfund Site.

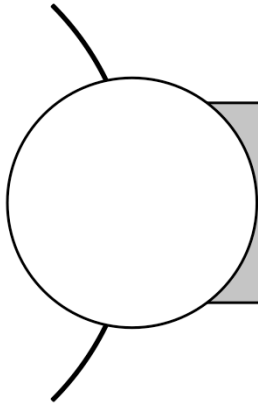
For more information, please contact:  
Monica Ramirez-Andresen, Email: mramirez@email.arizona.edu, Phone: 520.260.6640

**Results for Lunch**

Your Soil, Water and Vegetable Outcomes

*gardenroots*  
The Dewey-Humboldt, Arizona Garden Project

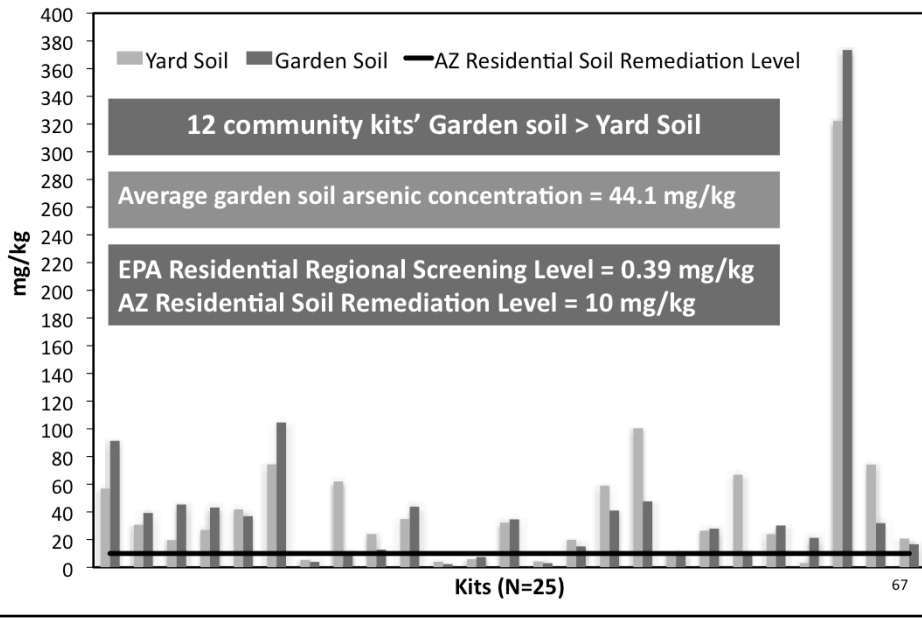
Saturday January 28, 2012      Dewey-Humboldt Town Library  
11:00AM to 2:00PM      2735 S Corral Street



