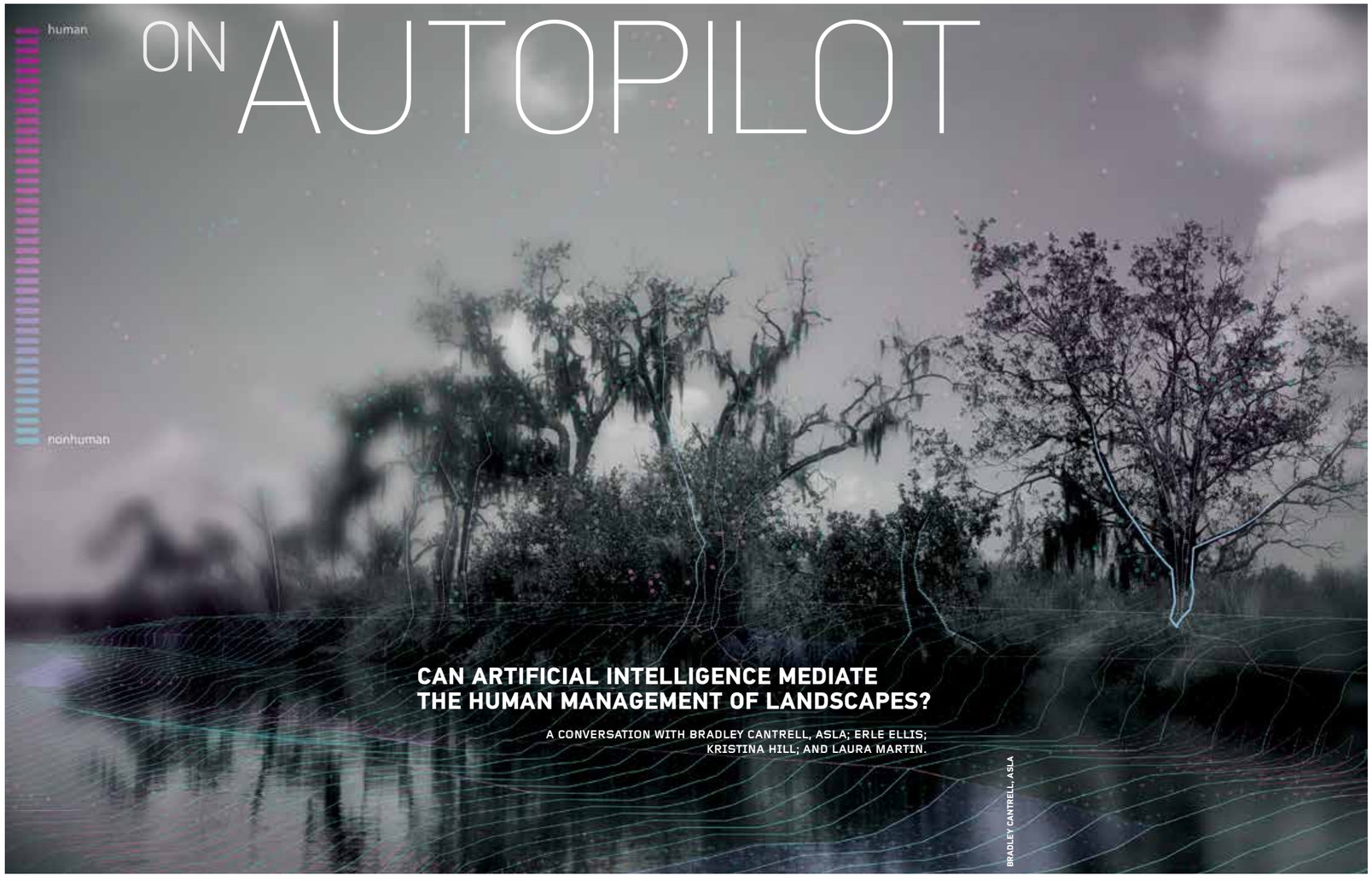
ECOLOGY ON AUTOPILOT



CAN ARTIFICIAL INTELLIGENCE MEDIATE THE HUMAN MANAGEMENT OF LANDSCAPES?

A CONVERSATION WITH BRADLEY CANTRELL, ASLA; ERLE ELLIS; KRISTINA HILL; AND LAURA MARTIN.

BRADLEY CANTRELL, ASLA

HILL CANTRELL MARTIN ELLIS

LEFT TO RIGHT: MIRANDA MAUPIN; BRADLEY CANTRELL, ASLA; EZRA FELDMAN; MICHAEL CHIARETTA

The Anthropocene age has delivered the Earth's populations to a state in which humans exert the greatest impact over the condition of global climate and the environment. Among professionals in the life sciences, this reality, which leaves no place on the planet unaffected, has focused awareness on ways to control human impacts as well as ways to safeguard the integrity of nonhuman species and systems. Questions of how to achieve these ends without direct, ongoing human management were explored in a paper that appeared in the March 2017 issue of the journal *Trends in Ecology & Evolution*, "Designing Autonomy: Opportunities for New Wildness in the Anthropocene." The authors are Bradley Cantrell, ASLA, currently the director of the master of landscape architecture degree program at the Harvard Graduate School of Design and soon to become chair of landscape architecture at the University of Virginia; Laura Martin, a historian of the environment and ecology at the Harvard University Center for the Environment; and Erle Ellis, a professor of geography and environmental systems at the University of Maryland, Baltimore County.

The paper elaborates scenarios in which autonomous or "deep learning" systems relying on forms of artificial intelligence are set in motion to create and conserve wildness in various environments. Some of these approaches to "designing wildness" are existing, such as the introduction of large mammals to Oostvaardersplassen, a nature preserve in the Netherlands, to reset the equilibrium of the food chain and thus the general ecology. Others are speculative. They all point to ways humans can achieve a type of arm's-length influence over wild places, even if those places are close to areas of human habitation.

