Wild EARTH

FALL 2000

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Wilderness Warrior

T.H. WATKINS (1936–2000)

by Terry Tempest Williams

THE WILDLANDS OF SOUTHERN UTAH lost one of its most eloquent and fierce defenders this past year. On February 23, 2000, Tom Watkins passed away in his home in Bozeman, Montana, from cancer. He is survived by his wife, Joan Parker Watkins, and two children, Lisa Pless of Pinole, California, and Kevin Watkins of Beaverton, Oregon. His father, Thomas F. Watkins, resides in Yacaipa, California.

Shortly after his death, Barry Lopez said, "What we have lost in Tom Watkins' passing is a front-line voice that understood the social history that informed political choice."

Nowhere was this more clearly evident than at The Orion Society's Fire & Grit Conference held in 1999 at the National Conservation Training Center in West Virginia. It is an image of Tom I will never forget. Watkins gave a tour-de-force speech on the confluence of conservation and social justice.

I do not think you can have a truly valid land ethic if you do not accept a social ethic that addresses the needs of human beings.

He went on to say how the same political impulse that brought relief to victims of the Depression also created the Soil Conservation Service, which created the atmosphere that enabled millions of acres to be included in the National Wildlife Refuge and National Park Systems; that the same political era that created the Wilderness Act, the Endangered Species Act, the Clean Air and Water Acts, and the Environmental Protection Agency also brought us the Civil Rights Act, the Voting Rights Act, Medicare and Medicaid, the Food Stamp Program, and Head Start.

It was a rousing call to arms in the name of environmental justice.

Too often, those of us within the conservation movement forget the powerful teacher history can be to understanding the psychology and patterns behind social change. As a historian, Watkins was always mindful of context as evident in his books, *Righteous Pilgrim*, the biography of Harold L. Ickes, secretary of Interior for Franklin D. Roosevelt, and *The Hungry Years: A Narrative History of the Great Depression*, published in 1999. It's what gave his voice authority and depth. Michael Kazin praised Watkins' prose in the *New York Times*, saying it "has the intensity and warmth of a photo by Dorothea Lange or a novel by John Steinbeck."

continues on page 2

illustration by Patrick Dengate

About Wild Earth *and The Wildlands Project*

Wild Earth and The Wildlands Project are closely allied but independent nonprofit organizations dedicated to the restoration and protection of wilderness and biodiversity. We share a vision of an ecologically healthy North America—with adequate habitat for all native species, containing vibrant natural and human communities.

Through the quarterly journal *Wild Earth*, other publications, and advocacy, **Wild Earth** works to foster a culture of conservation, helping to communicate and shape the latest thinking in conservation science, philosophy, politics, and activism.

■ We make the teachings of conservation biology accessible to non-scientists, that citizen advocates may employ them in defense of biodiversity. ■ We provide a forum for dialogue within the conservation movement on the scientific, strategic, and spiritual foundations of effective conservation action. ■ We highlight the campaigns of biodiversity preservation groups and coalitions across North America, and serve as a networking tool for wilderness activists. ■ We serve as the publishing wing of The Wildlands Project. ■ We expose threats to habitat and wildlife, and regularly explore the links between human population growth and biodiversity loss. ■ We defend wilderness both as ***idea*** and as ***place***.

The Wildlands Project is the organization guiding the design of a continental wilderness recovery strategy. Through advocacy, education, scientific consultation, and cooperation with many regional groups, The Wildlands Project is working to design and implement systems of protected natural areas—wildlands networks—across the continent.

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Black-chinned and Calliope Hummingbirds with Coral Bean, mixed media by Douglas Moore (©1996)

Little Things

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Wilderness Warrior

continued

He also had a clarity and wit about him.

On more than one occasion, I can tell you it was Tom's deadpan humor or perspective that saved the day in meetings of the Governing Council of The Wilderness Society, where he served as editor of *Wilderness*, the quarterly magazine of the Society, from 1982 to 1997. Again, he carried the history of the organization inside him, serving as a continuum between the generations of employees, activists, and council members.

As he lay dying, Tom found not only the fortitude but the physical and mental energy to pen a hard-edged op-ed piece for the *New York Times* entitled, "Nature, Up for Sale," in support of the Clinton administration's current moratorium on road-building on some 40 million acres of undeveloped national forest land, and with a pointed reminder that John McCain's environmental record was no better than that of George W. Bush. It was published a few days before his death.

Forever vigilant.

But what I loved most about Tom as a friend and fellow writer was his unguarded passion for Utah wilderness. The heat of the redrocks of southern Utah never cooled for him. Each year, he could hardly wait for his return to what he called "the home of my heart."

I am helplessly addicted to this place, this wondrous geographic puzzle of canyons turning in on themselves, of upthrust plateaus and big blisterlike mountains, of multi-colored rocks all layered and bent and broken, of curling rivers dammed by beavers and shaded by grandfather cottonwoods, of horizon-wide sweeps of sunlit emptiness and gracile unknown places where darkness hides and will not tell its name.

He first came to these wildlands in 1988 with his friend John G. Mitchell, who he had assigned to cover an article on the unprotected BLM wildlands in Utah for *Wilderness*. He recognized almost immediately,

The wildlands of southern Utah were not going to be like so many—too many other landscapes in my recent life, places that I had taken a look at then moved away from, satisfied that the memory alone would suffice. I wanted to know these lands, pry into their hidden places, walk where I could persuade myself no one else had ever walked before, at least not within the age of recorded time, take the measure of myself as well as the land.

I loved Tom. He was a friend and ally. As I write this piece, it is hard for me to comprehend his absence. But we have his words and that in itself is its own form of immortality. And we have the incomparable wildlands of southern Utah that he loved so much, where his joyous spirit will forever be found.

Last spring, somewhere along the Dirty Devil, a small group of close friends and family scattered his ashes.

In Tom's own words: *The sky above me has turned to ink. There are no answers and there is no moon. Only the stars; the stars; the stars.*

Conservationist and writer **Terry Tempest Williams** *is herself a wilderness warrior who has worked tirelessly on behalf of her beloved Utah wildlands. Her latest book is* Leap *(Pantheon, 2000).*

Love is a powerful tool, and maybe, just maybe, before the last little town is corrupted and the last of the unroaded and undeveloped wildness is given over to dreams of profit, maybe it will be love, finally, love for the land for its own sake and for what it holds of beauty and joy and spiritual redemption, that will make the redrock country of southern Utah not a battlefield but a revelation.

—T.H. WATKINS, *THE REDROCK CHRONICLES*

"Sky and Butte," redrocks, southern Utah by Patrick Dengate

Although the article, "The Killing Fields: Monarchs and Transgenic Corn," by Gary Paul Nabhan [Winter 1999/2000] seems to be very sensible and persuasive, it addresses a particular case. I worry that it will be generalized and will be exploited as yet another argument against genetically modified food.

Many environmentalists are opposed to this type of agriculture, which is unfortunate. Genetically modified food really does offer the best hope we have of preserving large tracts of land. This is not a myth, because it requires land to grow food. The more food we can extract from the least amount of land, the more land we can let go wild. After all, a farm, or a garden, is formed by ruthlessly uprooting the native vegetation and planting crops. Fortunately, the amount of farmland has been decreasing over recent decades. Much of it is being developed into human sprawl, but the rest of it is being allowed to revert to a natural state.

As long as we are well fed, protests against "frankenfood" will continue, because after the demonstrations the protestors can enjoy their dinner. But, what happens when something goes wrong with our food supply? After all, most of what we eat comes from just a few species. I fear that when we do encounter food shortages, our society will revert to slash-and-burn agriculture and our conservation efforts will be for naught.

Of course, genetic manipulation could provoke an agricultural calamity. So, where does the greater danger lurk? With our burgeoning human population, we face disaster if we do not make food production more efficient. So right now, I see more upside benefits from genetic manipulation than downside risks. The point is that environmentalists cannot just take some fashionable stand against genetically modified food; they must keep it as an open possibility.

Consider fire. It not only warms, cooks, and enables manufacturing; it also burns us and destroys our possessions. We do not protest against fire. We strive to control it so that we can use it safely. Genetic manipulation is playing with fire. We must learn to control it, so that we can reap its many benefits. This is not a simple issue.

DONALD A. WINDSOR
Norwich, New York

Ross MacPhee's letter [Letters, Summer 2000] regarding Dave Foreman's editorial, "...Forty Thousand Years of Extinction," took issue with a quote Foreman credited to an article I wrote for *Nature Conservancy* magazine: "No biologist has documented the extinction of a continental species of plant or animal caused by non-human agencies...." MacPhee replied, "William Stolzenburg's point is mere allegation."

I should point out that the point was not mine, but that of a collaboration of scientists contributing to the United Nation's *Global Biodiversity Assessment* (1995), and was so attributed in my article. I believe MacPhee misinterprets the quote when he asks, "How can it be that non-human agencies have just switched off, after moulding the earth's biota for the last billion years or more?" I read nothing in the *Assessment* stating that background extinctions have ceased, rather that they appear to be rare compared to those lately credited to humans.

WILL STOLZENBURG
Arlington, Virginia

Will Stolzenburg is Science Editor of Nature Conservancy *magazine.*

Ross MacPhee doesn't have it exactly backwards when he claims it is a departure from science to assume "extinctions going on at present must be due to human impacts." [Letters, Summer 2000]. But he does err obliquely. Rather, science cannot assume that extinctions are not due to human impacts.

This direction of reasoning is called for because the study of nature must now be done within an abstract space of a set of transformations on the natural world, rather than the natural world itself. This requirement is a result of our pervasive alteration of the planet. Thus a hypothesis of no changes, a null hypothesis, should mean no changes or deviations from the transformation we effect. What is important here is the corresponding shift in the burden of proof.

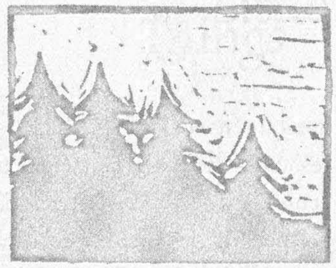
HENRY BRUSE
Wisconsin Rapids, Wisconsin

Wild Earth Launches Website

Activists, scholars, students, and potential supporters can now get information about the Wild Earth Society on the wild wild web. (That's what the "www" means, right?) Read selected excerpts from the current issue, search the back issues database for topics of interest, subscribe or renew your membership online, and more at: **www.wild-earth.org**

We welcome your comments. Please send letters to us at PO Box 455, Richmond, VT 05477 or via e-mail to letters@wild-earth.org.

A Wilderness View

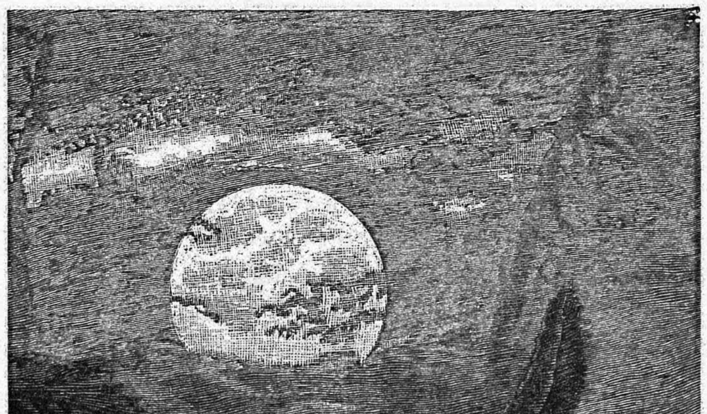


Cold Spots and Warm Hearts

Nature first, then theory. Or, better, Nature and theory closely intertwined while you throw all your intellectual capital at the subject. Love the organisms for themselves first, then strain for general explanations, and, with good fortune, discoveries will follow. If they don't, the love and the pleasure will have been enough.

—Edward O. Wilson[1]

In his lovely memoir *Naturalist*, E.O. Wilson fondly describes an epic entomological road trip, when he and fellow Harvard grad student Thomas Eisner spent the summer of 1952 rambling around America. The two young "naturalist hobos" subsisted on canned food and camped in parks and along roadsides, saving their few dollars to keep Eisner's '42 Chevy (a vehicle that "required a quart of oil every hundred miles") on the road. They explored prairies, mountains, swamps, and deserts—everywhere searching for and collecting insects. "We saw most of the major ecosystems of North America close up, and all we learned in that remarkable summer cemented our lifelong passion for field biology."[2]



engraving ca. 1895

The trip also cemented a lifelong friendship between two men who exemplify a melding of love for Nature and passion for scientific inquiry, and whose subsequent careers would help shape and advance the field of evolutionary biology. In a wide-ranging conversation in this issue (beginning on page seven) Tom Eisner discusses, among other topics, wilderness preservation, chemical prospecting, natural history, the interconnectedness of biological systems, and how biodiversity proponents might better communicate the fascinating life histories of invertebrates, such that a wider constituency for their protection may develop.

And Eisner comments on the hot issue of "hotspots." In reaction to the global extinction crisis, much current conservation energy is focused on areas of extraordinary biological richness, with high numbers of endemic species (organisms indigenous to a particular locale, with limited geographic distribution); such areas occur disproportionately in the tropics. Clearly, in a world with many pressing social and environmental needs, in which financial resources for land protection are finite, conservationists must set priorities—and hotspot criteria certainly have merit.

Moreover, conservationists from the developed nations (particularly Americans, as our ecological footprint is so large, extending now to the ends of the globe) have both an ethical and practical imperative to assist the developing world with biological conservation. We have the financial resources to do so, in many cases national governments and local non-governmental organizations do not, and the threats facing biodiversity—even in nominally protected areas—are grave.[3]

Conservation action focused on protecting biological hotspots, tepid spots, coolish spots, and cold spots will all be necessary to save the diversity of life.

While useful in real-world efforts to save the real world, prioritizing lands for protection either exclusively or primarily on species abundance and rarity is, however, problematic. As Eisner notes: "The general idea of 'hotspots' is a good one, and to include invertebrate diversity in the assessment of rarity and endemism is clearly the right thing to do....But listing hotspots means relegating other areas to the status of 'cold spots.' Do we really know enough about the world...to classify regions by value?"[4]

The answer to that question is an unambiguous, "yes and no." For groups of organisms that are reasonably well known—birds, mammals, flowering plants, mollusks—ecologists can say with authority which areas of the globe harbor large numbers of endemics, and thus are critically important to protect. But with estimates of the total number of species now present on Earth varying from 10 million to 100 million, and with only 1.5 million species described and classified taxonomically, most of living Nature is, to the human mind, *terra incognita*. Millions upon millions of other life-forms with unique interdependencies and evolutionary potentials: a grand mystery.

Although the new species being discovered every year span the taxonomic spectrum (even primates, occasionally![5]), the vast bulk of that unknown life is in the wondrous realm of "little things that run the world" which we celebrate in this issue of *Wild Earth*: insects and other invertebrates, soil microorganisms, plankton and diatoms...the whole swirling and spinning phantasmagoria that forms the ecological milieu for us "larger" species. (Not "higher," as Lynn Margulis and Dorion Sagan caution here in "The Microcosm," when they remind us that "all organisms today are equally evolved.")[6]

What practical conclusions flow, then, from the realization that most of life's diversity is yet unknown, that much of it resides literally in the ground under our feet, and that, to borrow a phrase from this journal's founding editor, "endemicity may be everywhere"?[7] Such realization gives deeper meaning to the oft-quoted platitude to "walk lightly" on the Earth; it surely means that to forestall extinction, it is important to save not just Brazilian rainforest but relict prairie in Iowa, cypress swamp in Louisiana, and boreal forest in Montana's Yaak Valley.

It should mean that individuals, communities, and governments institute policies that discourage any action that would convert or fragment remaining natural habitat. No net loss of wild habitat—*anywhere*—is a worthy goal, albeit one that will be difficult to achieve in a world of burgeoning human population. It should mean that we redouble our efforts to protect self-willed land everywhere, in Madagascar and Massachusetts, New Guinea and North Dakota. All land is sacred. And all land may be the habitat, *the home*, of wild creatures that perform vital ecological functions of which we yet have no knowledge.

In this journal, we regularly present a wide variety of articles on conservation strategy, science, and philosophy...a mix of the practical and idealistic. To be sure, a range of tactics at all levels of society are required if conservationists are to help as much of living Nature as possible survive the coming century. The problems are complex and the solutions will vary in different parts of the world. Conservation action focused on protecting biological hotspots, tepid spots, coolish spots, and cold spots will all be necessary to save the diversity of life.

The example of Tom Eisner and the work of many other effective conservation biologists and activists represented in this issue of *Wild Earth* give me hope. The bottom line is that Life is a mystery. Life is good. With every step we take, we have the potential to help it flourish or perish. If we were to turn away from our obligation to the rest of the ecological community—to living Nature—we would be a cold-hearted culture indeed.

—TOM BUTLER

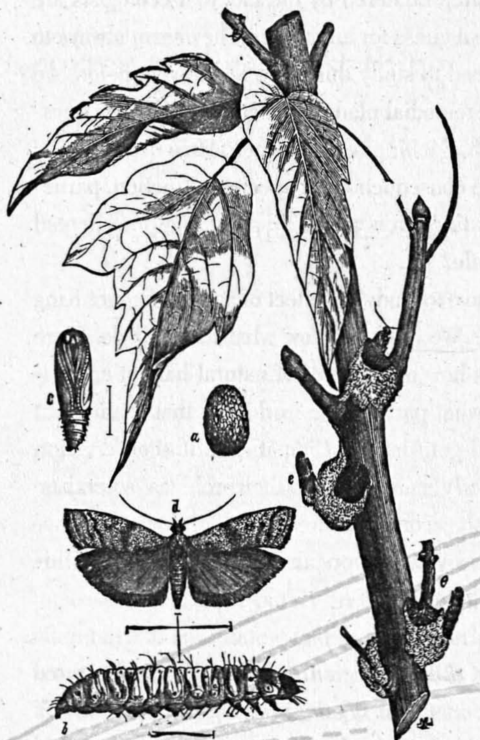
NOTES

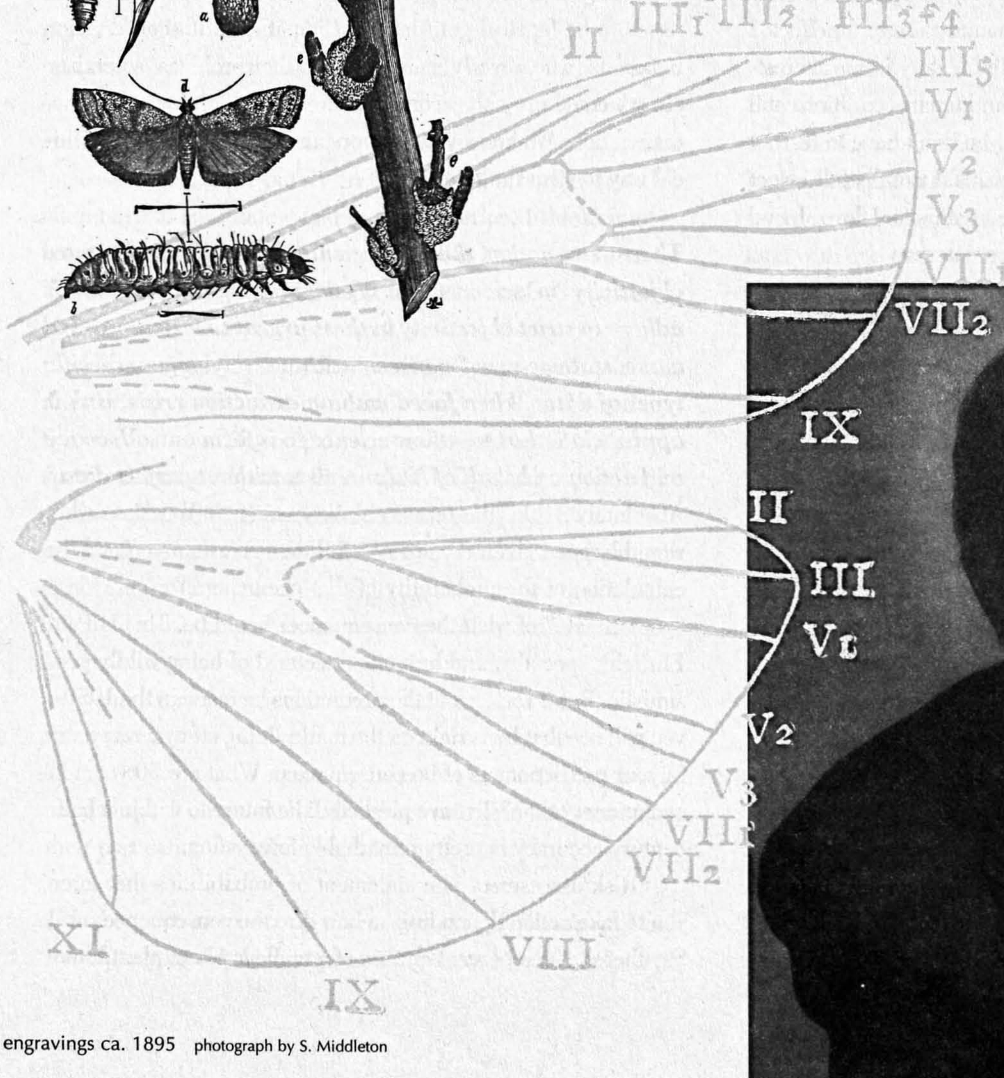
1. Wilson, Edward O. 1994. *Naturalist*. Washington, DC: Island Press. p. 191.
2. Ibid. p. 144.
3. For a superb overview of the problems facing protected areas globally, particularly in the tropics, see John Terborgh's compelling (and depressing) book *Requiem for Nature* (Island Press, 1999).
4. "An Interview with Tom Eisner," this issue, p. 7.
5. Quammen, David. 2000. "The Rivers of Marmosets," *Whole Earth* 102. pp. 20–24.
6. Margulis, Lynn and Dorion Sagan. "The Microcosm," this issue, p. 12.
7. Davis, John. 1992. "*WE* Role in the Wildlands." Wild Earth Special Issue: The Wildlands Project. p. 9.

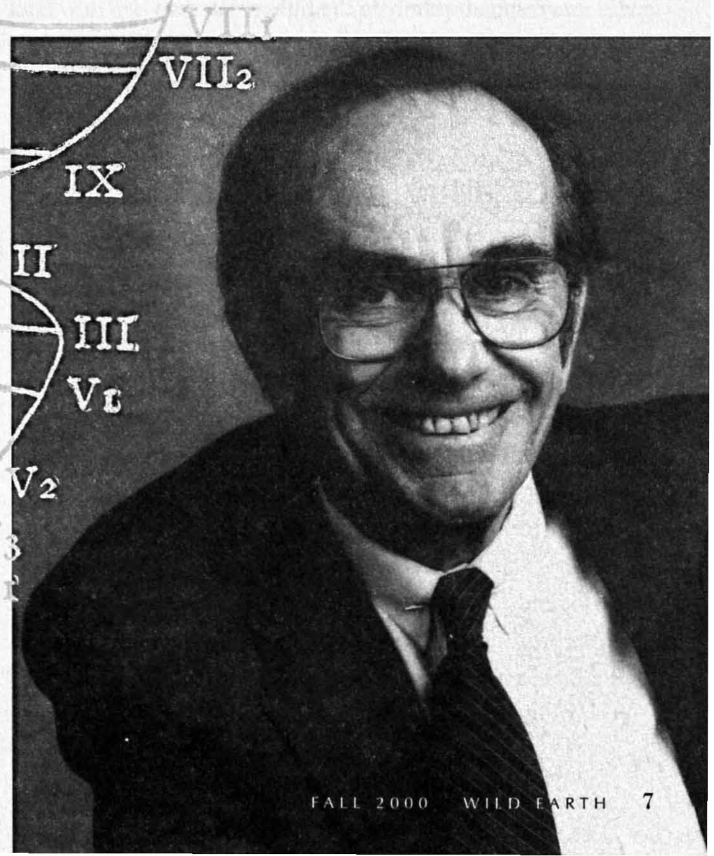
An interview with Tom Eisner

Thomas Eisner's extraordinary career has melded scientific inquiry at the highest level with consistent, forceful advocacy for living Nature. A world authority on animal behavior, ecology, and evolution, he is the Jacob Gould Schurman Professor of Chemical Ecology at Cornell University, and Director of the Cornell Institute for Research in Chemical Ecology (CIRCE). Pioneering fieldwork on the chemical interactions of insects and other organisms has taken him to four continents. He is author of some 300 scientific articles and six books—and played a key role in efforts to preserve wilderness areas in Florida and Texas. He has served on the Board of Directors of the National Audubon Society, the National Scientific Council of the Nature Conservancy, and as chairman of the Endangered Species Coalition; he is currently President of the Xerces Society. A nature photographer and avid pianist, Eisner grew up in Uruguay, is a naturalized American citizen, and received his BS and PhD degrees from Harvard University. Among a voluminous list of accomplishments and accolades, he received the National Medal of Science in 1994.

Interviewer **Amy Seidl**'s *research takes her hunting for butterflies high in the Rockies, where she studies the endangered Uncompahgre fritillary. She is an entomologist, ecologist, and faculty member of the Environmental Program at the University of Vermont. She spoke with Thomas Eisner on May 25, 2000.*







engravings ca. 1895 photograph by S. Middleton

Amy Seidl: ***You are a keen observer of insect life history strategies and your descriptions of insect behavior often resonate with a kind of Arthurian metaphor—beetle larvae jousting with millipedes and orb-weaving spiders entrapping insect prey. How can we move the intrigue of insect behavior into the mainstream as has been done with mammals?***

Tom Eisner: That's a very good question but not an easy one to answer. I recently gave an address in which I was supposed to talk about biocomplexity. As I was preparing the talk, I found myself becoming more and more impassioned about the whole notion of natural history and its survival. So I gave the lecture on that. Later, after thinking about it, I almost reached the conclusion that natural history may need to split off from the rest of science to achieve a place of its own on center stage. Passion for Nature will need to be given a chance again to become a prime justification for the saving of Nature.

Think of the consequences if at the end of the evening's news one were to have a two-minute nature spot instead of the conventional human-interest story. Slipping in a natural history story could easily be done. And it is bound to have an effect. I know this from lecturing to students. Tell a story in an interesting way, link it to conservation and the human condition, and they sit at the edge of their seats. And you don't have to restrict yourself to the large and familiar organisms. I usually tell insect stories because they happen to be the organisms I love. I find audiences respond warmly to the little creatures.

I'm intrigued by the notion of natural history splitting off from the other biological disciplines. Is that what you think should happen?

Not really. Natural history is bound to remain linked to taxonomy, behavior, evolution, and ecology, traditional disciplines that are likely to continue to flourish in the decades to come. It is also likely to establish links with molecular biology, given that biological phenomena are increasingly understandable in molecular terms these days. But natural history needs to be proclaimed as such. It is the prime reason so many of us are interested in Nature. Yet few are willing to admit that they are naturalists at heart, that they are driven by the instincts of the naturalist. In academic settings, certainly, the tendency is to shy away from the term. David Wilcove, of Environmental Defense, and I just wrote a piece for the *Chronicle of Higher Education* on natural history and what's happening to it. We start the piece with the postulate that natural history is slipping into oblivion.

I recently saw an editorial by E.O. Wilson in the journal* Conservation Biology *saying something very similar.

I saw that editorial too. I loved the expression he used there—that "planet Earth deserves intensive care."

That's a great quote. I think ecologists should develop an intimate understanding of the natural history of their study systems and then, from that knowledge, ask good research questions appropriate to the system.

I agree. But I am often bothered by the fact that ecologists are reluctant to venture a guess for an answer. They seem always to fall back on "we need to study this more intensively before we can come up with a remedial plan." How can there be any question about what is happening to the planet? How can there be any doubt about the consequences of species extinction, particularly when such extinction is proceeding at an unprecedented rate, on a global scale?

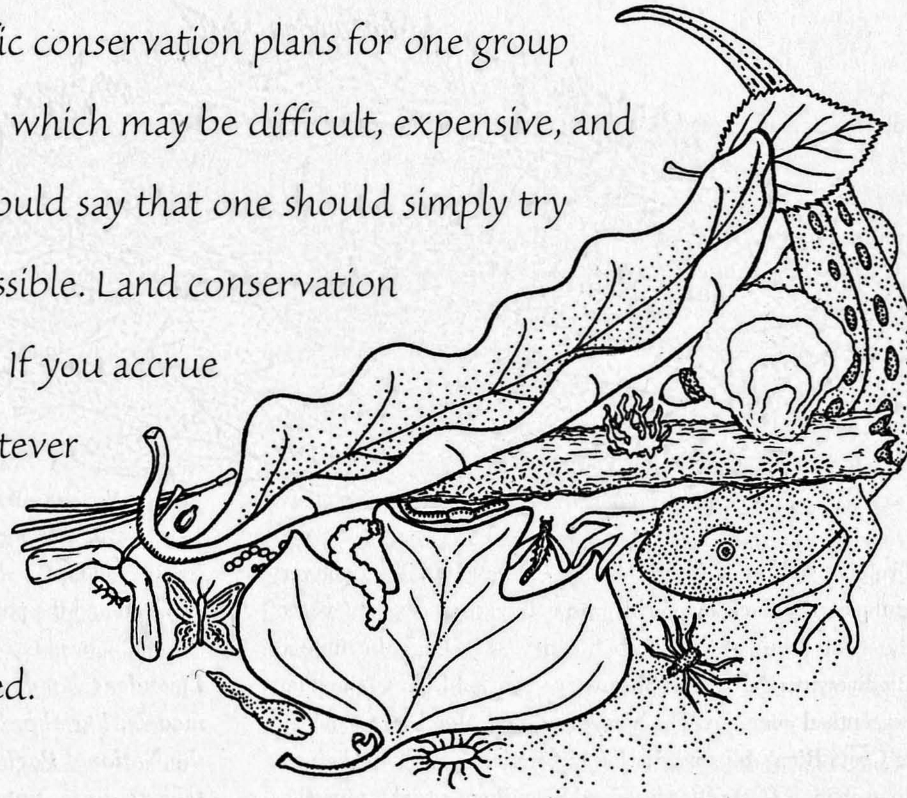
Do we really have to study the effect of another Burger King on an acre of land? We already know what that will do. More important, we know how many acres of natural habitat are disappearing, and in what parts of the world. It's that reality that needs to be faced. I get somewhat impatient with conservation biologists who, overly conscious of their role as scientists, always come up with recommendations for further study rather than action. We know what's happening, so let's find the political way to stem the tide.

There is a notion that the scientist must strive for pure objectivity in science, yet it's my feeling that we can't adhere to strict objectivity in these urgent times; we need to make statements of concern without relying on specific types of data. When faced with an extinction crisis, isn't it appropriate that we allow science to inform our advocacy and action on behalf of Nature, even without perfect data?

Absolutely. I like the term "risk assessment." You state what would happen given certain possibilities, and then you make a calculation of the probability of that occurring. You provide a "guesstimate" of what the consequences could be. This is Paul Ehrlich's specialty, and he's often accused of being wildly pessimistic. But if you look at the predictions he made in the 1950s, you will see that he is right on the mark. Being off by a few years in your predictions is of no consequence. What are 50 years in evolutionary time? To have predicted the future to within a half-century accuracy is pretty remarkable forecasting.

Risk assessment is a statement of probabilities that force you to take action depending on how dire the consequences are. Say there's a one percent chance of a nuclear power plant blow-

Rather than creating specific conservation plans for one group of invertebrates or another, which may be difficult, expensive, and time-consuming to do, I would say that one should simply try to save as much land as possible. Land conservation is my number one priority. If you accrue any kind of wealth, in whatever currency, the wisest thing you can do is convert that wealth into wilderness saved.



ing up. That's a low probability. But if it does happen, the consequences would be catastrophic, and obviously you have to do everything possible to prevent it from happening. When biologists testify before Congress, we get questions that are often impossible to answer purely on the basis of scientific fact. We often have to speculate—and that speculation, I think, is what has to mold the political response. We cannot predict, for instance, exactly what will happen if 14 out of 63 species of birds are lost in a particular area, or what the consequences would be, say, on algal production, if the temperature in a lake rises by a quarter degree as a result of water being flushed into the lake from a utility company. But we can assess the risks, and specify the range of probabilities of the consequences, and make decisions based on the magnitude of these risks. The idea is to err on the side of caution. As humans we have consistently denied reality and proceeded with optimism, hence the disaster.

It doesn't help that scientists are often misrepresented. When scientists say they cannot predict exactly what would happen, given a particular event, that is often translated by those with a vested interest as meaning that scientists can envision *no consequences* stemming from that event. Scientists will need to speak out in such fashion that cautionary statements on their part cannot be misrepresented.

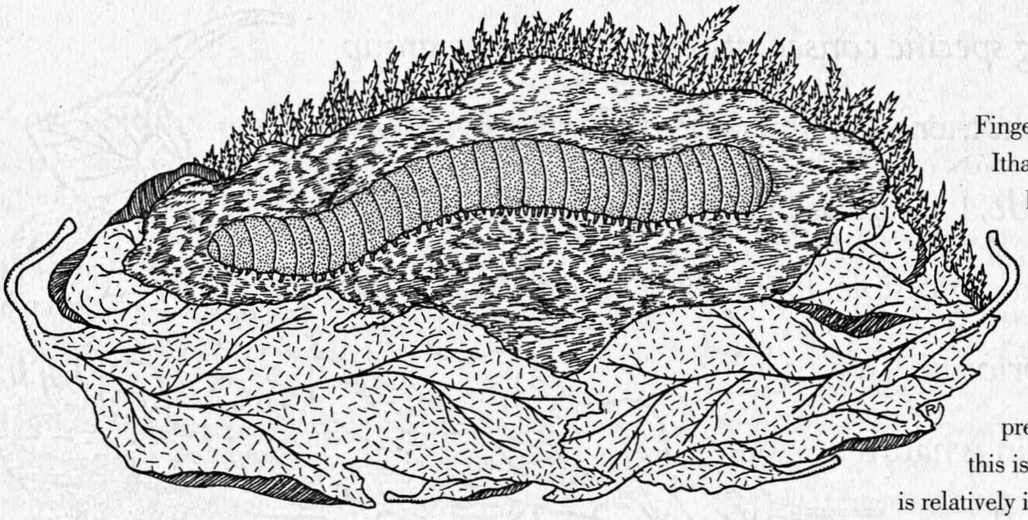
I'd like to steer us into a discussion on wildlands and ask whether you think that providing core areas and corridors for large carnivores will ultimately function to preserve invertebrate diversity as well.

There is no question that what helps the larger animals will help the little ones as well, although it may be difficult to be specific in the elaboration of this answer. Organisms are linked by their interdependencies. In principle therefore, if you are preserving land with one group of organisms in mind, you are also creating shelter for others. Rather than creating specific conservation plans for one group of invertebrates or another, which may be difficult, expensive, and time-consuming to do, I would say that one should simply try to save as much land as possible. Land conservation is my number one priority. If I could succeed in saving one acre per week, I would feel that my life has been worth living (I clearly have not been doing that). The future is in wilderness preservation. It's as simple as that.

If you accrue any kind of wealth, in whatever currency, the wisest thing you can do is convert that wealth into wilderness saved. We have not replaced the gold standard with the acre standard as yet, but we should take action, individually, that moves us in that direction.

Let's turn to chemical prospecting as a means of preserving wildlands, especially in the tropics. Some argue against chemical prospecting as it only delays development until an area's chemical "knowledge" has been extracted. Do you support using chemical prospecting as a conservation tactic?

illustration by Rob Messick



Finger Lakes Land Trust right here in Ithaca. That land trust was founded by Carl Leopold, Aldo Leopold's son, a colleague at Cornell and an ardent and effective conservationist. The Finger Lakes Land Trust is doing a fantastic job accruing land for preservation. In New York State this is still relatively easy to do. Land is relatively inexpensive, and large tracts are available for preservation. The problem is much more complex in a place like California where land values have skyrocketed and the population pressure is intense.

I've changed my views quite a bit on that. Initially, I got very enthusiastic about chemical prospecting, as a consequence of the deal I helped broker between Costa Rica's Institute of Biodiversity (INBio) and Merck, Sharpe, and Dohme, the pharmaceutical company. The agreement gave Merck & Co. access to Costa Rica's biodiversity for exploration for new medicinals. In exchange, Costa Rica received $1 million outright, as well as the guarantee of substantial royalties from products eventually developed by Merck on the basis of the exploration. I envisioned the possibility that similar agreements would be sought by other pharmaceutical companies and that conservation in developing countries, as a consequence, would get a boost. Indeed, Merck renewed the agreement over a period of years, and several million dollars must have gone to Costa Rica as a result. But the program has now been discontinued, and there's been virtually no effort on the part of other pharmaceutical companies to emulate the lead taken by Merck. The bottom line is that the pharmaceutical companies don't particularly care about conservation. They don't especially feel indebted to Nature for the ideas that they obtained from Nature.

Ultimately, the funds pumped into conservation so far by the pharmaceutical industry are trivial. Merck has obtained a great deal of good press as a consequence of their partnership with Costa Rica, although their total investment in the program amounted to less than 5% of what it costs the industry to develop a single drug. I don't think chemical prospecting is dead, but the Merck initiative has certainly done little to spur the industry to follow suit. New initiatives in this domain are clearly in order.

There are other conservation strategies besides those that involve industry, like the wildlands strategy and the land trust movement.

I have very strong positive views about the land trust movement, in part because of personal experiences I have had with the

I wonder what you think about the use of vegetation-based models, like those used by the Nature Conservancy and the National Park Service, to predict "hotspots" of invertebrate diversity and areas of rarity and endemism. How useful do you think this approach is?

I think the general idea of "hot spots" is a good one, and to include invertebrate diversity in the assessment of rarity and endemism is clearly the right thing to do. We are totally dependent on invertebrates, and it makes sense that every effort be made to prevent their extinction (think of the consequences if we were to continue to lose pollinators...). But listing hotspots means relegating other areas to the status of "cold spots." Do we really know enough about the world at large to classify regions by value? And might we not be writing off countless microbes as a consequence of erroneous assessment, given that the majority of microbes have not even been discovered as yet? And it's not just microbes. Biologists are in general agreement that the million and a half species so far known represent but a fraction of the total that is out there.

In my own exploration I am constantly reminded that Nature is a vast unknown. For some forty years now I have been doing field research at a preserved site in central Florida, the Archbold Biological Station. Countless biologists have worked there, and one would imagine that the area should be pretty well known by now. Yet discoveries are made at the site on an almost daily basis. I myself recently uncovered a new parasitic wasp there, and one of my graduate students found a new antlion larva, one that is unique in that it runs on the ground instead of building pits. But most remarkable have been the discoveries of one of the best naturalists I know, Mark Deyrup, the resident entomologist at the Archbold Station. Among other things, he uncovered a new species of cricket, which lives some 70 cen-

illustration by Rob Messick

timeters down in the soil, and comes up to near the surface following rain to feed on a layer of algae that grows 5 millimeters under the soil surface. That layer of algae was in itself a new find. Mark also discovered a caterpillar that lives in spider webs, and another that feeds on the shells of gopher turtles. Mind you, we are not talking about the rainforest here. We are talking about a supposedly "well explored" patch in good old temperate Florida.

Your example illustrates just how terribly complex and rich life is, and further, what's yet to be discovered.

Yes, and I should not have restricted myself to comments on terrestrial life. There are the oceans too. They are as wonderful and full of mystery as any other habitat, and they are equally threatened. Everyone knows about the fisheries, but the danger extends to the little beings in the oceans as well. Take the following scenario, for example. Plankton is the primary carbon-fixing population on the planet. Planktonic organisms—including the males and females of the various species—communicate with one another, and they use chemicals for the purpose. Some of these chemicals are likely to be oil-soluble since for expression of their message they need to be taken up by the lipid membranes that are part of the sensory surfaces of the receiving organisms. Now imagine what happens when a tanker comes along and breaks up in an accident, spilling its contents. The oil spreads over the surface, but we are quick to add emulsifying agents, thereby breaking up the oil slick into billions of droplets. And what do these droplets do? They pick up the messenger molecules of plankton, thereby depriving that community of its language. While I have no direct evidence for such a scenario, I think the speculation is not far off the mark.

Thus, perhaps, interrupting the relationships between thousands or millions of organisms.

Yes, a dangerous prospect, and if true, it would provide yet another example of how human actions—in this case oil spills—may have profound ecological consequences of which we are only dimly aware or totally ignorant.

Because I am a chemical ecologist, and have an interest in the discovery of medicinals from Nature, I am often asked, "How well is Nature known chemically?" My answer is: I have absolutely no idea. The fact is that we don't even know how many species there are. Experts disagree on that point. While some feel that there may be as many as 10 million species of organisms, others think the number is closer to 100 million. If we don't even know how many species there are, how can we possibly estimate the number of undiscovered chemicals? Nature is an unknown, and if we want to benefit from it, we had better preserve what is left.

Would you comment on the study of microcosms, including the invertebrate communities, and the usefulness of extrapolating results from relatively simple systems to macrocosm-level questions—that is, issues of global diversity and ecosystem function?

It's hard to do, but you need to have experience with but one interacting system to realize how complex such systems are and how meaningful they can be even in their simplest form. Let me give an example. For years now I have been studying a species of woolly aphid that lives on alder plants in New York State. It is "woolly" because its back is beset with white, wool-like tufts of wax. Like aphids generally, these woolly aphids excrete honeydew, which is avidly drunk by ants. The ants, in exchange, provide the aphids with protection against predators.

One predator, a chrysopid larva, manages to escape detection by the ants and to feed on the aphids. It escapes detection because it "dresses up" as an aphid. It plucks the waxy tufts from the back of the aphids and sticks them on its own back, thereby assuming the precise appearance of the aphid. The ants, fooled by the imitation, don't even notice the chrysopids.

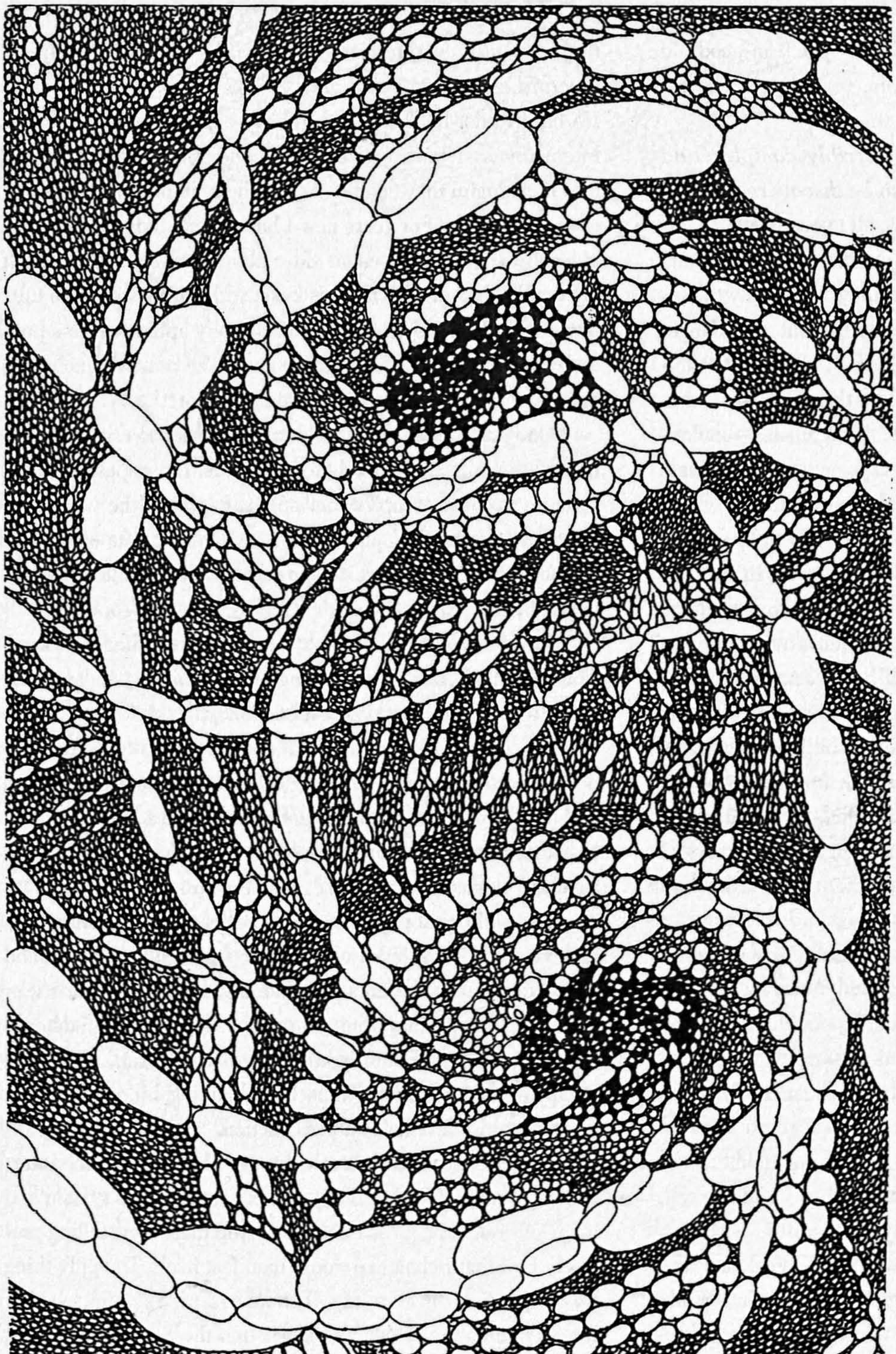
Now it turns out that honeydew is also relished by wasps, which are prevented from feeding on the fluid by the ants that guard the aphids. However, excess honeydew dribbles down to leaves beneath the aphid colony, where a fungus takes up residence, nurtured by the drippings. The ants ignore the fungus, and the wasps appear to be aware of that. Instead of attempting to gather honeydew from the aphid source, the wasps obtain it from the fungus, by squeezing the latter with the mandibles.

Two additional predators are a part of this community. One is the larva of a syrphid fly, which also feeds on the aphids, and which copes with the ants by gumming them up with a sticky secretion that it emits from the mouth. The second predator is the caterpillar of a butterfly, which lives amidst the aphids, but escapes detection by the ants by remaining hidden within a silken meshwork of its own construction.

The entire system is a microcosm, illustrative of the interconnectedness of life. Pull any component from the system and the result would be gross imbalance. And there is no telling precisely how that imbalance would manifest itself. The only thing we can predict with certainty when we perturb a system, whether it be a microcosm or macrocosm, is that there will be changes, at first on a small scale, but with time, inevitably, on a big scale. And it is the large changes that are likely to be the least predictable—and most calamitous. ☾

The Microcosm

by Lynn Margulis and Dorion Sagan



From the paramecium
meticulously organized,
microbial life. Far from
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and composed of them.
the beginnings of life,

This essay first appeared as the introduction to Microcosmos: Four Billion Years of Microbial Evolution *by Lynn Margulis and Dorion Sagan (©1997 University of California Press) and is used here with permission.*

Illustrations by Jim Nollman

When people look at life on Earth, it is easy to think we are supreme. The power of consciousness, of our society and our technical inventions, has made us think we are the most advanced form of life on the planet. Even the great blackness of space seen does not humble us. We view space as a no man's land to penetrate and conquer as we believe we have conquered the Earth.

Life on Earth has traditionally been studied as a prologue to humans: "lower" forms of life lacking intelligence preceded us and we now stand at the pinnacle of evolution. Indeed, so godlike do we consider ourselves that we may think we are taking evolution into our own hands by manipulating DNA, the mainspring of life, according to our own design. We study the microcosm—the age-old world of microorganisms—to discover life's secret mechanisms so that we can take better control, perhaps even "perfect" ourselves and the other living things on the Earth.

But during the past three decades, a revolution has taken place in the life sciences. Fossil evidence of primeval microbial life, the decoding of DNA, and discoveries about the composition of our own cells have exploded established ideas about the origins of life and the dynamics of evolution on Earth.

First, they have shown the folly of considering people as special, apart and supreme. The microscope has gradually exposed the vastness of the microcosm and is now giving us a startling view of our true place in Nature. It now appears that microbes—also called microorganisms, germs, bugs, protozoans, and bacteria, depending on the context—are not only the building blocks of life, but occupy and are indispensable to every known living structure on the Earth today. From the paramecium to the human race, all life forms are meticulously organized, sophisticated aggregates of evolving microbial life. Far from leaving microorganisms behind on an evolutionary "ladder," we are both surrounded by them and composed of them. Having survived in an unbroken line from the beginnings of life, all organisms today are equally evolved.

