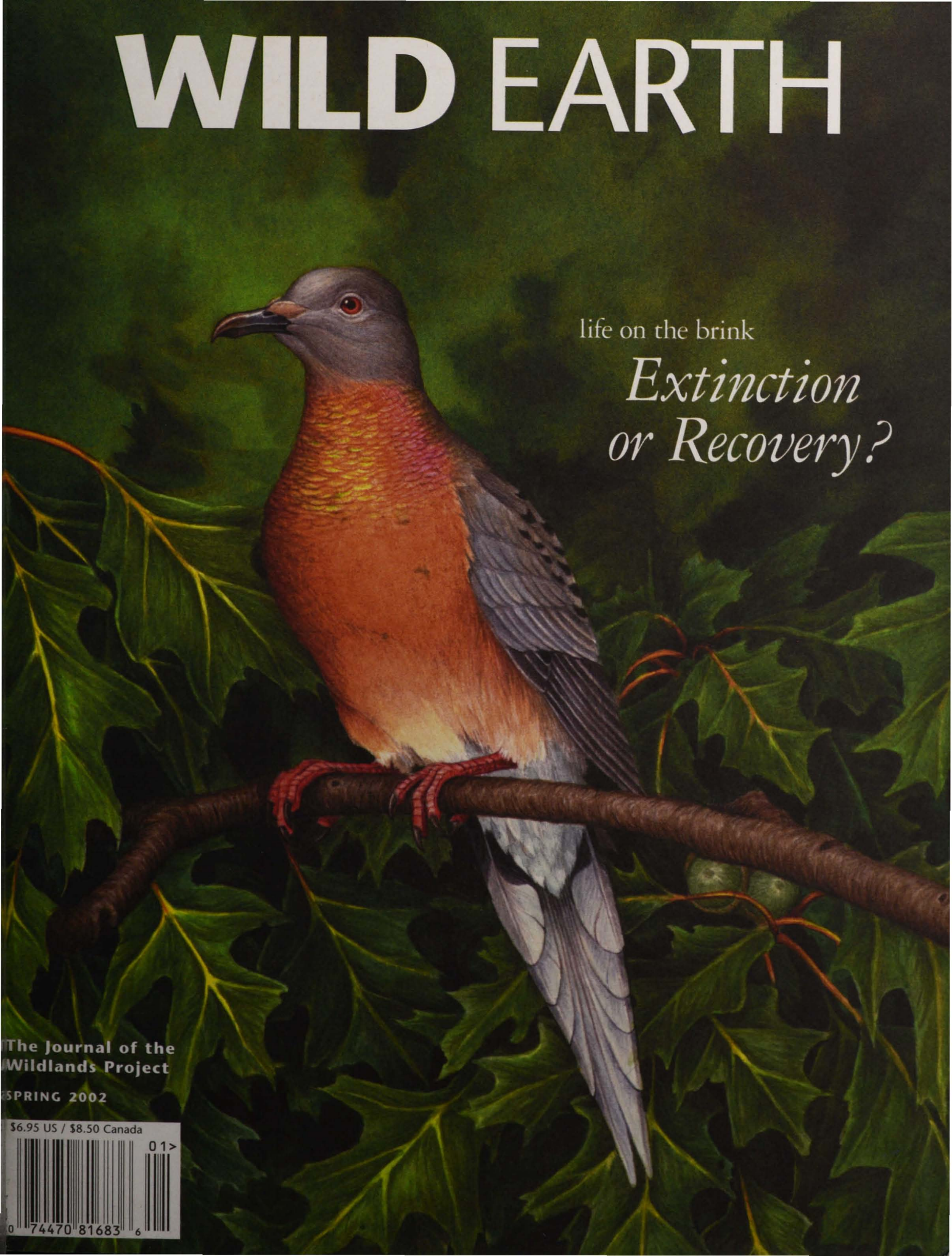
WILD EARTH



life on the brink

Extinction or Recovery?

The Journal of the Wildlands Project

SPRING 2002

$6.95 US / $8.50 Canada

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WILDLANDS PROJECT

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WE ARE AMBITIOUS. We live for the day when grizzlies in Chihuahua have an unbroken connection to grizzlies in Alaska; when wolf populations are restored from Mexico to the Yukon to Maine; when vast forests and flowing prairies again thrive and support their full range of native plants and animals; when humans dwell on the land with respect, humility, and affection.

Toward this end, the Wildlands Project is working to restore and protect the natural heritage of North America. Through advocacy, education, scientific consultation, and cooperation with many partners, we are designing and helping create systems of interconnected wilderness areas that can sustain the diversity of life.

Wild Earth—the quarterly publication of the Wildlands Project—inspires effective action for wild Nature by communicating the latest thinking in conservation science, philosophy, policy, and activism, and serves as a forum for diverse views within the conservation movement.

Wild Earth (ISSN 1055-1166) is published quarterly by the Wildlands Project, a nonprofit educational, scientific, and charitable corporation. • Periodicals postage paid at Richmond, VT and additional offices. Postmaster: Send address changes to *Wild Earth*, P.O. Box 455, Richmond, VT 05477. •

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passenger pigeon, watercolor by Matt Bohan, ©2001

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life on the brink

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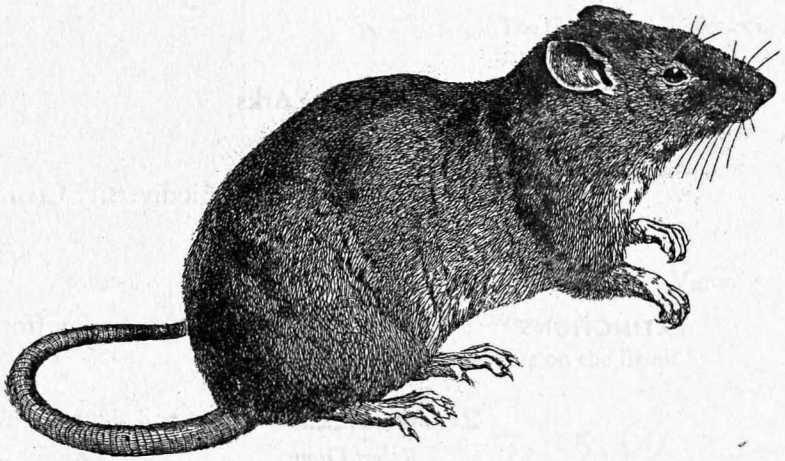


The Causes and Processes of Extinction

IN THE LAST ISSUE of *Wild Earth,* I laced together a history of how modern scientists and conservationists became aware of the reality of extinction of species, and then of today's mass extinction—the Pleistocene-Holocene Event—that humans are causing. Here, I want to look more closely at what causes extinction.

Many factors can push a species into the perpetual night of extinction. However, only a few things can cause mass extinction. For past mass extinctions, cataclysmic events—either terrestrial or extraterrestrial—so altered or harmed the biosphere that many species and whole groups of organisms died out. Scientists have found convincing evidence that the extinction of the dinosaurs 65 million years ago came suddenly (perhaps in a matter of days or weeks) when an asteroid struck Earth in a shallow sea where today's Yucatan peninsula of Mexico lies. A 180-mile-wide crater was formed at Chicxulub. The shock wave, tsunami, and widespread, massive forest fires from associated meteors killed many creatures immediately. Then a thick dust cloud in the atmosphere reduced by 20% the solar energy reaching Earth for a decade. University of Washington paleontologist Peter Ward writes that "this reduction would have been sufficient to produce a decade of freezing or near-freezing temperatures in a world that had been largely tropical. The prolonged 'impact winter'...is thus the most important killing mechanism...."[1] (Tim Flannery's recently published book, *The Eternal Frontier,* fills in much detail on the ecological effects and long-term consequences of the impact on North America—the part of Earth especially devastated.[2])

The great Permian extinction about 248 million years ago may have been caused by massive volcanism (flood basalts across Siberia are evidence) and the release of huge amounts of carbon dioxide from the deep ocean (there was only one ocean and one continent at that time).[3] The Triassic extinction about 180 million years ago could have happened from the giant continent Pangea breaking up and forming the Atlantic Ocean, thereby altering ocean circulation patterns and causing massive climate change.