To explore the ideas contained in "Designing Autonomy," we asked Kristina Hill, an associate professor of landscape architecture and environmental planning and urban design at the University of California, Berkeley, to examine the basic precepts of injecting deep-learning methods into landscapes to promote wildness. Hill first sought qualifications from the authors about the importance of wildness as a goal and about how the Anthropocene is defined before proceeding to questions about the mechanics of the imagined approaches,

OPPOSITE
Wildness creator is a conceptual design for an autonomous landscape infrastructure system that creates and sustains wildness by enhancing nonhuman influences while countering all forms of human influence.

“HOW DO YOU SEE THE ROLE OF AUTONOMY, AND WHAT DO YOU MEAN BY AUTONOMY IN DEFINING WILDNESS?”

—KRISTINA HILL

the respective roles of human and “machine” in this context, and the ethics and responsibility incumbent on humans in the pursuit of autonomously regenerating landscapes.

KRISTINA HILL: First, I want to look at some questions that I hope frame the conversation—about definition and purpose—and start with this idea about whether wildness, the word the article uses the most, is an important goal in the Anthropocene and the way we will live in this age. Is wildness an important goal, and why in this age?

BRADLEY CANTRELL: There’s a relationship with natural systems biology or ecology that says wildness, not wilderness, poses another entity that is outside of human control, and we perceive it as something not necessarily under our purview. The form of wildness we’re talking about is happening outside our cognition and has its own logic, and we’re forced to confront that. That logic comes from some other relationship with another entity, such as machine intelligence or artificial intelligence.

ERLE ELLIS: Working in the Anthropocene, one of the fundamental principles is that human societies are becoming entangled in every other creature’s business. It’s hard to find a space where humans aren’t interfering. Where wildness is an important feature of the Anthropocene, the classic example is you’ve got a wildlife preserve, not a zoo, and yet, we’re controlling the breeding of the most endangered species in processes where we’re starting to domesticate them. Even when trying to leave a wild place alone, we’re still shaping nature. What if we can find a way to disentangle ourselves from other species’ lives? It’s almost impossible to do it intentionally because we do it anyway, so having a referee that has its own playbook might be able to change that relationship. It’s imaginable that this wildness creation at some level might enable wild places to exist even where there are humans all around.

HILL: The Anthropocene as a greater human urbanization? Or as global climate change?

ELLIS: Climate change is one of the most pervasive, because there isn’t any place that isn’t affected.

CANTRELL: In terms of landscape architecture, urbanism is at the forefront for us—how we confront continual urban expansion, and how this interfaces with other biological systems. It’s more than just urbanism or climate change.

HILL: What is the importance of wildness, and is the Anthropocene defined by climate or urbanism, one or the other?

LAURA MARTIN: Many public conversations about the Anthropocene frame it as the loss of wildness at a global scale. Part of our collaborative work has been to challenge that idea—to make space for the wild in the Anthropocene. There doesn’t have to necessarily be a trade-off between wildness and human habitation of the globe. Could we design or co-curate nonhuman systems that are partly or fully self-actualizing?

HILL: I have a question about defining autonomy. How do you see the role of autonomy, and what do you mean by autonomy in defining what wildness is? This is the crux of whether autonomous machines can create wildness. How do you see the role?

ELLIS: This also is defining wilderness versus wildness.

MARTIN: There have historically been many definitions of wilderness, and in thinking through this project, we looked at different definitions of wilderness and wildness and came to focus on the autonomy of the things themselves we are seeking to promote. Wildness is defined typically in terms of lack of control—a thing that is not controlled or a thing that does not bear evidence of human influence on it. We were looking to untangle the different attributes of wildness and think through how the questions of autonomy raised by machine learning are akin to the questions asked about wildness and wilderness.

CANTRELL: I find the autonomy component interesting in landscape and design. We’ve had this discussion about how we curate or choreograph processes and, in some situations, take this hands-off role. If we think of the technological version of that and how the technologies are forming, an approach that we might design is the learning environment for that machine and the management of ecological systems and what that autonomy produces—the production of autonomous places, where succession would take place or we would allow species to find their own places. In our paper, we go to the farther end of that and find devices that would let that occur. Autonomy plays a big role in that. The actions are being learned through the intelligence we’ve created; their actions are autonomous themselves.

HILL: The learning environment is for the machine, the processing system through which the machine gains autonomy—not the environment, the ecology.

CANTRELL: The two become intertwined. The algorithms can be generalized and the actions and reinforcement are based on the environment they’re in or the data that they’re fed. The management scheme is specific to that set of algorithms and the context in which it sits.

HILL: What is it that humans would design in this environment that you imagine? When you say, “design the learning environment,” [you mean] changing proportions of species that you’re trying to address? What are we trying to design?

CANTRELL: The actual processing space, the computational learning environment. Not the physical environment. The design in that aspect is particularly around the design of the machine intelligence.

HILL: One of the commonsense questions in reading your piece is, are you asking the reader to believe that the designed machine is an extension of human agency, but that it is not an extension of human agency once it “learns” independently?

ELLIS: I would go with a real example of one of these deep learning systems, the automatic translation systems, and how they are able to produce behavior that humans do not understand or control but they ask for it. They translate German into English and translate Japanese into English. These systems have then been able to translate German to Japanese. They have a system for producing behaviors that are not put in by the designer. They can do things the designer didn’t know how to do. It’s a system that produces its own rules. That’s the fundamental idea here; you’re producing a system where you’ve got software and hardware, and the objective is to help the other species without any clear instructions of what that is to be. The deep learning system has to figure that out. It doesn’t have programmed rules.

