ELA Conference 2013: Phytoremediation: Selected Plants for Urban Restoration

Cost-effective, natural cleanup methods can be an effective strategy in mitigating on-site pollutants. Recent scientific studies on phytoremediation, the ability of plants to uptake and remove contaminates, will be presented, including advantages and limitations of plant-based cleanup. This session will also explore phytoforensics, a new set of techniques that uses data from plants to track subsurface contaminates.

Learning Objectives:

- Increase understanding of phytoremediation applications, including current scientific case studies
- Learn about phytoforensics, a newly developing set of techniques where data gathered from trees is utilized to pinpoint subsurface contaminates
- Understand horticultural limitations of phytotechnologies, and implications for future integration in design and planning

Resources:

- Rock, Steven. 2010. EPA Phytotechnologies Fact Sheets, Office of Superfund Remediation and Technology Innovation. http://www.epa.gov/tio/download/remed/phytotechnologies-factsheet.pdf
- Interstate Technology Regulatory Council. February 2009. Phytotechnology Technical and Regulatory Guidance and Decision Trees, Revised http://www.itrcweb.org/Documents/PHYTO-3.pdf
- EPA Technology Innovation Program, Contaminated Site Clean-up Information (Website for Project & Contaminate Searches) http://www.clu-in.org/

Presenter Bio & Contact Information:

Kate Kennen, principal of Offshoots, Inc. is a registered Landscape Architect based in Boston. Having spent her childhood at her family's garden center in central Massachusetts, Kate is well versed in the plants of the Northeast. She earned her undergraduate degree from Cornell University and Master's Degree in Landscape Architecture from Harvard University Graduate School of Design with distinction. Kate currently teaches a research seminar on phytotechnologies with Niall Kirkwood at the Harvard GSD. Their forthcoming book, *Phyto for Landscape Design* will be published in Fall 2014.

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Presentation Outline:

I. **Introduction:** Understanding Phytoremediation and Phytotechnologies
- A. What are Phytotechnologies?
  - 1. Definition
  - 2. Phytotechnologies vs Phytoremediation
- B. Location of Contaminates: Land, Air, Water. This presentation focuses on land and groundwater based contamination.
- C. The Extent of Brownfields
  - 1. 450,000 – 600,000 in US Alone
  - 2. Underground Storage Tanks, Department of Energy Sites, Department of Defense Sites
- D. Advantages vs Disadvantages & Short History of Phytotechnologies
  - 1. Cost Advantages & Extent of Remediation Market
  - 2. Discovery of Hyperaccumulators: Mining- Indicator Plants
  - 3. The Phytoremediation Boom and Bust of the 90s
  - 4. Where We are Today: International Phytotechnologies Society leading the science with guidance from EPA (Steve Rock)
- E. Introduction to Contaminates: Organic vs InOrganic Contaminates- What is the difference?

II. **Organic Contaminates:** The following contaminates will be reviewed, and scientific research case studies presented illustrating successes and failures of plant based cleanup
- *A. Petroleum*
  - 1. Genk, Belgium, Ford Manufacturing Plant (Scientist: Jaco Vansgroveld, Hasselt University): Groundwater plumes with petroleum contamination remediated with poplars and willows within 5 years
  - 2. Elizabeth City, North Carolina, US Coast Guard Fuel Farm (Scientist: Dr. Elizabeth Nichols and Dr. Rachel Cook, NC State University Deptartment of Forestry & Environmental Resources) Groundwater contamination contained and buffered from river with poplar, willow and pine planting.
- *B. Chlorinated Solvents*
  - 1. Using Phreatophytes to Tap Groundwater
  - 2. Summary of Research from Missouri S&T
- *C. Military Contaminates: Explosives*
  - 1. Summary of Research from Mike Reynolds, US Army Cold Weather Research Lab, NH. Tall Grass Species mitigating hydrocarbons, Promising us of poplars for TNT & RDX
- *D. POPs (Persistant Organice Pollutants)*
  - 1. Summary of Research from Dr. Jason White, CT Agriculture Experiment Station and President of International Phytotechnologies Society

III. **Inorganic Contaminates:** The following contaminates will be reviewed, and scientific research case studies presented illustrating successes and failures of plant based cleanup
- A. Metals: An Introduction
  - 1. Why so hard to remediate? Bioavailability.
  - 2. What are hyperaccumulators?
  - 3. Specific Metals
    - a) Metals: Cadmium
      - (1) Where does the contamination typically come from?
      - (2) Research: Hasselt University, Belgium

b) Metals: Nickel Mining
   (1) Extraction and burning
   (2) Dr. Scott Angler & Dr. Rufus Chaney, USDA
c) Metals: Arsenic
   (1) Where does the contamination typically come from?
   (2) Promising plant remediators: Dr. Om Pakarash, University of Massachusetts & Edenspace, Dr. Michael Blayloc, Chinese Brake Fern Research
d) Metals: Lead
   (1) Where does the contamination typically come from?
   (2) The misunderstood Sunflower & the Trenton, NJ Case Study
   (3) The Truth about Lead: Kansas State Research: Phytostabilization and making lead inaccessible via soil amending

B. Nutrients
1. Leachate: Nitrogen mitigation- Oregon Landfills: Biomass Production via plants, Work at CH2MHill, Portland, Oregon
2. Septic Outflow- Portland Oregon, CH2MHill

IV. **PhytoForensics**: Introduction, Research by Dr. Joel Burken, Missouri S&T

A. Using Plants to track sub surface contaminate plumes of Organic Contaminates. This tree coring technology is much less expensive and much more accurate than traditional boring and monitoring wells.

