



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:

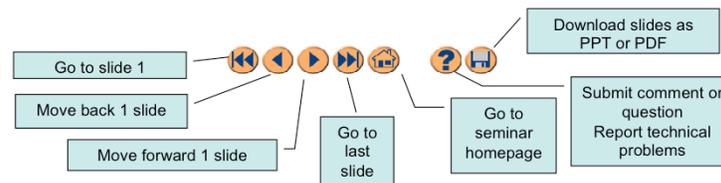
Sarah T. Wilkinson, Superfund Research Program, University of Arizona (wilkinso@pharmacy.arizona.edu)

Visit the Clean Up Information Network online at www.cluin.org

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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 1st 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



NASA, earth observatory



Arsenic in water and dust a growing concern

Arsenic and Disease

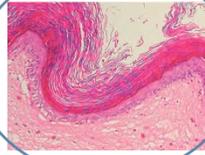
Cardiovascular



Cancer

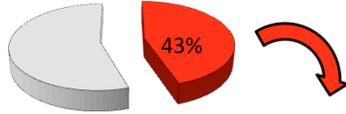


Many Others

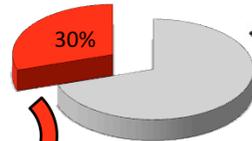


Overview and Impact

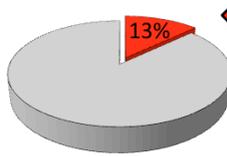
Cardiovascular deaths in Bangladesh



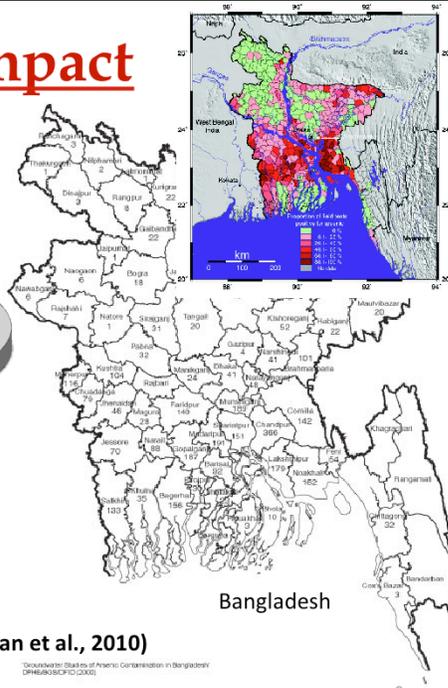
CV deaths attributable to Arsenic



Total Arsenic related CV deaths



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



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 NaAsO₂ for 22 wks

- **Aim 2**

- Hypothesis

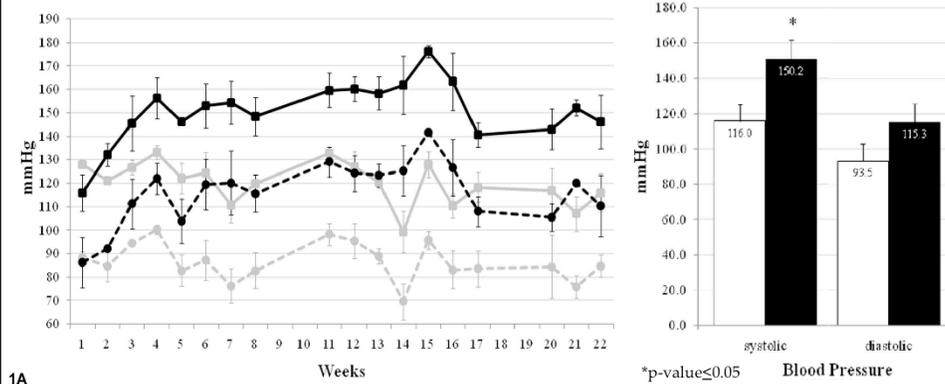
- Arsenic disrupts cardiovascular developmental programming and patterning
 - Developmental epithelial to mesenchymal transition (EMT)
 - Inhibition of key developmental gene programming

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Study design: Aim 1

- Mice were exposed to either 100 ppb NaAsO₂ 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

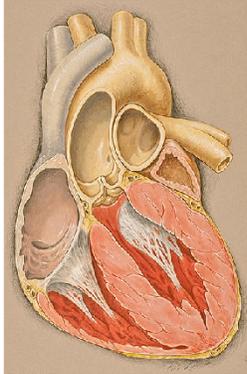
Arsenic promotes hypertension



Sanchez-Soria et al. Toxicologic Pathology 2012.

Chronic hypertension causes a constant stress on the heart

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.

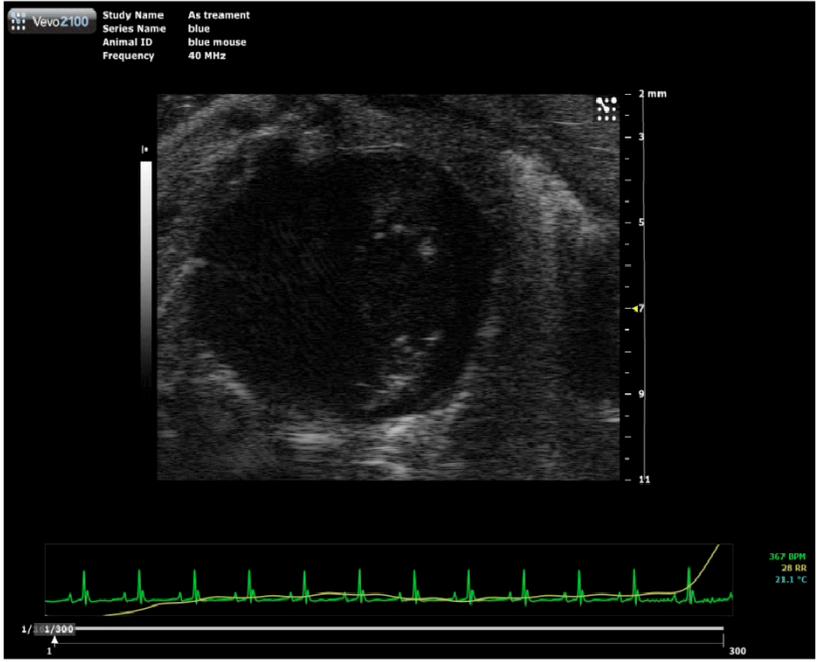


Physiological effects of hypertension

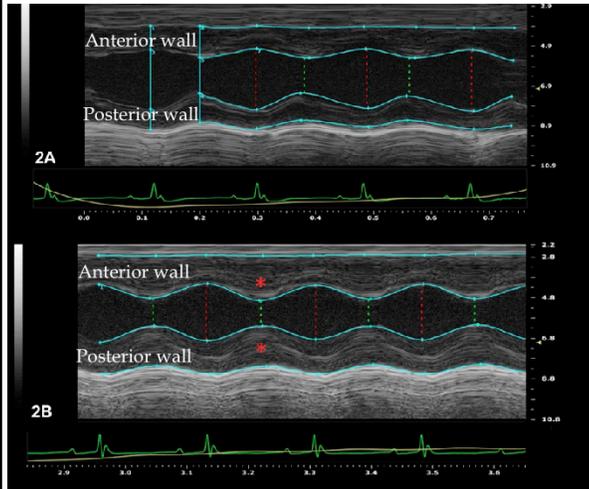


- Real time data acquisition
- Non-invasive
- Short axis (transverse plane)
- M-mode
- Gold Standard method for diagnosis of left ventricular hypertrophy
- Many other physiological parameters can be obtained

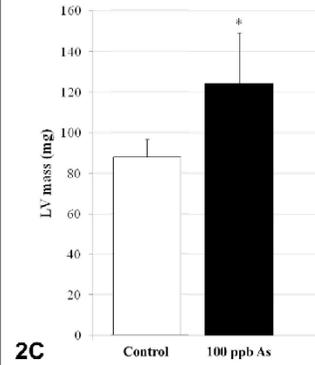




Left ventricular hypertrophy



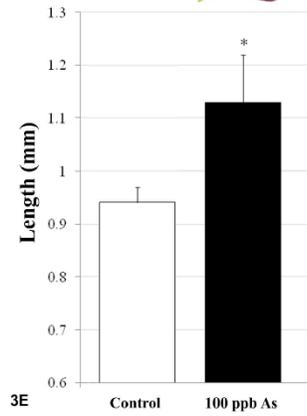
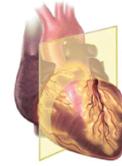
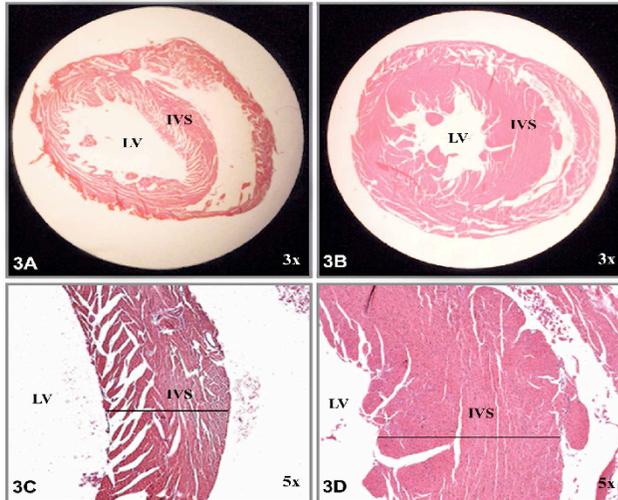
$$LV\ mass = 1.05 * (Avg.\ Diastolic\ Diameter\ at\ Outer\ Wall)^3 - (Avg.\ Diastolic\ Diameter\ at\ Inner\ Wall)^3$$



Sanchez-Soria et al. Toxicologic Pathology 2012.