HILL: Like neural network processing.

ELLIS: It starts to be very difficult for humans even to understand what the machine is doing.

CANTRELL: And we’re not necessarily asking you to suspend disbelief, but even through our own human agency we end up with a series of conditions in the human environment that are outside a human understanding of the environment. What we end up with is a disconnection between how humans would manage the environment and the way we perceive the results and the way this machine intelligence would manage the environment. It begins to be disconnected with how our logics might be systematically managed. It is tricky and peels away from our understanding of management. It doesn’t make complete sense to us, when we see wild places—the logic of the biological and hydrological. The human hand might not be there. In some ways, we’re trying to make the case that the product is wild and would be perceived as wild.

OPPOSITE
Konik ponies graze in the wetlands of the Oostvaardersplassen, a Dutch nature reserve.

T. W. VAN URK/SHUTTERSTOCK.COM

MARTIN: I do agree with Kristina's characterization. The paper asks us to think of machine intelligence as separate from human agency, as something beyond human agencies. This is happening in all aspects of machine learning technology. Self-driving cars make it more clear. One of the things that terrifies people about self-driving cars is the question of responsibility in case of an accident. It's unclear whether the responsible party would be the car itself, the programmers, the company paying the programmers, the driver who is in the driver seat but not driving, or society for allowing self-driving cars to exist. Who is liable?

HILL: That's a useful example. We have developed a body of law to think of how humans are responsible. I drink; I drive; I cause an injury. Am I responsible for the injury? Is the bartender? The designer of the street? My parents? Who is responsible? We have a body of law that has developed to clarify that when we think of responsibility as a human property. But if we apply it to a machine, would we say that when the machine's perception becomes different from the human's perception of the process, that's autonomy? Would that be the point where it becomes the machine's responsibility? In some countries, responsibility is defined differently, and it could be the bartender who goes to jail. In the United States, that's less likely. In defining machine responsibility, we would have to think about autonomy across culture, human group to human group.

CANTRELL: We talked about this quite a bit and where we were taking that definition from, and how that might very strictly lead to a Western definition of wildness. But there is a range of other ways of defining it.

HILL: We also have a history of thinking about whether some humans are wild, while others are not. I'm not clear who humans are as a group and how different they are from the machine. Maybe we're talking about defining autonomy as "difference." That makes me wonder whether ecosystems managed by self-learning devices would be "novel" in a different way than we currently define novel ecosystems.

ELLIS: Novel ecosystems are so broad a definition that it could include everything on Earth right now, including novel conditions brought by climate change. Another term: Would this be a designer ecosystem? That distinction would be interesting. The design is not to have human interference?

HILL: How would you define a designer ecosystem?

ELLIS: A designer ecosystem is not so different. It's a product in which you can see the hand of the people who thought of it, the human influence.

MARTIN: One of the things Brad brought to this paper is a literature on distanced authorship. This literature seems to be in dialogue with these same distinctions. How do you design something that is, or appears, less designed?

ELLIS: That was one of the coolest things theoretically that came in from the design world.

CANTRELL: We'd be setting processes in place and allowing them to take form over time. The author's hand is not always so apparent. It's based on catalyzing events as opposed to formalizing the results. That approach to landscape 15, 16 years ago in grad school was really what we were all talking about, and over the past 15 years, we've been creating representations of what those things could be but haven't explored what the actual tools and methods are for constructing those kinds of landscapes. I wouldn't say we're explaining how those landscapes get built, but thinking about ideas of wildness and ecological management and applied technologies that are coming online. What is the outcome of that logically? A series of landscapes, novel or not, in which there are ecological relationships we may not have seen before, so novel ecologies, landscapes that are highly managed, but highly managed to seem unmanaged. In some sense, that is what we're doing in restoration or conservation—this technological model around conservation. We get to a very strange place. For us, it's a thought experiment, and extremely interesting because it lays bare the issues we have in design, these formations of these ecologies and how design might play a role in that. The active component is a series of relationships that might not have a baseline to compare to and an ecology that is not completely new, but not possible to compare to a baseline that existed in the past.

HILL: That would parallel the way [Richard] Hobbs has written about novel ecosystems as different from emergent or persistent ecosystems. The problem has been that there is no threshold in persistence—that there's no way to define the length of time required before it's considered a novel ecosystem. You might be thinking of these machine-managed systems persisting according to the life span of the machines. I don't know whether the machines can self-regenerate, or have a defined life and then stop.

CANTRELL: We weren't thinking of an actual temporal component of the management and the machines within that management. The machine intelligence is always evolving and growing. The machines are coming online and off-line during that time. And the intensity of management there is not necessarily in the paper, but it's another part that needs to be explored as a further thought experiment.

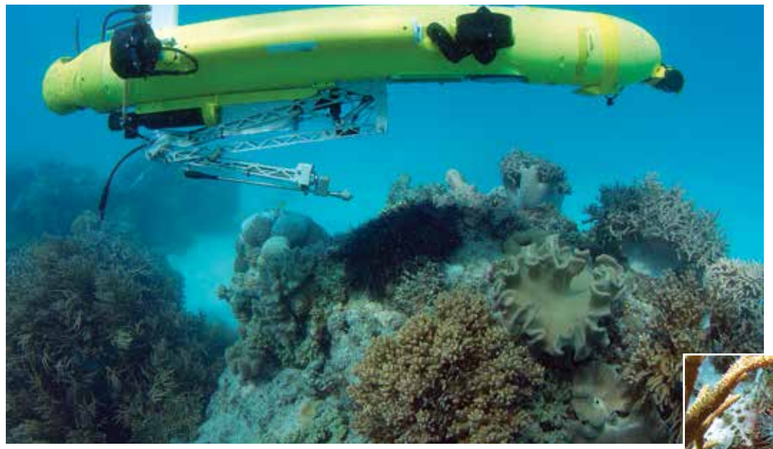
MARTIN: By the end of the project, we realized it's a different kind of process to think what the hardware would look like.