# Results



## Community Results: Arsenic Concentrations in Community Yard and Garden Soils



**What nutrients or amendments will you be adding to your garden this year?**



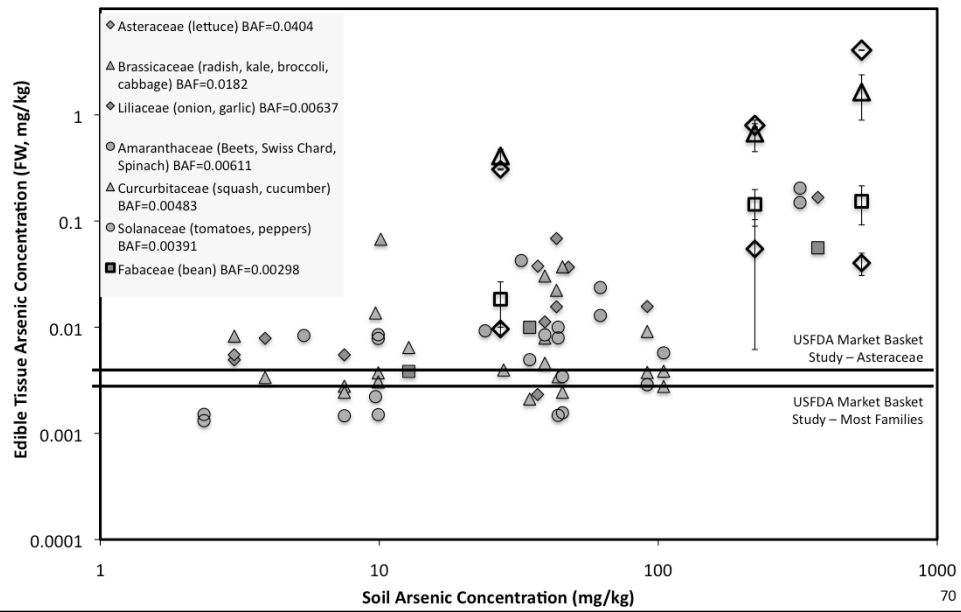


**Outcomes: Total Number of Vegetables Analyzed  
(Greenhouse and Community)**

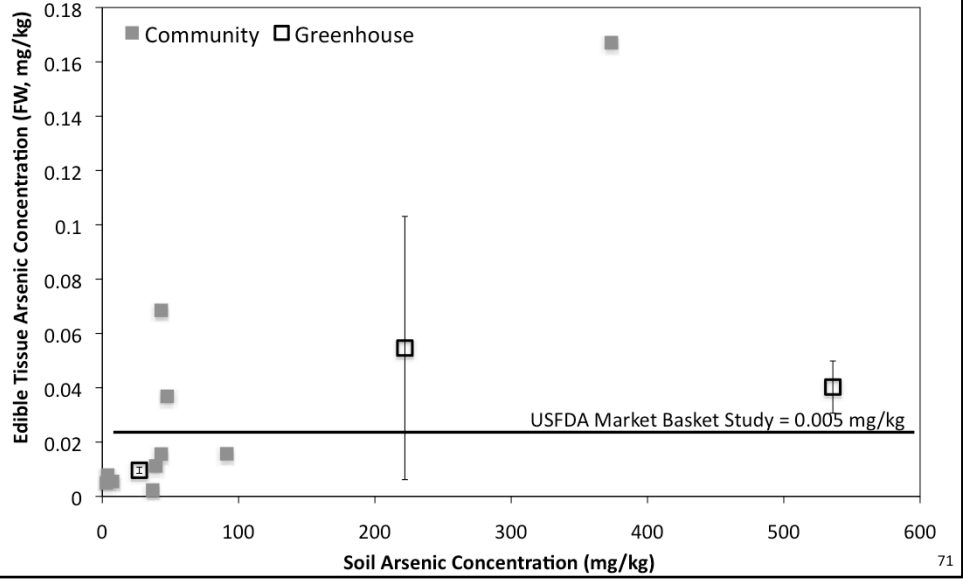
<b>Family</b>	<b># of Samples</b>
Asteraceae (lettuce)	14
Fabaceae (bean)	15
Brassicaceae (radish, kale, broccoli, cabbage)	19
Liliaceae (onion, garlic)	22
Solanaceae (tomatoes, peppers)	15
Curcubitaceae (squash, cucumber)	15
Amaranthaceae (beets, swiss chard, spinach)	8
<b>Total</b>	<b>108</b>

