



Jesse Ng, Bay Territory, oil on wood panel. |

*“A novel ecosystem consists of new combinations of species that have not previously coexisted, and/or new configurations of environmental factors such as changed climate or altered soil properties.”<sup>1</sup>*

–Richard Hobbs

## NOVEL ECOSYSTEMS

Interviews with Richard Hobbs, Joy Zedler, and Peter Del Tredici, with annotation by Alex Felson

*Conducted by Lunch 14 Editor Taryn Wiens*

*Illustrations by Aisha Sawatsky*

Lunch 14 editors conducted a series of interviews around the topic of “novel ecosystems”, a term developed in the field of ecology and now used widely in many fields, including landscape architecture.

### **Four Novel Urban Ecosystems Typologies**

**Remnant / Restored** (e.g. urban forest patches, marshes, riparian corridors, restored woodlands, wetlands)

**Abandoned / Ruderal** (e.g. brownfields, abandoned/derelict lands, transportation verges, drosscapes)

**Horticultural / Formal** (e.g. parks, public and private gardens, cemeteries)

**Green Infrastructure-related** (e.g. Created wetlands, bioswales, greenroofs, bluebelts, many green infrastructure practices).

The purpose of these interviews was to explore the origin of the term, to illuminate contemporary debates around the term, and to begin to understand how these differing perspectives matter in designing with ecology.

Interviewees include landscape ecologist Richard Hobbs, restoration ecologist Joy Zedler and urban ecologist and horticulturist Peter del Tredici.

Landscape architect and ecologist Alex Felson contributed annotations and emphasis of connections between the interviews.

The Lunch 14 editors would like to thank these four contributors for their time and participation in this project.

–Alex Felson

**Lunch Journal: What factors would you identify in deciding whether to plant and establish**

**Richard Hobbs:** You'd need to assess the inherent capacity of the system to recover – is the soil OK (in terms of physical and chemical characteristics)? Is there a source of propagules in the soil or dispersing from nearby? Are **conditions** suitable for regeneration – climate, grazing pressure etc? And also whether the self-regenerating system is heading towards the desired target, however that is decided on. And how fast do you want things to go? Natural succession may be too slow for many folks, or there may be completion criteria imposed by legislation.

**Lunch: What is your position on managing or combating invasive species? Do you envision**

**RH:** Some invasive species are definitely nasty and need to be controlled for effective conservation/restoration to occur. Others are either benign or may have positive values. Work in New Zealand has shown that non-native plants that were thought to be problematic actually encourage regeneration of native species. **We're never going to control/eradicate all invasives, and so we need to be smart about deciding which battles really need to be fought.** Species assemblages are going to become more and more mixed, especially as species migrate with **climate** change.

**Joy Zedler:** I don't think of these "choices" as a dichotomy; a planting would result in an ecosystem either way. Regardless, key factors to identify would be the **conditions** that favor establishment of target species. These are not necessarily the **conditions** where adult plants thrive. Nurse **plants** might be needed to shade seedlings of future canopy dominants. For example, a new paper suggests planting Mugwort in appropriate sites as an early succession species.

**JZ:** Since the earliest recognition of negative impacts, ecologists have advised that invaders be controlled as soon as they are identified; there is no better time to be effective. In Wisconsin, *Phalaris arundinacea* is our "worst wetland weed." I can't control it in my Sedge meadow unless the upstream farmer will stop allowing fertilizer to run off his cornfield (he won't). The nitrogen drains onto my wetland, where it fuels the invader. So, the need is to buy his land and convert it to an upstream nature reserve (obviously, not always practical). Then I could invest in weed control downstream. **My position for managing invasive species is to understand the causes of invasion and to identify potentially effective control measures, followed by continual surveillance and control treatments as needed.** By 2070, restoration sites will be subject to more and different invasive species. In 50 years, a warmer and wetter **climate** would favor invaders from warmer wetter homelands.

**(i.e., restore) an ecosystem vs deciding to facilitate natural succession in a disturbed site?**

**Peter Del Tredici:** From my perspective the most important thing is whether some remnant of the original soil profile still in tact. Native soils are layered, they tend to be well-drained, low in nutrients – they have a certain suite of characteristics that native ecosystems are built around. Once the native soil composition is destroyed (through agriculture or any sort of land development), it's very hard to restore a native ecosystem. You can plant native **plants** and they will grow but that's not sufficient.

