

URBAN FOREST CONNECTIONS

webinar series

Restoring Urban Ecosystems with Trees: Cleaning and greening

Wednesday, February 11, 2015 | 1:00 – 2:00pm ET

Q&A

Randy Neprash: Please discuss using urban trees as widely-distributed urban stormwater management techniques – not addressing specific degraded sites, but decentralized implementation systems similar and equivalent to rain gardens and green infrastructure. Address new tree planting systems, such as structural soil and suspended pavement systems. How can tree-based stormwater Best Management Practices be used to address water quality stormwater permits and TMDL requirements?

Rich Hallett: This is really outside of my area of expertise. However, the following papers may help:

Thomas, E., Bruce, R., & Emma, J. (2006). Comparison of Structural and Noncompacted Soils for Trees Surrounded by Pavement.

Xiao, Q., & McPherson, E. G. (2011). Performance of engineered soil and trees in a parking lot bioswale. *Urban Water Journal*, 8(4), 241–253.
doi:10.1080/1573062X.2011.596213

Franco Montalto at Drexel University has done some work in this area. [Link here.](#)

Ron Zalesny: Similar to Rich, this is also outside of my area of expertise. However, Randy addresses a very good point and I believe there is a tremendous amount of potential for taking the phytoremediation concepts and applying them to urban stormwater management. In fact, the Great Lakes Restoration Initiative (GLRI) included a green infrastructure program area in this year's Request for Proposals. Ken Belt's work is very relevant here: <http://www.nrs.fs.fed.us/people/kbelt>

Kim Knox: Why use clones? Are there concerns about monoculture impacts to wildlife?

Rich Hallett: This isn't that different from many naturally occurring poplar stands which are also clonal. In addition, we aren't just using one genotype. We are using the best performing genotypes from our selection process.

Ron Zalesny: As Rich points out, and as discussed during the seminar, the diversity of the system as a whole depends on the clonal mix that is planted on the site – which is one of the primary reasons we developed and continue to refine phyto-recurrent selection. In other words, the clones chosen for field deployment will be workhorses in their ability to survive, grow, and remediate the site, but also to provide adequate genetic variation to guard against things like insects and diseases.

Please see these papers for details on phyto-recurrent selection:

Zalesny, J.A., Zalesny, R.S. Jr., Wiese, A.H., and Hall, R.B. 2007. Choosing tree genotypes for phytoremediation of landfill leachate using phyto-recurrent selection. *International Journal of Phytoremediation* 9:513-530.

Zalesny, R.S. Jr., and Bauer, E.O. 2007. Selecting and utilizing *Populus* and *Salix* for landfill covers: implications for leachate irrigation. *International Journal of Phytoremediation* 9:497-511.

With regard to wildlife, there hasn't been a lot of research done on these liability sites. I don't know of any studies testing the differences among wildlife impacts at a disturbed site with treatments consisting of original conditions versus those with trees. It would be very beneficial! Nevertheless, imagine the impacts to wildlife when the site is highly disturbed/polluted – none of these systems are ideal, but what we're trying to do is to provide multiple ecosystem services. Hopefully, providing habitat for some wildlife is one of the benefits achieved.

Randy Neprash: If trees can do a good job with petroleum hydrocarbons and heavy metals, should they be used as stormwater BMPs for high-traffic-volume roads and highways? These land uses yield high levels of these types of chemicals in their runoff. Should we be designing and building tree-based stormwater treatment systems for our highway and ultra-urban stormwater runoff?

Rich Hallett: This is another good idea. This is another example of how trees could help in a highly functional way. Maybe a future research project?

Ron Zalesny: I agree with Rich.

Kent Holm: The tree species you are discussing have relatively short life spans. Part of the plan, obviously, then has to be how you deal with the tree removals – are there specific contaminants that are retained in the tree tissue and therefore need to be addressed when you are dealing with the tree removal?