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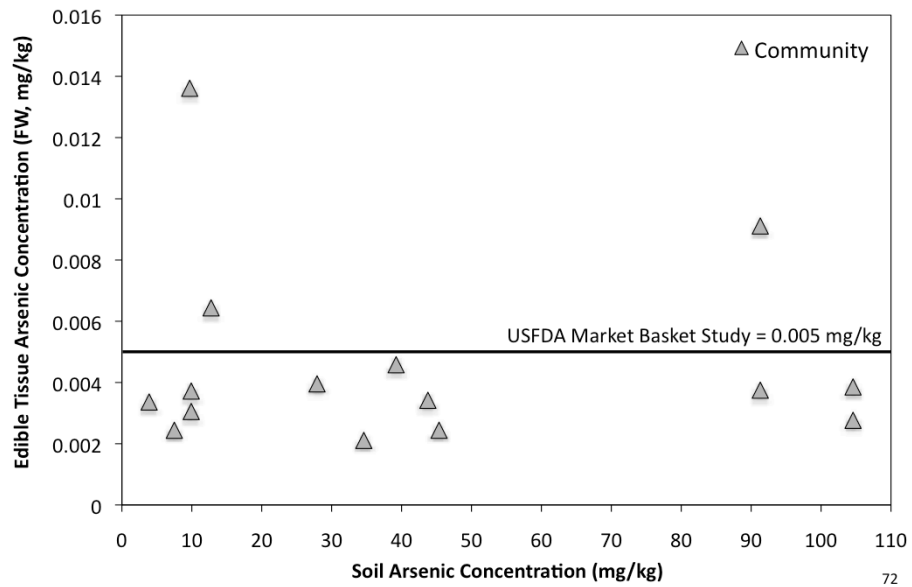
## Results: Arsenic Concentrations in **Greenhouse** and Community Vegetables