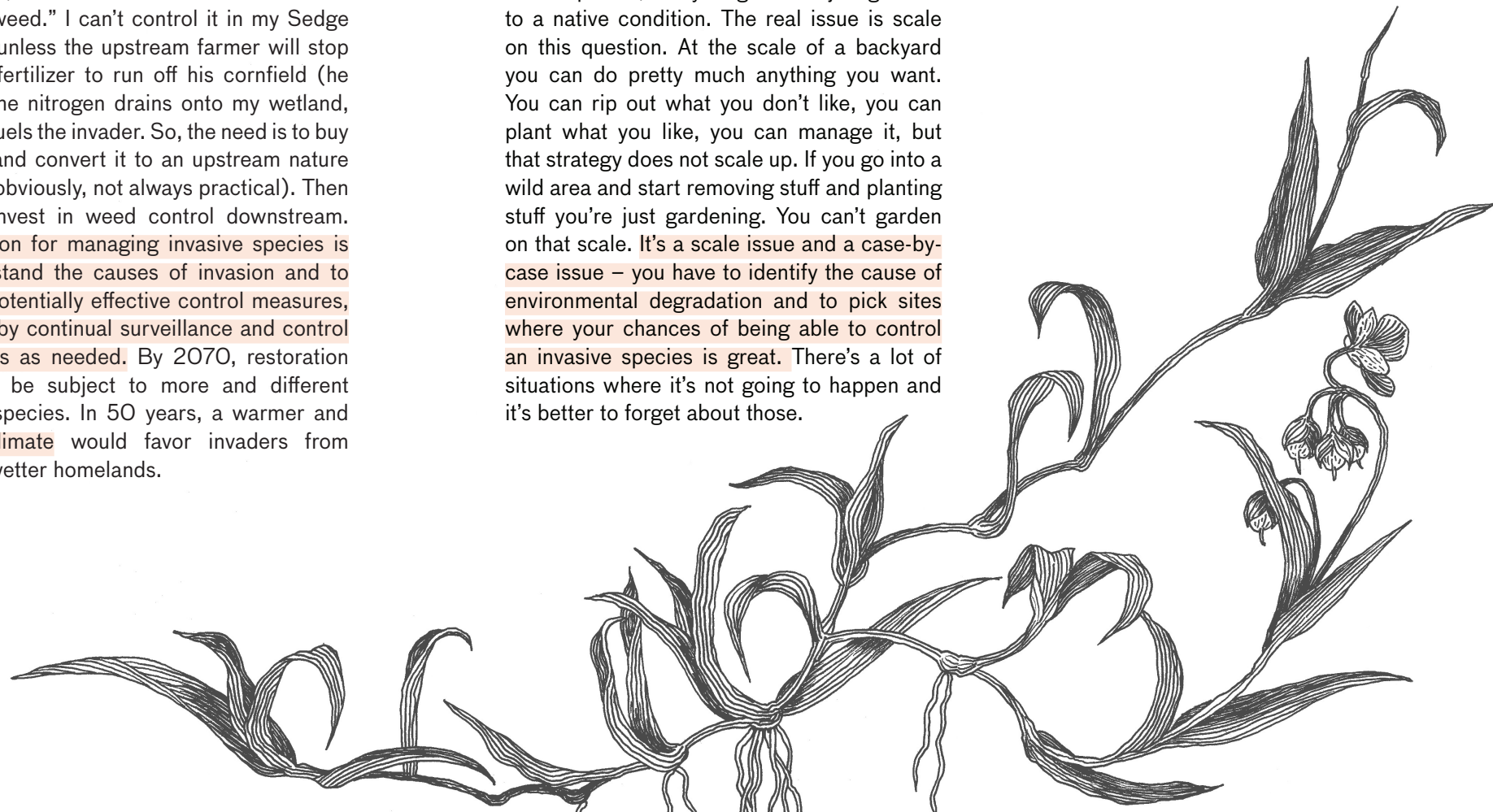
**this changing in the next fifty years and if so, how?**

**PDT:** I view the presence of non-native species in a landscape as a symptom of some form of environmental degradation as opposed to a cause, which means in removing the non-native species, everything doesn't just go back to a native condition. The real issue is scale on this question. At the scale of a backyard you can do pretty much anything you want. You can rip out what you don't like, you can plant what you like, you can manage it, but that strategy does not scale up. If you go into a wild area and start removing stuff and planting stuff you're just gardening. You can't garden on that scale. **It's a scale issue and a case-by-case issue – you have to identify the cause of environmental degradation and to pick sites where your chances of being able to control an invasive species is great.** There's a lot of situations where it's not going to happen and it's better to forget about those.

*"The responses expose the need for: (1) a clear understanding of the soil conditions, context and past disturbances to the selected site to inform site treatment, (2) the ambiguity around the language tied to novel ecosystems and restoration ecology and the need for more concise vocabulary, and (3) the underlying 'art of restoring ecosystems' and the importance of defining targets, or preferences."*  
–Alex Felson

*"The general approaches to restoration offered by the NE [novel ecosystem] concept are already established principles in ecological restoration and the NE concept is not a useful theory or framework."*<sup>2</sup>

*Invasive species can be thought of as biological pollutants, with potentially severe impacts on the ecosystems they inhabit. Like other pollutants, they may change the species composition of the environments they inhabit or impact the normal functioning of the ecosystem by altering fire regimes, hydrology, nutrient cycling and productivity."*<sup>3</sup>



**Lunch:** How do you think ecology could be most relevant to design professions? How do

**RH:** Ecology can provide design with guidelines for creating spaces/buildings that are more sustainable – water sensitivity, thermal efficiency, suitability as habitat for other species etc. Design can in turn translate ecological principles into on-ground action. We need to move away from the idea that you have designed spaces in one place and “nature” in another – urban greenspace is a prime example of where both can combine effectively.

**JZ:** Given that most people live in cities, I recommend integrated training; designers and ecologists should be in the same classroom, learning about varied viewpoints and approaches. We would see that we have a lot in common and that we each bring unique skills to the policy and decision-making arena.

