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.
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 wilderness, the word the article uses the most, is an important goal in the Anthropocene and the way we will live in this age. Is wilderness an important goal, and why in this age?

BRADLEY CANTRELL: There’s a relationship with natural systems biology or ecology that says wilderness, 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 wilderness we’re taking 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.

ERIE ELLIS: Working in the Anthropocene, one of the foundational 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 wilderness 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 on the planet. Part of our collaborative work has been to challenge that idea. We’re trying to find a space for the wild in the Anthropocene. There doesn’t have to necessarily be a trade-off between wilderness and human habitation of the globe. Could we design co-ordinate human systems that are partly or fully self-actualising?

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 wilderness is? This is the crux of whether autonomous machines can create wilderness. How do you see the role?

ELLIS: This also is defining wilderness versus wilderness.

MARTIN: There have historically been many definitions of wilderness, and in thinking through this project, we looked at different definitions of wilderness and wilderness and came to focus on the autonomy of the things themselves we are seeking to protect. Wilderness 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 want to understand the autonomy of wilderness and think through the questions of autonomy raised by machine learning and 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 technologist implementing, an approach that we might design is the learning environment for that machine and the management of ecological systems and what 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 generalised and the actions and reinforcement are based on the environment the system is in or on 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.

ELLIS: One of the common 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 we 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 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 preprogrammed rules.

HILL: I see 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 we think the machine would manage the environment. It begins to be disconnected with how our logic might be systematically managed. It is tricky and peels away from our understanding of management. It doesn’t make complete sense to us, and 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.
Society for allowing self-driving cars in the driver seat but not driving, or the programmers, the driver who is responsible would be the car itself, the machine. It's unclear whether the responsibility in case of an accident is the programmers, the company paying the programmers, the designer of the machine. Maybe we're talking about where the responsibility lies. How would you define a designer ecosystem? There are certain species, ecosystems, 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. 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 materializing the results. That approach in landscape, if 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 these kinds of landscapes. I wouldn't say we're explaining how those landscapes get built, but thinking about ideas of wilderness and ecological management and applied technologies that are coming online. What is the outcome of that logic? A series of landscapes, novel or not, in which there are ecological relationships we may have not seen before, so no 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.
I think they're transitional strategies. For example, I don’t know how long Oostvaardersplassen 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?

ELLIS: 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.

CANTRELL: I don’t think it was intentional. That’s what we were thinking of de-extinction cases where those in charge of land management have specifically thought to prioritize the wilderness of the place as defined by the autonomy of nonhuman species.

CANTRELL: You were very much a social institution not to interfere. It’s another level of autonomy that we’re trying to address.

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 than a human wouldn’t have played. 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’re learning the scope of management and prediction. Even if we’re overmanaging, we’ve been able to iterate and test more quickly.

HILL: There’s not a crisp dividing line between artificial intelligence and a machine.

—ERLE ELLIS

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. The design is the creation of a social institution not to interfere. 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 it 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 need 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 code 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 is 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’re 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 do 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 than a human wouldn’t have played. 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’re learning 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 to think of a place people would find very familiar? Did you choose unfamiliar or underrepresented sites for a reason?

Cantrell: I don’t think it was intentional. Those 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 of the examples 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 wilderness 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 human managers 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 wilderness creator.

Cantrell: You were very much against that, Erle.

Ellis: Well, I guess I was wrong.

Hill: This is an interesting point, thinking about wilderness. In a linguistic and conceptual sense, humans are the original wilderness creators, because we designate these species as wilderness creators, because we designate these species as wilderness creators, because we designate...
areas and create the idea that nonhuman species are wild. In that sense, rewilding will always be a human act.

ELLIS: Creation and perception—people making them the same. People have started to treat wilderness as a valuable thing. But the notion of wilderness 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 wilderness 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 wilderness or whether ancient humans had that concept. Where 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 wilderness 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 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: In the paper, there’s a focus on the machine intelligences 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 bots as wilderness 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 wilderness as outside of human intention. And that we might be able to design a device that can create an environment.

Below
Processes of ecosystem change in relation to human and nonhuman influences. The axes are the same as in the image at left.
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 try to remediate the environment, but we’re releasing control of that. We’re saying the intelligence is good enough to take on these tasks. In this 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 farming, controlling 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 a discipline, there is a new way we are defining this. 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 implement- ed 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 instance—Sandy Stroh, which noted that science fiction includes a repeating trope of people trying to escape an embodied condition. I wonder if it thinking about desires, for military or for visualizations, in ways that create an autonomy, are 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 and live 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 what kinds of ecological changes we’re going to have in the next decade. I’m thinking about a number of artists who have thought about machine-learning systems could write text and be authors.

HILL: Or make paintings. There’s a deep-learning machine algorithm that tries to paint 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, Stay- ing 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 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 both drones, etc., is a way of doing more, not less. What do you think of the proposal of doing less?

ELLIS: I’d like 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 de- creasing the intensity of our influ- ence around the globe. We’re taking the chance 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 by not taking 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 ques- tions 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 re- cent work on the Anthropocene and Chthulucene as a call for reform 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 act, along the continuum of the machine and the body, is important to us in being able to make a distinc- tion about who we are. I don’t think the idea of “purify” 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 wilderness, there has been a defini- tion 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 wilderness is the only desired result.

ELLIS: I agree. If you can produce and understand the wilderness yourself, then
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 wilderness 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, particularly puts 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.