Norway rat (*Rattus norvegicus*), engraving ca. 1800

But what causes "normal" extinctions, the kind that make up the background rate between the few big catastrophes? A species can become "extinct" by evolving into another species or several other species (speciation driven by natural selection), or a species may completely die out and not continue its evolutionary experiment. The latter is real extinction.

Extinction or evolution into daughter species is the fate of all life. Careful study of the marine invertebrate fossil record shows that species usually last for one million to ten million years.[4] Michael Soulé lists the possible factors that may lead to extinction:

1. Rarity (low density)
2. Rarity (small, infrequent patches)
3. Limited dispersal ability
4. Inbreeding
5. Loss of heterozygosity (genetic diversity)
6. Founder effects*
7. Hybridization
8. Successional loss of habitat
9. Environmental variation
10. Long-term environmental trends (such as climate change)
11. Catastrophe
12. Extinction or reduction of mutualist populations
13. Competition
14. Predation
15. Disease
16. Hunting and collecting
17. Habitat disturbance
18. Habitat destruction

Soulé points out that some of these factors "do not become operative until one or more of the other factors have reduced the local populations to a very small size."[5] (Note that he lumps the natural and human causes.)

In *Song of the Dodo,* David Quammen does a masterful job of showing how these various factors could work in concert to bring a species to its night.[6]

Soulé warns, however, that "it is disappointing that we know so little about natural extinction." Why does modern science know so little about this fascinating subject? It is because "no biologist has documented the extinction of a continental species of a plant or animal caused solely by non-human agencies...."[7]

The grim truth is that *we* are the cause of modern extinctions. How do we do it?

Extinction expert David Wilcove and his colleagues list five anthropogenic causes of extinction in the United States, in order of current importance:

1. Habitat destruction
2. Non-native (alien) species
3. Pollution
4. Overexploitation
5. Disease[8]

Carnivore ecologist Brian Miller of the Denver Zoo tells me that, worldwide, overexploitation is far more important than in the United States. In Miller's recent book (with Rich Reading), *Endangered Animals,* experts discuss the threats to 49 imperiled species around the world. For many of these creatures, direct killing by humans remains a major cause of their plight.[9] Let me give just a few examples of the ways we humans cause extinction in each of these categories.

HABITAT DESTRUCTION. We modify or transform natural habitat upon which species depend by burning, agricultural clearing, logging, mining, grazing by domestic animals, preventing natural fire, damming rivers, dewatering rivers through irrigation diversion, drying up springs and streams through groundwater pumping, eliminating keystone species like beaver and prairie dogs whose activities create habitat for other species, and urban and suburban development. Furthermore, we fragment habitat—thereby disrupting necessary patterns of movement of many species—through the above activities and by building roads, clearing powerline rights-of-way, and driving vehicles.

NON-NATIVE (ALIEN) SPECIES. As humans have spread into new lands, we have brought with us disruptive alien species that are generally well adapted to human disturbance and that outcompete native species, in part because their normal enemies, such as predators and diseases, are left behind. Such damaging invaders include plants and animals, both deliberately introduced species such as domestics or ornamentals, and accidentally introduced species such as weeds or pests. These non-native species include predators (cats, rats, pigs) and competitors (starlings, tamarisk, zebra mussels). Alfred Crosby of the University of Texas offered an early and insightful look at exotic species invasions in

The grim truth is that *we* are the cause of modern extinctions. How do we do it?

* Defined as "the principle that the founders of a new population carry only a random fraction of the genetic diversity found in the larger, parent population" (Gary K. Meffe, C. Ronald Carroll, and contributors, 1994, *Principles of Conservation Biology,* Sunderland, MA: Sinauer Associates, Inc.).

Ecological Imperialism: The Biological Expansion of Europe, 900–1900. He showed that temperate regions of the world in North America, South America, Australia, and New Zealand had become "neo-Europes" with the arrival of European colonists and their domestic crops and livestock, and weeds, diseases, and pests.[10]

POLLUTION. Pollution, whether localized or global (acid rain, greenhouse gases), can poison the waters and soils that are habitat for sensitive species, or leach away needed nutrients. Global warming and atmospheric ozone depletion—major threats to life forms worldwide—are caused largely by air pollution.

OVEREXPLOITATION. Hunting, fishing, trapping, collecting, and government "pest" eradication programs have caused the extinction of many species and seriously endanger others today.

DISEASE. As humans have spread around the world, we have brought exotic diseases with us. Global trade is spreading many new diseases. An exotic disease caused the loss of the American chestnut in the wild. The black-footed ferret was nearly wiped out by canine distemper, a disease not native to the Americas.

IT IS THE TASK of modern conservation to stop human-caused extinction. There is nothing more important; there is no greater ethical demand. Aldo Leopold called this healing ecological wounds.[11] The Wildlands Project is inspired by Leopold's vision of actively healing the wounds to the land, and has adapted Wilcove's five categories of wildlife threats into six primary categories of ecological wounds that we identify for conservation planning:

1. Species loss and decline
2. Ecosystems loss and degradation
3. Loss and decline of natural processes
4. Invasion by exotic species and diseases
5. Habitat fragmentation
6. Pollution

Based on these categories we can articulate conservation goals that will halt anthropogenic extinction through a dual approach of protection and restoration:

GOAL 1. Permanent protection of extant native species from extinction or endangerment, and recovery of all species native to a region.

GOAL 2. Permanent protection of all habitat types from further degradation and loss, and restoration of degraded habitats.

GOAL 3. Permanent protection of the functioning of ecological and evolutionary processes, and restoration and maintenance of disrupted ecological and evolutionary processes.

GOAL 4. Protection of the land from further fragmentation, and restoration of functional connectivity for all species native to a region.

GOAL 5. Prevention of the further spread of exotic species (including disease organisms), and elimination or control of exotic species present.

GOAL 6. Prevention or reduction of the further introduction of ecologically harmful pollution in a region, and removal or containment of existing pollutants.[12]

Such a framework gives conservationists a useful way to organize our various campaigns to protect wilderness and wildlife—to develop a practical vision of how we can sustain the diversity of life.

Reed Noss said it best in these pages 10 years ago: "We have an opportunity unique to our generation: to halt a mass extinction."[13]

~ Dave Foreman
somewhere on the border

NOTES

1. Peter D. Ward, 1997, *The Call of Distant Mammoths* (New York: Copernicus), 62.
2. Tim Flannery, 2001, *The Eternal Frontier: An Ecological History of North America and Its Peoples* (New York: Atlantic Monthly Press).
3. Ward, *The Call of Distant Mammoths,* 35–37.
4. Stuart L. Pimm, Gareth J. Russell, John L. Gittleman, and Thomas M. Brooks, 1995, The future of biodiversity, *Science* 269 (21 July): 347.
5. Michael E. Soulé, 1983, What do we really know about extinction?, in *Genetics and Conservation,* ed. Christine M. Schonewald-Cox et al. (Menlo Park, CA: Benjamin-Cummings), 116.
6. David Quammen, 1996, *The Song of the Dodo: Island Biogeography in an Age of Extinctions* (New York: Scribner), 294–296, 515–19.
7. Soulé, What do we really know about extinction?, 112.
8. David S. Wilcove, D. Rothstein, J. Dubow, A. Phillips, and E. Losos, 1998, Quantifying threats to imperiled species in the United States, *BioScience* 48 (August 1): 607–615.
9. Richard P. Reading and Brian Miller, eds., 2000, *Endangered Animals: A Reference Guide to Conflicting Issues* (Westport, CT: Greenwood Press). This is an essential reference on the extinction crisis.
10. Alfred W. Crosby, 1986, *Ecological Imperialism: The Biological Expansion of Europe, 900–1900* (New York: Cambridge University Press).
11. Aldo Leopold, 1972, The Round River—A parable, in *Round River: From the Journals of Aldo Leopold* (New York: Oxford University Press), 165.
12. The Wildlands Project, *The New Mexico Link Wildlands Network Vision,* forthcoming.
13. Reed Noss, 1992, The Wildlands Project land conservation strategy, *Wild Earth* Special Issue: 10.