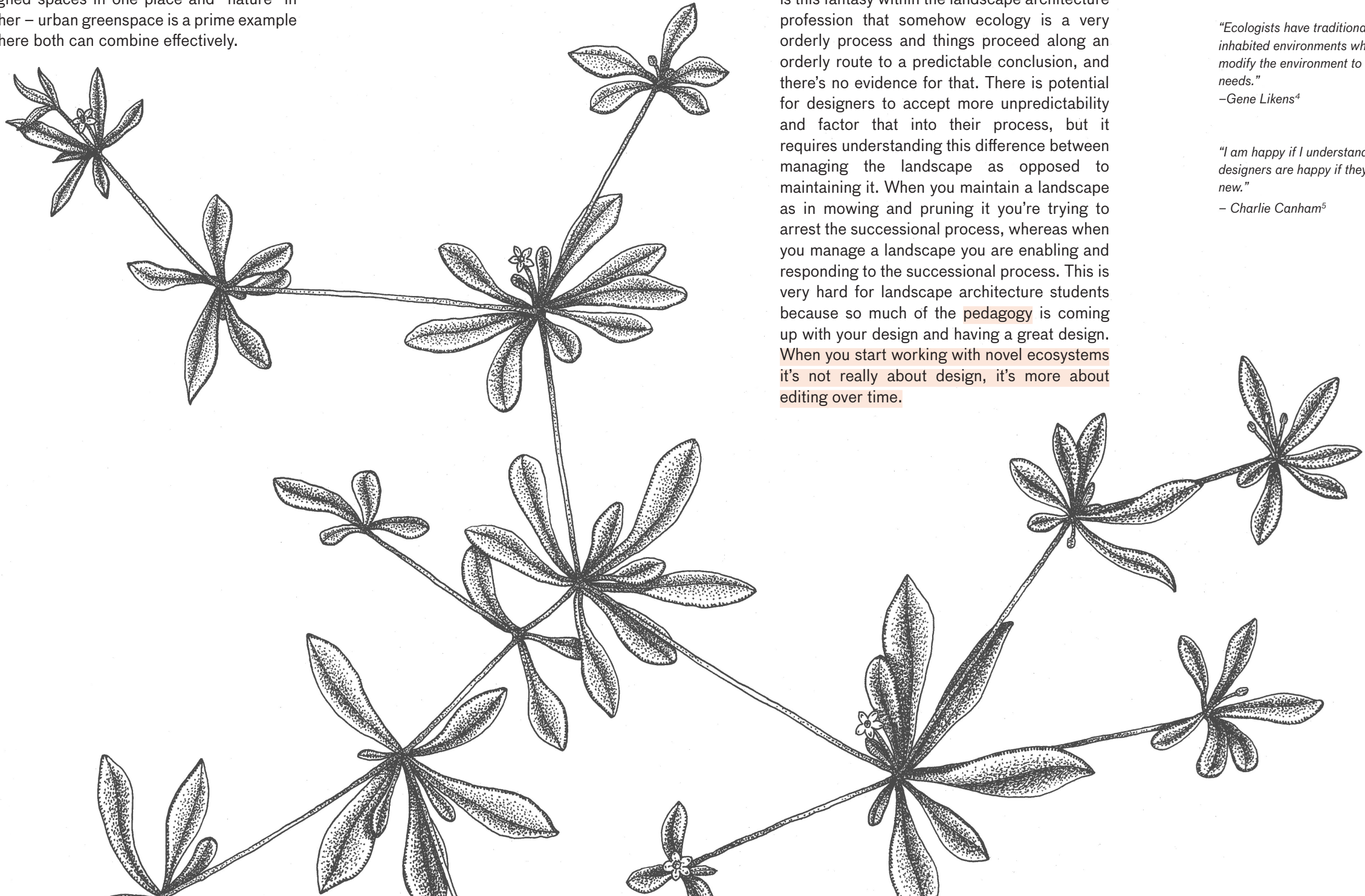
you think design could be most relevant to ecological science professions?

**PDT:** I think that the two do not make a natural fit, despite what landscape architects like to think. Design is about having a vision and imposing this vision on the site, controlling the process so it corresponds to your vision. Ecology is about letting go, a successional process, change over time and the end result is unpredictable. There is this fantasy within the landscape architecture profession that somehow ecology is a very orderly process and things proceed along an orderly route to a predictable conclusion, and there's no evidence for that. There is potential for designers to accept more unpredictability and factor that into their process, but it requires understanding this difference between managing the landscape as opposed to maintaining it. When you maintain a landscape as in mowing and pruning it you're trying to arrest the successional process, whereas when you manage a landscape you are enabling and responding to the successional process. This is very hard for landscape architecture students because so much of the pedagogy is coming up with your design and having a great design. When you start working with novel ecosystems it's not really about design, it's more about editing over time.

*“Perspectives on the relevance of ecology informing design and vice versa vary considerably across experts. Both skepticism and hope exists regarding this exchange. The exchange will be critical for both informing ecology and managing urbanized ecosystems.”*  
– Alex Felson

*“Ecologists have traditionally avoided human-inhabited environments while designers modify the environment to cater to human needs.”*  
– Gene Likens<sup>4</sup>

*“I am happy if I understand a system and designers are happy if they invent something new.”*  
– Charlie Canham<sup>5</sup>



**Lunch:** *Where would you place your own work on a spectrum from studying to shaping*

**RH:** I study ecosystems in order to understand them better and provide guidance on how best to shape them! Shaping ecosystems can occur on a spectrum from “letting nature do its own thing” through manipulating species abundances and ecosystem components, to complete design of systems for particular functions.

**Lunch:** *When did you begin writing about novel ecosystems, and how did the concept develop? Why do you think it has been contentious within the fields of ecology and ecological restoration?*

**RH:** I was involved in an international workshop in 2002 and ended up leading the development of the paper that resulted from the workshop. That came out in 2006 after repeated attempts to get it published.<sup>6</sup> That paper really just explored the idea that a wide array of altered ecosystems exist and that we need to pay more attention to them. That was followed by a paper in 2009 that explored the implications of novel ecosystems for conservation and restoration.<sup>7</sup> This paper annoyed people, particularly in restoration, because we suggested that some systems are altered to such an extent that it is no longer possible/desirable to restore them following classical restoration methods. A small but vociferous group of people in restoration see the novel ecosystems idea as a serious threat to restoration. However, their contention that we were trying to replace restoration with novel ecosystems thinking is nonsense – it’s an “as well as”, not an “instead of”. Within ecology, the concept has actually been pretty well received – most people see it as an accurate reflection of what they see in the real world. A couple of years ago the Ecological Society of America annual meeting was actually themed with novel ecosystems in the title.