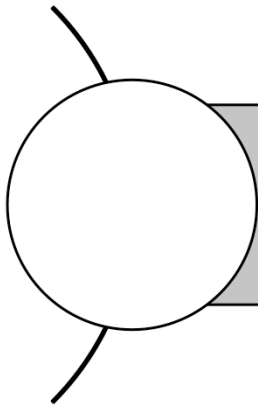


### Arsenic Concentration in Liliaceae Samples (FW, mg/kg)

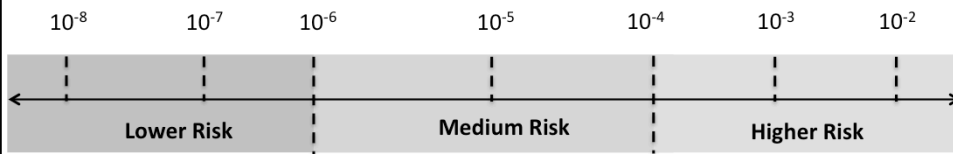


### Arsenic Concentration in Cucurbitaceae Samples (FW, mg/kg)

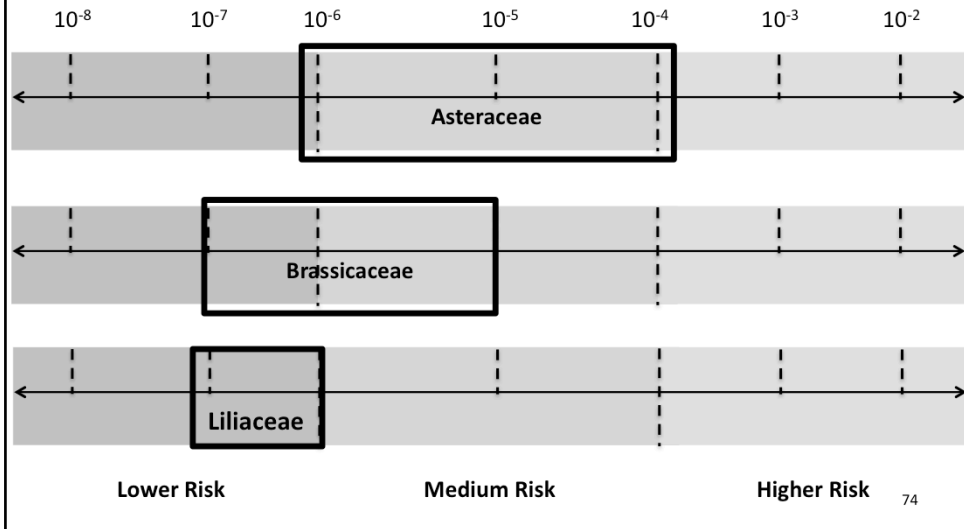




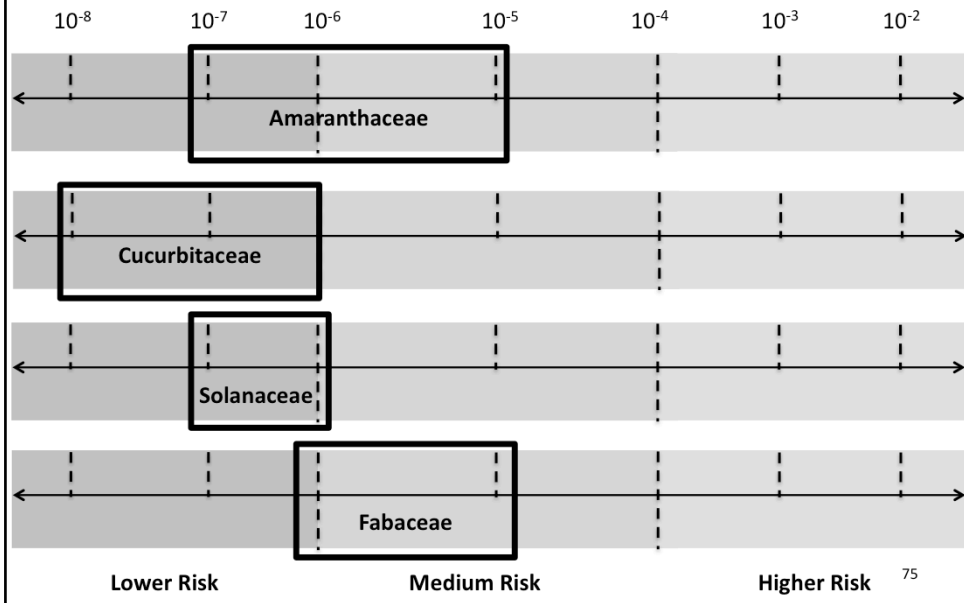
# Risk Characterization

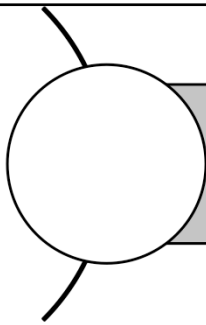


## Incremental Excess Lifetime Cancer Risk Range for Vegetable Families



# Incremental Excess Lifetime Cancer Risk Range for Vegetable Families



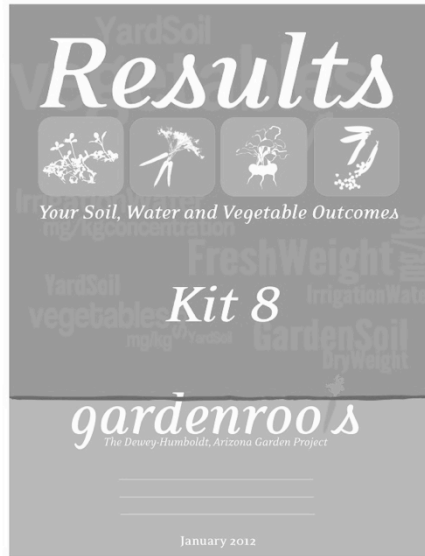


## Delivering results and risk communication





**Translating Their Results:** Empower them with the results so they could make informed decisions



- The metal(loid) concentrations in their soil, water and vegetables
- Their calculated cancer and non-cancer risk
- How much they can eat at various target risks
- Nutritional content in vegetables

# Risk Calculation – How Much Can You Eat?

Calculate how much you can eat at the concentration found in your vegetable sample at a specific target risk