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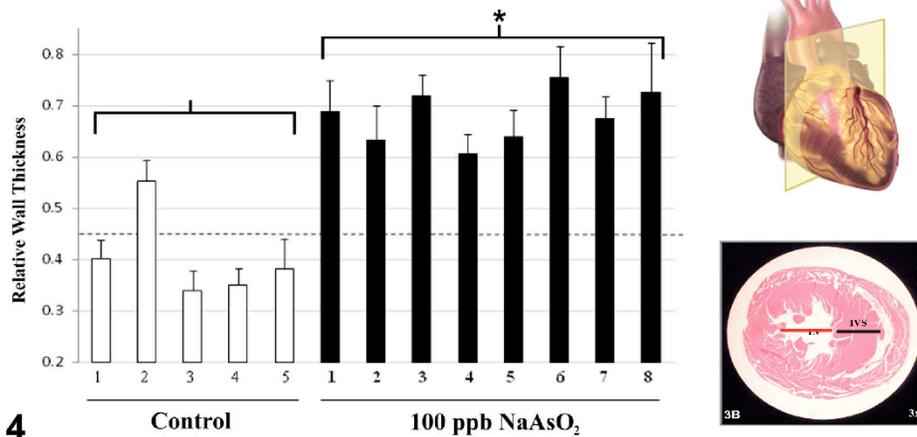
Left ventricular hypertrophy



Sanchez-Soria et al. Toxicologic Pathology 2012.

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Concentric hypertrophy



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Control

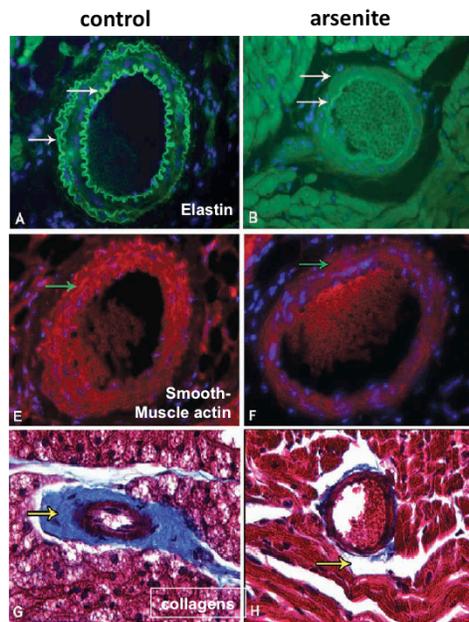
100 ppb NaAsO₂

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

Sanchez-Soria et al. Toxicologic Pathology 2012.

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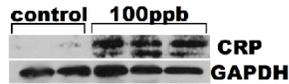
Disrupted Vascular Matrix



Hays, Camenisch et al.,
Tox Pathol 20

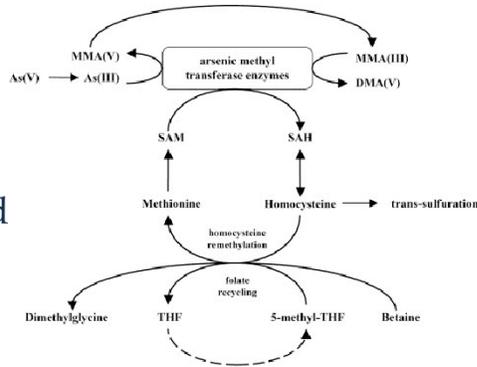
Future studies for aim 1

- 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

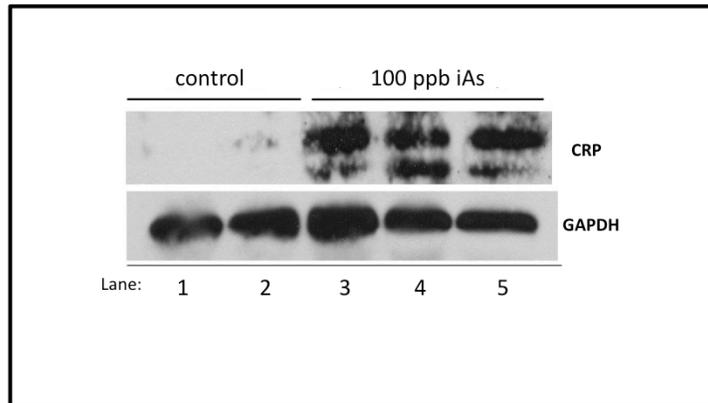


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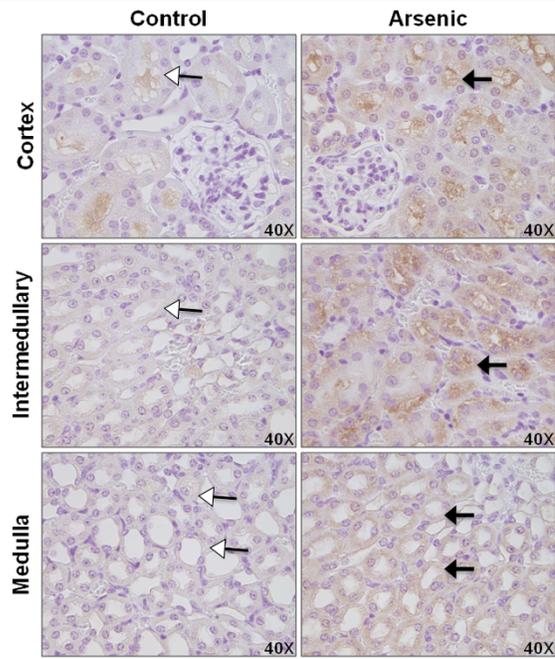
iAs Exposure induces CRP in Mouse Livers



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%

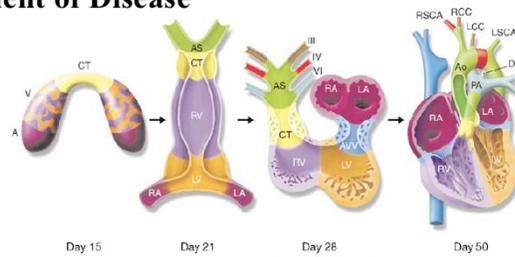
"Other" 75-85%

What about developmental origins of CV disease in adults?

Molecular Aspects of Mammalian Cardiovascular development

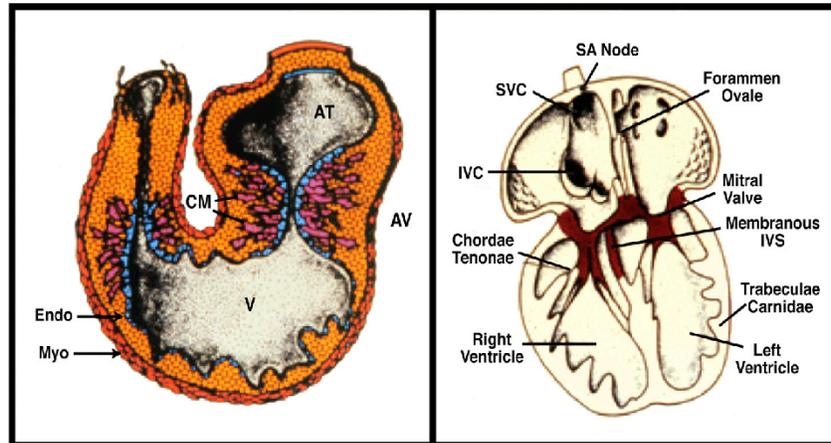
Developmental Biology
Development of Disease