**JZ:** Over the years, I’ve collaborated with students and postdocs who have worked to understand how ecosystems respond to a wide range of stressors and to figure out how to restore degraded sites; thus, I don’t consider study and shaping to be ends of a spectrum. I can’t study an ecosystem without considering how it might need to be managed, and I can’t suggest a restoration or management plan without studying it. Such people used to be called applied ecologists, with a somewhat derogatory tone.

Today, I see too much emphasis on dichotomies and labels. Debates persist in some of the literature for a while until someone calls for a bridge across boundaries that were never there in the first place. Note that I define restore very broadly; I do not intend to turn back the clock, much as the founders of restoration at the UW-Madison Arboretum did not expect to recreate a “pristine” prairie when they started planting native species in a former horse pasture.

**Lunch:** *What is your working definition of a novel ecosystem? What parts of this concept do you think are useful? What parts do you find problematic?*

**JZ:** When the Millennium Ecosystem Assessment showed in 2005 that the entire world is receiving nitrogen that humans made and applied as fertilizers, I realized that the term pristine went from being absolute to relative; all ecosystems have non-natural influences. Then I read that there are more than twenty invasive plants in the Antarctic, brought there on visitors’ Velcro, and I realized that people can introduce species everywhere. All ecosystems are altered; the questions are by what and how much?

**ecosystems?**

**PDT:** In urban environments we’ve already displaced all our native vegetation with structure, so I am interested in studying these novel ecosystems and the dynamics of these novel ecosystems—ones that have already been shaped intentionally or unintentionally.<sup>8</sup> I advocate for designers to shape urban ecosystems that are functional, that work, that will be able to sustain themselves without much maintenance—to not worry about if the plants they use were native at the time of Columbus.

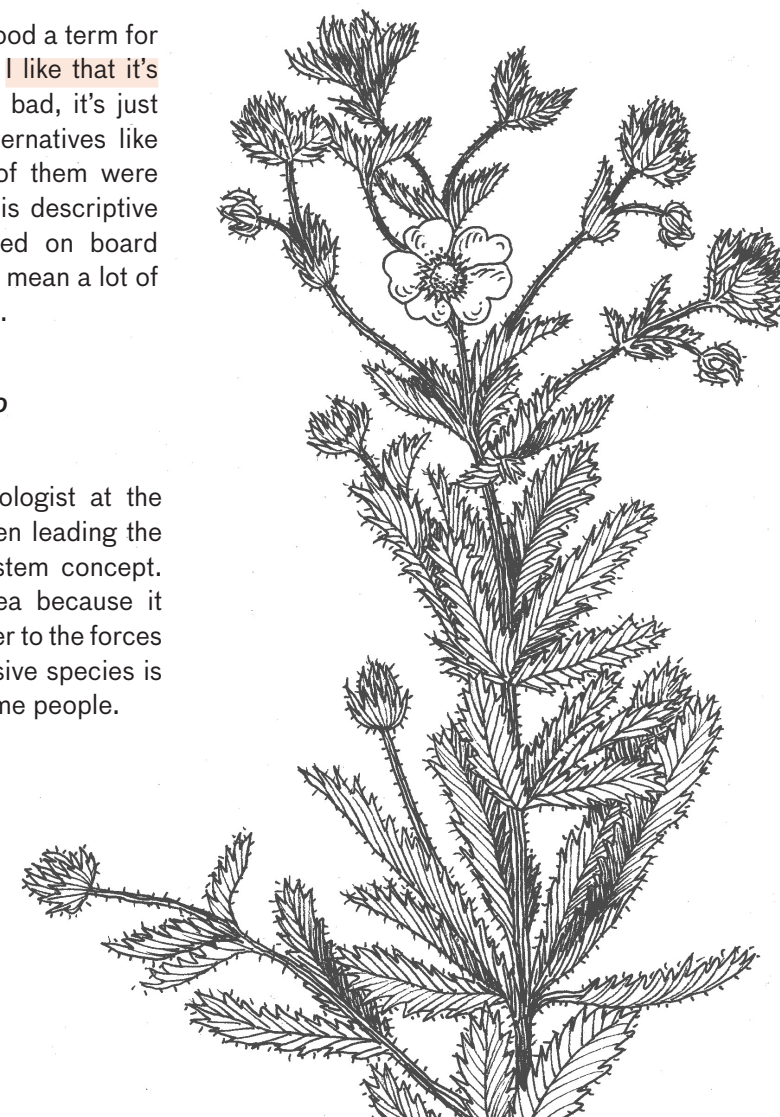
**Lunch:** *When did you first start using the term novel ecosystems? Has it changed how you’ve thought about these things, or just provided a better language for describing it?*

**PDT:** You know, there wasn’t a good a term for it until Richard Hobbs coined it. I like that it’s non-judgmental. It’s not good or bad, it’s just what it is. There were other alternatives like non-analog ecosystems but all of them were very unclear. Novel ecosystems is descriptive and non-judgmental, so I jumped on board because I think it’s a great term. I mean a lot of people hate it but I think it’s good.

**Lunch:** *Why do you think it’s so contentious?*

**PDT:** Daniel Simberloff, an ecologist at the University of Tennessee, has been leading the charge against the novel ecosystem concept. He thinks it is a dangerous idea because it implies acceptance of or surrender to the forces of darkness. Saying that an invasive species is okay is just not acceptable to some people.