Set the Target Risk = Predicted number of excess cancer cases over a lifetime

Use arsenic concentration found in vegetable

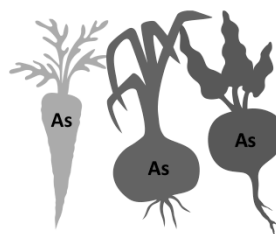
## Target Risk



→ 1/1,000,000

→ 1/100,000

→ 1/10,000



Dartboard Image Source: [http://harkleysocial.bravehost.com/myPictures/Darts\\_in\\_a\\_dartboard.jpg](http://harkleysocial.bravehost.com/myPictures/Darts_in_a_dartboard.jpg)

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## Assumptions Used to Complete Calculations

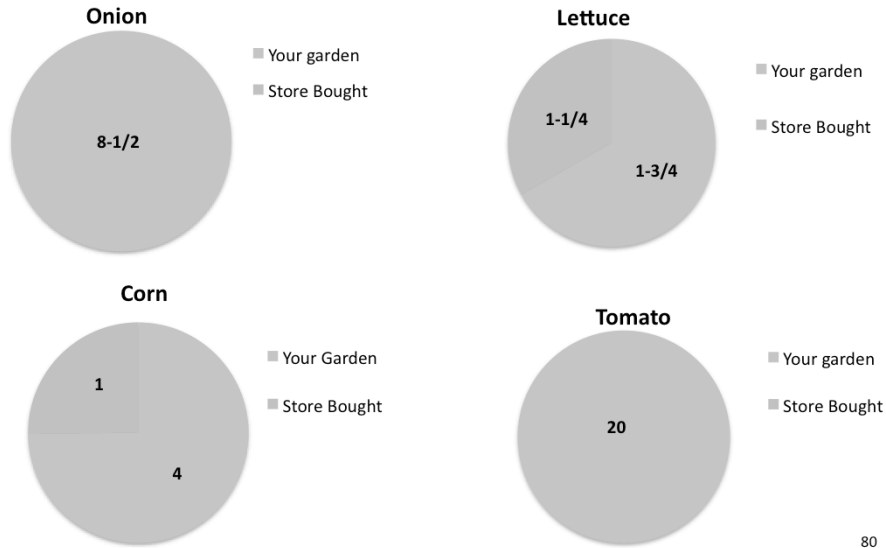
Along with other risk assumptions, one will:

- Be eating the U.S Department of Agriculture recommended amounts
- Only be eating that vegetable to meet the USDA recommended amount for the given vegetable group

The USDA recommends that you consume weekly:	Cups per Week	Vegetable Group
	1.5	Dark Green Vegetables (Kale, spinach, lettuce, broccoli, etc.)
	5	Red and Orange Vegetables
	1.5	Beans and Peas
	5	Starchy Vegetables
4	Other Vegetables (onions, zucchini, beets, cucumbers, celery, brussell sprouts, cabbage, green beans, etc.)	

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## How much can you eat a week at a Target Risk of 1/100,000?



***It is your choice to decide what target risk you want to use to make decisions about how many cups per week to consume from your garden.***

**Amount You Can Eat from Your Garden Based on a Cancer Target Risk**

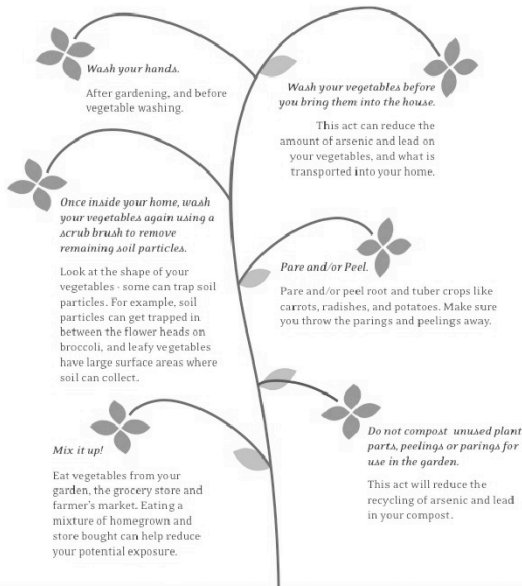
Location	Target Risk 1/1,000,000	Target Risk 1/100,000	Target Risk 1/10,000	USDA Recommended Amount (cups/week)
Onion				
Your Garden	3/4	7	70	4 cups/week total of "Other Vegetables"
Lettuce				
Your Garden	1-1/2	15	150	3 cups/week total of "Raw Leafy Dark Green Vegetables"
Tomato				
Your Garden	1/2	5	50	5 cups/week of "red and orange vegetables"
Corn				
Your Garden	3	30	300	5 cups/week of "starchy vegetables"