Overlapping Pathways



Nature Review 2000
Schroeder & Camenisch J Mol Med 2003

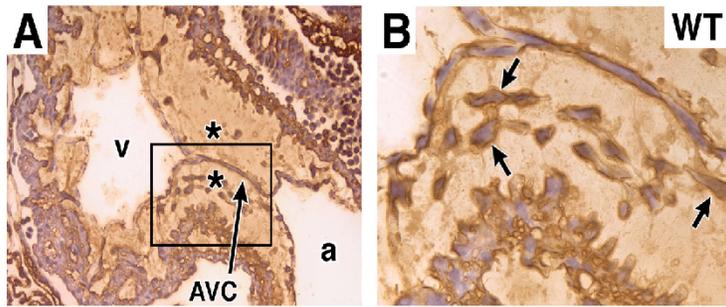
Atrioventricular Endocardial Cushions and the Adult Heart



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

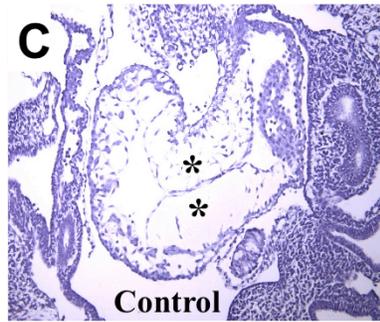
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Presence of HA in Forming AV Canals



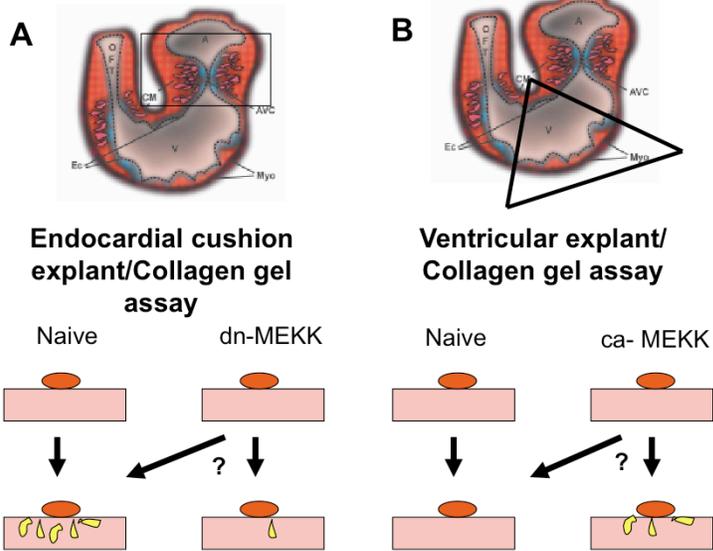
**Wild-type E9.5
Mouse embryos**

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



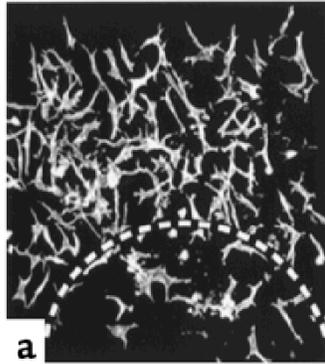
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Collagen Gel Invasion Assay



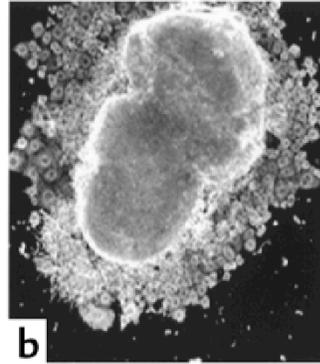
30

Ex Vivo Assay recapitulates EMT events *in Vivo*



a

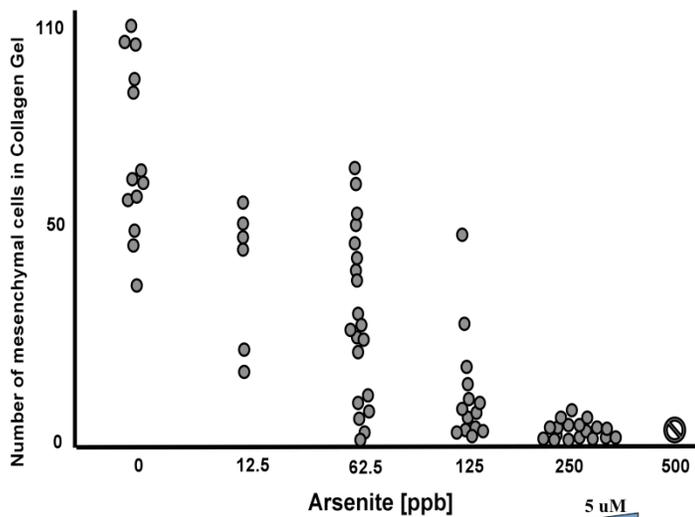
Normal EMT
Cardiac
mesenchyme



b

**Aborted or blocked
EMT
with Arsenite**

Arsenic disrupts EMT

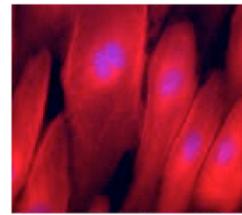
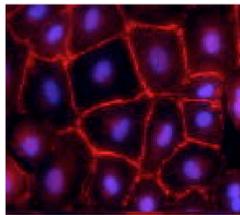
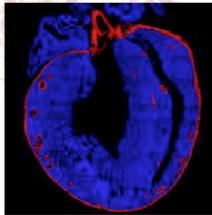


Lucinas & Camenisch et al., Tox Sci. 2010



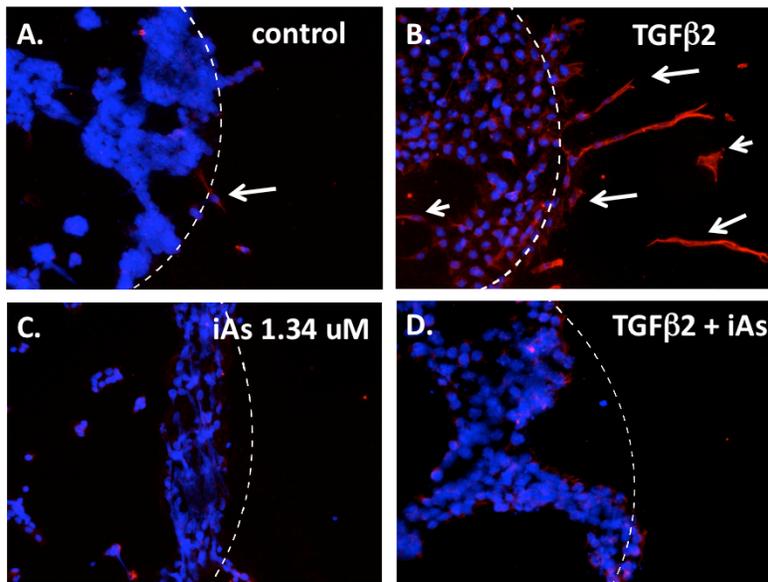
Coronary Progenitor Cell Line To study Cardiac EMT

- 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.



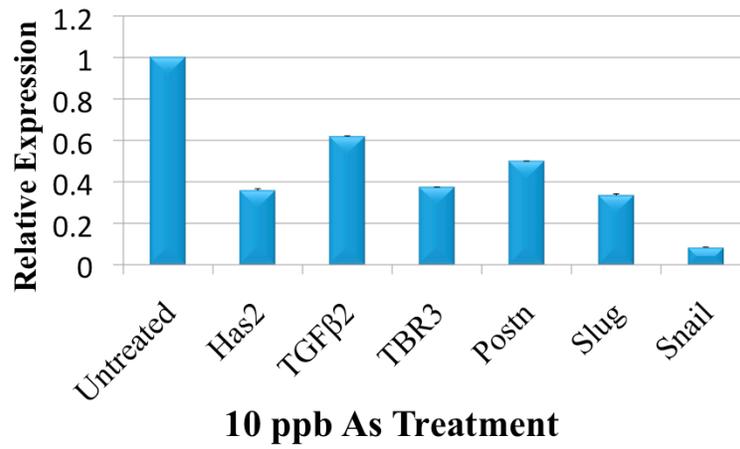
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iAs blocks TGFβ2 induced cardiac EMT

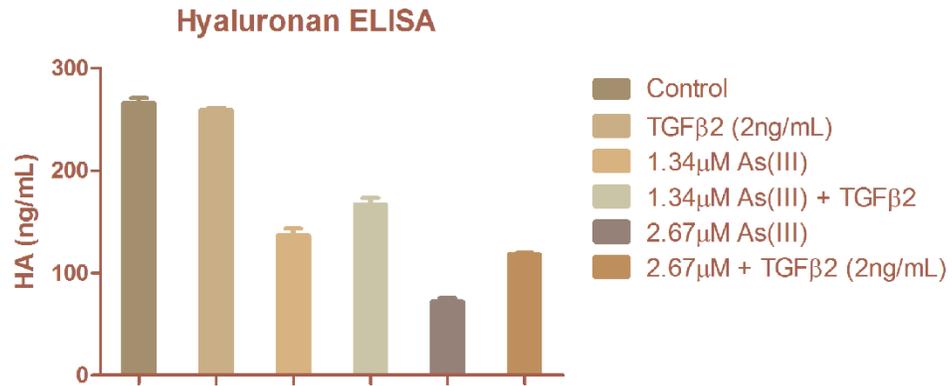


As disrupts EMT Gene Program

EMT Related Gene Expression



iAs blocks HA deposition



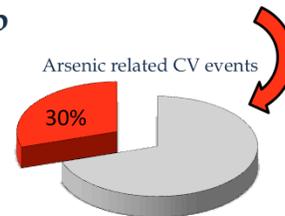
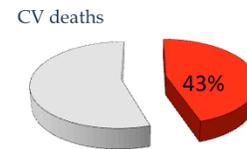
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Aim 2: Conclusions and Implications

- 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



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



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.

