

The Land Report

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Complexity!

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Cover Photo: Sally Cole

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Rebecca Green

Bounded Rationality

Brian Donahue

I am a reductionist. I like taking things apart to see what's inside. I love splitting wood, for example. Take down a whole tree, cut it into precise lengths, split them, stack the pieces back up in a pile to season. Where the tree stood, now you have a cord of wood. It is satisfying to impose this kind of order on nature, reducing it to simple terms, making it comprehensible and useful.

This kind of reductionism has its limits. I would not be particularly happy with an entire forest reduced to straight white oaks in neat rows. I do not believe that if we could just cut the whole world down into quarks, we could then put it back together in a more orderly, productive fashion, and live a better life. Meddling with nature is best when nature is left with most of the responsibility. I have helped "manage" a couple thousand acres of forest, but this was just manipulation within limits. The complex forest was doing the real managing itself.

In April we burned the prairie. Many people at the Land thought I would take this as a personal affront, since as a newly arrived Eastern woodlander I had been kidding everybody about the way the trees are taking over around here. People have been burning the tallgrass prairie for thousands of years, probably, keeping the trees out. No one is sure how much our species was responsible for maintaining this ecosystem. In any event, nature has the means to manage it perfectly well either way, as prairie if it burns or as forest if it doesn't. I figure we have plenty of forest in this country (even if we often mismanage it so badly that even nature is perplexed), and precious little prairie, so let's burn it.

Burning the prairie was a blast. Picture a tractor hauling a water tank down the road, followed by an excited Ecuadorian riding a bicycle named "Free Spirit," followed by two pickups crammed with other Land Institute interns and staff, more sloshing water barrels, and miscellaneous pyrotechnic gear. The wind was

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THE LAND INSTITUTE IS A NON-PROFIT RESEARCH AND EDUCATION ORGANIZATION DEVOTED TO SUSTAINABLE AGRICULTURE AND GOOD STEWARDSHIP OF THE EARTH

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northwest. We dropped a match in the northeast corner of the 160 acre quarter-section and split into two crews, working backfires along the north and east sides. My crew had it easy: we dragged the fire a half a mile south down Holmes Road, and then we turned the corner and dragged it another half a mile west down Water Well Road. The fire did jump the road once, but we won't speak of that little incident.

I decided dragging fire along for miles with a rake was way more fun than you can have in public in Massachusetts. We skirted the parking lot, took a turn around the Wauhob Prairie on the west end, and headed back up into the bottom. Now the wind was behind us, and the fire ran east toward our slow moving backfires at a terrific rate. Meanwhile, the group up on the north line was having a harder time of it. They had to breathe through wet, sooty burlap sacks. The wind kept shifting slightly into the south, pinning them against a tall barbed wire fence. When the fire got past the fence, they had to climb over and beat it out, while trying not to offend a few curious bison who wandered over to offer assistance.

Things got worse on the north line when they drove the tractor and water tank smack into the bottom and got it stuck. They sent for the big tractor and that got stuck, too. As we brought our fire up the southeast side of the bottom to meet them coming down the northeast side (having decided to forego the hill in the northwest corner), we noticed our last, least tractor heading up there like the little engine that could, followed by Jack's pickup at high speed.

"This is a male thing," I explained to one of the interns, as my fire met her fire and we shook hands, like the driving of the golden spike. I wasn't involved in it, so I could afford to be philosophical.

"Once we get something stuck like that we're going to get it out, by God, even if we get everything else stuck in the process." She laughed and said she was glad she was a woman. Later, she and another intern walked back to retrieve a pickup that had been prudently left on the far side of the bottom, drove it a couple miles in a circle, and left it hopelessly stuck in the bottom, too.

Sally came out and took a picture of virtually all of the Land's machinery lined up in the mud, with the bison standing there observing the wildlife. That was going to be my cover photo: "Complexity Rears its Ugly Head Again at the Land Institute." Unfortunately, she didn't have the right lens for a shot like that. I'm not sure the right lens has yet been made for a shot like that. Jack got ahold of a Cat D9 over the weekend and pulled everything out. Meanwhile, the rest of us crawled off into the low-peaked landscape of simplified desires and retold our stories over pizza and beer.

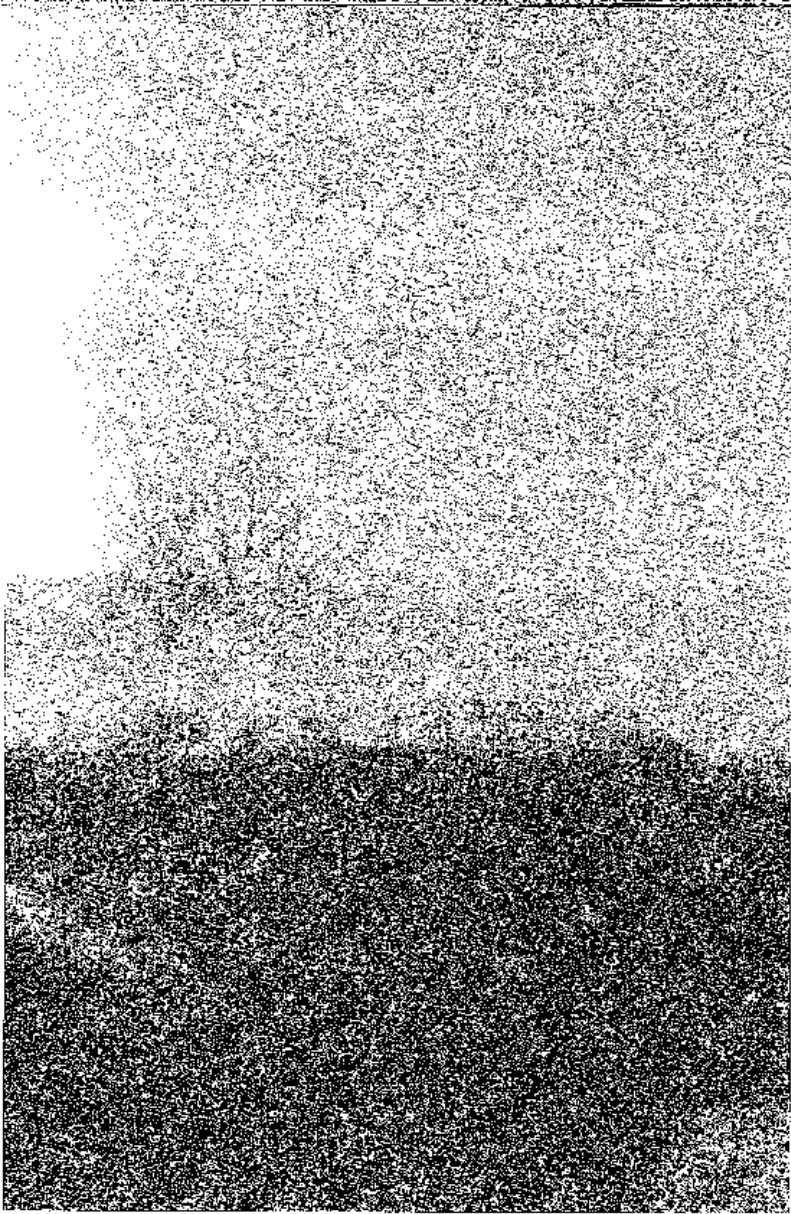
For a guy who loves to mess with nature, looking over half a mile of rolling, pure black prairie in the rain the next morning was sheer exhilaration. It had the same simplified, orderly look as a woodlot that has been thinned and left full of neat woodpiles, but what a scale! Of course, that simplicity was an illusion. Most of the life of the prairie is underground, and fire is just a simple mechanism to maintain one highly complex order of grasses and forbs, as opposed to another of trees and shrubs. Warmed and wakened by the fire, complexity was ready to re-emerge from the roots.

Reductionism is a powerful and dangerous tool for understanding and manipulating nature. It works best within a more complex protective reality. Stretched too far, its ability to explain and control nature passes its limits, and its simple linear systems break apart. It is our belief that large-scale tillage of prairie soils is one bad example. Large-scale clearcutting of temperate rainforests is another. There is a place in this world for techniques such as cutting trees and tilling soils, done on scales or within rotations that embed them in natural systems, in parts of the landscape that can accommodate such disturbances. Here at the Land, we are working slowly, like the crew along the north line, to develop a form of agriculture that incorporates more of nature's complexity internally. This involves us in trying to understand and create complex systems ourselves.

Over the past year, thanks to a grant from the Rockefeller Foundation, several leading scholars in complexity research have visited the Land Institute to help us think about complex systems. I am simple-minded myself, so for this issue of *The Land Report* I have tried to pick out parts of their talks that explain complexity in simple terms. The transcriptions were done by Corey Samuels, who also coordinated the scholars' visits. Most of these excerpts remain about as they were delivered, with some editing by the authors and myself. Dr. Sing took the opportunity to redraft his remarks into a more formal essay. Articles by Jon Piper and Wes Jackson give the view from our side.

Portia, Audrey and Rebecca, fresh from the north line, are pictured on the cover. That's the prairie fire behind them, burning itself out. Sally Cole took the picture. Rebecca Geisen took the picture on the back cover; that's Jack, like it says. When complexity arises, he can deal with it.

*Brian Donahue is Land Institute
Director of Education*



Rebecca Gleason

Complexity at the Land Institute

Wes Jackson

No system is simple. Some we can afford to treat in simple ways, like a home heating system which features a thermostat. Some we should not but do, a wheat field, for example. To a large degree it is a matter of boundary setting for what we choose to take into account and what we *de facto* elect to ignore. The economic system, a product of the human mind, is relatively simple and simplifying of things like wheat fields. Wheat fields experience high yields these days because individual wheat plants are manipulated as statistical entities. R. A. Fisher, the father of modern statistics, helped us understand how to treat both that individual plant and the population of which it is a member.

Let's say the interest of a wheat breeder is the range of resistance to wheat rust or the range of resistance to green bug, both of which might follow a normal distribution. It is straightforward. You calculate a mean, the standard deviation — do an analysis of variance. This knowledge of statistics is essential for proper experimental design and data analysis. It works, for indeed there have been yield increases in wheat and in essentially all of our major crops. We feel pretty good about ourselves, maybe even a bit heroic. The statistical tool is "powerful," we say. Powerful it may be, but the assumption is that wheat yield at as low a dollar cost as possible is what it is all about. We have, perhaps without thinking, set a boundary — some of us now believe too narrowly. It is because of a partitioning out of certain variables that are of no immediate interest, however, that we get results. Unfortunately, it is the partitioned out variables that we might wish we had one day, like resistance to

some new pest. Nevertheless, we have done what the early 17th century philosopher of science Rene Descartes said we should do, break down a problem to the point at which there is no ambiguity. The paradox is that it is at that precise point where all ambiguity is gone that our object of interest becomes totally irrelevant!

The point is we have failed to look outside our results to a larger realm of necessary considerations. It is not a simple matter of getting a little more complicated by looking at three or more variables at once, though that is what we once assumed. For my own Ph.D. work in genetics nearly 30 years ago, I employed what is called a multivariate discriminant analysis. I used seven characters at once to see whether plant structure correlated with three chromosomal races of plants which grew in the Southeastern part of the U. S. This effort kept me in shape, for it required that I lug numerous boxes of punched cards over to the computer center to run on a program written in Fortran. The next morning, if I were lucky, I could pick up my cards and my print-out and disappear back to the lab to pore over the numbers generated, resort my cards and do it all over again. Eventually I incorporated the results into a thesis.

Even though it was a minor part of my study, the power of that machine was impressive then. It seemed powerful just in size for it required a few hundred square feet of floor space and demanded exquisite climate control to do what an inexpensive laptop you can carry onto an airplane with one finger can do now. But what it did was still simple statistics, seven dimensions of reductionism melded together which was supposed to give me a more precise mathematical view of the reality cluttered by variability.

Everybody knows the story of what has happened since. Because of advances in computer technology we are now able to study these same systems using numbers of variables unimaginable even ten years ago. Systems theory is now a field. But we still can not get our computers to reveal the emergent properties which may pop up when scale is increased or when intersecting variables come together. System programs are just another form of reductionism.

Complexity, as a field, does not come out of the statistics of R. A. Fisher or systems theory. It comes out of chaos theory. Early on I was skeptical about it. Friends of the Land know of our resistance to being overly awed by every new thing, or by high tech heroics

of any sort. Nevertheless, I must say that I believe that complexity thinkers have something to offer. Most of the complexity people are still fuzzy, many are not eloquent, some are just looking for a way to make a name for themselves. That is the way things seem to go. But one can not ignore the curves which are common on the screens of physicists, economists, and ecologists. I don't understand the math, but it sounds as though when complex systems of a seemingly diverse nature are studied at deeper levels, there may be something more going on than that the families of curves generated from various disciplines resemble one another.