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*Recommended Practices for Safe Consumption of Homegrown Vegetables:  
Ways to Reduce Dietary Arsenic and Lead Ingestion*

Handout:

*Recommended  
Practices for Safe  
Consumption of  
Homegrown  
Vegetables*



Arsenic and lead occur naturally in soils. Concentrations of arsenic and lead in soils may be 10 to 100 times greater than concentrations in the vegetables you grow in that soil. Because of this, it is crucial to remove soil particles that stick to your garden crops.

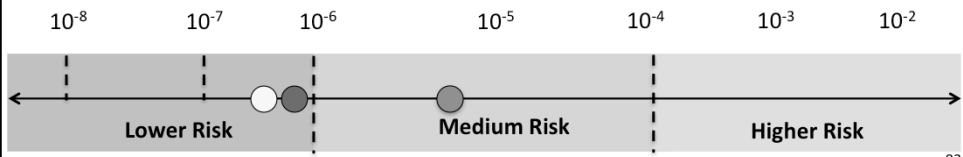
Above are important recommended practices.

## Risk Characterization for Arsenic in Soils and Irrigation Water – Cancer

Risk Characterization for Arsenic: Cancer	Yard Soil	Garden Soil	Scenario: Accidental soil ingestion while gardening
Incremental Excess Lifetime Cancer Risk	15 out of 1,000,000	9 out of 1,000,000	
Risk Characterization for Arsenic: Cancer	5 out of 100,000		Scenario: Drinking 2 liters/day
Incremental Excess Lifetime Cancer Risk			

**Legend**

- Yard Soil
- Garden Soil
- Irrigation Water



Handout:

## Recommended Practices for Garden Preparation

### Recommended Practices for Garden Preparation: Ways to Reduce Arsenic Absorption by Vegetables

#### Test your soils.

Before you amend, or grow anything, you should test your soils (once is only needed). Please refer to the *Gardenroots* Instructional Manual for soil collection methods. Please note that a safe soil arsenic standard for growing vegetables has not been established.

#### pH is crucial.

Keep your soils near the near the neutral zone (6.5-7.5).

#### Plant Nutrients.

Maintain adequate levels of plant nutrients like calcium, nitrogen, potassium, magnesium and phosphorus in your soils by fertilizing regularly, not excessively. Please refer to AZ1020 and AZ1435.

#### Some garden products may contain arsenic.

Pay attention to the garden soil and amendments that you are using.

#### Organic Matter.

The organic matter can help reduce how much a vegetable takes up. Apply at least a layer of organic matter 2 to 3 inches thick on the garden area about 1 to 2 months before planting. Please refer to AZ1435.

#### Iron in soils can reduce the available amount of arsenic.

The iron and arsenic come together to form iron arsenate, a form of arsenic that is not well absorbed by vegetables. Please refer to AZ1435.

#### Build Containers or raised beds.

Construct a container or raised bed using materials and soils low in arsenic and lead. For example, do not use arsenic treated lumber to construct raised beds. Make sure to test the bedding soils before planting.

#### Place a barrier.

You can put an impermeable barrier between the uncontaminated topsoil, and the underlying contaminated soil to reduce mixing, and remind you how deep to till. If you do this, you must provide for bed drainage.

#### Replace contaminated soils.

This may require technical assistance and guidance from the AZ Department of Environmental Quality.