*Novel ecosystems is a term that is currently being debated within the ecological restoration literature. The opposing researchers suggest that: “Applying the novel label to an ecosystem adds an unnecessary layer of complexity to an already complicated process of conservation, management, and restoration planning...We live in an age in which novelty and innovation are prized in endeavors such as product development and the arts. The novel ecosystem concept thus sends a message of scientific endorsement of improvement over the ‘old’ nature and breaking with the old ways. Embracing anthropogenic ecosystems as the ‘new normal’ or ‘new ecological world order’ opens the floodgates to the intellectual hubris of redesigning nature that assumes a complete knowledge of the ecological and biological outcomes and consequences.” Aronson et al.<sup>9</sup>*



**Lunch:** How do you think a designer should approach balancing the sometimes conflicting priorities of a target ecosystem (e.g. designing for species diversity vs. carbon sequestration/biomass)?

**RH:** By having up-front discussions with relevant stakeholders as to what the desired goals are. One thing that has changed with the recognition of novel ecosystems and environmental change is that there is no longer an automatic answer to the question of what the goal should be. Classical restoration always sets the goal as “what was there before” or “what is in the relevant reference system.” That was assumed to cover all bases, restoring both composition and function simultaneously. Today, we recognize that this is not always the case, and there need to be priorities decided on – are we shooting for the historical system, or are we more interested in functional aspects (such as flood control)? Additionally, how much time, money and effort do we want to invest in achieving a particular goal? If it’s going to be financially or practically unfeasible to achieve classic restoration, how far are we prepared to relax the rules and, say, settle for a species composition that is different from the original? There may be important cultural considerations that sway the decision about desired goals. There is not going to be a universal answer to these questions, but asking them up front opens up the conversation about what people actually want and are prepared to pay for/work towards.

**JZ:** Then the “novel ecosystems” term appeared and flourished in the ecological literature, and I watched it morph from a casual concept to a specific term that still didn’t have clarity, because few define it on first mention, so I don’t know what they mean. I used it in a general way in 2012 in an Ecology and Society issue, but now I avoid it. I don’t see a need for a word that confuses, when a few more words would describe something clearly. Now that I’m sensitized to others’ definitions, I avoid it, and I haven’t found a situation where I needed it.

Because all ecosystems have modifications caused by humans, either they all fit the definition of “novel ecosystem” (in which case it’s not helpful) or users and non-users would have to agree on where to draw the line. That seems unlikely. The debate seems more opinion- than science-based.

I blame my high school journalism training, during which I learned the value of clear and concise communication.

**Lunch:** In your book, *Urban Wild Plants of the Northeast*, you set up three different types of landscapes: constructed, agricultural, ecological and claim their main ecological difference to be frequency of disturbance. Instead of giving up on the first two as valuable ecosystems, would you say it’s possible to observe and predict cycles of disturbance and cultivate different ecosystems according to these differing temporal scales of succession?

**PDT:** In the 1970s and 80s the definition of disturbance was really fire, hurricane, flood, heat waves—they were considered to be large, environmental disruptions. But they were also considered to be one-shot deals—in other words a hurricane would come through and then there would be a recovery. These are what I’d call episodic disturbances. Since the late 90s and 2000s there are more what you would call chronic disturbances – rising CO2 levels, rising temperatures, atmospheric deposition of nitrogen, spread of invasive species – these are not going away. These are pressures, they’re not episodic, they’re chronic. Native ecosystems are really good at recovering from episodic disturbance—hurricanes, floods but they are not very good at dealing with chronic disturbance, such as nitrogen deposition which changes the baseline levels of nitrogen or rising temperatures from climate change. Novel ecosystems are better at adapting to chronic disturbances than native ecosystems.



*Building on Zedler’s comments, there have been counter arguments debating the value of novel ecosystems as a term. For example, Kattan et al (2016) argue that the definition “is still fuzzy and has little pragmatic value.” They note that “the initial idea was just to call attention to the growing number of unprecedented assemblages or potentially ‘emerging ecosystems.’” They argue that the novel ecosystems (NE) idea is not a scientific theory and that it does not provide clear management guidelines. They go so far as to suggest that “the concept is morphing into the perverse notion that all of conservation, ecosystem management, and restoration should be revamped in light of the NEs concept.” As a landscape architect, I believe the value of the term is distinct from restoration ecology. It has additional worth with clients as a way of celebrating constructed ecosystems and differentiating our work from restoring past ecosystems as a historian might work. It also creates interesting ways of building on the past through reconfigurations that impact cultural understanding, aesthetics and the relationship of form and function.*  
 –Alex Felson

*The build-it-and-they-will-come model described by Hobbs as classical restoration is the default ecological restoration strategy. It builds on the assumption that in restoring an ecosystem one should follow cues from nature.<sup>10</sup> In degraded and urbanized sites, this assumption needs to be evaluated within the context of multiple factors. This assumption that “nature knows best” spills over into the aesthetic form of restoration projects (usually as naturalistic) creating challenges for designers involved in habitat restoration to explore alternative aesthetics and to reveal the human hand. Novel ecosystems provides an alternative framework that gives more agency to the designer or ecologists.*  
 –Alex Felson

**Lunch:** Given the constant change of human activity and relatively short span of any project compared to an ecological time scale, should designers target highly-maintained, highly-robust ecosystems (in terms of biodiversity and productivity) or very low maintenance, perhaps less robust ecosystems that would continue to thrive without human management?

**RH:** My preference would be for aiming for systems that are relatively self-sustaining without the need for ongoing high-input maintenance. However, this again is a choice to be made by the relevant stakeholders. It's perfectly valid to opt for a system that is going to require ongoing maintenance to persist—as long as this requirement is made clear from the outset and people are prepared to invest in this. So, for instance, many classical restoration projects that aim for a previous native ecosystem are going to require ongoing management to prevent weed invasion. The alternative is to tolerate a degree of non-authenticity and accept a different species composition, providing this still fulfills the desired functions. Given that we don't actually know how systems are going to change in the face of climate change etc, I'd suggest that opting for a particular narrow target is likely to be less realistic and more dependent on ongoing high maintenance.