Rich Hallett: Yes, this is a possibility. For inorganic contaminants particularly we would just be removing them from the soil and concentrating them. It remains to be seen which elements might be taken up. This will be part of the data we collect over time. Ron can speak more about this, but I believe that in true phytoremediation, the trees are incinerated, which concentrates the contaminants further. Then the ash needs to be disposed of properly.

Ron Zalesny: Yes, Rich is correct. The concept of concentrating the contaminants and then disposing of them via regulatory processes (depends on the state) is crucial for project development. Similarly, there are efforts underway that involve planning for the economic value of the trees once their rotation age is reached. This is very powerful. If we can identify a use for the trees once the site clean-up is finished, then we not only have the ecological benefits of the system but also economic advantages. These two concepts also integrate well with our urban afforestation concept (see Rich's response to Brandon below) – establishing longer-lived, slower-growing tree species in the understory of the workhorses. These trees will then be there long after the workhorses are gone. Especially in urban areas, these have great potential to then provide social benefits, too.

Allyson Salisbury: What are the long term management goals of the projects Ron was describing? I.e. when the trees reach maturity, will they be replaced?

Ron Zalesny: Please see my previous response. To elaborate more, potential long-term goals are to use the trees as feedstock for bioenergy and bioproducts. An alternative to the urban afforestation concept (and one that is associated with "classical" phytoremediation) is to let the phyto-workhorse trees stump sprout to create the next stand of trees, or to interplant between and among rows with other workhorse genotypes.

Randy Neprash: It appears that the focus of today's webinar is addressing remediation for individual degrading or contaminated sites. Are there researchers within the USFS that are addressing the application of phytoremediation in tree-based urban stormwater treatment systems? Other than Greg McPherson and Dave Nowak?

Ron Zalesny: I don't know of any USFS researchers directly addressing this topic. As above, Randy brings up a very worthwhile and intriguing topic for future research.

Randy Neprash: If pollutants are taken up into the plant tissue, are they a problem if the plant tissue is burned for energy production? If yes, how should this be addressed?

Rich Hallett: See answer above on proper disposal of ash.

Ron Zalesny: In this situation, the problem is related to the engineering of the biomass facility rather than ecological concerns. That is, if the scrubbers can handle the metals, then the wood shouldn't pose any ecological concerns because the steam released into the atmosphere should be clean.

corinnef: What kind of interactions are anticipated between wildlife and trees that have absorbed pollutants?

Rich Hallett: We don't know the answer to this yet for the Freshkills project. It would depend on which pollutant we are talking about and whether it is sequestered in the roots, wood, or leaves. Then we would need to determine which wildlife species we are talking about and figure out which plant part they are ingesting.

Ron Zalesny: Similar to some of the responses above, this is an interesting topic that has not been thoroughly examined. We are, however, beginning to do some urban foraging work to see what the human health impacts are from harvesting plant parts from urban liability sites. From the standpoint of berries, fruits, etc. much of this information could be directly relevant to wildlife. I think Rich really addresses the main take home message, which is that it is very site dependent.

Kim Knox: And what about the considerations of wildlife with the use of non-native tree plantings?

Rich Hallett: We aren't talking about non-native tree species. In fact, for the Freshkills study, the genetic material being used was collected from Staten Island where the site is located.

Ron Zalesny: Please see my wildlife response above.

Barbara White: If the trees were 3-5 years old in containers when planted, what was done with the roots at planting time?

Rich Hallett: We haven't installed the study yet. We will follow planting guidelines specified in the contract written by the NYC Parks department.

Brandon: It seems like most of the trees that are working well on these sites are less than ideal urban street trees (willow, poplars, and tree-of-heaven).

Rich Hallett: This isn't a street tree study, it is an urban afforestation study. Ultimately, we hope to have a forest on the site, which is as self-sustaining as possible. Even so, the species mix of willows and poplars may not be the species that Freshkills Park wants on this site. If you follow the trajectory of forest establishment in our rural systems after a fire or landslide (major disturbance), we typically see pioneer species come in first, followed by more shade tolerant species later on. Later phases of this study might involve under planting with some of the more desirable species once the site is captured.

