PLANTS Can Help the **Soil** and Save our Watersheds

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&

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But shouldn't the soil be helping the plants?

Of course! But now more than ever the dirt (and in turn the whole natural system) could use a helping hand.

Contaminants agriculture, industry, and private consumption have leached into our ground systems:

mercury arsenic CRUDE OIL PCBs

hydrocarbons CADMIUM URANIUM

strontium benzene aluminum LEAD

gasoline *chromium* ***phosphorus***

So what about that earth there?

We've been puttin' them toxins in for a good long while….

Hyperaccumulators

*Plants that can slow and/or *reverse* the negative human impact on the ecosystem

*Over 400 types of plants are known to accumulate toxins

*Not only can these plants live in soil that would be toxic to most other plants, but many thrive in it

*The EPA estimates 40,000 U.S contaminated sites where *bioremediators* could restore the environment

Phytoremediation

Use of specially selected green plants to remove contaminants from the water & soil

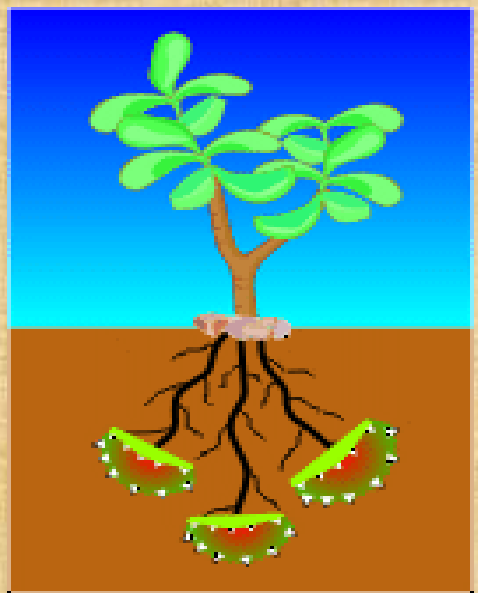
How the plants do it:

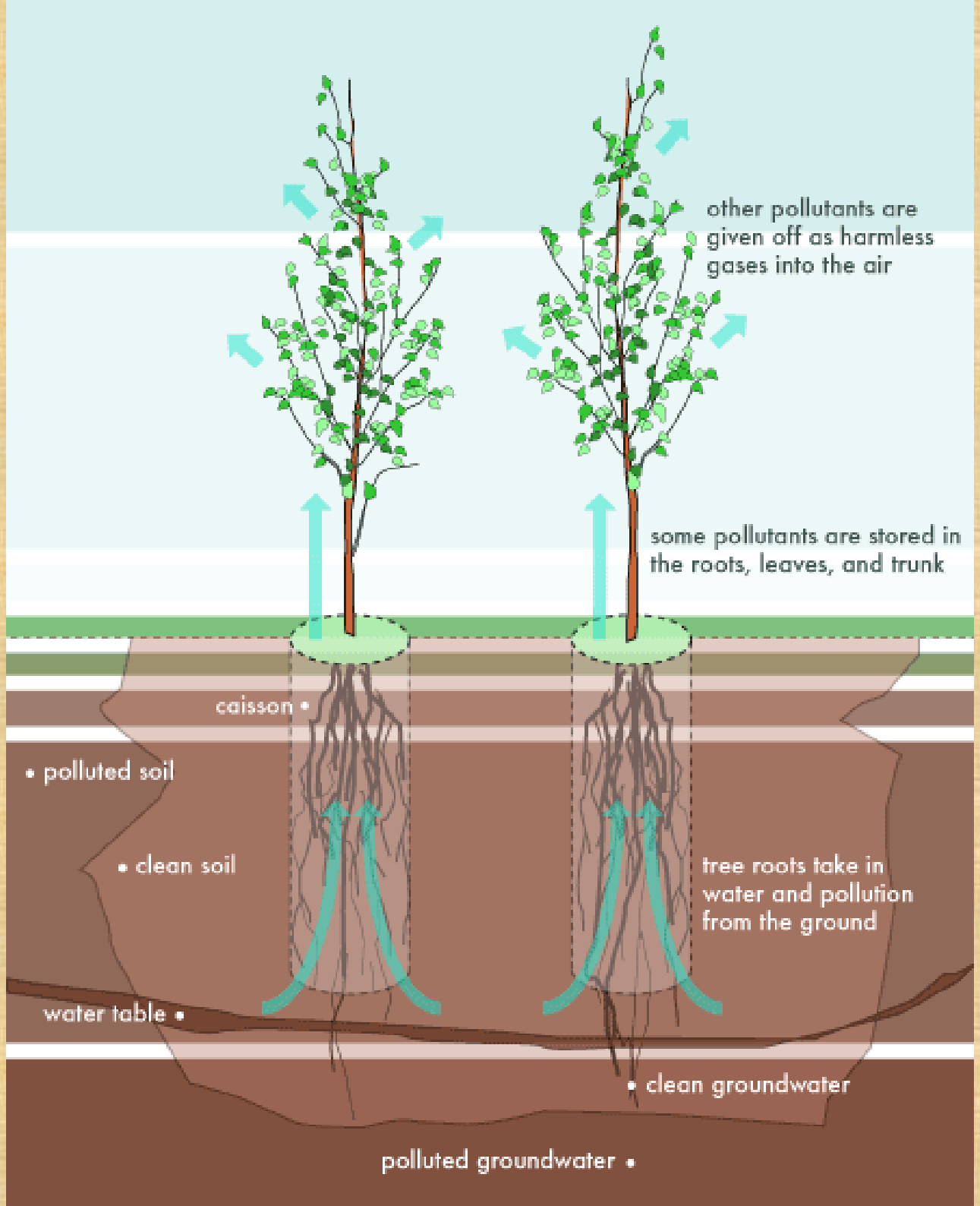
1. Store chemicals in their roots, stems and leaves.

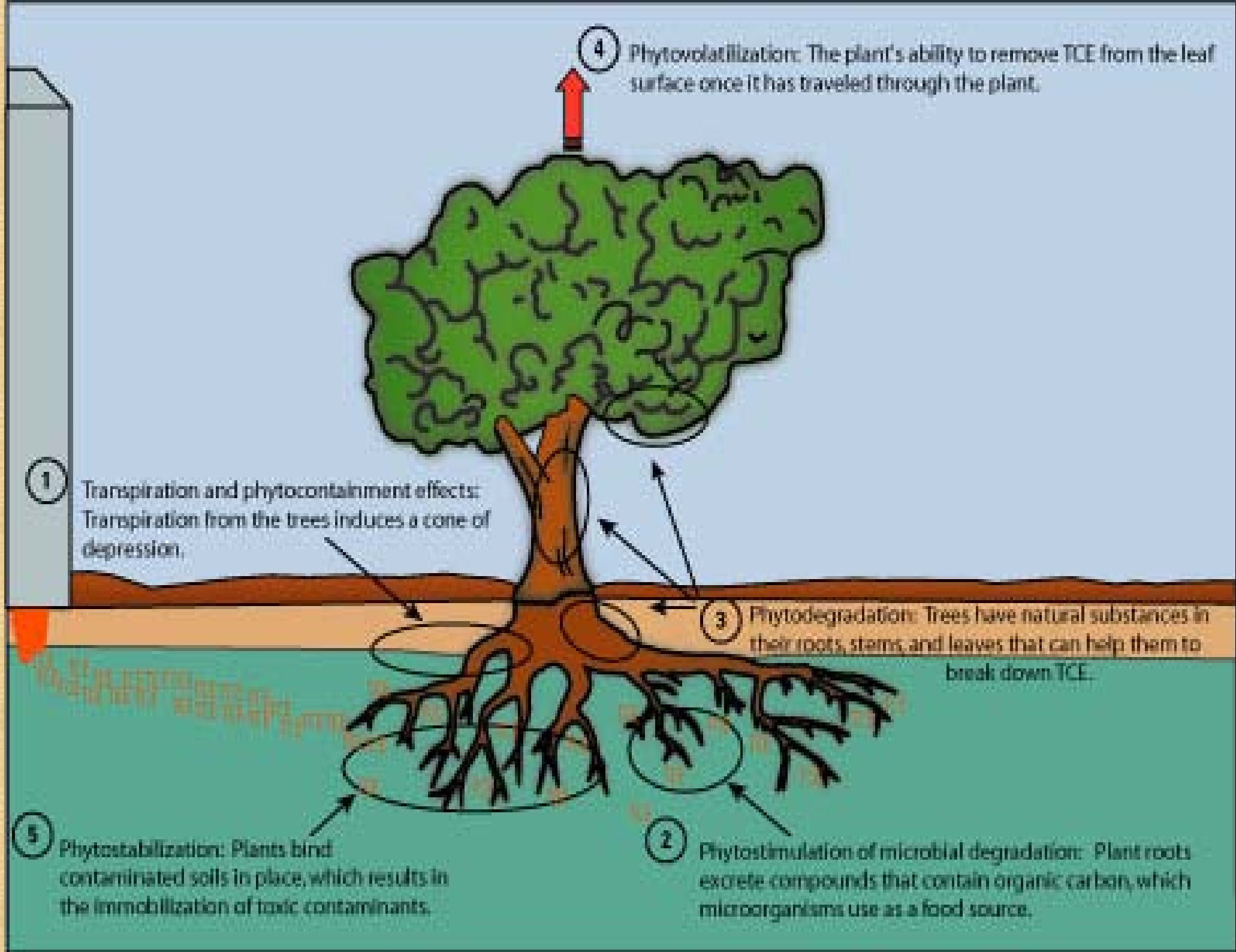
2. Transform the toxins into less harmful ones.