CANTRELL: It's one of those things we struggled with, to imagine what the machine is. We never really say that in the paper. It's this mysterious thing that we never really see. It's foggy.

HILL: Maybe an example would help. Let's talk about a place. I was going to bring up the Dutch example, Oostvaardersplassen. Why did that seem like a good example for the paper?

ELLIS: We're talking about this idea of giving other creatures autonomy to shape their lives. By bringing back a relatively powerful shaper of the environment, a megaherbivore—wild horses and cattle that resemble the cattle that lived wild in those regions before humans killed them off. By bringing them back and letting them run wild, and letting them die off in the winter, you are giving back a certain level of autonomy to the environment. In Oostvaardersplassen, during die-offs there are a lot of dead animals around, and people complain a lot, but this is the distanced authorship. You have to let that happen. It's giving autonomy back.

CANTRELL: There are certain species that are stand-ins for a specific condition. You're letting them run



LEFT
The COTSbot, developed by roboticists at the University of Queensland, scans for crown-of-thorns starfish and injects them with lethal bile salts.

BELOW
Rampant overpopulation of crown-of-thorns starfish contributes to the destruction of the Great Barrier Reef.

RICHARD FITZPATRICK FOR QUEENSLAND UNIVERSITY OF TECHNOLOGY; TOP: GREAT BARRIER REEF MARINE PARK; INSET

wild, but you're curating that with surrogates with similar behavior.

ELLIS: You're bringing in the animals, introducing them, but part of the design of such a wilderness area like Oostvaardersplassen is that you're creating human institutions that enforce a hands-off approach. That's part of a process. That's part of the design. The design is the creation of a social institution not to interfere.

CANTRELL: The other end is the COTSbot example; it is directed and behaving in a way that solves an upstream issue of nutrients coming into the Great Barrier Reef, so essentially developing a predator for that, killing off the crown-of-thorns starfish—finding the starfish, injecting it with a bile solution, and moving on to the next.

ELLIS: It's the same deal with self-driving cars. There's not a crisp dividing line between artificial intelligence and a machine. With a self-driving car, that's one of the higher levels of machine autonomy. What are the levels that produce design and engineering? You just tell it where you want to go. Imagine a self-driving car where you do not tell it where you want it to go. It figures it out itself. It's another level of autonomy that we're trying to address.

MARTIN: The contrast between [the two sites] captures the spectrum of actions that are already taken in restoration, from adding things to a landscape to removing things from a landscape. Increasingly these processes are being automated, whether it's the COTSbot robots that kill or remove species or drones that would reseed a difficult-to-access area. The examples we review in the paper are examples of semiautomatic labor of introducing or removing species from a landscape. We're taking that a step further and asking: What would it mean to automate the decision-making process—or to cede that process to algorithms?

HILL: It seems like the bot in the Great Barrier Reef is an example of a transitional strategy. Their goal is to stop the nutrients from coming in. They're trying to figure out how to use the bots to manage a process in the water temporarily, but the ultimate goal is to stop the nutrients from coming in the first place, by acting on the land. A lot of these autonomous technologies would be transitional strategies. For example, I don't know how long Oostvaardersplassen in the Netherlands is going to be around, with sea-level rise, but other Dutch areas will certainly be protected. Are these machine-managed systems transitional strategies, or permanent?

CANTRELL: I think they're transitional. In some ways, I'm not thinking of these methods of management as being totalizing. What is interesting is when we take a step back when there's a COTSbot, and we are standing back and letting it take an action. The idea is that it is transitional, keeping crown-of-thorns starfish at bay while we figure out a way to clean up the nutrient runoff, but it allows us to continue the runoff. As the COTSbot has this layer of machine learning in its interactions in the world and begins to learn what it's doing, it may find strategies that are outside our cognition to solve that problem. We may be able to interact; we could learn something about how that ecological system is functioning and how a more advanced version of that COTSbot might produce a more complex solution we were unaware of. The other idea is that the technologies are possibly more directed, in urban areas, toward finding ways to manage more complex ecological relationships in an urban environment. Plant material and oil might be managed in a way that might be more complex than it is today. There's this feedback that creates a heuristic about how these ecosystems are being managed. How we give back becomes really interesting. As we begin to move in this direction where we are managing ecological systems through machine intelligence, we are setting up new relationships between ourselves and the machine intelligence.

HILL: It's interesting to go back to your example of the way that AlphaGo allowed people to see new strategies in the game of Go that a human wouldn't have played. So that seems like an interesting option. How can we use a machine-learning context to gain insight about how rules play out in systems?

CANTRELL: I don't have the answer to this, but it's one of the more interesting aspects and where the opportunity lies in how we deploy these systems. We've learned to expand the scope of management and prediction. Even if we're overmanaging, we've been able to iterate and test more quickly. In some ways, it doesn't require us to develop the highly complex and accurate simulations that we've been talking about for the past 50 years. Instead it allows us to develop a more incremental approach into how these relationships form, and each time we interact with the environment, we're learning from it.

HILL: I'm wondering why you didn't choose an example for your paper from North America, such as a designated wilderness area? Did you deliberately try not to think of a place people would find very familiar? Did you choose unfamiliar or underwater sites for a reason?