How important is the field of complexity to the Land Institute, and why? We have no idea how important it is at the moment. But as a Friend of the Land you are aware that we are putting together several species to provide a rough structural analog of the prairie, a "weak mimic," we call it. That prairie we are imitating is complex. We dare not treat our polycultures as wheat or corn fields have been treated. Our plots are more like a whole person who possesses a heart. Some medical statisticians are still tempted to take all hearts of a certain age and sex group, say, and place them under the normal distribution of "hearthood" in America and then make probabilistic statements about the likelihood of a heart attack. The problem with regarding hearts as existing in "hearthood" like wheat plants in a field is that all hearts are not interacting with other hearts in a simplifiable way like an individual wheat plant is with other wheat plants in a monoculture. That heart has to interact with all the other organs of the person's body and beyond to the pressures in his or her life, as well as to the history of those pressures, and finally with the hearts of others. The wheat field also has interactions we have chosen to ignore. It is heavily dependent on an economy that is extractive and polluting. On sloping ground it will cause soil erosion. We need ways of thinking about agriculture that are as complex as necessary — meaning an exercise in judgement as to what constitutes "good enough."

So now comes the field of complexity and a different sort of vocabulary. You hear such expressions as "fractal analysis" and "genetic algorithms." These terms may be mathematically difficult, but they are not conceptually all that hard. Take fractal analysis, for example. Books have been written on it but what it boils down to is that the scale in which we choose to study something often leaves out factors which will catch us eventually. Here is an example. Say you want to know the length of a shoreline. If you choose a yardstick and have your minimum unit be a yard, your shoreline will be shorter than if you used the inch. The smaller the unit, the longer the shoreline. The smaller the unit, the more times you will see the direction of a shoreline going opposite to the general direction of the shore. This sounds like reductionism, and here it is necessary that while we have no objection to reducing things, breaking a problem down, we object to reduction as ideology in which priority is placed on part over the whole and especially where interaction of parts is ignored.

Now, let's imagine that there are some eddies offshore which for some reason are of interest to us and they are not explainable with the one yard measurement but are with the one inch. This is a most crude and simple example, but it does illustrate an aspect of what complexity addresses. How do we measure the prairie to

find the information we need to use nature as our standard? This is new to all of us at the Land. We don't know where it is headed, and though we are not devotees, we are more than casual observers of the unfolding of the discipline.

More than 20 years ago, Jay Forrester at MIT wrote a paper entitled "The Counter-intuitive Behavior of Social Systems." He did not have a satisfying explanation, to me at least, for why this was the case, but he was on to some thing — the counter-intuitive aspect — that a growing number of people from economists to ecologists have been worrying about. Complexity people have jumped into the middle of that problem. One of these times after they dive down they may come up with news of some current they have seen in the deep wellings below, something visible only as eddies on the surface.

In the long run this new field may go down. I don't think it will but even if that turns out to be the case, it should leave us with greater humility by revealing our profound ignorance about the nature of things. In the end, that may be complexity's most important product.

*Wes Jackson is President of
The Land Institute*

Intern Jeremy Plotkin



Rebecca Geisen



Am Thorpe

Single-Peaked Dining

Fitness Landscapes

Stuart Kauffman

Stuart Kauffman: Here is the idea. I want to pick up a thing that has N parts. Each part makes a fitness contribution to the whole — for example, the fitness contribution of wings to an airplane. Pretty important. The next idea is the essential one: the fitness contribution of any one part of a thing also depends upon other parts of the thing. I'll use the phrase "epistatic interactions" for these interconnections among the parts, which is what geneticists call them. So here is the N - K model: each part " N " makes a fitness contribution that also depends upon the states of K other parts. So " K " is the second part of the N - K model. It is how many other parts influence any one part.

John Todd: So the game is really to find out what K is. We know what N is.

Stuart Kauffman: Yes. And the whole point of this is to make a model world where we can tune K and see what happens. First, make a world having the property that K is zero. Every site is independent of every other site. It is a very simple model, and it will turn out to have a single peaked landscape. But if the epistatic interactions become very rich, so that every part interacts with every other part, the landscape gets very, very rugged ... As K gets larger, fundamentally what is happening is all of these couplings among the things create conflicting constraints. And when there are conflicting constraints, and maybe an easy example is with an airplane, if you want to make the supersonic transport, one group goes up and designs the wings, and somebody else comes along and says terrific, now we are going to design the hydraulics. This is actually the way they do it. It sounds pretty stupid. So now you design the hydraulics. Unfortunately, you have to fit the hydraulics into the airplane, with the wings. It turns out that a superb solution to the wing structure happens not to fit with the superb solution for the hydraulic structure and now you have to find a compromise between those two. So now you have to go back to the drawing board. And then you have to figure out how to put in the seats and so forth. What actually happens is finally someone says, we are going to have pink lavatories. And that fixes everything and everybody falls into place. It is

K=N-1



"Maybe an easy example is an airplane. It turns out that a superb solution to the wing structure happens not to fit with the superb solution for the hydraulic structure. And then you have to figure out how to put in the seats and so forth. What actually happens is finally someone says, 'We are going to have pink lavatories,' and that fixes everything. It is almost as bad as that."

Many-Peaked Dining

almost as bad as that. I gather that hard design problems are hard for these kinds of reasons. It is a very high dimensional space. People get stuck. Whole groups are interacting...

Anyway, as K goes up, the fitness landscape goes from having a single central peak to being more and more rugged, and finally when K is as large as possible, it is a random landscape. So the underlying notion is conflicting constraints, and Wes, what you are talking about, when you are talking about allocation of energy to seed as opposed to root as opposed to leaf, those are the conflicting constraints. And if you try to optimize a single thing, the rest of the organism may croak, or if you try to optimize ten different things across the organism, namely, seed and leaf area and photosynthate and capacity to pump stuff like water and hold it in the vicinity of the root, as you increase the number of things you are selecting for, there are always going to be more conflicting constraints.

Wes Jackson: I don't know if your model deals with this or not, but in the case of this eastern gamagrass mutant that we call "pistil" we're getting extra seeds, but there is no penalty to the plant. I mean the plant is not robbing from Peter to pay Paul, it just photosynthesizes more.

Stuart Kauffman: In that case you're home free. You can optimize on two things independently. If they are independent of one another, go for it. But in general, as K goes up, the landscape gets more rugged. There are more peaks — and because there are more conflicting constraints, the peaks actually get lower. You can see that they might. If you have to make more compromises among more arguing people, you will finally wind up going to McDonalds rather than to one of the seven superb restaurants in Salina.

Stuart Kauffman is Professor of Biochemistry and Biophysics at the University of Pennsylvania, and is associated with the Santa Fe Institute

Community Assembly

James Drake

Jim Drake: In the assembly work I have been doing, there is a deviation in the way that a community behaves versus classical ecological theory. Classical theory has a very strong hierarchy where the dominant species clobbers everything else in a real nice linear relationship. But I began to notice a very strange phenomenon. Sometimes the dominant competitor wins hands down, but if you build the system in a certain way, it doesn't. It doesn't exclude the other species.

I used a little chamber of interacting species. It has water and a nutrient reservoir and a pumping mechanism to put the stuff in, and an outflow to measure the nutrients and control everything. You keep everything perfectly sealed so you know exactly what species are in there. You can introduce them at different densities and at different times. The species are immaterial. We will call them A, B, and C. They are green algae.

When you put all these species in together at the same time, species A always excludes everything else. No matter what happens, this is always the result. Put them all in simultaneously and species A wins. Everything else goes extinct. A becomes exceedingly dominant. It blows everyone else away.

But yet when you look out in nature you see that there are some species that are not the best competitors, and in one-on-one competition they are going to get clobbered. But then how come they are out there and how come you don't just have one species covering the face of the earth?

So, what happens when we play some games with them? Let's add B first, and then A second and C third, and see what happens. We find that species A no longer has that competitive primacy where it can blow everyone away and destroy them. We get alternative states. Depending on how we build the system, we can get things happening like species B beating A, A beating C, C beating B, and so on. The linear hierarchy of competitive ability is now gone and we get these intransitive

relationships. In fact we can get coexistence of all those species if we build in a certain way.

Computer models are obviously an easy way to try this on a larger scale, with more species, because you just tell them what to do and they go off and they run, and the weather can be cold and nasty and it doesn't matter. Here is how you build communities. It looks awfully easy, doesn't it? The first step is to construct the species pool. With a computer this is real easy because you say, make me 2000 species, make me however many species I want. For growth rates I want them between these ranges. If I want interaction terms between them, I just specify the range that they can possibly be, and let the computer randomly decide who is going to feed on who and so on. Then the idea is to start introducing these things one species at a time into a developing community.

So in both computers and in constructing a real system you define this pool of species. Then you start off with some initial configuration, a base community I call it. In the experimental system, the base community is one producer. It didn't make much sense to put a consumer in first. I learned that right away. But in the computer model, I put in two producers and an herbivore as a starting point, and those are trophic interactions. Then, I go to the species pool, pull something out and put it in and see if it fits. If it does, fine. If it doesn't, throw it back in the species pool, pull out another one and see if it fits, if it does fine. And you just keep doing that.

After this period of building for a while, a strange thing happens: you get to a point where no further invasions are possible. It turns out that this result holds for a species pool of any size. You need correspondingly longer time, but this result holds no matter what. There may be 125 species in the pool the computer has to work with — goes in and pulls them out of the pool, puts them into the system. And sometimes after 400 invasions and sometimes after 1500 invasions you get to an invasion resistant state. At this point, nothing remaining in that pool can get in.

Now this is the fun part. When you run it again, using the same species pool, if you use a different order of invasions you get a different endpoint. Using different

sequences to construct these systems tends to give you alternative states. And here is another interesting thing: when you get to this community state, the invasion resistant endpoint, if you just take those final species, put them back in the computer, and try and rebuild the same community with just those pieces, you can't. So we can not go out and take all the species from the mature oak-hickory forest or the tall grass prairie or whatever, throw them out there and expect to get the system. It is not going to happen. In fact it is very, very difficult, given just those species to reconstruct the endpoint.

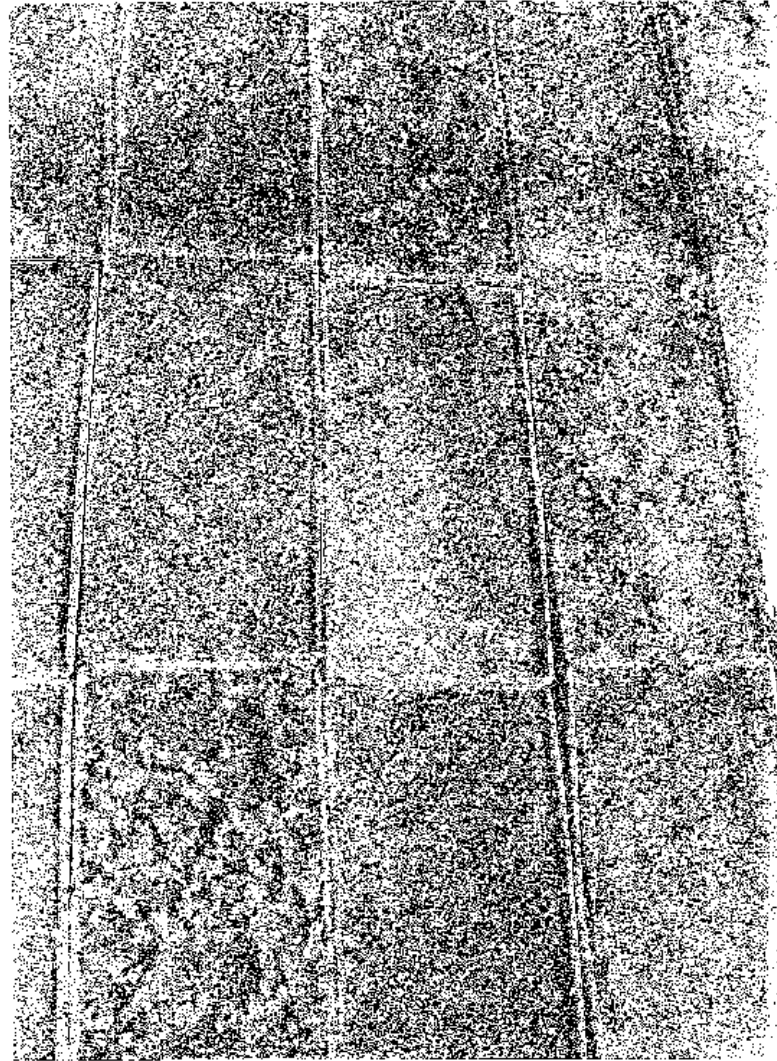
Chad Hellwinckel: You mean it is dependent on other species that have become extinct?