Tree-of-heaven and other exotic invasive species may do well, but are not planted and, in fact, are the focus of active invasive removal as part of the maintenance of these sites. One hypothesis is that our selected natives will prevent establishment of exotic invasive plant species thereby resulting in lower maintenance costs over time.

Jacob Busiahn: What is the typical life cycle of some of these 'work horse' species? Is there a plan to remove them and dispose of them offsite to remove contaminants from the area?

Rich Hallett: At Freshkills, this remains to be seen. See discussion in previous answers.

Mary Annja Anderson: What effect does it have on wildlife who eat the fruit, berries or acorns?

Rich Hallett: See previous answer.

alan clark 2: How much research is being done with mycoremediation in combination, as far as species succession goes?

Ron Zalesny: Our group has not done any work on this but it is very important for certain contaminants (i.e., petroleum hydrocarbons). In addition to the [International Phytotechnology Society](#), see work out of the University of Iowa, Dr. Jerald Schnoor's lab.

Lisa Perez: Are the residues of the trees (leaves, wood) contaminated? Would they pose a hazard to those visiting the area?

Rich Hallett: Inorganic elements would be sequestered in tree tissues and not pose a threat unless ingested and then it would depend on what element we are talking about and the concentration.

Ron Zalesny: And I would add that I don't think a person could physically ingest enough to cause problems. And, certainly, we wouldn't expect someone to ingest the tree tissues over time – so bioaccumulation should be ruled out. Also, from a soils perspective, this is one of the primary reasons to conduct phytoremediation – i.e., clean the soil so that we can use the area. This is done in concert with knowing the end use of the trees (see above).

Wai Lee: Do you have a phytoremediate plant palette for tropical areas, like Hawaii?

Ron Zalesny: Unfortunately, I am not familiar with one, but given that tropical trees grow so fast, there are likely genera that exist. One that comes to mind immediately is Eucalyptus. Dr. Don Rockwood of the University of Florida has conducted a tremendous amount of phyto work using Eucalyptus in Florida and Alabama. I'm not a Eucalyptus expert, but I would presume some of that material might work for Hawaii. But if it didn't, there must be something there that could offer potential for contaminant removal.

alan clark 2: I believe the fungus in the soil is doing most of the metabolizing of the contaminants.

Ron Zalesny: Yes, this is often the case with organic contaminants. For a meaningful discussion of the processes of phytoremediation (including rhizodegradation), please see Dr. Jaconette Mirck's paper:

Mirck, J., Isebrands, J.G., Verwijst, T., Ledin, S., 2005. Development of short-rotation willow coppice systems for environmental purposes in Sweden. *Biomass Bioenergy* 28, 219-228.

Wai Lee: How do you match contaminants with clones?

Ron Zalesny: For detail on this, please refer to the phyto-recurrent selection papers listed above. In summary, phyto-recurrent selection involves using multiple testing cycles to evaluate, identify, and select favorable clones based on the response of genotypes to variable pollutant chemistries and site conditions. Early cycles are relatively short and data collected are easy to acquire (typically done in the greenhouse or growth chamber), while later cycles require more time and resources to increase knowledge of genotypes advancing (typically done in the field). Fewer clones are tested as the complexity of the data increases, and multiple-trait selection strategies are used to evaluate the combination of complex phenotypic expressions regulated by quantitative traits. The ultimate goal is to deploy a combination of genotypes with improved phytoremediation potential over the original set of clones, as well as adequate genetic variation to guard against insect/disease outbreaks, changes in soil conditions (especially those induced by the pollutants), and unfavorable genotype x environment interactions (i.e., how the genotypes respond to the site conditions).

Randy Neprash: I am very interested in addressing phytoremediation in the context of using trees for urban stormwater management. I would be interested in participating in such a discussion – long-term.

Rich Hallett: This is an interesting topic to me, as well. I would recommend bringing Franco Montalto (see above) into the discussion. I have spoken with him on this topic and he is interested as well. Franco has several instrumented stormwater management sites in NYC that he is studying from an engineering perspective.

Ron Zalesny: Ditto on Rich's comments.

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