The opinions expressed in Campfire are my own, and do not necessarily reflect official policy of the Wildlands Project. —DF

AS A REGULAR READER of *Wild Earth,* I was excited to see a theme issue [fall/winter 2001–2002] on a topic I am especially close to—citizen science. But I found myself disappointed that the articles presented a limited understanding of the work of citizen scientists. In his anchor essay, Reed Noss labors his distinction between scientist and naturalist, a point that does not serve to focus the reader's attention or respect toward the work of citizen scientists. Two pages later, Rick Bonney characterizes citizen science projects as involving the public in organized research. The rest of the articles in the theme all report on citizen science as it fits within Bonney's definition.

I see the work of citizen scientists as much broader than was reflected in either Noss's or Bonney's essay, or any of the essays that followed. Both Noss and Bonney omit discussion of other kinds of citizen scientists, three of which seem to me important: self-trained independent scientific researchers; degreed researchers working independent of institutional affiliation; and organizations that perform scientific research independent of a staff with advanced scientific degrees.

Noss briefly acknowledges the historic contributions of self-trained independent researchers by mentioning the work of John Muir. But he then dismisses discussion of current work being done by such people with the observation that few people can afford the level of involvement that it now takes to obtain proficiency in the highly specialized world of science. Rare as such work might be, I am surprised that it did not warrant a more detailed look by *Wild Earth.*

But I am most concerned that recognition be given to organizations that perform scientific research outside the mainstream scientific establishment. Wildlife rehabilitation is one example of a field that has had to develop a scientific research aspect to its practice, research that is often carried out by non-degreed individuals working in humble "laboratory" conditions. Rehabilitators must conduct research in a wide array of topics, such as developing healthy diets for orphaned marsupials; anticipating which parasites are most likely to affect which species of waterfowl at which times of year; developing strategies for preventing sudden finch death; recognizing when forced hibernation in captivity will help a turtle heal.

These are just some of the kinds of projects that turn wildlife rehabilitators into independent researchers. Keeping track of case histories and treatment approaches, and also analyzing and interpreting the results of that data, are an integral part of professional practice for most rehabilitators. Many wildlife rehabilitation facilities have consulting veterinarians or conservation biologists, but many do not. And such professionals, even when present, do not necessarily play a role in organizing long-term research.

Megan Shaw Prelinger
San Francisco, California
Megan Shaw Prelinger is a wildlife rehabilitator at the International Bird Rescue Research Center in Cordelia, California.

THANKS FOR THE great piece by Douglas W. Scott on "'Untrammeled,' 'Wilderness Character,' and the Challenges of Wilderness Preservation" [fall/winter 2001–2002]. Not surprisingly, Scott takes a close look at the definition of wilderness penned by my

father, Howard Zahniser, the drafter of the 1964 Wilderness Act. The deliberate use of *untrammeled* in the definition can be read as more than a description of wilderness as self-willed lands; it also suggests an orientation of thought and spirit.

One of Howard Zahniser's literary heroes was the visionary English artist, engraver, and poet William Blake (1757–1827). In *Your Reason & Blake's System* (Hanuman Books, 1988), Allen Ginsberg says that in Blake's *Song of Los* and *Book of Urizen* "there are long, long passages describing the senses creating the world." Blake sees the human world system divided between the body, emotion in the body, imagination, and reason. Urizen personifies reason.

"Blake's basic conception," Ginsberg says, "is that if any single one of them 'takes over,' like Urizen (which he thought was characteristic of the Industrial Scientific Revolution), then all four parts of the human universe fall out of balance....His analysis of the present Western Industrial situation is that hyper-rationalism, Urizen, has taken over."

Urizen's "downfall to the state of Satan or error...was the desire for more power, more territory, for dominion, the ego-centric desire for total mental control of nature." To illustrate Urizen's punishment for overweening pride Blake showed him "bound in the hoary fishnet of his own thought-forms." Such a fish net is a *trammel*, so *untrammeled* would imply the absence of human "mental control of nature." This, too, is part of our wilderness imagination.

Ed Zahniser
Shepherdstown, West Virginia

Remembering Joy Belsky, Ph.D. (1944–2001)

THE CONSERVATION MOVEMENT has many exceptional scientists. The conservation movement has many exceptional advocates. Joy Belsky was both.

Most of us know a clearcut or even a tree farm from a forest. But grasslands are less intuitive. From the Serengeti to the once-lush regions of Oregon's high desert, Joy knew grass. She looked where she walked—and came to intimately understand the soils and grasses on which so much other life depends. In over 40 peer-reviewed papers on grassland ecology, she never shied from where the data led her: exotic alien species such as cattle and sheep degrade the land. Killing predators to make the land safe for domestic animals that have had the smarts bred out of them also degrades the land, hurts ecosystems, and disrupts vital natural processes.

Joy was never content to simply let others take her findings and try to redress the problem. And she certainly was not willing to have the science ignored by public land management agencies mandated to follow it but ultimately more attuned to political heat than ecological truth. Her courage was matched only by her tirelessness. She knew that persistence was important to success.

Conservationists—and even many of her opponents in the debates over livestock grazing and rangeland health—will miss Joy's intellectual contributions. And those of us who knew or had the privilege of working with Joy during her years at the Oregon Natural Resources Council or Oregon Natural Desert Association will miss her greatly. But her presence lives on in our hearts and in the land she loved and sought to help heal. Her legacy is wildness, integrity, and fearlessness in defense of living things.

David Johns
McMinnville, Oregon

THE DISCUSSION concerning population and immigration in the fall/winter issue [letters] neglects the impact of immigration on increased world population. One writer, Andy Robinson, even suggests that migration into the United States might create a net benefit for the continent's wildlife. What nonsense!

Local governments have long understood the desirability of letting their impoverished citizens emigrate rather than stay home to become criminals or foment revolution. During the 1880s, the Chinese Qing dynasty encouraged emigration as a safety valve for heavily populated provinces. As long as an excess population can emigrate, undeveloped countries such as Mexico or India have little impetus to develop measures for population control. Thus emigration encourages overpopulation. Secondly, the emigration of well-educated doctors and engineers removes from the undeveloped countries the very people who could improve the economy and

We welcome your comments. Please send them to us at P.O. Box 455, Richmond, VT 05477 or e-mail to letters@wild-earth.org. Published letters may be edited for length and clarity.

implement measures to control population. New immigrants are typically young with large families. They commence having children at a young age. In Chicago, the rate of teenage pregnancy is highest in the Hispanic population. One can best study emigration and population by looking at islands. Haiti is the world's best example of overpopulation, massive environmental destruction, and social unrest. The population of that island continues to skyrocket despite the fact that one-sixth of Haitians live in North America.

Edward O. Wilson estimates that the human population has already exceeded the Earth's sustainable carrying capacity. It is sad when so-called environmental organizations have their attention diverted by social rather than environmental issues. The Sierra Club, by not opposing immigration, is the best example. Our greedy businessmen and righteous, right-wing politicians encourage immigration to have a constant supply of cheap labor to produce all the useless gadgets purchased by our consumer society. We should applaud and emulate China's one family, one child policy.