Jim Drake: That is exactly right. Facilitating species. A species that is not in the final system, but is integral for something else to get in. Once that something got in, the facilitating species could go out, no problem. That is an entirely unexpected property. There is no way that you could predict that. These results were basically totally shocking. They weren't even the questions that we were asking when we first made the model. The questions were more standard food web structure questions. Then this stuff popped out, and we said, okay, what in the world is happening here?

Wes Jackson: Who or what determines what the rules for assembly are?

Jim Drake: They are emergent properties of how the system builds, and my basic argument is that you can walk out into nature, with National Science Foundation grants of a zillion dollars, measure everything perfectly, and still not understand why that system works the way it does, because it is historically derived. Without that knowledge, forget it.

*James Drake is Associate
Professor of Zoology at the
University of Tennessee*



Rebecca Geisen

When you get to the invasion resistant endpoint, if you just take those final species, put them back in the computer, and try and rebuild the same community with just those pieces, you can't. So we can not take all the species from the mature tall grass prairie, throw them out there and expect to get the system. It is not going to happen."

"Order comes out of chaos in a very simple, profound and topological way. The problem is how we can get order quickly, because we are not in the business of creating prairies over a million years."

Species Shakedown

Stuart Pimm

Stuart Pimm: There has been a long tradition in ecology that complexity is good, that complexity begets stability. It talks a lot about the evidence that complex systems are more stable than simple ones. In that tradition, we are alarmed at the simplification of nature. We are concerned that we are simplifying nature, because if we simplify nature we will make simple communities and simple communities will not be stable. They will lose species, and things will get worse.

Well, we now know that complexity is not always our friend, because complex systems are extremely hard to put together. We know that from models, we know that from efforts like Biosphere II; it is extremely hard to put together a complicated system like that. Bang! Put all the pieces together and expect it to work. That doesn't happen. The question, then, is how does complexity get there? We see that nature is complex and it is our best guess that it gets there because nature wasn't created yesterday. Natural communities are the end product of a long process of assembly where species are coming in and out. And we find, both in our models and in the microcosm studies which Jim Drake is doing, that we get complexity. What is more, we get persistent complexity. But we don't get it immediately. We get it after a long period of adding species to communities and watching them come in, displace other species, and go extinct in their turn. And some very simple topological models seem to suggest that we always get persistence. We get order for free.

But if we assemble things randomly, you might think that we can't get a complex system. All sorts of processes lead to exponential divergence in nature. Extraordinary chaos can come from even the most simple, deterministic process. You would think that if we put all that mess into an assembly, if we just simply try putting pieces together at random, that we would end up with a mess, and we don't. Repeatedly, we get order. Order comes out of the chaos in a very simple, profound, and satisfactory topological way. The problem, then, is how we get that order quickly, because we are not in the business of creating prairies over a million years.

So we are looking for ways of building complex, persistent systems. What the team here at the Land Institute has done is to try to find a way of assembling

the four species that they want, by trying various combinations of the four species in various frequencies to get them to work. My guess is, there is not better than a snowball's chance in hell of getting those species to work as four species, simply because the probability of finding a complex system that works is vanishingly small. The way to get a complex system to work is to do what we call a shake-down, you know, actually get a lot more species in the system. We may have to keep on adding species because while getting those four species to work and to be persistent and yield year after year without constantly weeding and seeding is remote, perhaps getting those four species plus two other species to work is more likely. Even if we had the four species we wanted plus twelve others, or sixteen species. In other words, if we do a shake-down, then there is a chance that we can get a community that is indeed persistent.

We see that there is a critical role for history. Communities, for these deep, topological reasons, will move towards a persistent state. What we want to do is to find a quick way of getting there so that we can in fact have a community that consists of the four desirable potentially economically viable species. Maybe one or two other things. What we need is a mix to get there.

Donald Worster: You said a million years to create a prairie on the one hand, but what would be shorter than that?

Stuart Pimm: We don't know. We do think that the initial shakedown may be quite rapid. And we are also beginning to talk about ways in which we can ensure that the things we want will tend to be well-represented in the end. In other words, we don't want just any species. We want to have a mix that has a predominance of the four species that we want. One of the obvious problems then is to ask, what kinds of patterns of dominance do we see in nature? And that dominance has a static and a dynamic component. The dynamic component is how communities resist things like drought, grazing, how quickly they recover; but the other side of that issue is the static pattern of dominance, what sort of relative abundances of species you could have.

Wes Jackson: We have looked at the prairie, and we have not insisted on creating a template. Treating the prairie as a template would be foolish because we would end up with something just like it is. We have talked about wanting to take advantage of the natural integrities that are inherent within the system. We want the bills to get paid by that system. Not by fossil fuel, not by so much human labor, not by chemicals we haven't evolved with. Now if our effort is more toward the assembly extreme, then we are faced with a very long time before we find out what those combinations are.

Stuart Pimm: Maybe. The shakedown happens fairly quickly in some of these systems, I think. I am not trying to build this up. We are not talking about 125 species, we are talking about 16 species. We know more than we do when we start throwing these species in at random. I think there is a reasonable chance that we can get something a lot faster than that. Time is the key issue. We need to come out of this room with a practical set of shake-down experiments.

Stuart Pimm is Professor of Ecology at the University of Tennessee



Kathleen Gibson

Reductionist Heuristics

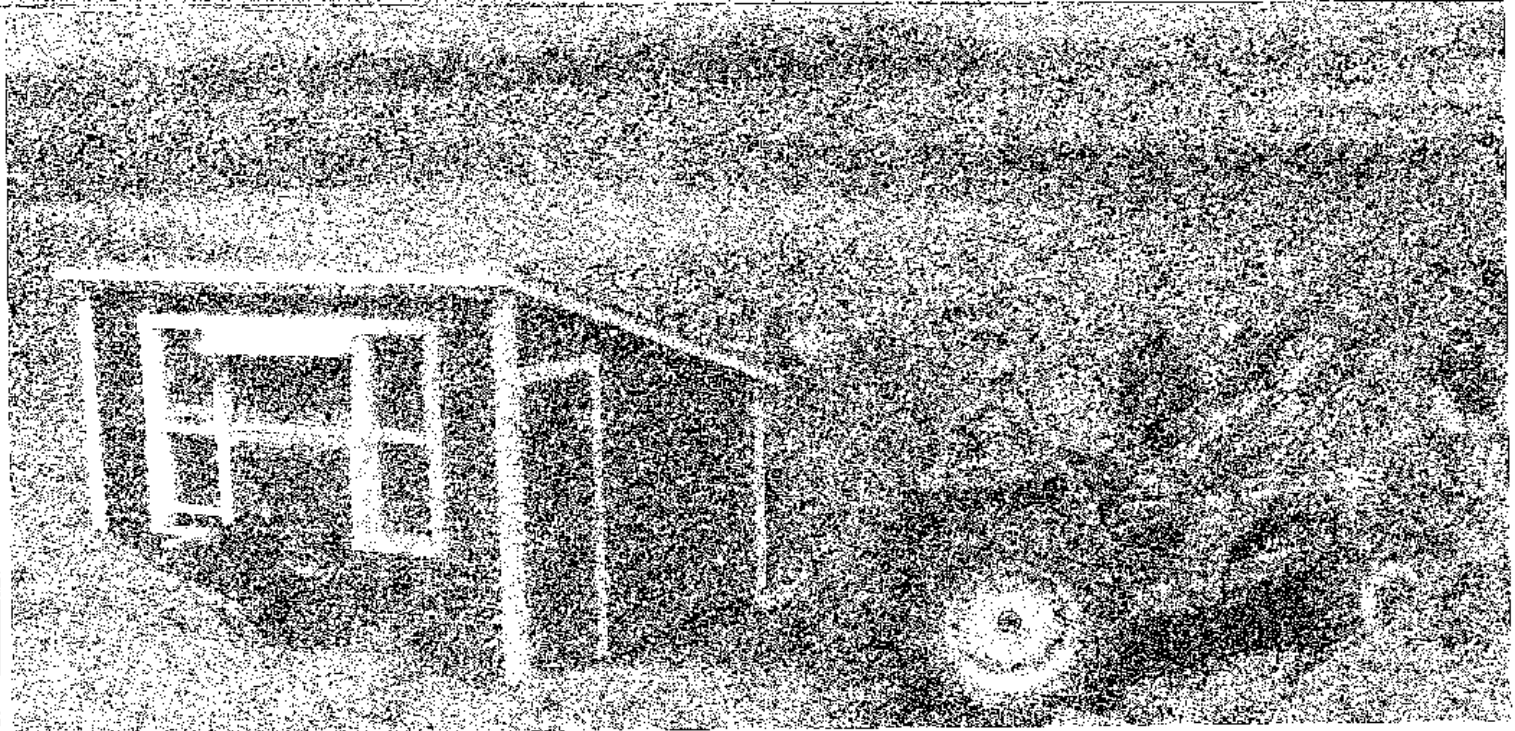
Bill Wimsatt

Bill Wimsatt: I want to formulate in general the situation a reductionistic problem solver is in and see what kinds of biases we might expect to occur. We do an awful lot of our reasoning by heuristics. Heuristics are sort of the pants rules that don't work all the time, but are very cost effective — so we use them even in preference to rules that may work all the time, but are a lot more work. In deciding to use heuristics we recognize that we are finite beings who can't do everything. The world is enormously more complex than our ability to solve and to simulate. No matter how powerful our computers get, the world is still more complex. We have to find ways to simplify. Simon's Principle of Bounded Rationality is that for any scientific problem we have to assume we are going to simplify somewhere. How do we decide what to do about it?

Say I am a reductionist and I accept Simon's Principle. I pick a system. Any system. And the rest of the world I place outside it. The system may be DNA sequences. It may be prairie ecosystems. It may be philosophers doing problem solving. The first judgment I am going to make is to put at least a tentative boundary between the system and its environment. Now as a reductionist, what do I do? A reductionist, broadly speaking, is anyone who applies analytical techniques to explain the behavior of a system in terms of the articulation of how its parts interact. This system has got a bunch of parts in it. There also can be some variables out in the world, and they are going to be interacting with things in the system. If I am a reductionist looking

for ways to simplify, I can get rid of a lot of variables by assuming that the environment is homogeneous in space or constant in time. Or that all environmental effects are randomly distributed. Or that maybe there is an oscillating input from the environment as with temperature or day length cycles through the seasons. The idea is, a reductionist is naturally going to simplify the environment outside the system. Of course I am going to simplify inside, too. But imagine the result if I assume that the system is all homogeneous inside, then... Oops. Where are the parts? I'm out of parts. If I'm a reductionist, I've got to have parts inside. So it can't be homogeneous there. But I can pretend it's homogeneous outside. So I put my parts back inside and make it homogeneous outside. There is my system.

Now, that is a systematic bias. That is how a reductionist has to differentially simplify. He'll simplify both places, and that's important, but he'll simplify more outside than inside. And if the model doesn't fit, then he'll say "Oh I made too many simplifications, so let's add more of the details inside." And he'll assume that there is always more that needs to be done inside, so he'll go down and down into smaller and smaller details there and he'll never get around to doing anything about the environment. That's the origin of bias in reductionistic heuristics.



"Heuristics are seat of the pants rules that don't work all the time, but are very cost-effective--so we use them even in preference to rules that may work all the time, but are a lot more work."

An example of this is the statement that fitness is a property of genes. Have you ever seen a gene reproduce by itself? It can't happen. There need to be over 200 enzymes for DNA to replicate itself. So fitness is not a property of genes in isolation. Fitness is a comparative measure of how a gene does against all of this necessary background inside and outside of the organism. It is really a relationship between organisms or phenotypes and their environment. But if you fix the environment — keep it constant — then it doesn't have to appear as a variable in your equations anymore. And if you just look at your equation (or your lab experiments where you haven't varied the environment) and you aren't thinking too hard, you might think the environment doesn't matter. You'd be wrong, of course. In fact, you see that because of this reductionist bias we have pared down our idea of fitness to the gene. We have moved it away from a relationship between phenotype and environment and attached it to genes in genotypes. We tend to treat relationships as if they were just features of the inner parts.