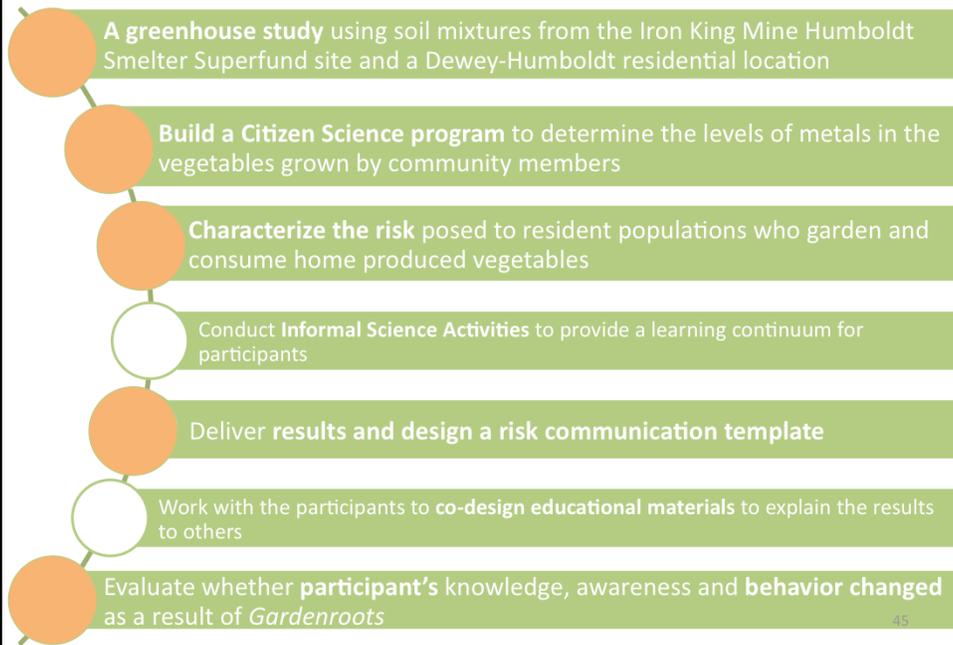
Gardenroots is:

Community driven

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

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

Gardenroots Project Activities



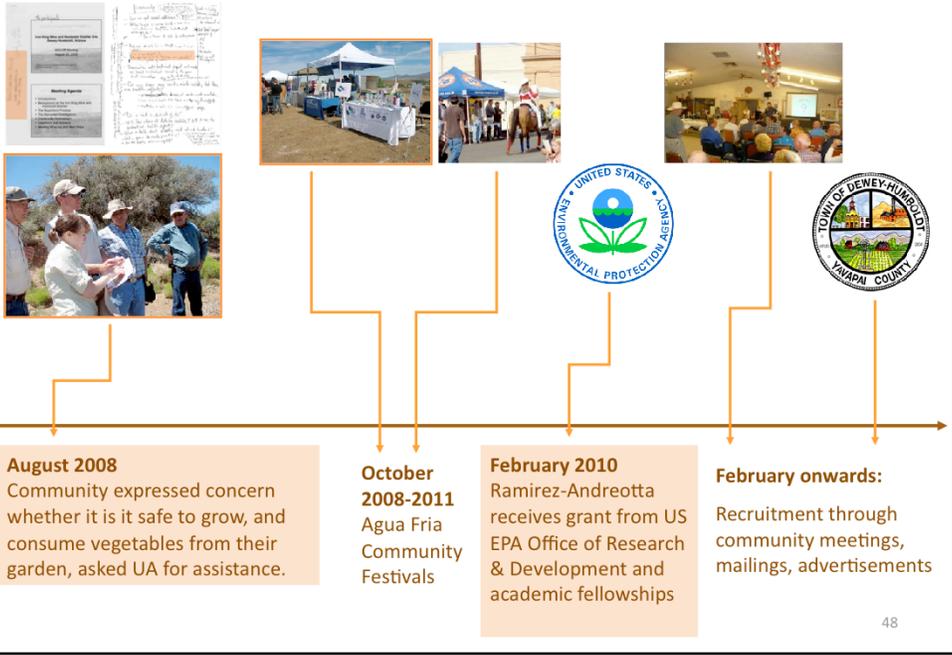
Introduction



Research Translation Timeline



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

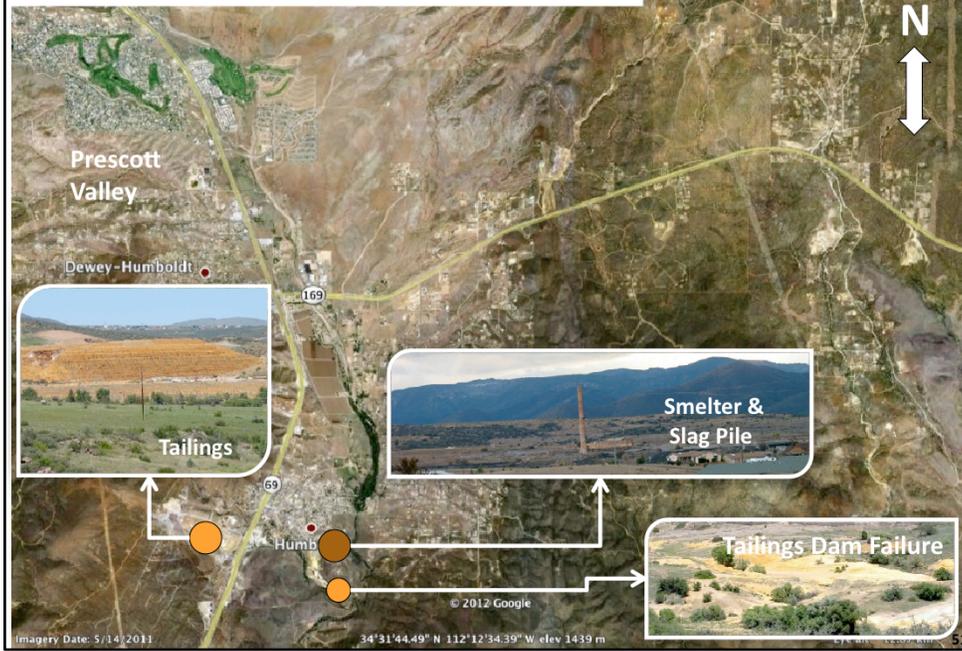
- Population: 3,894
- # Households: 1,589
- 93.3% high school graduate
- 16.7% Bachelor's degree +
- Nonmetropolitan community
- Majority Caucasian



Source:http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_10_5YR_DP02

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Gardenroots Study Area



Gardenroots Study Area

Soils for Greenhouse Study were from a residential area <2 miles from the tailings