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This realization sharply shows up the conceit and presumption of attempting to measure evolution by a linear progression from the simple—so-called lower—to the more complex (with humans as the absolute "highest" forms at the top of the hierarchy). The simplest and most ancient organisms are not only the forebears and the present substrate of the Earth's biota, but they are ready to expand and alter themselves and the rest of life, should we "higher" organisms be so foolish as to annihilate ourselves.

Next, the view of evolution as chronic bloody competition among individuals and species, a popular distortion of Darwin's notion of "survival of the fittest," dissolves before a new view of continual cooperation, strong interaction, and mutual dependence among life forms. Life did not take over the globe by combat, but by networking. Life forms multiplied and complexified by co-opting others, not just by killing them.

Because we cannot see the microcosm with the unaided eye, we tend to discount its significance. Yet of the three-and-a-half billion years that life has existed on Earth, the entire history of human beings from the cave to the condominium represents far less than one percent. Not only did life originate on Earth very early in its history as a planet, but for the first full two billion years, Earth was inhabited solely by bacteria.

In fact, so significant are bacteria and their evolution that the fundamental division in forms of life on Earth is not that between plants and animals, as is commonly assumed, but between prokaryotes—organisms composed of cells with no nucleus, that is, bacteria—and eukaryotes—all the other life forms.[1] In their first two billion years on Earth, prokaryotes continuously transformed the Earth's surface and atmosphere. They invented all of life's essential, miniaturized chemical systems—achievements that so far humanity has not approached. This ancient high *bio*technology led to the development of fermentation, photosynthesis, oxygen breathing, and the removal of nitrogen gas from the air. It also led to worldwide crises of starvation, pollution, and extinction long before the dawn of larger forms of life.

These staggering events early in life's history came about by the interaction of at least three recently discovered dynamics of evolution. The first is the remarkable orchestrating abilities of DNA. Identified as the heredity-transmitting substance in 1944 by Oswald T. Avery, Colin MacLeod, and Maclyn McCarty, DNA's code was cracked in the 1960s after its method of replication was revealed by James Watson and Francis Crick in 1953. Governed by DNA, the living cell can make a copy of itself, defying death and maintaining its identity by reproducing. Yet by also being susceptible to mutation, which randomly tinkers with identity, the cell has the potential to survive change.

A second evolutionary dynamic is a sort of natural genetic engineering. Evidence for it has long been accumulating in the field of bacteriology. Over the past fifty years or so, scientists have observed that prokaryotes routinely and rapidly transfer different bits of genetic material to other individuals. Each bacterium at any given time has the use of accessory genes, visiting from sometimes very different strains, which perform functions that its own DNA may not cover. Some of the genetic bits are recombined with the cell's native genes; others are passed on again. Some visiting genetic bits can readily move into the genetic apparatus of eukaryotic cells (such as our own) as well.

These exchanges are a standard part of the prokaryotic repertoire. Yet even today, many bacteriologists do not grasp their full significance: that as a result of this ability, all the world's bacteria essentially have access to a single gene pool and hence to the adaptive mechanisms of the entire bacterial kingdom. The speed of recombination over that of mutation is superior: it could take eukaryotic organisms a million years to adjust to a change on a worldwide scale that bacteria can accommodate in a few years. By constantly and rapidly adapting to environmental conditions, the organisms of the microcosm support the entire biota, their global exchange network ultimately affecting every living plant and animal. Human beings are just learning these techniques in the science of genetic engineering, whereby biochemicals are produced by introducing foreign genes into reproducing cells. But prokaryotes have been using these "new" techniques for billions of years. The result is a planet made fertile and inhabitable for larger forms of life by a communicating and cooperating worldwide superorganism of bacteria.

Far-reaching as they are, mutation and bacterial genetic transfer alone do not account for the evolution of all the life forms on the Earth today. In one of the most exciting discoveries of modern microbiology, clues to a third avenue of change appeared in the observation of mitochondria—tiny membrane-wrapped inclusions in the cells of animals, plants, fungi, and protists alike. Although they lie outside the nucleus in modern cells, mitochondria have their own genes composed of DNA. Unlike the cells in which they reside, mitochondria reproduce by simple division. Mitochondria reproduce at different times from the rest of the cell. Without mitochondria, the nucleated cell, and hence the plant or animal, cannot utilize oxygen and thus cannot live.

Subsequent speculation brought biologists to a striking scenario: The descendants of the bacteria that swam in primeval seas breathing oxygen three billion years ago exist now in our bodies as mitochondria. At one time, the ancient bacteria had combined with other microorganisms. They took up residence inside, providing waste disposal and oxygen-derived energy in return for food and shelter. The merged organisms went on to evolve into more complex oxygen-breathing forms of life. Here, then, was an evolutionary mechanism more sudden than mutation: a symbiotic alliance that becomes permanent. By creating organisms that are not simply the sum of their symbiotic parts—but something more like the sum of all the possible combinations of their parts—such alliances push developing beings into uncharted realms. Symbiosis, the merging of organisms into new collectives, proves to be a major power of change on Earth.[2]

As we examine ourselves as products of symbiosis over billions of years, the supporting evidence for our multimicrobe ancestry becomes overwhelming. Our bodies contain a veritable history of life on Earth. Our cells maintain an environment that is carbon- and hydrogen-rich, like that of the Earth when life began. They live in a medium of water and salts like the composition of the early seas. We became who we are by the coming together of bacterial partners in a watery environment. Although the evolutionary dynamics of DNA, genetic transfer, and symbiosis were not discovered until almost a century after Charles Darwin's death in 1882, he had the shrewdness to write:

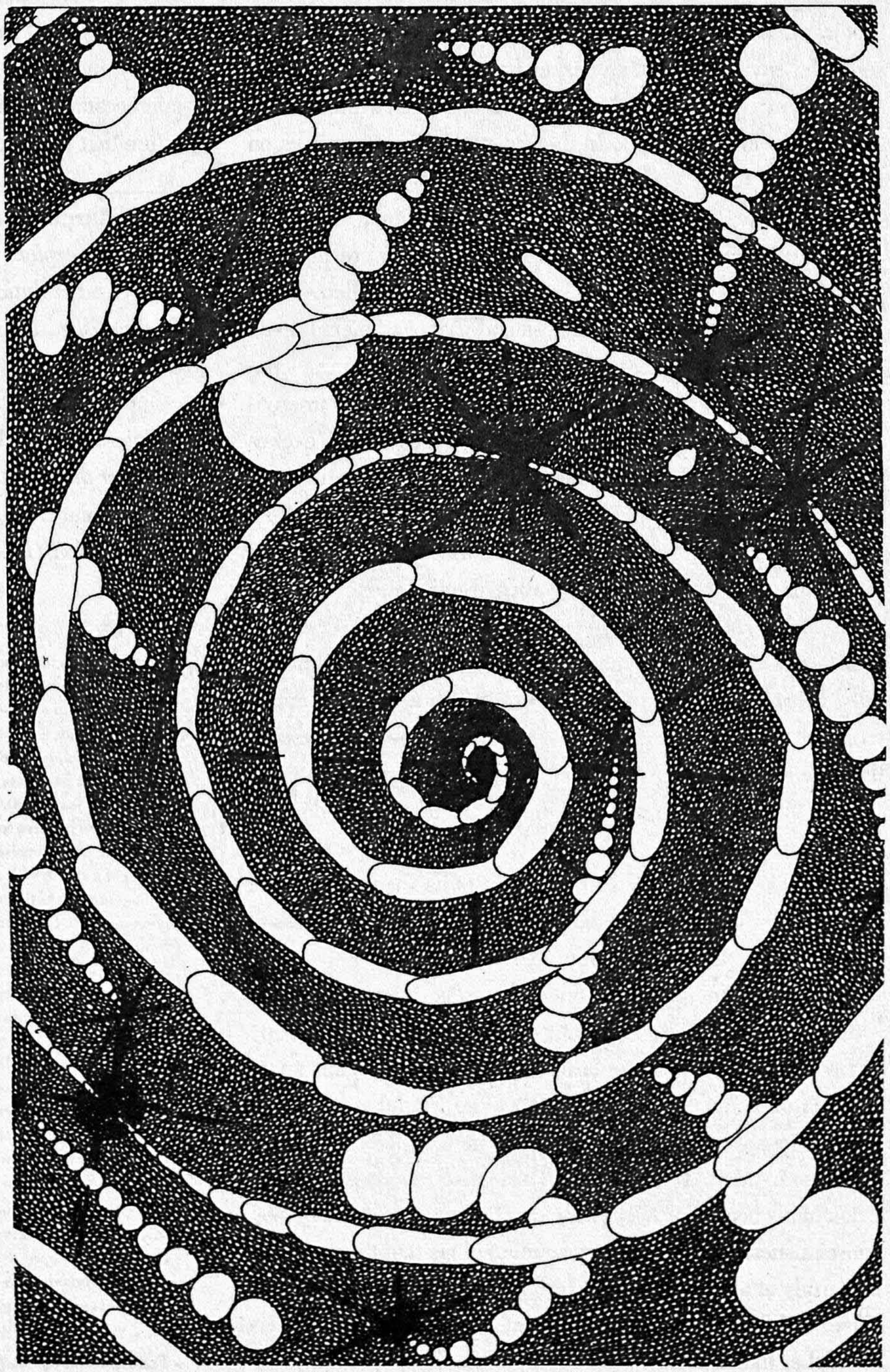
> *We cannot fathom the marvellous complexity of an organic being; but on the hypothesis here advanced this complexity is much increased. Each living creature must be looked at as a microcosm—a little universe, formed of a host of self-propagating organisms, inconceivably minute and as numerous as the stars in heaven.*[3]

The detailed structure of our cells betrays the secrets of their ancestors. Electron microscopic images of nerve cells from all animals reveal numerous conspicuous "microtubules." The waving cilia in the lining of our throats and the whipping tail of the human sperm cell both have the same unusual "telephone dial" arrangement of microtubules as do the cilia of ciliates, a group of successful microbes including more than eight thousand different species. These same microtubules appear in all cells of plants, animals, and fungi each time the cells divide. Enigmatically, the microtubules of dividing cells are made of proteins nearly identical to some found in brain cells; and these proteins resemble those found in certain fast-moving bacteria we hypothesize were among our ancestors.

These and other living relics of once-separate individuals, detected in a variety of species, make it increasingly certain that all visible organisms evolved through symbiosis, the coming together that leads to physical interdependence and the permanent sharing of cells and bodies. Although some details of the bacterial origin of microtubules, mitochondria, and other cell parts are hard to explain, the general outline of how evolution can work by symbiosis is agreed upon by those scientists who are familiar with the lifestyles of the microcosm.

The symbiotic process goes on unceasingly. We organisms of the macrocosm continue to interact with and depend upon the microcosm, as well as upon each other. Certain families of plants (such as the pea family, including peas, beans, and their relatives such as clover and vetch) cannot live in nitrogen-poor soil without the nitrogen-fixing bacteria in their root nodules, and we cannot live without the nitrogen that comes from such plants. Neither cows nor termites can digest the cellulose of grass and wood without communities of microbes in their guts. Fully ten percent of our own dry body weight consists of bacteria, some of which, although they are not a congenital part of our bodies, we can't live without. No mere quirk of Nature, such coexistence is the stuff of evolution itself. Let evolution continue a few million years more, for example, and those microorganisms producing vitamin B_{12} in our intestines may become parts of our own cells. An aggregate of specialized cells may become an organ. The union of once-lethal bacteria with amoebae, creating over time a new species of hybrid amoeba, has even been witnessed in the laboratory.

This revolution in the study of the microcosm brings before us a breathtaking view. It is not preposterous to postulate that the very consciousness that enables us to probe the workings of our cells may have been born of the concerted capacities of millions of microbes that evolved symbiotically to become the human brain. Now, this consciousness has led us to tinker with DNA and we have begun to tap into the ancient process of bacterial genetic transfer. Our ability to make new kinds of life can be seen as the newest way in which organic memory—life's recall and activation of the past in the present—becomes more acute. In one of life's giant, self-referential loops, changing DNA has led to the consciousness that enables us to change DNA. Our curiosity, our thirst to know, our



enthusiasm to enter space and spread ourselves and our probes to other planets and beyond represents part of the cutting edge of life's strategies for expansion that began in the microcosm some three-and-a-half billion years ago. We are but reflections of an ancient trend.

From the first primordial bacteria to the present, myriads of symbiotically formed organisms have lived and died. But the microbial common denominator remains essentially unchanged. Our DNA is derived in an unbroken sequence from the same molecules in the earliest cells that formed at the edges of the first warm, shallow oceans. Our bodies, like those of all life, preserve the environment of an earlier Earth. We coexist with present-day microbes and harbor remnants of others, symbiotically subsumed within our cells. In this way, the microcosm lives on in us and we in it.

Some people may find this notion disturbing, unsettling. Besides popping the overblown balloon that is our presumption of human sovereignty over the rest of Nature, it challenges our ideas of individuality, of uniqueness and independence. It even violates our view of ourselves as discrete physical beings separated from the rest of Nature. To think of ourselves and our environment as an evolutionary mosaic of microscopic life evokes imagery of being taken over, dissolved, annihilated. Still more disturbing is the philosophical conclusion we reach that the possible cybernetic control of the Earth's surface by unintelligent organisms calls into question the alleged uniqueness of human intelligent consciousness.

Paradoxically, as we magnify the microcosm to find our origins, we appreciate sharply both the triumph and the insignificance of the individual. The smallest unit of life—a single bacterial cell—is a monument of pattern and process unrivaled in the universe as we know it. Each individual that grows, doubles its size, and reproduces is a great success story. Yet just as the individual's success is subsumed in that of its species, so is the species subsumed in the global network of all life—a success of an even greater order of magnitude.

It is tempting, even for scientists, to get carried away by success stories. From the disciples of Darwin to today's genetic engineers, science has popularized the view that humans are at the top rung of Earth's evolutionary "ladder" and that with technology we have stepped outside the framework of evolution. Some eminent and sophisticated scientists, such as Francis Crick in his book, *Life Itself*, write that life in general and human consciousness in particular are so miraculous that they couldn't be earthly at all, but must have originated elsewhere in the universe.[4] Others still believe that humans are a product of a fatherly "higher intelligence"—the children of a divine patriarch.

These views underestimate the Earth and the ways of Nature. There is no evidence that human beings are the supreme stewards of life on Earth, nor the lesser offspring of a superintelligent extraterrestrial source. But there is evidence to show that we are recombined from powerful bacterial communities with a multibillion-year-old history. We are a part of an intricate network that comes from the original bacterial takeover of the Earth. Our powers of intelligence and technology do not belong specifically to us but to all life. Since useful attributes are rarely discarded in evolution it is likely that our powers, derived from the microcosm, will endure in the microcosm. Intelligence and technology, incubated by humankind, are really the property of the microcosm. They may well survive our species in forms of the future that lie beyond our limited imaginations. ☾

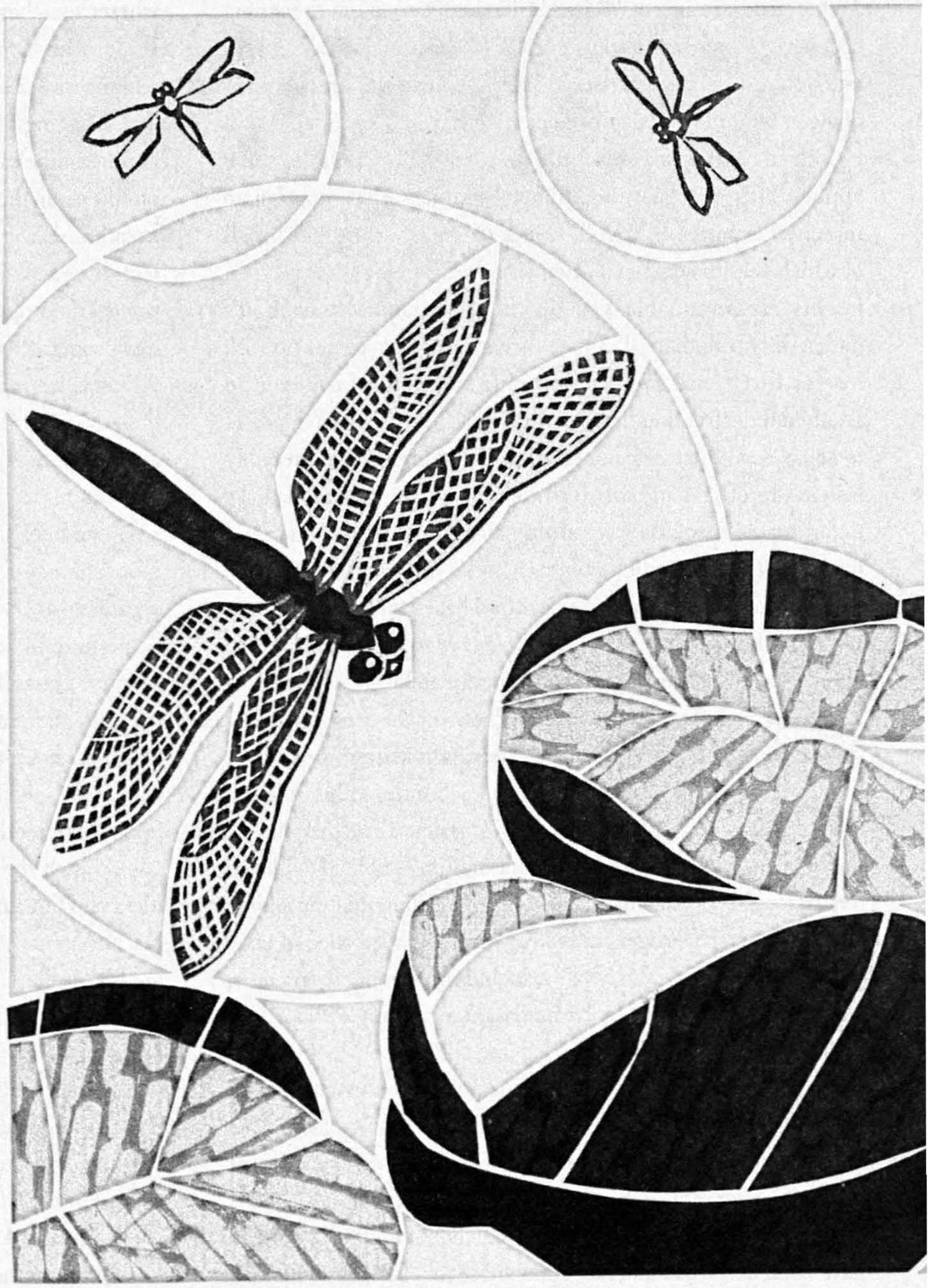
Lynn Margulis *and* **Dorion Sagan** *have teamed up on four books that explore a vast range of the living world—from the origin and evolution of cells to Gaia theory. Dr. Margulis is a Distinguished University Professor in the Department of Geosciences at the University of Massachusetts, Amherst, and a member of the National Academy of Sciences. Dorion Sagan is a writer living in Amherst and general partner of Sciencewriters. Together they are the authors of* Microcosmos *(1996),* Garden of Microbial Delights *(1995),* Mystery Dance *(1991), and* What Is Sex? *(1990).*

NOTES

1. Eukaryotes include the familiar plant and animal kingdoms, as well as the less familiar fungi and protoctist kingdoms. The informal term *protists* refers to the microbial, often single-celled, members of the kingdom Protoctista. Protoctista include amoebae, ciliates, malarial parasites (and, in general, the protozoa), diatoms, seaweeds (and, in general, the algae), slime nets, water molds, slime molds, plasmodial plant parasites, and other more obscure organisms that don't fit into the other kingdoms. Nearly 200,000 species of protoctista, grouped into about fifty phyla, are estimated to be alive today. The other three eukaryotic kingdoms, in order of their evolution, are Animalia: animals, which develop from embryos that form after the fusion of a sperm with an egg; Fungi: molds, mushrooms, yeasts, rusts, puffballs, and related organisms that develop from spores; and Plantae: mosses, liverworts, ferns, cone- and flower-bearing plants that develop from embryos surrounded by maternal tissue. The fifth, and earliest kingdom of living things to evolve, is the kingdom Monera, composed entirely of prokaryotes or bacteria. (The several names for bacteria—monerans, prokaryotes, germs, etc.—come from the traditions of their separate study within different fields of science. Natural history, botany, microbiology, medicine, agriculture, and zoology have maintained extremely different traditions of identifying, naming, and classifying the microbes.) The term *microbe* has no specific meaning in taxonomy or evolution, and is equivalent to *microorganism*, meaning any organism primarily seen through a microscope. All prokaryotes and many eukaryotic organisms, such as protists and fungi, are also microbes in that they are beyond the resolution of the human eye. Since *microorganism* and *microbe* are synonyms, we generally use the more biological and less medical term *microbe*.
2. Some biologists still do not believe in the symbiotic origin of mitochondria, chloroplasts, and other eukaryotic organelles. They are, however, increasingly in the minority. It is hoped that the weight of the evidence will convince biologists—as well as everybody else—of the need to view life as a symbiotic phenomenon.
3. Charles Darwin, *The Variation of Animals and Plants under Domestication*, Vol. 2 (New York: Organe Judd, 1868), p. 204.
4. Francis Crick, *Life Itself: Its Origin and Nature* (New York: Simon & Schuster, 1981).

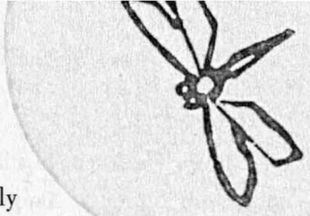
Getting to Know the Neighbors

by May Berenbaum



When people first hear that I'm an entomologist, they're generally a little nonplussed; it's a safe bet that the vast majority of Americans live out happy, fulfilling lives without ever running across an entomologist (unlike such other professionals as car mechanics, doctors, lawyers, politicians, teachers, shoe salesmen, or postal workers). But when people do discover they've encountered an entomologist, almost invariably they ask me the same question—"What good are insects?" Even my own daughter, who has known more than her share of entomologists, asked me this question recently (after being bitten repeatedly by mosquitoes while hiking through a forest).

illustration by Patrick Dengate



It's not an unreasonable question. Insects collectively don't make a very positive impression on people. Eating our crops, beleaguering our pets, infesting our houses, and consuming our body fluids are not behaviors calculated to win friends and influence people. And there's no denying that insects can—and do—cause much human misery. But the problem with the question "What good are insects?" is that it's being posed to the wrong species. Ask an insect-eating trout, "What good are insects?" and you're likely to get a cold stare because the answer is so obvious (and maybe also because fish have no eyelids). Ask a blackbird or a skunk or a turtle, for that matter, and the same applies. It's not just non-human animals that appreciate insects. For birdsfoot trefoil, skunk cabbage, or turtlehead, all of which rely to some extent on insects for pollination service, insects are invaluable genetic transportation. Although it's undeniably true that all of these organisms have to put up with insects that cause problems ranging from minor irritation to death and destruction, it's also true that their survival depends to some degree on insects. Ours does, too, but we're probably less aware of it than most birds, skunks, or turtles, and that's unfortunate—because we're the species that designs and implements conservation programs.

Conservation efforts are prioritized based on economic, ecological, cultural, or ethical values attributed to particular species. Humans, who define these values, unfortunately have a hard time recognizing one bug or beetle from another. This, too, is understandable. There are, after all, close to a million described insect species, and most Americans probably can't recognize or name more than a dozen of them. In North America, more than half of the described species are less than 6 millimeters long (with the largest topping out at only 15 centimeters). Differentiating among most of these species generally involves close inspection of various and sundry insect body parts, including reproductive organs, an activity that can't really be undertaken casually without specialized equipment, a lot of motivation, and a steely lack of concern about other people's opinions. According to the way most of our laws are structured, an organism cannot be protected unless it can be described and recognized, and unless an imminent threat to its existence can be reasonably demonstrated. It has been estimated that fewer than five percent of all insect species have been described and named; of those that have been named, only a small percentage have common names that would be recognized by anyone other than an entomologist. And for those species with names recognized by entomologists, for a remarkable number virtually nothing is known about the insect other than its name and perhaps some details about esoteric features of its genitalia.

So, altogether, it's not surprising that insects don't show up very often on endangered species lists. Although we must, ultimately, defend the intrinsic value of *all* species, probably the most broadly understood argument for protecting insects is that doing so helps to protect other species that people readily recognize and care about. Here in the "prairie state" of Illinois, where less than 0.01% of original prairie remains intact, the Illinois Endangered Species Protection Board designates as endangered 21 species of fish, 3 species of amphibians, 8 species of reptiles, 26 species of birds, and 5 species of mammals. It's likely that over three-quarters of these species depend on insects in their diet for survival. With few exceptions, nobody knows which insects these are, except in a general way. To protect these more charismatic vertebrate species, it's important to protect their diet as well. Conserving insects is also an important component of conserving endangered plant species. There are 265 species of plants on the Illinois list as well; over half of these depend on insects for pollination and/or seed dispersal. Again, precisely *which insects* is largely anyone's guess.

So, although ecological arguments are perhaps the most essential ones to make for conservation of insect species, there is insufficient information available in most cases to make the arguments very compelling. Life histories, chemical interactions, and ecological function are wholly a mystery for most species. Thus, aesthetic arguments often take precedent. There's nothing inherently wrong with that approach, except that, again, insects aren't playing on a level field. It's no coincidence that, of the seven species of insects listed by the Illinois Endangered Species Protection Board, five are butterflies or moths: the arogos skipper, the swamp metalmark, the hoary elfin, the Karner blue, and the rattlesnake master stem borer. These are all, in the insect scheme of things, showy and large (even the "tiny" elfins are bigger than an inch across). Of the remaining insects on the list, Hine's emerald dragonfly meets the same criteria—it's large and showy and fairly easily recognized. Butterflies and dragonflies show up disproportionately on both federal and state lists because they're "charismatic." The same can't be said of *Paraphlepsius lupalus*, a prairie leafhopper, which is extraordinarily fortunate to have made the list, given its unprepossessing appearance and its lack even of a widely used common name.

At the national level, there are 28 species of insects listed as endangered or threatened (19 of which are butterflies). But making the list of course is just the beginning of the process to achieve real-world protection for imperiled insects. Of those 28 listed insect species, recovery plans exist for only four species, all of them butterflies. The Illinois Endangered Species Protection Act, like many other state acts, makes illegal the "possession, taking, transportation, sale, offer for sale, or disposal of any listed animal or products of listed animals without a permit issued by the Department of Conservation." Although prohibiting the taking of mammals and birds hunted into oblivion makes sense, in the case of endangered insects collecting is rarely if ever the problem. In most cases, these species aren't endangered because people seek them out for their meat or pelts; they are in trouble because their habitats are being destroyed. To have a recovery plan necessitates careful records of population sizes and life history characteristics; unfortunately, for the vast majority of insects only the barest minimum of ecological information is available. A 1995 survey of inventory studies in US national parks revealed that information on invertebrates is "generally poor or nonexistent" (New 1999).

Habitat conservation is probably the best approach for rescuing insects on the brink, but, without that foundation of population and life history information, even that approach can be a two-edged sword. It's unlikely that individuals dedicated to rescuing vertebrate species from extinction will be as keen to participate in programs designed to rescue the host-specific arthropod parasites (and disease vectors) that depend on them. On occasion, too, habitat-based recovery plans for more charismatic species can actually increase the threat to low-profile cohabitants. Certain regimens of prairie burns can alter the composition of communities of ground-dwelling arthropods, and, in one case, efforts to save the Devil's Hole pupfish in hot springs habitats in Ash Meadows, Nevada, ended up extirpating the Ash Meadows naucorid (creeping water bug) from one of its few remaining habitats (Polhemus 1993).

However hopeless it may appear on the surface, the situation for identifying and saving insect species on the brink of extinction is actually improving. Knowledge is power; the more information that can be gathered about the arthropod communities in threatened habitats, the more easily the case can be made to the public for arthropod conservation. One thing is certain, though—they cannot remain nameless. Although entomologists are accustomed to dealing with Latin binomials, these are off-putting to the general public. Things that are effectively nameless are poor candidates for rescue. According to Webster's, "nameless" is "undistinguished, obscure, illegitimate, anonymous, unnamed (as in unnamed grave), indefinable," or "too repulsive or distressing to describe." In recognition of the importance of common names, the Entomological Society of America, which has maintained an official list of common names for American insects, recently revised its criteria for listing. Whereas in the past only American insects of economic or medical importance merited an official name, as of 1997 species determined to be unusual, abundant, imperiled, or distinctive in some way were entitled to public recognition as well. The names chosen are important, too—it's not a coincidence that the state insect of Oregon is the Oregon swallowtail, of Maryland is the Baltimore checkerspot, and of California the California dogface. The right name can instill a sense of local loyalty and can transform what once seemed strange and alien into something that belongs in a particular place.

In his masterpiece, *Through the Looking-Glass,* Lewis Carroll created a conversation between Alice and a gnat:

> *"What sort of insects do you rejoice in where you come from?" the Gnat inquired.*
>
> *"I don't rejoice in insects at all," Alice explained, "because I'm rather afraid of them...But I can tell you the names of some of them."*
>
> *"Of course they answer to their names?" the Gnat carelessly remarked.*
>
> *"I never knew them to do it."*
>
> *"What's the use of their having names," the Gnat said, "if they won't answer to them?"*
>
> *"No use to them," said Alice, "but it's useful to the people that name them, I suppose."*

It's useful for us to have a name for the insects we share the neighborhood with, wittingly or unwittingly. Once you know your neighbors' names, it's harder to remain a stranger. At the very least, knowing insects' names makes it easier to ask questions about them. And in the course of learning more about insects, people might discover just how useful they are—not only to humans, but also to the whole ecological neighborhood. ☾

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A century ago, the **American Burying Beetle** could be found throughout the eastern and midwestern United States and adjacent southern Canada. Starting around 1910 along the Atlantic Coast, and continuing westward through the 1940s and 1950s, the species simply disappeared.

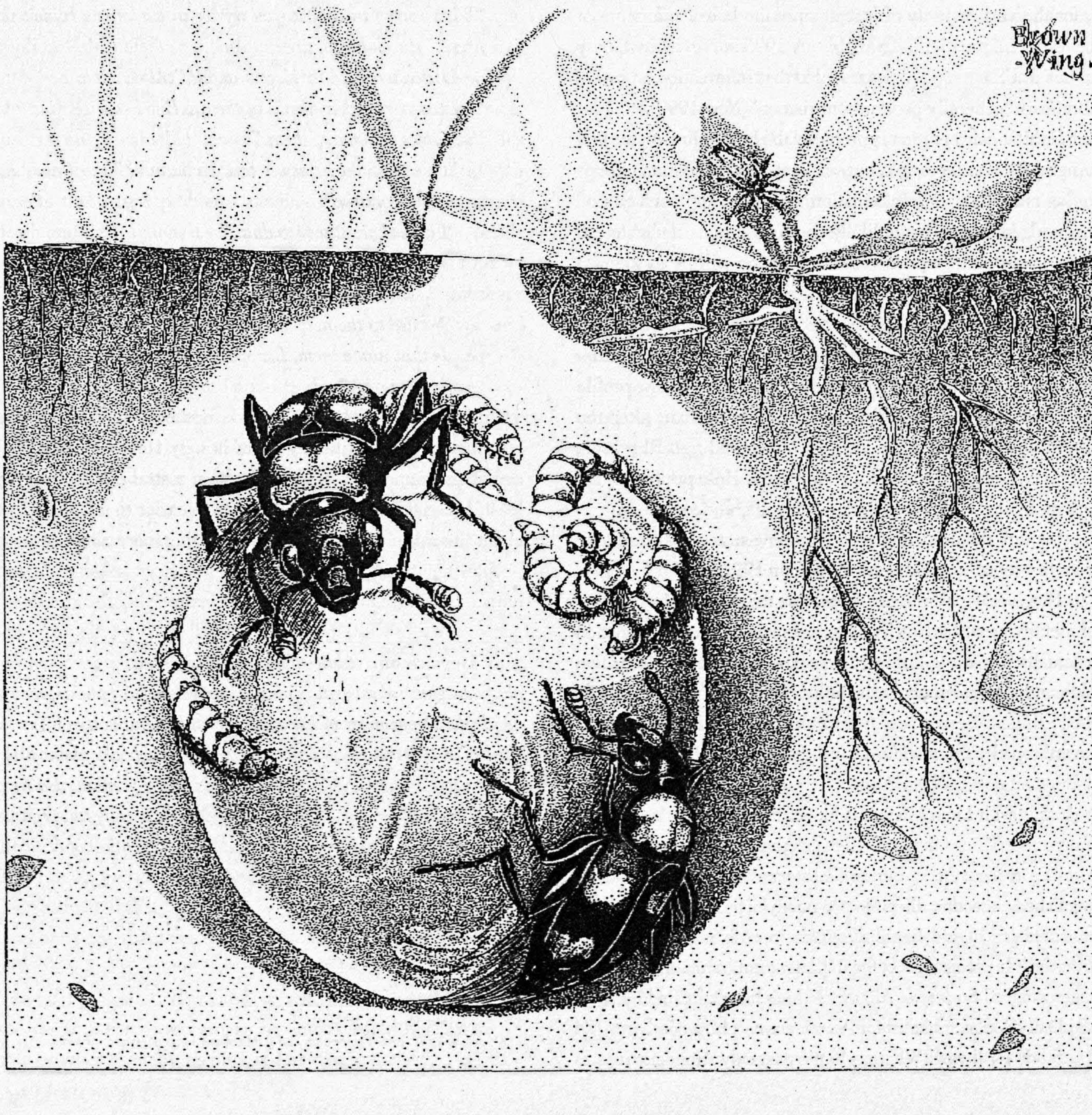
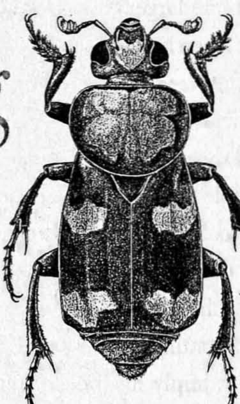


illustration by Katharine Brown-Wing Courtesy US Fish & Wildlife Service

Return of the American Burying Beetle



by David Horn

Many people express genuine surprise when informed that the Endangered Species Act covers obscure animals like beetles, snails, and mussels along with large and showy species like the grizzly bear and California condor. Evaluation and recovery of an endangered insect presents formidable challenges because the biology and ecology of many common species is little known. Often it is not clear that a species thought to be rare really *is* rare; it may simply be infrequently detected. Some moths are attracted to bait but not to light; others are attracted to neither and are considered "rare." A butterfly, the "early hairstreak," generally considered to be extremely rare in the eastern United States, apparently stays mostly in the high canopy of beech forests and rarely visits the understory, where entomologists live. Against this backdrop it becomes difficult to determine whether an insect species is truly in need of conservation, let alone to discern why it may have declined.

The burying beetles—also called carrion or sexton beetles—are a case in point. They are barely noticeable in the ecosystems that surround us but are an integral part of the array of scavengers that keep us from being overwhelmed with carcasses of small birds, mammals, reptiles, and amphibians. While ants and blowflies, along with scavenging mammals such as raccoons, skunks, and opossums, have the greatest role in carcass removal, burying beetles (genus *Nicrophorus,* family Silphidae) perform key ecological services.

These beetles have an unusual life history with a level of interaction, cooperation, and parental care rarely seen among insects (apart from ants, bees, wasps, and termites). By responding to odors of decay, a male and female burying beetle locate a freshly killed carcass of a small bird or mammal, and they may move it onto loose soil which they remove from underneath and pile on top of the carcass until it is completely buried. They usually work at night and can bury a carcass in a few hours or less. Then, still working together, the beetles remove the feathers or fur and compress the carcass into a "brood ball" on which the female lays ten to twenty eggs. After the larvae first hatch, they remain on the brood ball, not unlike baby birds in a nest, and, like some birds, the adults feed them on regurgitated stomach contents. After a few days, the larvae are old enough to feed directly on the decaying corpse. The adults remain with the larvae for up to several weeks and defend themselves and their brood as best they can against predators. The adults are capable of delivering a nasty and potentially infective bite.

As if all this were not unusual enough, adult burying beetles nearly always have mites riding on them, and these mites feed on fly eggs and maggots which otherwise might out-compete the beetle larvae for food. When the beetle larvae are mature, they form pupae in the surrounding soil while the adult pair leaves to repeat the process. Most burying beetles are nocturnal, and are rarely noticed unless one takes an interest in the insects that are attracted to outdoor lights. (Like many other harmless insects, they can be fried by "bug zappers," those odious machines so emblematic of our cultural antipathy toward the little things that run the world.)

In North America there are 15 species of burying beetles. (Eurasia has more.) Most are fairly common and of modest size (up to one inch long). However, one species, the American burying

illustration by Mark Marcuson Used by permission of the University of Nebraska State Museum beetle (*Nicrophorus americanus*), is a relative giant, having been called "the California condor of burying beetles." Individuals are nearly two inches long and require larger carcasses for reproduction. The other species can get by on a dead mouse or sparrow, but *N. americanus* needs carrion the size of a squirrel or baby rabbit.

A century ago, the American burying beetle could be found throughout the eastern and midwestern United States and adjacent southern Canada except for higher elevations in the Appalachians. Beetles were collected in 33 states and three provinces, from New England to central Nebraska, and from Ontario to Florida and Texas. However, starting around 1910 along the Atlantic Coast, and continuing westward through the 1940s and 1950s, the species simply disappeared from its former haunts. At first, nobody noticed or really cared. Because of their secretive habits, burying beetles were always a bit hard to find. There was no monitoring program in place and entomologists simply remarked that *N. americanus* "seemed to have become rare." In fact, they were *gone,* and by the 1980s they were limited to isolated pockets in Arkansas, Kansas, Nebraska, Oklahoma, and South Dakota, with an isolated eastern population on Block Island, Rhode Island. The lesson is plain: an obscure species can disappear completely without our knowledge, because we were not watching.

Reasons for the American burying beetle's disappearance are unclear, and a combination of factors is likely involved. Disruption of primeval forest and prairie probably had little or no impact, as this occurred a full century (or more) earlier, and the beetle's decline coincides with an *increase* in forest maturity in much of the eastern US. Insecticides probably also had little to do with it, as other, smaller *Nicrophorus* species are doing fine even in areas that have received repeated insecticide treatments.

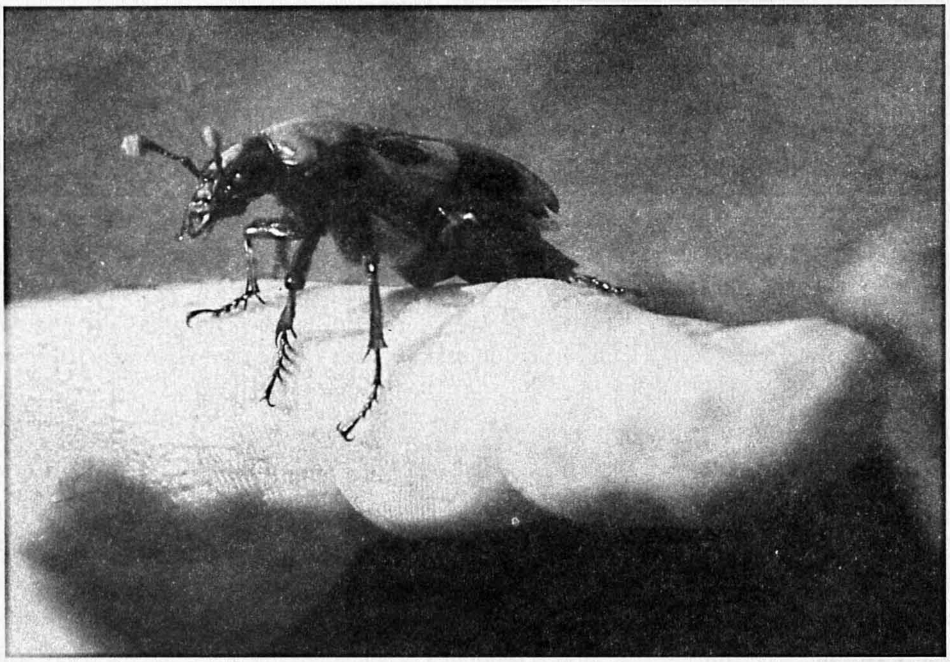
It is possible that competition from and predation by scavenging mammals such as skunks, possums, and raccoons may have directly impacted *N. americanus*. Populations of these mammals, especially the possum, increased enormously during the twentieth century in the eastern US. These increases were due in part to habitat fragmentation and to elimination of larger predators such as wolves and mountain lions which ate these medium-sized scavengers. Block Island, the American burying beetle's last stronghold in the East, has none of these scavenging mammals and boasts high populations of woodcocks, pheasants, and cottontails, all of which provide carcasses of ideal size for the species. Outdoor lighting may also interfere with the beetles' activity; in Nebraska where American burying beetles occur there are few lights. Finally, some scientists think that passenger pigeon squabs may have been a major resource for *N. americanus* in the nineteenth century, and we might now be witnessing the end of a long decline that began after the pigeons were exterminated.

In 1989 the American burying beetle gained the distinction of being the first beetle federally listed as an endangered species. The implemented recovery plan included intensive searches for remnant populations in states where the beetles were thought to be extinct. The standard method to search for burying beetles is to bury a 32-ounce plastic cup in the ground to its rim, bait it with a piece of putrefying meat, and secure it with a rain shield and chickenwire mammal guard. Researchers using this technique discovered a few additional populations since 1989 in an arc from Arkansas to South Dakota, but none have been found apart from there. In Ohio a single American burying beetle found in 1974 on a road-killed woodchuck represents the last known mainland occurrence east of the Mississippi River. (This specimen languished in a museum drawer for twenty years before its significance was known.) From 1992–1997 my associates and I used baited and unbaited pitfall traps, and after over 70,000 trap-nights, we could say with high probability that the species was gone from Ohio.

Meanwhile, in the late 1980s, some American burying beetles from Block Island were captured to establish a laboratory culture at Boston University where Andrea Kozol undertook the first (and to date, the only) detailed studies of the biology of the species. Most of our knowledge of the beetle—how long they live, how many eggs they lay, what size carcass is ideal—stems from Dr. Kozol's research. Perhaps we shouldn't feel too badly about this paucity of information—there were *no* detailed studies of the breeding biology of the passenger pigeon; ornithologists of the day simply did not think of studying such a common species.

There is currently a captive American burying beetle population at the Roger Williams Park Zoo in Providence, Rhode Island. This population provides the public with an opportunity to see living specimens of *Nicrophorus americanus* and serves as a reserve source of beetles for eventual reintroduction to the wild. It is not difficult to raise burying beetles in captivity as long as the facility is ventilated to prevent buildup of odors that zoo visitors might find offensive. For reintroduction it is preferable to use beetles captured from wild populations, as they may be better adapted to outdoor conditions.

In the early 1990s, beetles from the Block Island population were successfully reestablished on Penikese Island, Massachusetts. Penikese is 90 acres, has an active breeding colony of gulls and terns, and no potential interference by mammalian scavengers. The reestablishment went well and by 1995, the US Fish and Wildlife Service (USFWS), The Nature Conservancy, and the Massachusetts Audubon Society were ready



tles were the first evidence of successful mainland reproduction east of the Mississippi since 1974.

We repeated American burying beetle releases in 1999 and 2000. In both years, beetles successfully buried carcasses and established broods of larvae, although we have not captured any adult offspring of the beetles we released. The beetle may fly up to five miles in one night, and trying to trap them at that distance from the release is like "looking for a needle in a haystack with a refrigerator magnet," in the words of one of my students. We hope that *N. americanus* is slowly spreading from our immediate release site, and that once again this small but ecologically vital member of our primeval fauna stalks the forest floor in search of carcasses. ☾

for a release on the larger and more developed island of Nantucket. Releases there also resulted in establishment of a resident population of beetles, again amid a high density of pheasants and cottontails, and free from raccoons, possums, and skunks.

By 1998, the USFWS decided to attempt a mainland reintroduction, and coordinated an effort involving their Office of Endangered Species, the Ohio Department of Natural Resources Division of Wildlife, the Oklahoma Department of Natural Resources, and the Ohio State University Department of Entomology. Twenty-nine healthy pairs of *N. americanus* were trapped from a population in Arkansas and airlifted to Columbus. On July 24, 1998 each beetle was fitted with a numbered tag, and transported to a forested release site in southeastern Ohio. Each beetle pair was released on a quail carcass and covered with a ventilated plastic bucket, wired down and staked to deter mammals, for unlike the Massachusetts islands, southeastern Ohio abounds in mammalian scavengers. Once the beetles had buried a carcass, the bucket was removed and replaced with 50x50 centimeters of chickenwire. About half the pairs successfully buried a carcass and established larvae. Others abandoned their carcasses for reasons unknown, but perhaps they were not yet sexually mature. (We have no way of knowing the precise age of an adult beetle.) We hoped they would find success in the vicinity; the area has a high density of wild turkeys whose poults should provide an adequate carrion supply.

About two months later, on September 29–30, we baited 40 pitfall traps with putrid chicken and set them in the immediate area of release. A freshly-emerged adult American burying beetle was recovered each following morning. It is likely that these were just emerging from their pupal chambers and perhaps most of their generation had emerged and dispersed. These two bee-

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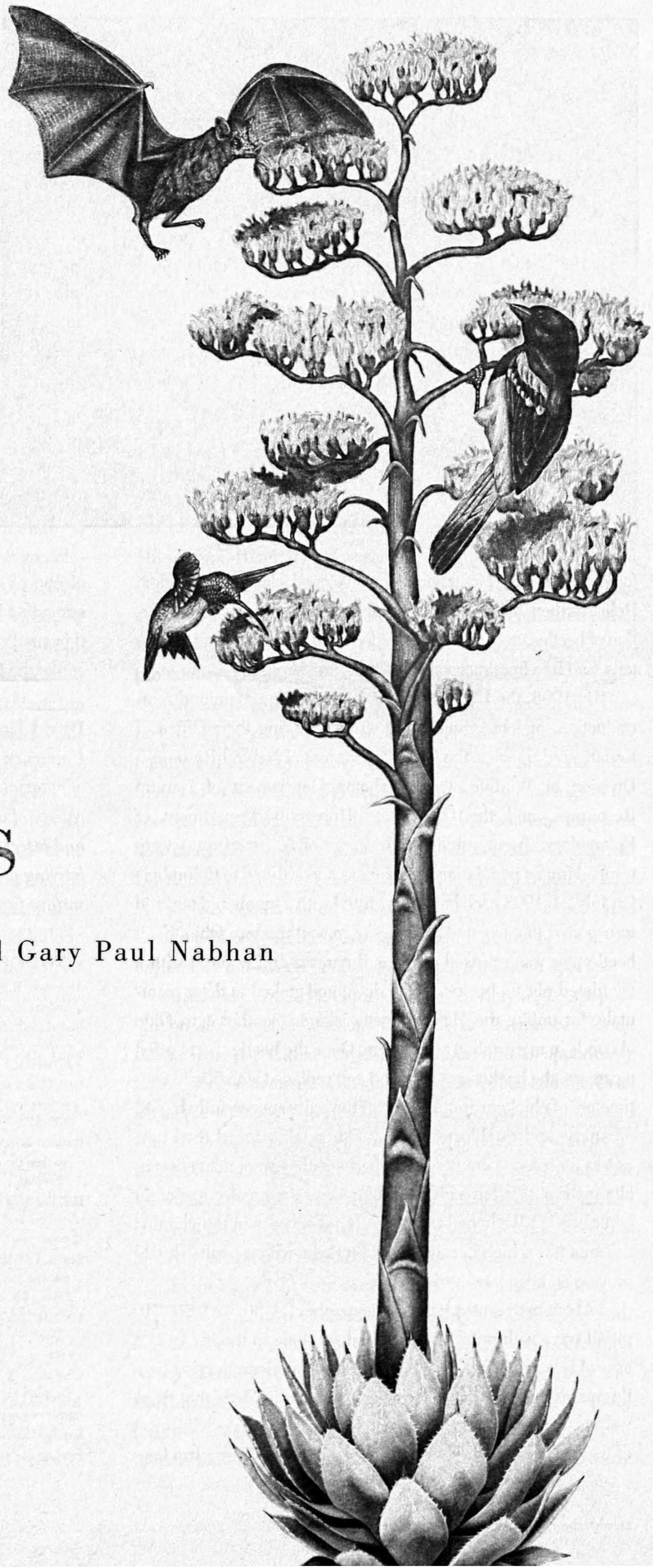

The Forgotten Pollinators

by Stephen L. Buchmann and Gary Paul Nabhan

Steve remembers:

If we were to kneel among the brilliantly colored and fragrant wildflowers of an alpine meadow, our attention would soon be diverted by the guests invited to feed at the banquet. The air is filled with thousands of flying insects of all possible sizes, colors, and forms. The combined noise of their beating wings is especially loud; the sound from a low-pitched passing bumblebee careens past our heads. Smaller insects are everywhere—from tiny straw-colored thrips invisibly feasting upon pollen inside flowers, to acrobatic flower flies, to bee flies, buprestid beetles, spider wasps, bees, and a winged gallery of gaudy butterflies.

