# Environmental Review

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## What's Wrong with Biotech?

Introduction:

Many people are uneasy about how biotechnology is being applied and commercialized, especially when it comes to food crops. The most extreme anti-genetically-modified-organism position is that the entire idea of biotech is wrong. We have no business cutting and pasting genes from one organism to another, and only bad can come of it.

The other side of the divide is represented by scientists who work in biotech and have no idea what all the fuss is about. People have been altering genes in plants and animals for thousands of years. Today's hybrid corn bears little resemblance to its wild ancestors and people don't call it a Frankenfood. Likewise today's dogs don't look like or act like (thankfully) their wild ancestors.

To people outside the business it may not be obvious how much molecular biology has influenced the life sciences, while to scientists in biotech its benefits are so obvious that it is hard for them to understand the public's anxieties. Today's scientists have grown up with molecular biology and it has become a senior partner in most life science disciplines. Since Watson and Crick received the Nobel Prize for working out the structure of DNA in the early 1950s, molecular biology has transformed how every biological discipline is done, including botany, zoology, genetics, medicine, pharmacology, and forensics. Molecular biology has been an academic juggernaut, rolling over departments, sucking up grant money and appointments, and explaining everything. Well not quite, but molecular biology has spun off a multi-billion dollar industry, biotechnology.

The most fervent anti-gmo organizations tend to play to peoples' ignorance and anxieties. A quick examination of their Websites shows the basic propaganda tool kit: scary catch phrases, screwy logic, using only information that supports the position and ignoring the rest. Such behavior is every bit as dishonest as the most despicable right wing ranter's. Lowering the debate about these important issues to the level of propaganda hurts the credibility of all environmental organizations and thus their ability to influence events.

The most effective way to protect people and the environment from unintended consequences and/or bad effects of biotech will be based on open and honest evaluations of the pros and cons of the various parts of the biotech enterprise.

We spoke with Steven Strauss about the public perceptions of biotechnology and how to raise the level of the debate.

**ER:** Professor Strauss, what is your training?

**SS:** I have a Bachelor's in biology from Cornell in plant and forest ecology; then a Master's at Yale School of Forestry; and a Ph.D. at Berkeley. Midway through my Ph.D. training I got interested in genetics, not biotechnology, but traditional population genetics and breeding in trees. It wasn't until I started my faculty position at Oregon State University that I started using DNA methods, and it wasn't until several years into that that I started working in genetic engineering.

At Berkeley I had to have someone on my committee who was not a biologist or a forester, so I had a sociologist on my supervisory committee who made me think about the social implications of genetics and technology. That has helped me as I try to explain to the public what we're doing in biotechnology and how to look at it in a broader environmental framework.

Most of my colleagues in biotechnology majored in biochemistry or some pretty technical reductionist

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biology and they have a difficult time even understanding why there's hostility to biotechnology. So my background has been helpful in that regard. At least I see the problem some people have.

**ER:** What's your position now?


**SS:** I'm a professor in the Department of Forest Science at Oregon State, with appointments in the Genetics program and the Molecular and Cell Biology programs.

**ER:** Where do you get your funding?

**SS:** All over the place: USDA, Department of Energy, National Science Foundation, Forest Industries, and many other smaller granting agencies. Those are the main ones. I get some grant money from industries, about one-tenth of our total funding.

**ER:** What are you thinking about in your own research?

**SS:** The core thing my lab has worked on for about ten years now is the problem of gene flow from genetically engineered trees. It was known to scientists as early as the 1980s that there are genes that we'd like to use commercially that we don't want wandering around the environment because of their ecological effects, like exotic pest resistance genes or an herbicide resistance gene. Controlling gene flow is going to be critical if some of these products that we were thinking about are ever to be used.

The trees I work with are cottonwoods. We grow them for their wood; we don't need their seeds or their fruit so making a sterile tree would be an easy way to control gene flow, and in fact it might also make the trees grow somewhat faster. Our focus has been on how to engineer that and how to do it in a robust way.

One other thing we've done in conjunction with that is some population genetics and modeling to see what level of sterility you need to give you socially acceptable containment. There are other studies that go on in the lab, but that's our core focus.

**ER:** What modifications are you trying to make to the trees?

**SS:** It's the platform of a technology upon which different variations are built. One of the parts of the platform for biotechnology is how to put genes in — do they give you healthy trees and do the genes work in a stable way? — without worrying about what exactly they're doing. The guidelines of how you design a new tree need to include environmental considerations. We're trying to make a platform in poplars for this technology. We have been working on the gene transfer process and testing it to make sure it's effective, efficient, and gives you a healthy tree. Part of that is building in a confinement system to make gene flow a non-issue so you can use these things readily in the environment, or make gene flow an acceptable issue. As I said, it's hard to get to absolute zero. Cottonwoods can propagate in fact vegetatively, so sexual sterility is never going to give you 100 percent containment.

**ER:** Plant material has a way of getting spread around.

**SS:** That's right, and clones are out there. People can and do steal plants and trees. That's one way cuttings move around is illegally. People can take a branch or a branch can float down a stream for that matter. One of the issues in the social picture is if society is not ready for biotech then tinkering with reducing environmental effects isn't going to get you anywhere.

**ER:** Many people think that playing with genetics is wrong. How to you respond to that?

**SS:** We have played with genetics routinely for hundreds of years and have taken it for granted. The most obvious example is dogs. We love these incredibly domesticated mutant organisms that look nothing like their wolf progenitors. If you look at any domesticated crop or animal, to various degrees — dogs are probably the most extreme, but broccoli is probably not far behind — they're dramatically changed, far more so than anything contemplated today for commercial genetic engineering. There's nothing on the biotech horizon that's going to create anything as radically different as a new variety of a dog, a chihuahua or terrier or whatever your dog of choice is.

Genetic tinkering should be familiar to us. We can make radical changes in organisms through traditional breeding, in fact we do it every day. Breeding is a big part of several important industries.

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We need to be honest about this. We love genetic manipulation when it comes to some of these animals that we have on farms and in our homes. We don't know exactly what the mechanisms of genetic changes are in these breeding experiments, but we know that they are profound. So there's a precedent for genetic modification. It's not new; it's a question of how you do it.