Dewey-Humboldt

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Humboldt

© 2012 Google

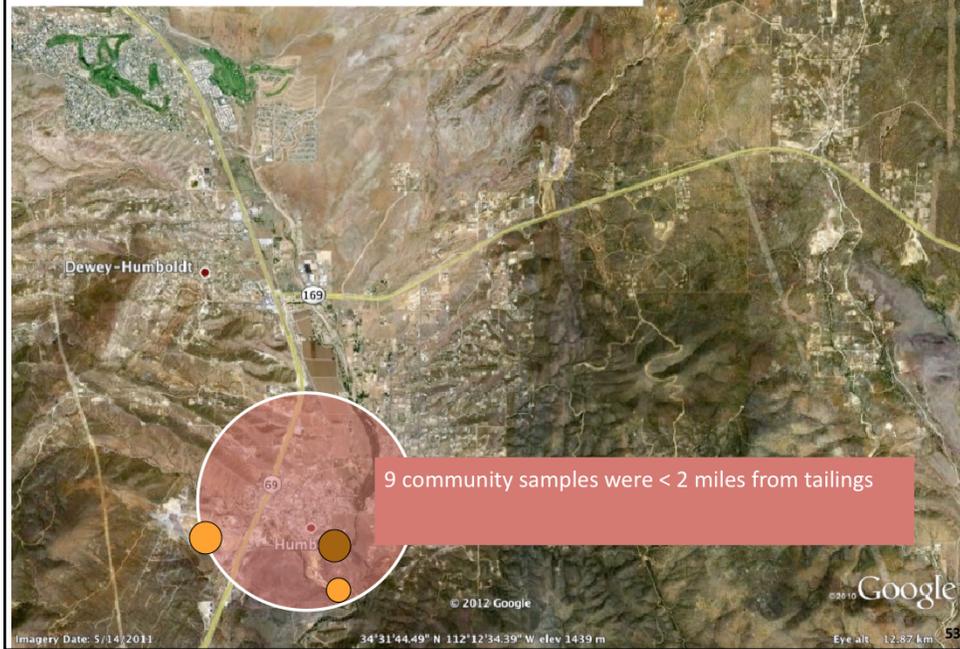
Imagery Date: 5/14/2011

34°31'44.49" N 112°12'34.39" W elev 1439 m

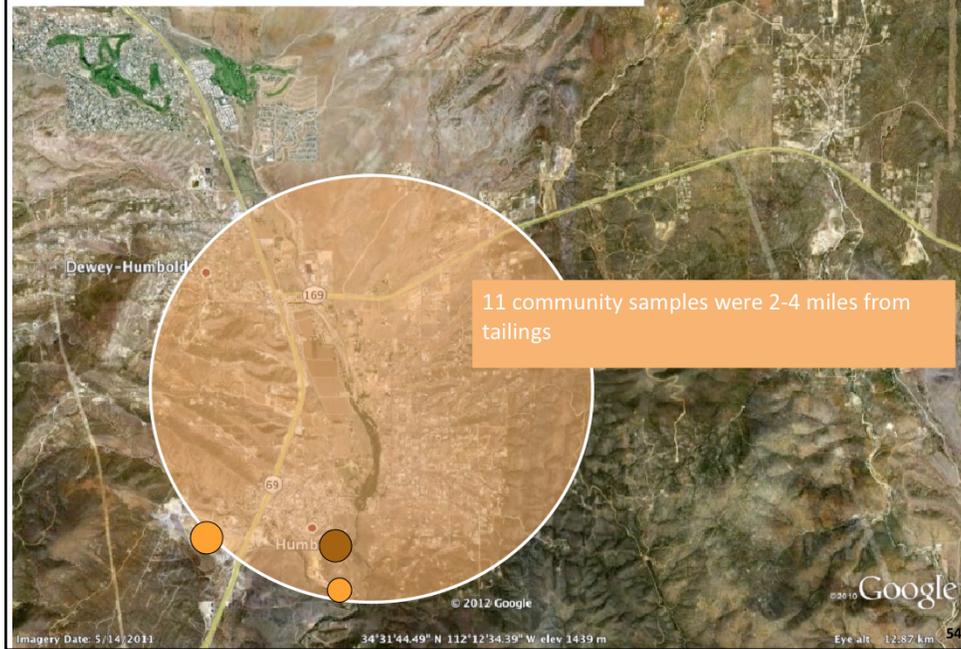
Eye alt: 12.82 km

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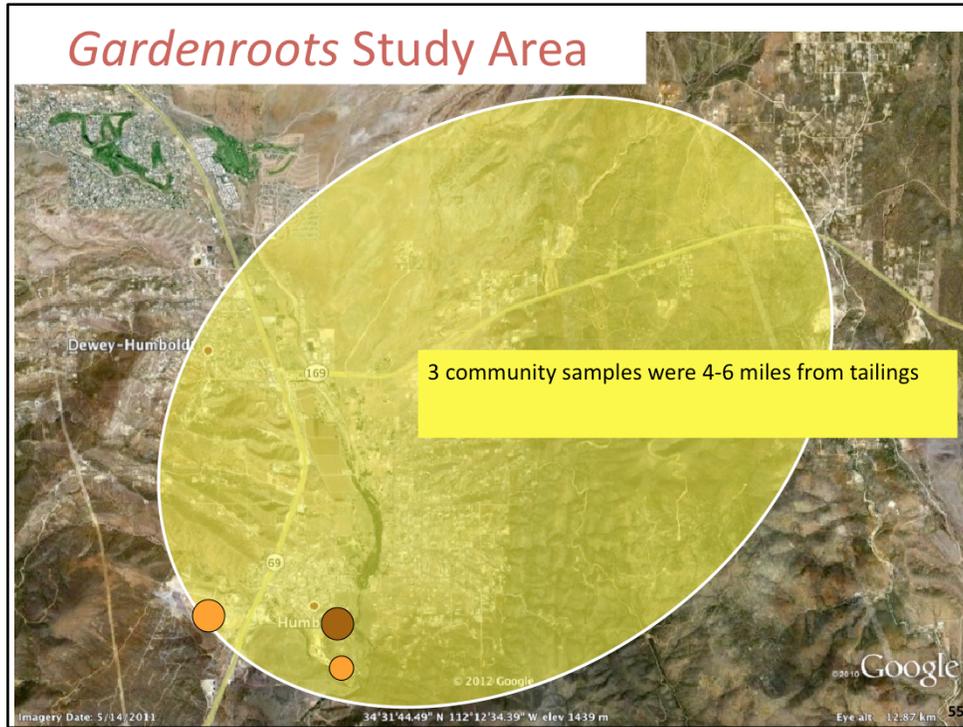
Gardenroots Study Area



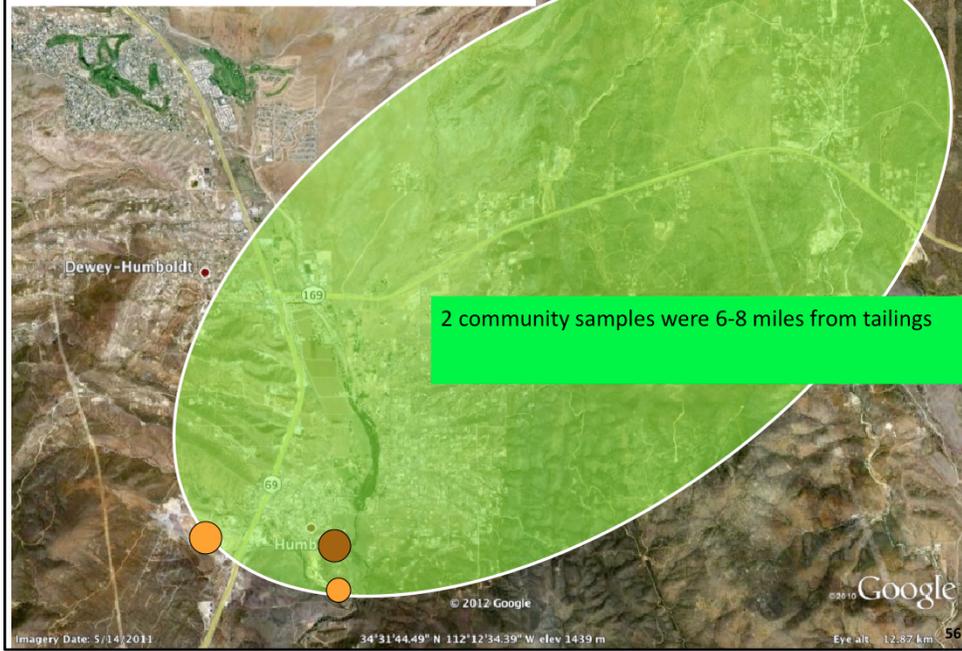
Gardenroots Study Area

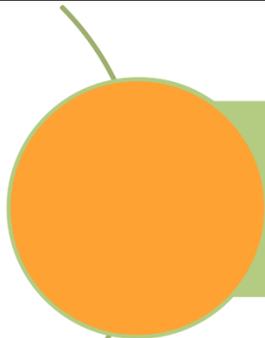


Gardenroots Study Area



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



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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? This tool will assess soil health and provide you with information for taking care of your soil.



The Dewey-Humboldt, Arizona Garden Project

Join Gardenroots!
As a **Citizen Scientist**, you will:

- Be trained to take soil samples and to recognize various soil types for nutrient and water content.
- Measure the quality of your soil in the vegetable growing zone.
- Be compensated as an ambassador for the environmental science profession.

Community Program Partners:
Arizona State University, University of Arizona, University of Wisconsin-Madison, University of California-Davis, University of Maryland, University of Michigan, University of Minnesota, University of North Carolina, University of Oregon, University of Pennsylvania, University of Texas, University of Washington, University of Wisconsin-Madison, University of Wisconsin-Minnesota, University of Wisconsin-River Falls, University of Wisconsin-Stevens Point, University of Wisconsin-Stout, University of Wisconsin-Superior, University of Wisconsin-Tulsa, University of Wisconsin-Whitewater, University of Wisconsin-Eau Claire, University of Wisconsin-La Crosse, University of Wisconsin-Oshkosh, University of Wisconsin-Oroquois, University of Wisconsin-Racine, University of Wisconsin-Sheboygan, University of Wisconsin-Stevens Point, University of Wisconsin-Stout, University of Wisconsin-Superior, University of Wisconsin-Tulsa, University of Wisconsin-Whitewater, University of Wisconsin-Eau Claire, University of Wisconsin-La Crosse, University of Wisconsin-Oshkosh, University of Wisconsin-Oroquois, University of Wisconsin-Racine, University of Wisconsin-Sheboygan.