All of these insects are floral visitors, but not all will acquire pollen that can be passed along to the next flower on their visits. Some have come to slit "floral throats," robbing them of sweet nectar or stealing away with pollen without fulfilling the implied pact with the flowers. A few of the insects—especially bees, flies, and butterflies—are excellent and faithful pollinators upon which the local flora "entrusts" its same-day pollen delivery service. Let's depart now from the flowers of the meadow and examine the diversity of these pollinators.

More than all the rest combined, the order Coleoptera (with over 350,000 named species worldwide and many yet to be discovered) is the largest extant insect order and probably always was so. From the sap beetle pollinators of western spicebush to the specialized scarab beetles that enter and pollinate the flowers of the giant Amazonian waterlilies, beetles are the customers and pollen vectors of choice for thousands of flowering plants on most continents.

Approximately thirty families of beetles are today engaged in the pollination trade, often acting as what has been termed "mess-and-soil pollinators." While the label is not terribly flattering to this ancient lineage of inordinately successful insects, it does indicate their mode of entry and gustatory pursuits. Thus, sap and rove beetles attracted to the fragrance of the western spicebush merrily chomp on special food tissues and on modified petals, in addition to the pollen grains. In so doing—and amidst a good deal of copulating and defecating—they effectively move the spicebush's and their own gametes around.

Whenever a bloodthirsty female mosquito peskily buzzes around our heads in a darkened room, we aren't likely to thank the males of its species for the pollination of rare orchids in Wisconsin peat bogs. Yet male mosquitoes seek out nectar-producing orchids and other plants and are dependable pollinators in many parts of the world. In temperate alpine meadows, there are often dozens of species clambering over the open, broad clusters of blossoms on plants like the giant cow parsnip. Our attention is diverted by the high-pitched whine and darting motions of a fuzzy golden bee fly with a black beaklike set of mouthparts used for extracting nectar from nearby blossoms. Thus the flies are exceedingly diverse and important pollinators the world over. The order to which they belong, the Diptera, contains over 150,000 described species. And of those species with a taste for food on the half petal, there are at least 45 families of flies that routinely visit flowers.

Tubular flowers that are often pink or yellow in color with a sweet scent and abundant nectar at their base attract those scaly winged beauties sought out by "butterfliers" (a new breed of butterfly hunter who do their hunting with binoculars, notebook, and pencil). Butterflies are active by day and are found in about 16 families that regularly visit flowers in search of nectar. The order to which moths and butterflies belong, the Lepidoptera, contains at least 100,000 living species according to current estimates by modern taxonomists. It may surprise the nonentomologist to learn that moths, the butterfly's nocturnal cousins (actually butterflies are likely derived evolutionarily from distant moth ancestors), outnumber the butterflies by about ten to one. And yet moths are extremely important pollinators of night bloomers including the sacred datura and many cacti.

Although not so numerous as bees, their "colleagues" in the order Hymenoptera, wasps, also pollinate certain flowers. In the American Southwest, many spider wasps (like the giant tarantula hawk) are important floral visitors and pollinators of native milkweed plants. Similarly, figwort blossoms are especially adapted for visitations by wasps. Many wasps have bodies that are too smooth—especially when compared to their hairy cousins the bees—to pick up much pollen. Some wasps do, however, have legs with coarse hairs that are adequate for picking up and transferring pollen from flower to flower while they go about their business of searching for sweet nectar within blossoms. There are about 10–15,000 species of wasps that function to some degree as pollinators of flowering plants.

It's hard to decide who might be the largest of the world's vertebrate pollinators—not because we don't know which floral visitor is the biggest of them all, but because we don't know which dependably moves pollen between different flowers. Our guess, however, is that this distinction belongs to a Malagasy lemur, now

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huachuca agave with lesser long-nosed bat, Scott's oriole, and Lucifer hummingbird by Rachel Ivanyi highly threatened. Compared to the tiniest bee (*Perdita minima*) or a thrip, the black and white ruffed lemur is a thousand times larger from its head to the tip of its tail—in all, some four feet in length. It is the largest of the quadrupedal lemurs still left on this planet. This lemur is also many times more endangered than the tiniest bee, not only because of continued destruction of Madagascar's lowland rainforests, but also because it is hunted and trapped as a human food delicacy throughout its restricted range. Between 1,000 and 10,000 of these lemurs remain in the wild. Nearly 500 are held captive in a hundred different zoos around the world. The subspecies *Varecia variegata variegata* is considered to be endangered according to World Conservation Union criteria. Conservation International has given its conservation and habitat protection a "high priority" ranking, since it remains a popular target for Malagasy hunters.

In a recently celebrated confirmation that large, nonflying mammals can be effective pollinators, Hilary Morland of the Wildlife Conservation Society spent several seasons watching 10-pound black and white ruffed lemurs. These lemurs lived in a forest of "traveler's trees," *Ravenala madagascarensis.* The national tree of Madagascar, this extraordinary plant has a single palmlike trunk which may grow 100 feet tall before sprouting a single vertical fan of banana-like leaves. During 40 daylight hours of observation, the lemurs were seen ascending the trunk to make 57 visits to the pale yellow flowers of the traveler's tree. Once the lemurs arrive at a flower stalk, they use their nimble hands to pull open the tough bracts protecting a dozen or so flowers, then stuff their muzzles inside each flower to drink its nectar. After fruit, the traveler's tree nectar is this lemur's most important food. No other vertebrate in Madagascar appears to have the combination of agility and strength required to open the bracts to obtain the floral nectar of the traveler's tree. Morland and colleagues confirmed beyond doubt that this 10-pound lemur carries pollen in its fur from one plant to the next, and that its association with traveler's trees is ancient.

Of course, length from head to tail is not the only way to determine maximum size of a pollinator. Wingspan is another, and some of the flying foxes open their forearms to let their wings cover a 5½-foot breadth. The largest flying foxes, however, are fruit-eaters first and come in a poor second as flower visitors and nectar drinkers. Their incidental movement of pollen, moreover, is not always well targeted. But certain smaller flying foxes in the genus *Pteropus* are not the wasters of flowers that their overgrown kin may be. *Pteropus* includes 56 to 59 species occurring east from the islands in the Indian Ocean, well into the islands of the South Pacific. In fact, some have been found 200 miles out at sea, away from any landmass, so it is conceivable that flying foxes may actually be able to move pollen some distance between islands.

On the islands and peninsulas that flying foxes frequent, there is often a paucity of other vertebrate pollinators. Indeed, many plants rely solely on flying foxes for transporting pollen from plant to plant. Paul Cox and colleagues report that more than 92 genera of plants in 50 different families have been visited by flying foxes. Unfortunately for the plants that rely on this keystone species, many populations of flying foxes have suffered declines nearly as dramatic as those of lemurs. In the Philippines, where 150,000 flying foxes would congregate in the 1920s, the largest gatherings today are seldom more than a couple hundred individuals. Three Pacific Island flying foxes have already gone extinct. Twelve other species are of concern to IUCN, and the US Fish and Wildlife Service lists three species as endangered on Pacific Islands claimed by the US government.

In many ways, the North American equivalents of flying foxes are the nectar-feeders among the American leaf-nosed bat family, the Phyllostomidae. Thirteen genera in the subfamily Glossophaginae have been confirmed as pollinators for a variety of plants, ranging from bananas and tree morning glories to towering century plants and columnar cacti. Mexico alone has 11 species of nectar-feeders in seven different genera, and six of those species are found nowhere else except Mexico. Two of them are locally rare, and there are unconfirmed reports that several others are in decline.

Aside from flying foxes and nectar-feeding leaf-nosed bats, 15 other genera of bats pollinate plants on various continents. Collectively they include at least 75 additional species that feed on nectar or pollen of vascular plants, including some plants known to be rare. It appears that a disproportionately large percentage of the 56 endangered species in the Chiropteran (bat) order are nectar-feeders and pollinators—also true of the ten bats that have already gone extinct. Nectar-feeding bats are a large component of the 533 mammal species considered threatened with extinction by the Global Biodiversity Assessment.

Other, nonflying mammals are reported to have pollinated certain plants, but most of these reports are anecdotal at best. Our colleagues Charlie Jansen and John Terborgh have done much to establish that nonflying mammals such as opossums, marmosets, and tamarins are legitimate pollinators in the neotropical forests, and their rigorous methodology will no doubt be used by others to add species to pollinator lists. But the accepted cases of nonflying mammals serving as pollinators come mostly from Australia, where honey possums, dibblers, dormouse possums, feather-tailed possums, pygmy gliders, brush-tailed possums, and spotted cuscuses are among the marsupials that regularly feed on flowers. There are also reports of pollination by tree squirrels, bush rats, galagos, tree shrews, raccoons, kinkajous, olingos, and longtailed weasels. Many of these mammalian visitors destroy flowers while obtaining nectar, however, and spend an inordinate amount of time in single trees, rather than transferring pollen from one plant to the next. If raccoons are indeed found to be legitimate pollinators of flowering plants, they will become the Heavyweight Pollinator Champions of the World, for they may weigh more than two and a half times the weight of the fattest variegated lemur.

Mammals may be the biggest vertebrates that serve as effective pollinators of plants, but they are hardly as diverse as

two-tailed swallowtail and carpenter bee on wavyleaf thistle by Rachel Ivanyi the avian pollinators worldwide. Over 1500 bird species in at least 18 families have been confirmed as effective pollinators of plants. Common names such as honeyeaters, honeycreepers, flowerpeckers, and honeyguides hint at these species' reliance on nectar. They range in size from two-inch hummingbirds to Hawaiian crows ten times their size.

Of all the continents, perhaps Australia has the most widespread occurrence of birds as pollinators. More than 110 species of birds have been seen visiting some 250 plant species in Australia alone. Some 70 species of honeyeaters may be effective pollinators of Australian plants. Lorikeets, parrots, silvereyes, woodswallows, chats, sunbirds, orioles, trillers, thornbills, shrike-thrushes, treecreepers, bowerbirds, and butcherbirds have also been seen taking pollen or nectar from Australian flowers.

It is not surprising that honeyeaters and certain other nectar-feeding birds have brush-tongues that mirror the morphological adaptations to nectar sucking found in certain bees. Theirs too presumably evolved for licking up sticky nectar. Asian flowerpeckers and honeyguides, Hawaiian honeycreepers, African sugarbirds, Australasian honeyeaters, paleotropical white-eyes—all show similar adaptations to particular floral traits such as long tubes and copious daytime nectar production. Neotropical hummingbirds clearly have no monopoly on avian adaptations to floral rewards.

At least 42 genera of nectar-feeding birds of the world, however, now include species threatened by the loss of floral resources and nesting habitat. Among these are no fewer than 26 humminghirds considered globally threatened. Some, such as the hook-billed hermit and Chilean woodstar, are clearly endangered by the diminution of nectar resources resulting from massive tropical forest conversion to croplands. In addition, ornithologists remain concerned about 22 other hermits, coquettes, pufflegs, and metaltails in the hummingbird family, as well as 37 white-eyes, seven flowerpeckers, 11 honeyeaters, four honeyguides, and seven orioles.

Although fish can walk and a few glide and fly, none have been reported as pollinators in the journals that we regularly read. The same can be said for frogs and salamanders. Thus the global decline in amphibians will not directly affect seed set among flowering plants. But a single reptile has made it onto our list of pollinators, as if to remind us that the Natural World seldom says "never." Geckos are the sole group of lizards that have been caught in the act of pollination—prying open the long flowers of New Zealand flax and inserting their tongues in the floral tubes to suck up nectar. These remarkable reptiles live on a few of New Zealand's offshore islands but are highly endangered due to introduced birds and mammals. While nectar-feeding, these geckos often brush up against flax anthers in a way that leaves plenty of golden pollen on their chins and throats. In fact, their throat scales are modified to hold onto flax pollen grains—much as the hairs of the lesser long-nosed bat in Arizona are elaborated to increase their surface area for effective pollen pickup and delivery. The geckos then move on, carrying some of this pollen with them to another flower, sometimes on a plant located a considerable distance away from the first.

All told, we conservatively estimate there may be between 130,000 and 200,000 invertebrate and vertebrate species that regularly visit the flowers of those higher plants which depend on animals to assure crosspollination. This number of animals is at least half the magnitude of the number of flowering plants (other than grasses) described in the floras of the continents of the world. How many are dependable, effective pollinators remains to be seen. And only our grandchildren will know how many of these animals and plants survive the next 50 years, for the biological diversity of the entire planet is façing unprecedented threats.

Gary remembers:

I once had a moment of recognition about the plight of migrant pollinators. Even when their roosts are protected in one area, the cumulative effects of disruptions along their entire nectar corridor may still diminish the numbers of arriving survivors. I witnessed this predicament firsthand one May evening when assisting with a nectar-feeding bat monitoring program in a borderland national park. I had volunteered to crawl into a mineshaft where up to 10,000 bats were known to congregate. Early in the warm season, perhaps only 5,000 had already arrived, and most of them were gravid females.

Arriving at the mineshaft entrance around eight in the evening, I sat with a US National Park Service employee and watched as dozens of bats whirred by on their way out to feed that night on the nectar and pollen from cactus flowers. Twenty to sixty lesser long-nosed bats rushed out of the roost at a constant clip. They did not form a continuous stream as from some of the giant tourist bat caves; it was more like a froth let loose from a bottleneck. They took off in several directions, toward large stands of saguaro cacti within a 60-mile reach.

After a half hour had passed, my friend and I put on our headlamps and began the slow crawl through the horizontal mineshaft toward the monitoring equipment. Guano stench bit at my nostrils as we moved along, spotting as we went the serpentine trackways of rattlesnakes and paths where desert tortoises had entered the shaft in the past. All the way, I could hear loud whirring and shuffling sounds, not unlike rain and wind on the roof in a storm.

Just before reaching the monitoring equipment, I noticed something grim: recently fallen bats were lying dead, in the guano, being consumed by dermestid beetle larvae. In just one section of the mineshaft near the monitoring equipment, I tallied between 50 and 100 bat skeletons, intact or disarticulated, with leathery hides stretched over them. I wondered how many more lay beneath the roost, dozens of yards further into the mountain, but I didn't crawl in to look—some of the females may have been giving birth in there, and did not need to be disturbed.

What caused the death of so many bats within just a few days? This question remains unanswered. Did already weakened bats attempt to cluster around the warmth and hum of our temperature and humidity probes, our technical data logger and battery? Did exposure to pesticides in Mexico finally catch up with some of the bats at the northern limits of their migration? Had they arrived out of synch with the local flowers, due to their hurrying through an area of desert that had been deforested, converted, or destroyed? Whatever the answer, the corpses of bats were now afloat in a sea of guano and dermestids.

Like the monarch butterflies, the lesser long-nosed bats are not as rare as most truly endangered species. A few fallen butterflies or bats do not mean that their kind is globally threatened. What is strikingly similar about monarchs and nectar-feeding bats is that each of these species aggregates into so few populations for a good part of each year. There are 33 threatened species of Mexican bats that roost in caves, but according to Mexican biologist Hector Arita, the lesser long-nosed bat is one of only two that nests in colonies of greater than 200 individuals. As for butterflies, the five monarch roosting sites in Michoacan collectively contain 20 to 50 times the number of monarchs in all the winter roosting sites in California combined. If one roost is destroyed, a fiftieth or a twentieth or perhaps even a tenth of all living individuals in the species may vanish with it in one moment.

Some plants—such as certain agaves—have devised a means of surviving such sudden fluctuations in pollinator numbers. Agaves with umbrella-shaped inflorescence may have been originally shaped by bat visitation behavior, yet their flowers remain generalized enough that bees and even hummingbirds will transfer pollen from one flower stalk to the next. Even when other pollinators are scarce, some agaves have another fallback strategy. Once the unvisited, unfertilized flowers wither, they produce small plantlets called *bulbils* in their stead. These bulbils are essentially parasitic on the mother plant and genetically identical to mom—they lack the genetic diversity associated with sexual recombination. But they allow mom's genetic legacy to persist until a pollinator returns to enable outcrossing.

Not all plants take out such life insurance policies. If they are to any extent reliant on migratory pollinators, their seed-setting abilities are susceptible to any and all fluctuations in pollinator numbers, whether due to natural or human causes. The plant's vulnerability increases with the length of the pollinator's migratory route, with the degree of disruption of nectar sources along the way, and with the intensity of aggregation of the pollinator's populations. Whenever too many eggs are put in the same basket, or whenever the basket has traveled too far over ground too dry or too rough, the results are likely to be broken, scrambled, rotten, or parched.

If migratory bats or monarchs were the only ones to deal with the perils found along the nectar trail, this story perhaps would be unremarkable. But throw in other kinds of nectar-feeders: the thirteen migratory hummingbirds, three sapsuckers, two warblers, and five orioles that move between the tropical and arctic reaches of the New World. Then consider the flying foxes that move between one island and the next in the Pacific. Then toss into the ring the hawkmoths that have been found to move between mountain ranges on successive nights. While most plants remain sessile, permanently rooted, there is a whole fleet of animals out there risking their lives as they serve as connective tissue between pollen donors and receptive stigmas for the local plant communities. Whether anther and stigma are a few feet apart or a few miles from one another, their animal intermediaries increasingly find that it is indeed a jungle out there. ☾

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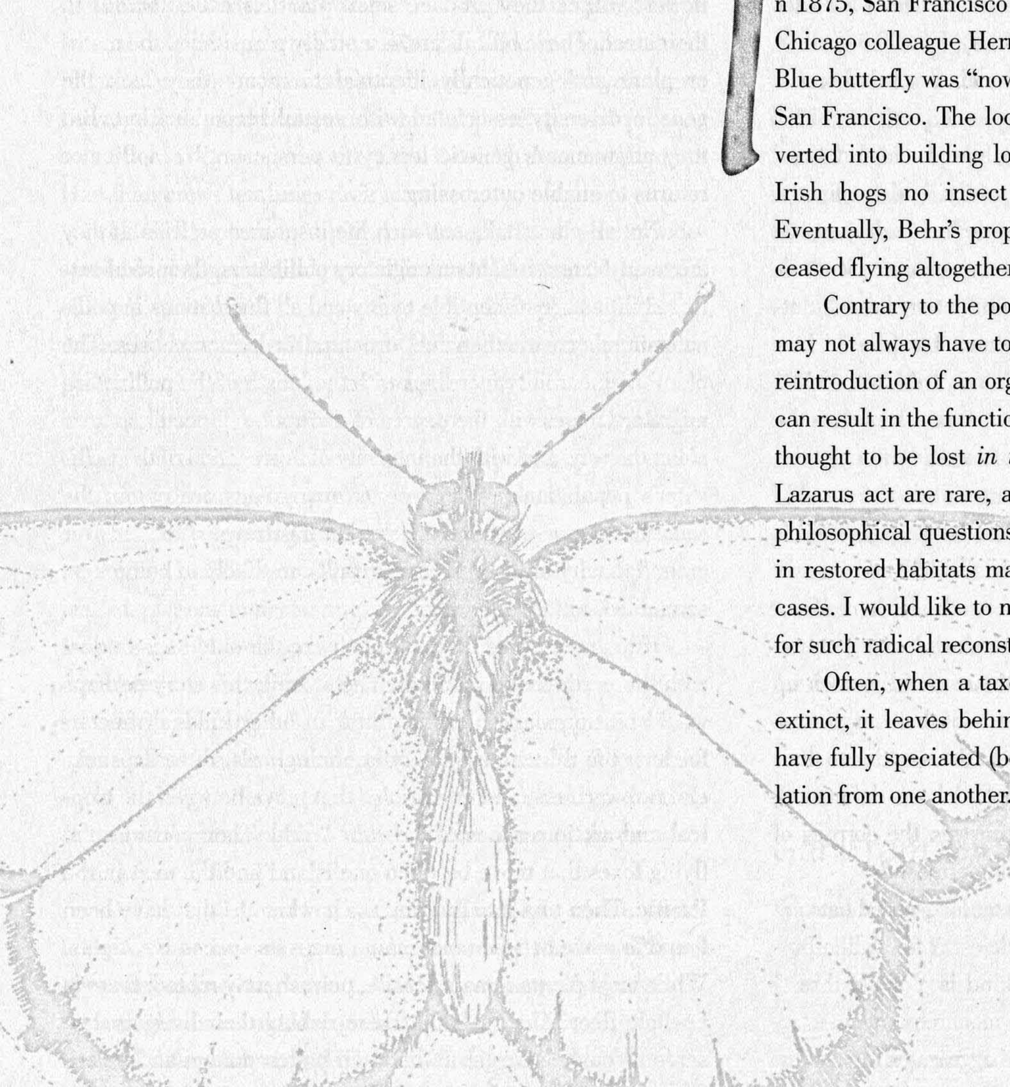
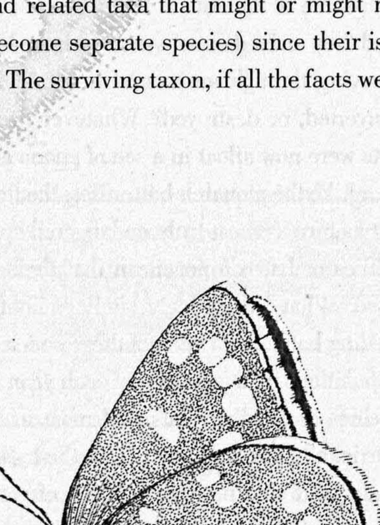


In 1875, San Francisco lepidopterist Herman Behr wrote to his Chicago colleague Herman Strecker, lamenting that the Xerces Blue butterfly was "now extinct, as regards the neighborhood of San Francisco. The locality where it used to be found is converted into building lots, and between German chickens and Irish hogs no insect can exist besides louse and flea." Eventually, Behr's prophecy panned out, and the Xerces Blue ceased flying altogether.

Contrary to the popular conservation aphorism, extinction may not always have to be forever. Occasionally, the thoughtful reintroduction of an organism closely related to an extinct type can result in the functional reconstruction of the animal or plant thought to be lost *in toto*. The conditions permitting such a Lazarus act are rare, and their employment raises all sorts of philosophical questions. Still, reestablishment of near relatives in restored habitats may be an act worth considering in some cases. I would like to nominate the Xerces Blue as a candidate for such radical reconstitution.

Often, when a taxon (a kind of plant or animal) becomes extinct, it leaves behind related taxa that might or might not have fully speciated (become separate species) since their isolation from one another. The surviving taxon, if all the facts were



by Robert Michael Pyle

Resurrec

Xerces blues by Sarah Anne Hughes

known, might be considered a different subspecies from the extinct type, or a different (but very close) species. This can be a difficult distinction to make with certainty, even with both members alive. But the Endangered Species Act allows for the listing of subspecies, recognizing that these are the active units of evolution, where differentiation is in the process of occurring. Far from irrelevant side issues, subspecies are where the action is in evolutionary terms. So when a creature drops out due to environmental change, surviving related taxa in not-too-distant localities may contain much the same genetic complement as the lost ones. Transported to the site of the extinction (assuming its supportive conditions have been restored), the survivor may re-inoculate the place with organisms similar to those lost; and in time, under those conditions, may evolve traits that make them virtually indistinguishable from the original occupants. This has occurred in Nature, as when extinct Floridian butterflies were replenished by arrivals from the Bahamas and Cuba.

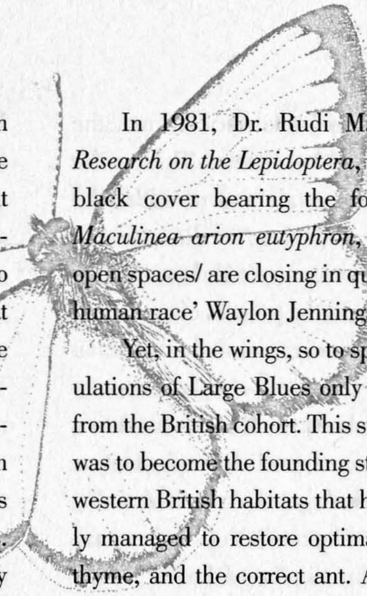
As denizens of stressed habitats decline, the number of instances where purposeful reintroduction may prove a useful tool will increase. For example, in 1975 I rediscovered a federally threatened butterfly, the Oregon Silverspot (*Speyeria zerene hippolyta*), in coastal Washington. Subsequently, development and a series of harsh summers seem to have wiped out the insect. State funds purchased critical habitat and managers aggressively planted violets for the larvae, but no adults could be found. Now the recovery plan envisions introducing related fritillaries from Oregon coastal colonies that are doing better. The genetic similarity is probably close enough for success, now that prime habitat is protected and improved for the species. But in this case, both the extinct and the donor populations belong to the same subspecies. Such an outplant recently bolstered an Oregon site with individuals bred in captivity from local parents.

Two celebrated experiments in more disparate reconstructive introduction have taken place with British butterflies, one an effective failure, the other an apparent success. In the first case, the English Large Copper (*Lycaena dispar dispar*) died out in the great fens of East Anglia when they were drained in earnest in the eighteenth and nineteenth centuries. The last individuals of this inch-and-a-half brilliancy, flaming metallic orange like a living ingot, flew in 1847. English entomologists, among them Lord Walter Rothschild, much disturbed by this and other losses, instituted the first committee for insect conservation in the 1920s. Among other measures, they set aside Woodwalton Fen, an extant, undrained remnant of the vast marshes sacrificed to agriculture. Committee members introduced the German Large Copper (*L. d. rutila*), hoping to replace the original. But the butterfly did not take. Later, they tried again with coppers from Dutch coastal fens (*L. d. batava*). And after a fashion, this effort worked: you can go to Woodwalton today and you might see Large Coppers. However, their survival has depended on extraordinary management measures including planting out the host plant, great water dock; manipulation of aquatic-edge habitats; taking the larvae indoors for the winter; and building an enormous (and expensive) clay apron all around the perimeter of the reserve, as the surrounding fenlands have shrunk by many feet through desiccation and blowing soil.

While studying this and other practices in British butterfly conservation in the 1970s, I heard it said by biologists involved in the project that, by some morphometric figures, the descendants of the introduced butterflies statistically resembled the extinct British coppers more closely than the Dutch founder stock. I have never seen any data published in support of this instance of micro-evolution, but this is, after all, what one would expect in time. In 1999, however, at an international symposium on Lepidoptera conservation held in Oxford, I was told that inbreeding depression had reduced the surviving Woodwalton population to virtual homozygotes, with little genetic variability or elasticity, and an effective inability to adapt to environmental change. The effort has not been without benefit, since Woodwalton is an important refuge for many other wetland species. But the "English Large Copper" is now, essentially, more a coddled clone than a viable resurrection.

tion Ecology

Bring Back the Xerces Blue!



The second instance involves another popular English insect, the Large Blue (*Maculinea arion*). About the size of the copper, it was a brilliant pale blue emblazoned with prominent coal spots. In the nineteenth century it inhabited certain meadows and downlands across southern England. But not long into the twentieth, the Large Blue began dropping out of one habitat after another, and its own committee was formed. Reserves were established and potentially harmful activities prevented, including collecting, grazing, and burning. The blue's larvae feed initially on wild thyme, not a rare plant. But its life history then becomes almost surreally baroque. The partly grown caterpillars drop onto the ground, where they are picked up by foraging ants. Placed in the ants' brood chamber underground, the butterfly larvae become carnivorous on the ant larvae; this is tolerated, and the ants milk the caterpillars for honeydew produced by specialized glands possessed by the larvae of many blues. Pupation takes place in the ant nest. In the spring the butterfly crawls up and out, spreads its wings, and begins anew.

Whenever an organism possesses such a degree of specialization, it is elegantly adapted to a certain narrow range of conditions, but extra-vulnerable to their disruption. In fact, several of the listed endangered species in the US are other species of blues possessing complex commensal relationships with ants (though none so bizarre as *Maculinea*!) and fine-tuned habitat needs often involving fire and overstory—the Mission Blue, the El Segundo Blue, the Palos Verde Blue, and Smith's Blue, all of California, and the famous Karner Blue of the Northeast, named by novelist/ lepidopterist Vladimir Nabokov. Because the specific needs of the Large Blue were imperfectly understood, losses continued in spite of protective efforts. Finally, in 1979, the final individuals, removed from the last site to the laboratory, flickered out without issue—and the English Large Blue became extinct.

Dr. Jeremy Thomas of the Institute of Terrestrial Ecology had studied the detailed life histories and mortality factors of several English rarities, and his findings often guided reserve management that led to their recovery. Just about the time the Large Blue crashed, he cracked its management mystery. It turned out that the early conservationists had it wrong—the Large Blue had co-evolved with fire and sheep, and actually required their effects. In the absence of burning and of grazing by sheep and rabbits, the nature of the turf altered; thyme was reduced through competition with gorse and coarse grasses, and most importantly, the dominant species of ant changed. The newly dominant ant picked up the blues' larvae all right—then ate them! At last Thomas had the formula for Large Blue management, and the butterfly's large constituency in Britain guaranteed funds to put the reserves back in shape. But the blues were all gone.

In 1981, Dr. Rudi Mattoni, editor of *The Journal of Research on the Lepidoptera*, published a memorial issue with a black cover bearing the following epitaph: "In Memoriam: *Maculinea arion eutyphron*, c. 10,000 BC–1979 AD 'the wide open spaces/ are closing in quickly/ from the weight/of the whole human race' Waylon Jennings."

Yet, in the wings, so to speak, awaited relatively robust populations of Large Blues only ten thousand years or so removed from the British cohort. This subspecies, the Swedish *M. a. arion*, was to become the founding stock for new Large Blue colonies in western British habitats that had been energetically and precisely managed to restore optimal conditions for the butterfly, the thyme, and the correct ant. And such has been done, with the support of British Butterflies and other organizations, agencies, and companies. At the Oxford symposium, Dr. Thomas reported impressive indications of success thus far. Care has been taken to maximize genetic diversity, and to avoid other pitfalls experienced by the century of experience with the Large Copper.

Many more subspecies than really exist have been named for the Large Blue, as for many European butterflies, where practically every valley's "race" bears its own name regardless of biology. These local ecotypes may have genetic bases and therefore evolutionary and conservation significance. But the currently accepted model recognizes three major European subspecies, with both the Swedish and UK forms belonging to *M. arion arion*, the original type named by Linnaeus.

However, Thomas points out that there are detectable (and mainly unpublished) differences which he believes most taxonomists would consider great enough for classification as two true subspecies. The Swedish individuals that he and his colleagues used for reintroduction were, on average, significantly larger and more heavily marked with black than any of the original UK populations. More importantly, they were adapted to a warmer summer climate (one–two degrees C) than any UK site, which affects their emergence dates. This is crucial, because it determines whether adult emergence coincides with thyme flowering for optimal egglaying. "They have been able to 'shift time zones' fine on most UK sites," says Thomas, "but interestingly, in the Cotswolds—much the coldest of the former regions inhabited by subspecies *M. a. eutyphron*—they haven't, and Swedish adults emerge two–three weeks late there, condemning the females to oviposit in the coolest parts of sites where thyme flowers later but where the host ant is most scarce. Needless to say these are the only introductions that have failed." He reports record numbers elsewhere this year, with extraordinary (and unsustainable) densities in Somerset, and Large Blues flying in twelve sites total, including some newly colonized nature reserves.

WHICH BRINGS US BACK TO THE XERCES BLUE. ONE century after the Large Copper last shimmered over the black fens of England, the Xerces Blue disappeared from California. Even after Behr's lament to Strecker about its decline, the butterfly remained common in places. William Hovanitz, a prominent California lepidopterist, used to bicycle out to the Presidio and collect as many as he liked without making a dent in their numbers, as he worked out their life history. He made a point of speaking about the area with the Presidio commander, who left it undisturbed for the time being. The renowned insect photographer Dr. Edward Ross and Harry Davis of UC-Davis were the last entomologists to see Xerces Blues on the wing. They observed them around a blue-flowered lupine near the Marine Hospital above Lobos Creek, on a slope at the head of a natural amphitheater. There, Ross told San Francisco butterfly authority Barbara Deutsch, one could see many individuals together on a fine spring day. That upland was subsequently flattened, graveled, and built upon by the army's ordnance department. Drs. Hovanitz and Mattoni photographed a small patch of deerweed persisting into the 1960s at the Presidio on a baseball diamond, and presented a one-page article in the *Journal of Research on the Lepidoptera*, showing the habitat. But the last known Xerces Blues flew over dunes at the Presidio in 1943. In 1956, Dr. John Downey, successor to Nabokov's blue-butterfly studies, documented the biology and extinction of *Glaucopsyche xerces*.

It was the decline of the British Large Blue that brought modern attention to *G. xerces*. On December 9, 1971, T. G. Howarth of the British Museum (Natural History) gave a talk in London cautioning that the Large Blue might soon be lost; and that if it were, we should take it as a symbol and resolve to lose no more British butterflies, of which there are, after all, only sixty-some species. In the end, the Large Blue was indeed lost (then found again, in Sweden). But Howarth's injunction had a farther-ranging impact. Having heard his lecture, I decided that night that a group should be formed to remember the Xerces Blue and to work for butterfly conservation in North America. The Xerces Society has since become an international voice for all small-scale life and its habitats.

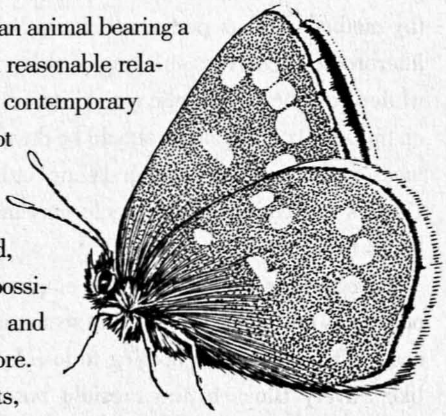
The Xerces Society will soon be thirty years old, and the Xerces Blue has been gone for nearly twice that long. The very changes that brought about Golden Gate Park, the Embarcadero, the Marina, and the neighborhoods of San Francisco replaced coastal dunes, hills, and swales with pavement, buildings, and parks. The same kinds of changes led to the endangerment of the Mission Blue, and as commercial use of the city densifies today, even the once-common butterflies of vacant lots and alleyways are becoming scarce. However, an opportunity looms that could exemplify a whole new era of butterfly (and habitat) sensitivity and imagination in San Francisco and elsewhere. Three conditions have converged to create this possibility.

First, since Xerces' demise, the military reservation known as the Presidio, where the butterfly last flew, has become part of the Golden Gate National Recreation Area. Extensive wetland restoration is taking place on part of the Presidio along San Francisco Bay, and in the western section of the old fort, an effort is underway to restore a semblance of native San Francisco duneland habitat.

Second, a California recovery tantamount to the restoration of the Large Blue in England is underway. A Los Angeles cousin of the Xerces Blue, the Palos Verdes Blue (*Glaucopsyche lygdamus palosverdesensis*) was thought to be the first federally listed taxon to become extinct on the government's watch. But it was later rediscovered at a US Navy fuel depot by Dr. Rudi Mattoni of UCLA, a prominent authority on the biology of blues and a veteran of conservation efforts on behalf of the endangered El Segundo Blue. The Palos Verdes Blue has since become the target of a major lab-rearing and restoration effort by Mattoni and colleagues, and the early results are promising.

Third, some fairly near relatives of Xerces may be extant today. A paper by Thomas C. and John F. Emmel in the recent tome *Systematics of Western North American Butterflies* (Mariposa Press, 1998) describes a new *xerces*-like subspecies of the Silvery Blue (*Glaucopsyche lygdamus*) from Santa Rosa Island, one of the California offshore islands and part of Channel Islands National Park. Although the males are a paler, more violet blue than those of *G. xerces*, and the females browner, the underside hindwings bear prominent white halos around the black spots, and sometimes only the white spots as in "the true *xerces* of San Francisco." As the Emmels put it, the name they gave the new subspecies, *G. l. pseudoxerces*, "reflects its phenotypic similarity to the extinct Xerces Blue, and recalls the opportunities for evolutionary biologists and geneticists that were lost with the passing of the highly variable Xerces Blue in 1943."

The discovery of an animal bearing a striking similarity and reasonable relationship to Xerces, contemporary with a vigorous attempt to restore suitable habitat in the last place Xerces existed, suggests a symbiotic possibility too obvious and appealing to ignore. Some lepidopterists,



such as Dr. James A. Scott, author of *The Butterflies of North America*, believe that the Xerces Blue was, in any case, conspecific with (i.e., the same species as) the Silvery Blue. Whether this is indeed the case or they are simply closely related, it is unlikely that *G. lygdamus* and *G. xerces* differentiated very long ago in the evolutionary past. The Emmels found *G. l. pseudoxerces* females ovipositing on California broom (or deerweed, *Lotus scoparius*), a legume that was the Xerces Blue's primary, if not sole, caterpillar host plant in San Francisco. It is a plant that, if it is not already being incorporated in the Presidio habitat restoration, should be.

But the Xerces Blue was not restricted to seaside habitats, and some believe it was not strictly a lotus-eater. Tree lupine has been reported as a host for it, and the larvae consumed Nuttall's pea in the laboratory. Nor was it always white-spotted; there was both a form with small black irises called "polyphemus," and one with larger dark centers called "antiacus" that quite resembled the Silvery Blue. It was just this extreme polymorphy that made Xerces so interesting from a population genetics standpoint. So the fact that the new island subspecies is the closest in appearance to the usual form of the old Xerces Blue might not be the most relevant factor in deciding whether *G. l. pseudoxerces* would be the best founder population for a reintroduction. In fact, Rudi Mattoni, to whom the idea of restoring Xerces occurred years ago, thinks it might not. After all, a Silvery Blue population that had evolved closer to the San Francisco Peninsula might well prove more suitable for local conditions than one from southern California, just as the Swedish Large Blues suited Somerset more than the Cotwolds. And geographically closer Silveries might also be more recently related to Xerces than the Channel Islands population. Besides, it would likely prove much easier to obtain and transport living material from outside a national park than from within.

The likely candidate would be *G. l. incognitus* (formerly called *G. l. behrii*) from Marin County, Santa Clara, and elsewhere on the north and central California coast. Mattoni suggests that this subspecies could be laboratory reared *en masse* (by methods he has perfected for the Palos Verdes Blue) and interbred to achieve something of the polymorphy of Xerces, while strengthening genetic variability. In order to further broaden the gene pool, founders should be drawn from several sites, a measure that Yale professor and eminent Lepidoptera geneticist Charles L. Remington suggests for any insect introduction that hopes to succeed.

Regardless of the subspecies employed, the reintroduction of blues to the Xerces' last habitat seems an idea whose time has come. There would be nothing to lose by introducing Xerces-like Silvery Blues to the Presidio but a modest number of founder individuals; and there might be a great deal to gain in terms of expanded support for the restoration and refined management practice. I feel the attempt would be worth it, if only for the vigorous debate and solid experience it would promote in the young practice I am bound to term Resurrection Ecology.

Reintroduction is a last resort that should never be undertaken until the original extinction is virtually certain, and this can be difficult to prove. For example, the Palos Verdes Blue had been thought extinct for years before Rudi Mattoni rediscovered it. But with so many people searching for the Xerces Blue over so many years, its extinction is virtually certain. Furthermore, reintroduction is pointless unless the original causes of extinction have been reversed. Restoration of damaged habitats is an imperfect science at best, and the hope that the resulting simulacrum will have much in the way of functional equivalency for its denizens is a long shot. For example, when I read the following statement by a Chinese official responding to criticism of a railroad spur through sensitive landscapes in the Hong Kong New Territories, my heart dropped: "The EIA report...has recommended both temporary and permanent mitigation measures to meet the environmental standards and requirements, including the creation or reprovisioning of wetland at the Long Valley area." "Reprovisioning wetlands" seldom approximates the complexity, diversity, or reality of the original. Many Habitat Conservation Plans fail for the same reason: it is easy to talk about replacing taken species, but very hard to do it.

Nonetheless, perhaps the Presidio restoration will succeed in bringing back a patch of habitat bearing some resemblance to the city's lost landscape. This patch could grow. If all went well, and if local conditions acted upon a similar genome to fix the white-spotted blue butterfly and attune it to the rebuilt habitat, who knows? At some future date, we might even be able to say, as the British can rightly crow about their Large Blue: Xerces flies again! ☾

Robert Michael Pyle *holds a PhD in butterfly ecogeography from Yale University and received a Distinguished Service Award from the Society for Conservation Biology in 1997. He is the author of a dozen books, including the John Burroughs Medal-winning* Wintergreen, *the* Audubon Society Field Guide to North American Butterflies, Chasing Monarchs: Migrating with the Butterflies of Passage, *and* Walking the High Ridge: Life as Field Trip.

The author would like to acknowledge the assistance of Drs. J. A. Thomas, R. Mattoni, N. Pierce, K. Johnson, and E. Ross, Mr. R. Dirig, and Ms. B. Deutsch in commenting on the manuscript.

Caddis Larvae

—spring tributary,
Crumarine Creek,
South Fork Palouse River—

"Odontoceridae—case cylindrical,
curved, made of sand..."*
and, here, flecks of mica.

This curious gathering and enclosure
in found and sorted miscellanea:

ballast for the crawling
and cocooned year in water?
Growing into wings—breeding in air,

example, as well, of the old
and honorable art of playful
misdirection?

Wading birds and minnows
with little taste for jewelry
overlook talons of mica,
flecks of spring ice,

exclamation points—
each ending a momentary
phrase in silt. Larvae
pulled up inside.

Safe enough 'til
trinket-eyed crows
catch on,
learn wading,

tease
apart

this
old
riddle.

—Wm Yake

* Pennak, R.W. 1953. *Freshwater Invertebrates of the United States.*

Faith, Hope, And Parasites

Some people are—well, just hopeless. Others
hope beyond all reason.
Two sanguine scientists from London's
Natural History Museum*
hope to rouse our sympathy
for the inevitable extinction
of certain lice and fleas and worms. They are
you see, too host specific
for their own good.

When the Passenger Pigeon, *Columbicola*
extinctus, passed away
Campanulotes defectus, its feather-chewing louse
died too. (Even their Latin names seem
the echo of neglected tragedy.)

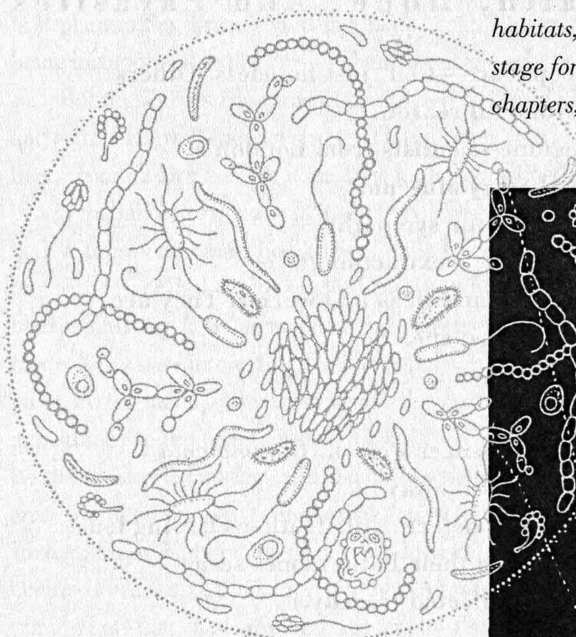
The relative worth
of louse and bird, the scientists suggest,
should concern, perplex us. Just
as we care for the mountain gorilla or
the great gray whale, we must—well,
they care! and hope you do
for the least of fallen sparrows.

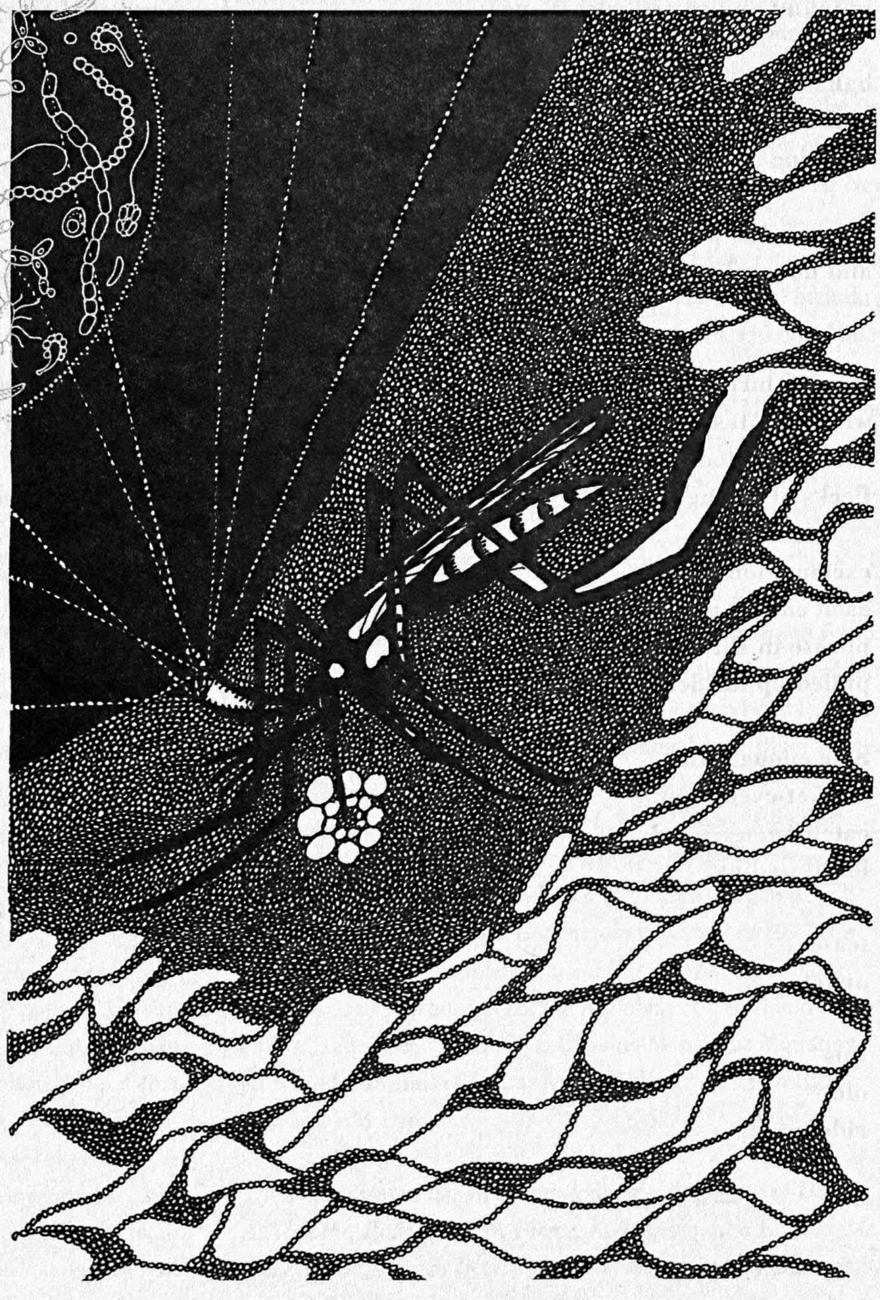
As we hope some one/some thing
will grieve for us
when our forest of feathers
has turned to dust.

—Robert Chute

* *Nature* Vol. 366 (Nov. 25, 1993), p. 307.

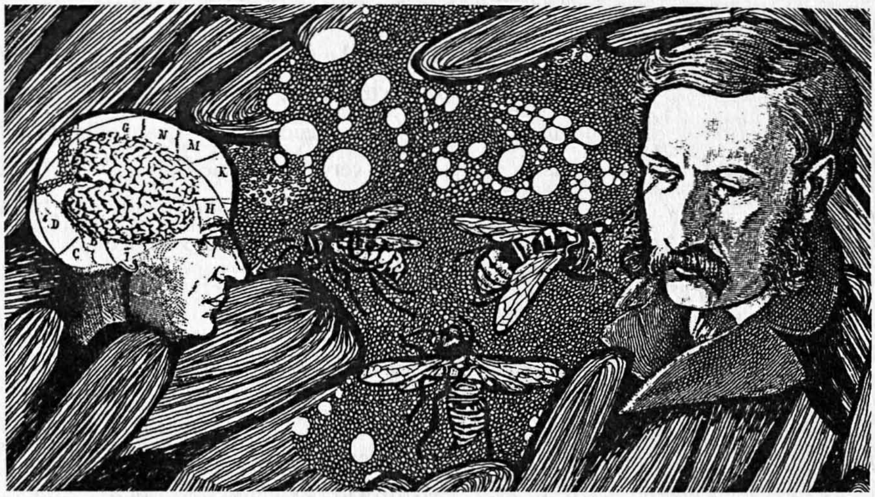
Editor's introduction *Laurie Garrett's landmark work of science journalism* The Coming Plague: Newly Emerging Diseases in a World Out of Balance *is no less relevant than when first published a half decade ago. A compelling storyteller, Garrett profiles outbreaks of Ebola, Machupo, hantavirus, HIV, and other emerging viruses deadly to humans, as well as bacterial and parasitic disease agents once thought vanquished but now resistant to drugs. The book should be required reading for college students, members of Congress, and cheerleaders for economic globalization. Garrett shows how burgeoning population growth, destruction of remaining natural habitats, a global transportation infrastructure, and misuse of antibiotics have set the stage for truly massive pandemics. This brief excerpt is adapted from the book's final chapters, "Nature and* Homo sapiens*" and "Searching for Solutions."* **—TB**





Nature and *Homo sapiens*

by Laurie Garrett



It is hard to gain historical perspective on an event that is completely unlike any other we have seen before.