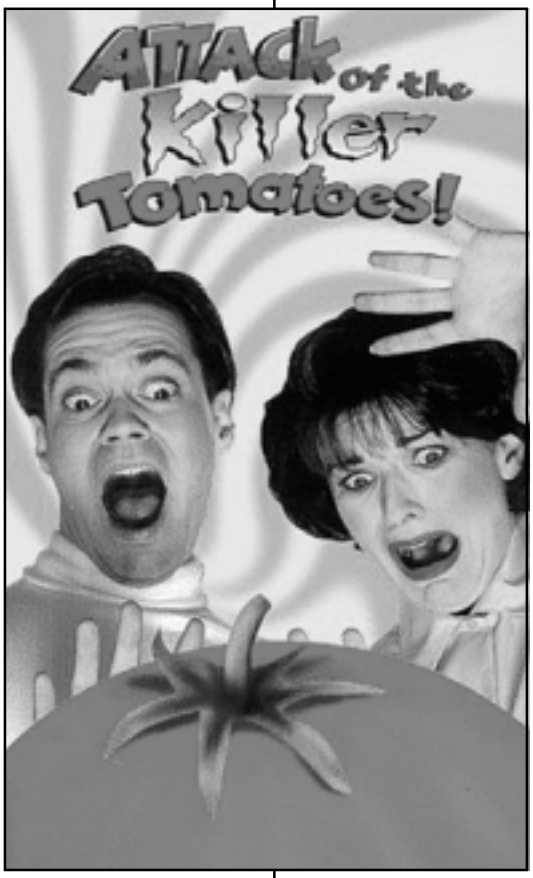
**ER:** But biotech is artificial: cutting and pasting pieces of DNA instead of the old-fashioned way.

**SS:** The old fashioned way also involves cutting and pasting and deleting and inserting DNA, it's just that we have no say in the matter. The mutants that we select for in traditional breeding are not warm and fuzzy when you look at what they actually are. Mutations are broken genes and they break in strange, random ways.

**ER:** Darwin understood that most changes in an organism would not be beneficial. This was before genetics was understood.

**SS:** That's right, they're not. Every now and then something happens in traditional breeding that's considered beneficial and is selected for further propagation, it's just that now we know better what we're doing. I think ethically however, when you know what you're doing it does tend to give you more responsibility as well as more choice. We've gotten to a point where we can say, Oh, you mean that's what inbreeding does? We're fixing an otherwise deleterious mutant to get this dwarf dog? What if we did that ourselves with genetic engineering methods? Would that be acceptable? We don't know. The ethical framework tends to be different when we have so much more knowledge about the process.

Another important thing that we need to talk about is that people assume genetic engineering is moving genes between organisms, and that's not what genetic engineering is. It's a method whereby you can change genes within an organism. It's possible society might decide there are familiar kinds of genetic engineering and there are unfamiliar kinds that should be dealt with differently.




I had an essay in *Science* magazine a couple months ago, and that's all I was saying: Maybe we can segregate the kinds of genetic engineering that look like domestication as we've known it, using genes that are homologous, native in function, but tweaking their expression to produce desired traits. That's different than moving a BT gene from a bacterium into a plant where there's no homolog and it's a totally unique gene function. *[BT is the bacterial toxin that is used to kill caterpillars. Ed.]*

**ER:** Tweaking the expression of a native gene would be more like conventional plant breeding wouldn't it?

**SS:** It's not exactly the same, but it's much more similar and in fact maybe safer because we're putting much more intentional design into it. We can build in safeguards that we haven't been able to before, such as gene flow safeguards in the case of my trees.

We might consider these different ways of addressing genetic engineering that are scientifically more enlightened, whereas now the controversy out there is more social. It's been dictated by groups like Greenpeace that have a fundamental ethical objection to playing with nature. They'll admit to that. Once they decide that they're against this, then they employ all the tactics of public relations to scare the hell out of you. They'll admit that too.

**ER:** How do you respond to that?

**SS:** That's difficult. Back when I started in this business we knew we had a challenge to educate the public about genetic engineering and what is responsible use of genetic engineering. That's a complicated thing to lay out for scientists to agree on; then to communicate that to the public is a challenging task.

Now it's much more challenging,

an order of magnitude more at least, because now we have to do it amidst this din of gross distortions of scientific information and outright fear mongering. We know from psychological studies that fear, particularly when it comes to things like food, can get into you. It takes five or ten positive messages to counterbalance one negative or scary message, particularly when it comes to your health or livelihood or the quality of your food.

Now we have this incredible challenge. We're on the defensive because people look at it and say, What are you doing to our food? Of course, there's also the association with corporate control and patents that modern biotechnology brings you apart from the science. One of the distortions you see is that biotech is all a corporate plot for profit. It is true that corporations do try to make profits, but to destroy the whole science and technology because of it is to me ethically repugnant and irresponsible. But that's what's happened and now we have this incredible challenge in communicating to the public that's been scared to death.

In Europe in particular they are frantic. If you had a discussion with someone in Europe in the late 1990s, 2000, about genetic engineering, they had been convinced it was Hitler all over again. That's how bad it is over there. That hasn't happened in the United States, except there is a segment of the public that does feel that way.

**ER:** Montesano is probably it's own worst enemy. People hear about terminator technology and it confirms their fears about corporate control. Would it be possible to liberate the technology?

**SS:** I think that's quite possible. I personally like terminator technology. I think it's good for the environment, I think it's good for business, and I think it's good for consumers. I think the more ability companies have to get rewards for their product, the more technology gets developed and the more consumers have choices.

I think the whole argument has been turned on its head due to gross distortions, but I realize other scientists have different views. I think it is important to get some of the basic technology out of the control of corporations. They're doing that slowly. They're making technology available for the Vitamin A rice, for example.

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**ER:** Who did that?

**SS:** Ingo Potrykos from Switzerland was the principal investigator, with funding from Rockefeller Foundation. This was no attempt to do public relations for industry and biotech as some people claim; rather it is an honest attempt to reduce blindness and associated diseases due to Vitamin A deficiencies in the developing world. He engineered a pathway using genes from petunia and bacteria to make the precursor to Vitamin A in rice grains. It had never been there before. The idea is that even small amounts of this in rice could reduce blindness in children to a quite large degree. It's a humanitarian project and it involves all these gene transfer technologies and pieces of genes that had various pathways associated with them.