Promotional Bookmark that was distributed at all community events and meetings



Website

Read the news! Dewey-Humboldt citizens

GARDENROOTS + CITIZEN SCIENCE = EDUCATIONIZATION OF SCIENCE

RECENT BLOG

UPCOMING EVENTS



February 6, 2011

Soil Sampling Service
Yavapai County Extension is offering a soil sampling service to help you determine the health of your soil. The service is available to all Yavapai County residents. For more information, please contact the Extension office at 928-744-2100.



The Dewey-Humboldt, Arizona Garden Project

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

Join Gardenroots!

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Remove your kit and pick up the results!

Press Release



February 2011

Join Gardenroots!

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- Be compensated as an ambassador for the environmental science profession.

Community Program Partners:
Arizona State University, University of Arizona, University of Wisconsin-Madison, University of California-Davis, University of Maryland, University of Michigan, University of Minnesota, University of North Carolina, University of Oregon, University of Pennsylvania, University of Texas, University of Washington, University of Wisconsin-Madison, University of Wisconsin-Minnesota, University of Wisconsin-River Falls, University of Wisconsin-Stevens Point, University of Wisconsin-Stout, University of Wisconsin-Superior, University of Wisconsin-Tulsa, University of Wisconsin-Whitewater, University of Wisconsin-Eau Claire, University of Wisconsin-La Crosse, University of Wisconsin-Oshkosh, University of Wisconsin-Oroquois, University of Wisconsin-Racine, University of Wisconsin-Sheboygan.

Remove your kit and pick up the results!

Letter to community members



2 THE DEWEY-HUMBOLDT NEWSLETTER

TOWN NEWS

GRASSROOTS

ARIZONA RAINBOW NEWS

NEED A RIDE?

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, 520-260-6620
- Janick Artiola, jartiola@cals.arizona.edu, 520-621-3516

Sample Drop-Off Concerns or Questions:
- Jeff Schalaus, 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:



Back



Gardenroots Instructional Manual

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 the 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 you 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.
2. 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

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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 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 Schabau, 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, 13811 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](#)



The Science Behind Gardenroots
The University of Arizona, Saturday November 12, 2011

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:
Melissa Bland via Facebook, Email: melissabland@u.arizona.edu, Phone: 520.286.6610

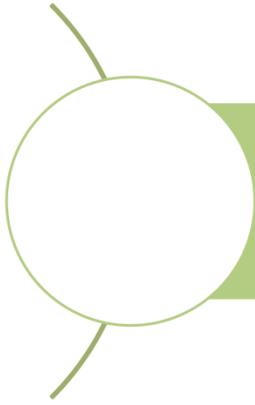
Results for Lunch

Your Soil, Water and Vegetables Outcomes

gardenroots
The Dewey-Humboldt, Arizona Garden Project

Saturday January 28, 2012
11:00AM to 2:00PM

Dewey-Humboldt Town Library
2735 S Corral Street

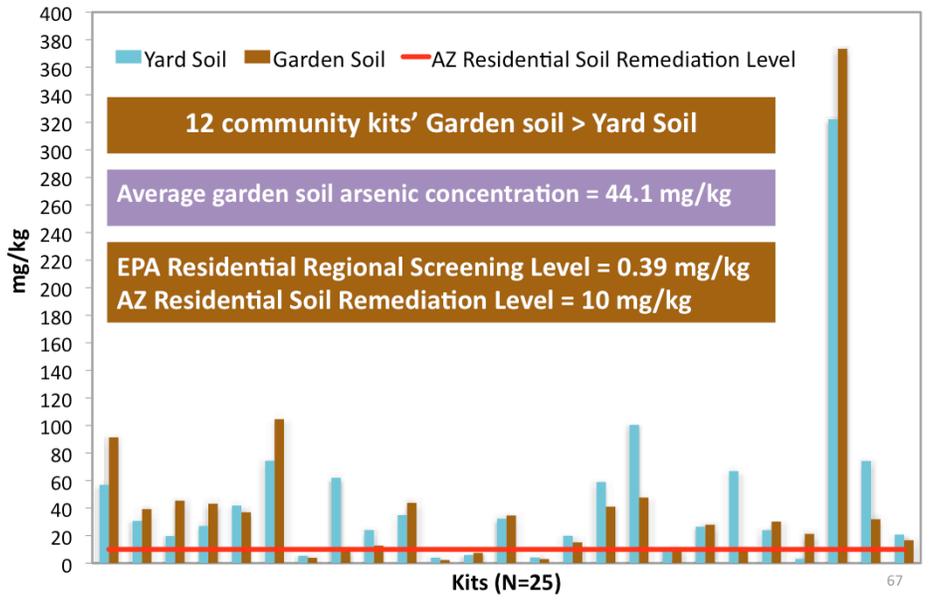


Results



66

Community Results: Arsenic Concentrations in Community Yard and Garden Soils



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

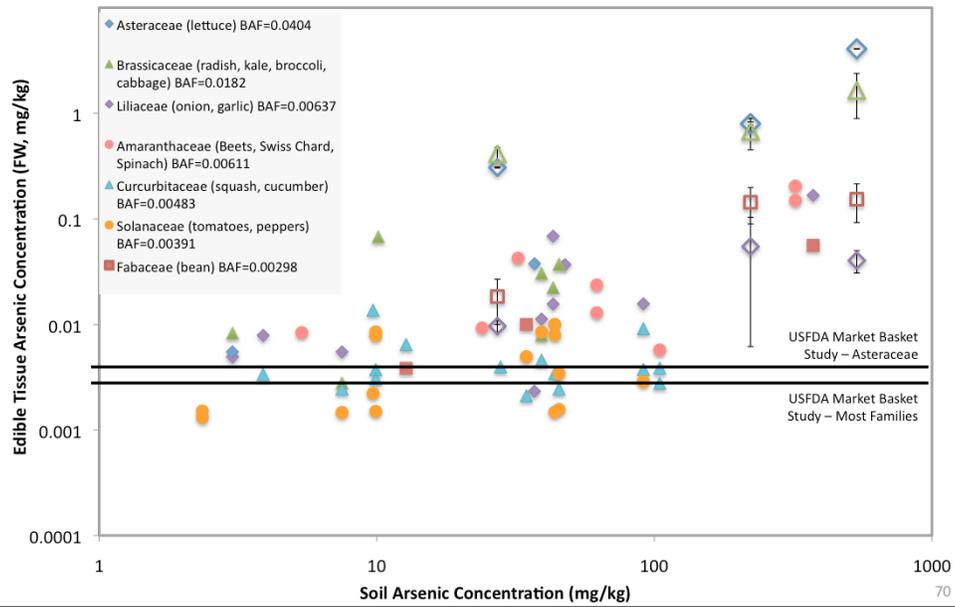


Outcomes: Total Number of Vegetables Analyzed
(Greenhouse and Community)

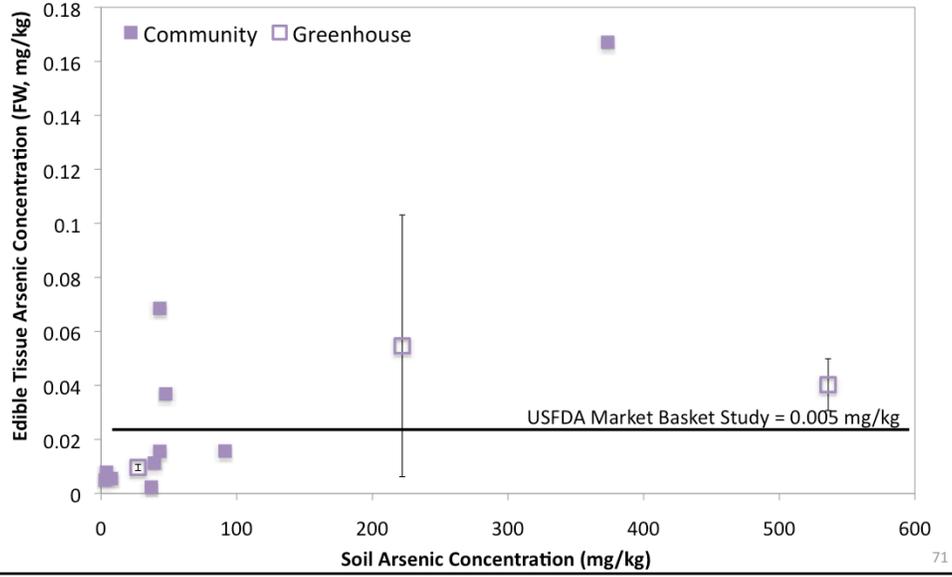
Family	# of Samples
Asteraceae (lettuce)	14
Fabaceae (bean)	15
Brassicaceae (radish, kale, broccoli, cabbage)	19
Liliaceae (onion, garlic)	22
Solanaceae (tomatoes, peppers)	15
Curcubitaceae (squash, cucumber)	15
Amaranthaceae (beets, swiss chard, spinach)	8
Total	108