—Al Gore, *Earth in the Balance*, 1992

That humanity had grossly underestimated the microbes was no longer, as the world approached the twenty-first century, a matter of doubt. The microbes were winning. The debate centered not on whether *Homo sapiens* was increasingly challenged by microscopic competitors for domination of the planet; rather, arguments among scientists focused on the whys, hows, and whens of an acknowledged threat.

It was the virologists, and one exceptional bacteriologist, who started the debate in 1989, but they were quickly joined by scientists and physicians representing fields as diverse as entomology, pediatric infectious disease, marine mammal biology, atmospheric chemistry, and nucleic genetics. Separated by enormous linguistic and perceptual gulfs, the researchers sought a common language and lens through which they could collectively analyze and interpret microbial events.

There had never really been a discipline of medical microbial ecology, though some exceptional scientists had, over the years, tried to frame disease and environmental issues in a manner that embraced the full range of events at the microscopic level. It was far less difficult to study ecology at the level of human interaction—the plainly visible.

There were certainly lessons to be drawn from the study of classical ecology and environmental science. Experts in those fields had, by the 1980s, declared that a crisis was afoot spanning virtually all tiers of earth's macroenvironment, from the naked mole rats that foraged beneath the earth to the planet's protective ozone layer. The extraordinary, rapid growth of the *Homo sapiens* population, coupled with its voracious appetite for planetary dominance and resource consumption, had put every measurable biological and chemical system on Earth in a state of imbalance.

Extinctions, toxic chemicals, greater background levels of nuclear and ionizing radiation, ultraviolet-light penetration of the atmosphere, global warming, wholesale devastations of ecosystems—these were the changes of which ecologists spoke as the world approached the twenty-first century. With nearly six billion human beings already crowded onto a planet in 1994 that had been occupied by fewer than 1.5 billion a century earlier, something had to give. That "something" was Nature—all observable biological systems other than *Homo sapiens* and their domesticated fellow animals. So rapid and seemingly unchallenged was human population growth, the World Bank predicted that nearly three times more *Homo sapiens*, on the order of 11 to 14.5 billion, would be crowded onto the planet's surface by 2050. Some high-end United Nations estimates forecast that more than nine billion human beings would be crammed together on Earth as early as 2025.

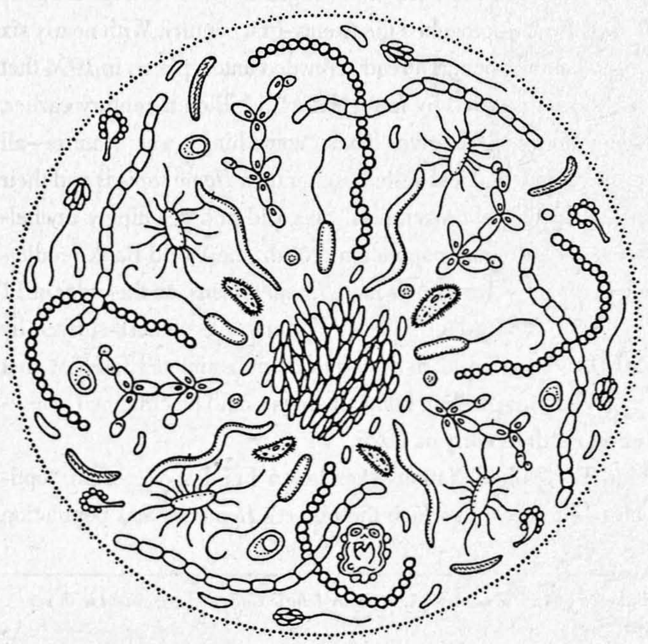
The United Nations Population Fund spoke of an "optimistic" forecast in which the planet's *Homo sapiens* population

This excerpt from The Coming Plague: Newly Emerging Diseases in a World Out of Balance *by Laurie Garrett (© 1994 by Laurie Garrett) is reprinted with permission of Farrar, Straus and Giroux, LLC.*

illustrations by Jim Nollman (above and mosquito, left) and Rob Messick (microbes, left) "stabilized" at nine billion by the middle of the twenty-first century.[1] But it was hard to imagine what kind of stability—or, more likely, *instability*—the world would then face, particularly given that the bulk of that human population growth would be in the poorest nations. By the 1990s it was already obvious that the countries that were experiencing the most radical population growths were also those confronting the most rapid environmental degradations and worst scales of human suffering.[2]

Biologists were appalled. Like archivists frantic to salvage documents for the sake of history, ecologists scrambled madly through the planet's most obscure ecospheres to discover, name, and catalogue as much flora and fauna as possible—before it ceased to exist. All over the world humans, driven by needs that ranged from the search for wood with which to heat their stoves to the desire for exotic locales for golf courses, were encroaching into ecological niches that hadn't previously been significant parts of the *Homo sapiens* habitat. No place, by 1994, was too remote, exotic, or severe for intrepid adventurers, tourists, and developers.

THANKS TO CHANGES IN *HOMO SAPIENS* ACTIVITIES, IN THE ways in which the human species lived and worked on the planet at the end of the twentieth century, microbes no longer remained confined to remote ecospheres or rare reservoir species: for them, the Earth had truly become a Global Village. Between 1950 and 1990 the number of passengers aboard international commercial air flights soared from two million to 280 million. Domestic passengers flying within the United States reached 424 million in 1990.[3] Infected human beings were moving rapidly about the planet, and the number of air passengers was expected to double by the year 2000, approaching 600 million on international flights.[4]



Once microbes reached new locales, increasing human population and urbanization ensured that even relatively poorly transmissible microbes faced ever-improving statistical odds of being spread from person to person. The overall density of average numbers of human beings residing on a square mile of land on the Earth rose steadily every year. In the United States, even adjusting for the increased land mass of the country over time, density (according to US census figures) rose as follows:

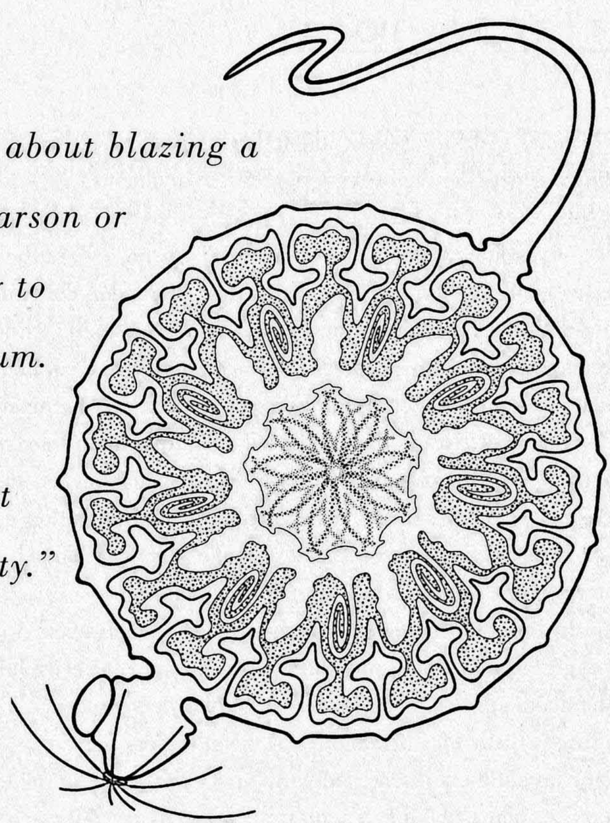
Year	*Total Population*	*Persons per Square Mile*
1790	3,929,214	4.5
1820	9,638,453	5.5
1850	23,191,876	7.9
1870	39,818,449	13.4
1890	62,947,714	21.2
1910	91,972,266	31.0
1930	122,775,046	41.2
1950	151,325,798	42.6
1970	203,211,926	57.5
1990	250,410,000	70.3
1992	256,561,239	70.4

In most of the world the observed increases were even more dramatic. In a comparison of 1990 and 1992 census information as collected by the United Nations, the two-year upward trend in population density was unmistakable:

Country	*1990 Population*	*1990 Persons per Square Mile*
China	1,130,065,000	288
India	850,067,000	658
Indonesia	191,266,000	255
Mexico	88,335,000	115
Rwanda	7,603,000	715

Country	*1992 Population*	*1992 Persons per Square Mile*	*% Density Difference 1990–92*
China	1,169,619,000	315	8.5
India	886,362,000	700	6.0
Indonesia	195,000,000	262	2.6
Mexico	92,380,000	121	4.9
Rwanda	8,206,000	806	11.3

The human race seems equally complacent about blazing a path into a rainforest with bulldozers and arson or using an antibiotic "scorched earth" policy to chase unwanted microbes across the duodenum. In both macro and microecology, human beings appear, as Harvard's Dick Levins put it, "utterly incapable of embracing complexity."



Though the population was spread unevenly over a country, density trends remained favorable to the microbes. If worst-case projections for human population size came to pass, some regions would have densities in excess of 3,000 people per square mile. At that rate the distinctions between cities, suburbs, and outlying towns would blur and few barriers for person-to-person spread of microbes would remain.

With the passage of time and the increase in travel it was becoming more and more difficult to pinpoint where, exactly, a microbe first emerged. The human immunodeficiency virus was a classic case in point, as it surfaced simultaneously on three continents and spread swiftly around the globe.

ULTIMATELY, HUMANITY WILL HAVE TO CHANGE ITS PERspective on its place in Earth's ecology if the species hopes to stave off or survive the next plague. Rapid globalization of human niches requires that human beings everywhere on the planet go beyond viewing their neighborhoods, provinces, countries, or hemispheres as the sum total of their personal ecospheres. Microbes, and their vectors, recognize none of the artificial boundaries erected by human beings. Theirs is the world of natural limitations: temperature, pH, ultraviolet light, the presence of vulnerable hosts, and mobile vectors.

In the microbial world warfare is a constant. The survival of most organisms necessitates the demise of others. Yeasts secrete antibiotics to ward off attacking bacteria. Viruses invade the bacteria and commandeer their genetic machinery to viral advantage.

A glimpse into the microbial world, aided by powers of exponential magnification, reveals a frantic, angry place, a colorless, high-speed pushing and shoving match that makes the lunch-hour sidewalk traffic of Tokyo seem positively poky. If microbes had elbows, one imagines they would forever be jabbing neighbors in an endless battle for biological turf.

Yet there are times of extraordinary collectivity in the microbial world, when the elbowing yields to combating a shared enemy. Swapping genes to counter an antibiotic threat or secreting a beneficial chemical inside a useful host to allow continued parasitic comfort is illustrative of this microscopic coincidence.

An individual microbe's world—its ecological milieu—is limited only by the organism's mobility and its ability to tolerate various ranges of temperature, sunlight, oxygen, acidity or alkalinity, and other factors in its soupy existence. Wherever there may be an ideal soup for a microbe, it will eagerly take hold, immediately joining in the local microbial pushing-and-shoving. Whether transported to fresh soup by its own micro motor and flagellae or with the external assistance of wind, human intercourse, flea, or an iota of dust makes little difference provided the soup in which the organism lands is minimally hostile and maximally comfortable.

The planet is nothing but a crazy quilt of micro soups scattered all over its 196,938,800-square-mile surface.

We, as individuals, can't see them, or sense their presence in any useful manner. The most sophisticated of their species have the ability to outwit or manipulate the one microbial sensing system *Homo sapiens* possess: our immune systems. By sheer force of numbers they overwhelm us. And they are evolving far more rapidly than *Homo sapiens*, adapting to changes in their environments by mutating, undergoing high-speed natural

illustrations by Rob Messick

selection, or drawing plasmids and transposons from the vast mobile genetic lending library in their environments.

Further, every microscopic pathogen is a parasite that survives by feeding off another organism. The parasites are themselves victims of parasitism. Like a Russian wooden doll-within-a-doll, the intestinal worm is infected with bacteria, which are infected with tiny phage viruses. The whale has a gut full of algae, which are infected with *Vibrio cholerae*. Each microparasite is another rivet in the Global Village airplane. Interlocked in sublimely complicated networks of webbed systems, they constantly adapt and change. Every individual alteration can change an entire system, each systemic shift can propel an interlaced network in a radical new direction.

In this fluid complexity human beings stomp about with swagger, elbowing their way without concern into one ecosphere after another. The human race seems equally complacent about blazing a path into a rainforest with bulldozers and arson or using an antibiotic "scorched earth" policy to chase unwanted microbes across the duodenum. In both macro and microecology, human beings appear, as Harvard's Dick Levins put it, "utterly incapable of embracing complexity."

Only by appreciating the fine nuances in their ecologies can human beings hope to understand how their actions, on the macro level, affect their micro competitors and predators.

Time is short.

As the *Homo sapiens* population swells, surging past the six billion mark at the millennium, the opportunities for pathogenic microbes multiply. If, as some have predicted, 100 million of those people might then be infected with HIV, the microbes will have an enormous pool of walking immunedeficient petri dishes in which to thrive, swap genes, and undergo endless evolutionary experiments.

"We are in an eternal competition. We have beaten out virtually every other species to the point where we may now talk about protecting our former predators," Joshua Lederberg told a 1994 Manhattan gathering of investment bankers.[5] "But we're not alone at the top of the food chain."

Our microbe predators are adapting, changing, evolving, he warned. "And any more rapid change would be at the cost of human devastation."

The human world was a very optimistic place on September 12, 1978, when the nations' representatives signed the Declaration of Alma Ata. By the year 2000 all of humanity was supposed to be immunized against most infectious diseases, basic health care was to be available to every man, woman, and child regardless of their economic class, race, religion, or place of birth.

But today, it seems, from the microbes' point of view, as if the entire planet, occupied by six billion mostly impoverished *Homo sapiens*, is like the city of Rome in 5 BC.

"The world really is just one village. Our tolerance of disease in any place in the world is at our own peril," Lederberg said. "Are we better off today than we were a century ago? In most respects, we're worse off. We have been neglectful of the microbes, and that is a recurring theme that is coming back to haunt us."

In the end, it seems that American journalist I. F. Stone was right when he said, "Either we learn to live together or we die together."

While the human race battles itself, fighting over ever more crowded turf and scarcer resources, the advantage moves to the microbes' court. They are our predators and they will be victorious if we, *Homo sapiens*, do not learn how to live in a rational global village that affords the microbes few opportunities.

It's either that or we brace ourselves for the coming plague. ☾

Laurie Garrett *is a health and science writer for* Newsday *and* New York Newsday *and was formerly a science correspondent for National Public Radio. She researched* The Coming Plague *as a fellow at the Harvard School of Public Health. Her latest book,* Betrayal of Trust: The Collapse of Global Public Health, *was published in August by Hyperion.*

NOTES

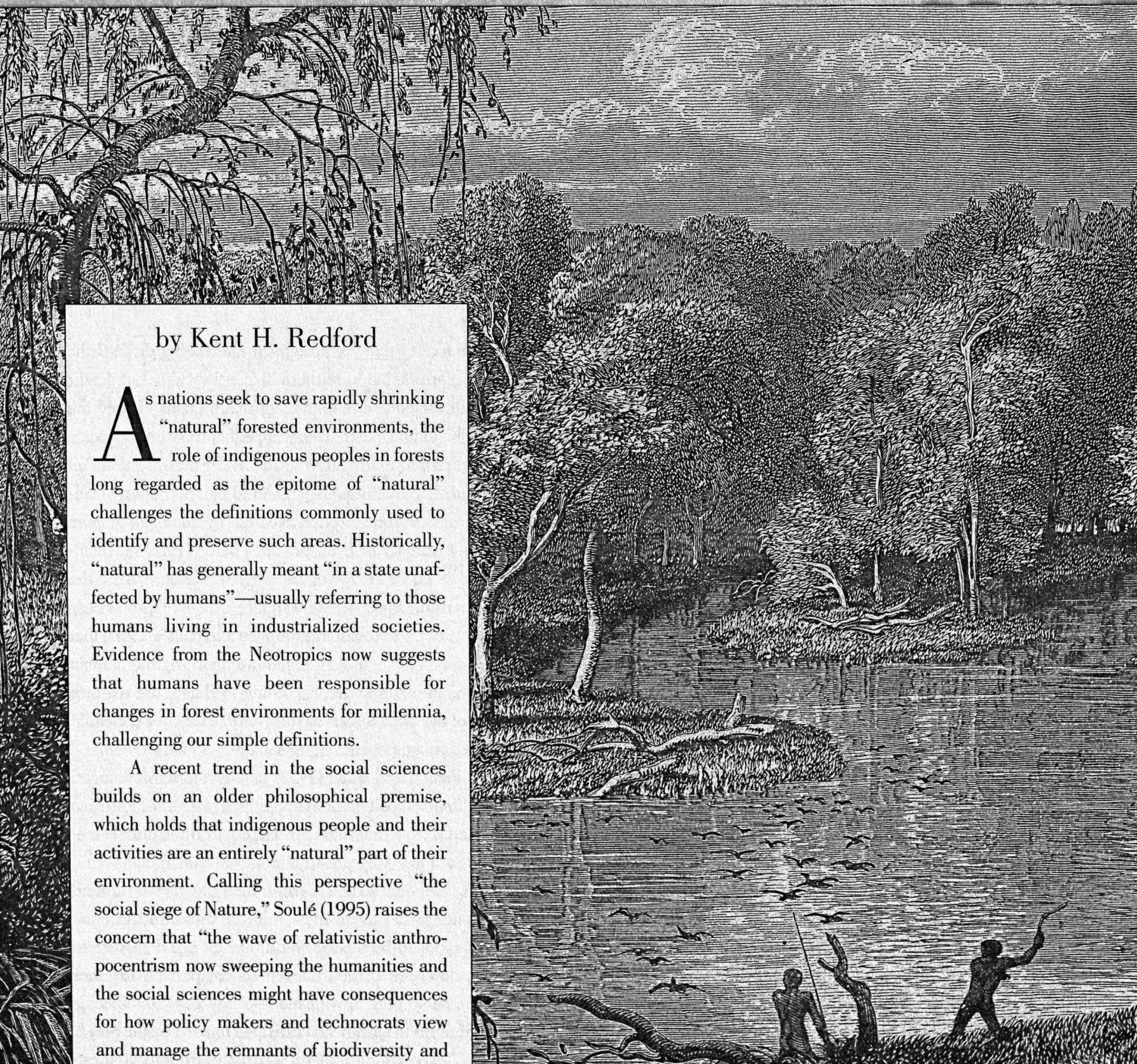
1. United Nations Population Fund, " The State of the World Population," United Nations, New York, 1991.
2. For cogent arguments on the relationship between rapid human population growth and environmental destruction and/or human suffering (warfare, economic despair, human rights violations, low quality of life), see P. Kennedy, *Preparing for the Twenty-first Century* (New York: Vintage, 1993); Population Crisis Committee, "Human Suffering Index," Washington, DC, 1987–93, annually; P. Harrison, *The Third Revolution* (London: I.B. Tauris, 1992); and R.D. Kaplan, "The Coming Anarchy," *Atlantic Monthly,* February 1994: 44–76.
3. COMMERCIAL AIR TRAFFIC

Source: International Air Transportation Association, 1993

	Year	Millions of Passengers
International	1950	2
	1960	42
	1970	74
	1980	163
	1990	280
Domestic, USA	1950	17
	1960	38
	1970	153
	1980	273
	1990	424

4. In addition to human beings, hundreds of millions of animals were shipped from continent to continent annually by 1990. House pets, research animals, thoroughbred horses, breeding livestock, illegally smuggled endangered animals, aquarium fish, and a host of other broad categories of animals were routinely shipped overseas aboard airplanes or ocean liners.
5. J. Lederberg, speech before the Irvington Institute for Medical Research, Bankers Trust Company, New York, February 8, 1994.

Natural Areas, Hunting, and Nature Conservation in the Neotropics



by Kent H. Redford

As nations seek to save rapidly shrinking "natural" forested environments, the role of indigenous peoples in forests long regarded as the epitome of "natural" challenges the definitions commonly used to identify and preserve such areas. Historically, "natural" has generally meant "in a state unaffected by humans"—usually referring to those humans living in industrialized societies. Evidence from the Neotropics now suggests that humans have been responsible for changes in forest environments for millennia, challenging our simple definitions.

A recent trend in the social sciences builds on an older philosophical premise, which holds that indigenous people and their activities are an entirely "natural" part of their environment. Calling this perspective "the social siege of Nature," Soulé (1995) raises the concern that "the wave of relativistic anthropocentrism now sweeping the humanities and the social sciences might have consequences for how policy makers and technocrats view and manage the remnants of biodiversity and remaining fragments of wilderness."

Research by both social scientists and ecologists shows that the impact of indigenous peoples' activities, such as agriculture and hunting, on local flora and fauna can be significant, having both immediate and long-term consequences. Such human activities can alter forest environments from what they would have been in the absence of human activity. Changes in forest cover are the most obvious of these effects and have received a great deal of attention. However, the subtler role of human-mediated changes in the forest fauna has been little studied.

In this paper I summarize what is known about the impacts of indigenous peoples' activities, particularly hunting, on neotropical forest environments. This brief summary is used to frame a discussion of whether or not hunting by humans should be considered a "natural" part of a protected tropical forest park. The paper ends by concluding that conservationists and advocates for local people need to trade unexamined and often politically-based assumptions about what is "natural," for terms that more precisely lay out hopes and goals for the long-term survival of tropical forests and their human and non-human inhabitants. Though this is a subject that has been of considerable interest in the context of North American ecosystems and indigenous people (see Vale 1998 for an excellent example from Yosemite), it has been much less discussed for neotropical forests.

HUMAN EFFECTS ON THE FLORA OF NEOTROPICAL FORESTS

At its most superficial, "natural" can refer to a purely visual impression, describing a quality of landscape involving the topography and flora of a particular place. From this perspective alone, many or perhaps most of the forests that may look "natural"—unscarred by humans—and are currently without human inhabitants have in fact been affected by humans at some point in the past.

A growing body of evidence has been used by scientists to conclude that virtually all neotropical forested habitats have been modified at one time or another by human activity (McNeely 1994). This evidence comes from the study of contemporary peoples (who actively manage forests by selective planting and culling); from the study of anthroposoils and charcoal deposits in soils; from palynology (the study of the structure and distribution of pollen and other spores, from which may be gleaned information about the historic distribution of vegetative communities); and from ethnobotanical studies. Consideration of many of these factors has led several authors to conclude that large portions of the Amazon Basin have been affected by human activity.

As early as 1962, Bennett noted that "it may (also) be inferred that virgin forests in the New World tropics may not exist except perhaps for some remote non-riverine tracts in the Amazon Basin." This conclusion has been echoed in such articles as "Taming the Wilderness Myth" (Gomez-Pompa and Kaus 1992) and "The Pristine Myth: The Landscape of the Americas in 1492," in which Denevan (1992) uncritically concluded that "there are no virgin tropical forests today, nor were there in 1492."

Nor is this conclusion confined to the tropics. Work in northern Europe, eastern Europe, and the United States has demonstrated that much of what we thought were "virgin" forests, wilderness areas, and "ancient forests" are in fact various types of forests regrown after large-scale human clearing or other alteration (Delcourt 1987, Willis 1993). In fact, McNeely (1994) has stated that "very few of today's forests anywhere in the world can be considered pristine, virgin, or even primary." This growing body of work has made clear that many areas that are now under forest cover were at one time or another cleared by humans.

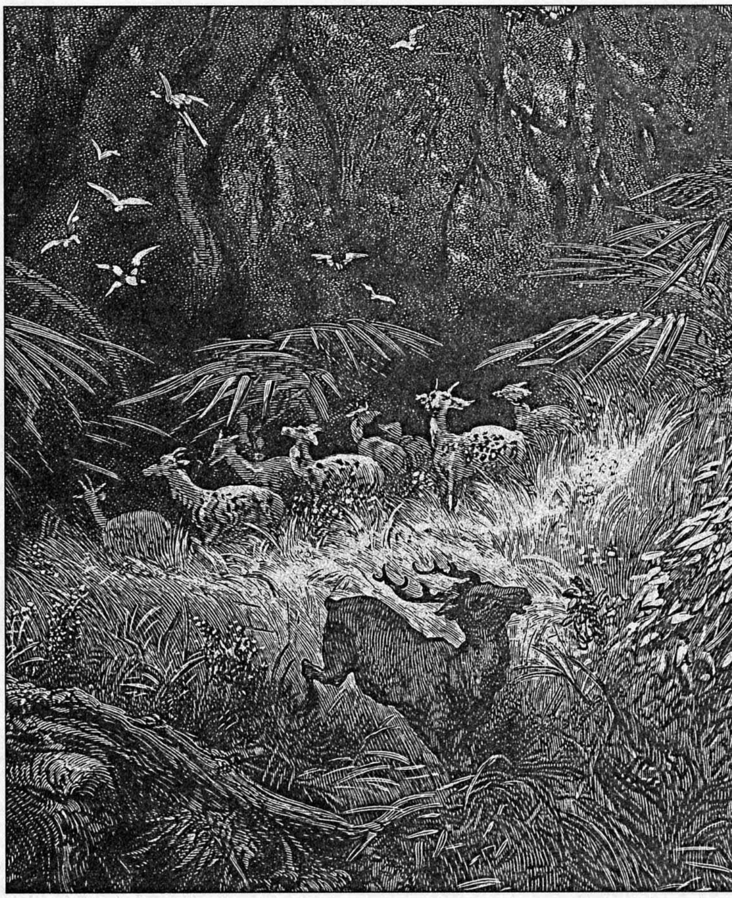
Are the forests that have regrown after being cleared the same kind of forests that were there before they were cut down? If not, is the difference due to the fact that humans cleared the area in the historical past? There appear to be very few data from the tropics that would allow us to answer this question. Yet this is the question that must be answered before properly evaluating claims that forests once cleared by long-ago human action are not primary or even pristine. Balée (1989) has concluded that at least 11.8% of the *terra firme* forests of the Brazilian Amazon, almost 400,000 square kilometers, show continuing effects of past human interference and (Balée 1994) that several vegetation types in Amazonia owe their origin to human manipulation. In other words, according to Balée, the regrown forests are *not* the same forests as they were before being cleared and/or altered by humans.

Gomez-Pompa and Kaus (1992) make a similar argument, stating that the composition of many forests in southern Mexico and northern Central America is in large part a result of selective clearing of forests by pre-Columbian Mayan Indians. In a similar vein, Terborgh (1992) writes that the forests around Tikal, Guatemala, and other sites in lowland Central America that were abandoned by the Maya 1200 years ago demonstrate anomalously low tree diversity, even in comparison to other forests in the same region, with many of the common species now present known to have been cultivated or used by the Maya. He observes, "even after a millennium, plant diversity in these formerly settled areas seems not to have fully recovered." In this quote Terborgh raises a critical question relating to ecological change. He states that the Mayan forests appear not to have "recovered." But, recovered to what? Is there a "natural" condition of the forests of the Tikal region? When you change these forests, do they return to this condition? And how long would this process take? In most cases the forest has been growing on land cleared only a few tree generations ago.

In a thought-provoking essay, Pickett and his colleagues (1992) declared that there is a new paradigm in ecology, one they termed the "flux of Nature" or "non-equilibrium paradigm," in contrast to the previous paradigm of the "balance of Nature" or the "equilibrium paradigm." In this new way of thinking, *process* rather than conclusion is emphasized, recognizing that communities have multiple stable states, and change is a constant. This revised thinking is endorsed by numerous plant ecologists working in tropical forests, such as Primack and Hall (1992), who concluded from their work in Asia that the forests they studied were in a state of non-equilibrium with unstable local populations of some common species and a rapid turnover of rare species.

Similarly, based on their work in the forests of Barro Colorado Island, Panama, Condit et al. (1992) note: "No community of species achieves, let alone remains, in static equilibrium. Species continually wax and wane in relative abundance; they even go extinct locally and remigrate. These changes are due to exogenous (e.g., climatic, geological, and anthropogenic) forcing of the community and to endogenous ecological and evolutionary change." They conclude that the forest of Barro Colorado Island is changing, with some species going locally extinct and others invading to replace them—changes most likely due to a drying trend with its root cause in extensive regional deforestation. Condit and his colleagues finish by stating: "Our results suggest that tropical forest diversity is only weakly self-preserving" and that some changes are irreversible.

Recent work on climate change has shown that the lowland forests of Central America did not develop before 10,000 to 11,000 years BP and in Tikal are probably considerably younger due to Mayan disturbance (Leyden 1984). This means that humans were likely in Central America as the current lowland forests were being formed. But clearly, for their first many millennia in the Neotropics, humans were not capable of altering Central American forests to any great extent. Many important questions remain unanswered. When did significant alteration begin? Was human-induced change different from non-human-induced change? And the question raised at the beginning of this section: Is there a natural condition to which forests return after human activity has ceased? Finally, are these questions of purely academic interest, or do they have contemporary management implications?

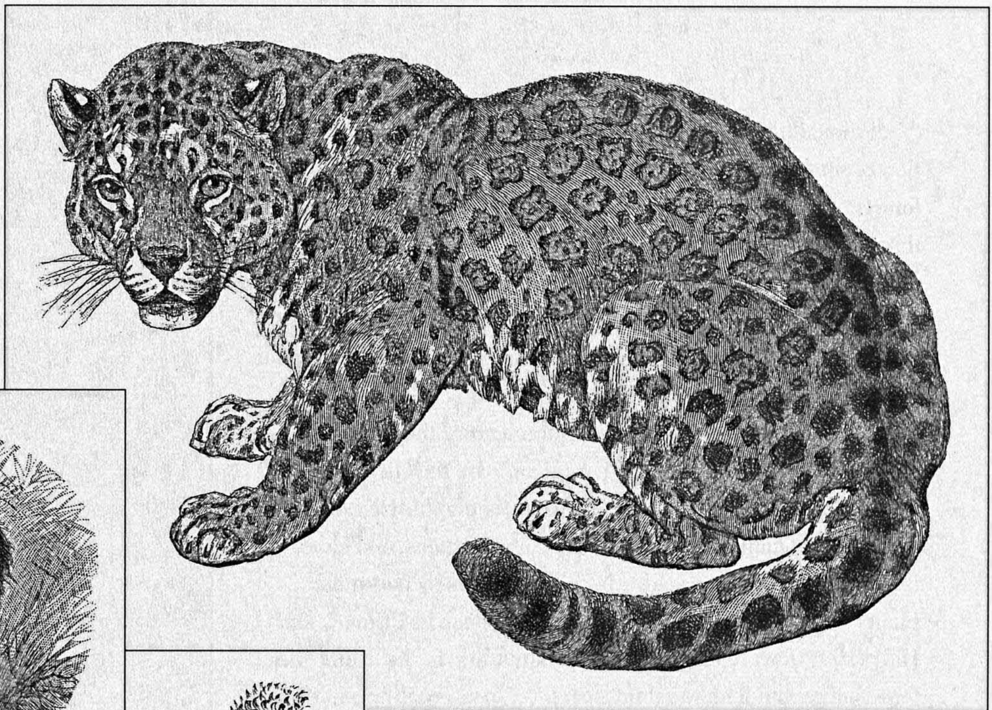


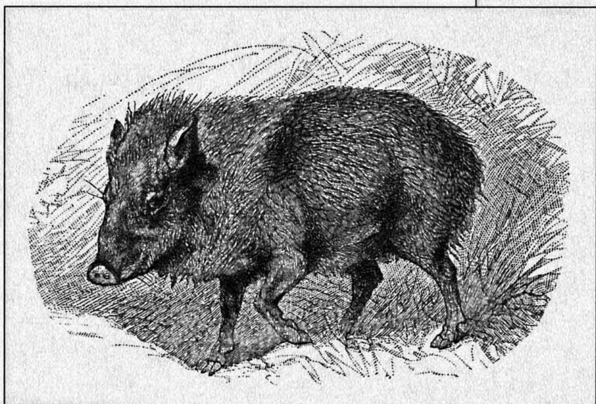
EFFECTS OF HUNTING BY HUMANS

If the desire is to preserve forests that not only look "natural" but also "act natural," then it becomes necessary to assess the interplay between the visible—plants—and invisible contributors—animals—to a "natural" forest environment. Unless our vision of Nature is an empty forest, bereft of large animals, then the long-term survival of the faunal inhabitants is central to forest conservation. Moreover, these faunal inhabitants have some important but poorly understood roles to play in the long-term health of forests.

The data show that large terrestrial vertebrates are key ecological actors, and important as sources of human food. For millennia, humans have been changing relationships among animals and their environments in localized areas through the activity of hunting. Until recently, this process has been buffered by the extent of the forests, and by the nomadic life of many indigenous peoples, a pattern that may have been dictated by the need to seek out new areas to hunt when game decreased in density around settlements. Anthropologists have identified game meat as the limiting resource in many forest-dwelling communities. Hunting may have significant, but underappreciated ecological effects.

What follows is a set of major conclusions reached from studying patterns of hunting in the Neotropics (drawn from Alvard 1993, Alvard et al. 1997, Bodmer 1989, Bodmer et al.





1994, Robinson and Bodmer 1999, Redford 1993, Redford 1992, Jorgenson and Redford 1993, Redford and Robinson 1987, Robinson and Bennett 2000, and references therein). The discussion is confined to hunting in the Neotropics done either for subsistence purposes or for local consumption.

1) Humans have been hunting since they "became human." Not only do they hunt deliberately, but they also hunt when involved in almost all other activities conducted away from the settlement. This pattern is still found amongst most peoples living in areas with reasonable remaining populations of game species and is particularly common amongst those involved in the extraction of forest products.

2) In certain conditions, through hunting, humans are capable of causing game animals to become globally extinct. In the past, this has taken place most frequently in insular settings or, more rarely, on a continental scale, when humans contact large animals that have evolved in the absence of human hunters.

3) Humans can hunt populations of game species to local extinction or to densities much lower than those found in the absence of hunting. There is evidence for this pattern from archaeological deposits in Central America (Cooke 1986) as well as from the Amazon Basin (Roosevelt 1989). There is also a great deal of evidence that this is occurring in contemporary settings. For example, a survey of several studies of contemporary hunting showed that it caused an average population decrease of 80.7% for non-primate game species; of 93.5% for large primates; and of between 73–94% for game birds (Redford 1992).

4) Humans preferentially hunt the largest animals in their area. In the Neotropics, for mammals, this usually corresponds to tapir (*Tapirus terrestris*), peccaries (*Tayassu tayassu* and *T. pecari*), and deer (*Odocoileus* and *Mazama*), and for birds, to species in the Cracid family.

5) Human hunting in the Neotropics focuses on frugivorous (fruit-eating) game species. The diets of many, if not most, of the largest species contain a large quantity of fruit and the selection of large species results in a selection of frugivorous ones.

6) When preferred species become scarce, human hunters will switch to less-preferred, smaller species. Despite this switch, large animals will still be killed when encountered.

7) Game animals and humans eat many of the same things. All forest fruits consumed by humans are also consumed by game species of birds and mammals, and all game mammals, birds, reptiles, and fish hunted by humans are also hunted by large non-human predators.

Examining these seven conclusions suggests that human hunting has the potential to have substantial ecological effects, though some may be subtle and perhaps indirect. These effects would be due to changes in interactions between large-seeded plants, seed predators and dispersers, and the predators of these

jaguar, peccary, and curassow (a Cracid) engravings animal species. It is difficult to unequivocally determine that changes in forest composition were caused by such indirect human activities. But is it possible to detect more coarse-level changes in forest composition caused by earlier human activity?

Hunting of animals is an essential part of human life in neotropical forests, and has been so since humans first occupied this ecosystem thousands of years ago. Human hunting can decrease population levels of game species and cause local extinctions of some species. This effect occurs with relatively low human population densities using traditional weapons and appears to have taken place during pre-Columbian times in areas with higher human population densities.

There is no consensus on this assessment as there are substantial differences in interpretation and understanding of human impacts on the fauna and flora of tropical forests. Underlying these differences appear to be different implicit models of the relationships between human-induced change and non-human-induced change—one of the key components in any attempt to define a natural condition. All available evidence suggests, no matter what model might be used, that animals can have strong effects on ecosystem structure and function, affecting species composition, species abundance, productivity, and nutrient cycling (Huntly 1995). Although not incontrovertible, the evidence from the Neotropics suggests that animals play important roles in structuring neotropical forests. Many of the animals that seem to play the most significant roles in these interactions are important game animals which have been hunted by humans for thousands of years.

In virtually all cases though, clearing of forests for agriculture took place in the same places where humans were hunting. The clearing was not as extensive in most areas as the hunting, but forest manipulation through clearing, weeding, and replanting did extend over vast areas (Balée 1994). This habitat alteration, combined with human competition with animals for forests fruits, undoubtedly also affected populations of game animals.

In sum, humans interacted with game animals in many complicated ways:

- preying on large vertebrate frugivores,
- competing with them, altering their habitat in some ways which negatively influenced population sizes,
- and in other ways positively influencing population sizes (e.g., increasing potential food sources by encouraging and planting fruit trees), and
- decreasing predation levels by killing jaguars, pumas, and other large predators.

These interactions in turn had complicated effects on forest structure and composition through changing patterns of seed dispersal and seed and seedling predation.

All of these interactions occurred under different levels of human density and technology, changing in pattern and scope over thousands of years. They were also all taking place at different temporal and spatial scales. And all of these interactions were imbedded within an ecological setting that itself was affecting, and in some cases was affected by, human actions. It is not a simple question to ask of such a system: What is natural?

PARKS, PEOPLE, AND THE DEFINITION OF NATURE

This would seem to be an ecological question, a question that should be answered by ecologists in collaboration with anthropologists. However, despite claims to the contrary (Anderson 1991), resolution of different definitions of the term "natural" has eluded the scientific community.

As the word Nature can be considered perhaps the most complex word in the English language (Williams 1989) it is no wonder that "natural" scientists have struggled with its definition. Various versions have been proposed, many of which derive from the idea of natural as other than human, including "a process, situation, or system free of human influence"; "the way the system in question would function (or would have functioned) in the absence of humans" (Anderson 1991); and "the spontaneous course of Nature" (Rolston 1979 in Anderson 1991). Those who regard humans as other than "natural" have a clear notion of the existence of Nature independent of human action. To them there exists something called "natural diversity," as distinct from what Angermeier (1994) terms "artificial diversity," which is "generated by any addition of biotic elements to wild systems through direct manipulations by humans."

There is strong scientific support for the statement that there are many scales, many species, and many ecological interactions which have existed and continue to exist outside the influence of human activity. There is *something* that most everyone can agree upon as "natural," in this sense, be it mineralization by earthworms or the impact of hurricanes on Central American forests.

While the most stringent definitions for "natural" exemplified in a "pure state, unsullied by humans" (Random House 1966, in Pickett and McDonnell 1993) may be useful in some scientific contexts, other contexts have given rise to less rigid, more relativistic definitions. A natural ecosystem has been defined as one that "portrays, to the extent feasible, either the same scene that was observed by the first European visitor to the area or the scene that would have existed today, or at some time in the future, if European settlers had not interfered with natural processes" (Bonnicksen and Stone 1982). (This definition would appear to include indigenous people as part of Nature, in a peculiarly eurocentric fashion, in line with a definition from Webster's (1979) establishing "natural" as "Being in a state of Nature without spiritual enlightenment; Living in or as if in a state of Nature untouched by the influences of civilisation and society.")

In many situations "unaffected by humans" actually means unaffected by *industrialized* humans. For example, in the document "Caring for the Earth" published by IUCN, UNEP, and WWF (IUCN et al. 1991), a natural ecosystem is defined as an "ecosystem where since the industrial revolution (say 1750) human impact a) has been no greater than that of any other native species, and b) has not affected the ecosystem's structure."

From this perspective, indigenous people are an integral part of Nature, and are in fact responsible for some of the biodiversity that we might wish to conserve. In other words, there is no such thing as "artificial diversity." This point of view holds that to remove humans would be to condemn certain components of Nature to destruction. To take a stand for Nature separate from humans, according to this perspective, is impossible as there is no difference between the two.

Despite its lack of clarity, natural is a term which is used very frequently, and is often the justification for proscribing specific management protocols (Bonnicksen and Stone 1985) as well as the baseline for measuring human impact on ecological systems (Angermeier and Karr 1994). Related terms, such as "virgin," "pristine," and "primary," are all based on a static view of Nature, one in which Nature remains unchanged until humans intrude and destroy. We have come to understand that this is not the case, that humans have made major ecological changes in most, if not all, forested parts of the world.

But is such change in forest structure caused by humans different from the change that would have been caused by non-human mediated change? Is human-induced change different from "natural" change? Many ecologists, educated under the assumption that humans are "other" than natural, have ignored or deliberately excluded this question from their studies (Shrader-Frechette and McCoy 1995). Ecologists have historically assumed that human actions affect ecological systems in ways different from non-human ecological actors. They therefore assumed that the contrasting scenarios would differentially affect forest composition, measured in terms of all the components of biodiversity: genes, populations/species, and communities/ecosystem in structure, composition, and function. As discussed above, many social scientists interested in this question have argued that there is no difference between the two scenarios. To do so, according to those who believe that indigenous people are part of their natural environment, is to take a stand against forest-dwelling people.

But who are these forest-dwelling people being talked about? On some forested stages they are gone, present solely as ecological ghosts known only from their ancient ecological handiwork—the shapers of the forests of Tikal and Ankor Watt (McNeely 1994). Elsewhere, they are living people with needs, wants, and dreams. These peoples, like many in the rest of the world, are increasingly becoming dominating ecological actors, forced to meet their needs at the expense of their forested homes. These forest peoples are not all content to be seen as guardians of the forest. They have been, and continue to be, interested in bettering their lives and the lives of their children, using the only resources available to them—those of the forest (Redford and Stearman 1993). And as these people pursue their own cultural and economic development, the forests they inhabit will be changed in fundamental ways.

The claim has been made (Balée 1994) that because humans have not been responsible for the extinction (read global extinction) of any animal species in the Amazon after the advent of settled village life, that they are not responsible for major decreases in the biodiversity of the basin. Yet, as discussed above, it is clear that when examining a given piece of neotropical forest, the human activity of hunting usually reduces populations of preferred game animals, at least while the hunting is taking place. Not only are the population sizes of game animals reduced but, increasingly, scientists (Dirzo and Miranda 1990, Terborgh 1988) suggest that the ecological functions (seed dispersal, seed predation, herbivory, pollination, and predation) of these game species are also affected (reviewed in Redford 1992, see also Berger and Wehausen 1991, McInnes et al. 1992, and Wright et al. 1994), thereby changing the forest despite lack of demographic extinction.

It is true that humans have been hunting in tropical forests for millennia. It is also true that data indicate that this hunting has the potential to alter forest structure. At this point we regard the existing forest as "natural"—as if hunting had not taken place and had not affected this "naturalness." Moreover, it is clear that the humans who are currently engaged in hunting in national parks are not the humans of thousands of years ago who (wrapped in a small ecological cocoon of strong interactions) once hunted neotropical forests. In the twentieth century, we cannot afford *not* to distinguish between human change and natural change.

These realizations come at a time when many ecologists are arguing that it is time to accept what Pickett et al. (1992) call the new, non-equilibrium paradigm of ecology which "permits the inclusion of humans in the scope of basic ecology." These authors argue that "once the openness of natural systems and their interaction with natural disturbances are recognized, it is a short logical step to include humans as agents of flux and disturbance in ecological systems." This argument, if accepted at face value, as it has been by many, is troubling for it is without reference to temporal or spatial scale; in effect, it makes human disturbance, no matter how destructive, unquestioningly a part of Nature. Yet, humans are engaged in massive restructuring of much of the Earth's surface, diverting energy flows, moving species around, and now moving genes as well. Pickett et al. (1992) acknowledge this concern, stating that "human-generated changes must be constrained because nature has functional, historical, and evolutionary limits." The challenge is in devising ways to keep these seemingly inescapable human forces from dominating everywhere on the Earth.

Rather than resolving the issue, the extensive research in ecology and social science of recent decades has served to point out that ultimately the definition of natural is a matter of choice, and a matter of power (Redford 1999). It is a relative term, and like many concepts involving land-use issues, its definition is, consciously or unconsciously, political. "Natural" has been defined by those who write history. As Nabhan (1995) has pointed out, what Muir called wilderness, many indigenous peoples called home: "Is it not odd that after ten to fourteen thousand years of indigenous cultures making their home in North America, Europeans moved in and hardly noticed that the place looked 'lived-in'?" Lease (1995) has asked the question: "Who precisely defines 'Nature'—that is, who is allowed to say what counts as Nature and why? These questions are questions of power and privilege." Too often, the answers to key management questions are being decided in political arenas (Smith and Theberge 1986).

Admitting that the term natural is defined in political arenas is not to say that there is no such thing as natural nor that conservation of Nature is a peculiarly quixotic response by a guilt-ridden, capitalist society. On the contrary, despite the strong political dimensions involved in any discussion of what is natural, there remains a core of the issue that is defined by science. Desiring to conserve and preserve Nature, we must look at the evidence that "pure" Nature doesn't exist, and then search for guidelines for the choices that must be made. We must admit that we are not establishing "natural" parks, but establishing parks at a particular state of "natural."

Wooster (1995) has laid out the case for conservation as an effort to protect multiple histories. That is, conservation is "an effort to protect certain rates of change going on within the biological world from incompatible changes going on within our economy and technology…it is an effort based on the idea that preserving a diversity of change ought to stand high in our system of values—that promoting the coexistence of many beings and many kinds of change is a rational thing to do.…'History' has given way to 'histories.' Each of these histories needs space to play itself out, to unwind its narrative."

This concept of conserving what might be termed "natural histories" might also be understood as an attempt to shield the histories of all the other species on the planet from the history of humans. In the Neolithic, humans, like other species, lived in a community of "strong interactions with a relatively few species, weak interactions with many others, but no significant interactions at all with most of the species in the landscapes they inhabited" (Colwell 1989). What has changed most dramatically between then and now is the balance in these types of interactions: now the number of strong interactions with other species has increased explosively and humans "have come to be unique among the species of the earth in having largely escaped (though perhaps only temporarily) from the governance of forces within our component biological community" (Colwell 1989).

Forest-dwelling peoples have inalienable rights which we must respect. They should have rights to hunt, to fish, and to develop or conserve the resources of their land. But we also must acknowledge the potential ecological destructiveness of humankind. Extractive reserves and Indian lands can be important in the conservation of many components of biodiversity, but will not alone protect all elements of living Nature. Such land uses complement—but do not replace—parks and other areas where the millions of other species co-inhabiting the Earth are free to live out their natural histories. ☾

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The Lobo Outback Funeral Home

AN EXCERPT

by Dave Foreman

Mormon settlers had named Hellsgate. It was the gash the Rio Diablo cut through the western face of the Diablo Mountains. To the latter-day saints, the towering pink and gray pillars of rock had marked a portal into another world—a passage from civilization to wilderness, a frontier between Man and Nature, between will-of-the-land and human will.

After leaping free of the mountains, the Rio Diablo meandered to the southwest, creating a mellow valley that had welcomed settlers. Northwest of the valley lay Cat's Paw Mesa—a sweep of grama grass, mesquite, and juniper running up to the toe of the mountains. Southeast of the valley were ridges and canyons spilling off the Apache Peaks—Nana, Victorio, Cochise, and Geronimo. The Apache Peaks rose a mile above the 4500-foot elevation of the valley. Like Hellsgate, they blocked human ambitions. Behind them, the never-glaciated, rounded summits of the Diablo high country stretched up another 1500 feet to top out at 11,000 feet.

The mountains, the river valley, and the surrounding benches and mesas were all part of the Diablo National Forest. In the river valley and nearby benchlands, fewer than a dozen square miles were privately owned. The rest was National Forest land, owned by all Americans, yet nearly all of it was under lease to eleven local ranchers, the biggest chunk to Buck Clayton.