Wes Jackson: Bill, this is crucial for us in our thinking at Matfield Green. Where do you put your boundary? It carries with it an assumption that is no more immune to criticism than those who said that the environment is homogeneous. I've been saying that the most exciting field for the next century will be accounting, and that the accountant is a student of boundaries. But to be a student of accounting requires that you have some criteria for deciding where you draw that boundary. Economists are finally acknowledging that they have simplified terribly. So my question is how do we escape that? You can put the boundary around Matfield Green and measure what goes through that township. Or you can put it around Chase County and you can measure what goes through that. Or you can put it around the state of Kansas. How do you decide?

Jon Piper: But in nature aren't there boundaries? Aren't there discontinuities across boundaries? That's how you can tell that they are boundaries.

Wes Jackson: Well, we look at Jon or we look at Bill and we say, "that's that person." And we say the environment is out there. But then we find that it all falls apart on us. Because the oxygen that was out there is on its way to oxidizing a six carbon sugar that was environment, and now it's us. And so we still have this typological problem about some kind of a natural boundary.

The Complex Ecology of Common Human Diseases

Charles Sing

We hear much these days about the molecular biology of human diseases. Hardly a week passes that we don't read in the newspaper about the discovery of a gene that causes this disease or that disease. Gene research is important, but there is a big difference between discovering such a gene and understanding the inheritance of the disease. I believe we should be placing equal emphasis on trying to understand the environmental influences that cause genes to be expressed in a harmful way, if our aim is to cure disease.

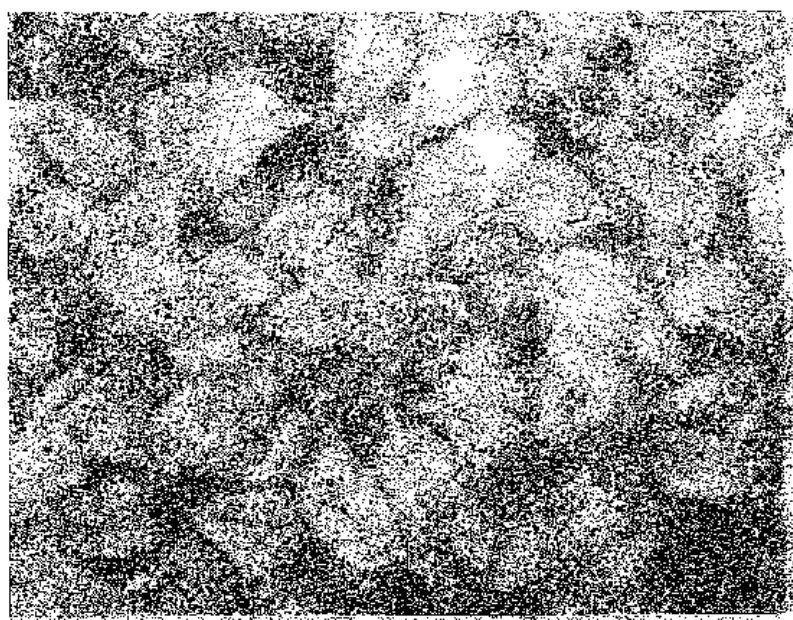
If the question is asked, "What do you think is inherited?", some might answer "Well, naturally the disease is inherited." No one would deny that we receive genes from our parents, but does this mean that we inherit disease? On the contrary, a "bad" gene that has been found in an individual with a particular disease frequently does not cause that disease in all those who carry it. I learned another answer in 1961 as a student on a trip across Kansas, somewhere between Salina and Hays, with geneticist Elmer Heyne from up at Kansas State. That answer was: what is inherited is the manner of reaction in a given environment. This genetic concept is particularly important for common diseases like cancer, hypertension, heart disease and diabetes.

In nearly all cases, neither genes acting alone nor environments acting independently of an individual's genetic make-up cause disease — it is the combination of a particular set of genes with exposures to particular environments that determines the onset, progression and severity of the most common diseases. The effects of variations in a gene cannot be revealed without being exposed to variations in environments that control the expression of the gene. The most important lesson from understanding genetics is the recognition that developing

Bill Wimsatt: Notice in that example you are looking at Jon or me on several different time scales. I guess what I think is that there are no magic bullets. There are no absolutely error-free procedures for finding the "right" boundaries, and what boundaries are the right ones will differ depending on what your problem is, and how accurately you need to know the answer, so it can get confusing. And we have to adapt our philosophy of science to that. But we can do various kinds of mental exercises that can increase our sensitivity to making errors. For example, you might draw a boundary and then investigate the consequences of drawing it further out and further in, and then ask, is this really a system that I am now embracing or is it just part of a system or does it overlap two systems? What are the interesting questions you might want to ask about something this big? Do a lot of other things interact as a whole, and in a lot of different ways, with this thing I've picked out with these boundaries? Those are good criteria for being a good chunky system, but not all things are like that. Experiment with placing your boundaries 'til you find a good fit for your problem. Different problems even for the same system, person, or community may require different boundaries. We have to get used to that.

*Bill Wimsatt is Professor of
Philosophy at the University of
Chicago*

Rebecca Gleason



*"If you want to go from Matfield Green to Kansas City,
you can go a thousand different ways."*

disease is not inevitable if one carries a disease susceptibility gene. We have the ability to alter our exposures to high risk environments so as to minimize the possibility that a susceptibility gene will harm us.

The first objective of research in our group at the University of Michigan is to find the changes in the DNA that determine genetic susceptibility to diseases like hypertension and coronary artery disease. But along with this we are asking an important question: how complex is the relationship between susceptibility genotypes and disease phenotypes? This involves understanding the links between variations in disease susceptibility genes, exposures to high risk environments, and the phenotypes that define the course of the disease.

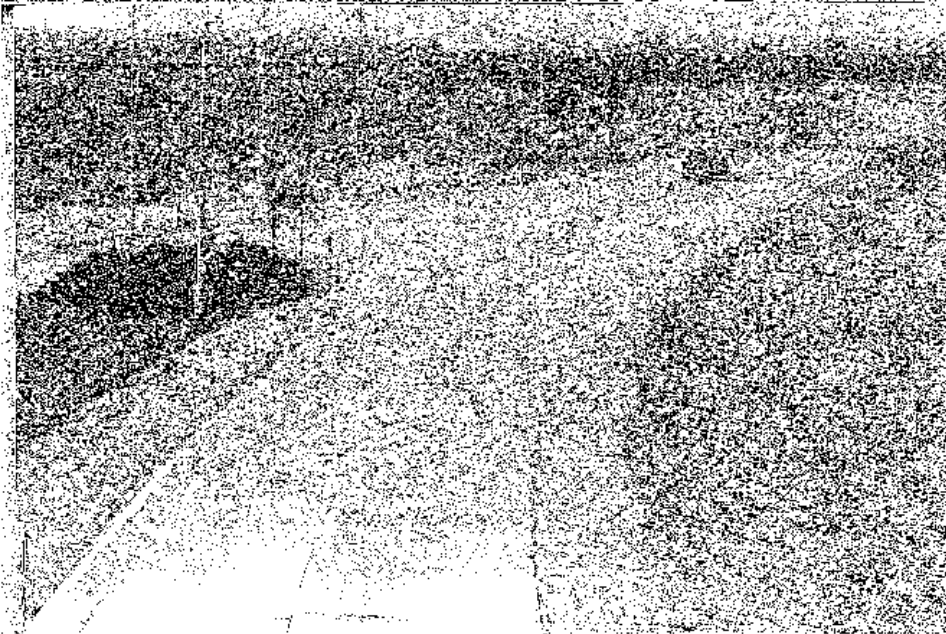
Basically, there are three different ways of modeling the relationship between the genome (the whole constellation of DNA that is in your chromosomes) and the risk of developing disease. First is the Mendelian model, where the mapping between changes in a single gene locus and the expression of the disease is one-to-one. That is where the Human Genome Project started and has achieved its greatest successes, with single gene disorders like cystic fibrosis and Huntington's disease. The second model is what we call the Fisherian model, where changes in many genes contribute to the disease state, or many-to-one mapping. Up at the University of Nebraska they have a pig genome project where they are trying to isolate all of the genes that contribute to determining growth rate in hogs. They are applying Fisher's model to understand the genetics of growth rate. Now what could be a more important trait if you were an American farmer than growth rate in hogs? Wait a minute, for about half of the farmers in America, heart disease could be more important! Back to heart disease.

A third idea was suggested by Wright. He came up with a model which involves many-to-many mapping, where changes in many genes are involved in the

biology of each trait, and changes in a particular gene influence many traits. Our research group has been using Wright's many-to-many model to understand complex diseases like hypertension and coronary heart disease, which are defined by the interplay of many traits. The many-to-many model says there is a metamer organization of agents at the genome level, at the biochemical level, and at the phenotype level. We survive as a species because we have evolved multiple ways of staying healthy long enough to produce offspring who carry our successful genes. Biological systems are organized like the map of a road network. If you want to go from Matfield Green to Kansas City, you can go a thousand different ways. You can go south, and then over into Missouri, and then north until you arrive. You can go north to Hiawatha, and then take the road east that is not closed for repairs on the day you make the trip. You may take a circuitous route, but you will get to Kansas City. There is a network of ways to get there. There is a metamer structure to the highway system.

God wouldn't have made a very complex and important phenotype like healthy blood pressure without allowing for many different ways to succeed. If blood pressure is too low, you faint. If it is too high, you may rupture a vessel. Evolution has produced a set of genes that orchestrate a whole network of causation resulting in a homeostatic system. This system can respond to adverse alterations in our environment with counteracting effects. Disease is a consequence of not being able to adapt to environmental insults which have the potential to alter phenotypes like blood pressure or cholesterol level beyond the healthy range.

Now, what properties can we recognize about human health and disease that are characteristic of all complex adaptive systems? In the past several years complexity research has helped us to rethink biology from an holistic point of view. First, we have learned to recognize the importance of the hierarchy of causation, from the genes in the basement to the expression of disease phenotypes at the top floors. There are many agents here — genes, the biochemical products of gene action, and environmental factors — all organized into this etiological hierarchy. A whole host of biochemical and physiological processes connects variations in the genome with variations between individuals in the occurrence of disease.



Richard Gelsen

"We survive as a species because we have evolved multiple ways of staying healthy."

Second, these agents in the hierarchical network of causation are organized into subsystems. There are strong forces between agents within subsystems, and weak forces between agents in different subsystems. For instance, blood cholesterol and triglycerides are strongly correlated within the lipid metabolism system, but they are only weakly correlated with adrenaline, which is in the subsystem that regulates blood pressure. Both subsystems are involved in determining your risk of developing heart disease.

Third, disease phenotypes are emergent properties that can't be predicted with certainty. Knowing about a single gene or a single trait from this hierarchy of agents and subsystems isn't enough. There is no one gene, one environmental condition, or one flaw of biochemistry or physiology that inevitably causes a common disease like heart disease. Something is left to chance, even if we know *all* of the genes and environmental factors involved. We can improve the accuracy of our prediction by measuring both genes and environments, but no particular combination of causal agents can tell us whether a certain disease will develop at a certain time. The folks working in weather prediction figured this principle out long before biologists became interested in complexity research.

Finally, the emergent properties of disease and their relationships to the causal agents are dynamic in time. Age is one of the most important predictors of human disease, and so are the environments associated with age. So, there is context-dependency in the emergence of the phenotypes that define health and disease. Different genes and different environmental factors may be involved in fostering the same disease at different times

throughout life.

There is a message emerging from our genetic studies of most common human diseases. Your genes are not important in themselves, the environments that you expose your genes to are not important in themselves, it is the relationship between them that determines your risk of developing disease. Your health is a complex emergent property of the interaction between the whole constellation of genes that are present at birth and the environments they are exposed to throughout your life. To minimize the risk of developing disease we must strive to understand how particular constellations of genes respond to particular environmental exposures. This must be followed up with the personal wisdom and courage to make the sometimes difficult environmental choices that are crucial to staying healthy.

These thoughts are a consequence of an ongoing dialogue with Eric Boerwinkle, Brian Ernsting, Martha Haviland, Sharon Reilly and Dave Sing. I gratefully acknowledge their dedication to bringing the important issues into focus.