The intellectual property lawyers at what used to be Zeneca helped him. They said here are the pieces you need, let's work out a way that we can get free access to this for subsistence farmers. They did it and now the Vitamin A genes are in the hands of breeders in Asia who are trying to move those genes into elite rice lines that people will grow. We'll know in a few years if the technology is effective and if people accept it, and they probably will if it has the benefits we think it does.I think those kinds of things need to happen more broadly. Several universities recently got together and said that all their intellectual property is going to be freely provided for applications in the developing world. People are working hard to try to untie the technology from big corporations.

I have talked to patent judges about this and a lot of key patents in biotechnology are running out, particularly with trees. By the time a lot of this would come forward commercially, the key patents will have lapsed. That whole issue of corporate control is going away. Having said that, things like terminator, things like genetic use restriction technologies, they have a lot of benefits as well.

**ER:** What is terminator technology?

**SS:** Terminator technology is like having a book you can't copy. It's a plant where the seed doesn't germinate or it produces a plant that a farmer wouldn't want to save the seed from it. If they want that plant again, they'd need to go back and buy the seed again. It's not forcing a farmer to buy seed, but if the seed has some characteristics the farmer wants then he has the choice, if it's priced reasonably, to buy

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the seed from this company. That's how hybrid corn works. Hybrid corn is effectively terminator corn.

**ER:** But it was achieved through conventional breeding.

**SS:** Right. In its heyday hybrids were a wild, radical technology and many people were against them. A key reason it's developed and the hybrids are so productive these days is because companies had an incentive to produce the top genetic material because they could sell the seed. It's the same principle.

People acknowledge protection of intellectual property for CDs and for books; and almost every landscape plant you buy these days is also patented. One thing you see in terms of these gross distortions by the groups that are against biotech is that patenting life is immoral and we shouldn't do it. Society had those discussions. It's moved beyond that. We don't need to discuss every little thing again. We want to reward innovators and give them some protection for their intellectual property.

There are many issues about getting the system right so it doesn't hurt people, and so that it's equitable. What you see out there is this whole notion that patents are destroying the heritage of life on Earth and the whole system is corrupt. It's nonsense, but that's what you see out there. And many people don't know any better. Hardly anyone knows that all their garden plants are patented. They're all cloned by the way as well, and no one seems to know that either. The educational challenge is huge.

**ER:** Public education is a big part of a university's mission.

**SS:** There's a program at Oregon State for analysis of biology issues — I've now inherited the directorship for this program — it's intended to try to provide sound science to the public about crop biotechnology issues. I was looking at some funding opportunities at the National Science Foundation about education and creating new technologies, new materials for teachers, for PBS, and there are all kinds of options that they would fund. The question is how you go about this.

**If you need evidence that biotech can be useful, farmers have adopted it at an incredible rate.**

One of the things that's vexing to me is I'm not sure you can go about this without first discrediting some of the fear mongers out there. How do you do it without first of all calling a spade a spade and then moving on to talk about the scientific complexities?

**ER:** Have there been debates?

**SS:** There have been lots of debates. Biotech opponents come to various public meetings and they're on scientific panels sometimes. One of the key issues is that scientists assume that if they understand how something works — figuring out a pathway, figuring out a production limitation, solving a problem — the system will then find a way to incorporate it. This is more of a bottom-up approach: you work with the science and then the system will incorporate it as it's appropriate.

But a lot of the anti biotechnology agenda is top down: it says agriculture should look a certain way, it's got to be no GMOs, or no chemicals, or whatever. The philosophical approach is radically different, and they're going in different directions.

If you establish broad, vague criteria at the top, where does a gene fit into that? If you set up these ethical criteria that are quite broad — it has to promote soil conservation for instance — how do you measure that down at the level of the plow and the herbicide and the crop? There is a different paradigm in how you approach biotech.

Europe is much more comfortable with what you might call for lack of a better word, a more socialistic view. That is, society will dictate how it ought to be, and then the economy will be that way. The United States is more a market of ideas, a market of technology and innovation. We try to promote individual freedom, technologies, entrepreneurs, and scientists, then society will let the market decide, assuming they pass some test of basic

safety. It's a different philosophy. But all the details about genetics don't matter and all this knowledge that we have about genes is irrelevant if you start off thinking it's all wrong.

**ER:** What do you think will be the result of Europe taking itself out of the GMO marketplace?

**SS:** Europe is on the wrong track as far as I'm concerned. They have traceability rules and regulations of GMOs that have no scientific credibility. To them every genetically modified organism is dangerous and horrible and they should treat it like nuclear waste. It's a social criterion that has little to do with biology or even common sense. I don't know if it will take a generation, a decade, or two generations, but over time as the science advances, products will appear that have obvious benefits. Whatever Europe does and the penalties it imposes will delay things, but they cannot possibly stop it because the need is too great. Over time, they're going to get marginalized. The EU is a huge trading block with huge cultural influence and they have lots of people who are dead set against any of this technology, so the inertia is going to be enormous. It is already enormous.

**ER:** What are some of the projected benefits? You were talking about food security in the Third World.

**SS:** Farming is local. It depends on problems farmers have in certain areas, with certain soils, with certain pests, with certain markets. There's no miracle of biotechnology. It's answers to particular problems. In some areas farmers need vitamin-enhanced crops, like poor people in developing countries who mainly eat rice. In other places that would be ridiculous because you have vegetables that give you your vitamins.

In some places you can have virus problems that are devastating your crops. If you have a biotech solution that's wonderful, but other places won't need it because there's no virus or there are resistant varieties of the crop. Farming is local and you can't understand why you'd want something until you know the details of what farmers face.

People in the developed world will spend a lot of money on food and they tend to use price as an important guide, but if people are scared, then price doesn't matter at all. If you scared them that biotech foods are inherently dangerous, which is nonsense, and then they will make choices. They'll ask for labeling, for example, because they're concerned about who has messed with their food.