Alfalfa fields, trailers, old homesteads, and the village of Rio Diablo (all on the scattered tracts of private land) elbowed their way into a lush deciduous forest along the river. In this river *bosque*, Fremont cottonwood, Arizona sycamore, Arizona walnut, netleaf hackberry, and Goodding willow grew rank. Actually, the trees only seemed to flourish; along much of the stream ever-present cattle nipped off the tender new shoots of cottonwood, willow, and sycamore as favored delicacies—"ice cream" species in the formal lingo of range science. Few new trees grew to replace the hoary sages nearing bosky senescence. Big live oaks—specifically Arizona white oak—grew back from the river at the base of the bordering mesas and benches. Mesquite and juniper drifted down into the lowlands on the flanks of the hills and terraces.

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illustration by R. Waldmire

Along the escarpment of Cat's Paw Mesa, deep erosion channels cut the conglomerate, a mixture of ancient river cobbles not quite munched into rock but not loose gravel either. Red and white cliffs rain-sculpted into Spanish ruins sprouted helter-skelter in the foothills of the Apache Peaks.

A highway ran west through the valley from road's end at Hellsgate. Downstream and west of town, a small concrete irrigation ditch paralleled the road. Water trickled from it down rows in bright green alfalfa fields between the ditch and the river. Big gray clumps of chamisa and spiky stalks of yellow-flowered flannel mullein grew along the roads. Heavy equipment had been at work in the bed of the Rio Diablo, like biker elephants rampaging on methamphetamines, leaving dikes of cobble and bulldozed earth.

A band of Mormon pioneers had founded the village of Rio Diablo. They spent five years fending off the Apaches. They outlasted Victorio, the last Apache war chief except for Geronimo. But when the United States had established a gentile government, they packed up their families of many wives and many times as many children and trailed south to Chihuahua and a new Zion. Thus they left Rio Diablo to the Texans and their cows.

Through the mid-twentieth century Rio Diablo plodded along as a ranching center and a bucolic resort. An airstrip on Cat's Paw Mesa brought in well-heeled vacationers from the East Coast and California—including a few movie stars and the owner of a major league baseball team—to the Rio Diablo Lodge at the upstream end of the valley beside Hellsgate. They came for refined rusticating—pack trips, fishing, hunting, barbecues, and soaking in the hot springs.

The lodge had closed by the late 1960s. Retirees trickled into the valley. They bought acre and half-acre lots in the *bosque*, built little houses, or set up mobile homes. Carved bleach bottles twirled on their fences. Pink flamingos staked down their lawns. Fruit trees, flower beds, gardens, and a few horses further civilized their ranchettes. In the 1970s, a couple dozen back-to-the-landers moved to the valley. "Hippies," the locals called them.

Three hundred people lived in the fifteen-mile-long Rio Diablo Valley. The 1900 census had tallied five hundred.

Five miles downstream from Hellsgate, where the narrow state highway crossed Calkin Creek over an even narrower bridge, was downtown. The Rio Diablo store, motel, cafe, and trailer park were on the downstream side of the bridge. A quarter mile up the river and highway was the Underwood establishment of trading post, motel, and bar. The village's second bar, the Hereford, was across the street from the Rio Diablo Cafe. It was seedier than Underwood's Beer Joint and drew the rowdies. The Rio Diablo Cafe was the only restaurant in town, although an elderly couple ran a "Snack Shack" in one of the outlying suburbs down the valley. Underwood's Beer Joint had kitchen facilities, but, other than burgers and sandwiches for lunch, hadn't served regular meals in five years.

Jack Hunter's place was north of the highway and across the river on a bench hard against the cliffs of Cat's Paw Mesa. He was a couple of miles west of the village of Rio Diablo. He got up early the morning after meeting MaryAnne McClellan. He had some packing to do—packing he should have done the night before.

The experts who write books on wilderness travel warn against going alone. They tout pricey tents, high-tech internal-frame packs, and gas stoves that roar like Navy jets taking off to smart-bomb Baghdad.

Jack Hunter shucked such advice. This morning, he went down a typed list and checked off each item as it went into its comfy spot in his old, reliable, external-frame Kelty backpack. For food, Hunter took jerky, raisins, nuts, sunflower seeds, whole wheat crackers, and dried fruit. The pack weighed fifty pounds—25 percent of Hunter's weight.

Thus outfitted, he drove eight miles east, where the state highway dead-ended at US Highway 666. Down the river from the 666 bridge into Arizona, the Rio Diablo boxed itself off from civilization once again.

Forty-five miles southeast of the junction was Platoro, the county seat of Cobre County—the county south of Fall, but here Hunter turned north. Thirty miles north of the junction was the Fall County seat, Homestead. With three times the population of Rio Diablo, Homestead was the big town for sprawling, lightly populated Fall County. A sawmill in Homestead was the largest employer in the county, except for the Forest Service.

Ten miles up 666, Hunter took a Forest Service road to the east that switchbacked up the mountains. After following it for twenty-five miles, he came to the little-used Kezar Creek trailhead on the north side of the Diablo Wilderness Area (elevation: 9,128 feet).

One hundred yards down the trail from the parking area stood a wooden sign reading "Diablo Wilderness Area." Beside it was a small metal sign declaring the area beyond closed to motorized vehicles. Hunter put his hand on the wooden sign, breathed in the must of old-growth spruce-fir forest, and whispered, "God, it's good to be home." After three years of roaming the world, of seeking adventure in rainforest, tundra, steppe, and high peaks, he was back home to the mountains that claimed his heart.

He was free for a week. Alone and with nothing to cook, he had no need to build a fire. A ground cloth and tarp would do if it rained, and that was unlikely in June. The remote spring where he planned to camp tonight was twelve miles away—not a tough walk for Hunter.

He turned onto the well-trodden Diablo Crest Trail after five miles. The topographic map said the elevation was now 10,560 feet. He needed to back-track on the crest trail for two miles to find a minor trail that led east and downhill to Mondt Park, twenty-seven trail miles away. A hundred yards down the crest trail, he heard a party of other backpackers. Hunter slipped off-trail and hid behind the trunk of a fat fir. After they passed, he hustled on, hoping he could steer clear of other hikers until he got to the overgrown route away from the crest trail. Humans were not what he was seeking on this trip.

At the beginning of the trek, worries settled down on Hunter's head like vultures on a giant cardón cactus outside a Sonoran chicken farm. They rolled in rhythm with his steps and ate the miles beneath his feet. There was much to chew on. Home, for one. Had he come home? How long would it last?

But hungrier vultures waylaid him in the dusty backways of his mind. They were the vultures he had met as he had tramped through the wild places of the world.

In his mind, they played rat-a-tat-tat like a film by Godfrey Reggio, music by Philip Glass. The Virunga volcanoes in Rwanda, home of the mountain gorilla: Peasants swarm like machete-stingered bees up the slopes. The great Amazon rainforest of Rondônia in Brazil: Ranchers burn thousands of hectares like suburbanites torching fall leaves. The stinking back alleys of Kuala Lumpur in Malaysia: Rotten-toothed hustlers hawk rare birds, cats, monkeys, and snakes like dope peddlers outside an inner city high school. Bustling ports in Sarawak, British Columbia, and Australia: Japanese freighters load up wood chips and thousand-year-old logs like Valley Girls with credit cards at a shopping mall. The killing fields of Kenya and Zaire: Tuskless elephants are strewn about like victims of a shooting spree at an Oklahoma post office. The high polar sea turned blood red: Degenerate sons of the Vikings hack whales into tatsuta-age. School lunches in Japan. The sea blood red...*the blood-dimmed tide*. The world was falling apart.

Everywhere people, people, people. Twice as many today as the day Hunter was born. Most now under twenty years of age. Girls and women with swollen bellies bringing death to the planet. Boys and men chalking up their rank by the number of women they pump up with their pricks.

Behind it all, the grow, grow, grow economies of industrialized nations, mainlining oil, soybeans, beef, pulp, and aluminum like junkies in Zurich's Platzspritz.

Global industrial civilization is a culture of teenaged boys, for teenaged boys, and by teenaged boys. It *is* a teenaged boy. Horny. Hungry. Heedless. Today and only today.

Hunter stopped. He stood in a blue-green-gold meadow of Rocky Mountain iris and goldenpea. Aspen, spruce, and fir fringed it; the sky formed a dome of bright blue overhead.

Somewhere Hunter had read of the psychological numbing that happens when one stands before an immense evil—like the Holocaust. Hunter had so diagnosed himself. The pillaging of the diversity of life was an evil that dwarfed even Hitler's.

Hunter had misdiagnosed himself, however. He was not numbed. Instead he was hypersensitive. He could not read an article or look at photographs about ancient forest logging in Oregon, rhino slaughter in Kenya, or drift netting in the North Pacific....

He chewed on the horror. The horror. The heart of darkness he had found was not the swallowing jungle seen from a steamer on the river Congo, but the baked, stripped hell brought by Komatsu, Stihl, and semen. The heart of darkness was not held by wilderness, but lurked in the breasts of men and women.

Hunter plotted a route off-trail. It would take him across an area of the Diablo National Forest that few people—even serious hikers—knew. Hunter knew it. He and Bill Crawford had found it over twenty years ago when their college wilderness group had surveyed roadless areas on the Diablo National Forest. It was not a spectacular landscape in terms of scenery. Many hikers would have even found it dull: flat to rolling forest and high prairie. Jack Hunter knew better.

During the last two days, he had crossed the Diablo Mountains and dropped two thousand feet down their eastern slope. Now he was on the edge of a sprawling old-growth forest of ponderosa pine and Gambel oak: Mondt Park. This was where he'd been headed.

Hunter sat on a rock outcrop studying his map. He was in the middle of a roadless area more than a million acres in size. This wild fastness sprawled nearly seventy miles east-west and over thirty miles north-south; it was the biggest highland wilderness in the Southwest. The Diablo Mountains, to Hunter's back and right, made up the western and south-central part of the roadless area. Hunter looked east. Thirty miles away another mountain range—the Sierra Prieta—ran north-south and formed the eastern part of the roadless area. Mondt Park and Davis Prairie were the north-central section of the Diablo roadless area. The forks of the Diablo River gathered rain and snow from all directions of the high country; together as the Diablo River they cut a mighty canyon west through the Diablo Mountains.

While the entire roadless area was undeveloped and wild, part of it was wilderness with a small "w"—*de facto wilderness*, or wilderness in fact but not in law. Two-thirds of the roadless area, 803,000 acres, was designated as the Diablo Wilderness Area. Though the Wilderness Area was protected from roads and logging by Congress, the rest of the roadless area—including the northern two-thirds of Mondt Park and Davis Prairie—was run-of-the-mill National Forest land potentially open to "multiple-use"—roads, bulldozers, vehicles, and chainsaws—and, according to MaryAnne McClellan, the bulldozers and chainsaws were poised to invade. This galled Hunter. He had begun his conservation career fighting to include Mondt Park in the Diablo Wilderness Area, and the job still was not done. He counted it as a personal failure that the 1980 New Mexico Wilderness Act had not added the rest of Mondt Park to the Diablo Wilderness. That bill had protected seven new Wilderness Areas and had added land to four existing Wilderness Areas in New Mexico. But the New Mexico congressional delegation had shied away from making additions to the Diablo Wilderness Area. Now the local yahoos were scheming to take away protection for all of it and open it to roads, logging, and god-knows-what.

Despite its lack of full legal protection, Hunter knew that Mondt Park was the wildest part of the Diablo country, which made it the wildest mountain area in the Southwest. It was the center of Hunter's universe. And now it faced destruction.

Hiking through the park-like forest, Hunter came upon a herd of elk loafing in the tall grass and chewing their cuds. He recalled his first visit to Alaska, how, on a backpacking trip through Denali National Park, he had marveled at the bounty of large mammals—moose, caribou, Dall sheep, grizzly bears, gray wolves. Alaska had indeed been the Great Land. Then he had realized that wildlife wasn't that rife in Alaska, that Alaska actually was slim pickings for most critters, that it seemed to be teeming with wildlife only because animal numbers had dropped so sharply in the rest of the United States. Tell a tourist from Kansas—or Ohio, for crissakes!—that it hadn't been long ago that her state had more big game than Alaska, and she would laugh at you. But it was true.

Elk, for instance, thought Hunter. He knew that, once upon a time, there had been five subspecies of elk in North America. One, the Eastern elk, had ranged from Georgia to New York and west to the Mississippi. Despite its wide range and abundance, overhunting and destruction of its habitat by homesteaders and loggers had caused its extinction by the mid-1800s. Three of the elk subspecies survived, although the native tule elk of California was down to a scant sixteen hundred or so (but up from a paltry two hundred). The subspecies native to New Mexico and Arizona, Merriam's elk, had vanished forever as the nineteenth century became the twentieth—not because its habitat had been taken by homesteaders, but because professional hunters had shot it into nothingness to feed mining camps.

Hunter knew that the elk he watched were descendants of a small herd of Rocky Mountain elk from Yellowstone National Park introduced into the Diablo by the New Mexico Department of Game and Fish in the 1950s. He thanked nameless wildlife managers for bringing back the elk after the absence of half a century. But they had done something else, too, thought Hunter. The return of elk had a hidden boon that made Mondt Park the most pristine, healthy ponderosa pine forest in the Southwest. Yes, Mondt Park had never been logged. And, because of its remoteness, Smokey the Bear hadn't been able to keep all the natural, lightning-caused fires from burning. But the third factor in this equation was Mondt Park's healthy bunchgrasses—there had been no cattle here for nearly forty years because of elk.

He knew that about the time he was born, in 1953, the New Mexico Department of Game and Fish had bought the Mondt Ranch. Through negotiations with the Forest Service, the "animal unit months" allocated to cattle had been switched to elk. The state wildlife biologists had believed the survival of the transplanted elk depended on getting the cattle out in order to improve the forage.

Hunter left the elk, following his nose and his compass. Around him, the plate-barked yellow pines reached up 130 feet; some of the gnarled Gambel oaks touched fifty. Skeleton snags of the big trees—dead from age or lightning—were high-rise apartments for birds, insects, squirrels, and bats. When the snags finally found their angle of repose in the duff, the decomposers—fungi, bacteria, invertebrates, what-have-you—melted the carcasses back into the soil to make other trees and bloom the flowers. The journey took centuries.

In this natural forest it was easy to walk without a trail. The big trees grew wide apart. Fire thinned new sprouts. Bunchgrass and bracken fern brushed Hunter's thighs. A flock of wild turkeys scurried away; the tall grass hid all but their heads. Blooming lupine washed a blue tide through the forest. Hunter spooked a great horned owl from a branch. He stood in the silence of its flight.

The elevation dropped from 8500 feet, the ponderosa pines became smaller, and the scattered Douglas-firs melted away. Smaller trees like alligator juniper—so-named for its rough, checkered bark—and Emory oak sifted up into the forest from lower elevations. Over a span of six miles the mesa ran down a thousand feet. Suddenly, a canyon broke the woodland. Its walls dropped five hundred feet to a fork of a fork of the Diablo River called Turkey Creek. Douglas-fir once again grew on the cool, north-facing side of the canyon. Hunter stood on a point of rock above where the canyon widened. A side stream—Stowe Creek—ran into it from the other side.

Hunter worked his way down the buttress of rock to the creek. He and Bill Crawford had camped in this spot in 1972. There was enough daylight left to hike two more hours, but this open streamside park of ponderosa pine and narrowleaf cottonwood was where he wanted to be. After sloughing his backpack, he found a huge cottonwood whose trunk and roots made a wilderness La-Z-Boy. He kicked back against the tree and inspected his home for the night.

Arizona alder and willow crowded the edge of the stream. Poison ivy girded it. Green gentian, larkspur, skyrocket, and tall green grass grew back from the stream in Stowe Creek Meadow. Dark piles of rich earth showed the soil-turning toil of pocket gophers. Like Mondt Park, this riparian meadow had been free of cows for Hunter's lifetime. There was no clover, thistle, or prickly poppy—the plants of cowed meadows. Acorn woodpeckers played flycatcher from a pine snag. Like tiny, feathered baleen whales, violet-green swallows scooped up aerial plankton. Hours later, owl hoots and the bounce of water over cobbles made a little night music. Hunter thought it the perfect campsite.

The next morning, he wandered a mile down Turkey Creek before he found a slope on the opposite wall that promised a route for a man laden with a backpack. The south-facing slope was dry—too dry for ponderosa, but ideal for brushy chaparral. The thick mountain mahogany and ceanothus were a bitch, even for a bushwhacker like Hunter. Though he had been out long enough to be moving like a resident cat, he was glad when he topped out and was back in the ponderosas.

At a little past noon, Hunter came out onto a rimrock. It was a high, windy place overlooking a vast and broken landscape. Twenty miles to the east, the Sierra Prieta walled the horizon. The pines along the ridge lulled him into laziness. Below was the cut of a dry drainage, and beyond was a rolling, grassy plain freckled with junipers and a few stubby ponderosas. Davis Prairie.

He worked along the ridge until a spot said lunch. He dropped his pack and peeled out of his sweat-drenched camouflage shirt. After hanging it and his equally damp boonie hat in the sun, Hunter nestled down into the carpet of needles shed by a wind-ripped Colorado piñon. He pulled off his boots, hung his socks to dry on piñon twigs, and propped up his feet. He leaned against his backpack, which leaned against the piñon trunk. An ancient world stretched out before him. It ran to the horizon and beyond. There was no spoor of Man. It was a landscape with a will of its own. Wil-der-ness: will-of-the-land.

Jack Hunter crunched his mixed nuts; MaryAnne McClellan danced through his skull. He tried to ignore her. A movement outside his head caught his eye. It was up a side canyon, across the dry stream, halfway up the slope leading to the tongue of the mesa. A deer? Hunter focused his binoculars on the place where the movement had occurred. No, it was a coyote...a coyote at her den! There were pups, too. Hunter had seen hundreds of coyotes, but never before had he been treated to watch their home life.

In the shadow beneath the piñon, he was screened so long as he was quiet and made no sudden moves. He unstrapped a lightweight tripod from the outside of his backpack and attached one of his cameras. Hunter was a serious photographer, though far from a Muench or Dykinga. He carried two 35-mm Olympus cameras—Olys because they were the lightest good cameras, and two so he could load one with slow 25 ASA Kodachrome for color-saturated scenics and one with fast 400 ASA Ektachrome for use with a telephoto. Hunter unscrewed the 70–210-mm zoom lens from the camera that had the faster film and screwed on a 500-mm telephoto lens. With the coyotes in the sunlight and with 400 ASA slide film in the camera, he figured he could get the shots he wanted. The coyotes wouldn't hear the shutter release thanks to distance and wind noise.

Hunter clicked off a few shots before he picked up his binoculars for a more leisurely view. He hadn't looked closely at them earlier. Now as he watched them, he realized something was amiss. This was the biggest coyote he had ever seen. There was a ruff of fur around her neck. Coyotes didn't have that. She had shorter, more rounded ears than the high, pointed ears a coyote had. He had first thought it a deer because this critter had much longer legs than a...

Ohmigod. These weren't coyotes. This was a lobo. A lobo and her den of pups.

Hunter lowered his glasses and stared, gape-jawed, where the wolves played. He didn't take a breath for at least a minute. He had never before been so stunned. Wolves.

Wolves hadn't lived in the Diablo for sixty years.

The chatter in his brain shut down. Nothing was abstract. Nothing was intellectualized. Hunter was no longer a Rational Man. He was an animal. His being was being. Not analyzing, not abstracting. Once again, he was truly alive, thoroughly in place. Being. Letting being be.

Hunter's homunculus did not stay quiet long, though. *What's going on here?* he asked. Not just a stray, solitary lobo wandering up from Mexico, this was a female with a den of pups. Four pups, he counted through the binoculars. That meant there was a male somewhere—probably out hunting. Sometime back in the early 1970s, a Mexican wolf had supposedly denned near San Luis Pass this side of the Mexican border in the Bootheel of New Mexico. But these wolves were one hundred and fifty miles north of there. There hadn't been a for-sure wolf sighting in the Diablo highlands since the mid-1930s. The federal government's Predatory Animal and Rodent Control pogrom had cleaned them out like Stalin had cleaned out the kulaks those same years. Species cleansing. Making the West safe for Herefords.

Hunter picked up the binoculars again. They had to be wolves. They weren't coyotes. Hunter called up the memories of all the gray wolves he'd seen—in Siberia; in the Boundary Waters of Minnesota; a fleeting glimpse in Slovakia; the unworried pack in Alaska's Arctic National Wildlife Refuge; the fleeing ghosts in India; the bored, neurotic ones in zoos; the photos in books; the diorama at the Smithsonian.

Wolf! *Canis lupus!*

The photos took on new weight. Hunter shot three rolls of thirty-six exposures, using both the zoom and the longer telephoto, bracketing exposures to ensure some perfectly exposed slides. The photo frenzy finished his 400, but there would be no wildlife sightings to compare with this on the rest of the trip. He also shot a series with his other camera using a normal 50 mm lens. The lobos would be mere specks in these slides, but the country they were in would be shown. He carefully marked his location and that of the wolves on the 1:24,000 scale US Geological Survey topographic map covering this part of the Diablo. He saw from the map that the dry stream course was one of the headwaters of Stowe Creek.

When mama and pups went back into the den for an afternoon siesta, the little man in Hunter's head barked his order. *Okay, asshole, get out of here now before they come back out and see you.*

Hunter threw his gear into his pack and skedaddled over the ridge away from them. It would have been unforgivable to spook them by being there. If they saw or heard him, the mother wolf would possibly abandon the den and try to move her pups. He knew the stress could cause the loss of a pup or even of the whole litter. This litter of wolves had to be protected so it could form a pack and then grow large enough to break into two packs, then four, then...

The evidence from Glacier National Park in Montana in the late 1980s had shown that when gray wolves moved into unoccupied territory and were left alone, births soared, and the new wolves spread out to fill the habitat. Grizzly bears, on the other hand, were slow breeders and could not lift their cub production to take advantage of such a situation. Give wolves a chance, though, and their numbers and range would rebound with startling swiftness.

Hunter realized that this sighting, these slides, this marked map could well be the padlock to shut down the planned logging and road building for Mondt Park that Bill Crawford and MaryAnne McClellan were fighting. Wait until I show these slides to MaryAnne! he thought. She'll have a conniption fit.

Wolves.

Wolves. Hunter's head was awash with the thrill of his sighting as he headed through the huge, ancient trees of Mondt Park into the afternoon sun. With each step through the duff of the forest floor, through the tall grass and ferns and lupine, he spun webs of political strategy: how to use the presence of the wolves to halt all development in the area; how to get Senator Karl Reed to push for adding the wolf-occupied territory in the Diablo Wilderness and to kill Representative Pugh's declassification bill; how to keep the wolves alive and spreading. For the first time since leaving Washington, his conservation heart was pumping blood.

Certain happenings crystallize life and being. The senses climb from the dull plain of mere existence to a howling peak. The wolves had taken Jack Hunter to such a pinnacle. If there was a heaven, this was it. Like Blake's Maiden, the wolves had caught Hunter in the Wild.

The wolf sighting left Hunter soaring and wheeling and *quorking* like a raven in love. It came on the heels of a whole slew of uplifting tidbits: the out-of-the-blue roll in the hay with Jodi Clayton, the flirty evening with MaryAnne McClellan at Underwood's, the primeval jolt of the fight with the Jukes gang, a solitary week in the Wilderness, and further dreams of MaryAnne. Hunter picked at his thoughts and emotions like a scab. The wolves had left him in such a rare state, however, that he didn't try to tease out why he was flying. He was merely feeling good and rolling in it.

The return to his vehicle, to that token of the sights, sounds, smells of the everywhereness of civilized Humankind on the planet, was more painful than usual. After first sighting the truck at the trailhead, he turned around to look at the uncut, unroaded, undammed, untrammeled, unpeopled wilderness—the lobo's wilderness.

A few puffy little white cumulus clouds scouted the high country when Hunter came out to his truck. But later, down in the Diablo Valley, there was only blue, blue and lazy pink as the sun drifted low. The horizon puckered its lips and sucked the sun down into it.

Despite the dusk, Hunter had enough light to see the arrow in the old plank door of his adobe. What the hell? Geronimo had been taken into shackles more than a hundred years ago. The arrow pinned a note to the door. It wasn't from Geronimo, but it was from another tough customer.

> *Hi, Horseshoer:*
> *Hope you got back safely from the mountains. City slickers like you should be careful about traipsing off into the wilderness alone. If you do make it back alive, though, why don't you come over after lunch on Tuesday to shoe my hoss and then we can run together (I know you run—I've been investigating you) and have a swim before I fix you one of my world-famous gourmet dinners?*
>
> *MaryAnne*

Jack Hunter read the note three times.

He fixed tacos for dinner. After a week of dried food, he needed a grease fix and his tacos—hamburger, onion, garlic, and lots of green chile, fried together, folded up with grated sharp cheddar cheese and sour cream in a soft-fried corn tortilla—were greasy. They were also *picante*. He drank a couple of Dos Equis with the tacos—nothing like good, dark Mexican beer to cut the grease off your teeth and quench the fire. Hunter had a four-star rating for New Mexican food: one, if his forehead sweated; two, if his eyes watered; three, if his nose ran; four, if he burned in the morning.

After dinner, he filled a tall glass with ice, squeezed in a quarter of a lime, splashed in two inches of gin, and topped it off with tonic water. He pulled out a good cigar—a Royal Jamaican Maduro, licked it down, and clipped the end. He pulled the dog-eared copy of Aldo Leopold's *A Sand County Almanac* from the bookshelf and went out onto the porch. There was no moon—the new moon was two days away by his reckoning. A host of stars floated over the dark bulk of the mountains. A great horned owl hoot tumbled down the rocky ridge behind the house. Its mate answered. Rodents surrounded. Hunter moved the rocking chair into the window light, leaned back, propped his feet on the porch railing, fired the cigar with a wooden kitchen match, and opened the book to "Thinking Like a Mountain."

In that short narrative, Leopold told about the wolf he had killed in Arizona's Apache National Forest in 1909. That killing ground was only fifty miles northwest of Rio Diablo, thought Hunter. It took no time to find the passage—he had marked it with a hi-liter when he had first read *A Sand County Almanac* twenty-one years ago as a freshman at the University of New Mexico. The print should have been fading from a thousand readings, but the words still stunned like the sudden strike of a snake.

> *We reached the old wolf in time to watch a fierce green fire dying in her eyes. I realized then, and have known ever since, that there was something new to me in those eyes—something known only to her and to the mountain. I was young then, and full of trigger-itch; I thought that because fewer wolves meant more deer, that no wolves would mean hunters' paradise. But after seeing the green fire die, I sensed that neither the wolf nor the mountain agreed with such a view.*

Those words brought the smell of the wolves back to Hunter's nostrils. He saw them frisking around the entrance to their den on the dry, grassy slope. He sent smoke rings up to the stars. He reveled in the sighting for long, nighttime minutes, sloshing it around in his mouth with the gin.

Wolves. I never thought I'd see them in the Diablo, he thought. *Good god. What to do?* If the ranchers found out about them, or the loggers, or the trappers, they would clean them out before the pups ever grew up to mate and produce pups of their own. The good ol' boys of Fall County sure as hell wouldn't worry about the Endangered Species Act.

The road into Mondt Park and Davis Prairie, and the logging to follow had to be stopped.

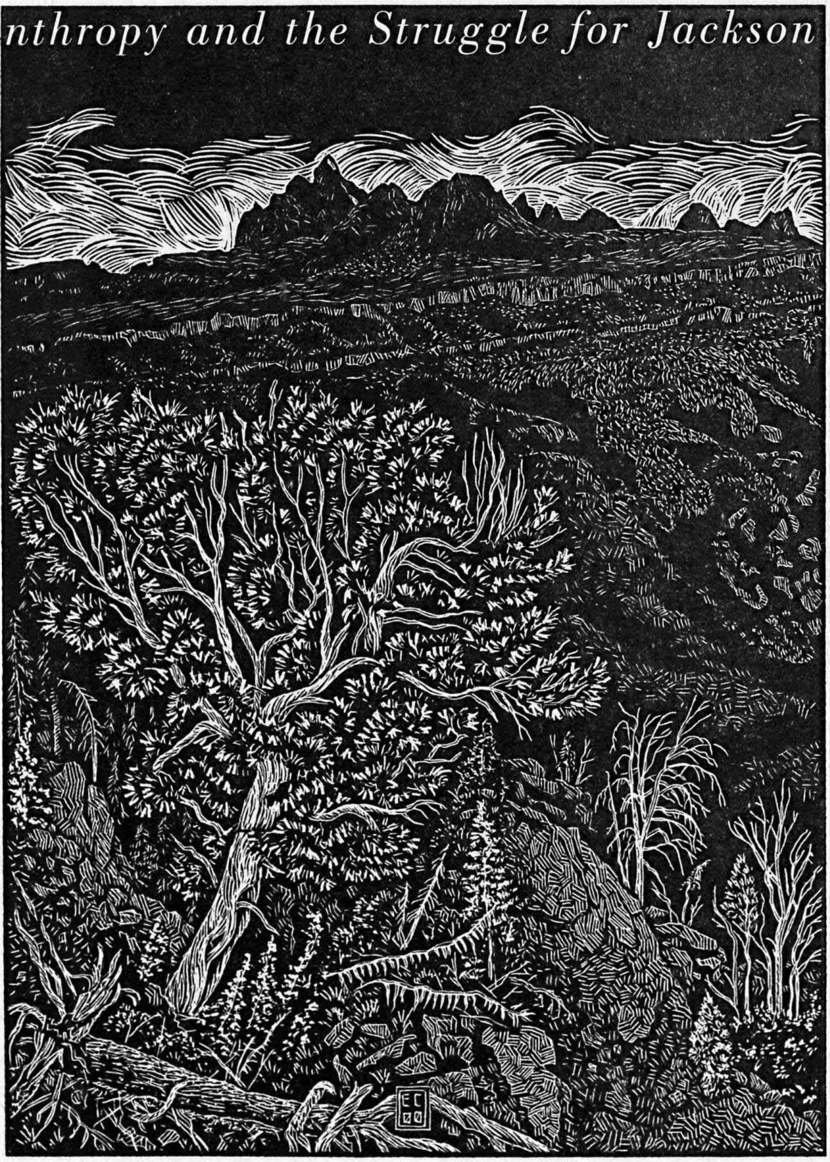
But this wasn't a fight for Hunter. He'd done his part. He'd tell MaryAnne and Bill about the wolves. They could handle it.

Jack Hunter threw the dead butt of his cigar into the night.

One of America's best-known and most experienced conservation leaders, Dave Foreman has worked as a Washington lobbyist for The Wilderness Society, served on the Sierra Club Board of Directors, and co-founded Earth First! in 1980. During the 1990s, he has been publisher of *Wild Earth* and chairman of The Wildlands Project. He is author of two nonfiction books—*The Big Outside* (with Howie Wolke) and *Confessions of an Eco-Warrior*—and is working on a third.

ROCKEFELLER'S CHOICE

Philanthropy and the Struggle for Jackson Hole



Death Canyon, Grand Teton National Park by Evan Cantor

by Robert W. Righter

It required a certain messianic zeal to be an ardent conservationist in the 1920s. In taking a stance against private enterprise and development, the preservationist lashed out against institutions as American as motherhood, apple pie, and the flag. He or she was out of step with the times. The concept that some land should be off limits to human manipulation was a minority view, and few individuals shared Aldo Leopold's rather bizarre notion that humanity had an ethical responsibility to natural communities, "to include soils, water, plants, and animals, or collectively: the land."[1]

This article is adapted from Chapter 4, "Philanthropy and Property," in Robert Righter's book Crucible for Conservation: The Struggle for Grand Teton National Park. *To mark this year's 50th anniversary celebration of Grand Teton National Park, a new edition of* Crucible for Conservation *has been issued by the Grand Teton Natural History Association (www.grandteton.com/gtnha). This excerpt is used by permission of the author and the Grand Teton Natural History Association.*

Furthermore, as an advocate of planning and prediction, the preservationist received little sympathy in the West, a region that often honored the "belief that progress is accidental and miraculous and unplanned."[2] The westerner's close relationship with Nature was to his liking, but it ought not to get in the way of making a living. He loved his streams, valleys, and mountains, but did not feel restrained in the use or abuse of these resources. A handful of preservationists saw the danger inherent in this attitude. In their minds appeared horrific scenarios of masses of people and concomitant commercialism snuffing out Nature and a quality of life that demanded that an intimate experience with wild Nature ought to be every American's birthright.

Surely these visions were held by those who fought to preserve Jackson Hole. The persons who met at Maud Noble's cabin in 1923 were motivated by idealism, but also by fear. Fear that the pristine valley they knew and loved would be overrun in a rapidly changing world dominated by urbanization and industrialization. They were determined that some of nineteenth-century frontier America should remain inviolate. Their convictions were such that they seemed intransigent to those who did not agree with their position. And, indeed, like any zealots, they were.

One who exemplified this passion for preservation was Horace Albright. Raised in the Owens Valley of California at the base of the eastern slope of the Sierra Nevada, he spent his youth in close association with Nature and wilderness. The small town of Bishop, with its grand Sierra peaks just to the west, was a good place to live, and the valley of the Owens River offered agricultural possibilities—until it went dry. It was during Albright's youth that the city of Los Angeles successfully fought local interests to divert the Owens River by aqueduct over two hundred miles southwest. As Albright later lamented, his boyhood valley came "completely under the influence and control of modern civilization."[3] Clearly the Benthamite-Progressive dictum of "the greatest good for the greatest numbers," the rationale with which Los Angeles moralized its insatiable thirst, could work to the disadvantage of the minority—and Nature was not considered in the formula.

Perhaps the loss of the Owens Valley made Albright all the more determined to guard Jackson Hole. Whatever the cause, the designation of the Teton Mountains and Jackson Hole as a unit of the National Park Service became a lifelong project in which he would bring to task all his considerable administrative abilities and his persuasive nature. He would never write or speak with the eloquence of a Henry David Thoreau or a John Muir, but his abilities were, perhaps, more in tune with the twentieth century. He was a superb administrator who knew how to get things done. He was both adept and aggressive in accomplishing his purpose. For some Jackson Hole residents he was too aggressive. Albright always seemed to be one step ahead of them, ready with a sedative for their doubts, a placebo for their fears, and an answer for their objections.

The wellspring of his determination was commitment. For Albright it was simply a matter of time: the inclusion of the Teton Range and the Jackson Hole region into the National Park System was inevitable and tantamount to a national trust. He once characterized the National Park System as the "Nation's Gallery of its finest works of Nature," and leaving the Teton-Jackson Hole expanse out would be like excluding a Rembrandt from the National Gallery of Art.[4]

Just as philanthropy has brought Rembrandt paintings to the National Gallery, it was the charitable instincts of the wealthy that would materialize Albright's dream. John D. Rockefeller Jr. visited Yellowstone National Park in 1924 with his sons John, Nelson, and Laurance. Albright, then superintendent of Yellowstone, met the millionaire in Gardiner, Montana, arranged for him and his family to tour the park quietly for three days, then saw to their departure via Cody, Wyoming.[5] It was the beginning of a lifelong friendship.

This was not the first trip to Yellowstone for Rockefeller. In 1886, as a youth of twelve, he had accompanied his family to the semi-civilized park in the West. Although we have no record of his impressions, he must have enjoyed the wonders of Yellowstone and the Rocky Mountain West.[6] In time he would give from his great wealth so that some of this mountain splendor would be preserved.

In 1924, however, Albright's instructions were that the scion of wealth from the East was not to be burdened with the financial problems of the Park Service in general and Yellowstone in particular. Albright scrupulously observed these instructions, allowing Rockefeller and his family to enjoy the park with special considerations but with no distractions.

The summer of 1926 found John D. Rockefeller Jr., his wife Abby Aldrich Rockefeller, and three children again journeying to the West. After a visit to the Southwest and California, in July they arrived at Yellowstone for a twelve-day stay. Soon Albright was motoring his guests south to the Teton country. The first day they picnicked on a hill overlooking Jackson Lake. Five moose browsed contentedly in the marsh below them. Across the lake spread the majestic Teton Range. It was a day and a view destined to have a lasting impression on Rockefeller.

The following morning they continued south toward Jackson, visiting the Bar BC and the JY ranches, dude ranches owned by Struthers Burt, Horace Carncross, and Henry Stewart, all avid supporters of the plan to make Jackson Hole a national

Horace Albright, 1930

Driving the roads or hiking the trails of Grand Teton National Park, a visitor can't help but marvel at the incomparable mountains, offset and enhanced by the spacious valley called Jackson Hole. It is a horizontal and vertical feast for the eyes. To add to this sublime scenery, the swift-flowing Snake River bisects the hole, a watery ribbon tying the scraggy peaks to the sage-covered valley. By any standard it is a grand exhibit of the finest works of Nature.

Today, it is difficult to imagine any other fate for this valley than as a national park. It seems so natural, so perfect. And yet history reveals that the creation of the park was not easy. The valley provided the stage for one of the longest, most bitterly fought of all American conservation battles. Whereas Yellowstone National Park took only two years from idea to reality, Grand Teton took fifty. The disputes commenced in earnest in 1915. From that date until 1950, rugged individualists, cattlemen, Easterners, "New Dealers," "states' righters," state of Wyoming officials, Forest Service personnel, and Park Service leaders cajoled, struggled, fought, and sued each other. They all wanted control. Thus, although the mountains are clearly the handiwork of natural forces, the park is the design of conservation-minded men and women who patiently worked toward a noble cause in the face of opposition.

Why was this a "valley in discord," as Olaus and Margaret Murie labeled it? There are many explanations, but the presence of settlers is important. Jackson Hole was partially homesteaded long before the national park idea surfaced in the valley. From 1885 on, a few tough pioneers drifted in to farm and run cattle. Often they hunted and simply lived off the land. These hardy folks were not affluent, for this is a harsh, unforgiving land—but it is one which encourages a strong sense of place. It was easy to become attached to the magnificent valley that gave them inspiration as well as a living. Relinquishment of private lands to public ownership would not come easy for many reasons.

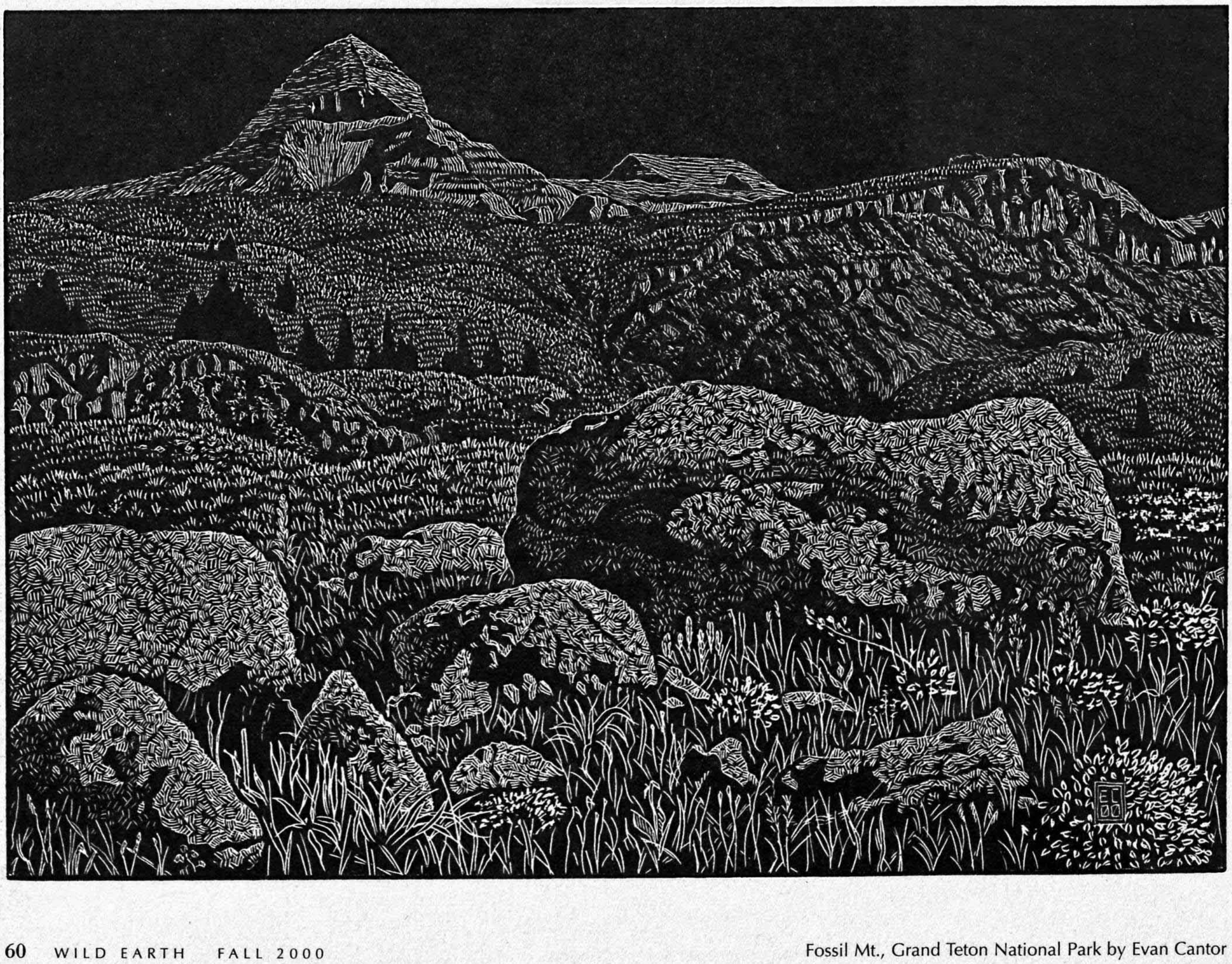
Congress created the first Grand Teton National Park in 1929. Even though it was a small "rocks and ice" park, its establishment came only after controversy, compromise,

CONTINUES

photograph courtesy National Park Service; map: Library of Congress Geography and Map Division recreational area. John and Abby Rockefeller were profoundly impressed by the Leigh-String-Jenny Lake region, but were appalled by the encroaching commercialism. A rather tawdry dancehall seemed inappropriate, "unsightly structures" marred the road, and telephone wires bisected the Teton view. Jackson Hole seemed destined for the ubiquitous uglification coincidental with unplanned tourist development. Mrs. Rockefeller was particularly irate and asked if anything could be done. Visual abuse led to verbal communication and soon Albright was sharing his ideas. Returning to Yellowstone, they stopped at Hedricks Point, a bluff overlooking the Snake River which afforded a magnificent view in all directions. It was here that Albright revealed the concerns of the Maud Noble cabin meeting three years earlier, and the plan to save not only the mountains but also much of the valley spread out before them.[7]

Although Rockefeller was noncommittal, he listened intently to Horace Albright's account of the efforts to save the valley. In truth, it may not have been the first time he had heard of the project. If this was the case, Rockefeller gave no indication. He gave no sign of approval or disapproval, leaving Albright in a state of anxiety. However, concern changed to guarded optimism when Rockefeller wrote from New York requesting that maps be prepared and sent to him indicating the private holdings south of Jenny Lake and west of the Snake River. He also invited cost estimates for purchasing some of the roadside properties on which stood the most offensive structures. Albright was delighted, writing his friend Struthers Burt that Rockefeller was "very much interested in our big Jackson Hole plan."[8] Perhaps the philanthropist they had sought in 1923 had now been found?

The following winter Albright called on Rockefeller in New York, well-laden with maps that detailed the information Albright had thought Rockefeller requested.[9] After spreading them out it was clear that Mr. Rockefeller was not pleased. Later, Albright recalled that Rockefeller exclaimed, "Mr. Albright, this isn't what I wanted from you." A discussion ensued in which Rockefeller made it clear that he was only interested in an ideal and complete project—namely, the big Jackson Hole project which Albright had outlined at Hedricks Point. When the Yellowstone superintendent responded that the



Fossil Mt., Grand Teton National Park by Evan Cantor and diplomacy. Yet many were not satisfied with it, for the valley remained unprotected. Concerned persons such as author and dude rancher Struthers Burt, philanthropist and tycoon John D. Rockefeller Jr., and Yellowstone Park Superintendent Horace Albright realized that by the 1920s the valley had opened to business interests intent on profit. Unsightly commercialism had already intruded, and clearly this was only the beginning. Facing the threat of development, in 1927 Rockefeller committed well over a million dollars to purchase approximately 35,000 acres of northern Jackson Hole land. His intention was to donate this land to the public and thus enhance the original paltry park acreage.

Local people did not react with enthusiasm. The idea that this land would be off-limits to development irked local ranchers and businessmen. Certainly the people of Jackson Hole loved their streams, valleys, and mountains, but they did not put preservation before economic development. Furthermore, the county was already over 80 percent owned by the federal government. More park land meant further loss of property tax revenue. Beyond any tax issues, both the state of Wyoming and the US Forest Service each believed they could do a better job of managing this stunning resource.

Perhaps most important to park opponents was the image of John D. Rockefeller Jr. working with the National Park Service to deprive them of their land. It seemed a perfect example of the colonization of the West by a powerful Eastern capitalist coupled with a federal bureaucracy.

Wyoming politicians and some valley residents resisted the park with all the strength at their disposal. For thirteen years they were successful in delaying park expansion, but finally in 1943 Rockefeller tired of the game and threatened to sell the land if the federal government would not accept it. Given that pressure, Secretary of the Interior Harold Ickes prevailed upon President Franklin D. Roosevelt to proclaim the contested area as Jackson Hole National Monument. Enraged valley residents grumbled that what could not be accomplished through Congress and the democratic process was now mandated through executive fiat. They considered the order "a foul, sneaking Pearl Harbor blow." Wyoming Governor Lester Hunt proclaimed that he would "utilize all police authority at my disposal to exit from the proposed Jackson Hole National Monument any federal official who attempts to assume control." He never carried out his threat, but the *Jackson's Hole Courier* was so delighted with the governor's belligerent statement that it emblazoned its masthead with the quote for four months. It was a bitter time.

By 1949 cooler heads prevailed, and many people and politicians who had opposed the park now realized that their hostility was misguided. Reasonable people recognized that their true "cash cow" would not be livestock, but the millions of tourists that the new park would attract. After a number of compromises, in 1950 Congress established the park that we enjoy today, incorporating lands within the original 1929 park and much of the valley floor purchased by John D. Rockefeller Jr.

In spite of its turbulent history, Grand Teton National Park has become one of Wyoming's and the West's most treasured assets. We honor the park this year on its 50th birthday, eager to share its beauty and history with the nation. As visitors gaze on the scenery, view the abundant wildlife, and appreciate the ecological integrity that the park protects, they should reflect on the dedication of the early conservationists who worked to keep this landscape forever wild. Without their commitment, this valley could—and certainly would—have looked very different.

Just how different? Historical evidence suggests that the road from the town of Jackson to Jenny Lake would have been heavily developed with motels, fancy campgrounds, and fast food restaurants. The first signs were already noticeable in 1926 when Rockefeller put a stop to it. Away from the highway, side roads would weave about to private cabins or "ranchettes" situated on three to five acres. There would be precious little public land and wildlife would be scarce. To the east of the Snake River, Highway 89 would feature billboards and audacious tourist attractions, diminishing the open space and intruding on the Teton views.

Exquisite Jenny Lake would be dammed to store water for Idaho agriculture. As many as 400 summer homes would encircle Jackson Lake (a natural lake until dammed and expanded in 1911), making access difficult and causing serious pollution problems. A small logging operation would be evident at the old town of Moran. Scattered throughout northern Jackson Hole one would find as many as 6000 summer homes, if a 1933 Forest Service plan had been implemented.

Other developments were surely contemplated as men of means, but not necessarily vision, aimed to profit from Jackson Hole. Fortunately, they encountered a philanthropist, an aggressive agency, and local people of imagination who foiled their attempts. Today the park is not perfect, and, indeed, compromises are evident in grazing policies and, particularly, the airport. Yet it is a place which informs and inspires, that features the work of Nature, not—thanks to the efforts of many people—the manipulations of humans intent on profit. —**ROBERT W. RIGHTER** project might cost from a million to a million and a half dollars, Rockefeller assured him that money was not the major consideration. If he was to undertake a project he did not want to do a halfway job. The young Yellowstone Park superintendent was instructed to return with new maps and revised estimates which would reflect Rockefeller's intent to purchase all the private land in Jackson Hole.[10]

Only euphoric could describe Albright's state of mind as he left Rockefeller's office. He had come to New York with hopes that Rockefeller could be persuaded to purchase some 14,170 acres, land all on the west side of the Snake River, at an estimated cost of $397,000. When Rockefeller signaled his desire to purchase the whole northern valley, it was a remarkable turn of fortune. Shortly thereafter, William A. Welsh, general manager of Palisades Interstate Park in New York wrote Albright that he had heard that an ambitious young park service employee had "called on a certain gentleman with the idea of selling him a proposition of about a .22 caliber and found this gentleman willing to consider nothing less than a 16 inch cannon...."[11]

Immediately after the interview Albright posted a letter requesting the necessary information. He was sorely tempted to telephone or wire allies in Wyoming with the good news, but the latter methods of communication offered little privacy in Jackson in the 1920s.[12] Nevertheless, within a month Albright had the additional maps and estimates and was once again on his way to New York.