**Lunch:** If a designer inherits a site with a thriving but non-native ecosystem, what factors do you think are important in deciding how to manage it, specifically in the balance between preserving and replacing?

**JZ:** At the site scale, Wisconsin wetlands offer two examples—*P. arundinacea* and *T. x glauca*. If asked to advise on management, I'd need to study the watershed—where are the sources of the nutrients and sediments that caused the invasion and dominance of these nutrient-demanding invaders? Can those sources be curbed, or can the contaminants be removed or sequestered upstream? If not, I'd still protect the wetland, because it likely provides multiple ecosystem services, such as contaminant storage, flood peak reduction, and possibly carbon storage. Wetlands are like diamonds—small but extremely valuable (see Sept. 30 Op-Ed)".

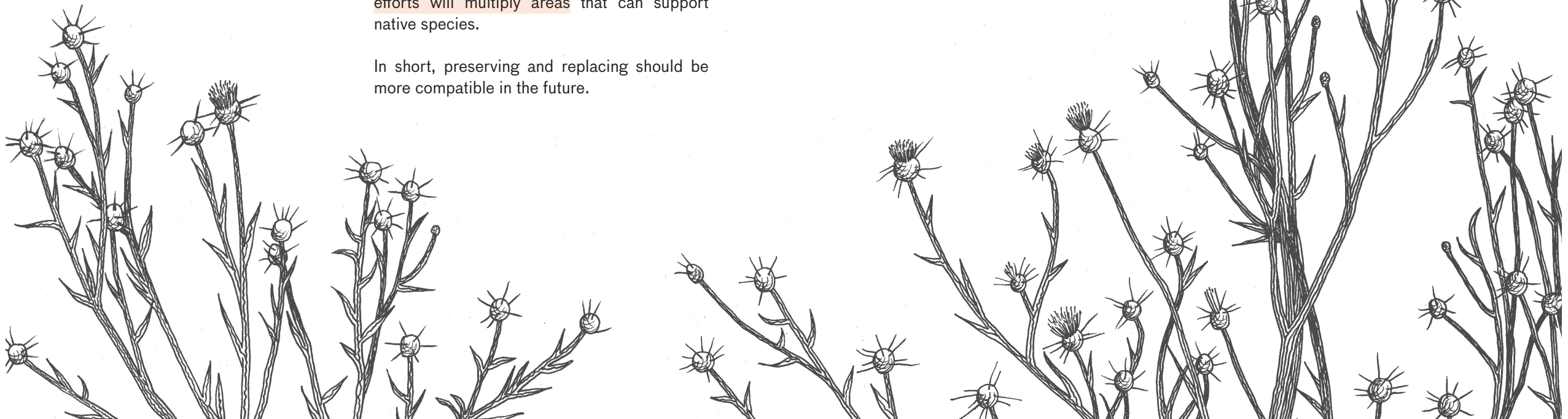
At present, it is not economically feasible or environmentally wise to replace all invaded ecosystems. One Wisconsin restorationist removes drain tiles and fills drainage ditches with sediment that has accumulated over decades. Such sites can be replanted. Another has a 7-year program for using grass-specific herbiciding and carefully timed control burning to convert *P. arundinacea* to diverse Sedge meadow. These examples give hope that future efforts will multiply areas that can support native species.

In short, preserving and replacing should be more compatible in the future.

**Lunch:** When we are designing, if we are designing for novel ecosystems or even if we are trying to restore native ecosystems, how do we coordinate all of these different timescales – the chronic disturbances with the recurring disturbances with the timescale of a client or a project – what are we designing for?

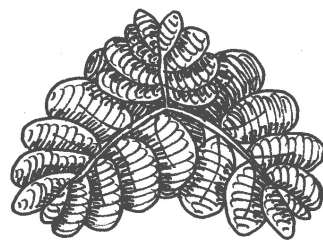
**PDT:** Well you put your finger on it. I don't really blame the profession of landscape architecture because it's structured along capitalistic lines—you have a job, you have a time-frame, the job is completed and when the job is done you walk away from the project and the project has to look good on the day it opens. So that structure, which is the way most landscape jobs work is really problematic. I cannot give you some magic answer to that, because the way it looks on opening day is the way it gets judged. Almost nobody goes back ten years later and says, well did it work or not? Change happens whether you like it or not, so the goal would be to write a management plan as part of the project—so in other words I think yes, you can still have a finished product but here is also a management plan, this is what you will have to do not just to maintain it, but we know it is going to change over time and this is how we think it's going to change and this is what you should be doing over the next ten years to assert some level of control over the process.

The demand for low-maintenance landscapes as well as immediate gratification are recurring themes that landscape architecture practitioners face in the profession. Clients commonly request low maintenance plantings. This is particularly challenging with large parks, where the costs of implementation and maintenance can escalate exponentially. This is a shared concern with restoration ecology. It creates opportunities to consider novel ecosystems with low maintenance as a priority. At the same time, using successional processes that may build on historically and local referenced functional ecosystems (depending on how modified the soils are and the impacts of climate change) are considerations for both designers and ecologists.  
—Alex Felson



**Lunch:** Do you think designers in urban areas should accommodate and even encourage volunteer vegetation and plant communities in tough conditions where most things won't grow? Would you identify potential consequences of this style of responsive design or management?