It's hard to sit back and make grandiose statements about how biotech is going to change the world. In aggregate, when you look at these different products, when you look at virus-resistance technology, which is now in the field in papaya and cassava, there are a variety of crops with problems where genetic engineering provides a powerful solution.

**ER:** Like adding drought resistance or salt tolerance to a crop.

**SS:** I'm a little bit more skeptical about whether we're going to make quantum leaps for traits like drought resistance. Maybe, but drought resistance is a complex trait. Maybe salt tolerance, but the way a lot of these genetic changes work is they'll expand the range of the plant a little bit or allow you to get a harvestable crop from a soil that before you wouldn't get anything. It may not even be a radical change. It may be that now you have a variety that gets over the economic threshold in terms of producing enough fruit, whereas before it didn't. I think some things you mentioned will happen, but it's going to take some time and a lot of field trials.

One of the points I made in my *Science* essay is that if you can only do a field trial after you've done ten years of regulatory studies and ecological assessments, as is the case in Europe, you'll never get there with those traits. It requires a more flexible, permissive regulatory system.

A lot of good things are going to happen in nutrition, improvements in protein composition and oil quality for instance. Pest resistance is big in many parts of the world already, and there are certainly many other proteins apart from BT that could be used to improve pest resistance. The key question is how high the regulatory barrier is before they are permitted.

**ER:** I think scientists can be a little smug. They just assume people approve of what they're doing.

**SS:** Agriculturalists tend to assume the public supports what they do because they have done so much good: the Green Revolution, longer life expectancy and so on. There have also been environmental negatives with the Green Revolution, no question about it, but agriculturists assume that the picture has been so dramatically positive and that the Green Revolution has been such an overall success that the world ought to all love them. Maybe they need to go back to square one and sell themselves to the public. In terms of the public education part of this, maybe that's the critical thing to do. Some of these things like pharmaceutical crops have huge potentials, and the issue is whether they're going to be closed down by the food industry or by Friends of the Earth, because there will be some cases of leakage into the food supply.

One other difficult thing about biotech is that the regulations we have are always lagging behind by years. I've been amazed seeing this. You would think that a smart regulatory system would be something that you put in place right away to make sure the technology develops appropriately, but there are so many political forces impinging on it, it doesn't change until there's a crisis.

We also have a smart law in this country that says that food labels can't be misleading. You can't put on information that gives people undue concern about their food or undue ease about their food. You can't say things are going to extend your life span when they won't, and you can't say that they are hazardous when they're not. I feel the public does not understand that we actually have a damn good regulatory system. But the science has gotten so far ahead of the ability of the government to deal with it that certain science and technologies that are going nowhere. I came back from this tree biotech meeting. I've been in touch with regulators for years; a BT tree is going nowhere.

**ER:** What do you mean?

**SS:** The way things are today the things they want to know about it are so stringent that until somebody has a watertight gene containment system (and we may never have one tight enough) it's going nowhere, the economic benefits for the growers notwithstanding, until there's some exotic pest where this is going to solve a problem and it's an overwhelming mandate to do it.

The regulatory system now, while scientifically imperfect, is rigorous in the United States. The BT poplar is not going to go forward even though we know it works. My sense of it is that the real risk is that the insects are going to overcome it so quickly you're not going to get many economic benefits.

**ER:** Is there a problem in poplar with insect damage?

**SS:** No question about it. Poplars would probably be grown much more widely commercially if when you grew them you had a fair confidence they'd survive and grow well, but they have some serious insect pests, which are expensive to treat commercially. The growers would love to see insect-resistant poplars.

If we ever got around to growing bioenergy crops or product crops with plastic precursors or enzymes in them, then that insect resistance becomes a bread and butter issue but I don't see the EPA approving it unless our gene flow technology is effective and we can demonstrate it pretty quickly.

**ER:** How does the precautionary principle apply to biotech?

**SS:** Unfortunately to too many people the precautionary principle is a way to say I don't want this technology. The precautionary principle could be taken to mean don't do anything the first time. If you have the philosophy that biotech doesn't fit your view of what agriculture and sustainability should be, then the precautionary principle is your argument why you can't do it. Even doctors use anesthetics and drugs and surgical procedures that all have real risks attached to them because the benefits, in society's judgment, outweigh the risks.

Having said that, I think there are places where we want to be more careful with biotech. We shouldn't make the mistakes with GMOs we made with pesticides. DDT was registered and used under a totally different regulatory regime and it caused serious environmental damage, but it also saved millions of peoples' lives, and continues to do so. These issues are not black and white.

The regulations have not kept up with the science. Companies are scared to death about these regulations and they're stringent enough that there's a serious question in the United States about whether they're killing the technology. If you use biotech the regulations are going to demand incredible details about all the direct and indirect ecological effects. But if you did the same thing through traditional breeding, they wouldn't ask you about that at all. It's stringent but it's not smart.

**ER:** It seems like the regulations are more concerned with the process rather than the result.

**SS:** They say they're not, but that's where it's evolved to be, mainly because they respond to public controversy, they respond to what politicians hear from their constituents. It's not as simple as all GMOs are bad, or all GMOs are good. We have a regulatory system and a social deliberation process for helping us decide what we want to use and we're going to learn by doing.

**ER:** What is the safety record for biotech so far?

**SS:** What's the record from the crops that have been deregulated so far? There have been vast reductions in pesticide use and large increases in soil conservation. So far the record is impressive and an honest evaluation of biotech has to take that into consideration.

**ER:** Is that because of no till agriculture?

**SS:** No till, and in the case of Roundup-ready soybeans and in the case of BT crops, the reductions in pesticide applications have been dramatic. That's not to say that every agricultural practice doesn't have some externalities, but so far it seems to me that the positives swamp the negatives. If you need evidence that biotech can be useful, farmers have adopted it at an incredible rate. Biotech is delivering real benefits to them because it makes farming more reliable, more precise; it takes less energy, less plowing, less chemical use.

So far the regulatory system is working well, I think. We're trying to improve it. I know the regulators, for example, are thinking this Roundup-ready soybean is great, but maybe we should be a little more demanding in making sure farmers rotate different weed control practices so Roundup resistant weeds don't evolve any more rapidly than necessary. Resistant pests are going to evolve, they already have. But they would evolve even if you didn't have Roundup-ready crops. All the cases we know of did not evolve because of Roundup-ready crops at all but because of Roundup use.