Within a few days of receiving the material, Rockefeller gave his approval in a letter to his principal advisor and trusted executive, Colonel Arthur Woods. The letter pledged John D. Rockefeller Jr. to purchase "the entire Jackson Hole Valley with a view to its being ultimately turned over to the Government for joint or partial operation by the Department of Parks and the Forestry Department." Specifically, he wished to preserve the big game and the outstanding scenery by eventually having the land added to Yellowstone National Park.

Rockefeller empowered Woods to purchase 14,170 acres on the west side of the Snake River for the price of $397,000, an average of $28 per acre. On the east side of the river, he authorized the purchase of some 100,000 acres at a cost of $1,000,000 or $10 per acre. In typical fashion, Rockefeller then turned over the entire project to Arthur Woods. "I desire to place this entire matter in your hands," wrote Woods' employer, "to plan, organize and carry out."[13] As with so many of his projects, John D. Rockefeller Jr. now considered his direct association at an end, and that his capable subordinates would carry out his wishes expeditiously. However, this was not to be, for, as Rockefeller's biographer stated, before this project was completed it "would bring him many perplexing hours."[14] Perhaps "many perplexing *years*" would be more appropriate. Twenty-three years of debate and political maneuvering between local, state, and federal agencies, and private and public interests would finally result, in 1950, in the creation of the park that we enjoy today.

Most Americans do not know that this place was once a battleground, but perhaps they need not know. Perhaps it should be enough to know that so many people find spiritual and physical renewal in visiting such a place of natural beauty. Yet, it seems important that future generations know that the park commemorates not only the grandeur of Nature, but the spirit of people acting for a noble cause. It is a park not of chance, but of human design. ☾

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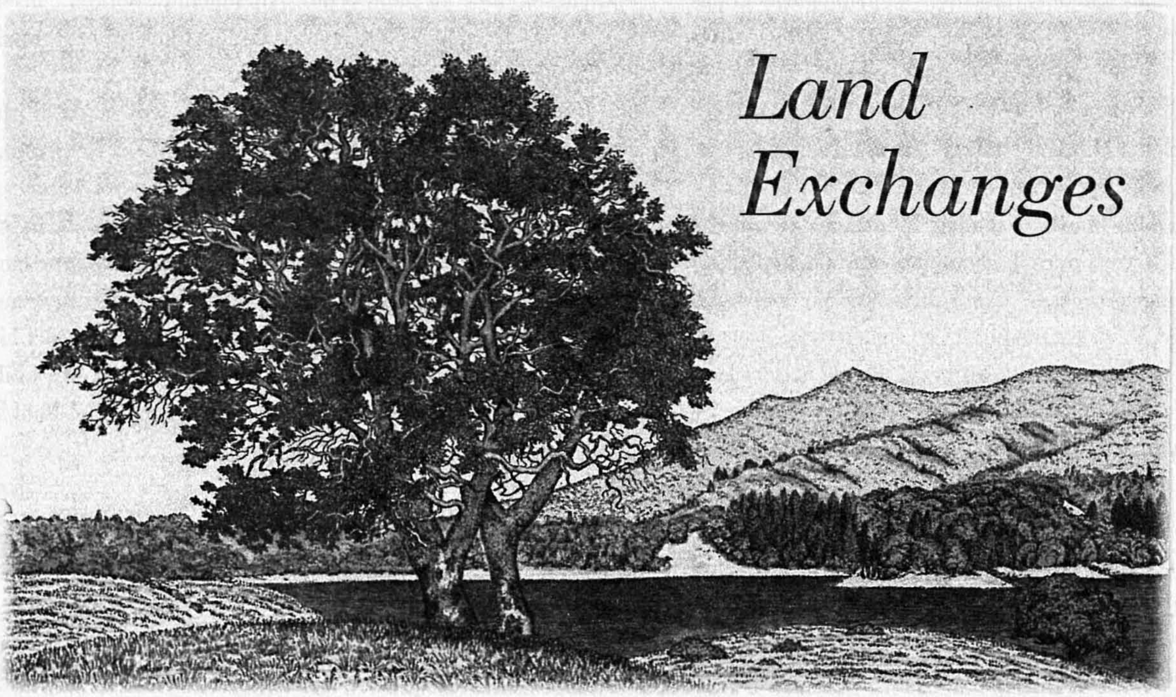
NOTES

1. Aldo Leopold, *A Sand County Almanac* (New York: Sierra Club/ Ballentine Books, 1970 ed.), p. 239. For an argument that natural objects have legal "standing," see Christopher Stone, *Should Trees Have Standing?* (New York: Discus Books, 1974).
2. Joe Frantz, *Aspects of the American West* (College Station, Texas: Texas A&M University Press, 1976), p. 69.
3. Horace Albright to Wilford Neilson, April 5, 1933, in *Mr. John D. Rockefeller, Jr.'s Proposed Gift of Land for the National Park System in Wyoming* (n.p., n.d.), p. 2.
4. Horace Albright to Rose Phelps, undated, File 602.1, Box 461, Yellowstone National Park, National Park Service, Record Group 79, National Archives.
5. Donald Swain, *Wilderness Defender: Horace M. Albright and Conservation* (Chicago: University of Chicago Press, 1970), p. 154.
6. Raymond B. Fosdick, *John D. Rockefeller, Jr.: A Portrait* (New York: Harper & Brothers, 1956), pp. 36–37.
7. Horace Albright to Wilford Neilson, April 5, 1933, in *Mr. John D. Rockefeller, Jr.'s Proposed Gift*, p. 24.
8. Horace M. Albright to Struthers Burt, October 19, 1926, in "Albright–Jackson Hole Correspondence, 1923–1927," National Park Service section, Yellowstone Archives, Yellowstone National Park.
9. Horace M. Albright to Wilford Neilson, April 5, 1933, in *Mr. John D. Rockefeller, Jr.'s Proposed Gift*, p. 25.
10. "Interview with Mr. Horace Albright," by Assistant Superintendent of Grand Teton National Park Haraden and Chief Naturalist Dilley at Jackson Lake Lodge, September 12, 1967, p. 41.
11. William A. Welsh to Horace M. Albright, February 23, 1927, in "Albright–Jackson Hole Correspondence, 1923–1927," National Park Service section, Yellowstone Archives, Yellowstone National Park.
12. "Interview with Mr. Horace Albright," p. 42.
13. John D. Rockefeller, Jr. to Arthur Woods, February 28, 1927, in "Jackson Hole Property," Box 98, Cultural Interests, Record Group 2, Private Archives of Messrs. Rockefeller, New York.
14. Fosdick, *Rockefeller*, p. 309.



Land Exchanges

Sound Management Tool or Invitation to Speculation?

by John Borstelmann

There is no hunger like land hunger, and no object for which men are more ready to use unfair and desperate means than the acquisition of land.

—Gifford Pinchot (chief of the US Forest Service, 1898–1910), *The Fight for Conservation*

For more than a century, land exchanges have been an important land acquisition tool for the public lands agencies of the United States, especially the Forest Service and the Bureau of Land Management (BLM). Land trades have complemented purchases in efforts to consolidate land ownership patterns for easier management and to acquire land valuable for recreation and ecological benefits.

Land exchanges have increased dramatically in number and size over the last twenty years, especially in the 1990s. The Forest Service and BLM complete about 300 land swaps a year, trading away an annual average of 150,000 acres worth $130 million, usually receiving considerably more acreage in return. Between 1989 and 1999 the Forest Service performed 1,265 exchanges worth more than $1 billion, acquiring a net total of 950 square miles (611,000 acres). The BLM, using a different accounting method, completed 2,600 transactions, acquiring a net total of 550 square miles (352,000 acres).

illustrations by Claus Sievert

For two decades Congress has closely held the purse strings limiting land purchases by federal agencies, and private entrepreneurs have discovered the profit potential of land exchanges—although exchanges are required by law to be of equal market value and in the public interest. Investigations by the press and audits by the Inspectors General of the Interior and Agriculture departments in the late 1990s have revealed a disturbing increase in appraisal manipulation, fraud, and abuse of the land exchange process, where private corporations and individuals have profited at the public expense.

Critics across the country, especially in the West where most public lands are and where most exchanges occur, are growing increasingly concerned about abuse of the land exchange process. While some conservationists call for fundamental reform and even an end to land exchanges, Congress continues to deal with land trades on a case-by-case basis, often legislating exchanges as favors for important constituents, typically corporate clients. Timber companies such as Weyerhaeuser and Plum Creek have vigorously pursued land exchanges in the Pacific Northwest and lobbied Congress to pass laws to expedite land swaps. Mining companies, land developers like the Del Webb Co., and ski resorts are the other main players seeking property exchanges.

The most hopeful reform on the horizon is legislation to fully and permanently fund the Land and Water Conservation Fund with $900 million a year, removing LWCF from the annual appropriations fights in Congress and between the president and Congress. This would enable federal land agencies to acquire important parcels without trading away public lands. Bills have been introduced to accomplish full funding of the program, and there is strong bipartisan, nationwide support for this effort to empower federal agencies and states to buy open space for wildlife habitat and recreational use.

THE LAND AND WATER CONSERVATION FUND

Purchase of land is dependent upon the largesse of Congress in appropriating the necessary funds to buy inholdings and other significant land (whereas land exchanges can be undertaken without the political uncertainty of appropriation). Congress created the Land and Water Conservation Fund in 1964 to spend as much as $900 million each year to buy land and water resources for recreation, open space, and wildlife habitat. Oil and gas lease revenues from the outer continental shelf have generated an average of $4 to $5 billion dollars each year since 1965, with a high of $12 billion in 1981. But since 1965, only $3.2 billion *in total* has been spent on land purchases. Most of the revenues siphoned away from conservation have gone to feed defense spending, domestic programs, or the national deficit.

The actual amount available each year depends on the political "budget dance," as Colorado land exchange expert and attorney Andy Wiessner calls the authorization process. Secretary of the Interior Bruce Babbitt condemned Congress's two-decades-long failure to appropriate more money for land purchases in blunter terms. "Thirteen billion dollars evaporated into the deficit, defense, and entitlement programs," Babbitt said during a public speech in Colorado in October, 1999, while promoting the president's new Lands Legacy program. Babbitt said that the Land and Water Conservation Fund:

> *was always an authorization only. At the time it was created, there was, I think, a clear understanding that the appropriations committees would respond to specific appropriations requests up to the $900 million per year cap. That describes a Congressional process that no longer exists. The one missing ingredient was that the trust fund presumed some trust in the United States Congress. It was a big mistake, because that trust has been broken.*

Occasionally, political struggles have elevated national awareness of significant private land parcels enough to stimulate Congress to allocate money to buy those lands. This happened with the New World Mine just outside the northwest corner of Yellowstone and with the Headwaters Grove of old-growth redwoods owned by Pacific Lumber (wholly owned by Charles Hurwitz's Maxxam Corp.) in northern California. Congress granted $699 million in a special authorization to complete these purchases in 1998.

Generally, the process of obtaining funds to purchase land is competitive not only within each national forest and region, but also nationally. The US Forest Service received only $118 million in fiscal year 1999. Perhaps in response to widespread, bipartisan public support for recreational lands purchases, Congress appropriated almost $500 million to the LWCF for the current fiscal year.

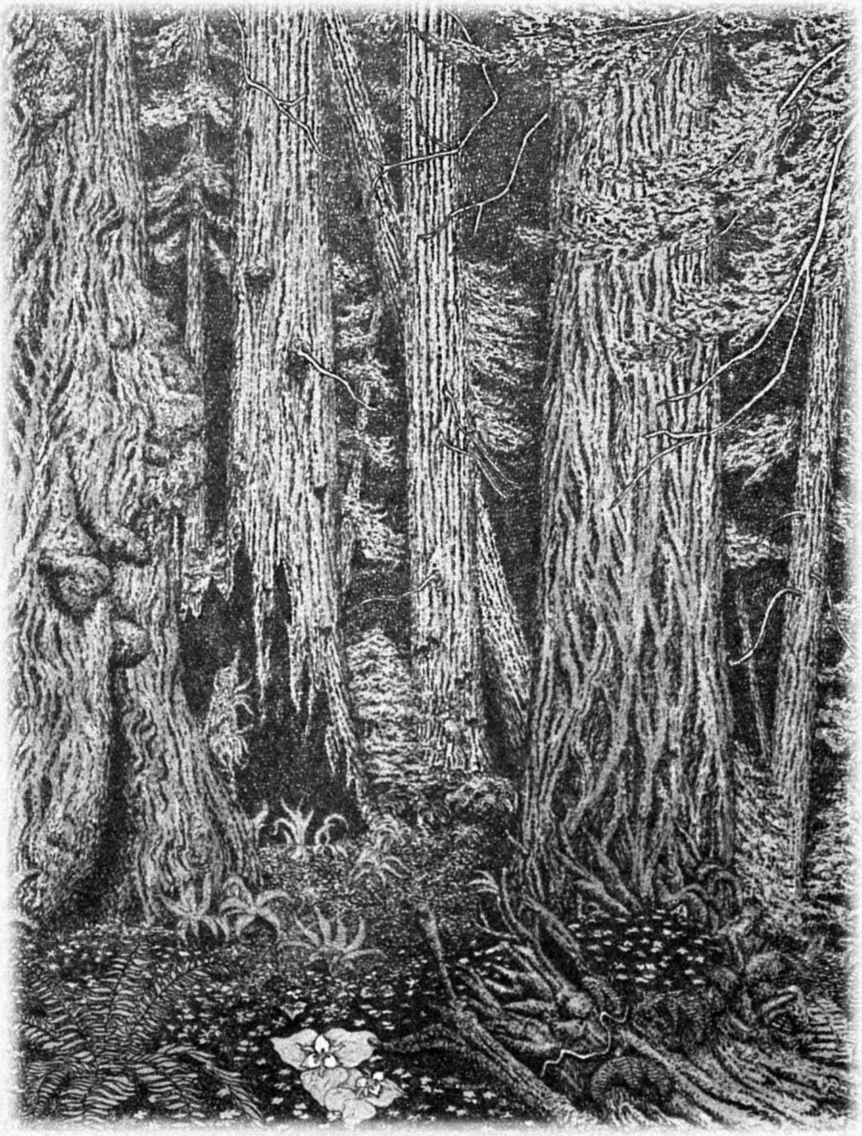
In the last twenty years, Congress has never come close to fully funding the LWCF; appropriations have averaged close to the statutory minimum of $300 million—or less, especially in real dollars, adjusted for inflation. During the Reagan and Bush years, hostility to public lands ownership imbued the executive branch, best exemplified by Secretary of the Interior James Watt's desire to sell off public lands. The deficit demanded money, and the billions in oil and gas revenues became a cookie jar of funds that members of Congress dipped into for pet projects.

"Land exchanges are more and more how we do business, since Congress hasn't seen fit to give us money for purchases of sensitive land," Agriculture Department Undersecretary Jim Lyons, who oversees the Forest Service, told the *Seattle Times* in 1998. "Unfortunately Congress has taken away one of our tools."

In this political climate of limited budgets to buy land, federal agencies have responded by encouraging land exchanges as their only means to acquire inholdings and other important parcels. But Forest Service and BLM managers have often shown themselves ill-equipped to assure that the public interest is served in land trades. Tight budgets have significantly reduced staff; the Forest Service appraisal staff declined from 155 in 1992 to only 64 in 1998. Private landowners have been able to take advantage of loopholes in the exchange rules—such as hiring the appraisers—to maximize their benefit and shortchange the public. Land exchange appraisals in Nevada and California have shorted the public millions of dollars, according to audits in the late 1990s by the Inspectors General of the Interior and Agriculture departments.

THE GREAT BARBECUE CARVED UP THE WEST

Historic government policies that promoted development of the West created "general cartographic chaos," according to George Coggins, a law professor at the University of Kansas. Federal policy centered on disposal of public land to encourage settlement by farmers, ranchers, and miners. Land speculators took advantage of the opportunities with massive fraud and abuse, so much that historian Vernon Parrington called the mid-nineteenth-century free-for-all "the Great Barbecue." More than one billion acres of public land were sold or given away by the early twentieth century.



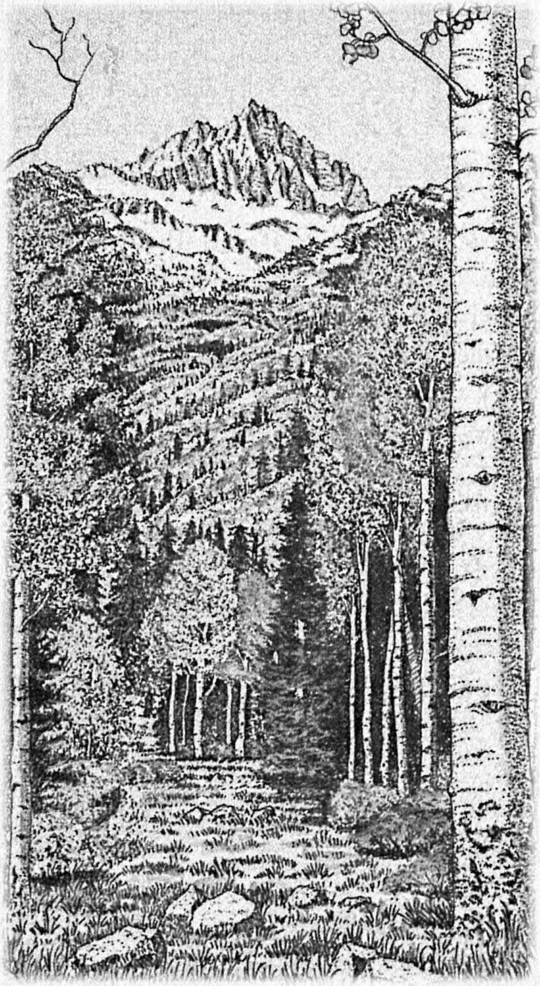
Between 1850 and 1870 Congress created the landscape's checkerboard pattern by giving away more than 90 million acres in alternate sections directly to the railroads and another 35 to 40 million acres in land grants to states to be used by the railroads, showing "splendid indifference to the common public good," according to legal scholars Coggins and Charles Wilkinson.

The Mining Act of 1872 encouraged mining by offering free hardrock minerals and cheap land ($2.50 an acre) to ambitious, industrious prospectors who proved and patented their claims. Mining created a legacy of inholdings sprinkled throughout public lands of the West, especially in remote mountain regions. Many sites are now abandoned, littered with debris, and still generating toxic mine pollution as acidic effluent leaches into streams; quite a few are Superfund sites, a huge public burden to clean up.

The Homestead Act of 1862, the Stock-Raising Homestead Act of 1916, and land grants to western states at statehood also created inholdings within the public lands. Most public lands were withdrawn from homesteading by the end of the nineteenth century, and the forest reserves (later renamed the national forests) were created in 1891 as part of a general revision of land laws. But the Homestead Act was not officially repealed until 1976, when the Federal Land Planning and Management Act (FLPMA) dictated that retention and management were now the foundations of public land policy.

Millions of acres of inholdings—typically high-altitude mining claims and isolated homesteads—are scattered throughout the West, even in national parks and wilderness areas. Congress also granted land to western states at statehood to help subsidize public schools, creating another checkerboard layer.

In an attempt to redress the cartographic chaos, between 1964 and 1994 the four main federal public lands agencies (Forest Service, BLM, National Park Service, and Fish and Wildlife Service) acquired more than 10.8 million acres through purchase (5 million acres), land exchange (3.25 million acres), donation, and condemnation, according to a 1996 Government Accounting Office report. Despite years of land exchanges and purchases, an estimated 50 million acres of inholdings still dot national parks and forests. With the affluence of the 1980s and 1990s, development pressures on inholdings and other ecologically significant private property adjacent to public lands are mounting.



LAND EXCHANGES COME UNDER FIRE

In the 1990s land exchanges that benefit private individuals and corporations increasingly came under fire from local environmental groups in the Pacific Northwest and the Rocky Mountains. The Western Land Exchange Project successfully contested the Huckleberry Mountain exchange in Washington that would have traded old-growth forest for already harvested timber lands, winning an important legal precedent in federal appeals court.

Save Our Canyons, an environmental group in Utah, futilely opposed the recently completed land exchange at Snowbasin ski area, in which Earl Holding, owner of Snowbasin, Sinclair Oil Co., Sun Valley ski resort, and Little America hotels, obtained 1,377 acres at the base of the ski area. The Forest Service had reluctantly agreed to trade 220 acres, but that wasn't enough for Holding, who convinced Senator Orrin Hatch and the Utah delegation to maneuver a bill through Congress in 1996 that ordered a much larger exchange and exempted it from NEPA (National Environmental Policy Act) review.

A leading national critic of land exchanges, Janine Blaeloch, founded an advocacy group, the Western Land Exchange Project, in Seattle in 1996 to monitor public land exchanges and fight for reform. Previously she worked for years writing environmental impact statements for the Forest Service. Blaeloch is convinced that the land exchange process is fundamentally flawed, calling it the "newest liquidation scheme" for public lands. "There is this nebulous but pretty consistent problem with these exchanges," Blaeloch said. "A relationship is created that works to make these deals happen. They really do seem to be foregone conclusions early in the process, so EISs just show what the impacts will be. Just in the nature of land trades, it's always contaminated by private interests."

Blaeloch believes that the process is so prone to corruption that the only real solution is eliminating land exchanges entirely and using purchase as the only tool for federal agencies to acquire land. Short of that goal, she recommends several reforms: making appraisals public as soon as possible, eliminating third party facilitators, eliminating legislated exchanges that are exempted from NEPA, using eminent domain to acquire

The fundamental question about land exchanges rests on conflicting visions of the public lands. Are they a resource best utilized by private parties to maximize gain—the Hamiltonian vision that underpinned the Great Barbecue and strongly lingers today? Or are public lands a sacrosanct commons that should be added to opportunistically, by purchase or trade, to provide maximum protection for wildlife, old-growth forests, ecosystem integrity, and ecological restoration?

land threatened with development, imposing a moratorium on exchanges to allow for a full national-level review of policy, and enacting public land policy that protects old-growth forests and other critical habitat.

In the fall of 1998, the *Seattle Times* published an in-depth series of investigative articles about federal land exchanges entitled "Trading Away the West." The reporters (Jim Simon, Deborah Nelson, Danny Westneat, and Eric Nalder) found numerous examples of abuses—distorted appraisals, trading away old-growth forest for logged land in the Pacific Northwest, and sweetheart deals for the politically connected. Summarizing the problems with land exchanges, the *Seattle Times* concluded:

> *The public often doesn't stand much of a chance in these transactions, which are routinely manipulated by special interests behind closed doors. The manipulators include not only large companies such as Weyerhaeuser, but also land speculators, politicians, even environmental groups. Private parties often propose the deals, select and pay the people who analyze them, then quietly negotiate the details with low-level bureaucrats invested with the authority to literally move mountains from public to private ownership. Just within the Forest Service and the Bureau of Land Management more than 1.5 million acres have changed hands in the past five years (1993–1998), and deals involving 700,000 more acres are pending.* (Seattle Times, 9/27/98)

The newspaper recommended reforms similar to Blaeloch's suggestions—federal agencies should buy land instead of trading for it, sell surplus land in a competitive auction to assure the highest price (something federal agencies are not allowed by law to do now), make appraisals public before a deal is done, involve the public and welcome expert scrutiny, and use land experts of its own to protect the public interest.

POLITICS—NATIONAL AND LOCAL

Land exchanges are starting to receive closer scrutiny politically and legally. In the fall of 1998, both the Forest Service and the Bureau of Land Management created national review teams to evaluate land exchanges worth $500,000 or more in an effort to clean up the abuses. So far the national review teams have not changed the basic process and have rejected only a small handful of proposed land deals. In September 1999, more than twenty environmental groups in the Northwest asked President Clinton in an open letter to impose a moratorium on land exchanges until the process is reformed. This summer, 120 environmental groups from all over the nation called for a land exchange moratorium, based on a new Government Accounting Office (GAO) report. The Clinton administration has not yet responded.

In May 1999, a federal appeals court suspended the controversial Huckleberry Mountain land exchange in Washington State. The court said the environmental analysis had been inadequate, even though deeds had changed hands and Weyerhaeuser's loggers were already felling trees on Huckleberry Mountain, an old-growth forest on the west slope of the North Cascades, southeast of Seattle. Independent appraisers found the original appraisals had been skewed as much as $15 million in favor of Weyerhaeuser. An amended exchange is expected to go through after new appraisals and more thorough environmental analysis.

Only political pressure can sway the decision if the Forest Service and BLM comply with all procedural requirements. According to the law, an exchange must be "value for value" and "in the public interest." As a major federal action, every land exchange must be scrutinized through a NEPA analysis, which requires an environmental impact statement, or at minimum an environmental analysis.

"As long as the Forest Service isn't stupid, the hurdle isn't that high," said Tom Lustig, an experienced litigator in federal courts and agencies for the National Wildlife Federation in Boulder, Colorado. Other experienced public lands attorneys have underscored how much discretion the Forest Service has in performing land exchanges. Attorney Charles White in Denver said appraisals can only be challenged in administrative appeals, not in federal court. The Supreme Court has recognized federal agencies' broad discretionary power in managing public lands, even in the face of evidence that their chosen course of action will not have the least environmental impact (Robertson v. Methow Valley Citizens Council, 1989).

Officially, the federal agencies are not supposed to initiate trade proposals. Yet this frequently occurs, as in the case of the ongoing Grand Targhee-Squirrel Meadows swap in Wyoming that would trade Targhee National Forest land at the base of the ski area on the west side of the Tetons for an inholding of critical wetlands habitat for grizzly bears close to Yellowstone. Federal land managers often seem invested in accomplishing an exchange they have proposed or encouraged. In such cases, public funds and the work of public agency employees are spent processing proposed land exchanges.

Private exchange proponents spend considerable sums of money on environmental analyses, lobbying and marketing efforts, options to purchase land, and other expenses. They may even pay for the appraisals required. For example, Booth Creek Ski Holdings has so far spent about $1 million pursuing the Grand Targhee-Squirrel Meadows exchange in the Tetons. This sort of investment receives notice, and perhaps undue deference, from federal land managers.

Public land and resource decision making all comes back to politics. The major proponents of land exchanges—timber and mining companies—have been lobbying Congress to speed up trades by removing them from environmental review and imposing a deadline of one year to complete an exchange. A 1988 law, the Federal Land Exchange Facilitation Act, streamlined exchange procedures, imposed uniform appraisal rules, and created an arbitration procedure for appraisal disputes. But NEPA compliance is both expensive and time-consuming.

Congress has occasionally legislated land exchanges, such as the Snowbasin deal in Utah, and exempted them from environmental review. Congress generally looks at land trades on an individual basis; members of Congress often get involved to expedite a controversial trade. Legislative sources report that few in Congress are focused on the systemic problems with land exchanges.

Particularly bothersome cases of extorting maximum value from the public, such as Tom Chapman's deals in Colorado, irritate even conservative congressional representatives and senators. Chapman's 1994 swap of a West Elk Wilderness 240-acre inholding for prime development land near Telluride, which he sold within two years for more than four times as much as the appraised value, provoked harshly critical public statements by Colorado's Senator Ben Campbell and Rep. Scott McInnis, both conservative Republicans not known for vigorous action to defend public lands. But no action has resulted. Chapman and copycat entrepreneurs continue to buy inholdings and threaten to develop them.

Land exchange reform seems unlikely, although Rep. George Miller (D-CA), the ranking minority member of the House Resources Committee, has introduced a land exchange reform bill. Miller said: "We need to take a hard look at land exchanges to make sure the public interest is protected. In too many land exchanges the public and the environment are the losers. Clearly something is wrong when we trade away land and then watch developers sell it off for several times what appraisers said it was worth."

Last fall Rep. Miller directed the Government Accounting Office, the investigative arm of Congress, to take an in-depth look at federal land exchanges. This latest GAO report, released in June 2000, condemned the Forest Service and especially the BLM for failing to ensure that land was appropriately valued and that the public interest was protected. The GAO evaluated all land exchanges made between 1989 and 1999, with an in-depth look at 50 trades, to determine how the Federal Land Exchange Facilitation Act of 1988 affected the process. Despite the strong desire of the federal agencies to continue their exchange authority, the GAO recommended that Congress direct the Forest Service and the BLM to discontinue all land exchanges due to "the inherent difficulties" of the process. The GAO report also recommended that Congress direct these agencies to acquire and sell land only on a competitive, cash basis, and concluded that:

> *Both agencies want to retain land exchanges as a means to acquire land, but in most circumstances, cash-based transactions would be simpler and less costly. We believe that the agencies' program improvements cannot address the inherent difficulties associated with land-for-land exchanges and that the agencies' desire to continue exchanges is more than offset by their programs' and exchanges' fundamental inefficiencies.*

Are land exchanges merely a neutral tool for land management or an irresistible opportunity for private profiteering at public expense? Can federal agencies clean up their procedures enough to guarantee that the public interest is served and that exchanges are truly of equal value? Appraising land values is more of an art than a science, and most land trades pose difficulties in finding comparable recent sales with which to determine value. Each case is unique—some trades are clearly benign, while others appear to be fueled by corporate interests grasping for public land that could be obtained in no other way.

The fundamental question about land exchanges rests on conflicting visions of the public lands. Are they a resource best utilized by private parties to maximize gain—the Hamiltonian vision that underpinned the Great Barbecue and strongly lingers today? Or are public lands a sacrosanct commons that should be added to opportunistically, by purchase or trade, to provide maximum protection for wildlife, old-growth forests, ecosystem integrity, and ecological restoration? The United States Congress and the American public are ambivalent about this fundamental question, and often ignorant about land exchanges, so profit seekers continue to play the system for their own benefit. ☾

John Borstelmann *(170 West Rigby Rd., Alta, WY 83422; zimborst@tetontel.com), a Stanford grad and Duke Law School dropout, has worked at almost everything you can do in the mountains—tree thinning, carpentry, teaching, nordic ski instructing and coaching, climbing guiding, etc. He recently gained an MA in journalism in hopes of earning a living as a writer in his "golden years." He follows public lands issues from his home in the Tetons.*

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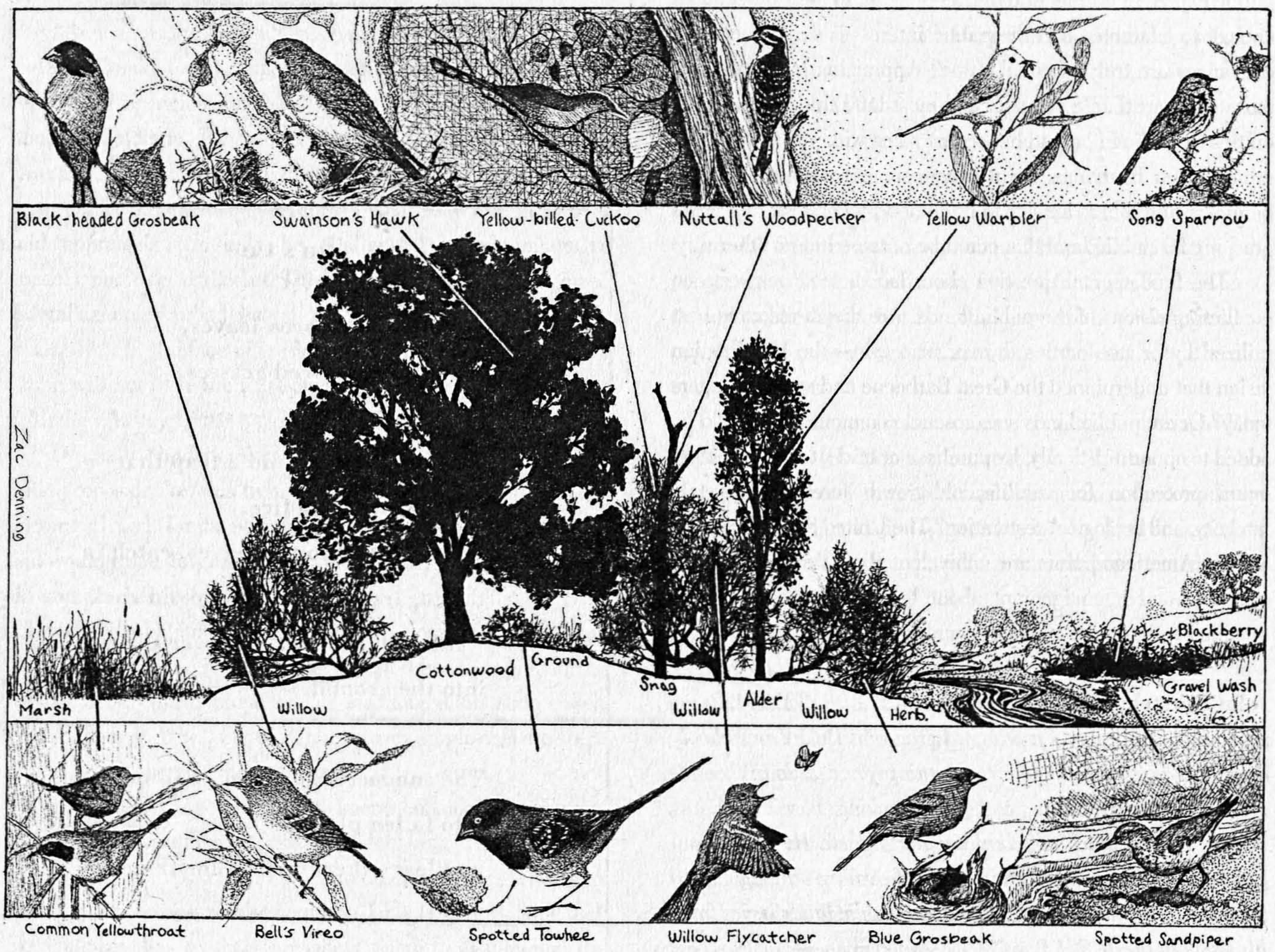
The Taste

The salmon colored leaves,
the salmon colored grasses,
the wind arranged grasses.
The trees have found a trap that
makes food from fire,
catch the sun in the leaves, catch in
the sugars of fruits, heave old rock
through branches, deliver the sun
into the ground.

The summer's last wasps will be eating
into fallen plums,
and leave them opened for the rains
and the winter.
The ground will receive unto itself
the sweetness it will not taste.

—Johanna Barron



Conserving Birds and Riparian Zones

A New Resource for Californians

by Gregg Elliott and Geoffrey Geupel

illustration by Zac Denning

In California, where developers continue to propose building in the floodplains of major river systems such as the San Joaquin, and where Ventura County recently brought suit against neighboring Los Angeles County for a planned 21,600-unit development along the Santa Clara River, riparian zones and the wildlife dependent upon them are under siege. In an effort to provide an up-to-date, science-based picture of the status of California's riparian systems, a coalition was formed of federal, state, and nonprofit conservation organizations. This Riparian Habitat Joint Venture released the first edition of its *Riparian Bird Conservation Plan* in spring 2000.

The plan was developed collaboratively by leading bird researchers in California under the auspices of *Partners in Flight*, an international movement to conserve the migratory landbirds of North America. Recognizing that riparian areas are the single most critical habitat for the conservation of neotropical migrant and resident birds in California, the plan marshals information concerning threats to riparian avifauna and corresponding conservation needs. The conservation plan also highlights the effects of habitat and land use changes on a suite of 14 birds chosen as focal species representative of the full range of riparian habitat types in the state. Analyses of monitoring data on focal and other species, collected in the last ten years at over 350 sites throughout California, indicate:

■ Ten of the 14 focal species have suffered reductions in a significant portion of their former breeding range and 7 of 14 are still declining. Extirpation appears to have resulted primarily from historical loss of riparian habitat, increased isolation of remaining habitat patches, and loss of understory cover, primarily shrubs and herbaceous cover important to nesting birds.

■ Current restoration and rehabilitation efforts throughout the state should seek to increase riparian habitat by restoring natural hydrological processes or by managing dam releases and flood control to mimic a natural hydrograph.

■ Brood parasitism by brown-headed cowbirds and high predation rates by both native and non-native predators are contributing to decreased reproductive success. Both factors are heavily influenced by the structure and diversity of riparian vegetation, including patch size and isolation of remaining riparian habitats, coupled with landscape-scale factors, such as the type and configuration of surrounding land use.

Additionally, the plan proposes specific, yet inexpensive, recommendations to improve the benefits of cultivated riparian restoration (i.e., planting of native species) for landbirds, as well as over twenty-five recommendations on how to adjust land management practices to improve the overall structure and diversity of riparian habitat. Many recommendations concern

A sample of recommendations from the *Riparian Bird Conservation Plan*

- Seek to protect and restore riparian sites that encompass or are contiguous with adjacent upland habitats.
- Plant native forb and sedge species; control star thistle and other "weedy" non-native species to promote a diverse herb layer.
- Retain existing mature or tall trees on restoration sites, with restoration plantings taking place around them, to promote utilization by cavity nesters.
- Connect patches of existing riparian habitat by restoring connector strips of dense, continuous vegetation at least 3–10 meters wide.
- Use a groundcover in orchards and vineyards to discourage foraging by brown-headed cowbirds and increase productivity.
- Postpone mowing until after peak breeding season. If mowing must be done during breeding season, do not allow herb layer to grow thick and tall enough to attract nesting birds (below 6 inches recommended).
- To lessen impacts of year-round grazing in riparian zones, establish relatively wide riparian pastures (at least 200 meters wide in the Central Valley and foothill riparian habitats) that allow for precise management of the intensity and timing of livestock grazing.
- Limit restoration activities and disturbance events (e.g., grazing, disking, herbicide application, and high-water events) to the nonbreeding season whenever possible.
- In sites with dams or other flood control devices, manage flow to allow a near-natural hydrography (i.e., mimic natural flood events) sufficient to support scouring, deposition, and point bar formation. However, time manage "flood events" to avoid detrimental impacts on bank swallow nesting colonies.
- Conduct selective monitoring at key sites to determine the factors influencing nest success of song sparrow, Lazuli bunting, yellow warbler, and warbling vireo.
- Conduct a statewide population/distribution survey every 5 years for the Swainson's hawk and bank swallow, and every 10 years for the yellow-billed cuckoo.
- Develop a series of monitoring and research projects that 1) determine the habitat attributes that affect migratory stopover use and 2) assess how migratory stopover habitat may affect species survival.
- Population source/sink dynamics (and therefore productivity data on bird populations) should be widely recognized as an important criterion for designating priority or special-status habitats, including Areas of Critical Environmental Concern (Bureau of Land Management), Research Natural Areas (Bureau of Land Management), and other Forest Service and Fish and Wildlife Service areas that are specially managed to support biodiversity.

practices that can be cost-effectively implemented on farms and rangelands in California to either directly protect and enhance riparian habitats, or provide a beneficial buffer to riparian zones to lessen the impact of nest predation and brood parasitism by brown-headed cowbirds.

The plan emphasizes that the efficacy of conservation efforts, such as the highly touted Natural Communities Conservation Planning program in southern California, will remain unknown without adequate monitoring of wildlife response. The *Riparian Bird Conservation Plan* makes a case for the utility of monitoring songbirds to assess ecosystem health and the birds' response to restoration, and will be updated regularly as new information becomes available. ☾

Gregg Elliott *is policy analyst and* **Geoffrey Geupel** *is director of the Terrestrial Program at the Point Reyes Bird Observatory (PRBO). PRBO is a member of the Riparian Habitat Joint Venture and California Partners in Flight. For a copy of the plan, consult the Point Reyes Bird Observatory website:* www.prbo.org.

POETRY

Salutatory

—for Bella Hammond

For all the small birds,
chickadees, juncos, swallows,
and the tiny warbler and the sparrow—
friends, with whom I have grown
out of loneliness, as I tend
the garden or gather wood:

I am thankful for your presence,
for the psalm of your taut bodies,
your wings, the words,
your flight, their syllable's
swift echo.

You offer things that cannot
be given, only lent:
a sideways look, a dance,
as you hop from branch to branch,
flashing white and black,
and yellow and blue.

And though I know you are not here
for me, nor I for you, I think
proximity has its own calling;
we share these paths
and this pebbled beach as equals,
fragile creatures, versed
in all that is temporal
and dear in the world.

—Anne Coray

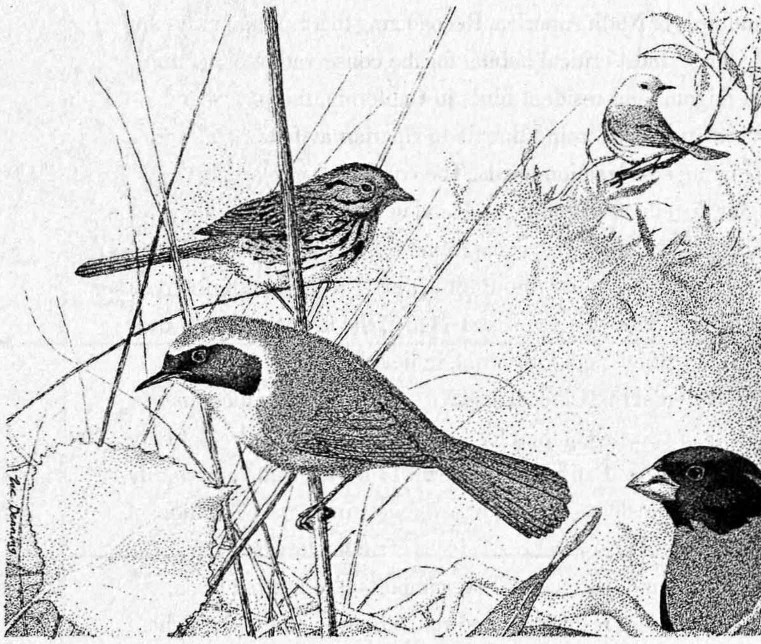
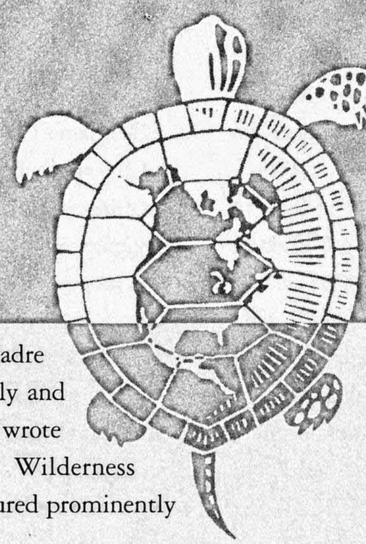


illustration by Zac Denning

The Wildlands Project

Update

BY LEANNE KLYZA LINCK



It is fitting that The Wildlands Project (TWP) released the first comprehensive Wildlands Network Conservation Plan in a room packed full of leading wilderness advocates from around the country; over 120 participants attended TWP's half-day workshop that kicked off this fall's National Wilderness Conference in Denver.

It is also fitting that the first such plan, which is based on the concept of rewilding, addresses the Sky Islands region of southeast Arizona, southwest New Mexico, and Mexico's northern Sierra Madre Occidental—a region that is both biologically and historically rich, about which Aldo Leopold wrote extensively, birthplace of our National Wilderness Preservation System, a landscape that has figured prominently in American conservation history.

The Sky Islands Wildlands Network (SIWN) Conservation Plan is a 220-page prototype for protecting and restoring Nature throughout this extraordinary region. The Conservation Plan includes eight chapters: Introduction and Background; Approach; Ecological Wounds; Mission and Goals; Rewilding; Focal Species; Network Design; and Conservation Plan. The Wildlands Project's approach to conservation planning is distinctive because it is based on healing ecological wounds and rewilding: helping to restore ecological processes across the landscape, particularly natural predation regimes that have been lost across much of North America where top carnivores have been eliminated. The SIWN Conservation Plan crafts a wildlands network design, and also includes implementation steps, monitoring, and evaluation protocols. TWP fully expects to update and revise the plan over the years and is committed to working with our partners in the region to build the coalition necessary to ensure its implementation.

TWP's unique blend of activism and science is reflected in the Sky Islands plan. While scientifically rigorous, the SIWN Conservation Plan also incorporates hundreds of hours of volunteer work organized by our partners at the Sky Island Alliance. Scores of activists conducted research on focal species and truth-checked GIS maps in the field. Hundreds of individuals contributed to the research and final design of the network and conservation plan. Knowledge gained in this inventive process will be shared with our grassroots cooperators and partners across the continent and will expedite completion of similar comprehensive conservation plans throughout North America.

All of us at TWP extend a special thanks to our friends at the Sky Island Alliance, Naturalia (Mexico), New Mexico Wilderness Alliance, and Southwest Forest Alliance.

Leanne Klyza Linck is executive director of The Wildlands Project.

For a copy of the SIWN Conservation Plan, send $35 to The Wildlands Project, 1955 West Grant Road, Suite 145, Tucson, AZ 85745-1147.

The Sky Islands Wildlands Network Conservation Plan

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A Wilder Vision

for the Texas Hill Country

by Christopher Wilhite

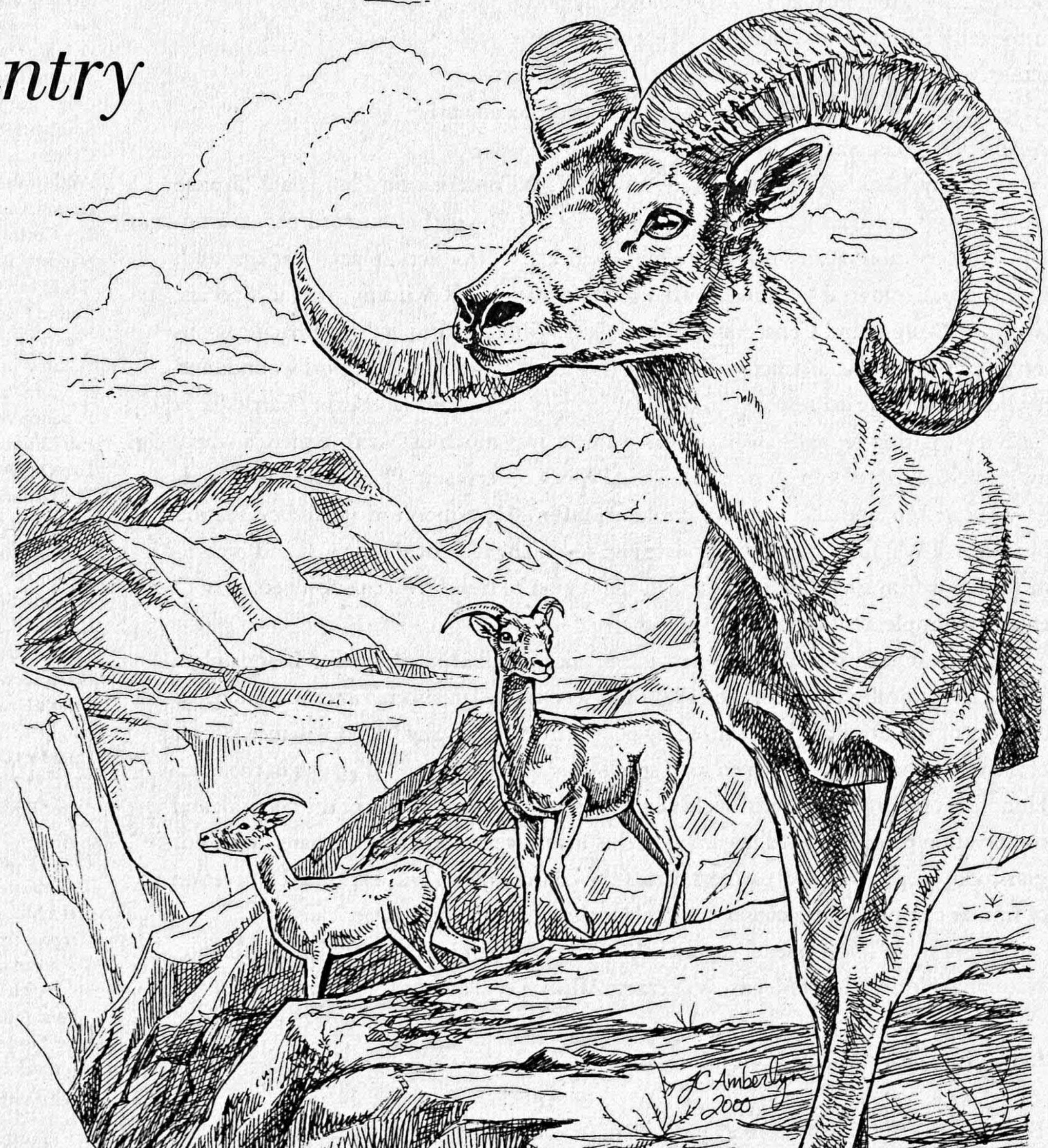


illustration by J.C. Amberlyn

The Edwards Plateau and Llano Uplift regions of Texas, collectively nicknamed the Texas Hill Country, are a vast area of ranches, roads, few large predators, fewer wildlife preserves, and several imperiled species. This large region can be simplified into four distinct subregions: the Balcones Canyonlands, the Lampasas Cut-plain, the western plateau, and the Llano Uplift (see Fig. 1). It is characterized as a subtropical-subhumid to semiarid (Larkin and Bomar 1983) savanna interspersed with thick woodlands and dissected by several rivers (Riskind and Diamond 1988). Some authors (Foster 1917, Weniger 1988, Amos and Rowell 1988) suggest that the vegetation of the region represents a meeting place of four major regions, including the arid mountain West, the eastern woodlands, the Neotropics, and the Great Plains. Indeed, historic faunal assemblages also suggest this area is an ecological melting pot; ocelots, jaguars, gray wolves, bison, pronghorn, red wolves, and desert bighorns are all native to the region. The hill country is also the site of rare karst ecosystems (a limestone geography marked by abrupt ridges, fissures, and canyons).