3. Change toxins into gases, which are exhaled and reduced to harmless trace amounts when combined with the air.

Letting nature clean up our slip-up




other pollutants are given off as harmless gases into the air
some pollutants are stored in the roots, leaves, and trunk
caisson
polluted soil
clean soil
tree roots take in water and pollution from the ground
water table
clean groundwater
polluted groundwater


4 Phytovolatilization: The plant's ability to remove TCE from the leaf surface once it has traveled through the plant.
1 Transpiration and phytocontainment effects: Transpiration from the trees induces a cone of depression.
3 Phytodegradation: Trees have natural substances in their roots, stems, and leaves that can help them to break down TCE.
5 Phytostabilization: Plants bind contaminated soils in place, which results in the immobilization of toxic contaminants.
2 Phytostimulation of microbial degradation: Plant roots excrete compounds that contain organic carbon, which microorganisms use as a food source.

Common phytoremediators:

Members of the mustard family
Pigweed
Cabbage
Poplars
Sunflowers
Duckweed
Juniper
Fescue
Grasses
Alfalfa
Pine
Dogwood
Corn

Some organisms are just good at what they do.

Reishis have long been revered in Asia as the "supernatural mushrooms". For over 2000 years they have been used in Traditional Chinese medicine as Detoxifiers of the human body.

Lingzhi, or Reishi mushrooms
(*Ganoderma lucidum*)

Oyster Mushrooms
(*Pleurotus ostreatus*)

Oyster mushrooms naturally detox the earth of petroleum and PCBs

You got any research on that?

Mel Chin

Revival Field

Chin's project attempted to detoxify a 60 square foot section of the Pig's Eye landfill in St. Paul, Minnesota

Functional design
Intersecting paths create four fields & each were tested separately

- six types of plants
- two pH
- two fertilizer tests

Control plot of local grasses.

Project conclusion

Research showed that Alpine pennycress was the best at leeching heavy metals, although no plants were effective enough at cleaning up the land.

