Rocks, Radishes, and Restoration
On the Relationships between Clean Water and Healthy Soil
Aviva Rahmani and Ray Weil

In A. Toland, et al., eds. Field to palette – the soil art dialogues CRC Press (Taylor and Francis), Boca Raton.

Aviva Rahmani’s current project, The Blued Trees Symphony, has fellowships and support from the New York Foundation for the Arts, A Blade of Grass, and the Ethelwyn Doolittle Justice and Outreach Fund to replace toxic fossil fuel infrastructure with sonified biogeographic sculpture. Rahmani’s work is internationally exhibited, written about and published. Her transdisciplinary PhD is from Plymouth University, United Kingdom, and her masters is from the California Institute of the Arts, where she was teaching assistant to Allan Kaprow and Morton Sobotnick. She is an affiliate with INSTAAR, University of Colorado at Boulder, and has taught at Stony Brook University. Rahmani’s Trigger Points/Tipping Points, film on global warming premiered at the 2007 Venice Biennale, as part of Gulf to Gulf, a NYFA sponsored

**Ray Weil** is professor of soil science in the Department of Environmental Science and Technology at the University of Maryland where he conducts research, teaches undergraduate and graduate courses, and conducts outreach education to the environmental and farming communities. He is a Fellow of both the Soil Science Society of America and the American Society of Agronomy, and has twice been awarded a Fulbright Fellowship to support his work in Africa. He is probably best known for his ecological approach to soil science in writing the 11th to 15th editions of the internationally most widely adopted, translated, and cited textbook in the field, *The Nature and Properties of Soils*. Weil is a leader in researching and promoting the adoption of sustainable agricultural systems in both industrial and developing countries. His research focuses on soil organic matter and plant management for enhanced soil health, ecosystem functions, and nutrient cycling for water quality and agricultural sustainability.

---

Ecological artist Aviva Rahmani and soils scientist Ray Weil discuss their various approaches to restoration work, concluding that a transdisciplinary approach is the most effective solution to degraded systems. They compare issues that they have encountered respectively in wetlands and fisheries degradation (Rahmani) and in agricultural ecosystems (Weil). Rahmani describes two projects, *Ghost Nets* (1990–2000) in Maine, and *Fish Story* (2012–2013) in the Gulf of Mexico and Memphis, Tennessee. Weil discusses how his use of daikon radishes helps wean agribusiness farmers from the use of heavy fertilizers. Together, they compare ecosystem conditions and discuss how their insights and discoveries can be applied to remediate problems at the local level, as well as large landscape problems such as eutrophication in the Gulf of Mexico. Their conversation reveals where art becomes science, and science becomes art.
Ray Weil: Aviva, how are you interested in restoring natural systems? You've done a lot of land restoration. In *Ghost Nets*, you were doing some on-the-ground restoration in the estuary around your home, rebuilding the wetland up from the sea. You called it a *pocket salt marsh*?

Aviva Rahmani: Yes. I coined the term because the entire upper half estuarine system of the Gulf of Maine is characterized by small, rocky intertidal marshes rather than the flat expanses most people associate with salt marsh. Many of these small marshes have been filled in since settler times before we had a chance to know the unique functions of these tiny marshes compared to larger barrier estuarine systems. I restored a 1/3 acre salt marsh as a test model. It was part of the old town dump in Roberts Harbor, on a hill sloping into Penobscot Bay in the Gulf of Maine. The site started off as a pile of granite tailings (riprap) that were thrown into the estuary by the granite industry. That created land for a deep-water wharf to take finished stonework down the coast in schooners. When they stopped quarrying, it became the town's garbage dump. I bought the whole site (two and a half acres), built my home there, and restored the local upland riparian zone and the estuary. My intention was to provide local landowners with a regionally appropriate model for other landowners to replicate. I thought the restoration work could trigger a bioregional response. To make my case, I used Geographic Information Systems to map species distribution. It was very difficult to create conclusive proof of the immediate impact, but it did catalyze new research about the community interactions in these saltmarshes at the Wells National Research Reserve. The director of the Reserve, Michele Dionne, supported the idea.

There was no soil when I began in 1990, just rocky detritus. I began with soil creation, which any habitat restoration needs. I spent most of 10 years creating soil from green manure by planting legumes, encouraging leaf decomposition, composting, and hauling up seaweed that washed up on the shore. Finally, in 1997, I removed the granite debris that separated the tide from the land and opened up the coastline again.