Charles Sing is Professor of Human Genetics at the University of Michigan

Perennial Polyculture as an Assembled Community

Jon K. Piper

The Land Institute's research in perennial grain agriculture looks to the tallgrass prairie as its model for a sustainable biological system. One striking feature of the prairie is the high diversity of species present. Even on the small prairie at The Land Institute we have identified 215 vascular plant species within 56 families. Conservation biologists concerned with species preservation have long assumed the value of diversity, an index of complexity in nature. Recently, other ecologists have confirmed that complexity is an important component of ecosystem structure and function. David Tilman, Sam McNaughton, and their associates have discovered that species-rich grasslands recover better after drought or grazing than species-poor grasslands¹. The Land Institute recognizes the ecological importance of diversity, and has attempted to grow perennial grain polycultures that mimic the prairie's complex vegetative structure, in place of annual monocultures, which do not.

Our dilemma is that diverse, stable perennial polycultures are good to have but hard to get. Finding a system that remains stable has been elusive because of the large number of possible species combinations that we would need to evaluate by trial and error. We have thus been faced with the daunting task of trying many possible species combinations, or just going with our best guess polyculture.

Along the way toward developing a perennial polyculture, we have encountered the limitations of the reductionist scientific paradigm for understanding complex systems and have been searching for alternative, more holistic approaches. We were excited by the presentations of two visiting scholars from the University of Tennessee at our January conference. Jim Drake, Stuart Pimm and their students have explored the

process of "community assembly," the sequence of states through which biological systems pass before reaching a stable state.

Jim Drake's team studied community assembly by using "microcosms," communities of aquatic microorganisms in tanks of water². They found that after going through seemingly chaotic flux, communities tended to assemble to stable endpoints. They also showed that community organization in their experimental systems cannot be explained solely by currently observable mechanisms in the final state. Rather, historical information was essential for understanding the community structure that emerged. They warned against drawing erroneous conclusions about the factors responsible for this structure, when the history of its assembly is unknown or ignored. Other researchers have also demonstrated a powerful role for history in community assembly, showing that initially identical conditions can lead to very different final plant communities³.

Stuart Pimm pointed out that complex systems, while desirable for perennial polyculture as well as for ecological restoration, are extremely hard to put together. One cannot simply introduce the desired pieces and expect the system to persist, be it a tallgrass prairie, oak-hickory forest, or perennial polyculture. His theoretical work, coupled with some experimental examples, points to a "shake-down" process as more likely to lead to a successful endpoint. In this case, one starts with a rich species pool and allows species composition to change via extinction, colonization, and interactions between species. Consistently, the final communities that emerge after such a shakedown are stable and persistent. Stuart Kauffman has called such processes of self-organization "order for free." The problem for mortal scientists, and even more for farmers who will someday grow perennial grain crops, is how to get that order quickly. So we are looking for ways to build complex, persistent systems that shake down within a few years, and result in something resembling what we want.

The ecologists from Tennessee proposed an experiment that incorporates some of their community assembly ideas into our work. The study involves monitoring the assembly of perennial polycultures from several initial species mixtures. The goal of the experiment is to

*Jon Piper is Land Institute
Ecologist*

Table 1. Diversity treatments used in new polyculture experiment.

Treatment	C4 grasses	C3 grasses	Legumes	Composites
I	eastern gamagrass	wildrye	Illinois bundleflower	Maximilian sunflower
II	eastern gamagrass hybrid sorghum	wildrye blue wildrye	Illinois bundleflower purple prairie clover	Maximilian sunflower ashy sunflower
III	eastern gamagrass hybrid sorghum switchgrass	wildrye blue wildrye intermediate wheatgrass	Illinois bundleflower purple prairie clover bird's-foot trefoil	Maximilian sunflower ashy sunflower grayhead prairie coneflower
IV	eastern gamagrass hybrid sorghum switchgrass sand lovegrass	wildrye blue wildrye intermediate wheatgrass western wheatgrass	Illinois bundleflower purple prairie clover bird's-foot trefoil leadplant	Maximilian sunflower ashy sunflower grayhead prairie coneflower Kansas gayfeather

allow these communities to assemble over several growing seasons until they persist without any more weeding and seeding. The initial mixtures range from four to sixteen species representing the four groups that predominate on the prairie: C4 (warm-season) grasses, C3 (cool-season) grasses, N-fixing legumes, and composites¹. Each mixture will include our four leading perennial grain candidates. (Table 1).

In March, we laid out and seeded 16 plots, spaced 3.7 m (12 feet) apart to prevent them from influencing one another. The plots are 16 m x 16 m, large enough to minimize edge effects. They are located within a recently plowed area at the southeast end of the original 28 acres at The Land Institute. Half of the plots will be left alone to assemble as they will. We will reseed the other plots with any species that fail to establish, or that disappear after having established initially.

The variables we will measure include:

1. Persistence in species composition
2. Resistance to invasion by weeds ranging from foxtail grass to cottonwoods, and our success in reestablishing species that disappear from a plot
3. Seed yield
4. Year-to-year variability
5. Species richness, including weedy species
6. Relative abundances (% cover, species diversity)
7. Presence of animals (deer mice, Dickcissels, and doodlebugs)
8. Trajectories from initial assembly to final community; predictable intermediate stable states (detectable in retrospect)

Examples of the kinds of questions we will ask with this study are:

1. Is it possible to determine the rules that govern community assembly and lead to a stable, diverse, and predictable endpoint?
2. Can these rules be used to produce plant communities with the specific properties of persistence and high seed yield?

3. Are species-rich communities better than species-poor communities, using measurable criteria?

This new experiment is valuable to The Land Institute for at least two reasons. First, it represents a new, potentially fruitful methodology that is an alternative to a piecemeal, reductionist approach to developing persistent perennial polycultures. Second, it places our work within the emerging field of complexity which is developing largely outside of the agricultural sciences. It will be exciting for us to watch these initially very different plant communities assemble over the next few growing seasons.

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1994 Interns

at the Land



Rebecca Geisen

Front row, left to right: Dave Tepfer, Joel Gerwin, Portia Blume, Audrey Barker, Sally Cole, Victor Rabinovich. Back row: Brian Donahue, Antonio Serrano, Debbie Crockett, Kathy Holm, Jeremy Plotkin, Rebecca Geisen.

Portia Blume grew up in Starved Rock State Park in Illinois and has a BA in biology from Oberlin College in Ohio. She has done research and field work in Ecuadorian agriculture and wrote her senior thesis on house gardens in Ecuador. Most recently she has completed an internship with the Nature Conservancy in Illinois. Portia plans a career in sustainable agriculture research and education.

Debbie Crockett is originally from Seattle, WA, but has spent the past three years teaching biology and environmental science in New York City. She has a BA in molecular biology from Princeton University and as an undergraduate she co-directed a Princeton-sponsored outdoor education program for inner-city youth. This past fall she worked on a teaching-farm for children in upstate New York and participated in a Witness for Peace human rights delegation to Guatemala.

Rebecca Geisen has a BS in Conservation and Resource Studies from the University of CA-Berkeley. She has worked as an environmental planner for Pacific Gas and Electric Company in San Francisco for the past four years. As an undergraduate she was an Student Conservation Association volunteer in the Aleutian Islands.

Joel Gerwin is from Bethesda, MD, and has a BA in biology from Harvard University. He is an active organizer of Jewish, homeless and rural communities and is especially interested in building connections between urban and rural communities. He has taught environmental education and has spent time in Israel on kibbutz and researching grazing.

Kathy Holm recently received an MS in forest resources and has a BA in journalism and political science from the University of Minnesota - Twin Cities. Kathy is from the Twin Cities area and volunteered at the Land Stewardship Project in Marine, MN, while in graduate school. She has also worked in India with a Baha'i afforestation project and the Centre for Development Studies and Activities in Pune, Maharashtra State.

Jeremy Plotkin is from central New York state. He has a BA in biology from Earlham College in Indiana. He has worked on a low-input vegetable farm in Virginia and a large organic farm in Vermont. He has had field ecology experience in Mexico, Nicaragua and the American Southwest. As an undergraduate, Jeremy organized a garden and education program at the Earlham College farm and ran his own sandwich delivery business.

Victor Rabinovich grew up on a coffee, fruit and cattle farm in Colombia. He has a BA in French and philosophy from Claremont McKenna College and has worked on a small farm in France. He has practical experience with the biological control of insects and has worked at a biological field station in California.

Antonio Serrano has an MS in International Agricultural Development from California Polytechnic and a BS in agronomy from Texas A&M University. His MS thesis was on tropical forest regeneration and as a graduate student he managed the student sustainable farm at Cal Poly. Antonio grew up on a family farm in Ecuador.

Dave Tepfer grew up on a small farm in southern Minnesota but has been living in Colorado for the past several years. He has done MS work in agricultural economics and philosophy at Colorado State University and has a BS in Animal Science from South Dakota State University. He has worked on farms in New Zealand and Germany and while in Colorado he worked with the Rocky Mountain Raptor Program.

Caroline Mahon and **Sara Wilson** are the continuing Land Institute interns in Matfield Green.

So Many Highlights, So Little Time

By Kathy Holm

Burning over 100 acres of prairie, listening to Wendell Berry read a new short story, and playing basketball with the community of Matfield Green are just a few of the highlights the 1994 interns have experienced since their February 14 arrival at The Land Institute.

A typical spring intern schedule includes morning discussion warm-ups and classes, typically Mondays, Wednesdays and Fridays, and working on a variety of Land Institute research and maintenance tasks throughout the remaining time. This year's nine interns come to The Land with diverse academic backgrounds and from wide-ranging geographic locations, including two students from South America. What follows are some of the high points the 1994 intern have experienced during their short tenure at the Land Institute:

Every few years the Land Institute burns a 160 acre parcel of its land in the spring. Some of this land is native, unplowed prairie and some of it was once farmland that has been planted back to native grasses. In early April, interns and staff gathered up water tanks, buckets, rakes and burlap sacks in order to burn this patch of prairie. The fire was dragged along with rakes and fire lines were maintained by interns who beat out the flames with wet burlap sacks. The interns watched flames being fanned into whirlwinds and then die back with rapidly shifting winds. This year not all of the 160 acres was burned, allowing next year's interns their chance to be part of a prairie burn.

On a Friday night in mid-April the interns gathered at Wes Jackson's house for an evening with Wendell Berry. Interns and staff introduced themselves and spent part of the evening eating dessert and chatting until at Wes' request Wendell pulled out a new short story and read it to all assembled. It was read with obvious pleasure and joy in the characters he'd created. Later, many interns could not resist getting a few autographs in well-worn copies of Wendell Berry's books.

The Land Institute's Matfield Green project was introduced to the interns at the beginning of March. A weekend trip was made to tour the town and to get the school building ready for the first annual Matfield Green

community potluck/basketball tournament. Interns toured the various buildings owned by Wes Jackson and The Land Institute, broke bread and drank coffee at the Matfield Cafe and had some discussion about the ecological accounting project gestating in Matfield Green. The potluck and basketball game were well-attended and many interns showed real promise on the court.

Former Land Institute intern Kathy Collmer invited the new interns to her family's farm for lunch and a tour near Minneapolis, KS. Kathy and her husband Jim Sharplaz run a cow-calf operation on land that contains native Kansas prairie grasses such as big and little bluestem, switchgrass and Indian grass. Kathy and Jim have begun direct-marketing their grassfed beef and as they showed interns their pastures, they discussed the promises and difficulties of direct marketing in their area.

In early April the interns made a trip to the Konza Prairie Research Natural Area, which is an outdoor research laboratory to preserve and study the tallgrass prairie. It is owned by the Nature Conservancy and managed by the Division of Biology of Kansas State University (KSU). Some of the research on this prairie include examining the ecological effects of bison grazing and fire regimes. Grasses are the dominant plants on the Konza Prairie, but there are also over 500 species of wildflowers, shrubs and trees. Most of the Konza Prairie is closed to the public, but an excellent tour of the Konza bison loop was given to the interns by KSU Professor John Zimmerman.

This is just a sampling of the 1994 intern experience thus far. In short — they believe it bodes well for the coming seven months.

Kathy Holm is a 1994 Land Institute Intern

Update: Great Plains Research Project

By Christian Anders Petrovich

"Pick up that plant."

I picked it up, but I didn't know why I was holding a potted aloe as Tim Miller described his organic farm.

Tim and I had just finished planting the first perennial polyculture research plot outside of The Land Institute's Salina, KS, property. Tim's farm is in Kyle, TX, on the western edge of the Blackland Prairie. It is the southern-most site location of the 1994 *Great Plains Research Project*, a region-wide study of The Land's main research plants.