Arsenic and lead occur naturally in soils. It is impossible to grow plants completely free of arsenic and lead, but there are ways to reduce the amount that is available to, and taken up by your vegetables. Above are important recommended practices.



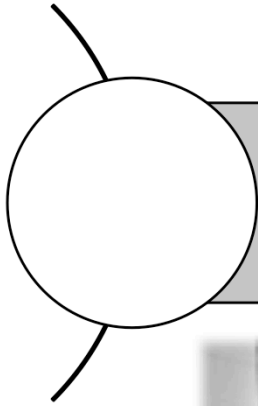
Handout:

## Recommended Practices for Safe Gardening

### Recommended Practices for Safe Gardening: Ways to Reduce Incidental Soil Ingestion and Inhalation



You can greatly reduce your exposure to arsenic from your soil if you follow the suggestions above.



## *Gardenroots'* Impacts

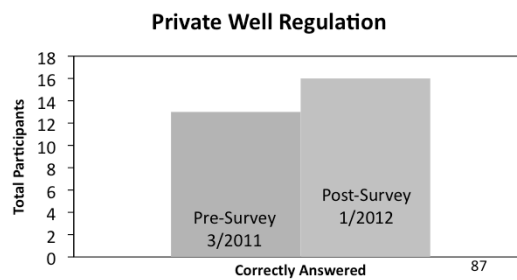
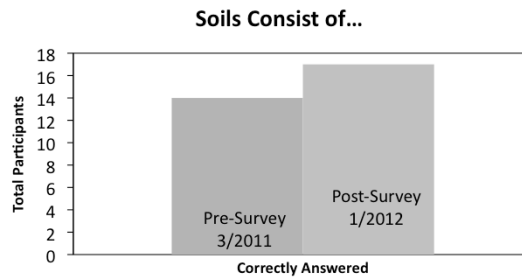


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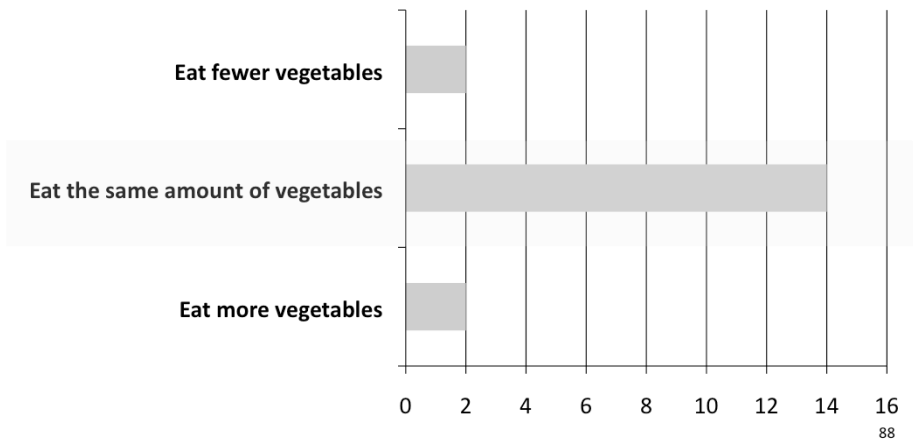
## Selected Impacts: Pre/Post Survey

