**Things I learned from Kristin Ohlson’s *The Soil Will Save Us*:**

p. 3

plowing actually damages the soil structure and exposes soil carbon…to the air, where it combines with oxygen and floats away as carbon dioxide

p. 4

“An earthworm can drag a leaf down more than three feet into the soil.”

Rattan Lal, director of Ohio State University’s

Carbon Management and Sequestration Center

p. 12

As soon as humans segued from a hunter-gatherer lifestyle to an agricultural one, they began to alter the natural balance of carbon dioxide in the soil and the atmosphere.

p. 14

Healthy soil is rich with tiny organisms—an amazing 6 billion in a tablespoon—than can disarm toxins and pollutants that soak into the soil through the rain.

p. 15

land misuse accounts for 30 percent of the carbon emissions entering the atmosphere

pp. 16-17

even people with backyards have to make sure plants are growing vigorously, without large stretches of bare earth—photosynthesis can’t happen on bare earth. We have to take care of the billions of microbes and fungi that interact with the plants’ roots and turn carbon sugars into carbon-rich humus. And we have to protect that humus from erosion by wind, rain, unwise development, and other disturbances.

p. 17

When good land management practices create a ton of carbon in the soil, that represents slightly more than 3 tons of carbon dioxide removed from the atmosphere.

*Possibility for 3 billion tons of carbon to be sequestered annually in the world’s soils.*

p. 18

agrarian renaissance

p. 19

“future-friendly farming”

p. 27

*plants’ leaves as Earth’s first solar panels,* as the green chlorophylls absorbed light from the highly energetic blue and red wavelengths of sunlight.

p. 28

plants leak. And in doing so, they support another world entirely: The world under our feet; the dark kingdom of which we’re astoundingly unaware; the down under that may account for up to 95 percent of our planet’s species diversity. This is the world of soil microorganisms. Dig up a teaspoonful of healthy soil from your garden or from a city park or from the weedy strip alongside a highway, and you’re looking at something like 1 billion to 7 billion organisms, depending on the health of the soil. Scientists guess that as many as 75,000 species of bacteria could be in that teaspoon, along with 25,000 species of fungi 1,000 species of protozoa, and 100 species of tiny worms called nematodes—and the count of microorganisms keeps rising, as scientists figure out better and better ways to look for them.

pp. 30-31

plants and soil microorganisms have developed a sophisticated trading / network over the millennia by which plants shunt up to 40 percent of their carbon sugars to their roots and microorganisms pay for these goodies by delivering a mix of minerals to the door like pizza deliverymen….Australian ecologist Christine Jones calls this symbiosis “the very first carbon-trading scheme.”

p. 31

mycorrhizal fungi range far and wide and can connect whole communities of plants with nutrients.

p. 35

the microbial underworld

it take a village to nurture a plant….when you look at a healthy plant you’re seeing the productive output of a busy village down around the roots, making sure it gets everything it needs.

p. 36

it’s alive down there. Plant roots can plunge as far as 200 feet. Even some of the grasses that we grow in our parks and on our lawns, if they’re healthy, have roots that can descend 15 feet—and every millimeter of those roots is thrumming with microogasmic bustle. Microorganisms themselves have been found as far as 10 miles down in the soil. Oil companies have to be careful not to contaminate deep pockets of oil with these organisms, because they will happily feed on the oil.

p. 36

five main categories of soil microorganisms:

fungi, bacteria, mobile one-celled organisms called protozoa, tiny worms called nematodes, and microarthropods

pp. 36-37

Gathered nearest the plant roots are the fungi and / bacteria, both of which line up like pigs at a trough to get their carbon sugars.

p. 37

Both fungi and bacteria secrete enzymes that liberate minerals from the clay, silt, and sand, as well as from stones and actual bedrock.

p. 40

the soil

***The Soil Will Save Us*, by Kristin Ohlson**

Chapter 8

Heroes of the Underground

[Urban Potential]

p. 219

We often have the idea that cities are dead zones—concrete jungles—where the only life is that of us humans, moving through our various intersecting orbits, along with the rats, pigeons, and cockroaches that flourish in our presence. But cities are also teeming with life. Microbial ecologist Peter Groffman of the Cary Institute of Ecosystem Studies in Millbrook, New York, says that only 20 percent of the urban landscape is truly impervious. The other 80 percent is natural or seminatural. “There are really a lot of plants in urban areas, a lot of animals, and a lot of ecological function,” explained Groffman, who since 1998 has been studying soil and water in Baltimore, one of 26 long-term ecological research sites funded by the National Science Foundation. “There is a lot of soil functioning in urban areas”—the buildup of carbon, impeding nitrogen and phosphorus from washing away—“and to me, that’s a really positive message.”

p. 221

taking a serious look at ecological function in cities…that previously unrecognized 80 percent. “People manage these areas,” he [Groffman] said. “We live and work there. If we learn how they function, then we can improve or alter that capacity to reach certain goals, whether it’s carbon storage to regulate the climate or absorbing water. It’s a great opportunity to use our understanding to achieve specific goals.”

p. 222

respecting the ancient synergy between plants and soil organisms.