1. Process- Tree Core Sampling- How it is completed
2. Case Study Examples

B. Compounds that have been verified to date include a wide range of chlorinated solvents, explosive compounds RDX and HMX, BTEX contaminants, and PAH compounds.

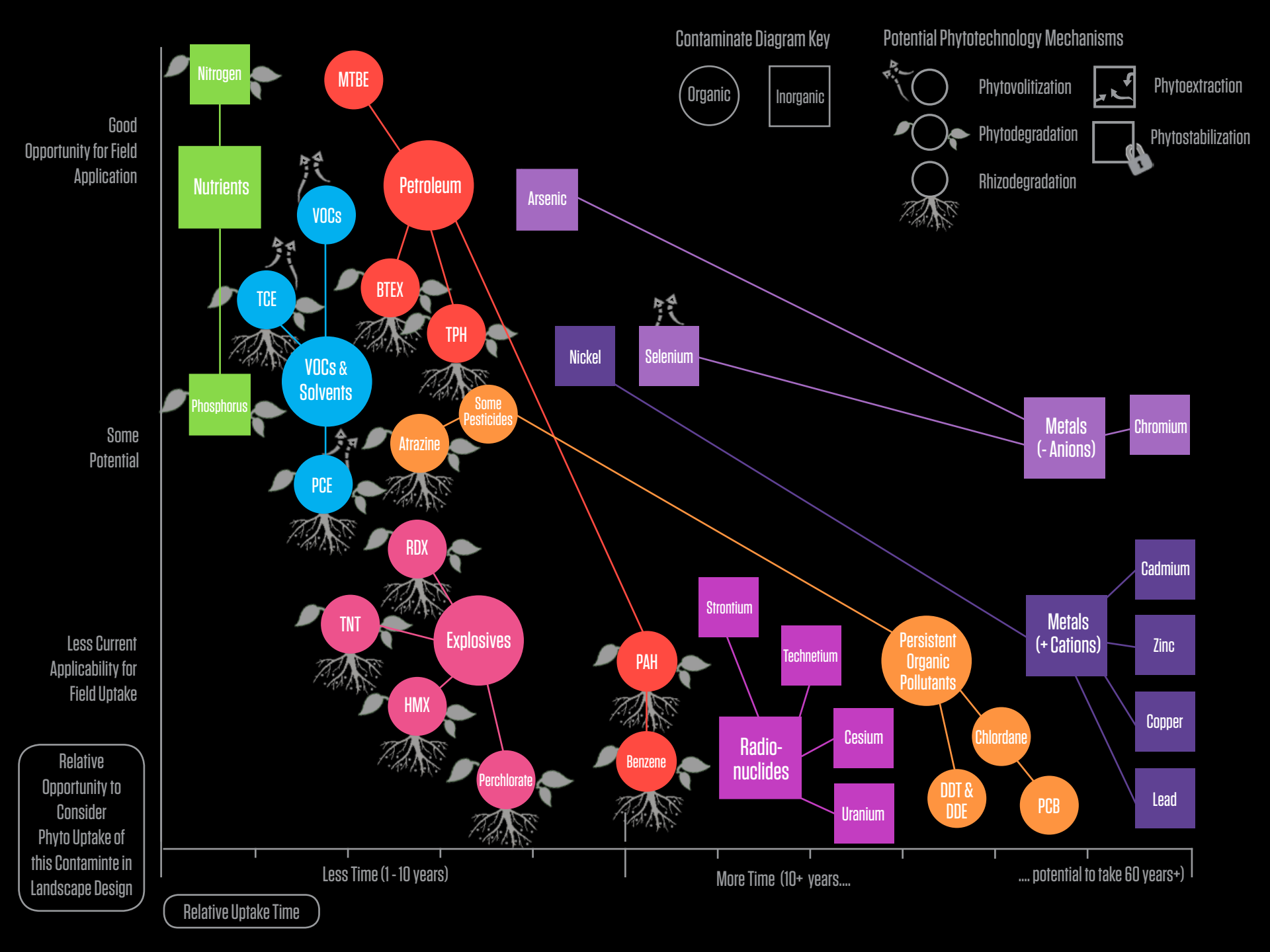
C. Recent breakthroughs in the field of phytoforensics
1. Directional analysis from a single tree
2. Advances in solid phase sampler development
3. Real time/in-field GCMS analysis
4. Long term monitoring advances

V. **The Future of Phyto:** Integration in design and landscape practice

A. Case Studies of phytotechnology principal integration into design concepts
1. Former Gas Station: Plantworks, 725 Main Street, Hyannis MA
2. Other Projects

B. Summary of work being completed at Harvard University, GSD. Suggestions for integration of pytotechnologies into the landscape installation profession.

C. List of Resources for Further Research


Contaminate Diagram Key
Organic
Inorganic
Potential Phytotechnology Mechanisms
Phytovolitization
Phytoextraction
Phytodegradation
Phytostabilization
Rhizodegradation
Good Opportunity for Field Application
Some Potential
Less Current Applicability for Field Uptake
Relative Opportunity to Consider Phyto Uptake of this Contaminte in Landscape Design
Nitrogen
Nutrients
Phosphorus
MTBE
Petroleum
VOCs
BTEX
TCE
TPH
VOCs & Solvents
PCE
Some Pesticides
Atrazine
RDX
TNT
Explosives
HMX
Perchlorate
Arsenic
Nickel
Selenium
Metals (- Anions)
Chromium
PAH
Benzene
Strontium
Technetium
Radio-nuclides
Cesium
Uranium
Persistent Organic Pollutants
Chlordane
DDT & DDE
PCB
Metals (+ Cations)
Cadmium
Zinc
Copper
Lead
Less Time (1 - 10 years)
More Time (10+ years....
.... potential to take 60 years+)
Relative Uptake Time