Ed Abbey said, meet them at the river, give them a good rifle and cartridges, and send them back to change their government. We could amend that: give them a ten-year supply of condoms.

John Raffensperger, MD
Chicago, Illinois

ERRATUM *As part of our coverage of citizen science in the last issue, we published "Diving for Data," adapted from an article which originally appeared in* Underwater Naturalist *(vol. 25, no. 4), the journal of the American Littoral Society. We accidentally omitted the credit line and regret the error.*

Bloodroot

Out of the cold tatters of years,
we are born by spring's sleight of hand

to live for a time under trees,
to dig, to take hold of what we can.

We flourish in wind, love the sun
and the light that drifts at the pace

of clouds when there is no wind
but just the earth turning. We grieve

rain even as we drink it. Bless
the legs of bees, the mouths of birds,

the blue capes which enclose us,
the blood red at the root of us.

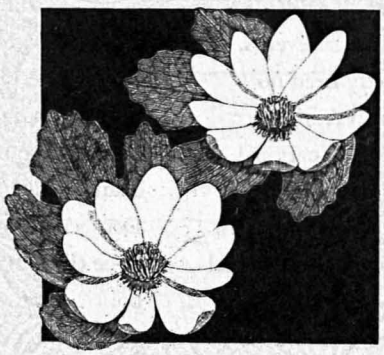
Night ages into day. We dress,
we undress, throw down our linen

and gold, gather in the brightness
and press it, because we must,

because it is shrinking, because
the only magic we learn

through our denial is that we
vanish into winter's white folds.

Gary J. Whitehead



bloodroot, scratchboard by Suzanne DeJohn

Life on the Brink

IN NEARLY FIVE YEARS of writing this column, I have studiously avoided discussing short-term, electoral politics. That's intentional: Few things go stale so quickly as political news or commentary, and in this journal we generally strive to present articles, and even editorials, that will have an extended shelf life.

This issue's theme coverage on imperiled species, ecosystems, and processes is timed, however, to align with political events—namely, the imminent legislative battle over the Endangered Species Act (ESA) and forthcoming mid-term congressional elections. The writers herein, though, are hardly constrained to topics of passing interest; they explore formidable questions before the conservation community: What kinds of arks must we build to float a more durable, ecologically vibrant civilization? Does focusing on extinction rates help or hinder the cause of protecting endangered wildlife? What constitutes recovery of endangered species—mere demographic viability or function in the ecosystem?

These and other questions of pressing importance to long-term wilderness recovery are most definitely affected by current political events. *Wild Earth* readers likely need no reminder of recent Bush Administration actions—rolling back national forest roadless area protection, abandoning grizzly bear reintroduction in Idaho, failing to fight developers' challenges to critical habitat designations for endangered species, and working to open the Arctic National Wildlife Refuge to petroleum development.

The directive to public land managers has been made perfectly clear: get the log trucks rolling and the roughnecks drilling. Keep the cows grazing, the miners digging, and motorized recreationists despoiling public lands. How are agency and justice department lawyers to help? Roll over and play dead when developers sue to overturn current protections for endangered species and habitats, or clean air and water. Settle up. Give in. Polluters win.

So far, this strategy is working famously—for the developers and the politicians who support their looting of public resources. The mid-term elections later this year will not end these outrages (indeed, supporting public lands exploitation has a rich bipartisan tradition), but the control of the Senate—whether Tom Daschle (D-SD) or Trent Lott (R-MS) wields the gavel—will make the Bush administration's war on wilderness and wildlife more or less effective. That marginal difference may make all the difference for many wild places and creatures.

For my part, I hope that the large, Washington D.C.–based environmental groups will wage an all-out counteroffensive against the administration's assault on wild America. With the control of both legislative chambers at stake, and the razor-thin Democratic majority in the Senate, I hope they'll use every tactic of modern political warfare to help elect pro-conservation candidates—of whatever party or no party at all. In the current political landscape, though, that usually means Democrats. (It would take another essay to consider why that is problematic, and why the as-yet unsuccessful efforts of Republicans for Environmental Protection [www.Repamerica.org] to move the GOP back toward its traditional pro-conservation values is vital to conservation movement success.)

Despite misgivings about unseemly tactics (does it not seem odd that the modern marketing tools used to sell this or that detergent are similarly employed to help voters choose a living planet?), I hope that pro-Nature partisans will use to good effect every scrap of information generated by the social scientists, pollsters, and pitchmen who test Americans' political attitudes. If focus groups and polling can identify the hot-button issues for target constituencies of conservation voters—say, clean air and water for suburban Republican soccer moms, or healthy wildlife populations for Democratic southern male hunters and anglers—and thereby elect good candidates, that's a victory, right?

Yes, it is—but I worry about conservationists relying too much on feel-good, utilitarian, what's-in-it-for-me messages even if they are effective in today's election cycle. (The Sierra Club's slogan, "for our families and for our future," probably tests great in focus groups, but surely grates on conservationists who value Nature for its own sake.) That way lies peril, or at

least a moral quagmire, if conservation movement communications reinforce dominant, anthropocentric attitudes that the natural world is simply for human use, enjoyment, and profit. What then of species with no known or potential utility to humans? How will society come to value all members of the land community if conservationists don't emphasize the intrinsic right of other species to life and liberty?

You may remember the "medicine bottle campaign" of 1995 when activists working to fend off another assault on the Endangered Species Act urged ESA supporters to send empty medicine bottles to Congress. (Try *that* in post-anthrax America!) The conceit, of course, was that we must fight for the ESA because someday an endangered plant may yield a cure for cancer. If that campaign was effective in drawing links between ecosystem and human health, fine. But I remember thinking at the time that its blatantly utilitarian approach to generating concern for imperiled wildlife was ethically repugnant.

Endangered species are not just potential vaccines or canaries in the coal mine, warning of illness in the land community that may affect human health and welfare. (Although they may be this too.) They are our biological neighbors and relatives, products of the same evolutionary pressures and processes that created us. Understood another way, they are part of the same sacred Creation, the great mystery and miracle of life. Humanity's greatest crime against beauty and integrity—against Creation—is causing other species to become extinct.

Whether or not concern over the extinction crisis can be translated into significant voting bloc pressure in American elections is questionable. Arguably, though, conservation messages based on Nature's intrinsic value and the rights of other species already have some currency in the body politic. In their fascinating book *Environmental Values in American Culture,* Willett Kempton and his coauthors gauged attitudes across the spectrum, from presumably pro-conservation to anti-conservation groups.* They tested anthropocentric and biocentric conservation arguments of various kinds with Earth First!ers, Sierra Club members, the general public, California dry cleaners (where air quality regulations had affected the industry), and laid-off sawmill workers in the Pacific Northwest.

The results were remarkable. For example, consider the levels of agreement to the statements below:

Kempton's study and others suggest that a majority of Americans believe that plants and animals do not exist primarily to be used by humans: wildlife and wild places have a right to exist whether or not they benefit us. That's hopeful news, and our public communications should build on this foundation, not undermine these attitudes by emphasizing utilitarian arguments for conservation.

To be sure, the need to protect endangered species and the natural habitats on which they depend is also a practical matter, but, fundamentally, it is an ethical imperative. It's a matter of right and wrong.

Will we allow canebrakes, California condors, and prairie dogs to survive and thrive in twenty-first-century America? Will Alaska's coastal plain be defiled by oil development or be preserved as a self-willed landscape where self-willed animals find refuge? That remains to be seen, but one key step toward that noble goal of wilderness and wildlife preserved is for millions of conservation-minded people to step into voting booths later this year.