Unfortunately, this major biological crossroads has also been the canvas of extreme manifest destiny. Livestock grazing and fire suppression have changed the vegetation and have led to a decline in species diversity (Fuhlendorf and Smeins 1997). Most of the large vertebrates have been hunted to local extinction (Davis and Schmidley 1994), and many other endemic species face global extinction from human activity. Urban development along the I-35 corridor has exacerbated this problem as concrete and asphalt now surround most of the karst habitats.

Past conservation efforts have largely focused on single issues and have rarely confronted comprehensive ecosystem problems. Most single-issue actions have involved endangered karst invertebrates or endangered songbirds. While these are extremely important causes, no effective protection for these species—in the broader context of ecosystem protection—has been achieved.

For instance, two native songbirds of the region are federally listed endangered species: the golden-cheeked warbler and the black-capped vireo. The Balcones Canyonlands Conservation Plan (BCCP) set aside a few thousand acres of habitat for these songbirds. However, the land acquired was terribly fragmented and each preserve was near urban development. The songbirds are eaten by small carnivores (including domestic cats), and black-capped vireo habitat is degraded by overabundant deer. The absence of large carnivores has not been confronted as a major obstacle for the protection of these species.

Wildlife preserves in the region are small, few, and far between. The Nature Conservancy of Texas owns some important preserves; Audubon also owns a few small areas, and the state of Texas owns a few "State Natural Areas" and parks. However, all of these combined are too small to provide a complete ecosystem, much less continuity or connectivity between ecosystems. The state is creating some opportunities for private landholders to manage their land for wildlife instead of livestock and still receive the agricultural tax exemption. So far, however, few landowners are taking advantage of such incentives.

THE NEED FOR A RESERVE NETWORK

Each of the problems noted by local biologists and conservationists regarding the hill country ecosystem would be manageable, if not solved, were there a system of interconnected preserves of adequate size. A first step in that direction is to list the region's ecological problems—or wounds—and critique current management plans. A second step is to formulate a vision of future habitat restoration and preservation.

The first major ecological problem is the change in vegetation. The description of the historical vegetation of the Edwards Plateau is charged with controversy. Some believe that the region was once grassy and has over the past century been invaded by Ashe juniper (*Juniperus ashei,* often called cedar) (Foster 1917). This idea is very popular among ranchers who value grasslands and therefore often clear every bit of juniper from their land. Others believe that the entire region was at one time completely forested (Weniger 1988). Still others suggest that the region was once a juniper-oak savanna with the occurrence of woody species controlled by fire frequency (Fuhlendorf and Smeins 1997, Fuhlendorf et al. 1996). We may never know the natural potential vegetation of the region, but the best guess is a combination in which the region was probably heavily forested during wetter times with fewer fires, and mainly grassy under drier, fire-prone conditions.

The Texas Hill Country has been grazed by livestock for well over a hundred years and wildfires have been suppressed for almost as long. Although nobody carefully recorded what the land looked like before that (indeed, few notes were taken and ecology as an observational science had not yet arisen), we do know enough to roughly summarize what has happened to the region's vegetation ecology: As grazing became more common, herbaceous diversity decreased. As human population increased along with the war against fire, wildfires were suppressed and ranchers prescribed fire less. As a result, Ashe juniper, a rather opportunistic native, invaded all this freshly overgrazed soil. To exacerbate the problem, deer became more abundant due to the extirpation of native large carnivores. These native herbivores helped ranchers' domesticated animals chew up almost every plant besides the unpalatable junipers. Oak were reported to have declined in regeneration due to over-browsing (Russell et al. 1996), and anyone can note the injuries inflicted upon many smaller trees, such as Texas madrone, by rutting bucks. Thus, too many cows, sheep, and deer, and the removal of fire and large predators, have degraded this landscape.

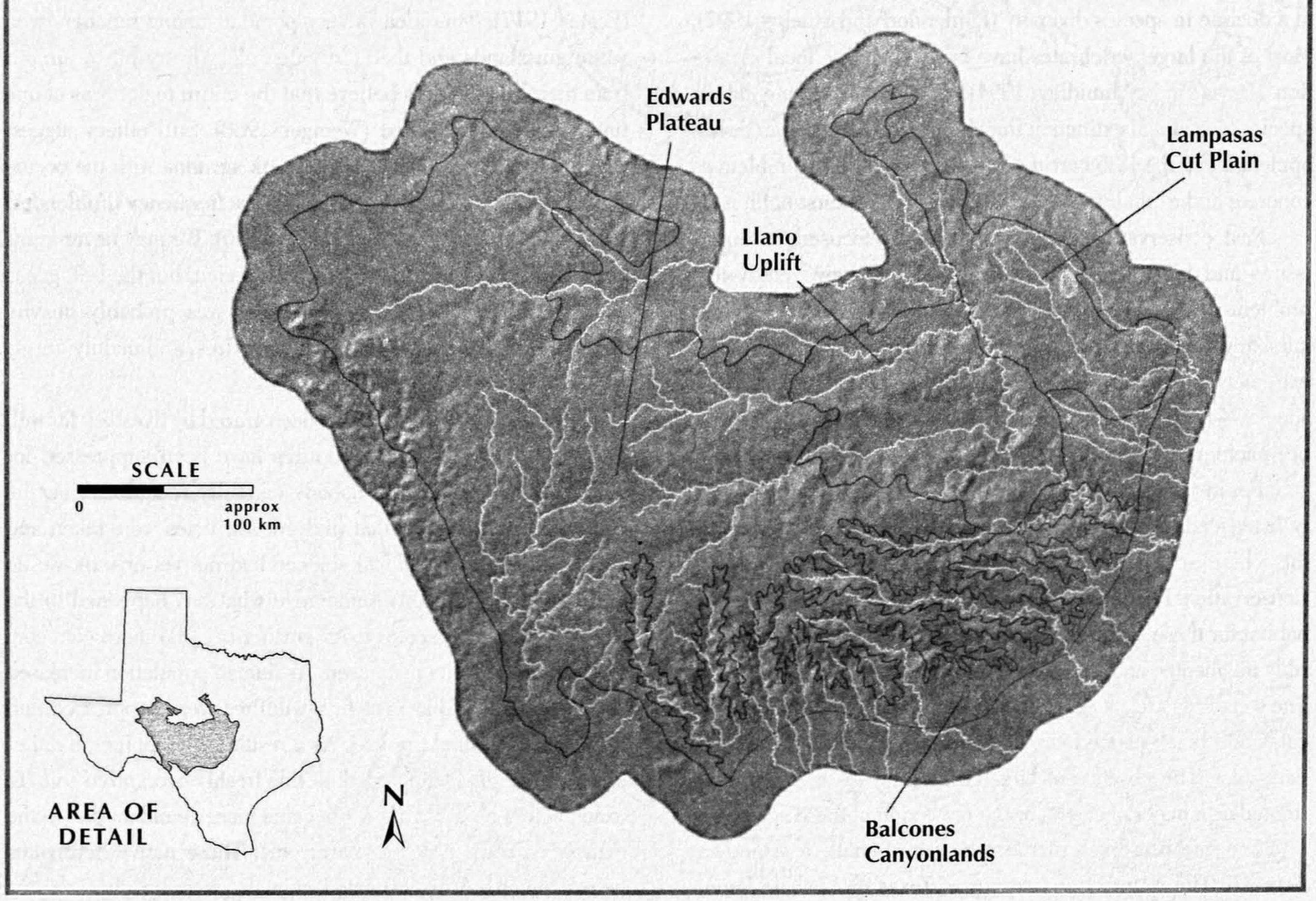
The second major problem, or wound, is related to the first. Native large vertebrates (with the exception of deer) have become rare in the Texas Hill Country. Large ungulates once inhabiting the region include plains bison, pronghorn, white-tailed deer, and possibly desert bighorn. Bison may have played a key role in a regional disturbance regime, grazing areas intensively from time to time and affecting the presence of woody vegetation. Desert bighorn sheep may have occurred in the Devils River and Pecos River areas on the western fringe of the Edwards Plateau (Jones 1993).

Native large carnivores included gray wolf (associated with bison herds), red wolf (associated with the eastern portion of the region), black bear, mountain lion, and jaguar. The last jaguar was killed near Kerrville in 1910, and wolves were eradicated by the middle part of the twentieth century (Davis and Schmidley 1994). Black bears have partially reestablished themselves in the region after having been eradicated in the 1940s. Mountain lions are uncommon, but still hang on in the face of ranchers' gunshot and urban sprawl.

POSSIBILITIES

The difficulties surrounding wildlands restoration in the hill country can seem overwhelming. The region has been heavily influenced by human use, the public lacks meaningful influence over private lands management, and public lands are scarce. Dave Foreman and Howie Wolke (1992) wrote that Texas is the dramatic example of what happens to wildlands when there is little or no public land. Private lands conservation will be central to a successful reserve network in the Texas Hill Country, but effective incentives and a culture of conservation are not yet in place.

Fig 1. The Ecoregions of the Texas Hill Country



map courtesy Hill Country Wild; adapted from LBJ School of Public Affairs, 1978

Data will often be difficult to gather, especially information on endangered species and large predators. Much will need to be assumed from aerial photos, Texas Parks and Wildlife reports, and other non-verified sources.* A US Gap Analysis Project is underway for the state of Texas. Initially, though, informed intuition will need to guide the conservation planning process. Much of our data will be in the form of digital maps (GIS) and will include roads, streams, human population density, existing public lands, and, possibly, privately owned wildlife preserves. This data should suggest possible core areas and corridors.

Once we have established a vision map based on the above data, by connecting wildlife preserves and hypothesizing enlargement or buffer zones, we will be ready to begin the next process: forming an alliance of private landowners, land trusts, and conservationists. Such an alliance would promote the use of private land for conservation, largely through financial incentives. These include land conservation easements sponsored in part and supported by the state; wildlife management agricultural tax exemptions, where a landowner who currently has the ag-tax exemption can continue to receive that benefit if choosing to manage for wildlife species; and "Safe Harbor," a program being used by the US Fish and Wildlife Service to foster conservation of imperiled species on private lands. A wildlands alliance would also encourage an economy compatible with biodiversity, perhaps including high-intensity-low-frequency bison grazing, predator friendly beef, and possibly a bison commons.

These private lands could be pieced together into a cooperative system of wild landscape continuity. The previously mentioned alliance would act as a venue for communication between conservation biologists, conservation activists, landowners, and land trusts. Research would continue within this alliance to ensure that selected habitat blocks and corridors adequately maintain biodiversity. Implementation will be a long-term process, perhaps spanning the next century.

Hill Country Wild (HCW) is an organization founded to initiate the reserve design process for the Edwards Plateau and Llano Uplift regions. Our initial goals are to conduct research projects, including the compilation of several data sets in GIS format; to collect historical and current ecological data; and to reach out to landowners interested in wildlife and ecological preservation. HCW has begun compiling data sets from the Texas Natural Resource Information System (TNRIS) database and others; such data include roads, hydrology (streams and aquifers), public lands, and human population densities. We hope to build rough estimates of road density inside, outside, and between proposed wildlife preserves, natural migration pathways (based on the scientific literature), and possibilities for creating habitat reserve blocks. Then, we can begin to include cooperating private lands into our map. A few ranchers in the region are sympathetic to wildlands restoration and an ecologically sustainable economy.

The restoration and rewilding of the Texas Hill Country may be a long and winding trail (as most are in these parts), but folks here have enough love for the land and common sense to hike the full loop. A little dedication on the part of locals can create a natural wildfire effect of ecological awareness and restoration throughout the regional community. Hopefully this fire will spread outward, influencing conservation efforts throughout Texas. ☾

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* While much of the data originating from the Texas Parks & Wildlife Department is valid, it suffers from a lack of ground-truthing field work, due to the agency's deference towards private property rights.

Myths of Convenience

The golden-cheeked warbler (*Dendroica chrysoparia*) is a federally listed endangered species that breeds only in the juniper-oak forests of the Texas Hill Country (Blair 1950).[1] In this diverse region, life forms endemic to particular forest, meadow, limestone cliff, spring, and karst habitats co-occur with species of more northerly, southerly, easterly, and westerly distributions (Gehlbach 1991, USFWS 1979). Central Texas endemics include at least 76 plant, 8 fish, 11 salamander, 2 reptile, 3 mammal, 1 bird, and 187 invertebrate species (Amos and Rowell 1988, Correll and Johnston 1970, Diggs et al. 1999, Howells et al. 1996, and Ziser, pers. comm.).

Hill country forests deserve highest regional priority for conservation, being second only to the Trans-Pecos in density of rare species occurrences in Texas (Diamond et al. 1997). Forests dominated by Ashe juniper (*Juniperus ashei*), along with ancient post oak- (*Quercus stellata*) blackjack oak (*Q. marilandica*) forests of the adjacent Cross Timbers, are legitimate old-growth associations in desperate need of protection (Diamond 1997, Stahle and Herr 1984).

Preservation of hill country endemics and old-growth forests is closely tied to preservation of the forest-dwelling golden-cheeked warbler. United States Fish and Wildlife Service Recovery Plan objectives for this species demand creation of eight core conservation areas, protection of habitat on public lands, and maintenance of interconnecting dispersal corridors (Beardmore et al. 1996, Keddy-Hector 1992). Fulfillment of these objectives also sets the stage for preserving mountain lions and restoring extirpated species such as black bear, timber wolf, and perhaps also ocelot and jaguar. Achieving this ideal is complicated by problems of perception, misconception, mythology, and a local "science" of convenience that strives to make needs of rare species compatible with needs of dominant game and range management interests.

GUILT BY ASSOCIATION

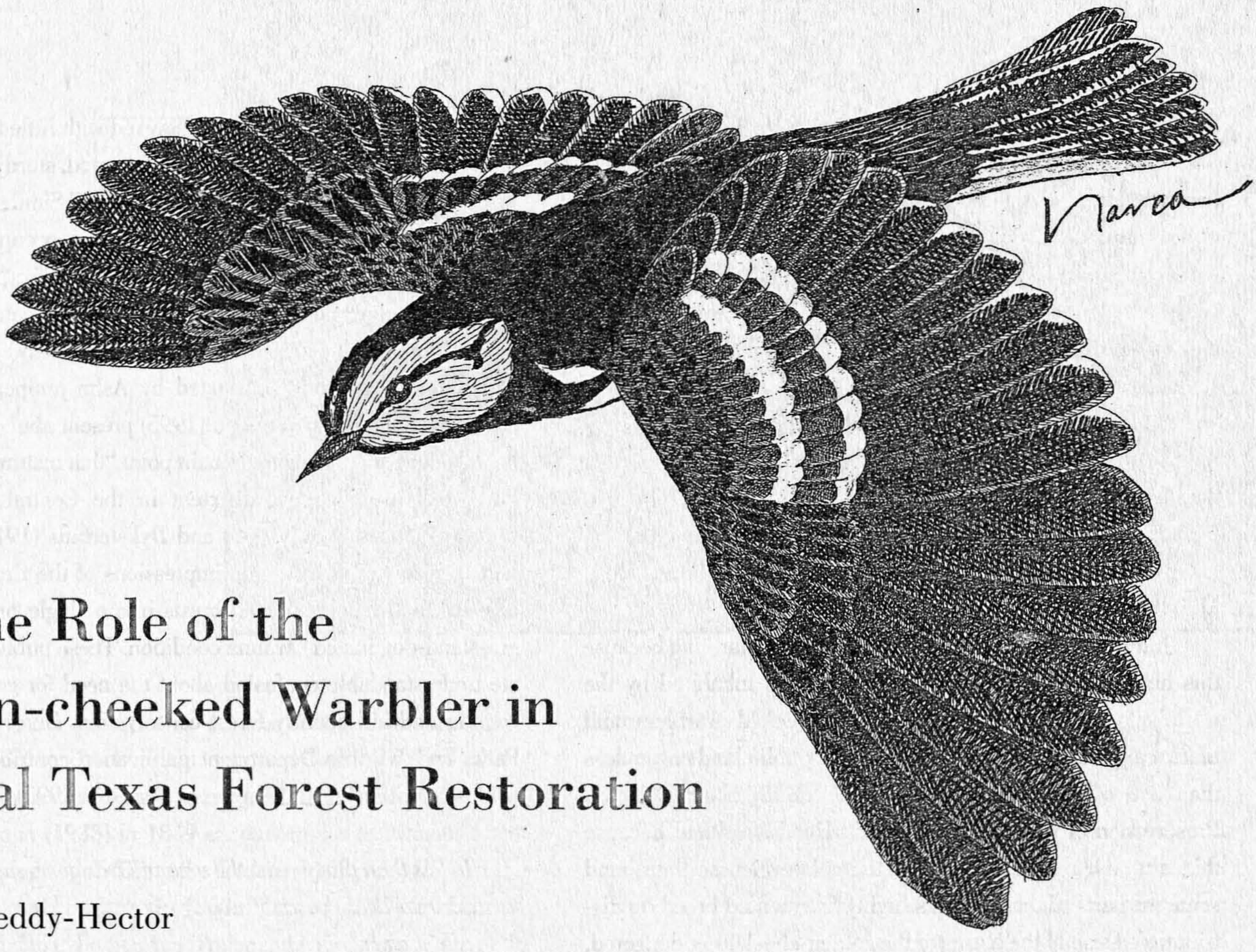
A deeply entrenched tradition of prejudice against Ashe juniper and expansive hill country forests undermines warbler conservation. Golden-cheeked warblers are dependent on juniper trees for foraging and nesting sites and on shredded juniper bark for nesting material (Attwater in Chapman 1907, Beardmore 1994, Pulich 1976, Kroll 1980). Junipers indirectly benefit golden-cheeks by readily recolonizing cleared land, burned areas, and other disturbed sites. These attributes do not endear juniper to ranchers, game managers, and real estate developers who consider the species a noxious competitor.

Locals accuse juniper of degrading rangeland and wildlife habitat, stealing water, promoting erosion, being an allelopath (producing chemicals that are toxic to other plants), reducing biodiversity, increasing risks of forest fire, causing human allergies, and even of being an exotic species. Most of these accusations lack scientific merit or require careful qualification (Belsky 1996, Slaughter 1997). That juniper pollen causes allergies may be the only incontestable point. Uncritical acceptance of anti-juniper mythology has demoted Ashe juniper from a highly valued source of timber products—for fence posts, timbers for log cabins, railroad ties, charcoal, wood for cedar chests, and even perfume essence—to a "noxious" species, best eradicated.

In the mid-nineteenth century Roemer (1935) described local juniper forests or "cedar brakes" as "a treasure to the colonists of New Braunfels, since the wood was preferred above all others on account of its durability when used in building houses and fences." Wimberley (in Schawe 1963) called these forests "nature's cathedrals." But perceptions changed as demand for juniper products and open space fueled repeated bouts of deforestation. By the turn of the century, juniper harvest involved widespread clearcutting (Bray 1904). In the 1920s and 1930s two to three trains per day left Real County carrying as many as 40,000 cedar posts per shipment (Huss 1954). Not surprisingly, the local saw mill industry declined as overharvest depleted the supply of the large junipers used for squared-off framing stock (Wimberley in Schawe 1963).

When government-subsidized cedar eradication began in the 1930s, one county agriculture extension agent wrote that "Some writers have an idea that the cedars are valuable and should not be cut, others know their awful damage and are working to rid the range of every specimen" (Jenkins 1939). One of Jenkins's justifications for juniper extirpation was the belief that junipers steal water from the rancher. This belief has been used

1. Hill Country or Balcones Canyonlands is the most dissected portion of the Balconian Biotic Province (W.F. Blair, 1950) or Edwards Plateau. This bioregion also includes as subregions the Lampasas Cut-plains and Central Mineral Region.



and the Role of the Golden-cheeked Warbler in Central Texas Forest Restoration

by Dean Keddy-Hector

to justify modern juniper removal projects (Eddleman and Miller 1992). Agencies reinforce this idea by simplistically extrapolating huge predicted water gains from maximal transpiration rates of individual junipers (Hibbert 1983). Apparent verification comes from short-term juniper removal "studies" that rarely acknowledge interpretive limitations created by confounding factors, and the short-term nature and narrow focus (on maximizing run-off) of these projects (Dugas and Hicks 1994, Thurow and Taylor 1995).

These studies fail to admit any possible beneficial role of junipers in nutrient cycling, erosion control, infiltration enhancement, and soil formation. Under some conditions junipers may also increase local precipitation via phenomena like fog drip that in some parts of the United States account for 40% of total annual precipitation (Harr 1982, Lovett et al. 1982). These studies also admit no potentially deleterious impacts of landscape-scale deforestation on regional climate, boundary layer effects on evapotranspiration, and wholesale release of greenhouse gases from burned slash (Shukla and Mintz 1982, Waring and Schlesinger 1985).

No one warns landowners that increasing precipitation directly reaching the ground is not desirable in a region where moist maritime air masses interacting with the hill country's uplifted topography create some of the most intense short-duration rainfall events in the world. One such storm in 1998 produced 20 inches of rain in less than 24 hours. A 1935 storm produced 32 inches in only two hours (Slade 1986). Rainstorms of this intensity quickly leach nutrients and sediments from deforested watersheds and degrade both terrestrial and downstream aquatic communities (Waring and Schlesinger 1985). USDA-Soil Conservation Service aerial photographs taken in the late 1940s and early 1950s show the true costs of hill country deforestation: hills and slopes stripped of protective vegetation and soil. Fifty years later, many of these slopes remain unvegetated, unheeded reminders of past land abuses. Near Austin, soil losses of over 14 centimeters occurred (Marsh and Marsh 1992).

But humans tend quickly to forget past lessons. In 1904, Bray warned that in hill country canyons, rain "broken by the timber covering, is shorn of its force, and instead of packing the soil and debris and then running off, is largely taken up by the porous ground. Thus the water is prevented from getting head enough to form a flood or to erode the soil, and at the same time is detained so that vastly greater quantities are absorbed by the limestone formation beneath." Woodruff and Marsh (1992) found that Ashe juniper contributed to "added organic matter, increased filtration, reduced soil loss, improved surface stability, and mitigation of the

golden-cheeked warbler by Narca Moore-Craig harsh ground level microclimate." Slaughter (1997) cautioned that increasing runoff by eliminating junipers may actually decrease aquifer recharge by filling recharge zones with eroded particulate matter. Soil compaction and devegetation by cattle exacerbate this process (Belsky and Blumenthal 1997). But such views find few supporters among those devoted to maximizing grazable terrain, short-term gains in water runoff, and federal and state funds for range "improvements" and range improvement "research." Ongoing "watershed improvement studies" will remove juniper not only from the private lands of eight river drainages, but also from the following public land sites inhabited by juniper-loving golden-cheek warblers: Government Canyon State Park, Honey Creek State Natural Area, and the Ft. Hood Military Reservation (Conner 1999).

Juniper clearing at Ft. Hood is especially alarming because this huge (87,600 hectares) military base is inhabited by the world's largest population of golden-cheeked warblers and black-capped vireos on public land, and public land covers less than 3% of Texas (Texas Center for Policy Studies 1995). Preservation of warbler habitat at Ft. Hood is critical because this site must maintain connectivity between northern and southern parts of the warbler's highly fragmented breeding distribution. Despite the listing of the golden-cheek as endangered, Ft. Hood has experienced steady loss of its warbler habitat to forest fire and a juniper clearing project launched by the Department of Army, USDA-Natural Resources Conservation Service, and Central Texas Cattlemans' Association.

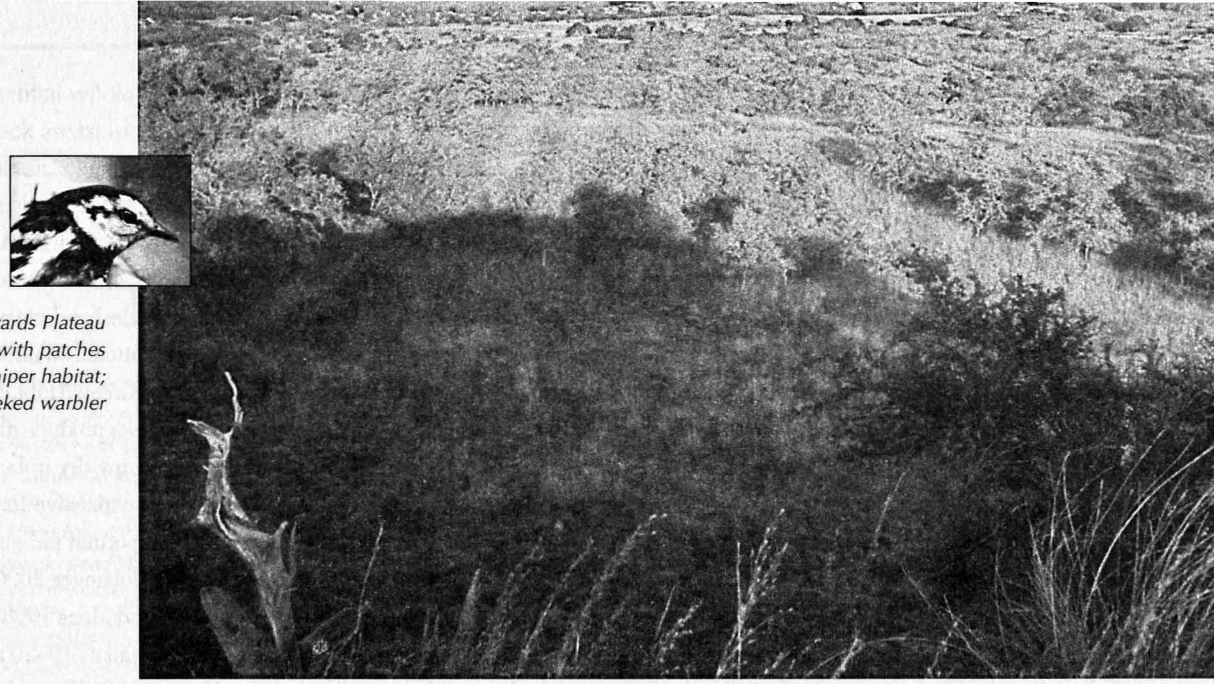
WHY WORRY ABOUT "ORIGINAL" CONDITIONS?

In central Texas, juniper removal is equated with ecological restoration by assuming so-called "presettlement conditions" to be grassland-dominated. This assumption, however, depends on overgeneralization, and misrepresentation or limited review of available historical accounts. For example, Nadkarni et al. (1985) justify hill country juniper removal by presenting Frederick Law Olmsted's 1853 observation, "The live-oaks, standing alone or in picturesque groups near and far upon the clean sward, which rolled in long waves" (Olmsted 1857). This quote, however, refers to the Blackland Prairie, not the adjacent hill country.[2] A few pages later Olmsted describes the "hill-range" or hill country to the north as "well wooded with cedar and liveoak." Despite this, Nadkarni et al. (1985) claim "The first settlers found the landscape covered with little timber other than ancient cypress trees and some scattered, sturdy oaks growing upon a carpet of lush grasses and herbs." Similarly, Schnepf et al. (1998) justify juniper removal within occupied warbler habitat by misparaphrasing Diamond et al. (1995): "suppression of anthropogenic and natural fires has eliminated patches of early successional habitat and transformed this [the Edwards Plateau] region into woodlands dominated by Ashe juniper (*Juniperus ashei*)." In fact, Diamond et al. (1995) present abundant historical evidence supporting their main point "that mature woodlands have decreased in spatial extent in the Central Texas Hill Country." Diggs et al. (1999) and Dyksterhuis (1948) likewise homogenize varied historical impressions of the Cross Timbers post oak and blackjack oak forests into a single presettlement grassland-dominated savanna condition. These publications create understandable confusion about the need for golden-cheek warbler and hill country forest conservation. One recent Texas Parks and Wildlife Department publication contributes to this confusion with a corrupted premise (Sansom 1995):[3]

> *In less than thirty years the savanna was gone, supplanted by a dense cover of woody vegetation dominated by ash juniper, often in nearly pure stands called cedar brakes. In these woodlands nest two rare birds...the Golden-cheeked Warbler and Black-capped Vireo.*

Eyewitness accounts clearly portray the hill country of the eighteenth and early nineteenth centuries as a diverse landscape of bottomland hardwood forests, dense juniper and post oak forests, oak and mesquite savannas, and prairies. The only available quantitative analysis examined 3,428 surveyors logs and estimated that 76% to 39% (the range of county averages, and 51% overall) of witness posts in 13 hill country counties stood in wooded locations (Weniger 1988). Various historical accounts support these findings. Miranda, traveling through Comal, Blanco, and Hays Counties in 1756, encountered "many...thickets of cedar and oak timber" (Patten 1970). In 1767, Rubi found "hills that were thickly covered with wild cedar" near the headwaters of the South Llano River along the Kinney and Edwards County Line (Jackson 1995). Berlandier found "heavy" forests and "an abundance of cedar" while hunting in Kerr County in 1828 (Weniger 1988). Kennedy described the hill country of 1835 as "clothed with forests of pine, oak,

2. This quote describes the Blackland Prairie as viewed by Olmsted immediately after climbing out of the Colorado River bottom: "After spending a pleasant week in Austin, we crossed the Colorado, into, distinctively, Western Texas....The wooded bottom is narrow, and we soon came upon high prairies...."
3. Texas Parks and Wildlife Department attempted to punish Diamond for release of the Diamond et al. (1995) juniper conservation paper at a time when all its authors worked for the department's now-defunct Texas Natural Heritage Program (TxPEER 2000). Sansom is the executive director of the same agency.



Characteristic Edwards Plateau oak savanna with patches of Ashe juniper habitat; male golden-cheeked warbler

cedar and other trees, with a great variety of shrubbery" (Kennedy 1841). Bracht (1931) reported "heavy timber" covering the hills extending between Austin and San Antonio in 1848. Roemer (1935) in 1849 encountered a continuous forest "several miles wide" filling the Pedernales River valley in the vicinity of Fredricksburg. In 1853, Olmsted (1857) found heavily wooded broad bottomlands along the Guadalupe River in Comal and Kerr Counties. In 1858, De Cordova traveled through an "extensive range of cedar hills" along Barton Creek upstream from Austin (Travis County); and "a dense forest of 'Mountain Cedar'" 40 miles and 70 miles upstream from Austin along the Colorado River in Burnet and San Saba Counties (De Cordova 1858). Johnston describes riding six miles through a dense cedar brake 14 miles north of Austin in 1855 (Johnston 1964).

Amos and Gehlbach (1988) opined that "Prior to European settlement, the Edwards Plateau was forested along the Balcones Escarpment and northward in proximity to the Cross Timbers." To some degree, woodlands currently dominate these same areas. Beuchner (1944), for example, wrote that in Kerr County "a large part of the area now designated as cedar brakes was originally covered with cedar when white man made his appearance."

Del Weniger (1984) has pointed out that the "mostly grassland-savanna" perspective depends on remembrances of late-nineteenth-century and early-twentieth-century landscapes already heavily modified by European settlement. In fact, by 1860 Texas supported an estimated four million head of cattle (Donahue 1999). "Droves of hogs" foraged in hill country river bottoms (Olmsted 1857), and 30,000–40,000 sheep ranged over the region just north of San Antonio (McDanield and Taylor 1877). Nineteenth-century explorers also reported widespread accidental and intentional fires (set by American colonists) in both grass- and forest-dominated settings, and the logging of the dense post oak woodlands surrounding Fredricksburg (Breeden 1994, Olmsted 1857, Roemer 1935, Weniger 1984).

This discussion reaffirms that generalizations about past landscapes must be constrained by the natural heterogeneity of complex topographies and biota, and that ecological restoration is not a mindless molding of biota into faithful renditions of selected eyewitness accounts. Those working to popularize the grassland-savanna paradigm for central Texas have used oversimplification, omission, bias, and embellishment to generate a convenient partial truth that equates ecological restoration with conditions favorable to livestock, game animals, and intensive landscape management.

Wolke (1999) describes how the forestry industry has used a similar approach to equate intrusive management (to protect forest health) with ecological restoration. True ecological restoration is restoration of natural processes, preservation of natural potentials, and conservation of rare species and rare communities. From a practical standpoint, this means giving regional endemic species and endemic communities highest priority in regional restoration programs. This requires greater appreciation for the historical prevalence of various central Texas plant communities and the weaning of local land stewards from anti-forest prejudices acquired during the past century. Especially on public lands, land management practices must be steered away from those currently homogenizing the appearance and ecology of most private and many public lands in central Texas. This does not require abandoning local grassland restoration projects. It does require a shifting of land management objectives from a simplistic and extreme savanna/grassland-dominated objective to a more balanced approach favoring larg-

photographs by Dean Keddy-Hector (warbler) and courtesy SOS Alliance er-scale mosaics of different plant communities and habitat conditions favoring endemics and declining species. At a most fundamental level, this requires large refugia, cessation of deforestation campaigns, exclusion of exotic herbivores, and restoration of extirpated upper trophic level predators.

WHAT GOLDEN-CHEEKS REALLY NEED

To some extent, development of management recommendations for golden-cheeked warblers has paralleled efforts to oversimplify other hill country restoration objectives. Although Pulich (1976) recommended preservation of larger blocks of warbler habitat (up to 5,000 acres), James Kroll (1980) challenged this recommendation because he felt that golden-cheeks inhabiting one heavily fragmented state park preferentially located territories along "roads, clearings, and trails." From this he reasoned that if juniper was confined to escarpments and stream courses in the nineteenth century, then "Golden-cheeks apparently co-evolved as an edge species inhabiting the interface between grassland and juniper-oak." Kroll then advised breaking up large blocks of juniper with "trails, firebreaks, senderos, and other narrow clearings" and "limited shredding and/or grazing" of scrub oaks; while retaining "strips of mature (>= 40 years) Ashe juniper...no less than 75 m...along stream and river courses, hill crests, limestone outcrops, and ravines." The Kroll guidelines have been widely accepted despite the fact that the golden-cheek is a forest-dwelling, canopy-foraging songbird, and despite the fact that these guidelines bear a suspicious resemblance to standard white-tailed deer management guidelines (Ladd 1985, Morse 1989, Packard 1995, Pulich et al. 1989).[4]

An educational video and legally binding management guidelines, jointly negotiated by the US Fish and Wildlife Service, USDA-Natural Resources Conservation Service, and Texas Parks and Wildlife Department, further promote the Kroll orientation by approving removal of junipers and construction of ranch roads within occupied warbler habitat (Campbell 1995). A recent Texas Department of Transportation-funded study even argued that highways may benefit golden-cheeks by creating more habitat "edge" (Benson 1995).

Unfortunately, Kroll's conclusions depend on superficial examinations of displaying males at sites heavily disturbed by past brush clearing. Determining what factors actually benefit warblers requires in-depth, long-term examination of patterns of productivity, age structure, and mortality over a range of disturbed and undisturbed settings. Although labor-intensive, examination of such factors allows detection of optimum habitat and so-called "ecological traps" where survival and fecundity in otherwise suitable habitat is depressed by deleterious edge effects.

Data from recent in-depth studies suggest that golden-cheeks do not benefit from edge species management. Various studies, including long-term colorbanding projects at Ft. Hood, the Balcones Canyonlands National Wildlife Refuge, and the Nature Conservancy's Barton Creek Habitat Preserve, support the possibility that golden-cheeks produce more young in expansive, unfragmented forests; occupy dry upland forests as well as interior locations within more expansive forests; and use Ashe juniper as one of their most important foraging and nesting trees (Attwater in Chapman 1907, Bolsinger 2000, Beardmore 1994, Keddy-Hector et al. in press, and Maas 1998). A recent Ft. Hood study found that openings as small as 10–20 meters degrade warbler breeding habitat (Horne 1999). These findings conflict with the Kroll guidelines by supporting woodland expansion as the best way to improve warbler habitat quality.

A HILL COUNTRY SYSTEM OF WARBLER WILDLANDS

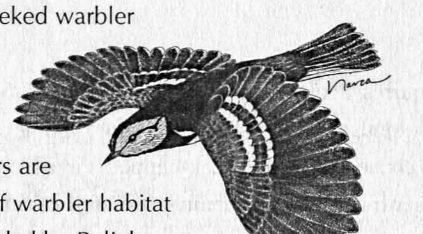
Multi-layered misconceptions about juniper and golden-cheeks make formidable barriers to the conservation of warblers and other forest-dependent species in central Texas. Overcoming these barriers requires full application of the Recovery Plan objective of protecting "sufficient breeding habitat...to ensure the continued existence of at least one viable, self-sustaining population in each of eight regions outlined in the plan" (Keddy-Hector 1992). A similar requirement for the black-capped vireo calls for six self-sustaining populations (Gryzbowski 1991).

Population viability analysis predicts that 3,000 contiguous golden-cheek territories would reduce risks of extinction for an isolated population to less than 1% of the potential century-long population trajectories (Beardmore et al. 1996). At warbler densities typical of good habitat (19 territories per 100 hectares), 3,000 contiguous territories requires a minimum of 16,000 hectares (40,000 acres) of contiguous juniper-oak forest. Of the currently protected populations of golden-cheeks, only Ft. Hood Military Reservation, with 915 documented territories, approaches this ideal (Jette et al. 1998). The new Balcones Canyonlands National Wildlife Refuge (40,000 acres) and Balcones Canyonlands Preserve (40,000 acres) contain even fewer territories. Lost Maples State Park (3,000 acres), one of the largest in central Texas, contains less than 100 territories.

Realistically, extant golden-cheek habitat is so fragmented that meeting minimal criteria for long-term population viability

4. Kroll currently maintains the "Dr. Deer" website (http://www.drdeer.com/index2.html) to advertise his white-tailed deer management consulting business.

Figure 1. Potential wildlands preserve sites (within dashed lines) and golden-cheeked warbler habitat (gray-black areas) in the Texas Hill Country. Numbers 1–15 mark potential wildlands preserve sites listed in the text. Roman numerals mark individual recovery regions as demarcated in the Golden-cheeked Warbler Recovery Plan (Keddy-Hector 1992). Potential core conservation areas for golden-cheeked warblers are organized by the eight recovery regions, but emphasize protection of key patches of warbler habitat associated with principal watersheds; these include eight sites originally recommended by Pulich.



1) Region I: *Possum Kingdom State Park and Brazos River Corridor*

2) Region II: *Dinosaur Valley State Park and Paluxy River Drainage connection to Brazos River Corridor*

3) Region II & III: *Bosque River in vicinity of Meridian State Park and connection to Brazos River Corridor*

4) Region III: *Ft. Hood Military Reservation*

5) Region IV: *Colorado Bend State Park and Upper Colorado River connection via Colorado River to Travis County sites*

6) Region IV: *Mason-Gillespie County Border, area south of Llano River*

7) Region V: *Travis County—Balcones Canyonlands Preserve System and Balcones Canyonlands National Wildlife connection via Colorado River to sites on Pedernales and Llano River*

8) Region V: *Hays County, Blanco River Valley*

9) Region VI: *Comal County, Guadalupe River—Guadalupe River State Park or Camp Bullis, links via Guadalupe River to sites in Kendall and Kerr Counties*

10) Region VI: *Government Canyon or Camp Bullis Areas*

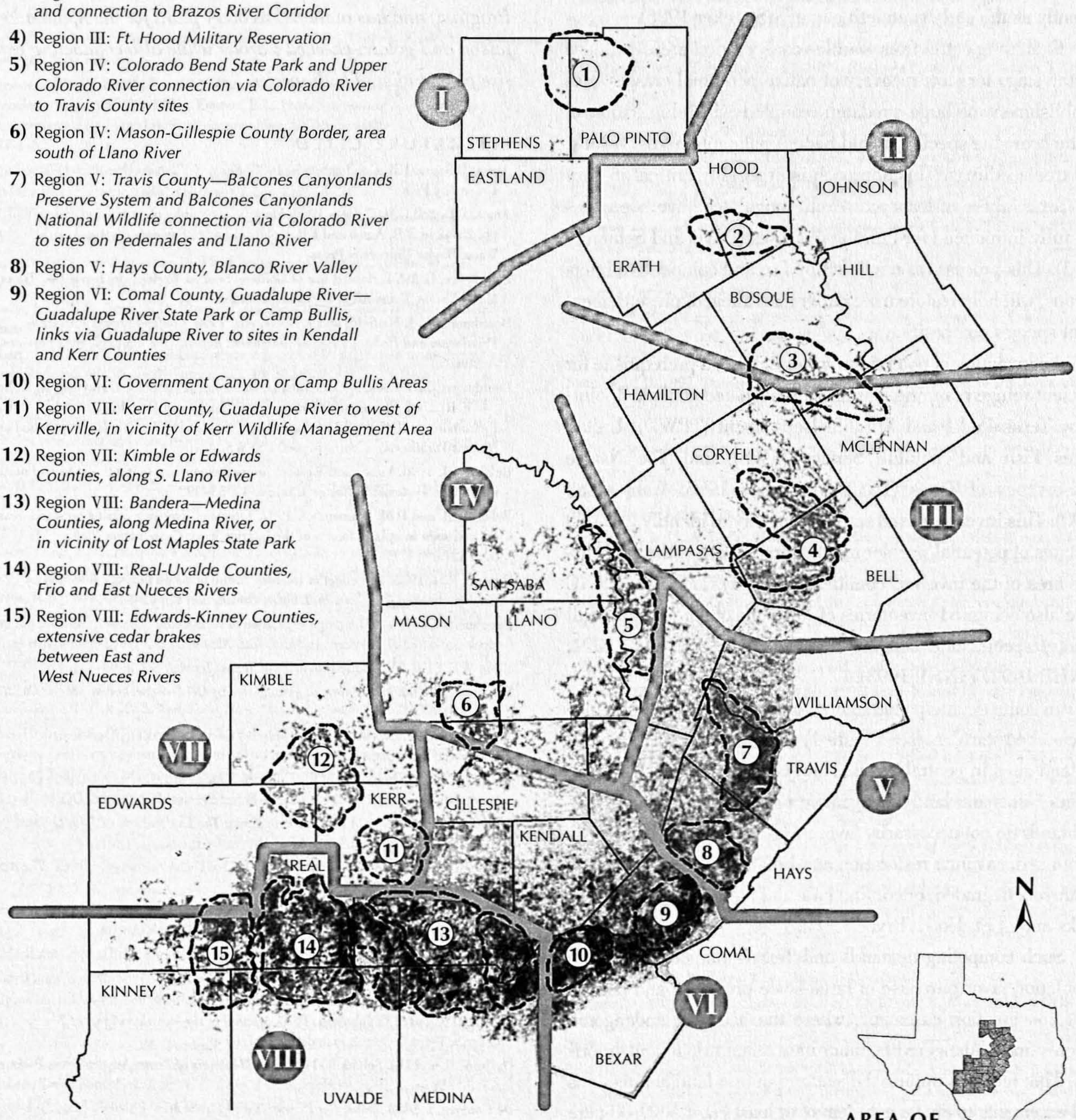
11) Region VII: *Kerr County, Guadalupe River to west of Kerrville, in vicinity of Kerr Wildlife Management Area*

12) Region VII: *Kimble or Edwards Counties, along S. Llano River*

13) Region VIII: *Bandera—Medina Counties, along Medina River, or in vicinity of Lost Maples State Park*

14) Region VIII: *Real-Uvalde Counties, Frio and East Nueces Rivers*

15) Region VIII: *Edwards-Kinney Counties, extensive cedar brakes between East and West Nueces Rivers*



requires acquisition of areas perhaps 3–5 times larger. This would also create opportunities for linking warbler conservation to conservation of black-capped vireos, mountain lions, and other hill country endemics—as well as future reestablishment of extirpated top carnivores, including black bear, timber wolf, ocelot, and jaguar, all species encountered in central Texas forests in the nineteenth century (Bracht 1931, Riddell in Breeden 1994, Roemer 1935). The ocelot and jaguar, in fact, ranged north of Austin (Mills and McLennan Counties) as recently as the early twentieth century (Strecker 1926).

Excluding cattle from warbler conservation areas will also set the stage for slow recovery of native perennial grasses. Reestablishment of large predators coupled with elimination of exotic browsing species should benefit palatable herbs, shrubs, and tree seedlings. This approach is especially critical in central Texas where at least four exotic ungulates have been successfully introduced for hunting purposes (Davis and Schmidly 1994). This process, as mediated by fire and competitive interactions, will help restore true, rather than alleged, presettlement plant species compositions.

An inventory of potential warbler habitat, a prerequisite for efficient refuge planning, has already been accomplished jointly by Texas Parks and Wildlife Department (TPWD), United States Fish and Wildlife Service (FWS), and The Nature Conservancy of Texas (TNC) (McKinney 1995, Wahl et al. 1990). This inventory used satellite imagery to identify 546,000 hectares of potential warbler habitat, or only 5% of the total surface area of the involved counties (Figure 1). TPWD and TNC have also compiled inventories of locations of other unique hill country species and communities (TNC 1991, TxNHP 1991, TxNHP 1992, TxNHP 1993).

To some degree potential core conservation areas for golden-cheeked warblers (see Figure 1) coincide with existing public land sites in central Texas. However, the small size of most of these sites and land management practices on state and federal lands do not necessarily favor the golden-cheek. As already mentioned, savanna restoration and brush control have already destroyed, degraded, or confined warbler habitat at several state parks and at Ft. Hood (Bryce 1993).