If we make the system better by putting in good management practices in conjunction with biotech crops, all the better. That's what's happened with BT crops, the first pesticidal trait in history where the EPA has said, We're not going to let you use it outright but subject to conditions: you must have intensive stewardship; you must have refugia; you must test for resistant insects; and if you don't do all this we're going to withdraw the registration. So biotech has heralded in an era of more precise, more scientifically based farming, which is good.

**ER:** From that perspective we are in the middle of a long, drawn-out political process and scientific process.

**SS:** That brings us back to where we started: top-down versus bottom-up. Biotech, by focusing on genes, lets you be more precise, make more differentiated products, do more differentiated management because you have more fine control of the biological system.

That's what society should be doing; that is, getting more sophisticated and choosing which parts of biotech it likes and doesn't like and then how exactly to use it. Big social-political forces are saying they don't want that whole broad domain of applied science because it doesn't suit their view of how agriculture ought to be. It's a push of science to diversify, to get more sophisticated, versus this social push to be more naturalistic, organic, and don't do so much of this technology that's not natural, whatever that means.

I think it comes down to this: it's people who believe that technology in general leads us to a better place (we're trading up; there's trade-offs, but we trade up with each step) versus those who think that the negatives of technology outweigh the positives so they want to move away from it, or they want to be so discriminatory that they only use technologies that have been proven for 50 or 100 years, or they have a paradigm which is overly simplistic. Those two worldviews are going head-on and you've got to decide which one you believe.

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## Protecting the Last Populations of Great Apes In Africa

Introduction:

Gorilla and chimpanzee populations have been eliminated from most of East and West Africa and the relatively intact forests of western equatorial Africa are considered the last stronghold for African apes. Gabon and the Republic of Congo retain much of their native forests, and they account for 80 percent of the world's remaining wild gorillas and most of the remaining wild chimpanzees.

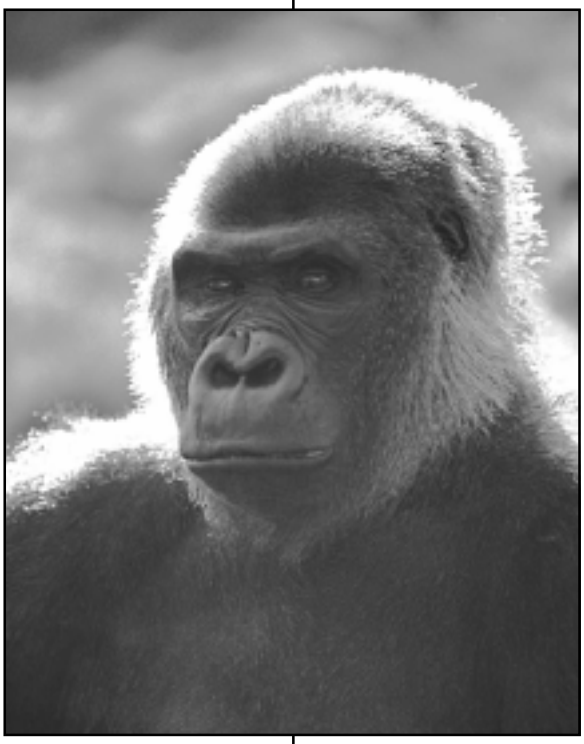
In a recent letter to *Nature*, Walsh et. al. reported that ape populations in Gabon declined by more than half between 1983 and 2000[1]. The main cause of this decline was commercial hunting for the bush meat trade, which has been facilitated by rapidly expanded logging operations. Furthermore an epidemic of Ebola haemorrhagic fever is spreading through these isolated ape populations and may well rival hunting as a threat to their survival. The authors call for these apes to be elevated to critically endangered status to help prevent their extinction.

We spoke with John Oates about his work on the ecology and on the conservation of monkeys and apes in Africa, and his thoughts on the best way to protect them.

**ER:** Professor Oates, what is your training?

**JO:** I was trained as a zoologist at University College, London. That's where I did my undergraduate work and was then registered for a Ph.D. I began doctoral research studies in West Africa in Nigeria on small mammals, including some of the smaller nocturnal primates. That project was brought to an end by the outbreak of the Nigerian civil war, the Biafran war, and eventually I ended up working in Uganda and studying the ecology of colobus monkeys to finish up my doctoral work.

That led to postdoctoral studies on some related forest monkeys, langurs, in India. In that work I was attached to Rockefeller University in New York. In both of these studies in Uganda and India I found myself dealing with people in what was then the New York Zoological Society and is now the Wildlife Conservation Society.



After the postdoctoral work I got a teaching position here at Hunter College at City University of New York and developed a program of primate field studies in Sierra Leone in West Africa at a site called Tiwai Island looking at basic ecology of a community of rainforest monkeys and one ape, the chimpanzee. I got heavily involved in conservation issues there. We worked with local people and the government to set up a wildlife sanctuary.

Along the way I was made a member of IUCN *[IUCN is the World Conservation Union. Ed.]* Species Survival Commission's Primate Specialist Group and by the eighties was working with them to draw up a conservation action plan for all of Africa's primates. I compiled this with much input from other members of the group with knowledge of African primates. This action plan was published in 1986, and a revised edition was published in 1996.

The field I have been professionally most involved in has been studies of the ecology of rainforest primates, not especially the great apes. In recent years some of my students have begun studies of great apes in West Africa, but my own direct fieldwork in the past was on other kinds of primates such as colobus monkeys and guenon monkeys, looking at basic ecology.

I think almost any ecologist studying any larger mammal in the tropics these days almost inevitably gets drawn into conservation issues because almost all these animals are to some extent threatened.

**ER:** Civil war adds a layer of difficulty to doing this kind of work.

**JO:** Sierra Leone, like Nigeria before it, then had its own problems of civil warfare with a rebel insurgency sponsored from Liberia. The Tiwai program could not continue; the research site became part of a war zone. I started to refocus on some primate ecology and conservation questions in Nigeria, a place I had kept in touch with since my early doctoral research days.