~ Tom Butler

	Earth First!	Sierra Club	Public	Dry cleaners	Sawmill workers
All species have a right to evolve without human interference. If extinction is going to happen, it should happen naturally, not through human action.	100%	82%	87%	77%	59%
If there is no economic, aesthetic, or other human use for a species, for example, some lichen out in the desert, then there is no reason to worry much about it becoming extinct.	0%	15%	13%	17%	52%
Justice is not just for human beings. We need to be as fair to plants and animals as we are towards people.	97%	85%	90%	83%	63%
Our obligation to preserve nature isn't just a responsibility to other people but to the environment itself.	97%	100%	87%	90%	82%

* Willett Kempton, James S. Boster, and Jennifer Jartley, 1995, *Environmental Values in American Culture,* Cambridge: MIT Press.

A Fleet of Arks

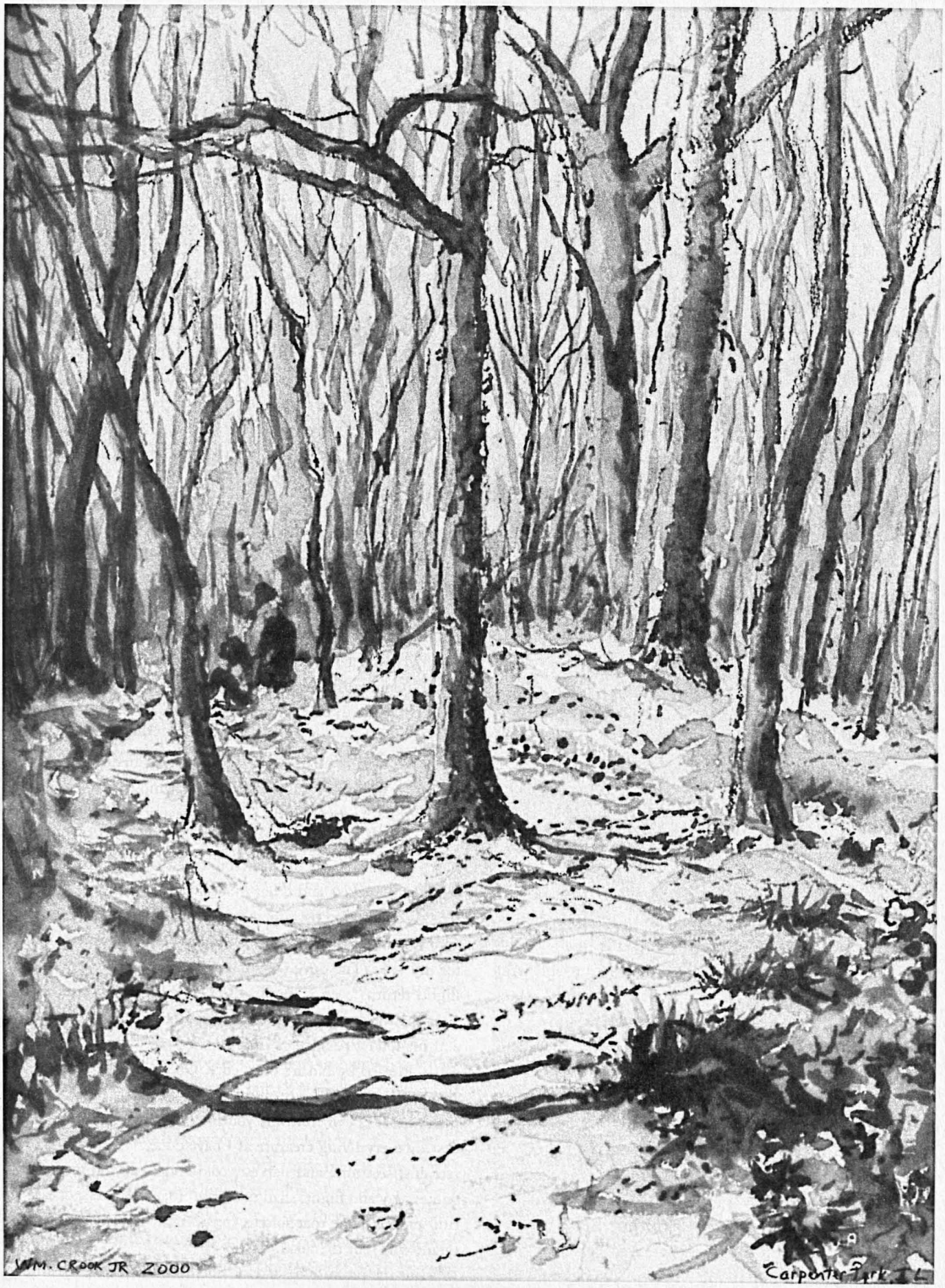
BY SCOTT RUSSELL SANDERS

AT DAWN ONE MORNING this past July, police showed up with bullhorns, bulldozers, chainsaws, and guns to force a band of protesters out of a 50-acre woods in my hometown of Bloomington, Indiana. The sheriff and his deputies and the state police were upholding a ruling by the county council, which gave an Indianapolis developer the right to turn these woods into an apartment complex. The protesters were upholding the right of the woods to remain a woods, one of the last parcels of big trees left within the noose of roads encircling our city. A few protesters had lived for months up in the trees on temporary platforms, while local people took turns bringing them food and drink. The tree-sitters were arrested along with a number of their supporters, sixteen in all, and they are now awaiting trial. As I write these lines, the trees are falling, and a private security firm guards the perimeter of the vanishing woods.

The police had the law on their side, of course, but they also had the banks, building contractors, realtors, merchants, utility companies, fast-food vendors, newspaper, and countless other boosters that stood to make money from the development. The protesters set against that power their unarmed bodies and their unfashionable convictions. They believe there are values more important than money. They believe that red oaks and red foxes and all the creatures of the woods deserve a home. They believe that a civilized community must show restraint by leaving some land alone, to remind ourselves of the wild world on which our lives depend and to keep ourselves humble and sane.

Similar conflicts are being played out from coast to coast, in more or less dramatic fashion, over the fate of more or fewer acres. By and large the boosters are winning. Yet it's plain to many people that the Earth cannot support for much longer the extravagant way of life so common in rich countries, nor can it support the spreading of that extravagance to poor countries. Sooner or later we'll burn up all the cheap oil, we'll pump the aquifers dry, we'll cut down the last big trees, we'll fish the oceans bare, we'll plow up the last arable land and taint the last clean air. The life of endless consumption is ruinous to the planet and bound to fail. The question is not whether it will fail but when, and how the end of our spree will come—by choice, or by catastrophe.

Knowing all this, how should a person act? We might shrug off the knowledge, pretend we can go on building vast houses, driving enormous cars, shopping around the clock, wiping out other species, fouling the atmosphere, polluting water, and squandering soil forever and ever. We might admit the gravity of our situation, while counting on scientists and engineers to come up with a technical fix. We might place our faith in the free market, believing it will somehow furnish a second, unspoiled Earth for our use, once the price is right. We might concede that neither economics nor technology will enable us to pursue infinite growth on a finite globe, and so decide to live it up while we can, leaving future generations to figure out how to survive on a ransacked planet. Or we might seek to live more lightly, reducing our demands on the Earth, devising or recovering simple, elegant, durable prac-



watercolor by William Crook Jr.

tices that could serve our descendants long after the current binge of consumption has withered away.

The first four responses to Earth's limits are by far the most visible. Those who strive to live more simply are harder to see. They don't crowd the malls or fast-food shops. Occasionally they make news by defending trees from bulldozers, but they rarely show up on talk shows, on the covers of magazines, on ballots or business pages. Instead, largely invisible except to one another, they go about learning the skills and mastering the tools necessary for meeting basic human needs. They grow food. They build shelters. They make clothes. They draw energy from sun and wind and wood. They get by with fewer possessions, and learn to repair the ones they have. They create much of their own entertainment, with homemade art, music, and stories. They derive pleasure from good work, human company, and the perennial show that Nature puts on. So far as possible, they rear their children away from television and advertising. They buy as little as they can from the global economy, and instead support local economies based on cooperation, barter, and sharing. They protect and restore woods, prairies, rivers, and swamps, making room for wildness.