Revival Field, Mel Chin (1990-present)

Pig's Eye Landfill, St. Paul, Minnesota

Taking on Blue Mountain

Zinc Pile Located on Blue Mt. in Palmerton, Pennsylvania

1898 – 1981; it was a site for major zinc smelting operations

2.5 miles; 255 acres; 33 million tons of waste material had been left behind

850 acres were re-vegetated at Blue Mountain. Ten years later the site has retained more than 70 percent of its vegetative cover

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Blue Mountain Zinc Pile

Contaminant	Initial Concentration	Media
Cadmium	364-1,300 ppm	Soil
Cadmium	250 ppm	Sediment
Cadmium	1-1,670 ppm	Ground Water
Lead	1,200-6,475 ppm	Soil
Lead	3,600 ppm	Sediment
Lead	1-1,630 ppm	Ground Water
Zinc	13,000-35,000 ppm	Soil
Zinc	27,000 ppm	Sediment
Zinc	40-2,122,00 ppm	Ground Water

Alpine Pennycress

Most plants can tolerate about 100 ppm of zinc in their systems and 1 ppm of cadmium, and would be poisoned with as little as 1,000 ppm zinc and 20-50 ppm cadmium in their shoots

According to the USDA, Pennycress can accumulate up to 30,000 ppm zinc and1,500 ppm cadmium

Chernobyl

Iodine, cesium-137, strontium, and plutonium--concentrated in the soil, plants, and animals within a 30 km radius of the disaster site

EPA estimates it could be over 200 years before the site is completely decommissioned

Experimental sunflower plantation in Silesia, Poland. Heavy metals are directly applied on the top soil by dispenser designed at the Institute for Ecology of Industrial Areas - Kotowice, Poland. (Photo: IETU)

Bring it to the classroom!

Sunflowers are an easily recognizable and beautiful plant. Since they are often planted in gardens, and in yards, sunflowers are a good introduction for students

Sunflowers specialize in absorbing heavy metals from the soil (up to 1% of their dry weight)