**ER:** Has Nigeria calmed down enough to go back to work?

**JO:** The original problems that led to me having to leave Nigeria were back in the sixties during the civil war. That conflict came to a close in 1970. Nigeria has had its own problems since then, but no outright civil war.

**ER:** Not enough to stop you from working there?

**JO:** No. At least since 1990 I have concentrated my work in the part of Nigeria closest to Cameroon, where there is the most westerly population of gorillas in Africa. One of my graduate students, Kelley McFarland, embarked on an ecological study of one of these highly endangered populations.

Another student has looked at the genetics of chimpanzees in Nigeria, trying to figure out their evolutionary relationships. It turns out that they are more closely related to chimpanzees farther west in West Africa than had been expected.

In the last three years my fieldwork has swung much more fully towards conservation and away from basic ecological research on primates. I've been undertaking surveys in the general Nigeria-Cameroon border area, which is a region with many unique endemic species and subspecies, high species richness, and many threats to its ecological systems.

I've conducted surveys in Nigeria and Cameroon and, with support from Conservation International and the Wildlife Conservation Society, helped develop a biodiversity research and conservation program in Nigeria in collaboration with the Nigerian Conservation Foundation. That is ongoing. Meanwhile, I'm still employed on the faculty at Hunter College, where I'm a Professor of Anthropology.

**Gorillas throughout their range in western Africa are hunted for their meat as part of the bush meat trade...**

**ER:** Why have you moved more into conservation issues?

**JO:** Conservation has always been of interest to me personally. From the early days when I was doing fieldwork I saw threats to wild animal populations and their environments which concerned me. I found myself working with mentors who had a very strong interest in conservation. As my work has continued, the animals that I work with and their environments have come under more and more pressure, so given that I had a natural early interest and this was nurtured by various mentors it was almost inevitable that I would pay more and more attention in my research to conservation issues as opposed to pure academic biology.

In my case I think conservation was always a part of my career, so it's just become stronger. I wasn't a pure scientist studying monkey feeding behavior. I and the people I worked with, from a very early point back in the 1960s when I started this, were interested and concerned with conservation issues.

The parts of the world I've worked in are ones with particularly high levels of threat to their wildlife and its environments. In Nigeria we are talking about a country with 130 million people, so it's hard to avoid these issues. In such an environment your study populations are often hovering on the brink of extinction, and practically and ethically you can't avoid conservation concerns.

A good example is the study of one of these endangered gorilla populations in Nigeria where my graduate student, Kelley McFarland, worked for her doctoral dissertation. This is a site called Afi Mountain in Nigeria in Cross River State. It's the most westerly gorilla population in Africa, now isolated on a small mountain range, a mountain with its surrounding forest covering about 100 square kilometers.

Kelley did a study spanning at least two years of the ecology of these animals by tracking their nest sites, which allowed her to figure out how many gorillas were in a group. From collecting dung samples deposited by night nests, she was able to study diets, and by looking at separation of nest sites, to study ranging patterns and so on.

This area is under such pressure from habitat disturbance and hunting that from the beginning of our research we were working with other groups looking at ways to give it better protection. These other groups included non-

governmental organizations, and the local forestry department, now called Forestry Commission. Working together we managed to get the area declared a wildlife sanctuary, and we are now working together to establish more effective management of Afi Mountain. This effort includes recruiting a ranger force, equipping them, building ranger stations, and working with local communities to try and get them on board and understanding the rationale for the sanctuary. Although this area had long been a so-called forest reserve, local people had been hunting and farming in the reserve for a long time.

**ER:** Hunting gorillas as well?

**JO:** Gorillas have been hunted in small numbers, and one of Kelley's study group was killed during the course of her study. Gorillas there and throughout their range in western Africa are hunted for their meat as part of the bush meat trade, which is part of what Peter Walsh and others have been talking about.

So Afi is one particular site where we got involved to learn more about the basic ecology of the animals, but from the beginning were concerned also about trying to protect the animals in the long term. The Afi gorillas belong to a subspecies called the Cross River gorilla, which we estimate has only some 250-300 individuals remaining in the Nigeria-Cameroon border region. They're fragmented into about ten subpopulations which are only tenuously in contact with each other, and they are being hunted, so their survival prospects are very bleak. We are trying to learn more about them to assess how viable the whole population is, as well as particular subpopulations, and to assess what the most effective long-term conservation strategies might be.

**ER:** Of these 250 individuals, certainly they're not all in this 100-square kilometer reserve.

**Kelley McFarland did her doctoral work studying the Cross River gorillas in Nigeria.**

**JO:** No.

**ER:** How many are you trying to support in what is basically six miles on a side?

**JO:** Something of that order. It's actually a more rectangular area. It would be more like eight by four or so. It's a tiny area.

**ER:** How many animals are in there?

**JO:** We estimate there may be on the order of twenty-five individuals left there. This is why this gorilla is in such trouble. There are, as I say, about ten surviving subpopulations, each of which have somewhere between fifteen and thirty individuals. They are all separated from each other but most have some lowland forest or lowland forest and farmland still connecting them. One of the things some of my colleagues have been trying to figure out is to what extent individual animals may still occasionally migrate between these populations and therefore maintain some gene flow.

The remaining Cross River gorilla habitats are almost all hill areas and the lowlands have most of the people. Inevitably human population growth and development are occurring, so between the Afi population and the nearest gorilla population there's a road which is about to be improved by the federal government of Nigeria, making it even less likely that individuals can move from one site to another.

**ER:** They're rather secretive aren't they?

**JO:** Yes. And they're intelligent; that is probably one reason why they've persisted as long as they have. This specific case then does come back to the generalities that Peter Walsh and others have been talking about. These gorillas have been rare for a very long time. The gorillas in Nigeria only became known to people outside that part of Nigeria in the 1930s. From the beginning the foreign naturalists and other foresters who went into the area

expressed concern that these animals were headed for extinction, but they're still there. These are long-lived animals, and they are clever and they are sometimes rather more adaptable than we perhaps give them credit for.