CANTRELL: I don't think it was intentional. These seemed like good examples at the time, but in the global context, it wasn't something we had a discussion about.

MARTIN: We were trying to capture examples in different places. A few are happening on a prototype scale in North America, including drone reseeding in California. A lot of the examples are not going to be familiar to readers, and they are right now small-scale projects.

HILL: The Dutch example involves a clone, not a species.

MARTIN: We were thinking of de-extinction cases where those in charge of land management have specifically thought to prioritize the wildness of the place as defined by the autonomy of nonhuman species.

HILL: We're talking here about the core of the 19th-century concept of what wilderness is—that wilderness is defined in part by the presence of charismatic nonhuman species. In spite of the conceptual problems of those older definitions, we've learned a lot from the reintroduction of wolves in Yellowstone, for example. Wolves turned out to produce a different landscape, acting as top predators, than 20th-century humans did when they tried to manage the landscape without the wolves.

ELLIS: I argued against including de-extinction of the woolly mammoth as an example of designed autonomy. But the more I think about it, as a powerful shaper of the environment, it's very much like bringing in a wildness creator.

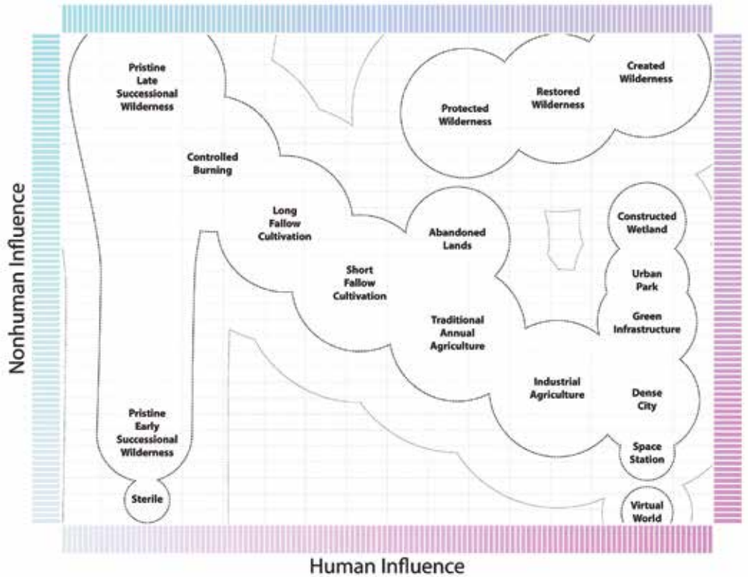
CANTRELL: You were very much against that, Erle.

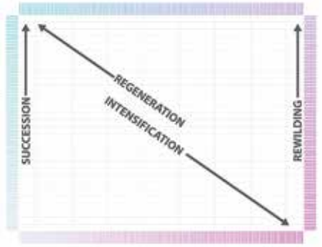
ELLIS: Well, I guess I was wrong.

HILL: This is an interesting point, thinking about wildness creators. In a linguistic and conceptual sense, humans are the original wildness creators, because we designate these

“THERE'S NOT A CRISP DIVIDING LINE BETWEEN ARTIFICIAL INTELLIGENCE AND A MACHINE.”

—ERLE ELLIS





LEFT
Relative human and nonhuman influences on ecosystem patterns and processes. The *y* axis depicts increasing degrees of nonhuman biological influence, defined here as "wildness," from sterile environments to late successional wilderness. The *x* axis highlights increasing intensities of human influence, from controlled burning to the development of dense cities.

BELOW
Processes of ecosystem change in relation to human and nonhuman influences. The axes are the same as in the image at left.

areas and create the idea that nonhuman species are wild. In that sense, rewilding will always be a human act.

ELLIS: Creation and perception—you're making them the same. People have started to treat wildness as a valuable thing. But the notion of wildness has always been around. The interpretation is new. People always knew about wild things.

HILL: I'm talking about humans as having always acted as the originators of concepts, as long as we have had language and art.

ELLIS: The perception of wildness is not the same as the effort to create it.

MARTIN: I would agree and say that wilderness preservation, in the U.S. context, began with efforts to preserve scenic views and efforts to control where people could and could not live. It was not until the 1970s that the wilderness preservation and biodiversity conservation movements aligned.