**RH:** I think the answer can be seen from what's already happening in cities like New York. The High Line is the classic example of where a disused area spontaneously created a new "wild" ecosystem (borrowing from Emma Marris' ideas)<sup>12</sup> that has now morphed and become a highly valued space. Areas that are allowed to "go wild" can become invaluable repositories for urban biodiversity, providing homes for many species and becoming local de facto nature reserves, learning areas etc. Such areas are certainly easier and less costly to maintain than highly designed areas that may need high inputs in terms of water, fertilizer etc. As with everything, a balance is needed—obviously, not everywhere should be let run wild, but equivalently not everywhere needs to be micro-managed.



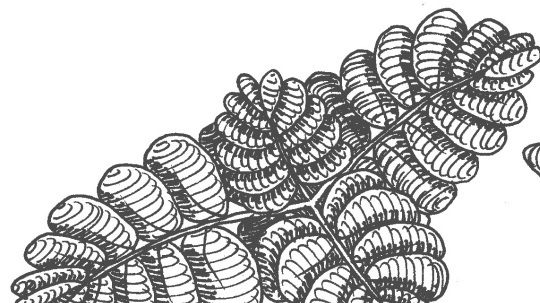
Discussing the Highline in this way is problematic. The Highline is a very successful park with a huge impact on real estate and extensive gentrification of the area, but over \$150 million was spent completely replacing soils and plants designed to look "wild." It was originally a wild successional ecosystems and this was part of its beauty. In fact, an alternative proposal for the Highline had the idea of embracing this landscape character and building on this succession as a driver of the landscape a similar way to RH's suggestion. In the end, the project designed by Field Operations, Diller Scofidio + Renfro, and Piet Oudolf was not a wild ecosystem and it requires extensive upkeep. At roughly \$520-670k per acre per year, it is the most expensive park upkeep in the entire city.  
—Alex Felson

**Lunch:** You have shown that, for gramanoids in urban wetlands, species richness and primary productivity are not necessarily positively correlated. In which cases should a designer prioritize species richness in making a planting plan (e.g. planting more species), and when do you think prioritizing maximum productivity is better? (e.g. planting more of a species known to be successful and productive in that environment)

**JZ:** Once again, I don't see this as a dichotomy but an opportunity for phased implementation. I recommend establishing dominant native plant species (except ones that behave like invaders, e.g., *Salicornia virginica*) to gain rapid cover, then add "nodes of diversity" where a broader complement of plant species is introduced and tracked to see which expands and where. A problem is that contracts for restoration tend to stop when the first seed is sown. We need longer-term efforts and monitoring with citizen scientists. There's a job for designers and restorationists to work together to solve.

When would I prioritize maximum productivity (assuming you mean net annual primary productivity aboveground)? Probably never, since wetland primary productivity can be very low (e.g., in fens and bogs), while other ecosystem services are very high.

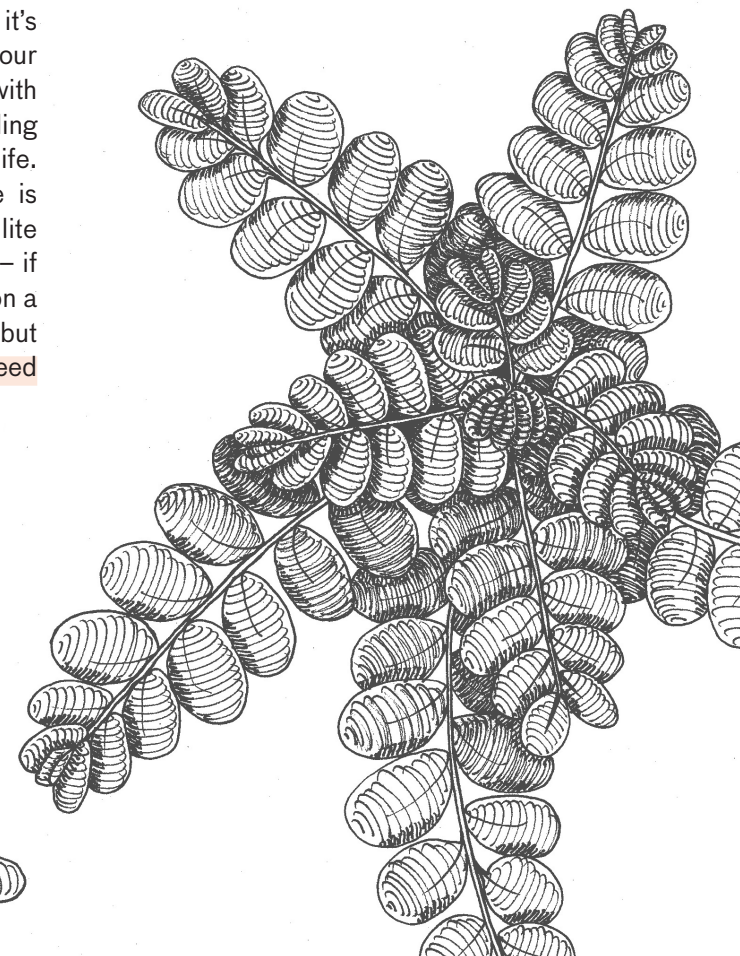
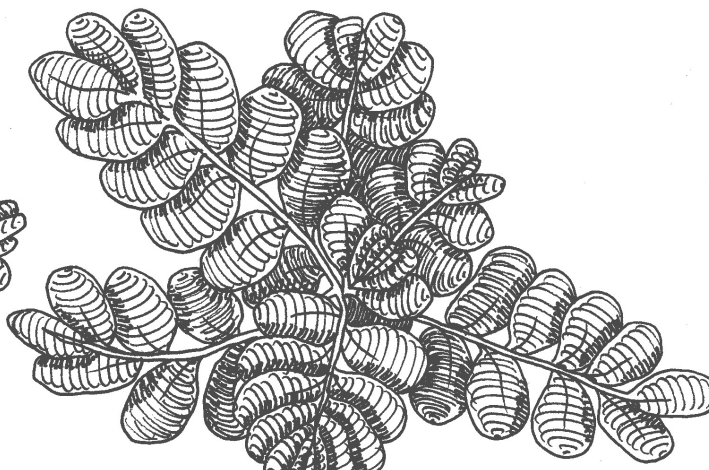
Given the cost, scale and maintenance challenges, as well as the unknowns of urban ecology, thinking in incremental and phased approaches is necessary. We need to develop the expertise around constructing novel ecosystems or restoring ecosystems. Regardless of how we choose to describe our actions, a next phase of trial and error, focusing on creative design, implementation and testing, will be necessary to inform future novel ecosystems.  
—Alex Felson