If gorillas in such perilous circumstances can hold on for decades (although I have to agree that the Cross River gorilla subspecies itself is critically endangered, and if we do nothing they seem to be on an inevitable path to extinction), the fact that they've persisted so long in these circumstances makes me think that gorillas and chimpanzees as a whole in Africa are not all going to be gone within a few years, as some people suggest. Chimpanzees are much more widespread than gorillas both geographically and in terms of habitat range.

This comes to my main bone of contention with the Walsh et al. paper: the suggestion that we should reclassify all the African great apes as critically endangered, a particular IUCN category which really does suggest they are in imminent danger of going extinct. I don't think that's the case, and I fear that by perhaps exaggerating the threats to various animals we may as conservationists lose credibility because people will say, You're telling us every year that everything is about to go down the tubes, and here they are all still in front of us. Should we take you seriously?

One can hardly say that any rainforest organisms around the planet, especially large ones, are completely safe from the threat of extinction. But what are the most seriously endangered species? What are the most dire circumstances we should pay attention to? Probably the status of chimpanzees right across Africa in my view is not one of those. If you consider chimpanzee conservation in the perspective of primate conservation generally, there are other kinds of primate that get less attention that are in more trouble, especially various kinds of colobus monkeys, which is where we come back to another of my particular interests. Some of us have been very concerned about certain forms of red colobus monkeys, which are going extinct in front of our eyes.

One can understand why people are concerned about great apes: they are our closest relatives, we have many behavioral features in common, and so on; they're emotive in that they arouse our emotions because of our similarities to them, and so it's easy to give them press coverage which attracts attention. But as scientists we have to continually guard against saying things for more subjective than objective reasons.

**ER:** Getting back to the plight of red colobus...

**JO:** With colleagues Thomas Struhsaker, George Whitesides and Scott McGraw I was involved in surveys a few years back in Ghana and Ivory Coast of rare forest primates, especially three monkeys unique to that area, a red colobus monkey, a mangabey, and a local form of a Diana monkey called the Roloway monkey. After a great deal of searching in both countries with various teams of people we could find no direct evidence for the survival of the red colobus monkey, the so-called Miss Waldron's red colobus.

We eventually published a paper in the journal *Conservation Biology* saying that in our view Miss Waldron's colobus was probably extinct, and if a few individuals or a small number survived their populations were probably not viable[3]. Since then, in one area on the border of Ivory Coast and Ghana, one tail and one skin have been found recently, apparently killed by hunters. So Certainly a few animals did persist until very recently, but still none of us, or our associates, or teams sent out by Conservation International have managed to see one of these monkeys alive. I think we would still support our original conclusion that they are probably extinct, or if some survive they may not be viable any longer.

That report did receive quite a bit of attention at the time, but since then the attention has subsided and not

**The Cross River gorilla, a distinct sub species, has only 250 to 300 individuals remaining in the Nigeria-Camaroon border area... their survival prospects are very bleak.**

much more has been done. There are other red colobus monkey populations in Africa that are probably getting close to the edge, but a red colobus monkey doesn't attract as much popular concern — perhaps understandably — as a chimpanzee or gorilla.

**ER:** What is the main reason for their decline?

**JO:** Again, it's hunting almost entirely for the bush meat trade, hunting not for subsistence but as part of a commercial trade in meat. Colobus monkeys seem to be particularly sensitive to this hunting, especially red colobus. They are in many places quite restricted in their range. They seem to be habitat specialists. They live high in the forest canopy. They are rather clumsy movers, they have bright colors, they make a lot of noise, so they're rather easy to hunt. Some people would say they also seem to be a little dim-witted.

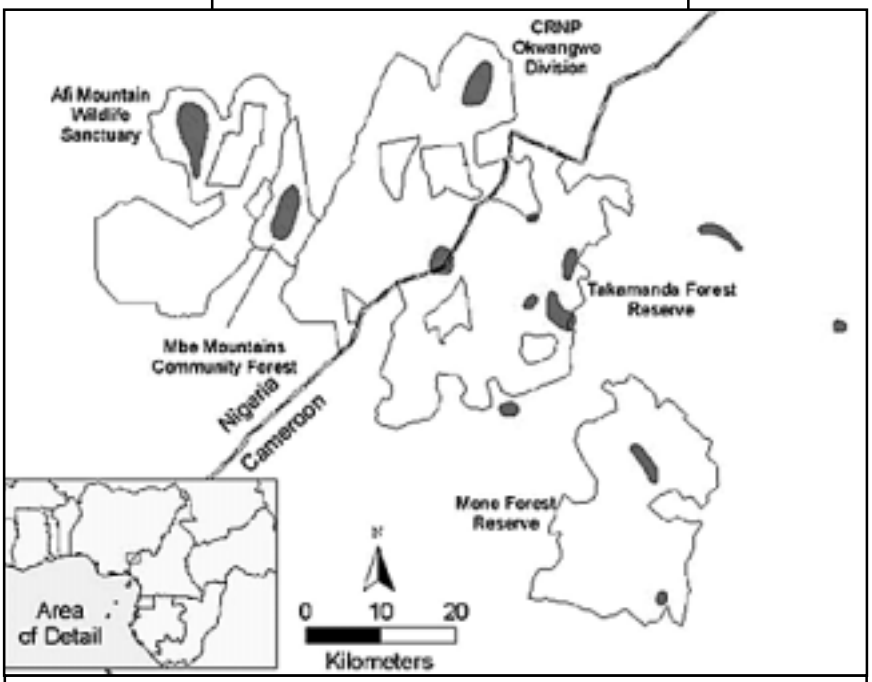
**ER:** Top predators are frequently not afraid of things that they need to be afraid of.

**JO:** These are leaf eaters, but chimpanzees actually are one of the main predators of the red colobus in Ivory Coast and in Kibale Forest in Uganda. One of the factors possibly threatening red colobus monkeys is therefore chimpanzee predation. They particularly like eating these especially threatened monkeys.

**ER:** What was your concern with the Walsh et al paper?

**JO:** Walsh et al were arguing that all gorillas and chimpanzees in Africa should be regarded as critically endangered. That caught my attention because I have been involved in the past in helping the IUCN and Species Survival Commission come up with threat ratings of African primates. My concern was that these authors were extrapolating too far from a comprehensive but still limited data set. That was my concern.