I think of these people as builders of arks, for their ways and works are vessels designed to preserve from extinction not merely our fellow creatures, as on Noah's legendary ark, but also the wisdom necessary for dwelling in place generation after generation without diminishing either the place or the planet. In their efforts to conserve skillful means and wild lands, they point the way beyond the rising flood of extinction—the ecological cataclysm precipitated by growth in human population and consumption—toward a new and durable civilization.

We desperately need the companionship of other species.
We need them for pleasure, for instruction, for inspiration.
We need them to recall us from the frenzy of our lives.

THE FOREST THAT THE TREE-SITTERS were trying to save is called Brown's Woods, after the local speculator who owned it. Bill Brown—who is by all accounts a rich as well as a decent man—could have sold or even donated the woods to a land trust or the city of Bloomington, but he stood to make a tidy sum by selling it to the developer, so that is what he did. The arguments for turning Brown's Woods into the Canterbury House Apartments are familiar: people need somewhere to live; people need jobs; investors deserve a return on their capital; the city must grow. We can always think of reasons for subduing land to our desires.

Whatever the arguments, the upshot is that the felling of Brown's Woods has diminished our commonwealth, and those who live here after us will inherit a grimmer, grimier place. We are not the only ones hurt. The hawks, the coyotes, the toads and salamanders, the spicebush butterflies and orb-weaver spiders will all have to leave, if they can outrun the bulldozers, and if they can find another haven anywhere near the sprawling city. The red oaks and shagbark hickories have no such chance, nor do the trout lilies and dogtooth violets, the bloodroot and chanterelles. These neighbors have no say over the future of the neighborhood. They write no checks, cast no votes. They have no voice in how we use the land—unless some of us speak up for them, as the tree-sitters have tried to do.

YOU WILL RECALL that God sends the Biblical flood in punishment for human corruption, sparing only the upright Noah, Noah's family, and a breeding pair of "every living thing" (Genesis 6:19). God instructs Noah to build an ark and take refuge there along with a male and female of each species. Then come forty days and forty nights of rain. "And all flesh died that moved upon the earth, birds, cattle, beasts, all swarming creatures that swarm upon the earth, and every man; everything on the dry land in whose nostrils was the breath of life" (7:21–22). You might wonder why all the crows and crickets and other innocent breathers must drown for sins committed by humans, but the Bible does not say.

When the skies clear, Noah sends forth a dove to search for dry land. The dove comes back empty-billed on its first flight, returns bearing an olive leaf on the second flight, and after the third flight does not return at all. Reassured, Noah and his fellow passengers drift to shore and step onto solid earth. Pleased by Noah's obedience, God vows, "I will never again curse the ground because of man, for the imagination of man's heart is evil from his youth; neither will I ever again destroy every living creature as I have done. While the earth remains, seedtime and harvest, cold and heat, summer and winter, day and night, shall not cease" (8:21–22). It's a beautiful promise, one that softens considerably the image of the tyrant who sent the flood.

But the promise has a dark side, from which we are still

suffering. For God says to Noah, "Be fruitful and multiply, and fill the earth. The fear of you and the dread of you shall be upon every beast of the earth, and upon every bird of the air, upon everything that creeps on the ground and all the fish of the sea; into your hand they are delivered. Every moving thing that lives shall be food for you; and as I gave you the green plants, I give you everything" (9:1–3). The passage may be read as merely stating the plain truth: all beasts *do* live in dread of us, because we are clever enough to displace, capture, or kill every other species. Understood in this light, God's charge to Noah may be taken as a warning not to abuse our power. But the same words may also be read—and in fact, have often been read—as justifying our utter dominion over Nature. If every animal and plant was created to serve our needs, if everything has been given into our hands, then we may use the Earth as we see fit. Read in this way, the passage becomes a license to loot the planet.

A few verses later, however, we find yet a third variation on the promise, one that clearly limits our dominion. "Behold," God tells Noah, "I establish my covenant with you and your descendants after you, and with every living creature that is with you, the birds, the cattle, and every beast of the earth with you, as many as came out of the ark. I establish my covenant with you, that never again shall all flesh be cut off by the waters of a flood, and never again shall there be a flood to destroy the earth" (9:9–11). The God who speaks here sounds chastened, as if regretting the slaughter of so many innocent beings. This God is the creator and protector of crickets and crows, rattlesnakes and rotifers. This God cherishes *all* creatures, whether or not they go about on two legs, and by implication Noah is being told to cherish them as well.

The lesson we draw from the Biblical flood depends on which of these rival traditions we embrace. One tradition blesses humans alone, conveying the whole Earth to our use; the other blesses all creatures alike, granting to each species its own right to survive and flourish. The first view instructs us to fill the Earth with our kind and to impose our will on all living things; the second instructs us to honor our fellow creatures, to show restraint in our uses of the Earth, and to take our place modestly in the household of Nature.

By and large, those who wield the levers of power in our society hold by the first view. They insist on the sovereignty of human appetite. Nothing has value in their eyes except insofar as it can be bought or sold or otherwise used. They scorn the idea that animals or plants could have rights, even the right to survive. While they fight against protections for

watercolor by William Crook Jr.

endangered species—mocking those who defend snail darters or spotted owls—they support the engineering and patenting of new life forms, which can be turned more conveniently into cash. They resist every effort to preserve wilderness; they regard public land as an arena for private plunder; they reject any limits to growth; they seek to overthrow every barrier to drilling, mining, logging, road-building, polluting, or profit-making. By largely controlling the delivery of news, advertising, and entertainment, they tell us what to believe and what to buy, and they force-feed us a lethal vision of the good life.

Those who embrace the contrary view insist that human beings belong to the community of soil, water, air, and all living things, and they seek to live in such a way as to preserve and enhance the health of this greater community. They accept limits to growth and limits to human population. Whether or not they've read the Bible, their actions are in keeping with God's command to Noah, which was to save not only those species that would be useful to humans, but *everything*—the creepers and crawlers, the stingers and biters, the predators and parasites. From a religious perspective, these are all the handiwork of God, who loves the Creation and wishes to preserve it. From an ecological perspective, each species is vital because it embodies an irreplaceable store of knowledge accumulated over millions of years, and it interacts with other species in ways far more intricate than we could ever fathom let alone recreate. Religion and biology alike instruct us to honor all life. And so, recognizing that the Earth has suffered great damage because of our carelessness, and realizing that many other species besides our own are in danger, those who believe in the solidarity of living things have set about building arks.

A BOOK MAY BE AN ARK, as *Walden* and *A Sand County Almanac* clearly are, ferrying the vision of a land ethic through stormy times. Horse-logging, organic farming, solar designing, or other practices that protect the fertility and abundance of Earth may be arks. A co-op for sharing food or housing or tools might be an ark, and so might be a community chorus, an arts center, a backyard garden, a children's science museum, a yoga class, a school—any human structure, invention, or gathering that conserves the wisdom necessary for meeting our needs without despoiling the planet.

Among the builders and tenders of arks, the ones who come closest to fulfilling Noah's task are the people who work at protecting and restoring wild lands. Some devote a portion or even the whole of their own land to providing habitat for other creatures. Others join together to protect land through conservation easements, donation, or outright purchase. In my own county, the Sycamore Land Trust has combined gifts, grants, and federal and state funds to protect a 336-acre parcel of wet bottomland forest along Beanblossom Creek, which is home to a rookery for great blue herons. Every time I see one of these magisterial birds wading in a nearby lake or flying overhead with long legs trailing, I realize they might not be here at all without the Beanblossom Refuge.