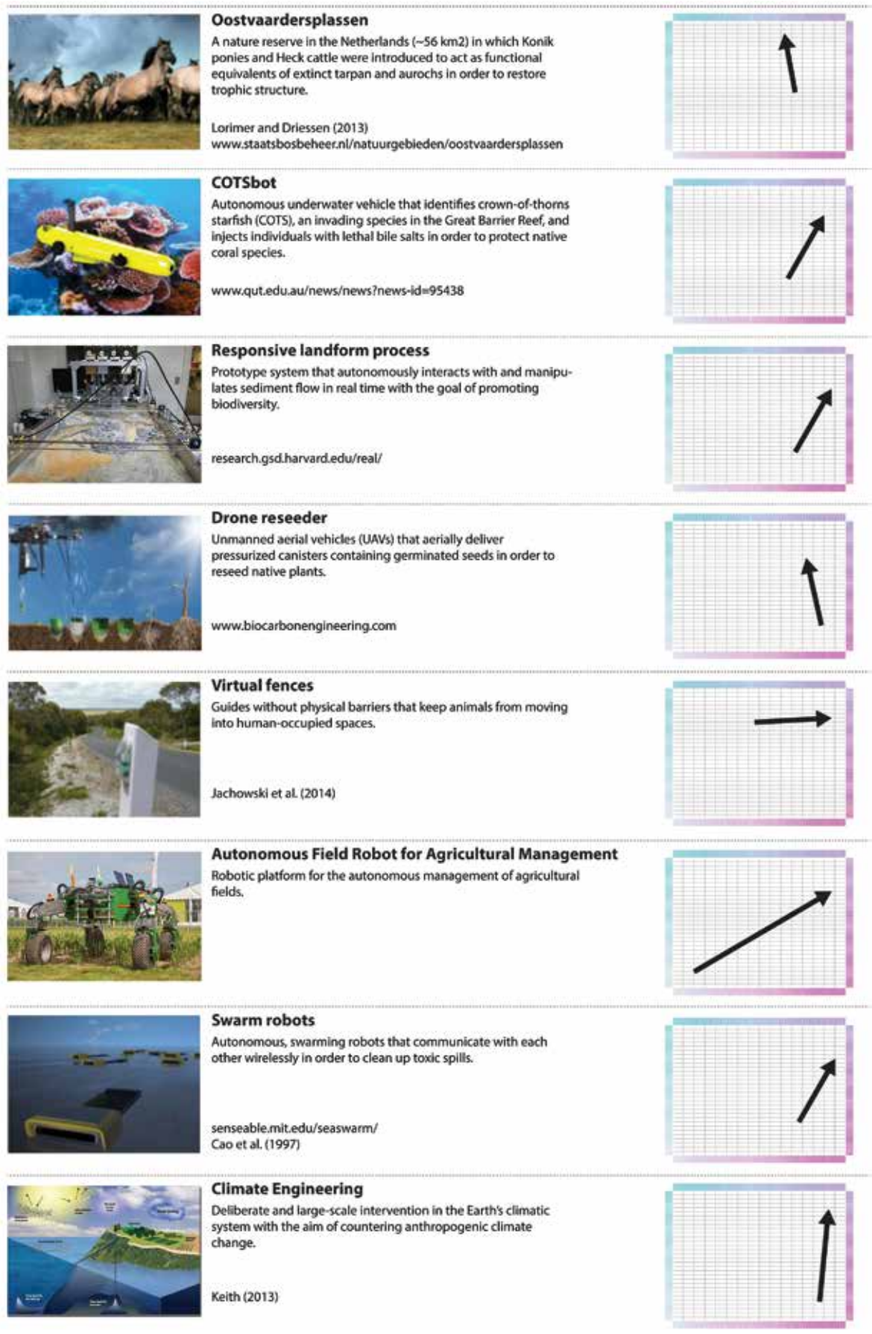
HILL: We may disagree about whether humans recently created the concept of wildness or whether ancient humans had that concept. When an indigenous people has been confronted by a colonizer, the indigenous people are often thought of by the colonizer as wild. But those same indigenous people may not see the animals in their environment as wild. Maybe wildness has something to do with control and colonization.

ELLIS: Perhaps, but in using autonomy here, we're thinking of whether an actor can be designed to behave independently of what you control.

HILL: The idea of a wilderness creator has a range—from breeding animals, in the Dutch example, to building bots. I wonder why you are defining this range of so-called wilderness creators to include the machine. Are you really interested in the spectrum of wildness creation, or the spectrum of things that are not human? Your paper defines the machine as different and autonomous from the human. Why not look at the wider range of wildness creation that includes humans, animals, and machines built by humans?

CANTRELL: I think in the paper, there's a focus on the machine intelligence components and the advances in robotics that we believe would allow these things to happen. The examples we're picking, the range of them go from wild horses to the bots as wildness creators, but writing about that range was outside the scope of what we were trying to accomplish. It required real focus because of how broad things started to get. In some sense, we're thinking of the creation of wildness as outside of human intention. And that we might be able to design a device that can create an environment

BRADLEY CANTRELL, ASLA



BRADLEY CANTRELL, ASLA

LEFT
Eight recent projects employing transformative semiautonomous strategies to eliminate, counter, or mitigate human interventions in ecosystem management. (The tables on this spread appeared in the March 2017 *Trends in Ecology & Evolution.)*

“TO LET US GET OUTSIDE OF OURSELVES THAT MIGHT REQUIRE SOME OTHER MEDIATOR, WHICH COULD BE MACHINE INTELLIGENCE.”

—BRADLEY CANTRELL, ASLA

outside human intention is new to these forms of machine intelligence. The lack of human intention has been a by-product of what we didn't design, and what we're designing now is the intelligence. We might have to remediate the environment, but we're releasing control of that. We're saying the intelligence is good enough to take on these tasks. Is this what we want? That question is certainly up for debate. We're going to move in that direction faster than we think. These machine abilities will be embedded in smaller and smaller devices. We could have autonomous bots managing agricultural systems that we can imagine right now. This does ask us to redefine what wildness is, particularly in North America, but in terms of landscape architecture, it asks us to consider the environmental stewardship we hold dear as landscape architects—as a discipline, there is a new way we are defining this. But the idea of a wildness creator, it alters our role in protecting or being environmental stewards.

HILL: In a way, you're in the genre of science fiction, since a lot of these ideas have not yet been implemented in the way you're envisioning. I'd like to bring up some fictional examples, such as William Gibson's book *Neuromancer.* I remember a particular review by Sandy Stone, which noted that science fiction includes a repeating trope of people trying to escape an embodied condition. I wonder if in thinking about drones, for military or for visualizations, in ways that create an autonomy, are we expressing a desire for disembodied existence, a desire for redefining what it means to be human as we enter the Anthropocene?

ELLIS: One of the remarkable facts is that most animals are not afraid of vehicles. So, in a vehicle, you can drive up to a wild animal and they're not so concerned. Yet when a person gets out of the car, they're concerned. But they're ambivalent about these other entities. An effort to build an interface between humans and wild species is a form of being in sympathy with them, to let them go about their lives without having to interact with us. For animals, it's not good to have us around. They don't benefit from having us around.