I'm certainly concerned about the survival of African forest primates, including apes, and I would not at all disagree that we should be concerned about the status of many wild chimpanzee and gorilla populations. I was a little concerned about some of the methodology in the Walsh et al. paper, but they were working in an area that I have not worked in and were using modeling techniques that I am not familiar with. But until I have had a chance to study a lot more carefully more of the details of that paper I am a little reluctant to give extensive comments about methodological issues. My particular concern was more the extrapolation from one study in Gabon, one that had to make a good number of assumptions to reach its conclusions about local ape populations, to a statement that chimpanzees should now be reclassified as a critically endangered species across Africa.




**The Cross River gorilla sub species is reduced to about 300 individuals living in ten isolated patches of forest.**

**ER:** Why do you think they conflated the two species?

**JO:** They conflated the chimps and gorillas in the Gabon study, as I understand it, because of the difficulty of reliably distinguishing chimpanzee and gorilla nests in the field, especially during rapid censuses. To collect much of their data they employed what Peter Walsh refers to as a reconnaissance survey technique, which means moving relatively quickly along existing paths and noting what you see.

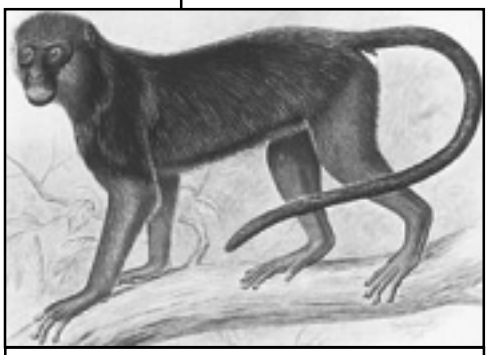
The original ape censuses in Gabon, with which Walsh et al. compare their data, distinguish chimpanzee and gorilla nests particularly based on height in the trees. Since then we have learned that this can result in a

high level of misclassification. If you're doing a rather rapid assessment and you don't want to make too many errors, I guess it's sensible to pool those data.

So having pooled all the nest data they then cannot really say for sure, when they appear to find a decline in the numbers of chimps and gorillas, whether there's been a larger decline in one species or the other. They have a general estimated ape decline in Gabon based on the techniques they used, then from that they extrapolate to the two apes together across Africa.

**ER:** Why are the estimates so shaky?

**JO:** Peter Walsh's strength is mathematical modeling and mine is not. These are very difficult animals to study, and many population assessments rely on a good deal of estimation and extrapolation. There isn't a huge amount of past data, and the original census data from Gabon have been lost.



**Miss Waldrons red colobus has recently gone extinct.**

**ER:** Did they ground-truth to check their modeling data to see how well it described field conditions?

**JO:** I'm not aware that since they did the estimation somebody then went back to the field to use a different technique to check how robust some of the estimates might be. What they did do was have a measure of ground-truthing, if you like, or calibration of some of the recce [recce is the term Peter and others use] sampling by using the traditional line-transect sampling. As I understand it they conducted line transect censusing in certain places, so that from a technique generally regarded as pretty accurate they were then able to get a calibration point for local recce work which they then conducted over a much larger area in which they did not perform transect censusing.

**ER:** I'm sure Peter has given considerable thought to these difficulties.

**JO:** He has.

**ER:** My point in asking is that modeling is a favorite target of people with anti-conservation agendas of various sorts.

**JO:** Like global warming and so on.

**ER:** Right. And the way scientists deal with these difficulties is more transparent and honest than how it's often presented in the media.

**JO:** I agree, and I'd like to emphasize that I'm not one with an anti-conservation agenda, and I'm not against doing all we can for great apes. In this case it was really more some specific extrapolations from a local study that gave me concern.

Just to criticize my own position a bit here, in the interests of transparency, it would be worth pointing out that the IUCN category of critically endangered relies on making a number of measurements or estimates of a population and its rate of decline, and these can be related to generation times.

Because the great apes are such long-lived animals, if you're talking about a reduction of at least 80 percent within the next three generations (one of IUCN criteria for critical endangerment), that can be on the order of at least sixty years for great apes.

There are many factors that could potentially lead to chimpanzees all across Africa declining by 80 percent in the next sixty years. A categorization of critically endangered then isn't so hard to justify, although I think when IUCN drew up these categorizations in the first place they weren't really thinking so much about the problems of applying the categories to animals with very different generation times. The same IUCN system is applied to a nematode worm as to a gorilla here, despite the very different generation times involved. I think ordinary members of the public thinking about endangerment are thinking about things likely to happen in the next few years rather than about what may happen in 60 to 100 years, where of course the whole planet may well change vastly, with vast numbers of species presumably facing a pretty good threat of having their populations reduced by 80 percent in the next sixty years.

Yet most people would probably not be comfortable regarding all such species as critically endangered. So that gets us into a rather philosophical area. Being my own critic here, I can see that if one does stick by the IUCN rule and incorporate generation time, then it is hard not to argue that all great apes everywhere are likely to decline significantly in numbers in the next 60 to 100 years, and therefore could justifiably be regarded by that criterion as critically endangered.

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**ER:** But gorillas more than chimps?

**JO:** I think that from what we know of their current distribution and numbers, gorillas would have to be regarded as in more trouble than chimpanzees. They seem to be able to occupy a smaller range of habitats. They occur in a much smaller geographical area and therefore, starting from today, they would be more likely if current pressures continue, to go extinct in the foreseeable future than chimpanzees.

If you're taking a period of 60 to 100 years then everything is in trouble, but from what I've seen of the African apes the common chimpanzee is probably the species that holds up best to the pressures of habitat change and destruction, and hunting.

**Literature Cited:**

1) Catastrophic Ape Decline in Western Equatorial Africa. P.D. Walsh et al. 2003 *Nature* 422:611-614

2) 2000. Extinction of a West African red colobus monkey.Ed. J.F. Oates, M. Abedi-Lartey, W.S. McGraw, T.T. Struhsaker, G.H. Whitesides. *Conservation Biology* 14: 1526-1532

More information on the Guinean Forests of West Africa can be found at www.cepf.net/xp/cepf

The IUCN action plan for African primates is online at www.redlist.org

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