- **Science Questions**

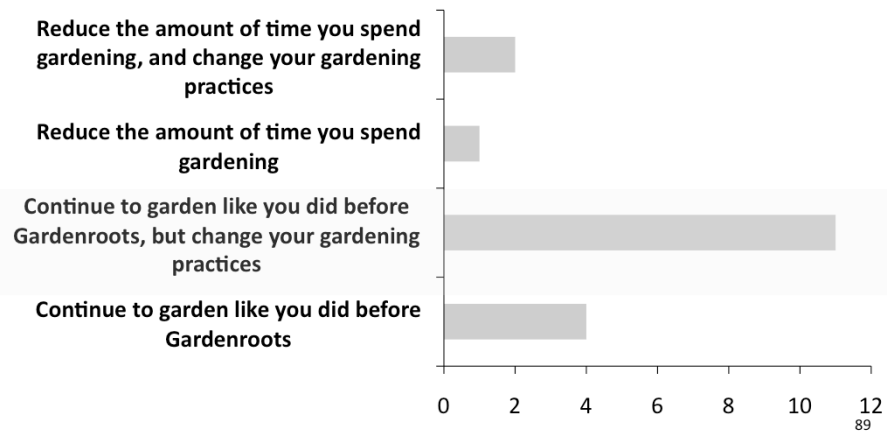
- There was an increase in the number of correct answers given for 8/14 questions



**Selected Behavioral Outcomes:**  
*Overall, now that you have the results  
for your garden, will you:*



**Selected Behavioral Outcomes:**  
*Now that you have the results from  
your garden, will you:*



## Conclusions: Vegetables Results

- Overall, arsenic concentrations in the Gardenroots vegetables > store bought vegetables
- Bioaccumulation Factor:  
Asteraceae > Brassicaceae > Liliaceae > Amaranthaceae > Cucurbitaceae > Solanaceae > Fabaceae.
  - Similar bioaccumulation factors and values were observed in the literature.
- The Incremental Excess Lifetime Cancer Risks for the Gardenroots vegetables ranged between  $10^{-8}$  to  $10^{-4}$

## Conclusions: Citizen Science and Risk Communication

- Public participation allowed for both a greenhouse and field study → more data, while residents increased their knowledge and awareness
- Providing people the opportunity to decide their own acceptable risk is a powerful risk communication and educational activity
- People will continue to eat their vegetables, but will be changing their gardening practices

## Take Home Message

- Building a relationship with the Dewey-Humboldt, AZ community allowed me to conduct research and apply my mission statement to a Superfund site
- A valuable research project can incorporate:
  - Research translation efforts
  - Public participation
    - Crucial to harness their knowledge and enthusiasm
    - New questions arose from community data
    - Communities are experts in their own right



# Acknowledgements

## *gardenroots* The Dewey-Humboldt, Arizona Garden Project



**Thank You Gardenroots' Citizen Scientists!**  
**Your participation made this project successful!**



## Special thanks to:

- Advisors: **Janick Artiola**, **Mark Brusseau**, **Raina Maier**, Paloma Beamer, Kelly Reynolds
- **Jeff Schalau, UA Yavapai Cooperative Extension**
- Laboratory Managers: Mike Kopplin and Atasi Ray-Maitra
- Greenhouse Supervisors: Fernando Soliz and Juliana Gil-Loaiza
- Student Assistants: Logan P. Cole and Travis Burillo-Hunter
- A. Jay Gandolfi

Thank you for your time and  
consideration.



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# Resources & Feedback

- To view a complete list of resources for this seminar, please visit the [Additional Resources](#)
- Please complete the [Feedback Form](#) to help ensure events like this are offered in the future

U.S. EPA Technical Support Project Engineering Forum  
Green Remediation: Opening the Door to Field Use Session C (Green Remediation Tools and Examples)  
Seminar Feedback Form

We would like to receive any feedback you might have that would make this service more valuable.  
Please take the time to fill out this form before leaving the site.

First Name: Jean  
Last Name: Bent  
Daytime Phone Number: 793-603-9024  
Email Address: jeant.pandey@epa.gov  
Date of Seminar: December 15, 2009

Please send a copy of my feedback confirmation as a record of my participation to this address.

Need confirmation of your participation today?

Fill out the feedback form and check box for confirmation email.

## New Ways to stay connected!

- Follow CLU-IN on Facebook, LinkedIn, or Twitter



<https://www.facebook.com/EPACleanUpTech>



<https://twitter.com/#!/EPACleanUpTech>



<http://www.linkedin.com/groups/Clean-Up-Information-Network-CLUIN-4405740>