CANTRELL: In some ways, when we think of conservation and restoration, there is an underlying health and human welfare component but also a level of guilt in those practices. In my mind, one of the things would be a redefinition of humanity's role on the planet. Instead of interfacing nature in a way that is predicated on human wants, desires, and comfort, we're beginning to think about a system that makes larger-scale decisions about what directions these systems go and takes on many variables alongside human comfort. To let us get outside of ourselves that might require some other mediator, which could be machine intelligence—to get away from our own biases and allow a broader range of solutions and interactions with the world. Erle and I share the idea that to have a more complex relationship with other species may require a way of mediating that relationship. Our relationship with the environment may be more distant than in the past, through technology, simulation, or other methods. Our understanding of that interaction with the environment has become more complex. We cannot act on that particularly well just yet, but it is important to our understanding of the world to evolve that relationship and deal with the remediation that has to come with it.

MARTIN: The point on remediation is interesting. I summarize the paper as an effort to reorient the focus of technologists from human health, satisfaction, and wellness to ask how technology could be used to promote the flourishing of nonhuman species. I'd agree with Kristina's observation that changing technologies are changing how we think of human social systems and humans as individuals. Technological change is challenging our definitions of intelligence and creativity and the ability to design—those redefinitions are going to have real consequences in land management in the next decade. I'm thinking about a number of artists who have thought about how machine-learning systems could write text and be authors.

HILL: Or make paintings. There's a deep-learning machine algorithm that tries to produce paintings in the style of master human painters *(The Next Rembrandt)*. I want to pick up on some of what you're saying in the paper and try a different version of it. In Donna Haraway's book, *Staying with the Trouble: Making Kin in the Chthulucene,* she's interested in the politics of interspecies relationships in the age we are now entering, which she calls the Chthulucene, named after the old subterranean Greek gods. She comes to the point of arguing that we should do less in many cases, rather than do more, to create separate spaces for other species. It seems the idea of bots, drones, etc., is a way of doing more, not less. What do you think of the proposal of doing less?

ELLIS: I'd love to hear what Donna Haraway would think. She would have a take none of us would. You're taking the interaction to the next level because you're going beyond anything any organism or we can do, to nothing that exists already. You can also look at this as an effort to paint humans out of the picture. You're actually doing less.

CANTRELL: In order to do less, we have to find whole new ways of decreasing the intensity of our influence around the globe. We're taking the stance of increasing intensity in a way that implies less intensity. Machine intelligence systems might not be about acting on the land but learning about it in deeper ways. How to have the kind of continual expansion of the human species on the Earth while having less intensive operations on the Earth. In terms of our current way forward, I have a hard time seeing how doing less will get us to where we need to be. Our current forms of management of human-dominated landscapes don't need more, but need a more complex understanding of managing the biology, geology, and hydrology.

HILL: I think it's true that Donna Haraway presents contradicting ideas in her writing. Interacting with other species is a concept that exists in motion, and can't be fixed at one point in time or space. But she writes about the idea that we could try not to take action on everything—that we could instead act to restrain ourselves. We could choose not to go certain places, to reestablish the mystery of our world by limiting where we do and don't go. A restrained strategy doesn't require developing this “third thing” you're writing about, this mediating form of machine learning.

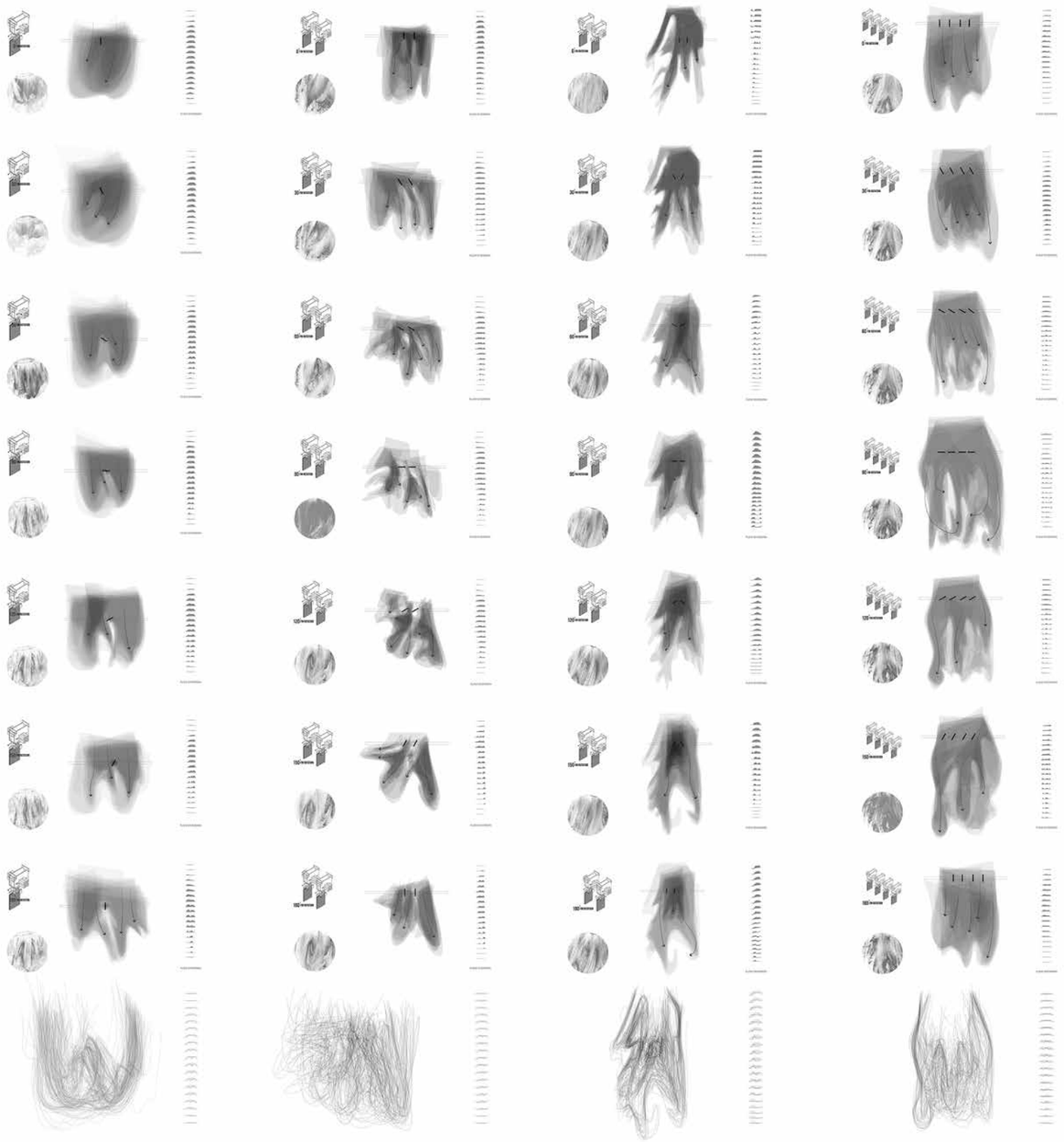
CANTRELL: My goal with the project is not advocating that this is what we need to do. It's about painting a picture that allows us to dive into questions like you're starting to bring up. With Donna Haraway talking about a more complex or nuanced relationship with the environment, how do we get there? Not to a more primitive space but to a more enlightened way of interfacing with the environment.