Such competing demands and Texas's burgeoning human population favor purchase of large-scale preserves and permanent conservation easements where the needs of endangered species and endangered communities remain dominant priorities. This requires upping the scale of public land acquisitions and easements to create a system of at least eight 100,000-acre preserves, each fully devoted to preserving hill country biodiversity by preserving dynamic landscapes of extensive cedar brakes, restored cypress and sycamore bottoms, dense post oak and live oak forests, post-fire shrublands and grasslands, and thriving populations of endemic biota. ☾

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Book *Reviews*

Reviewed in this issue

For the Health of the Land: Previously Unpublished Essays and Other Writings

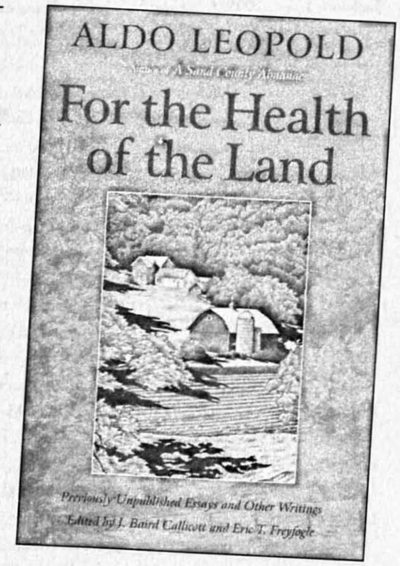
by Aldo Leopold, edited by J. Baird Callicott and Eric T. Freyfogle
Island Press (Washington, DC), 1999 ■ 240 pages, $22.95 cloth

The Essential Aldo Leopold: Quotations and Commentaries

edited by Curt Meine and Richard L. Knight
The University of Wisconsin Press (Madison, WI), 1999 ■ 384 pages, $27.95

Aldo Leopold composed *A Sand County Almanac* between 1941 and 1948. Originally titled *Great Possessions*, its essays weave together ethical, esthetic, and ecological insights that Leopold summarizes in three interrelated claims: that the land is to be loved and respected, that the land yields a cultural harvest, and that the land is a community to which we belong. The essays also gather together the whole of Leopold's life by drawing on his experiences as timber cruiser, game manager, outdoor recreationist, wildlife expert, ecologist, professor, landowner, and neighbor. We know and cherish Leopold for encompassing, in both thought and life, seemingly contrary poles: science and poetry, economics and ethics, management and membership, persistence and humility. To commemorate the 1949 publication of *A Sand County Almanac* and to pay homage to Aldo Leopold's conservationist vision, two fine books have recently appeared: *For the Health of the Land: Previously Unpublished Essays and Other Writings* and *The Essential Aldo Leopold: Quotations and Commentaries.*

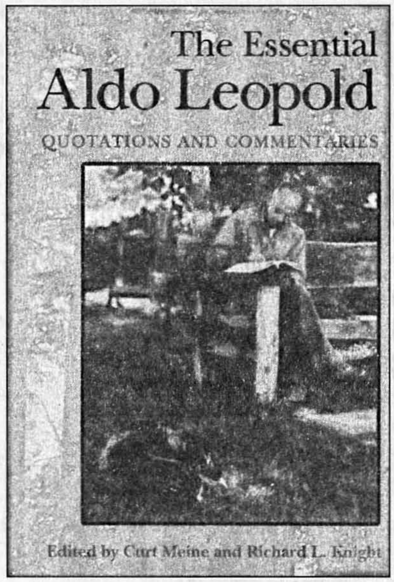
Leopold is always striving for the "big picture"—an articulated comprehension of the land as a whole, a reforged communion between humanity and Nature, a national system of wilderness areas—but he never abandons the perspective of everyday life. He continually expresses the concern that if conservation techniques and ecological science grow aloof of everyday experience and do not speak to the average person, then efforts to cultivate land health, no matter how sophisticated, will fight an uphill battle. Leopold understands conservation to be an activity, partly scientific and partly artistic, properly practiced by ordinary people within their lived environment. The scientist is primarily a guide who indicates the many ways in which one might become acquainted with the land and who can articulate what healthy land looks like. *For the Health of the Land* provides a glimpse of Aldo Leopold working and thinking at this practical, everyday level, somewhat removed from the wilderness visionary of the *Almanac*, introducing landowners to the possibilities for restoring wildlife, game fowl in particular, on their private lands. The essays were written with the thinly concealed hope that the "dramas" enchanting the land will lead those willing to invest themselves toward the "great possessions" of life—a sense of belonging to the land. In "History of the Riley Game Cooperative, 1931–1939," for instance, Leopold momentarily turns a scientific eye upon his neighbors in the cooperative and observes that "Some of the farmers have developed interests that extend far beyond game. Two of them, by their own initiative, have started an artificially planted tamarack grove, with the ultimate objective of



reintroducing ladyslippers" (p. 190).

Other posthumously published works, *Round River* (1952) and *The River of the Mother of God and Other Essays* (1991), represent the highlights of the many articles and journal entries that Leopold wrote over the course of his life. Both texts are important contributions that can round out our understanding of Leopold's land philosophy in its ethical, esthetic, and ecological dimensions. With *For the Health of the Land*, editors J. Baird Callicott and Eric T. Freyfogle take the restoration of Leopold's land philosophy a step further: they reconstruct a book that Leopold could not complete himself because, as Stanley A. Temple notes in the afterword, he was unable to interest anyone in publishing it. The book Leopold envisioned would have served as a hands-on wildlife management manual for the average landowner—a middle ground between his scientific *Game Management* (1933) and the poetic-philosophical *Almanac*. The essays that the editors have chosen to reconstruct the intended manual are drawn from the period between 1938 and 1942, when Leopold was settling into a new position at the University of Wisconsin as the chair of the Department of Wildlife Management. Most of the essays were originally printed in trade journals and newspapers, including the series of short essays the editors have called "A Landowner's Conservation Almanac," which serves as the centerpiece of the book. In addition, *For the Health of the Land* features five longer essays of "vintage stock" that are being published for the first time.

The editors of *The Essential Aldo Leopold* offer a different, but equally ambitious tribute. They too claim to disclose the Aldo Leopold that has



been relegated to archives and is accessible only to a few Leopold scholars. The book consists of 21 chapters, each of which treats a different aspect or theme of Leopold's land philosophy, for example, "Outdoor Recreation," "Ecological Restoration," "Economics," and "Land Esthetics." For each theme, editors Curt Meine and Richard L. Knight provide an impressive set of quotations of the relevant passages, some of which are extracted from Leopold's archived writings. Turning to the chapter on "Land Esthetics," for instance, one can read over Leopold's landmark statements, arranged in chronological order, on the question of the beauty of the land. Moreover, each chapter features an introductory essay by a contemporary expert in that field, who discusses the significance of Leopold's perspective to their work and within Leopold's own context.

I have one reservation about *The Essential Aldo Leopold* and that is my concern that we are already in danger of over-analyzing a thinker who, after all, strives for an understanding that is synthetic. In the foreword to the *Almanac*, Leopold expresses this orientation when he claims that his essays attempt to "weld" together the ethical, esthetic, and ecological themes. Leopold suggests that the cultivation of synthetic thinking is *the* pressing task for modern America because our society has a tendency toward reductionism, specialization, and compartmentalization. Do we not lose, then, the essence of the land philosophy when we convert Leopold's writings into a ready-made catalogue of quotations? The editors are aware of this concern, but they claim that *The Essential Aldo Leopold* preserves the spirit of his thinking insofar as there is a good deal of overlap between chapters.

Indeed, if Leopold was right, there cannot help but be a good deal of overlap. But I think that the way in which the wholeness characteristic of Leopold's land philosophy is disclosed in *A Sand County Almanac* is quite different from the way this unity comes forward in *The Essential Aldo Leopold*. Like the land community that he studied, the *Almanac* does not immediately disclose its secrets and this, I believe, is why we are drawn to read it again and again. I am reminded of a passage at page 20 of the *Almanac* that concludes "What a dull world if we knew all about geese!" The same insight holds for Leopold and his own, unique "goose music." *The Essential Aldo Leopold* will be an excellent resource for Leopold scholars, both professional and home-grown, who do not have access to the archives and who would focus on a particular (and underappreciated) feature of the land philosophy, like Leopold's concept of a land esthetic—but the book can not supersede the great American fugue that it commemorates.

Reviewed by **PAUL MEDEIROS**, *Professor of Philosophy at Elon College, North Carolina*

Restoring North America's Birds:
Lessons from Landscape Ecology

by Robert A. Askins
Yale University Press (New Haven, CT), 2000 ■ 320 pages, $30

The plight of the California condor is now well known. The sole wild bird was captured in 1987, to join 26 others in zoos. They were gingerly propagated, the chicks hand-fed, survivors transported to the only suitable habitat (desert in Arizona)—and, with breath held, a few were released. There is a chance that this multi-million dollar effort will mean the survival of the condor, for which we should be thankful.

But is this scenario merely a taste of the future for many North American birds? What is the cost of defining bird restoration as last-gasp heroics for species orphaned from the habitats and landscapes they need? Robert Askins' clear-eyed book, *Restoring North America's Birds: Lessons from Landscape Ecology*, offers "foresters, wildlife managers, nature preserve managers, biologists with the Nature Conservancy," as well as academic researchers and students, a more powerful, and hopeful, approach.

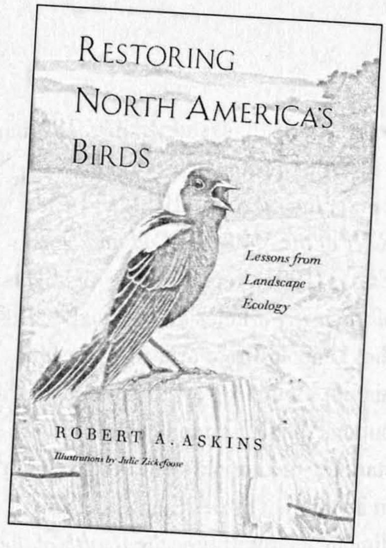
Askins shows how intelligent bird restoration strategies arise from outcrossing the descriptive traditions of ornithology with the theories of landscape ecology. The observations of the ornithologist come first: "Grasshopper Sparrows are most common in grasslands dominated by bunchgrass with patches of bare ground, and Henslow's Sparrows are found in grasslands dominated by tall, dense grass with little or no bare ground." Then, landscape ecology enriches this knowledge on a variety of scales.

In a particular ecosystem, "only a mosaic of patches of grassland in different stages of recovery from disturbance will support [both] of these species." On another scale, these specific habitat requirements are irrelevant if the area requirements of the bird are not met: "Grasshopper Sparrows were not found on…less than 75 acres of grassland." On the largest scale, the almost total destruction of midwestern prairie leaves declining grassland birds on the East Coast cut off from a key population source.

Askins also makes clear that while the current decline of eastern grassland birds like the bobolink may be partly attributed to the returning eastern forest, it is wrong to write them off as midwestern invaders. These open country birds long pre-date Indian and European tree removal: disturbance agents, like beavers and fire, provided openings in the forest matrix. *Restoring North America's Birds* argues that genuine restoration strategies must meet birds' complex requirements—from precise assemblages of vegetation to international flyways—while also viewing historical distributions of birds as a benchmark.

Like most good general histories—natural or otherwise—there is little original material in this book. Instead, Askins is the storyteller. He distills numerous specialized (occasionally contradictory) scientific studies—the product of a two-decade explosion of inquiry within landscape ecology—into a series of landscape narratives: "Birds of the Western Slopes," "Declining Birds of the Southwestern Floodplains," "Industrial Forestry and the Prospect for Northern Birds," and six others, all sharply etched.

Through these case studies, Askins demonstrates why conservation-



ists shouldn't be focused strictly on either population numbers or even population trends—but rather on something more subtle and essential: resilience. Birds' ability to persist is not simply a function of abundance. Witness the passenger pigeon.

The chapter "Lost Birds of the Eastern Forest" shows how this ill-fated bird was not brought down by overhunting or disease, but by the complex interplay of the pigeons' dependence on huge flocks to search for beech nuts and acorns—continent-wide—and the destruction of large portions of the eastern forest in the nineteenth century. While many miles of beech forest produce abundant mast one year and not the next, this pattern is not synchronous across the whole continent—which allowed the birds to feed by the billion in Michigan one year and Pennsylvania the next. With the interruption of this huge cycle by industrial-scale forest cutting, the pigeons were doomed, even though they still were aloft by the millions.

This book poses key questions for environmental policy-makers and land managers: What are the vibrant source populations that must be protected to provide the new individuals to restored habitats? When fire renews an older prairie, what other piece of the plains mosaic will provide new-prairie specialists? How do we assure that if we save rare habitat something rare will inhabit there?

Askins' conservation recommendations (at the end of each chapter) challenge conservationists to think and work at every scale. These recommendations also cut across cherished ideological fault lines. He advocates for unbroken tracts of big, wild forest—crucial to deep-interior species like the black-throated blue warbler. He also calls for the maintenance of powerline corridors as an interim shrubland in the face of the nearly total obliteration of the forest/prairie ecotone that once provided this intermediate habitat naturally.

Many bird watchers have waited in the springtime for the first waves of neotropical migrant birds—say, American redstarts—and marveled at their journey. Rising off the forests and grasslands of Jamaica or Belize or Brazil these birds have made a trip of breathtaking distance and complexity. Bird conservation plans must protect the fragile pathways of migrant and nomadic birds.

While Thoreau's mantra for resisting the industrial age—simplify, simplify, simplify—may have weight in the realm of human lifestyle choices, Askins methodically shows us that nearly the opposite values need to be celebrated in ecological restoration—complexity, subtlety, connectivity. *Restoring North America's Birds* ties together a broad range of scientific study to show how these values are more than just abstractions—they are a lifeline to the winged co-inhabitants of this continent.

Reviewed by **JOSHUA BROWN**, *assistant editor at* Wild Earth, *and* **ZOE RICHARDS**, *an ornithologist working on conservation projects for the Green Mountain National Forest*

Slipping Through Our Hands:
Imperiled Wildlife of the Greater San Juans

by Tony Povilitis
Life Net Publishing (Willcox, AZ), 2000 ■ 311 pages, $12

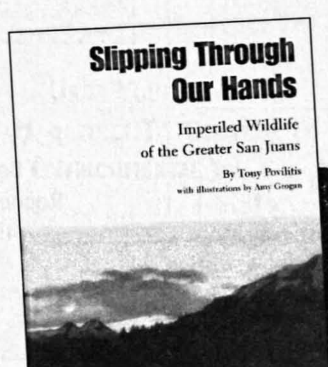
If you haven't seen this handsome new backpack Baedeker for imperiled wildlife in the Greater San Juans, then you've not likely heard of Dr. Tony Povilitis either. And that would be a shame. Povilitis is one of those mountain visionaries who dreams landscapes, not profitshares, who imagines a Southern Rockies network of nature preserves where others just see real estate. He's taken on the thorny yet crucial task of putting together a usable field guide for all of the region's wild critters—mammals, birds, amphibians, fishes, insects, and plant species—that are endangered, threatened, or otherwise imperiled. (Someday I hope a biologist writes regional guides that get us down to mushrooms and spiders, slimes and soil bacteria.)

Amy Grogan, a regular *Wild Earth* illustrator, has done a fine job illuminating Tony's guide—iconic black and whites convey the rough essence of each species, and the cover oil captures the purple reds of a San Juan panoramic alpenglühen just past dusk. Maps are included that give a rough continental scan of habitat as well as county-by-county detail. Not the exact site, mind you, but the vicinity—good enough to encourage readers to get out and do some of their own rambling.

Maybe what interests me most, and makes this book an invaluable companion to standard animal and plant guides, is that Povilitis adds more to the natural history story than merely description. We get a scorecard status report: legal status, global ranking, local distribution. For each subject, we learn about its habitat, threats and concerns, conservation needs, and vulnerability factors.

With this book, Povilitis has created a new genre, a kind of conservation biology field guide, a tool to help us become better stewards of precious places, like the San Juan Mountains of southwestern Colorado and northwestern New Mexico. If you're planning to spend any time in this neck of the woods, get a copy and use it to learn the plants, like the poet Gary Snyder suggests we do to find our way through the next millennium, "for the children." Highly recommended.

Reviewed by poet, writer, and San Miguel County (Colorado) Commissioner **ART GOODTIMES**



Ord's kangaroo rat by Amy Grogan from *Slipping Through Our Hands*

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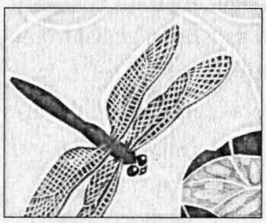

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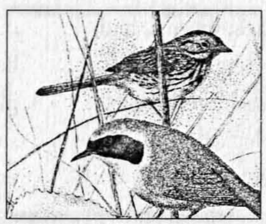

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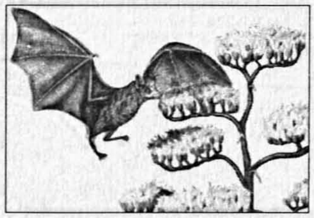

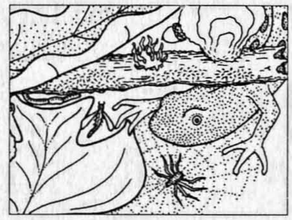

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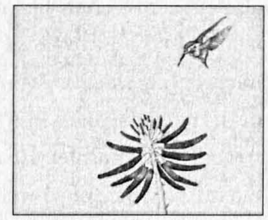

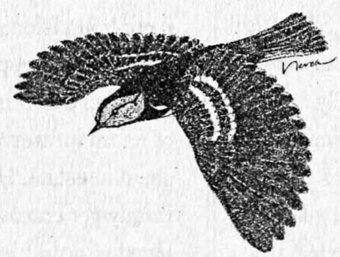

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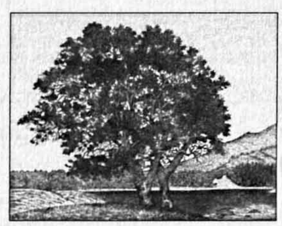

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Carnivores 2000

Defenders of Wildlife's third national conference will be held in Denver, Colorado, November 12–15, 2000 at the Omni Interlocken Resort Hotel. Carnivores 2000 will focus on predator biology and conservation in the 21st century. Contact Heather Pellet, Defenders of Wildlife, 1101 14th St., NW, Suite 1400, Washington, DC 20005, 202-789-2844 ext. 315, carnivores2000@defenders.org.

Monadnock Institute Conference

David W. Orr, author of *Ecological Literacy* and *Earth in Mind*, will address ecological competence in secondary and post-secondary education at the Monadnock Institute's Fall Symposium, "The Nature of Place," October 28, Franklin Pierce College, Rindge, New Hampshire. Call 603-899-4010 or email harrisjr@fpc.edu.

Pacific Northwest Conservation Assessment

Conservation information on the Pacific Northwest is now available on Conservation Biology Institute's website: www.consbio.org. From CBI's home page, click on the map of the Pacific Northwest or go directly to: www.consbio.org/cbi/assess/assess-main.htm. The site reviews forty terrestrial ecoregions of the Pacific Northwest as defined by World Wildlife Fund.

Rockies Conference

The Central Rockies Chapter of the Society for Ecological Restoration's first regional conference, "Restoring the Rockies: Restoration and Conservation Strategies in the West," will be held April 26–27, 2001 in Keystone, Colorado. The goal: building an alliance to better ensure long-term survival of Rockies ecosystems. A call for papers is open; submission deadline is December 1, 2000. Focus areas include: riparian and wetland areas, rangeland restoration, restoration on private lands, and restoration education. Contact Lisa Tasker, lisatasker@earthlink.net.

Religion and Forests Conference

A conference on religion and forest conservation will address the fast-growing problem of chip mills in the Southeast and other forest protection issues. It takes place on December 8–10, 2000 at the Kanuga Conference Center in Hendersonville, North Carolina. Co-sponsors include the Coalition on Religion in Appalachia (CORA), The Dogwood Alliance, Episcopal Appalachia Ministries (EAM), the Roman Catholic Franciscan JPIC committee in the Southeast, American Lands, and the Southern Biodiversity Project. Contact the Religious Campaign for Forest Conservation, 409 Mendocino Ave., Suite A, Santa Rosa, CA 95401; www.creationethics.org.

CALL FOR POSTER ABSTRACTS!

Managing River Flows for Biodiversity: A Conference on Science, Policy and Conservation Action

July 30-August 2, 2001
Colorado State University, Fort Collins (CO)

Abstracts of posters are invited for this conference. Posters may cover themes related to managing river flows for biodiversity, including case studies on particular flow restoration efforts. Deadline for abstracts is December 31, 2000. Notification for accepted posters will follow by the end of January, 2001. Please send all abstracts to Nicole Silk by e-mail (nsilk@tnc.org) by or before the deadline listed above.

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We list here only each issue's major articles, by partial title or subject. For a more complete listing, request a comprehensive Back Issues List (see form, next page). Note: (✖) = issue is sold out, but photocopies of articles available.

BACK ISSUES

1/Spring 1991 • Ecological Foundations for Big Wilderness, Howie Wolke on The Impoverished Landscape, Reed Noss on Florida Ecosystem Restoration, Biodiversity & Corridors in Klamath Mtns., Earth First! Wilderness Preserve System, GYE Marshall Plan, Dolores LaChapelle on Wild Humans, Dave Foreman "Around the Campfire," and Bill McCormick's Is Population Control Genocide?

2/Summer 1991 • Dave Foreman on the New Conservation Movement, Ancient Forests: The Perpetual Crisis, Wolke on The Wild Rockies, Grizzly Hunting in Montana, Noss on What Wilderness Can Do for Biodiversity, Mendocino NF Reserve Proposal, Christopher Manes on the Cenozoic Era, and Part 2 of McCormick's Is Population Control Genocide?

3/Fall 1991 • (✖) The New Conservation Movement continued. Farley Mowat on James Bay, George Washington National Forest, the Red Wolf, George Wuerthner on the Yellowstone Elk Controversy, The Problems of Post Modern Wilderness by Michael P. Cohen and Part 3 of McCormick's Is Population Control Genocide?

4/Winter 1991/92 • Devastation in the North, Rod Nash on Island Civilization, North American Wilderness Recovery Strategy, Wilderness in Canada, Canadian National Parks, Hidden Costs of Natural Gas Development, A View of James Bay from Quebec, Noss on Biologists and Biophiles, BLM Wilderness in AZ, Wilderness Around the Finger Lakes: A Vision, National ORV Task Force

5/Spring 1992 • Foreman on ranching, Ecological Costs of Livestock, Wuerthner on Gunning Down Bison, Mollie Matteson on Devotion to Trout and Habitat, Walden, The Northeast Kingdom, Southern Rockies Ecosystem Protection, Conservation is Good Work by Wendell Berry, Representing the Lives of Plants and Animals by Gary Paul Nabhan, and The Reinvention of the American Frontier by Frank and Deborah Popper

6/Summer 1992 • The Need for Politically Active Biologists, US Endangered Species Crisis Primer, Wuerthner on Forest Health, Ancient Forest Legislation Dialogue, Toward Realistic Appeals and Lawsuits, Naomi Rachel on Civil Disobedience, Victor Rozek on The Cost of Compromise, The Practical Relevance of Deep Ecology, and An Ecofeminist's Quandary

7/Fall 1992 • How to Save the Nationals, The Backlash Against the ESA, Saving Grandfather Mountain, Conserving Diversity in the 20th Century, Southern California Biodiversity, Old Growth in the Adirondacks, Practicing Bioregionalism, Biodiversity Conservation Areas in AZ and NM, Big Bend Ecosystem Proposal, George Sessions on Radical Environmentalism in the 90s, Max Oelschlaeger on Mountains that Walk, and Mollie Matteson on The Dignity of Wild Things

8/Winter 1992/93 • Critique of Patriarchal Management, Mary O'Brien's Risk Assessment in the Northern Rockies, Is it Un-Biocentric to Manage?, Reef Ecosystems and Resources, Grassroots Resistance in Developing Nations, Wuerthner's Greater Desert Wildlands Proposal, Wolke on Bad Science, Homo Carcinomicus, Natural Law and Human Population Growth, Excerpts from *Tracking & the Art of Seeing* and *Ghost Bears*

Wildlands Project Special Issue #1 • TWP (North American Wilderness Recovery Strategy) Mission Statement, Noss's Wildlands Conservation Strategy, Foreman on Developing a Regional Wilderness Recovery Plan, Primeval Adirondacks, Southern Appalachians Proposal, National Roadless Area Map, NREPA, Gary Snyder's Coming into the Watershed, Regenerating Scotland's Caledonian Forest, Geographic Information Systems

9/Spring 1993 • The Unpredictable as a Source of Hope, Why Glenn Parton is a Primitivist, Hydro-Quebec Construction Continues, RESTORE: The North Woods, Temperate Forest Networks, The Mitigation Scam, Bill McKibben's Proposal for a Park Without Fences, Arne Naess on the Breadth and Limits of the Deep Ecology Movement, Mary de La Valette says Malthus Was Right, Noss's Preliminary Biodiversity Plan for the Oregon Coast, Eco-Porn and the Manipulation of Desire

10/Summer 1993 • Greg McNamee questions Arizona's Floating Desert, Foreman on Eastern Forest Recovery, Is Ozone Affecting our Forests?, Wolke on the Greater Salmon/Selway Project, Deep Ecology in the Former Soviet Union, Topophilia, Ray Vaughan and Nedd Mudd advocate Alabama Wildlands, Incorporating Bear, The Presence of the Absence of Nature, Facing the Immigration Issue

11/Fall 1993 • Crawling by Gary Snyder, Dave Willis challenges handicapped access developments, Biodiversity in the Selkirk Mtns., Monocultures Worth Preserving, Partial Solutions to Road Impacts, Kittatinny Raptor Corridor, Changing State Forestry Laws, Wild & Scenic Rivers Act, Wuerthner Envisions Wildland Restoration, Toward [Population] Policy That Does Least Harm, Dolores LaChappelle's Rhizome Connection

12/Winter 1993/94 • A Plea for Biological Honesty, A Plea for Political Honesty, Endangered Invertebrates and How to Worry About Them, Faith Thompson Campbell on Exotic Pests of American Forests, Mitch Lansky on The Northern Forest, Human Fear Diminishes Diversity in Rocky Mtn. Forests, Gonzo Law #2: The Freedom of Information Act, Foreman on NREPA and the Evolving Wilderness Area Model, Rocky Mtn. Nat. Park Reserve Proposal, Harvey Locke on Yellowstone to Yukon campaign

13/Spring 1994 • Ed Abbey posthumously decries The Enemy, David Clarke Burks's Place of the Wild, Ecosystem Mismanagement in Southern Appalachia, Mohawk Park Proposal, RESTORE vs. Whole-Tree Logging, Noss & Cooperrider on Saving Aquatic Biodiversity, Atlantic Canada Regional Report, Paul Watson on Neptune's Navy, The Restoration Alternative, Intercontinental Forest Defense, Failures of Babbitt and Clinton, Chris McGrory-Klyza outlines Lessons from Vermont Wilderness

14/Summer 1994 • Bil Alverson's Habitat Island of Dr. Moreau, Bob Leverett's Eastern Old Growth Definitional Dilemma, Wolke against Butchering the Big Wild, FWS Experiments on Endangered Species, Serpentine Biodiversity, Andy Kerr promotes Hemp to Save the Forests, Mapping the Terrain of Hope, A Walk Down Camp Branch by Wendell Berry, Carrying Capacity and the Death of a Culture by William Catton Jr., Industrial Culture vs. Trout

15/Fall 1994 • BC Raincoast Wilderness, Algoma Highlands, Helping Protect Canada's Forests, Central Appalachian Forests Activist Guide, Reconsidering Fish Stocking of High Wilderness Lakes, Using General Land Office Survey Notes in Ecosystem Mapping, Gonzo Law #4: Finding Your Own Lawyer, The Role of Radio in Spreading the Biodiversity Message, Jamie Sayen and Rudy Engholm's Thoreau Wilderness Proposal

16/Winter 1994/95 • Ecosystem Management Cannot Work, Great Lakes Biodiversity, Peregrine Falcons in Urban Environments, State Complicity in Wildlife Losses, How to Burn Your Favorite Forest, ROAD-RIPort #2, Recovery of the Common Lands, A Critique and Defenses of the Wilderness Idea by J. Baird Callicott, Dave Foreman, and Reed Noss

17/Spring 1995 • Christopher Manes pits Free Marketeers vs. Traditional Environmentalists, Last Chance for the Prairie Dog, interview with tracker Susan Morse, Befriending a Central Hardwood Forest part 1, Economics for the Community of Life: Part 1, Minnesota Biosphere Recovery, Michael Frome insists Wilderness Does Work, Dave Foreman looks at electoral politics, Wilderness or Biosphere Reserve: Is That a Question?, Deep Grammar by J. Baird Callicott

18/Summer 1995 • (✖) Wolke on Loss of Place, Dick Carter on Utah Wilderness: The First Decade, *WE* Reader Survey Results, Ecological Differences Between Logging and Wildfire, Bernd Heinrich on Bumblebee Ecology, Michael Soulé on the Health Implications of Global Warming, Peter Brussard on Nevada Biodiversity Initiative, Preliminary Columbia Mtns. Conservation Plan, Foreman on advocacy politics, Environmental Consequences of Having a Baby in the US

19/Fall 1995 • (✖) Wendell Berry on Private Property and the Common Wealth, Eastside Forest Restoration, Global Warming and The Wildlands Project, Paul J. Kalisz on Sustainable Silviculture in Eastern Hardwood Forests, Old Growth in the Catskills and Adirondacks, Threatened Eastern Old Growth, Andy Kerr on Cow Cops, Dave Foreman on libertarianism, Fending of SLAPPS, Using Conservation Easements to save wildlands, David Orton on Wilderness and First Nations

20/Winter 1995/96 • *TWP Special Issue #2.* Testimony from Terry Tempest Williams, Foreman's Wilderness: From Scenery to Strategy, Noss on Science Grounding Strategy and The Role of Endangered Ecosystems in TWP, Roz McClellan explains how Mapping Reserves Wins Commitments, Second Chance for the Northern Forest: Headwaters Proposal, Klamath/Siskiyou Biodiversity Conservation Plan, Wilderness Areas and National Parks in Wildland Proposal, ROAD-RIP and TWP, Steve Trombulak, Jim Strittholt, and Reed Noss confront Obstacles to Implementing TWP Vision

21/Spring 1996 • (✖) Bill McKibben on Finding Common Ground with Conservatives, Public Naturalization Projects, the Complexities of Zero-cut, Curt Steger on Ecological Condition of Adirondack Lakes, Acid Rain in the Adirondacks, Bob Mueller on Central Appalachian Plant Distribution, Brian Tokar on Biotechnology vs. Biodiversity, Stephanie Mills on Leopold's Shack, Soulé asks Are Ecosystem Processes Enough?, Poems for the Wild Earth, Limitations of Conservation Easements, Kerr on Environmental Groups and Political Organization

22/Summer 1996 • McKibben on Text, Civility, Conservation and Community, Eastside Forest Restoration Forum, Grazing and Forest Health, debut of Landscape Stories department, Friends of the Boundary Waters Wilderness, Foreman on Public Lands Conservation, Private Lands in Ecological Reserves, Public Institutions Twisting the Ear of Congress, Laura Westra's Ecosystem Integrity and the Fish Wars, Caribou Commons Wilderness Proposal for Manitoba

23/Fall 1996 Religion and Biodiversity, Eastern Old Growth: Big Tree Update, Gary Nabhan on Pollinators and Predators, South African Biodiversity, Dave Foreman praises Paul Shepard, NPS Prescribed Fires in the Post-Yellowstone Era, Alaska: the Wildlands Model, Mad Cows and Montanans, Humans as Cancer, Wildlands Recovery in Pennsylvania

24/Winter 1996/97 • (✖) Opposing Wilderness Deconstruction: Gary Snyder, Dave Foreman, George Sessions, Don Waller, Michael McCloskey respond to attacks on wilderness. The Aldo Leopold Foundation, Grand Fir Mosaic, eastern old-growth report, environmental leadership. Andy Robinson on grassroots fundraising, Edward Grumbine on Using Biodiversity as a Justification for Nature Protection, Rick Bass on the Yaak Valley, Bill McCormick on Reproductive Sanity, and portrait of a Blunt-nosed Leopard Lizard

25/Spring 1997 • (✖) Perceiving the Diversity of Life: David Abram's Returning to Our Animal Senses, Stephanie Kaza on Shedding Stereotypes, Jerry Mander on Technologies of Globalization, Christopher Manes's Contact and the Solid Earth, Connie Barlow Re-Stories Biodiversity by Way of Science, Imperiled Freshwater Clams, WildWaters Project, eastern old-growth report, American Sycamore, Kathleen Dean Moore's Traveling the Logging Road, Mollie Matteson's Wolf Re-story-ation, Maxine McCloskey on Protected Areas on the High Seas

26/Summer 1997 • (✖) Doug Peacock on the Yellowstone Bison Slaughter, Reed Noss on Endangered Major Ecosystems of the United States, Dave Foreman challenges abiologists, Hugh Iltis challenges abiologists, Virginia Abernethy explains How Population Growth Discourages Environmentally Sound Behavior. Gaian Ecology and Environmentalism, The Bottom Line on Option Nine, Eastern Old Growth Report, How Government Tax Subsidies Destroy Habitat, Geology in Reserve Design, part 2 of NPS Prescribed Fires in the Post-Yellowstone Era

27/Fall 1997 • (✖) Bill McKibben discusses Job and Wilderness, Anne LaBastille values Silence, Allen Cooperrider and David Johnston discuss Changes in the Desert, Donald Worster on The Wilderness of History, Nancy Smith on Forever Wild Easements in New England, Foreman explores fear and loathing of wilderness, George Wuerthner on Subdivisions and Extractive Industries, More Threatened Eastern Old Growth, part 2, the Precautionary Principle, North and South Carolina's Jocasse Gorges, Effects of Climate Change on Butterflies, the Northern Right Whale, Integrating Conservation and Community in the San Juan Mtns., Las Vegas Leopard Frog

28/Winter 1997/98 • ***Overpopulation Issue*** explores the factors of the I=PAT model: Gretchen Daily & Paul Ehrlich on Population Extinction and the Biodiversity Crisis, Stephanie Mills revisits nulliparity, Alexandra Morton on the impacts of salmon farming, Sandy Irvine punctures pronatalist myths, William Catton Jr. on carrying capacity, Virginia Abernethy considers premodern population planning, Stephanie Kaza on affluence and the costs of consumption, Kirkpatrick Sale criticizes the Technological Imperative, McKibben addresses overpopulation One (Child) Family at a Time, Foreman on left-wing cornucopianism Interview with Stuart Pimm, Resources for Population Publications & Overpopulation Action, Spotlight on Ebola Virus

29/Spring 1998 • (✖) Interview with David Brower, Anthony Ricciardi on the Exotic Species Problem and Freshwater Conservation, George Wuerthner explores the Myths We Live By, Dave Foreman critique of "environment," forum on ballot initiatives, John Clark & Alexis Lathem consider Electric Restructuring, Paul Faulstich on Geophilia, critiques of motorized wreckreation, Mitch Friedman's Earth in the Balance Sheet, Anne Woiwode on Pittman Robinson, Peter Friederici's Tracks, Eastern Old Growth, Connie Barlow's Abstainers

30/Summer 1998 • ***Wildlands Philanthropy*** tradition discussed by Robin Winks, John Davis on Private Wealth Protecting Public Values, Doug Tompkins on Philanthropy, Cultural Decadence, & Wild Nature, Sweet Water Trust saves wildlands in New England, A Time Line of Land Protection in the US, Rupert Cutler on Land Trusts and Wildlands Protection, profiles of conservation heroes Howard Zahniser, Ernie Dickerman, & Mardy Murie, Michael Frome recollects the wilderness wars, David Carle explores early conservation activism and National Parks, and Barry Lopez on The Language of Animals

31/Fall 1998 • ***Agriculture & Biodiversity*** (✖) examined by Paul Shepard, Catherine Badgley, Wes Jackson, and Frieda Knobloch, Scott Russell Sanders on Landscape and Imagination, Amy Seidl addresses exotics, Steve Trombulak on the Language of Despoilment, George Wuerthner & Andy Kerr on livestock grazing, **Rewilding** paper by Michael Soulé & Reed Noss, Gary Nabhan critiques the Terminals of Seduction, Noss asks whether conservation biology needs natural history, Y2Y part 2, profile of Dan Luten

32/Winter 1998/99 • ***A Wilderness Revival*** perspectives from Bill Meadows on the American Heart, Juri Peepre on Canada, Jamie Sayen on the Northern Appalachians, and John Elder on the edge of wilderness, Louisa Willcox on grizzlies, politics from Carl Pope, Ken Rait's Heritage Forests, Jim Jontz's Big Wilderness Legislative Strategy, Debbie Sease & Melanie Griffin's stormy political forecast, Dave Foreman on the River Wild as metaphor, Mike Matz's Domino Theory, Wilderness campaign updates from Oregon, California, Nevada, Grand Canyon, New Mexico, Colorado, and Utah, NREPA, focal species paper by Brian Miller et al.

33/Spring 1999 • ***Coming Home to the Wild*** Flo Shepard, Paul Rezendes, Glendon Brunk, and Kelpie Wilson imagine rewilding ourselves, Paul Martin and David Burney suggest we Bring Back the Elephants! and Connie Barlow discusses Rewilding for Evolution, Freeman House on restoring salmon, John Davis on Anchoring the Millennial Ark, Chris Genovali exposes risks to Canada's Great Bear Rainforest, Madsen and Peepre on saving Yukon's rivers, Bryan Bird on roads and snags, George Wuerthner on population growth, Brock Evans uses wild language, Dave Foreman studies the word wilderness, and John Terborgh and Michael Soulé's "Why We Need Megareserves: Large-scale Networks and How to Design Them"

34/Summer 1999 • ***Carnivore Ecology and Recovery*** "The Role of Top Carnivores in Regulating Terrestrial Ecosystems" by Terborgh et al., Todd Wilkinson on the Yellowstone Grizzlies Delisting Dilemma, Wolves for Oregon, Carnivores Rewilding Texas, fire ecologist Tim Ingalsbee suggests we Learn from the Burn, David Orr continues the Not-So-Great Wilderness Debate, Tom Fleischner on Revitalizing Natural History, Jim Northup remembers Wildlands Philanthropist Joseph Battell, the Continuing Story of the American Chestnut

35/Fall 1999 • Nina Leopold Bradley, David Ehrenfeld, Terry Tempest Williams, and Curt Meine celebrate Leopold's legacy, wildlands philanthropy saves forests in Washington & California, Thomas Vale dispels the Myth of the Humanized Landscape, articles on Indigenous Knowledge and Conservation Policy in Papua New Guinea and threats to northwest Siberia's cultural & biological diversity, Janisse Ray takes us to the Land of the Longleaf, Robert Hunter Jones critiques NPS fire policy at Crater Lake, State of the Southern Rockies and the Grand Canyon Ecoregions, Sizing Up Sprawl

36/Winter 1999/2000 • ***Vision*** Jamie Sayen compares abolitionism and preservationism, Winona LaDuke rethinks the Constitution, Donella Meadows on shaping our future, Deborah & Frank Popper explore the Buffalo Commons, and Michael Soulé on networks of people and wildlands; Dave Foreman puts our extinction crisis in a 40,000-year context, Gary Paul Nabhan update on monarch butterflies and transgenic corn, David Maehr on South Florida carnivores, Michael Robinson discusses politics of jaguars and wolves in the Southwest, Reed Noss reserve design for the Klamath-Siskiyou, Andy Kerr's Big Wild legislative strategy, George Wuerthner on local control, Roger Kaye explores the Arctic National Wildlife Refuge

37/ Spring 2000 • ***The Wildlands Project Special Issue*** E.O. Wilson offers a personal brief for TWP, Harvey Locke suggests a balanced approach to sharing North America. Sky Islands (AZ, NM) section: 4 articles on the Sky Islands Wildlands Network by Dave Foreman et al. address the elements of a conservation plan, healing the wounds, and implementation, color map of the draft proposal, Wildlands Project efforts in Mexico's Sierra Madre Occidental, David Petersen's "Baboquivari!", Leopold's legacy in New Mexico. Wildlands networks proposals for the Central Coast of British Columbia by M.A. Sanjayan et al. & the Wild San Juans of Colorado by Mark Pearson. Mike Phillips on conserving biodiversity on & beyond the Turner lands, the economy of Y2Y, roadless area protection by Jim Jontz

38/Summer 2000 • ***American Parks and Protected Areas*** Foreman on resourcism vs. will-of-the-land, historical perspectives from John Muir and Gifford Pinchot, Richard West Sellars reflects on the history of national park management, American environmentalism 1890–1920, David Carle calls for expanding national parks by shrinking national forests, Andy Kerr and Mark Salvo describe problems with livestock grazing in parks and wilderness, Sonoran Desert National Park proposal, David Rothenberg and Michael Kellett debate on Maine Woods National Park, wildlands proposals for Maine and connectivity between Algonquin and Adirondack parks, Brad Meiklejohn retires cows from Great Basin, southwest New Hampshire wildlands, a Maine land trust, viewpoints on biodiversity conservation and "nature as amusement park," Thomas Berry interview

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Additional *Wild Earth* Publications

Old Growth in the East: A Survey
by Mary Byrd Davis

Special Paper #2: *While Mapping Wildlands, Don't Forget the Aliens* by Faith T. Campbell

Special Paper #3: *A Citizen's Guide to Ecosystem Management* by Reed Noss

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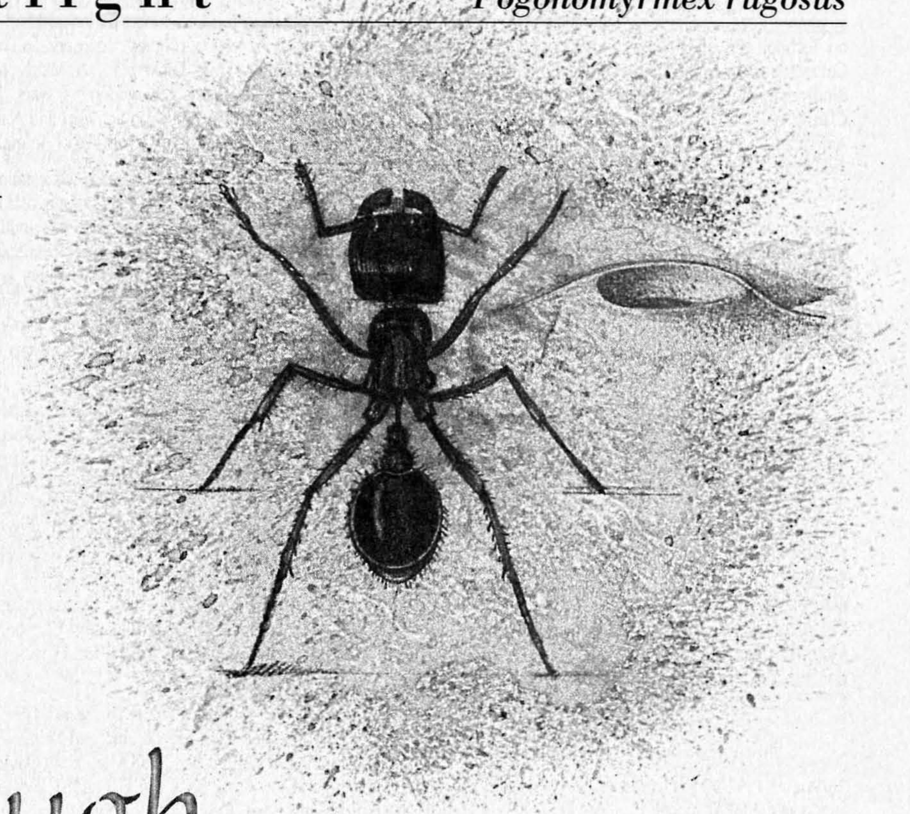
If all of humanity were to disappear, the remainder of life would spring back and flourish.... If all the ants somehow disappeared, the effect would be exactly the opposite, and catastrophic.

—Bert Hölldobler and Edward O. Wilson, JOURNEY TO THE ANTS



Rough Harvester Ant

NAME Harvester ants are named for their feeding activity: they forage for seeds. *Pogonomyrmex* means "bearded ant" in Greek, a reference to the hairs that cover the bodies of these big ants; *rugosus,* or "wrinkled" in Latin, apparently refers to the rough look caused by the coarse hairs.

SIZE Up to one-half inch long, depending on the caste, with a large, helmetlike head and massive jaws

COLOR Black head and rust red abdomen

RANGE The most conspicuous ant in the deserts, found throughout the southwestern United States and northern Mexico

HABITAT Areas of sandy or silty soil from basin floors up to the woodlands of the lower mountains

NOTES Nest entrances are surrounded by a mound up to two feet across. Beyond that, they may graze bare an area many feet in diameter.

On a July evening in 1975, entomologist Bert Hölldobler stumbled on an extraordinary find: a harvester ant mating ground. It was, as he describes in *Journey to the Ants,* an area in the open desert the size of a tennis court, where the ground was "roiling" with big, winged ants. Hölldobler watched, fascinated, as thousands of harvester ant queens flew in, lit on the ground, and were rushed by eager males. Once successfully inseminated, a queen rubbed two body segments together, making a squeaking noise. At that signal, her suitors dropped off and rushed away to pursue another female. The mated queen flew away; the males stayed on for more trysts.

The discovery of this harvester ant lekking ground surprised Hölldobler and other myrmecologists (scientists who study ants). Vertebrate animals such as sage grouse and pronghorn antelope were known to gather at a lek, a sort of wild Lover's Lane, to court and mate, but not ants. Further, Hölldobler found, the harvester ants returned to the exact same spot to mate July after July. Yet, each year's eager suitors were a brand-new generation—how did they know to fly to that spot in the desert? What signals and genetic memories trigger such gatherings? We do not know.

Harvester ants are the largest and most conspicuous ants in the deserts. Like all ants, they are social insects, members of highly organized colonies numbering from a few dozen to millions of individuals. A mated queen founds a colony by first nibbling off her now-useless wings, and then scratching out a small chamber in the soil and laying a batch of eggs. (Her mate and the other males of her generation die soon after the mating flights.) She survives without eating as this first generation grows by metabolizing her flight muscles and the fat in her own body. After the offspring mature, however, they care for her, leaving the queen with literally nothing to do but lie around and reproduce. Over perhaps six years of life, a harvester ant queen may lay thousands of eggs fertilized by the sperm stored in her body from that single mating frenzy. The majority of her eggs grow into sterile, wingless female ants. These generations devote their lives to tending the queen and their sisters, enlarging the nest, foraging for food, and defending the colony.

When a harvester ant colony has grown sufficiently large, the queen lays special eggs which mature into winged, fertile beings of both sexes. On summer evenings after rainstorms, the winged ants pour from their parent colony, take to the air, and cruise for mates. After the frenzy is over, mated females fly off in search of a place to dig a nest; males die. The next year, a new generation arrives to consummate their desires.

Ant colonies are excellent examples of superorganisms, groups of lives that act as if they were parts of some larger being. Altruism, cooperation for the sake of the whole group, is the corporate culture here, not independent thinking. According to Hölldobler and his colleague Edward O. Wilson, this self-sacrificial colonial existence is the reason for ants' abundance and importance on earth.

Harvester ants, as their name implies, are seed-eating ants. In clement weather—when the above-ground air temperature is between about 60 and 120 degrees—harvester ant workers stream out of their underground nests to collect seeds and leaves. These efficient foragers have an enormous impact on desert ecosystems. Workers from a single colony of harvester ants travel as far as 130 feet from their nest, and can collect as many as 7,000 seeds in a day—over 2 million seeds per year. (Each worker can lift fifty times her own weight.) Colonies often strip the vegetation around their nest for many feet. The relationship between plants and ants works both ways, however. Some desert plants, including sacred datura, rely on harvester ants to spread their seeds around. These plants have evolved seeds with alluring scents, special "handles" to make carrying easy, and tough coats that ant jaws cannot penetrate. Ants carry the seeds away from the parent plant, but abandon them uneaten.

Since harvester ants are abundant and large, it seems logical that they would be a coveted food source. But their aggressive self-defense deters most predators. A harvester ant grasps its attacker with powerful jaws, thrusts the stinger at the end of its abdomen into the attacker's skin, and injects a venom that causes excruciating pain in humans and can immobilize smaller animals.

One predator, however, has evolved ways to exploit this plentiful, but difficult, food resource. Horned lizards—small, stout lizards unique to the western parts of North and Central America—eat *only* ants, including harvester ants. Horned lizards are named for the ferocious collar of hornlike spines that rings the base of their head. Their flattened, toadlike body earns them another common name, horny toad.

Horned lizards' predilection for ants means significant tradeoffs for the little lizards. Their chosen food may be abundant, but it is low in energy, giving these lizards a sluggish metabolism. In order to obtain sufficient nutrition, horned lizards must pack away large amounts of ants, hence their tanklike body, designed to accommodate an enormous stomach, which comprises some 30 percent of their body weight. (In a 120-pound human, an analogous stomach would weigh about forty pounds!) Even the lizards' hunting behavior is affected by their prey: in order to avoid being stung, horned lizards hunt with unlizardlike stealth. A horned lizard hides by an ant foraging trail, munches a few ants, and then moves on before its prey notice it and attack. Horned lizards have also evolved antitoxins specific to harvester ant venom.

With chunky bodies and slow metabolisms, horned lizards rely on camouflage rather than speed to escape becoming dinner themselves. They can change the background color of their scales to match the shade of the soil. Dark blotches on their backs mimic shadows; fringed scales around the edges of their midsection break up their outline. Motionless, the stout lizards simply disappear. When a predator does spot one, a horned lizard calls on unusual defenses. It gulps air like a blowfish, swelling up so that its sharp "horns" make it nearly impossible to swallow. In extreme danger, a horned lizard can even squirt a stream of blood from a pore in its eyelids, startling and deterring its attacker.

Harvester ant nests are easy to locate. These ants dump their trash—waste, seed husks, small pebbles, and excavated soil—around the entrance to their nest, accumulating a cone-shaped mound. The thermal mass of the mound helps regulate both temperature and humidity inside the extensive nest. If you find a harvester ant nest, walk outwards from it in a spiral, looking closely at every small, warty rock that you see. You may find a horned lizard, waiting for a meal. ☾

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Kirk Caldwell *is an award-winning San Francisco Bay Area artist and designer.* *This essay and illustration originally appeared as a chapter in* Seasons in the Desert: A Naturalist's Notebook *(©1998 by Susan J. Tweit; illustrations ©1998 by Kirk Caldwell) and are reprinted here by kind permission of the author and artist.* Seasons in the Desert *is part of a remarkable and beautifully illustrated collection of natural history notebooks by Tweit that are available from Chronicle Books (85 Second Street, San Francisco, CA 94105; www.chronbooks.com).*

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