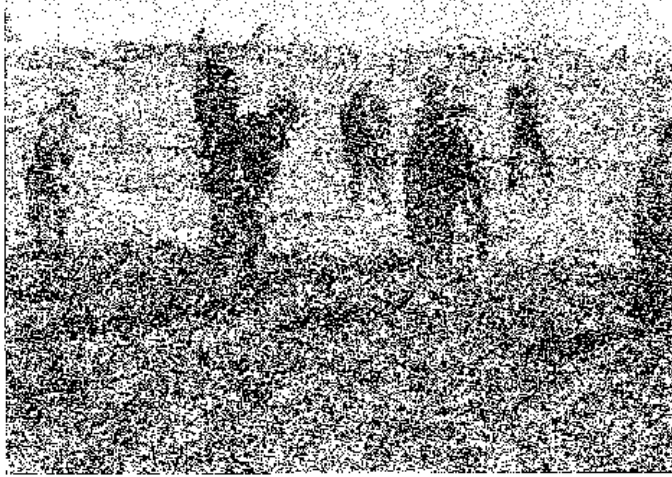
After 20 minutes of wildly inspiring conversation about Tim's farm and natural reseeding of his annual vegetable crops, he said, "You can keep that," pointing to the aloe in my grasp.

This has been the nature of the *Great Plains Research Project* so far — blooming with kind generosity and powerful inspiration.

The 1979 Ford F-100 "Official" Land Institute Research Vehicle has carried that house plant through four states (Texas, Oklahoma, Missouri and Kansas) and 28 plantings to date. It is April 2nd as I write. The aloe has a place between the box of files on prairie ecology and the spare tire, below the shelf with the red box for clean clothes and the blue box for dirty clothes. Then there are the seeds, packed away in the soft, tight bundles of cotton seed bags — each labeled by species with a pen that bleeds into cotton fiber. The rakes and hoes hang along the side and roof of the pickup topper, leaving enough space for a fold-out foam sleeping pad in the center of the truck bed. I've taken to calling this old blue pickup "Henry," for the times when I'm driving alone between plot plantings. Talking to Henry somehow seems much better than talking to myself.

For most of the first third of this research planting, I have avoided the lone mumbling that makes passers-by nervous. This is because I am fortunate to have 1993 intern alumna Jen Tressler helping me with the project. Together we have met the remarkable people who agreed to become collaborative researchers in this Great Plains-scale research project. All together there are 78 individuals, families, groups and schools collaborating with The Land Institute's research across 14 states. The response I received to this study has been truly phenomenal.

In addition to the 78 study participants, I had to turn down over 40 other people who wanted to collaborate



Megan McKamy

with The Land's research. Unfortunately I simply could not plant with them for lack of seeds and time. I cannot express how inspiring this response has been to all of us here at The Land Institute. It is heartening to know that so many people want to participate in this grassroots level research project. I wish I could plant with all of you.

It has been a joy and an honor to meet all the people who have decided to dedicate effort to this study: the lawyers who save seed and gather wild edibles; the sociology professors who plant gardens and graft walnut trees; the cable company workers who become farmers because their gardens get out-of-control; the rotational grazers whose electric fences draw more curiosity than current; the postal workers who deliver lambs, calves and colts as well as mail; the school teachers who shear sheep; the fifth graders who help compress the soil on our plots by doing the bunny hop; the research scientists who find spaces for us on university farms; the extended families that live and work together; the realtors who raise pigeons; and the ad writers who also run organic farms.

There is one characteristic that all the above participants and I imagine all of you who receive this *Land Report* embody: an individual dedication to creating a soil-building and community-building daily reality worthy of this prairie place we live in. That has been the greatest inspiration to me — observing the silent dedication taking place in people's back yards.

Prairie soils took millennia to build, particle upon particle, root entwined with decomposing root. It is by the accumulation of your often unacknowledged efforts that we find the hope and inspiration to continue in our quiet quest.

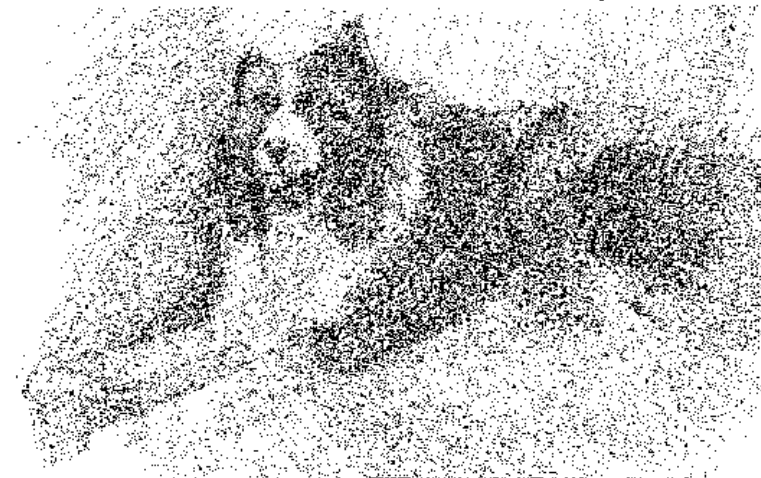
*Christian Anders Petrovich is a
Land Institute Research Fellow*

Farewell to Molly and Bobbins

By Audrey Barker

For as long as most people here can recall, Molly, a border collie, and Bobbins, a poodle mix, have been a part of the vitality of The Land Institute. Raised from puphood by the Jacksons, Molly and Bobbins claimed the hearts of staff and interns as their domain. At lunchtime on the classroom patio, they would politely join the interns. Molly was a good hunter, helping to keep down rodents that munched the garden. Bobbins was usually on hand to greet visitors at the office door. At home on the prairie, Molly faithfully accompanied us for the prairie study, and Bobbins would join in on prairie walks, amusing us as she leapt through the tallgrass. Through staff changes and wholesale turnover of interns each year, the dogs were familiar and friendly faces at many Prairie Festivals. Although a bit slower in the past year, Molly and Bobbins were very active until they died within two weeks of one another in April. Happy romping in dog heaven, Molly and Bobbins - we miss you!

Molly



Caroline Mahon



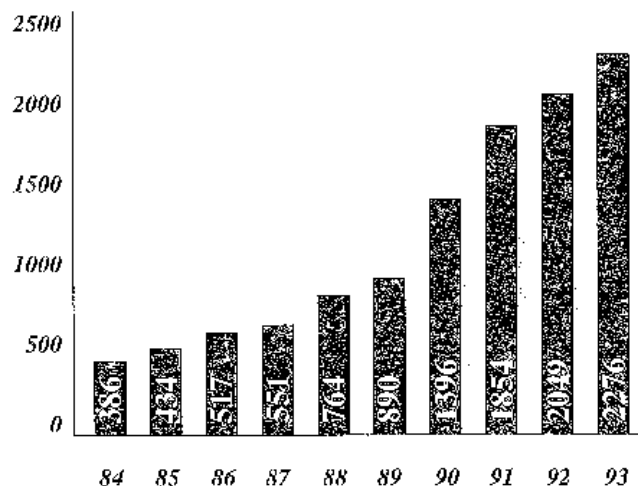
Bobbins

The Land Institute 1993 Financial Report

Fiscal Year Ending June 30, 1993

Operating Income		
Foundations	\$302,624	55%
Individuals	196,996	36%
Corporations	3,750	1%
Earned Income	21,543	4%
Interest	23,817	4%
Total	\$548,730	100%
Operating Expenses		
Research	\$191,211	35%
Education	113,628	21%
Intern Program	115,767	21%
Conservation	24,225	5%
Matfield Green	12,907	2%
Management	38,080	7%
Development	49,771	9%
Total	\$545,589	100%

Friends of The Land Donors



Matfield Green School Re-opens

By Caroline Mahon

Several weeks ago, our Matfield Green neighbor Clara Jo Talkington took me to see the last home basketball game of the season at Chase County High School in Cottonwood Falls. There, I saw what must have been a majority of Chase County's 3000 residents gathered together in the bleachers of the gym. Clara Jo's son Jay refereed the freshman boys' basketball game. He is a science teacher and baseball coach at the high school.

The Matfield Green school is located only 200 yards from Clara Jo and Wilbur Talkington's home of 35 years. There used to be basketball, baseball and volleyball games, roller skating parties, one-act plays, recitals, and numerous community meetings at the school. According to Clara Jo, there were never any dances because "some folks that lived out at Homestead [a hamlet west of Matfield Green] didn't believe in dancing." Dances or no dances, today she and other parents and community members living in the township must travel fifteen to twenty-five miles each way to attend such events at the county-wide elementary school or high school in Cottonwood Falls, or at the middle school in Strong City.

Despite the centralization of Chase County schools which prompted the closure of Matfield Green's high school and elementary school years ago, Clara Jo and others have remained active within the Chase County school system. The county schools serve children dispersed throughout Chase County, along with the majority of students who now live in the "twin cities" of Cottonwood Falls and Strong City. Twenty-one children from Matfield Township are bussed in and out of the Twin Cities every day. With the schools gone, with few businesses left, and with the "almost final" termination of our post office, it's not surprising that five more children have moved from Matfield to larger towns this past year. The decline in the number of school-age children in Matfield Green and the decline of Matfield Green itself goes on in a downward spiral. It takes a strong family identity, much personal energy, and countless tanks of gasoline for Clara Jo and other parents, grandparents and community members to stay connected with their schools.

So, how did it seem to residents of Matfield Green when the elementary school, which had been closed in 1974 and is now owned by the Land Institute, re-opened on March 7th to host a community basketball game and pot luck supper? For many months Chase Countians, Matfield Green residents (especially children), numerous Friends of the Land, and Land interns and staff down from Salina had joined the Matfield Green project members to clean, repair, and paint the gym, kitchen, and East classroom in preparation for the evening of the

7th. For the final touch, Brian Engle (11) and Mike Ades (12), students at Strong City Middle School, painted both basketball hoops and replaced the torn old nets with new ones.

Eighty-five to ninety people, including many former residents of Matfield Green now living in Emporia, attended the community gathering. The seven or so matches that spanned the hour and a half before supper were charged with adrenaline. Taking part in the game were many local youngsters, along with an older generation who played their high school ball in Cottonwood Falls after the local school closed. But the generation that played for Matfield Green High School was on hand, too. Wilbur Talkington refereed and his brother June took the floor. Of the six Talkington brothers who played on Matfield Green basketball teams in the '30s and '40s, four were in the gym that Saturday night.

Since the game, every weekend and some afternoons after school a number of neighborhood kids appear at the door to the Old Lumberyard Bakery and Coffeeshop to ask if they can "shoot hoops" in the gym. So at least in a small way, the school is once again a vital part of Matfield Green. And perhaps the following attests to how some of the older folks felt seeing the elementary school gym being used again. One local man was heard saying to another, "Now... we should get some softball games going again." To which the other replied, "They should never have sold off that back acreage where the ballfield used to be!"

Caroline Mahon is a Land Institute Intern at Matfield Green.

Changes at the Land

Matthew Logan of Chanute, Kansas, joins the Land Institute staff as Director of Development beginning June 23. Matt holds two Masters Degrees from the University of Kansas, one in Urban Planning and another in History. He comes to us from working in community development for a 12-county coalition in southeast Kansas.

Matt replaces Tom Mulhern, who has taken a new position at the Commission on Aging in Salina. Long-time plant breeder Peter Kulakow also left the Land at the end of April. Both Tom and Peter will be missed, and we wish them well.

Linda Okeson, our Administrative Assistant for many years, is now keeping the Land Institute's books on a part-time basis. Former Development Assistant Louise Sorenson comes in to help with mailings as needed.

Stan Amick and Laura Sayre were in a car accident over the winter. Stan suffered multiple fractures of the foot which required surgery and skin grafts. He is getting around better now and we hope he will soon be back at work part-time as he continues to heal.

Laura, who ably edited the last two Land Reports, is carrying on "The Land's Harvest," the market gardening operation associated with the Land Institute this spring. She has been delivering a bumper crop of asparagus to local supermarkets.

Don't Hit the Road, Jack

By Kathy Holm

He wears a cowboy hat, a matchstick between his teeth and a leather belt with his name stamped across the back. It's real easy to pick him out at The Land if you approach him from behind. He used to drag race and claims his hobbies are raising draft horses and drinking beer.

It took some doing to entice him to work at The Land Institute, being asked in person by both Wes Jackson and Wendell Berry. Eventually he accepted and now Jack Worman is the new Sunshine Farm (SSF) Manager/Operations Coordinator.

"I really like farming and I wanted to work my horses more," Jack said, explaining why he decided to come to The Land Institute in August, 1993. "Recently I've planted most of my farm's acres back to grass."