MARTIN: I read Haraway's most recent work on the Anthropocene and Chthulucene as a call for refuge that doesn't lean on resiliency. We need areas of undetermined potential. Conservation that doesn't depend on the idea of keeping humans out, a complication of the distinction between technical and natural.

HILL: The question of how do we learn, along the continuum of the machine and the body, is important to us in being able to make a distinction about who we are. I don't think the ideas of “purity” and “progress” have to be part of the approach; they can be counterproductive. Haraway is a touchstone for me because she doesn't use those concepts much.

CANTRELL: In terms of our idea of defining wildness, there is some definition we're aiming for, although the path there might be outside of our kind of understanding. I don't think it is ever part of our intent, that pure wildness is the only desired result.

ELLIS: I agree. If you can name and produce the wildness yourself, then



TYLER MOHR AND ANDREW BOYD

KEITH SCOTT

RIGHT
A recent exhibition at the Harvard Graduate School of Design shows methodologies for developing relationships between autonomous infrastructures and land formation. Exhibit design by Bradley Cantrell, ASLA, and Jeremy Hartley.

OPPOSITE
Research by Tyler Mohr and Andrew Boyd examining land formation as an indeterminate process in fluvial landscapes. The illustrations depict landform within a range of probability and directly relate the forms to the operations of physical infrastructure.

it's not what we're shooting for. It has to be something that is not just classic restoration, an image of what nature should be, and you just make it. A project like this has to have some of that in it, but the intention is to make not something that we know but something that we don't know. It's not about what we desire.

MARTIN: We do ask what would it mean to design a system that is free of human influence. In that way we are not using the language of "collaboration" with technology. Our purpose is not to advocate that approach as a way forward for landscape management but to open up technical and philosophical questions about what that approach would look like—questions about design and landscape management.

ELLIS: It's not just philosophical. It's a design and concept. I'd like to see some experiments. It's far from anything we can apply. It's an experimental idea. It might never be a good idea in reality.

HILL: I have been interested in how folklore affects the way people interact with the landscape. In folklore such as traditional Irish fairy stories, fairies are human-sized but have different powers and live in different ways. This kind of folklore introduces an anthropomorphic character that acts as a mediator, something humans learn from through interactions over time. In a sense, the autonomous machine represents an independent character as well, a mediator that allows us to see the world differently and see ourselves differently.

CANTRELL: It's obviously a product of humanity but an extension of our slow understanding of our relationship with the environment.

HILL: It does raise the question of whether this is a "should"—should we try to introduce autonomous machines or breed ancient animals? It's kind of a prosthesis for human experience. Are we talking about it as a kind of "progress"? Or would we do it just because we can? And is it something we should do?

CANTRELL: My take is that it's a should with caution. For me, these forays into machine intelligence are an extension of human agency but also an extension of the human brain and the collaboration with our own ability to think, perceive, and understand the world. The fact that they're all autonomous physical management devices is one aspect. How we would deploy them would be another question. Like methods of modeling, it's a form of representation of the world through this other intelligence, and how we begin to interact with that becomes an important step in our understanding of the world.

MARTIN: I'm not convinced that we should embark on creating a prototype of the wildness creator. But should we call for interdisciplinary work at the intersection of technology and design and landscape management? Absolutely. There are many things to be critical of in landscape management right now, and it's an ever-changing and ever-dynamic landscape. Recent calls to set aside large areas for protection of other species purposefully elide political and social questions, questions of power that we cannot run away from. We cannot save other species and ecological processes by setting humans and technologies apart from everything else. Given the science of global climate change, it's a fiction to think that untouched areas exist right now, never mind into the future.

HILL: As you were talking, I was thinking about genetic modification. We have experimented with it. Once it begins, it creates a new social and political landscape and may quickly alter our sense of what's good. But instead of modifying the gene, we're talking about modifying the landscape through the agency of machines and organisms we initiate but don't control. ●