Ray Weil: How did you happen to find the site?

Aviva Rahmani: I decided on the site because it looked promising on geological maps. It had many edges and lots of water. Local fishing was very rich. The Gulf Stream and other abiotic factors seemed to indicate the makings of a biological hot spot, a place where habitat complexity could provide rich biological diversity. And while I did that, I also organized the site into a series of stroll gardens and microhabitats for human visitors and other critters using the site for foraging or nesting. I selected plants that birds and small mammals might eat. Now the soil is thick with earthworms.

My goal in restoring the soil was to achieve a healthy aquatic system. Water depends on soil-making systems that result in fertility. The project seemed to be an equally psychological, creative, and practical commitment. I named it *Ghost Nets*, after the fishing drift nets that come loose and strip mine the ocean of marine life by trapping them in a wholesale extractive process. By focusing on the metaphorical, different observations emerged than would have emerged from quantitative analysis alone. *Ghost Nets* is an analogy for what I think the whole human race may have to embrace; accommodating our lifestyles to habitat reparations.

Ray Weil: How does your art, your paintings, or photographs, or objects, intervene in natural systems? And how can natural systems be seen as part of your artistic process?
Aviva Rahmani: The paintings and installations are visual formulas to intervene in conventional thinking … A sense of loss informs all my work. For example, in *Fish Story* (2012–2013), a participatory mapping project I did in Memphis, in collaboration with paleoecologist Jim White and wetlands biologist Eugene Turner, I was able to negotiate with stakeholders, especially big corporations who have developed the riverfront around Memphis and are focused on short-term financial profits and losses. The painting reminds me that I have to introduce that anguish without self-righteousness to engage their willingness to be part of the solution instead of the problem. It is more than evocative illustration. Contemplating the image of the river helps me think through the consequences of losing ecological structures and lets my mind drift into imagining new solutions.

In *Ghost Nets*, I think that the main artistic impact was creating a precedent to say: “You can do this yourself. Theoretically, you could buy a dump site. You could restore it. You can create soil where there was none. You could make these beautiful gardens, and it would benefit the region.” If every degraded pocket marsh in the upper half of the Gulf of Maine were restored, it might have a larger biological impact. The difference between what I did and creating any old backyard habitat for birds and butterflies is in how carefully I calculated where to position my efforts, my decision to begin with a dump site, and my need to share the restoration work with the public as a creative process. I took the environmental philosopher Robert Elliot’s position on restoration seriously. Elliot claimed that restoration is fake because it’s *artful*. I decided, Okay. If it’s going to be art, then let’s really make it art.

Ray Weil: We can look for the art in working with soil and the soil working in art … I use photography to interest people in my work with soil. You use natural phenomena to interest people in your art.

Aviva Rahmani: We both use visuals, albeit differently, even though our intentions might be similar. I draw attention to a site with art. The art is the middle of a process, not the end product. The first part is identifying where to pay attention. The middle is the restoration. The final part is monitoring how the system might change rhizomatically on an ecological and cultural level. My interest is in forging another approach to engage people differently in the science and art of restoring ecological systems.
Ray Weil: You’ve talked about Ghost Nets and other works as trigger points. Did you borrow that term from acupuncture? Does it reflect relationships between the greater landscape and the soil underneath? In your work on the Wolf River, are you thinking about the whole watershed and the hydrology that impacts the city of Memphis in terms of certain sites?