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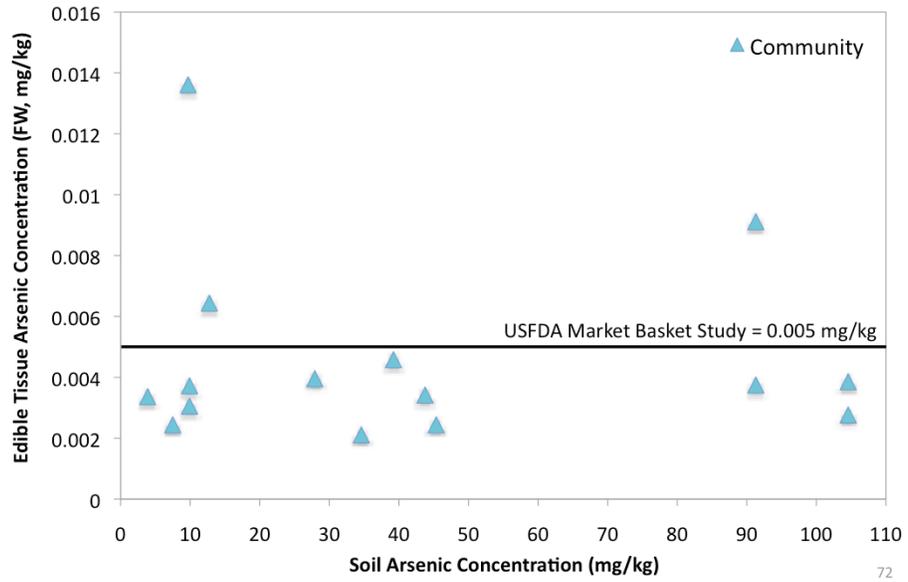
Results: Arsenic Concentrations in Greenhouse and Community Vegetables

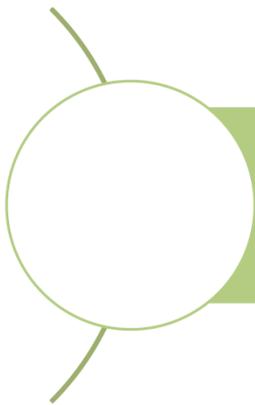


Arsenic Concentration in Liliaceae Samples (FW, mg/kg)

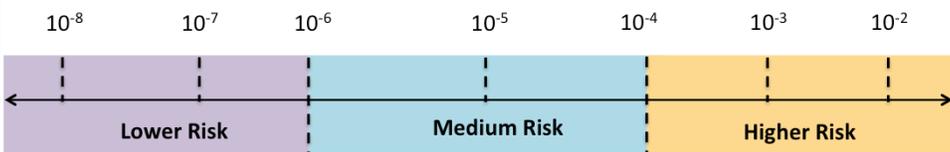


Arsenic Concentration in Cucurbitaceae Samples (FW, mg/kg)

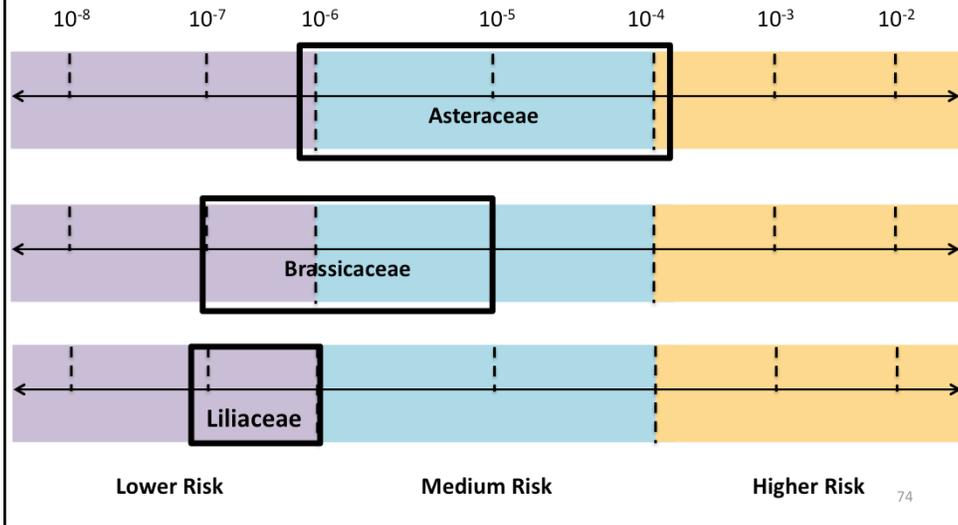




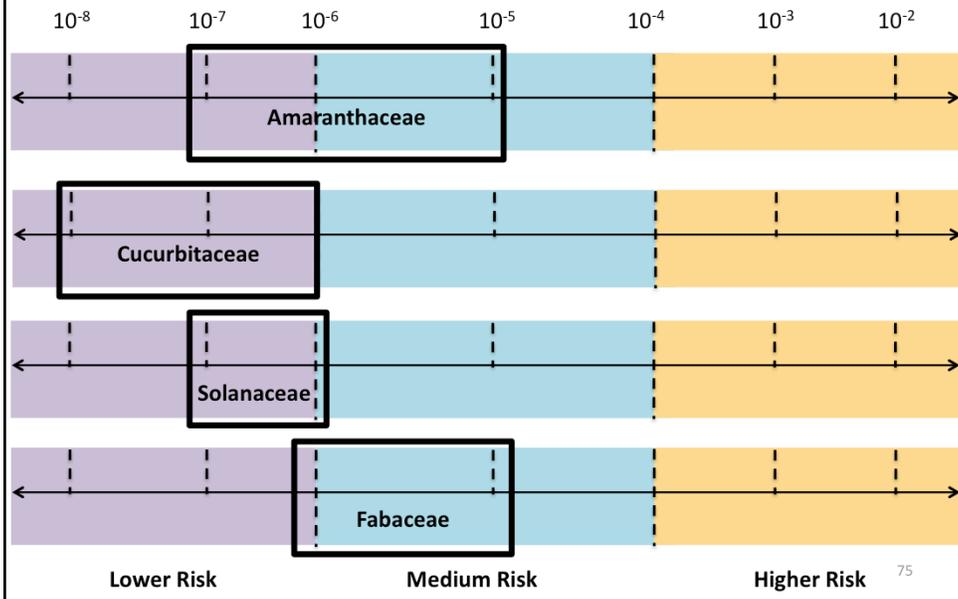
Risk Characterization



Incremental Excess Lifetime Cancer Risk Range for Vegetable Families



Incremental Excess Lifetime Cancer Risk Range for Vegetable Families

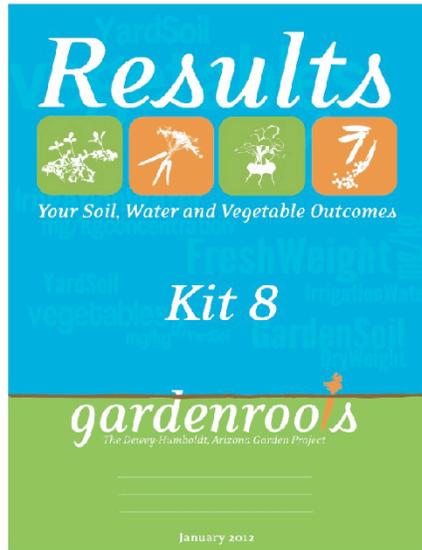




Delivering results and risk communication



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

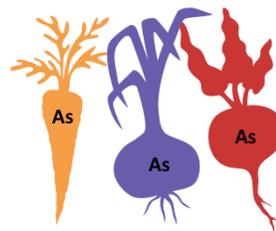
Target Risk



1/1,000,000

1/100,000

1/10,000



Dartboard Image Source: http://hartkysocial.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?