Whether protected by government, trusts, or individuals, natural lands offer the last resort for other species as well as for those of our own species who crave contact with wildness. These preserves need not be large to be valuable; every scrap of ground can serve as an ark. Quite a few people in my city have dug up their lawns and planted their yards to native flowers, ferns, shrubs, and vines. As one yard after another goes native, the roar and stink of mowers give way to the songs of birds and the smell of flowers. In summer, monarch butterflies on migration stop to sip nectar on blossoms, and in winter possums leave their tracks in the snow. All year, people walking by these exuberant yards pause on the sidewalks to gaze and listen, caught by a feral scent, a startling shape, a flash of life.

Refuge is the key word. Every unsprayed garden and unkempt yard, every meadow, marsh, and woods may become a reservoir for biological possibilities, keeping alive creatures who bear in their genes a wealth of evolutionary discoveries. Every such refuge may also become a reservoir for spiritual possibilities, keeping alive our connection with the land, reminding us of our origins in the green world.

Ark-builders realize, however, that nothing is gained by creating refuges in one place if we behave in such a way as to contribute to the pillaging of land somewhere else. If we're going to build arks, we should do everything we can to avoid swelling the flood. This means living more lightly, and it means nurturing local economies, since the global economy cares neither for the fate of the Earth nor for the health of particular places. By protecting wild land, ark-builders are helping to preserve the biological heritage—the seed stock, the diversity of species, the intricate web of fertility—that we will need to replenish the Earth after the flood recedes.

WHEN THE TREE-SITTERS were arrested in Brown's Woods, the sheriff was quoted in the paper as saying, "We want to do this slow and easy, so no one gets injured—so everybody has their say and can get on with their lives." What he didn't seem to grasp was that the protesters *were* getting on

with their lives. They were expressing their love for a piece of the Earth. In this dispute over Brown's Woods, one side has its say by sending in police and bulldozers, and by throwing the protesters in jail; the other side has its say by weaving yarn among the trees and speaking plain words on behalf of the community of all beings.

If I were in the dock—as by rights I should be, given my sympathies—I would testify that we must protect the remaining wild lands, especially in our cities, because we desperately need the companionship of other species. We need them for pleasure, for instruction, for inspiration. We need them to recall us from the frenzy of our lives. We need the birds, butterflies, frogs, and snakes to help us monitor the health of our home places. We need the trees and other plants to purify our water and air. We need wild lands as reminders of the natural cycles and deep time out of which we have evolved and on which we depend. These untrammeled spaces offer us relief from the hard, temporary, sometimes ugly shapes of human constructions.

The defenders of Brown's Woods and the other people I am calling ark-builders don't belong to a single political party. They don't follow one particular religion, or perhaps any religion at all. They don't come from one age bracket, ethnic group, or educational background. They don't obey a master plan, nor do they pretend to have a remedy for all the ills of our day. Instead, they're bound together by a certain joy and boldness in seeking to preserve the diversity of living things and the essentials of human knowledge and art. What they share is a moral vision, one informed by an understanding of ecology and a reverence for life.

Building an ark when the floodwaters are rising is not an act of despair—it's an act of hope. To build an ark is to create a space within which life in its abundance may continue. But no refuge can be sealed off entirely from the worldwide flood. Acid rain may leach it; ultraviolet radiation pouring through the ozone hole may bleach it; invasive insects or viruses may attack it; pollution from adjoining land may wash over it. In any case, no single refuge is large enough to contain the full array of species. The big predators, such as grizzlies and wolves, need more space, as do grazing animals such as bison. And the animals that migrate, from snow geese to hummingbirds, need sanctuaries stretching across entire continents for feeding, resting, and nesting. Even thousands of sanctuaries, blooming across our cities and countryside, will not be spacious enough if the rest of the planet becomes an industrial wasteland.

Ultimately, there will be no security for life on Earth unless we see the whole planet as an ark. We are not the captains of this vessel, although we may flatter ourselves by thinking so. We are common passengers, and yet because we are both clever and numerous, we bear a unique responsibility to do everything we can to assure that this one precious ark will stay afloat, with all the least and greatest of our fellow travelers safely on board. ☾

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[POETRY]

What Passes

Spring or what passes
for spring
snow still deep
on the ground.
Firewood gone
we scavenge the woods
breaking off dead limbs
that pine has left out
of consideration.
We cut a dead birch
still waving to the sun.
I do not need to be told
it does not fall
willingly.
What dead
I say.

~ **Elizabeth Caffrey**

Quantifying the Biodiversity Crisis

BY EILEEN CRIST

A RECENT ARTICLE in *Scientific American*—inauspiciously advertised on the cover as "The Truth About Today's Biodiversity Crisis"—illustrates some troubling repercussions of relying too heavily on expressing biodiversity losses in quantitative terms. The article, written by W. Wayt Gibbs, reports on quantitative estimates of extinction rates, the way these estimates are calculated, and how they have recently been called into question. A box of the article's highlights, titled "Overview/Extinction Rates," summarizes ostensible challenges to certain estimates and comparisons. Two of the three bulleted items read:

> ➢ Eminent ecologists warn that humans are causing a mass extinction event of a severity not seen since the age of dinosaurs came to an end 65 million years ago. But paleontologists and statisticians have called such comparisons into doubt.
> ➢ It is hard to know how fast species are disappearing. Models based on the speed of tropical deforestation or on the growth of endangered species lists predict rising extinction rates. But biologists' bias toward plants and vertebrates, which represent a minority of life, undermine these predictions. Because 90 percent of species do not yet have names, let alone censuses, they are impossible to verify. (Gibbs 2001)

Quantitative estimates of species losses have been both necessary and effective tools in calling attention to the biodiversity crisis. The question that arises, however, is whether too much emphasis on such estimates distracts from a deeper understanding of the Earth's ecological predicament.

Biodiversity denotes the richness and variety not only of species, but also of subspecies, varieties, hybrid species, populations, biomass, habitats, ecosystems, evolutionary surging, and genetic material that comprise the biosphere. The devastation of life that conservation biologists call the "biodiversity crisis" refers to the annihilation of native species and subspecies; shrinking populations especially of animals and plants; the strangling of organisms' natural ranges and animals' migration paths; the snuffing out of ecosystems, or their reduction to rudimentary forms; the pressure on, or conversion of, nearly every habitat of the planet; and the contraction and fragmentation of the spacious wilderness that is necessary for the continued flourishing, and evolutionary unfolding, of complex life on Earth.

In contrast, much recent discussion—and a seemingly inevitable wrangling over numbers—has focused on quantitative measures of species and extinctions: the number of extant species on Earth (Erwin 1982, 1991; Gaston 1991); the average lifespan of a species (Wilson 1992); the natural or background extinction rate (Raup 1986; Raven 2001); human-driven extinction rates in absolute and relative (to background extinction) terms (Myers 2001a; Wilson 1994); numbers of species expected to go extinct by a set date—for example by 2000, 2050, or 2100 (Myers 1979, 1988; Lovejoy 1980; Raven 1985); percentage of species vanishing per decade or century (Wilson 1994; Raven and McNeely 1998); and proportion of species extinguished per fraction of habitat destroyed (Simberloff 1986).

The predilection to quantify such key information stems from two sources: first, a generalized Enlightenment norm of science that identifies precision, objectivity, and impartiality with quantitative expressions of scientific findings; and second, more specifically for advancing conservation, the desire to show in succinct fashion that the biodiversity crisis is real and startling in magnitude. The time-honored and well-meaning intent of scientists' partiality to quantification notwithstanding, there is some indication that the biodiversity crisis numbers-game could backfire on conservation biologists' mission to educate the public and influence policy. As the *Scientific American* article noted, statisticians and paleontologists have begun scrutinizing the methods by which certain of the above estimates are generated. Indeed, it is no mathematical or logical feat to challenge them: life scientists who estimate biodiversity losses are the first to acknowledge the tentative nature of their projections (see Harwood 1982; Pimm 2001; Wilson cited in Gibbs 2001).