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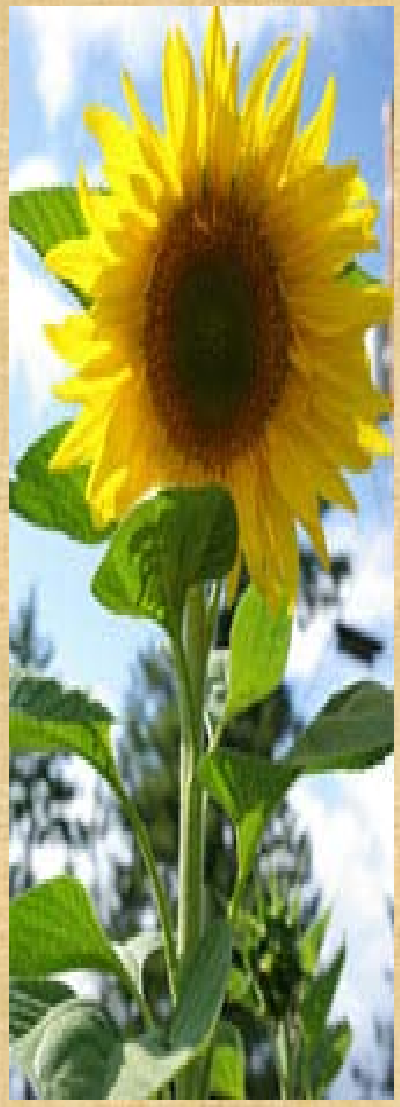
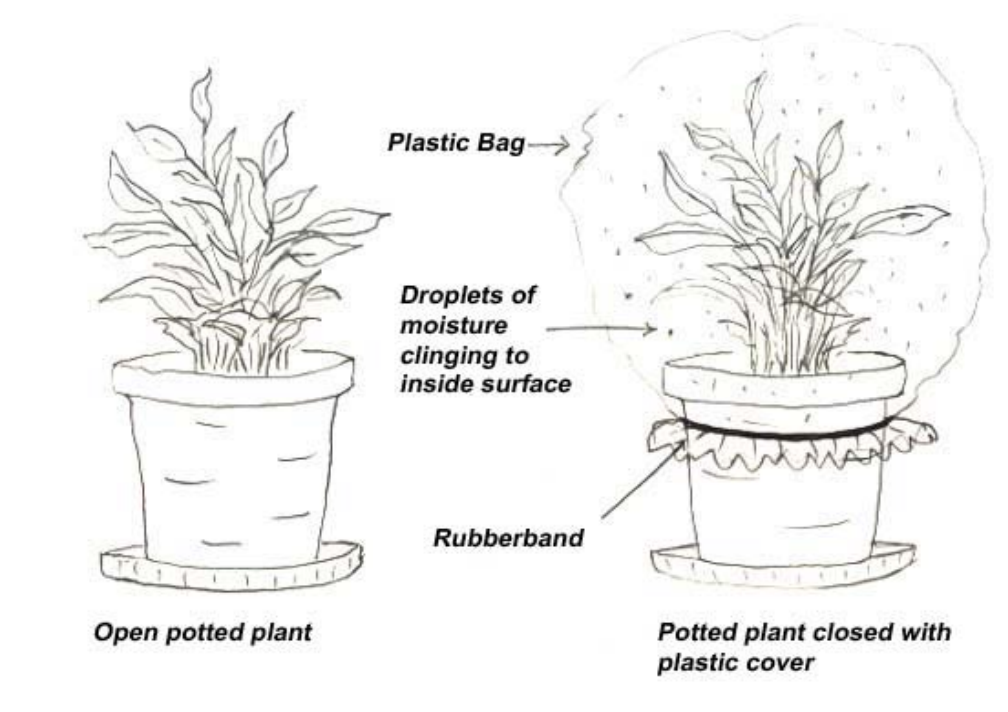
Ideal for planting near the edges of parking lots to absorb run off!



Plant Transpiration



Evidence that the plant is breathing

Achieving Success

Effecting Factors

- Species and number of plants used
- Type and amount of harmful chemicals present
- Size and depth of polluted area
- Type of soil and conditions present

Plants may have to be replaced because of bad weather or animal interference

It can take anywhere from three to ten growing seasons to get results

Phytoremediation is most effective when the contamination is located at or just below the soil surface.

New England projects

What's working here---are plants being used to remove chemical waste? Why/why not?

Woonsaquatucket river restoration project (buffer)

New Bedford waste site----factory? *Brownfield*

ReSouRcEs

Reclaiming the Spoils of Mining, L.A. Times

Phytoremediation: A new hope,

Plants, a good way to clean up soil toxins, Jeanne Roberts
http://www.celsias.com/article/plants-a-good-way-to-clean-up-soil-toxins/