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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

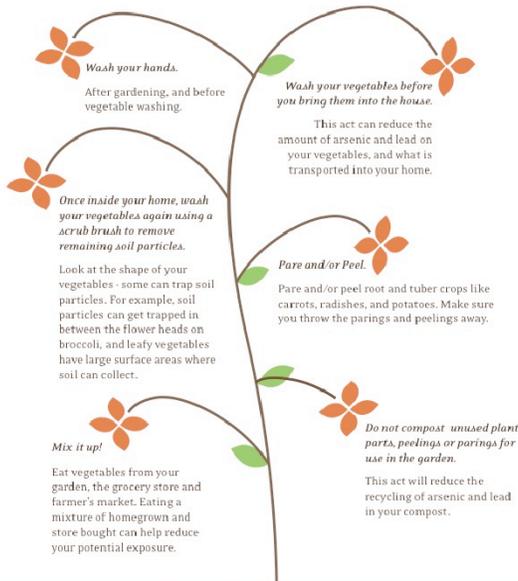
Location	Target Risk 1/1,000,000	Target Risk 1/100,000	Target Risk 1/10,000	USDA Recommended Amount (cups/week)
Onion				
Your Garden	3/4	7	70	4 cups/week total of "Other Vegetables"
Lettuce				
Your Garden	1-1/2	15	150	3 cups/week total of "Raw Leafy Dark Green Vegetables"
Tomato				
Your Garden	1/2	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:

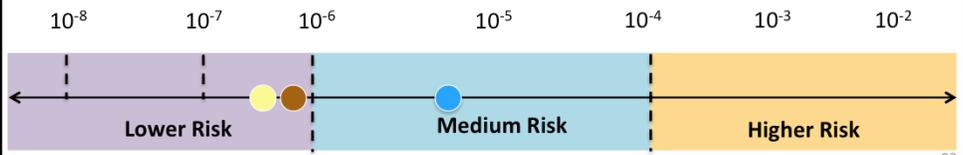
Recommended Practices for Safe Consumption of Homegrown Vegetables



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

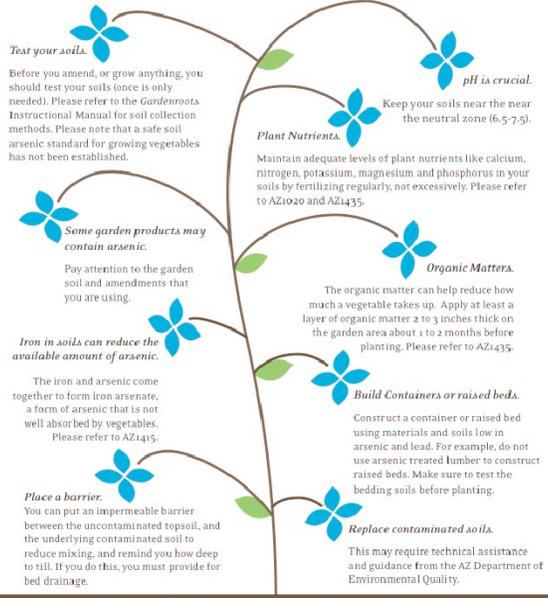
Risk Characterization for Arsenic: Cancer				Legend Yard Soil Garden Soil Irrigation Water
Incremental Excess Lifetime Cancer Risk	Yard Soil 15 out of 1,000,000	Garden Soil 9 out of 1,000,000	Scenario: Accidental soil ingestion while gardening	
Risk Characterization for Arsenic: Cancer				
Incremental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



Handout:

Recommended Practices for Garden Preparation

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



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**

Windy Days = No Gardening.
Avoid gardening on windy days.

Cover Up.
Consider wearing a mask in dusty environments.

Stay Clean.
Wash your hands and all exposed body surfaces after gardening.

Avoid eating and drinking while you garden.
Soils and dust might get on your food or in your drink, and you could accidentally swallow it.

Leave your shoes outside.
Remove your shoes right before enter your home to avoid tracking soil into your home.

Keep soils moist while gardening to control dust.
This will limit the amount of dust you inhale.

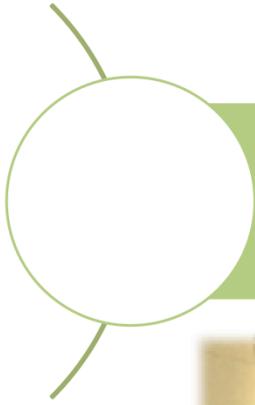
Home Care
Mop floors with a damp mop, and wipe down surfaces in your home regularly.
Change your vacuum bag more often, or upgrade your vacuum to one that has a High-Efficiency Particulate Air (HEPA) filter.

Designate certain clothes and shoes for gardening use only, and store them outside.
Keep your gardening clothes and shoes outside, or in a plastic bag outside. Try your best to keep your gardening clothes and shoes out of your home.

Gardening Tools
Wash, and then store all your gardening tools outside.

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

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Gardenroots' Impacts

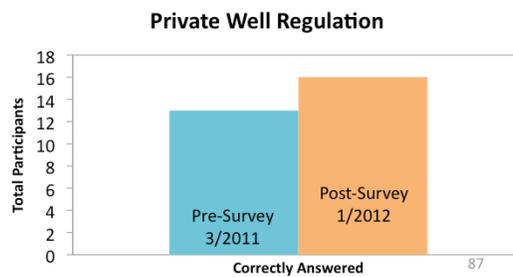
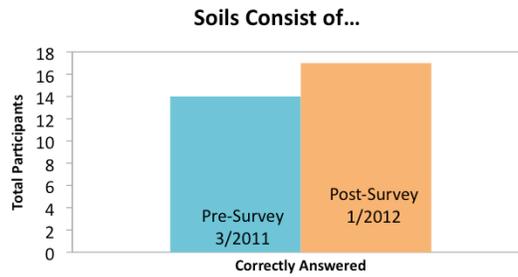


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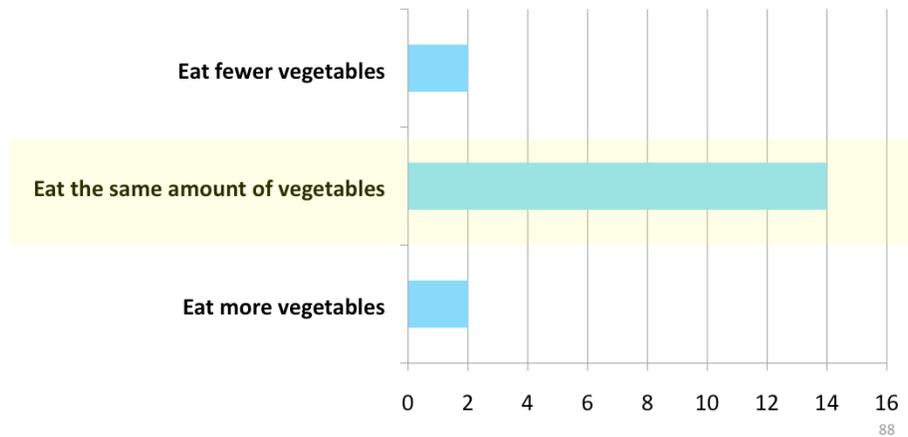
Selected Impacts: Pre/Post Survey

- **Science Questions**

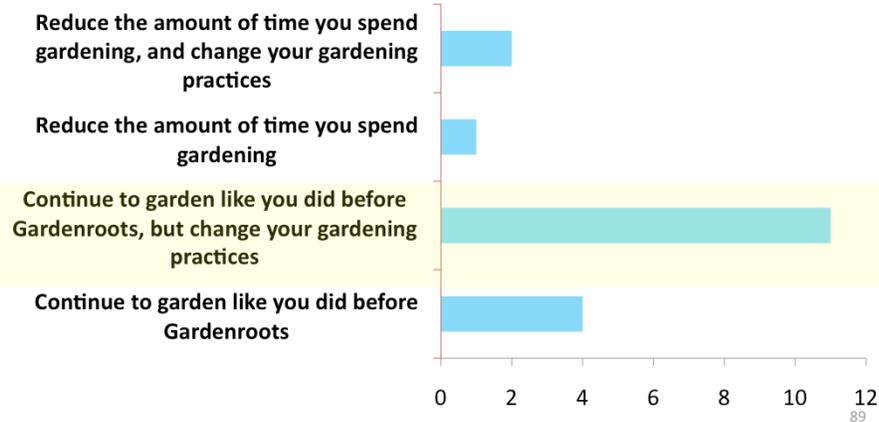
- There was an increase in the number of correct answers given for 8/14 questions



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



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

The screenshot shows the EPA Technology Innovation Program feedback form. The form is titled "U.S. EPA Technical Support Project Engineering Forum (Green Assessment: Opening the Door to Field Use: Session 7 (Green Remediation: Tools and Perspectives) - Scholar Feedback Form)". It includes a "Feedback" section with a "Please take the time to fill out this form before leaving the site." instruction. The form contains several input fields for "First Name", "Last Name", "Phone", "Company / School / Employer", "E-mail Address", and "Event Date". A red box highlights the "E-mail Address" field, which contains the text "Please provide a copy of the feedback to the person at the address of the party order to this address:". An arrow points from the text "Fill out the feedback form and check box for confirmation email." to the "E-mail Address" field.

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



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