p. 221

Eric T. Fleisher, director of horticulture at New York’s Battery Park City Parks Conservancy

p. 224

ecosystem services that come from trees

 cool cities in the summer

 warm them in the winter

 filter pollutants from the air

 and they’re beautiful

pp. 224-225

Groffman’s research in Baltimore has led him to some startling conclusions. “We assumed lawns were going to be biological deserts,” he told me. “They’re not. We’re taking / core samples down to a meter and we’re finding a lot of natural-looking soil profiles in these lawns, not just compacted fill. A lot of roots, a lot of biology, a lot of carbon, and a better environmental performance than we expected.”

p. 225

With fewer chemicals to turbocharge the performance of some plants and kill others, lawns become more diverse environments, both above and below the soil line. And just as in nature and on well-managed farms and ranches, this diversity supports the ancient and noble partnership of plants working with the biology in the soil. That partnership snatches carbon dioxide from the atmosphere, breaks it down into carbon, and puts the latter to good use.

p. 225

About 80 percent of American homeowners have lawns.

p. 226

Lawns are the largest irrigated crop in America, taking up three times as much space as corn, the next-biggest irrigated crop. What we do with our urban green matters, whether it’s in our yards or our parks or even our highway median strips.

p. 226

Bob Streitmatter, manager of Luthy Botanical Garden in Peoria, Illinois

runs a class teaching homeowners how to transition their own yards to soil health

“When you start making the change, it can be a little more costly,” Streitmatter told me. “But you’re setting up a soil ecosystem for the long haul. Down the road, your costs drop dramatically.”

p. 227

“I tell people that they aren’t going to be hosting the Masters,” Streitmatter said. “There’s no need to put that much water, chemicals, and labor into their lawns. It’s just not necessary.”

Streitmatter’s recommendations:

* *Plant clover in partnership with turf grasses (forego the ideal of a monoculture lawn)*
* *Aim for maximum biodiversity and density in flower beds that feature shrubs, perennials, and bulbs for both spring and fall bloom, with some annuals and biennials wandering through. Tuck some leguminous plants in to add nitrogen.*
* *Plant densely to increase the amount of exudates and protect soil from erosion and carbon loss.*
* *Combine plants as they occur in native plant communities.*
* *Hand pull weeds and heavily mulch large weedy areas with “lasagna” compost*
* *Cut your grass no lower than 2 ½ inches*
* *Sow vegetable seeds in masses, not in rows, so that growing plants cover the bare soil completely.*

pp. 228-229

We can all be heroes of the underground by taking care of the soil around us, patronizing the agriculturalists who take care of theirs, and monitoring the political climate / that affects soil health around the world.

p. 229

We have to pay attention to the farm bill! It’s the single largest manifestation of our nation’s food policy, and it has a huge impact on how our food is grown and how agriculture affects the greater environment, and on who benefits from this enterprise. Will it be consumers and average farmers, or will it be agribusiness?

p. 229-231

New Mexico State University molecular biologist David C. Johnson worked on creating lower-salinity compost. Apparently cow poop is salty. Developed a no-turn method of making compost that left fungi populations undisturbed and able to flourish.

*There are advantages to managing the biology of the soil, as well as its chemistry. A balanced population of fungi and bacteria make plants thrive. Most composts host a predominantly bacterial population.*

“We showed that you can grow more crops faster, better, and with less water on soils where we’ve improved the population of microbes, both fungi and bacteria,” Johnson told me. “The carbon sequestration is the icing on the cake.”

p. 231-232

The NMSU research suggests that the soil really can save us—and faster than anyone expected. In these plots made highly fertile by the interaction between plants and the soil biology, the plants were generously shuttling 72 percent of the carbon they pulled from the air into the soil. Even more amazing, far more of this carbon was staying fixed in the soil compared to land where the soil biology is weak and maltreated. While the researchers expected the / amount of CO2 wafting off the soil—the exhaled breath of the soil biology—to increase as the microorganisms themselves increased, the rate of respiration actually dropped. Meaning, soil carbon storage was accelerating in a nonlinear fashion. Two plus two was adding up to 15 or 20.

p. 232

Weirdly, we’ve all been schooled in the notion that plants are takers, removing nutrients from the soil and leaving it poorer. But when plants are allowed to work with their partners in the soil, they’re givers. They feed carbon exudates to the community of bacteria and fungi to keep them thrumming with life and pulling mineral nutrients from the bedrock as well as from particles of sand, silt, and clay because they know—if that word can be applied to organisms without brains—that they will profit from the gift. When the predator soil organisms eat the bacteria and fungi, all those nutrients are released near the plant. There’s always enough, unless humans or some other force messes up the system.

p. 233

NMSU conclusions in report to Sandia

“The rates of biomass production we are currently observing in this system have the capability to capture enough C02 (50 tons CO2/acre) to offset all anthropogenic CO2 emissions on less than 11 percent of world cropland. Over twice this amount of land is fallow at any time worldwide.”

p. 234

How do we feed 9 billion people? Answer: Let’s begin by feeding our microbes.

[current world population 7.7 billion people]

It appears to be in our power to reduce our legacy load of carbon dioxide…. We can only do it by working with plants and soil microorganisms, which have been carrying on the most wondrous dance since the early morning of time. We can’t keep being the oaf that breaks into the dance, bumping one partner or the other out of the way, thinking we can improve upon their step and sway. We suffer for this clumsiness. We need to stand back, pay close attention to the ways in which these partners need our help, and offer it with the greatest respect.