http://www.epa.gov/aml/tech/palmerton.pdf

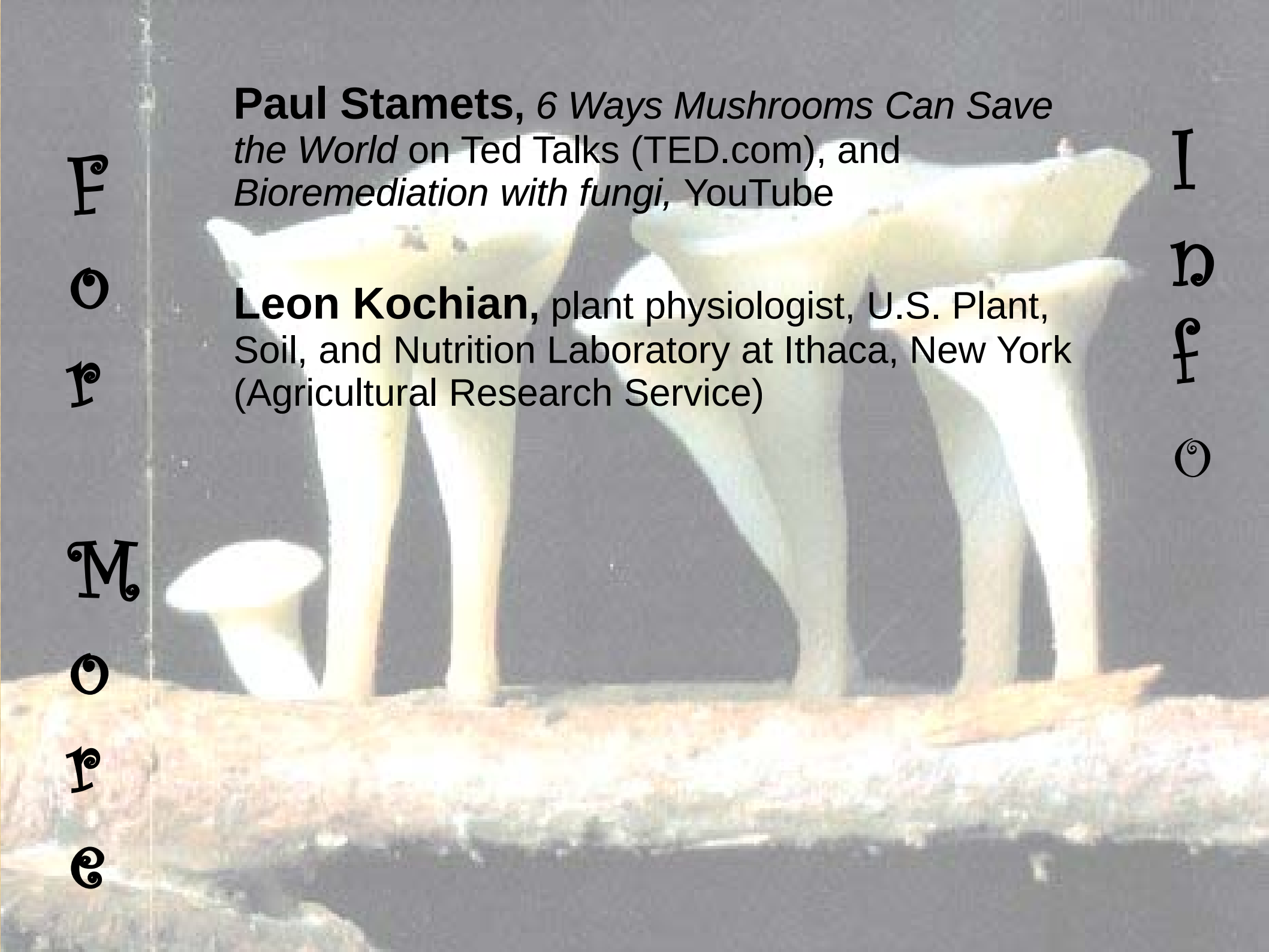
Cleaning up the soil and water, Food & Fertilizer Technology Center
http://www.agnet.org/library/nc/136c/

Phytoremediation: a solution to safer decontamination?
Anindita Nayak; http://climatechange.thinkaboutit.eu/think4/post/phytoremediation_a_solution_to_safer_decontamination

Phytoremediation: Using Plants To Clean Up Soils, USDA
http://www.ars.usda.gov/is/AR/archive/jun00/soil0600.htm

Phytoremediation:Using Plants To Clean Soil, McGraw Hill
http://www.mhhe.com/biosci/pae/botany/botany_map/articles/article_10.html

http://www.epa.gov/athens/education/PhytoLessonPlan/learnp_05.html



For More Info

Paul Stamets, *6 Ways Mushrooms Can Save the World* on Ted Talks (TED.com), and *Bioremediation with fungi,* YouTube

Leon Kochian, plant physiologist, U.S. Plant, Soil, and Nutrition Laboratory at Ithaca, New York (Agricultural Research Service)