Aviva Rahmani: Just as we activate meridians of the human body, it seemed like the biogeographic dynamics of Gaia might be activated for marine and coastal recovery. A similar approach originated in South America, called nucleation, for forest succession. (See, for example, Zahawi, R.A., Holl, K.D., Cole, R.J., and Reid, J.L., 2013, Testing applied nucleation as a strategy to facilitate tropical forest recovery, Journal of Applied Ecology, 50: 88–96. doi:10.1111/1365-2664.12014.) My process push-pulls between intuitive diagnoses of what needs to be done, on-site discovery, and learning about the scientific methods and strategies to create contiguous systems. My conceptual premise is what I call trigger points, locations in the landscape that indicate where dynamic confluences can catalyze a cascade of impacts—negative and positive. That is, the discreet trigger point can be identified by layering data, but it is conditional on and interdependent with the much larger system. I elaborate more on this theory in my forthcoming book. In 2013, I did a series of works I collectively called Fish Story, including an installation at the Memphis College of Art, an international webcast, and a journal article. Part of the project was conceptual, part was the social interaction, and part was on site. Wetlands biologist Gene Turner and I canoed the Wolf River toward the Mississippi and noted what kinds of species had been taken out of the system. We were looking for a trigger point that might impact the Mississippi Water Basin and the Gulf of Mexico. For example, most of the canopy trees were gone, along with the beavers, which left the water dead relative to how it had been in preindustrialization times before 1930. We conjectured that if contiguity were reestablished between the Wolf River and the Mississippi, at exactly the point where the Army Corps of Engineers had interrupted the flow of water, ecological relationships might be restored and have wider consequences on regional sustainability.

Ray Weil: Following up on the idea of trigger points and environmental health, how much do you, or the people you work with, diagnose what’s
Fish Story, cut and acrylic painted paper installation at Memphis Institute of Art, Memphis, Tennessee, 2013 for Memphis Social curated by Tom McGlynn. H: 132" × W: 1728"
Photograph by Katie Maish. Reprinted with permission from the artist.

Wolf River Entrance Point #1, starting an exploration of a new, previously unmapped Lost Swamp Trail portion before the Ghost River section of the Wolf River by canoe with Aviva Rahmani, Gene Turner, and the Wolf River Conservancy from Bateman Bridge to Moscow, Tennessee.
Photograph by Aviva Rahmani 2013. Reprinted with permission from the artist.
wrong with the river and how that came to be? Is it a matter of toxic chemicals? It is a matter of clearing vegetation? Erosion from the uplands? Dredging? All of the above?

Aviva Rahmani: All of the above. In the case of the Wolf River, degradation has been exacerbated by an invasion of privet, which has out-competed the canopy trees that provided the habitat with shade. I think the most important thing is to reconnect the tributaries. Then fish populations can become indicators for success. As in the ocean, there’s been dramatic overfishing. The rivers are also subject to lots of nitrate pollution. The question is whether the populations can recover if the linkages are restored. Meanwhile, a lot of the Mississippi River is being periodically, artificially restocked with fish for sport.

Ray Weil: The fundamental problem with the Mississippi Basin is dumping too much nitrogen in the rivers. That’s coming mainly from large-scale farms. So, farmers are going to be the ones to solve that part of the problem. Waterfront development on the Wolf River is mainly about local development. You’re going to have lots of local people involved. But in terms of the nutrients coming down the Wolf River, it’s the farms in the watershed that have to change.

One of the best ways to control the loss of nitrates is to introduce cover crops … I’ve been studying cover crops for the last 10 or 15 years in the United States. These crops are grown to feed the soil, to help enrich it, and to improve the farming system.

I’m really excited because over the past 10 years or so I can see the use of this practice growing. In fact, in recent years I have been speaking at cover crop meetings and field days where hundreds of farmers come to exchange ideas and hear about cover cropping. I think it’s pretty amazing and going to change the face of mainstream, large-scale American agriculture. Farmers are being very innovative on thousands of acres of large farms producing our basic grains. My former grad student and I also made a website (www.notillveggies.org) focused on smaller farms producing vegetables. The farmers leading this movement see this as a win-win situation. There are indirect pathways by which adding cover crops into a system changes all kinds of things with benefits to the farmer and the environment. Growing cover crops is a very powerful way that farmers can enhance their soil’s environmental filtration capacity and ability to transform excess nutrients into beneficial soil organic matter and a reduced need for fertilizer. In my research, I have seen that by using the right cover crop system, farmers can capture soluble nitrogen from as deep as 2 meters in the soil and prevent it from leaching to waterways.

Aviva Rahmani: I think these changes are a result of people demanding organic food, and conventional farmers working together with organic farmers. I was at a conference recently where a young woman representing small organic farms explained how they had convinced large grape growers in upstate New York to let weeds grow between the vine rows so they could graze their goats and sheep. It was a win-win for everybody because, of course, dung was added to the soil, the weed cover was kept down for the big farmers, and the small farmers had an inexpensive, clever way to feed their herds.