Jack has farmed most of his life along side working at Sears and Roebuck for 15 years and working for Graves Truck Line. He is married to Ruth, who has worked as a Senior Marketing Representative for Kansas Power and Light for 35 years and runs a catering business. They share their farm with one dog, 10 cats and 18 horses. He and Ruth have a daughter and son-in law, Michelle and Craig Stephenson, and two grandchildren. Jack leaves work at the same time every afternoon to spend time with his grandkids when they get home from school.

Rebecca Gelson



If You Like Worms, It's a Great Place To Be

By Kathy Hohn

As the Sunshine Farm Manager Jack works closely with Marty Bender, who heads SSF research, making farm operations run smoothly to meet research objectives. Jack says he is interested in "doing it right." Along the way he likes to teach the interns "real" skills, like giving them building projects and showing them how to operate various Land machinery.

Jack has a strong affection for horses. For the past 25 years, he has raised and sold draft horses, Percherons, for work and show. Raising horses seems to run in his family. Jack remembers spending summers with his grandfather and his horses in Oklahoma when he was a kid. His father raised Percherons and eventually Jack took over the business.

Jack plans to bring a team of his draft horses to use for cultivating, plowing, planting, harrowing and hauling manure and hay at the Sunshine Farm. He said he expects to keep them there from about May through December. Jack will bring his horses back to his farm over the winter.

In his "spare" time, Jack also has a custom harness shop to run. He builds leather and nylon harnesses and custom parts and repairs harnesses and saddles. He's been doing this kind of work for a long time for himself and his neighbors, but decided to go commercial and opened a shop in 1988.

If that wasn't enough, he has begun building harnesses for service dogs that serve physically handicapped people too. He estimates that he builds about 60 harnesses a year for a non-profit training center in Washington, KS, called *Kansas Specialty Dog Service*. These dogs are trained to perform a variety of tasks, including pulling people in wheelchairs, turning on lights and acting as seeing eye dogs.

Jack and his harness work are well known in the area. A recent visitor to the Land Institute, Byron Patton, heard that Jack was now the SSF manager. He opened his wallet and pulled out a photo of a team of horses with a harness Jack had repaired a few years ago. He said, "You won't see better work than this."

A self-described "great composter" who likes nothing better than to dig up her garden to look at the worms has made her way to The Land Institute as its first official full-time volunteer.

Sally Cole left her ranch in the Roaring Fork Valley just outside Aspen, CO, to become the new volunteer Land Institute Coordinator. She moved to Salina at the end of October, 1993, and began her new duties in mid-February, 1994.

Sally spends mornings in class with the interns and afternoons working in the office doing "whatever needs to be done," she says. That includes answering telephones, greeting people who visit and helping out Land Institute staff.

"I love the interaction I get being with energetic people full of knowledge here at The Land Institute — I love learning from them," Sally said. "Through class discussions and readings I get the opportunity to explore more deeply the many facets of sustainable agriculture and prairie ecology. They are two subjects I'm really interested in learning more about."

Sally said she first heard about The Land Institute from her cousin Dick Austin, an environmental theologian. She began her involvement by becoming a Land board member one and a half years ago. She enjoys that, but by being a volunteer staff member she believes she can more readily get the essence of the place and that, she says, is more satisfying.

The best "Land Institute Moment" Sally has had so far occurred early one spring morning on a prairie walk led by staff ecologist Jon Piper. Each month Jon and the interns take an early morning walk on The Land's Wauhob Prairie to note monthly vegetation changes. "During the March walk we found a sunny patch of prairie, sat ourselves down and read passages from *PrairieEarth*, a book about Chase County Kansas by William Least Heat-Moon. That was sublime."

In addition to her work at The Land Institute, Sally is quick to point out that she is the mother of three terrific daughters. She also enjoys gardening, hiking, biking, backpacking and is an accomplished equestrian. Her most exciting backpacking trip (so far) was the one she took to Copper Canyon in Mexico last year with the Sierra Club. Its purpose was to explore the Tarahumara Indian culture more closely. "There were hardly any trails, it was a very difficult trip, but I learned a great deal about myself."

Sally says she's not sure how long her volunteer tenure at The Land Institute will be, however she hopes to do something beneficial with all the information she is gathering.



Volunteer Opportunities at The Land Institute

Be like Sally, come help out at The Land!

The Land Institute has volunteer opportunities for interested, qualified persons. We can use volunteers both at The Land in Salina for the perennial polyculture research and Sunshine Farm projects and at Matfield Green in Chase County for the ecological community accounting project.

Volunteers will take responsibility for a full-time position and report to another staff person. We will develop job descriptions appropriate to available skills. In Salina, some skills might include ecologist, plant breeder, soil scientist, plant pathologist, entomologist, research technician, systems modeller, greenhouse person, farmer, fund accountant, fundraising and development, administration and clerical skills, organizing and event coordination.

In Matfield Green, construction skills are directly useful, as are gardening, cooking, baking (we have a Tuscan-style wood-fired bread oven that also turns out first-

rate pizza), community interaction, organizing and hosting visitors, scholars, and house guests. We are also looking for someone to assist in setting up the books for measuring energy flow and materials recycling to assess present and potential community sustainability. We are thinking about the human carrying capacity of the landscape of which Matfield Green is a part.

If you offer skills not mentioned that might fit at The Land, we would like to hear your suggestions.

The Land Institute can provide a farmhouse in Salina or small rooms in our Lumberyard Cafe at Matfield Green. In each place, we can accommodate a family or several single people willing to share a household. We prefer a one-year commitment.

If you are interested, please write us about your interests, background and skills, when you would be available and for how long, and enclose your phone number. For more information contact Sally Cole at (913) 823-5376.

Books

Clearcut: The Tragedy of Industrial Forestry

Reviewed by Brian Donahue



Clearcut: The Tragedy of Industrial Forestry
Edited by Bill Devall.

San Francisco, California: Sierra Club Books and Earth Island Press, 1993. 292 pp.
\$50.00

A sharp line cuts across the cover of *Clearcut: The Tragedy of Industrial Forestry*. To the left of the line stands the intact old-growth forest of a roadless wilderness area in Gifford Pinchot National Forest. To the right lies a road-scarred industrial wasteland of clearcut Weyerhaeuser property running up to the wilderness boundary. The title of the photo is "The Cutting Edge." Once the cutting edge has passed, nothing is left standing.

Clearcut is a coffee-table picture book about good and evil, light and darkness. The edge between them is as sharp as a well-filed saw chain, or as the cry of an enraged goshawk defending its nest. It was put together by Bill Devall, editor; Edgar Boyles, photo editor; and Douglas Tompkins, project director. Published by Sierra Club Books and Earth Island Press, *Clearcut* is a descendant of the exhibit-format books put out by Sierra

Club in the 1960s, whose images of pristine natural beauty were designed to inspire wilderness protection. The book is a "sad testimony" to our failure to escape from the shadow of industrial clearcutting that has fallen across the entire globe over the past few decades. The intent of this book is to inspire a "green rage" in North Americans deceived by the "beauty strips" loggers leave along scenic rivers and roads. It is a call to action for those who have been diverted by TV documentaries on the tropical rainforest from paying attention to the devastation in the backyard of their own continent.

At the heart of this book lies darkness. The editor calls the photos the "shadow side" of the logging industry. Clearcut forest landscapes, seen mostly from the air, stretch across page after page in mind-numbing succession. In the upper left corner, red spots charring to black spread over a map of North America as the destruction of bio-region after bio-region is exposed. The color photos have been printed on 70% recycled, off-white, slightly rough-textured paper so that the dark ink soaks through the images, staining everything. Blue sky is rendered almost black. A haze lies over the land, suggesting air pollution and acid rain. We seem to be seeing the earth's surface bathed in black light pouring down through the wounded ozone layer, or perhaps we are looking through the blighted degradation of human vision itself. There is no clear focus or sense of depth in these pictures; they are flat and brutal in their impact. One does not enter into these vistas of ruin, one is struck by them.

Perhaps we need to be struck, and struck again. Since 1950, the earth's forest cover has been cut from something like 32% to about 26% — a global decline we can ill afford to see continue. According to the Worldwatch Institute, only 12% of the world still supports "intact forest ecosystems," as opposed to plantations and degraded second growth.¹ Still, I am not aware of any evidence that clearcutting in North America, ugly as it may be, is rapidly wiping out our remaining forest in the way many readers of this book will probably be led to conclude. Most of these cutover landscapes will grow back to trees on their own. Perhaps the authors of *Clearcut* would not call them forests anymore, but I have lived in such forests all my life, and that is what I call them. In fact, there is a good deal more forest in the United States now than there was when similar warning cries were first raised a century ago, because of the regrowth of abandoned farmland in

the East and South. Surprisingly, our consumption of wood in this country has not grown past where it stood at the turn of the century, either. This is because fuelwood has been largely replaced by coal, oil and gas; and timber construction has been partly replaced by more energy-intensive steel and concrete. Only a tremendous increase in pulpwood production has made up for these declines. So we are not yet on the brink of inhabiting a deforested continent.

None of this is to condone industrial forestry as it is now practiced. I have looked often enough into the teeth of this kind of logging to fear it. It is no more sustainable, in any ecologically meaningful sense of that word, than the industrial form of agriculture we are contending with here at the Land. On the other hand, over nearly two decades of practicing community forestry in Massachusetts, I have endured my share of "green rage," too — usually from people who oppose the cutting of a single tree, proclaiming that "nature knows best." Sometimes I have a hard time swallowing that from environmentalists who are typically among the world's leading consumers of forest products. Sure, industrial forestry is bad, and it is likely to become even worse. The question is, what would be better?

The overwhelming answer of *Clearcut* is: Wilderness. The cover alone makes that clear. How much wilderness would be enough? The accompanying essays suggest that we need wilderness over at least 50% of the United States to ensure ecological health. Beyond calling for the protection of remaining old-growth forest in the West, Dave Forman's essay on "The Big Woods and Ecological Wilderness Recovery" advocates letting portions of the reforested Eastern US return to wilderness, as well. I have close friends involved in pieces of that effort, and I wish them well: we surely need more wild forest than we have now. The problem is, that's the most wilderness they're ever going to preserve: pieces. The "Wildlands Project" (of which this essay is a version) is often criticized for being too radical, but it isn't nearly radical enough. When you look at the wild preserves that are actually being proposed in the East, you can see that they don't amount to very much.² For the full range of forest species to thrive in the long run, what we need to preserve is a continuous, reasonably intact natural forest over the entire region. "Big Wilderness" sounds exciting, but we need *vast* forests. To have healthy forests, we need to turn around not just industrial forestry, but industrial "development" and industrial pollution driven by the reckless squandering of a non-renewable resource, fossil energy. Wilderness alone isn't going to do it. Wilderness is important, but the real

crux of the issue is sustainable use of all the rest, a far more difficult challenge. Otherwise, we're going to wind up with a few parks surrounded by suburbs and biomass plantations by the time the oil runs out.

Industrial forestry emerged along with industrial agriculture in 19th century America, when natural resources began to be extracted, processed and consumed on a new scale as part of a national economy integrated by rail. In the 20th century age of oil these two enterprises have shared many features: large operational units, reliance on heavy machinery, wholesale application of chemicals, ecological over-simplification and "collateral damage" to the land, declining labor requirements and hence declining rural communities. Increasingly, what is grown is treated as a denatured commodity: ground up, reprocessed, and shipped long distances to be ultimately consumed in virtually unrecognizable forms. The possibility of a healthy relationship between people and the rest of the natural world has been steadily pulled apart.

This peculiar and offensive behavior is the product of capitalist culture with a gusher of low-priced fossil fuel behind it. Most of us in the environmental movement share the assumption that it cannot last forever. On our optimistic days, we hope that our extravagant use of energy to manipulate the world will be curtailed before it runs its full course — either because energy grows scarce and expensive, or because we finally realize it is too dangerous. The unprecedented modern scale and intensity of human environmental impact, including industrial logging, stems from a global system of resource extraction and manipulation driven by irresponsible use of fossil fuel. Now, we have to contemplate making far more restrained use of our power, while still supporting billions of human beings without spoiling the world. When I envision this future, I do not see a world gone back to the wild.

The longing for wilderness is largely a recoiling from the ugliness of the industrial age. It is self-reproach for our rapacity, a cry in the dark; for some even a comforting portent of the earth's recovery if we crash. I share this deep attraction to wilderness, but that does not mean that I see it as central to solving the ecological dilemma of the human species. Looking at the East, even in my wildest dreams I do not foresee a vast reforested wilderness, Alaska come south to buffer concentrated human settlements with tiny intensive gardens. Instead, I look for a *re-farmed* landscape. Recultivation of Eastern farmland that was once given up will be needed because sustainable farming will probably produce less food per acre than industrial agriculture, and because large parts of the irrigated West will no longer pump out the produce. A good part of the land that reverted to forest was not so much "marginal" as mis-farmed, and then abandoned when it became superfluous in the age of cheap oil. There is little doubt

in my mind that someday we will need to farm that part again, let us hope in better ways.