**Lunch:** Have you seen landscape designs that may not have added much to ecological function but instead found a way to change the perception of ruderal species or novel ecosystems?

**PDT:** I've done some work on novel ecosystems in really derelict sites, and I created a mobile sound app with one of my colleagues from the University of Buffalo to change people's perceptions about these landscapes and get them to think about them differently as opposed to oh, we've got to get rid of this. I'm as much interested in the social ramifications of this and how you change people's attitudes. Novel ecosystems aren't going anywhere, in fact they are increasing dramatically. Getting real about what is happening and not always wanting to go back to something—we can't go back, not with climate change. This issue of how you change people's attitudes is really important.

Marginal roadside landscapes have all of these invasive species providing ecological services without anyone paying a penny for them. If you tried to manage a native landscape there you'd be pouring resources into that. And it's not clear if you'd ever get a return on your investment. While this roadside covered with invasive species isn't a good thing, it is holding the land down, it is providing cover for wildlife. It's doing stuff. This whole issue of scale is important – once you get high up in a satellite and start looking at ecological functionality – if it's green it's good. And then you get down on a lower level and it's a little more complicated but on that large scale, plants are great. We need them.



Given the debates around the application of novel ecosystems to real world situations, it is essential to develop demonstrations and to focus on how ecologists can work with practitioners through the design process to shift across studying to shaping novel urban ecosystems. The shift from site analysis (studying) to conceptual design (shaping) affords a learning opportunity for ecologists (Felson et al. 2013).<sup>13</sup> Using an approach such as designed experiments to establish hypotheses, set up research and monitoring protocols, and work through the process of building and testing novel ecosystems would address both the naysayers and the supporters of novel ecosystems and it would build on the rich history of restoration ecology. Using designed experiments to test novel ecosystems would also educate designers about the state of the science for urban ecology and the effectiveness of specific novel ecosystems.  
—Alex Felson

<sup>1</sup>Brief definition given for this article.

<sup>2</sup>Kattan, Gustavo H., et al. "Does the Novel Ecosystem Concept Provide a Framework for Practical Applications and a Path Forward? A Reply to Miller and Bestelmeyer." *Restoration Ecology* 24, no. 6 (2016): 714–716.

<sup>3</sup>"Invasive Fact Sheet." Ecological Society of America (2004) [www.esa.org/wp-content/uploads/2012/12/invasion.pdf](http://www.esa.org/wp-content/uploads/2012/12/invasion.pdf).

<sup>4</sup>Likens, Gene E., and Otto Kinne. *The Ecosystem Approach: Its Use and Abuse*. Germany: Ecology Institute, 1992.

<sup>5</sup>Charlie Canham in conversation with Alex Felson

<sup>6</sup>Hobbs, Richard J. et al. "Novel ecosystems: theoretical and management aspects of the new ecological world order." *Global Ecology and Biogeography* 15 (2006): 1-7.

<sup>7</sup>Hobbs, Richard J. et al. "Novel ecosystems: implications for conservation and restoration." *Trends in Ecology & Evolution* 24, no.11 (2009): 599-605.

<sup>8</sup>Del Tredici, Peter, *Wild Urban Plants of the Northeast: A Field Guide*. Ithaca, NY: Cornell University Press, 2010.

<sup>9</sup>Aronson, J., Murcia, C., Kattan, G. H., Moreno-Mateos, D., Dixon, K., & Simberloff, D. "The Road to Confusion Is Paved with Novel Ecosystem Labels: a Reply to Hobbs Et Al." *Trends in Ecology & Evolution*, 29 no. 12 (2014): 646–647.

<sup>10</sup>Palmer, Margaret A., et al. "Ecological Theory and Community Restoration Ecology." *Restoration Ecology* 5, no. 4 (1997): 291–300.  
and  
Palmer, Margaret A., et al. "River Restoration, Habitat Heterogeneity and Biodiversity: a Failure of Theory or Practice?" *Freshwater Biology* 55 (2010): 205–222.

<sup>11</sup>Zedler, Joy. "Invaluable Wetlands Fight Floods" *Wisconsin State Journal*, September 30, 2018.

<sup>12</sup>Marris, Emma. *Rambunctious Garden: Saving Nature in a Post-Wild World*. New York: Bloomsbury, 2013.

<sup>13</sup>Felson, Alexander J., et al. "Mapping the Design Process for Urban Ecology Researchers." *BioScience*, 63, no. 11 (2013): 854–865.

*"One reason why novel ecosystems may more readily fit with landscape architecture practice than restoration ecology relates to a fundamental difference in priorities: ecologists want to hide the human hand while designers want to make it visible. This difference means the theoretical framework of novel ecosystems supports designers' objectives but questions the underpinnings of restoration ecology and the historic reference."*

*–Alex Felson*