Ray Weil: Yes. There are lots of these synergies starting to come into play. Quite a few farmers are learning to integrate their livestock with crop production by using cover crops for both soil improvement and grazing. Weeds can be pretty useful too. I developed new, multipurpose cover cropping systems using a daikon-type radish cover crop that I had seen growing in Brazil. It grows so vigorously that even very business-minded farmers are quite impressed and excited about using it. Now there are a million acres of it planted for soil improvement.
**Aviva Rahmani:** Do radishes work like dandelions pulling up nutrients?

**Ray Weil:** Exactly … They pull up a lot of the nutrients that rainwater has washed down, even from several meters deep, and brings them to the surface. It loosens the soil and suppresses weeds. Some large-scale farmers have been able to skip their burn-down herbicide spray. The cover crop itself freeze-kills in the winter in cooler regions, so there is no problem dealing with it in spring. In the spring, it quickly decays and the nutrients are released into the soil. It provides big holes, which prevent runoff, and the radish attracts earthworms like a magnet. The worms love it because it’s got a lot of sugars, which bacteria eat, and then the earthworms eat the bacteria.

If they have room to grow, these radishes can grow as big as baseball bats. This remarkable root impresses farmers into thinking, “Well, maybe this is doing something for me.” And it is. It sells itself because it’s so unique looking and grows so fast … More and more, I’ve been talking to groups...
of large-scale farmers interested in soil health and biodiversity and how they can work to effect this change. It's an innovative, small percentage of farmers doing it, but you're finding it now in popular farm literature. All the agricultural journals and magazines have taken it up.

**Aviva Rahmani:** I'm thrilled to hear that. Maybe they could get to a point where they would even allow pigs and cattle to forage on agricultural lands.

**Ray Weil:** Cattle definitely. There are large-scale farmers with big equipment and credibility within the community, who are growing thousands of acres and doing it completely different now. They are integrating livestock and making more money. We find that the radish holes are like injecting fertilizer because it changes the soil structure and makes fields more fertile. When I show farmers plots or photos of my plots of radish cover crops, they see that there are virtually no weeds growing in them in early spring. It's absolutely weed-free! People think I sprayed herbicide on it, but it's the radish.

**Aviva Rahmani:** I'd love to see big farmers weaned off herbicides and pesticides.

**Ray Weil:** That's what they're trying to do—even bragging about how few, if any, herbicide and pesticide applications they need to make, and how little fertilizer they use. This means lower chemical load, which is relevant for the restoration of ecosystems like the Wolf River Watershed, and also lower production costs. The general American public is unaware of this revolution, but I think it's reaching a mainstream tipping point. Most U.S. farmland grows animal feed, although some farmers grow wheat for bread. I don't think most farmers are trying to get into the organic market. However, they are trying to improve their soil for the future, to make farming easier, more profitable, and preparing their farms for the coming large droughts and erratic weather from climate change. These farmers are putting food into the mainstream food system, and these new systems reduce their production costs.

**Aviva Rahmani:** One of the biggest problems though, and the reason why we're having this conversation now, is that we don't have 20 years any more to learn from each other. We need faster ways into changing these large systems.

We have to find ways for the general population to find their own points of entry into problems. It's one thing for us to talk about the methodologies of restoring soil or tributaries; it's another for this to happen in the lifetime of somebody whose dinner menu is going to change.

**Ray Weil:** Solutions take a while to work. Unfortunately, natural processes can take a long time to undo environmental damage, even when we change practices. Take the example in the Mississippi basin. Nitrogen already in the groundwater and soil profiles is going to take decades to flush out. It will take time for rivers to recover and for us to see change and impact in the dead zones—even if we started doing everything right overnight. This long delay in end-result makes it politically difficult.

**Aviva Rahmani:** I think there's also the issue of how we approach these problems. There are different models in different locations and for different problems. The real task is getting people to think about whole systems rather than disparate and disconnected sites. Even though the agents and relational dynamics might be different, approaches might be similar and overlap. We have to take all these approaches—the heuristic and the quantitative—and marry them. The problems are too large to rely on any one solution. We have to hook people's imagination to do things differently.

**Ray Weil:** Yes. There's no silver bullet, but we can use many little silver hammers to promote soil health and biodiversity—as scientists and artists, farmers, consumers, and politicians.