This is not to say that the great Eastern forest should be eradicated, or reduced to woodlots. Farmland, pastures, orchards and settlements should be fitted into a healthy, continuous forested landscape, I agree. This landscape should have wild tracts at its spiritual and ecological core. I believe *most* of it will have to be sustainably managed in ways that respect and maintain its ecological diversity. This holistic approach is ecologically preferable to the dualism of separate wilderness and human reservations. It is nothing new: it appears that a large part of this forest has been manipulated by its human inhabitants for the past 10,000 years, and not in trivial ways. The forest can provide a large amount of fuel to help meet regional home-heating needs — presuming houses are better insulated and wood is burned in well-designed, clean-burning stoves, of course. It can also provide a wonderful variety of woods for buildings, furniture, and other durable goods. In a post-fossil fuel world, I believe we will be relying on this forest for *relatively* more, not less of our material needs. I know the forest can take care of itself, but when I consider the alternatives, I don't want to let it be: I want to live in the forest, not just hike in it.

Being an Easterner, I have less of a feel for the forests of the West and North, which are the main concern of *Clearcut*. Perhaps in a post-fossil fuel world fewer people could live in these regions, and so more wilderness is in their future if those eco-cards are ever dealt. I certainly agree that we have no need to cut any more of our few remaining old-growth forests. But I suspect that in this region too, what we need as much as preserving existing old-growth is promoting forestry that manages for more old-growth. This would allow the highest-quality timber (along with many other forest products) to be harvested from mature, ecologically diverse stands, so it makes long-term economic sense as well. This would in turn support the most stable human communities in the forest regions. I would certainly look for these regions to remain major exporters of lumber, or of more finished wood products. The point is, "sustained yield" would have to be redefined in a much more ecologically inclusive, long-term fashion than is now the practice in industrial forestry.

I have cut down thousands of trees in my life, including some venerable giants — well, venerable giants for Massachusetts, anyway. I feel compassion when I cut such trees, but not guilt. I like living among trees. I like the smell of fresh-split oak, and of pine pitch on my hands; and it makes me feel like a brother, not a murderer. I like building with wood, heating with wood, surrounding myself with wooden objects that

retain the character and spirit of the forest that grew them. I think we could safely harvest forest products from the vast majority of forested land on our continent in this way, forever. It would mean cutting at a level that allows mature forest ecosystems to flourish, and it would mean cutting in ways that minimize the impact of logging itself. It would mean protecting fragile areas, respecting and encouraging diversity, and maintaining forest continuity in the landscape at every scale, so that forest species can continue to flow with the ecological tides as they have always done. This would be a far cry from the way we abuse the forest today. I think it is more important to our future as a species to learn these skills than to fight tooth and nail to create more wilderness. Unless we learn this, the wilderness is doomed.

Many of the essays in the back of *Clearcut*, especially those by Edward Grumbine on "Policy in the Woods" and Herb Hammond on "Wholistic Forest Use," sound reasonable to me. I do not think there are major differences between the authors of *Clearcut* and me, except that they put wilderness in a position of absolute primacy that I believe is unachievable, and that discounts the ecological possibilities of human landscapes. Because of this, any positive vision of people living in the forest is eclipsed by the relentless photographs of destruction that dominate the book. Not once do we see a person lovingly at work in the woods. Even opposite the "Ecoforestry Declaration of Interdependence" we find not a nice shot of a team of horses skidding firewood in a diverse woodlot or something like that, but a repeat of Daniel Dancer's grim "Cutting Edge" from the cover, now in grainy black and white — nothing but wilderness versus slaughter vanishing into the hazy distance, nor a hint of anything better within sight. In fact, in the background we see that logging has insidiously crept over the line. So much for ecoforestry, seems to be the photo's comment on the text. Indeed, many of the same "wholistic" practices suggested in the closing essays are derided throughout the main body of the book as cynical ploys of the logging industry. It is true that the rhetoric and techniques of "sustainability" such as "shelterwood" harvesting are often co-opted by the public relations arm of the timber companies. The editors of *Clearcut* have neglected to show us a single illustration of these tools being put to good use.

I think the authors would respond that showing responsible logging would have undercut the central message of their book, which is to raise the alarm about the scale of destruction now taking place behind the beauty strips. That may well be true. But to again pose the forest debate in such a stark way only perpetuates the

Manichean polarity between pristine wilderness and industrial wasteland. *Clearcut* closes, very appropriately, with a picture of a "Dead End" sign at the end of a logging road, and with a picture of an ecowarrior standing on top of a huge stump, gazing into the distance at the receding wilderness. This is indeed a dead end debate, and believe me, industrial extraction will win the lion's share. It already has. The key struggle now is over the fate of the regrowth. Unsatisfactory compromises between irreconcilable old-growth preservation and industrial extraction are not what we need. We need a new path into the forest.

Clearcut is a powerful book. The cause is a good one, but I wonder if it is best served anymore by this kind of polarized treatment. An even more powerful book would counterposed images of destruction with images of hope — and not just works of ecological penance, but real attempts at responsible, productive forest management. Yes, we need to preserve virtually all the wild forest that remains. Yes, we need more wild preserves at every scale as we attempt to learn to manage forests in ways that are truly sustainable. But it is unrealistic to think that we can set aside enough wilderness to safeguard forests in the long run: unless we learn to live with the forest, and on a very large scale, whatever we set aside will inevitably be overrun or stranded. Like it or not, the future of most forest species on this planet probably depends much more on sustainable forestry that includes biodiversity as one of its central goals, than it does on wilderness. Perhaps the very skillful, dedicated producers of *Clearcut* will see fit to shine a little light on the many practicing woodlanders who may not fully share their deep ecology platform, but who also love the forest and have dedicated themselves to treating it better than we have in the past, and who are their natural allies in the fight against industrial devastation.

1. Alan Thein Durning, "Redefining the Forest Economy," in Lester Brown et al, *State of the World 1994*, Worldwatch Institute, NY, W.W. Norton, 1994, pp. 22-23.

2. "The Wildlands Project," *Wild Earth* Special Issue, 1992.

The Necessity of Wilderness: A Comment

Wes Jackson

This review joins a rich and necessary discussion. The editors of *Clearcut* and the reviewer are careful thinkers about the meaning of wilderness and the old question of the role of the human in nature. Last year's Prairie Festival theme had to do with the search for the primitive and featured the necessity to protect wilderness.

I agree with Brian here but I think there is a point that needs emphasis by both the authors and the review and the point is this. We of Western civilization have gone from the Church dominating our lives and a period in which we built the great cathedrals of that era. Then came the nation state which dominated our way of thinking. The national capitals are the physical monuments to that mindset. But the nation state peaked at the time of World War II and now Economics has come to dominate our thinking. We are in that era now, building shopping malls as monuments to the gods of secular materialism. We flock to them every Sunday. NAFTA and GATT are more important to us than national well being. Boeing can go to China, GM to Mexico, Japan to Kentucky and nearly everywhere else.

What is next, let's hope, is Ecology. This time we will turn to that not made by human hands, nature's natural ecosystems, wilderness, places which have experienced minimum human disruption. We should protect wilderness and indeed let much land go back to wilderness because it represents our best standard against which to judge so many of our human activities. Many are acknowledging now that wilderness has answers to questions we have not yet learned to ask.

There is another matter in all this. We might improve a great cathedral or improve a national capital or for sure improve a shopping mall. There is no proof that humans have ever improved wilderness on the standard of sustainability. Whether it is alpine meadow or tropical rainforest or prairie, these wild ecosystems have featured material recycling and have run on sunlight. We can come close, but never do as well.

I favor the wild standard partly because, like Brian, I want humans engaged in the woods. Wilderness has much to teach us about how to be good woodlanders. But there is more than mechanics in the woods at work here. Proper mental engagement would see board feet as a derivative of well-managed forests, just as managed forests are a derivative of wilderness. Let's welcome back the wild animals which have been extirpated from the wilderness areas, and let nature make the cathedrals of the future.

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in The Land Institute!

The work of The Land Institute is based on a vision of a way of agriculture and a way of life that protects the long-term ability of the earth to support a variety of life and culture. If you share this vision and would like to get more actively involved in making it a reality, please clip and return the form below to The Land Institute.



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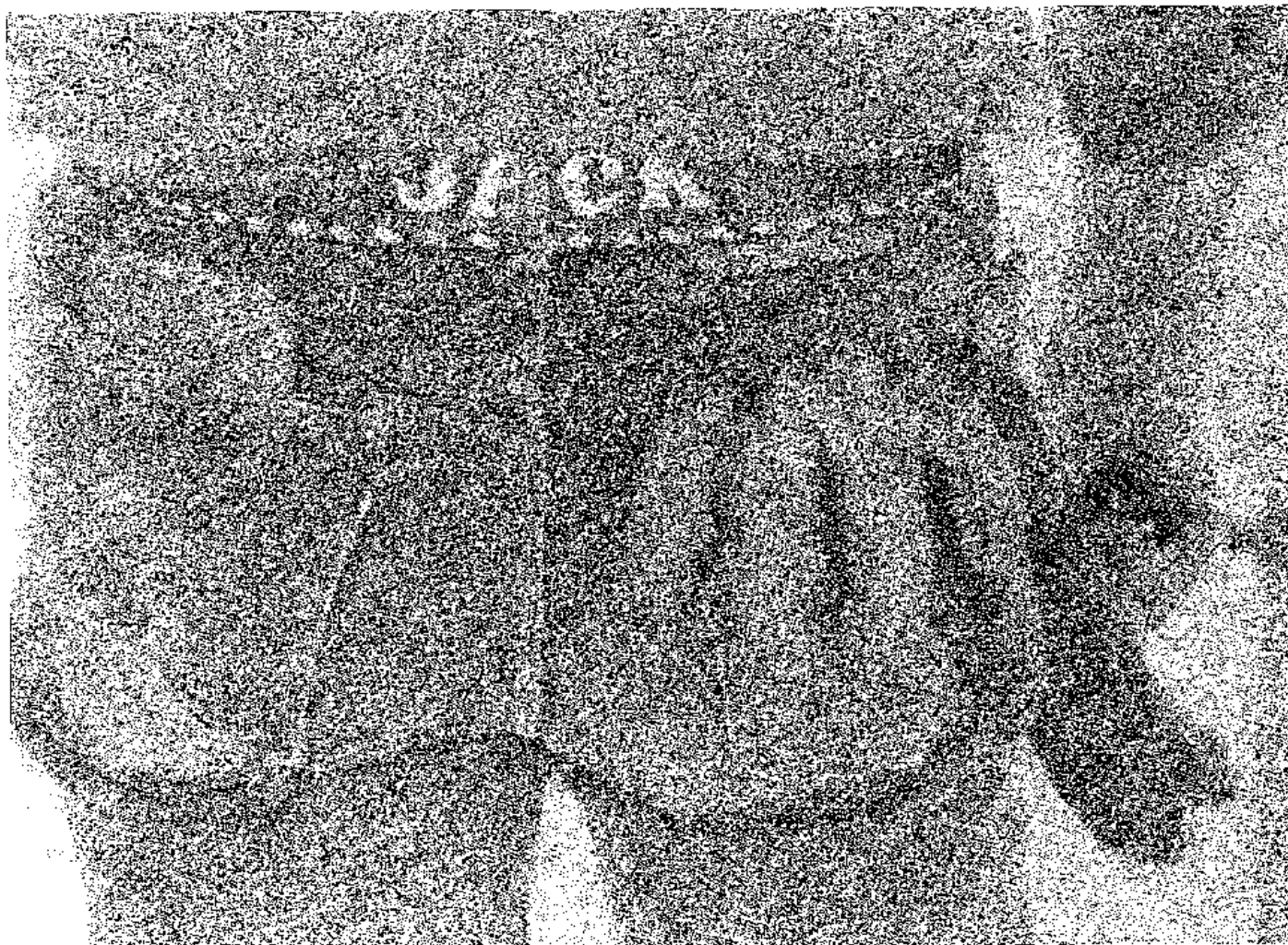
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Name _____

Address _____

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- _____ Generating a tax deduction from my personal residence or farm
- _____ Providing for The Land Institute in my will
- _____ Making a gift of art or antiques
- _____ Setting up a memorial fund
- _____ Joining the Friends of The Land



Rebecca Gritsen



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