In particular, the article highlights two weaknesses of extinction estimates. Since the baseline of total species on the planet remains undetermined—between 5 million and 30 million—estimated proportions of species losses are bound to vary correspondingly. And since the paleontological record is incomplete, and the lifespan of different species diverge, quantitative estimates of the background extinction rate become vulnerable to challenge. Disputes over assumptions built into quantitative measurements constitute an intrinsic and salutary part of the scientific process—but in the case of the biodiversity crisis, they may be a distracting sideshow at a time when the onslaught on the Earth's natural systems is quickening in speed and intensity.

First, when estimates of human-driven extinction rates can be plausibly undermined by skeptics, the credibility of conservation biologists to quantify other key facts may become damaged as well. The overall tone of the *Scientific American* article conveys skepticism toward the reliability of extinction numbers—and thus toward the reliability of the science that generates them. After citing Robert May's keynote address—at the last meeting of the Society for Conservation Biology—as "painting a truly dreadful picture" about the prospects of biodiversity, Gibbs continues: "But is despair justified? *The Skeptical Environmentalist,* the new English translation of a recent book by Danish statistician Bjørn Lomborg, charges that reports of the death of biodiversity have been greatly exaggerated." Thus a statistician's challenge to extinction rates can unfortunately become a venue for a high-profile journal, like

serigraph by David Hunsberger

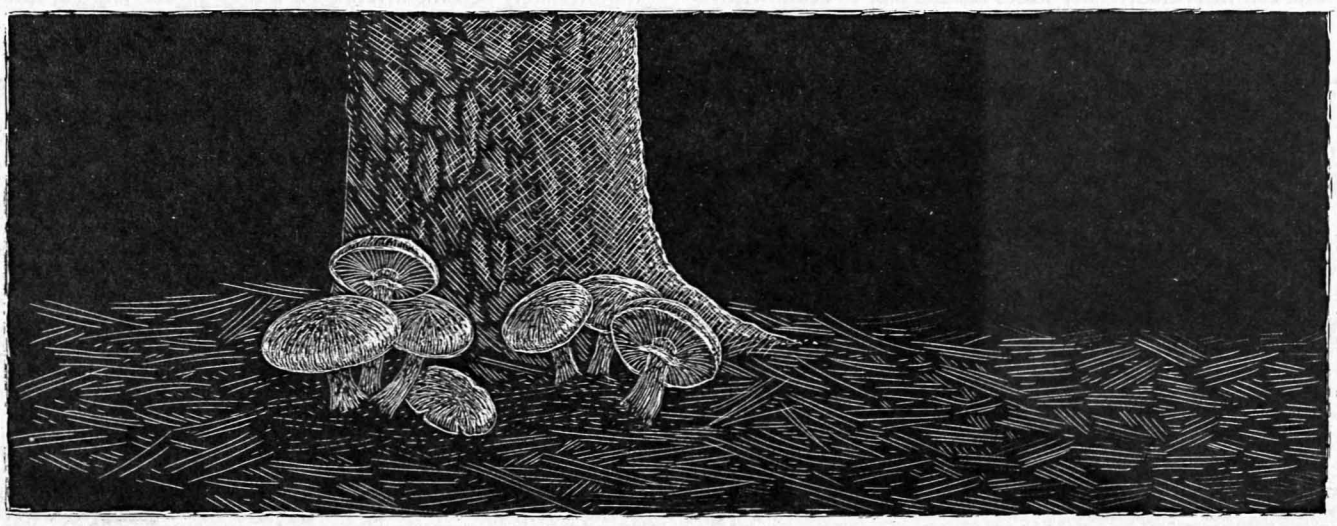
Scientific American, to question the credibility of a larger body of evidence—both quantitative and descriptive—which demonstrates that life's current predicament is grim.*

Another way that numbers may sidetrack attention away from the biodiversity crisis arises from the potentially compromising aftermath of making highly specific predictions by set dates. Such projections may, in any case, be moot if they cannot be verified, and they can be self-defeating for the conservationist cause, if anti-environmentalists can successfully brand them as overestimates. Indeed, guestimates about species losses have had largely emblematic force, because—though they are projected on the basis of scientific information and methods—they are unverifiable: the bulk of extinctions are occurring in the tropics where losses are virtually impossible to track.

A number of projections regarding species losses by 2000 were submitted during the last quarter of the twentieth century. Predictions affixed with an "expiration date" invite comparison with how things stand when the set date arrives. The *Scientific American* article insinuates that anticipated extinctions by the year 2000 were overestimates. After citing predictions made in 1979 by Norman Myers, and later by Thomas Lovejoy and Paul Ehrlich, of species losses upward of 20% by the turn of the twenty-first century, fish biologist Kirk Winemiller is quoted as saying, "I'm reasonably certain that the elimination of one-fifth of species didn't happen." (According to the article, Winemiller's evaluation was based on a review of the literature on extinction rates.) If species losses can be labeled overestimates, then a general impression is promoted that things are "not so bad after all"—exactly what a public presently more preoccupied with economic issues than ecological ones is open to hearing.

By deflecting attention from a *qualitative* appreciation of the human assault on the natural world, over-reliance on quantitative measures may hamper deep insight into the ecological predicament. E. O. Wilson's ballpark figure that 27,000 species are vanishing every year (cited in Gibbs 2001) reveals the stark reality of biocide; at the same time, however, since this estimate largely represents species disappearing in the tropics, it may implicitly convey the message that life's crisis is restricted to biodiversity hotspots that are (usually) "somewhere else." Awareness of the magnitude of pressures on nonhumans and their habitats all over the globe, including the North American continent, is correspondingly dimmed.

When quantitative measures obviate comprehensive appreciation of the conversion and overexploitation of the Earth's remaining wilderness and semi-wilderness, then surely emphasis on numbers risks missing the forest for the trees. Evidence for this confusion again appears in the article under discussion. The well-known figure of species-area relation—that the elimination of 90% of a habitat can lead to a 50% species demise—is challenged by purported counterevidence. Lomborg is cited as alleging that tropical deforestation is "not taking the toll that was feared," and that clearing 98% of the primary forest in the eastern United States and Puerto Rico did not wipe out 50% of the native birds of those habitats.



scratchboard by Suzanne DeJohn

* To its credit, the January 2002 issue of the journal features a section titled "Misleading Math about the Earth," which includes essays by scientists Stephen Schneider and Thomas Lovejoy who show that the author of *The Skeptical Environmentalist* is, in the words of the section legend, "out of touch with the facts."

Whether Lomborg misunderstands the species-area theory (as conservation biologist Stuart Pimm is quoted to argue) overlooks a crucial point: that destroying ancient forests is implicitly cast in a benign light if projected extinctions (purportedly or actually) fail to materialize, or if forest species hang on, in vastly reduced populations, in the impoverished environments that replace their homelands.

By casting doubt on anticipated species losses, the chief engine driving the biodiversity crisis—the ruination of wilderness—can be hidden under a cloak of controversy about numbers. This is exactly what Lomborg attempts in his chapter on biodiversity which is bent on disparaging estimates of extinction rates. While his statistical methods and conclusions have been challenged as faulty by prominent life scientists including E. O. Wilson (2001), Norman Myers (2001b), Thomas Lovejoy (2002), and others, his qualitative grasp of biodiversity destruction is even more wanting. In the subsection "What do we lose?" he focuses on tropical deforestation and tries to trivialize it by maintaining that perishing species "consist of beetles, ants, flies, microscopic worms and fungi, as well as bacteria, algae and viruses"—a list that is swiftly abbreviated to "insects, bacteria and viruses." Here Lomborg omits the annihilation of plants, and elsewhere in the chapter downgrades their significance by claiming that many medicines "used to originate in plants" but now are "produced synthetically." He also denigrates the importance of losing invertebrate species, veiling his dismissive attitude behind claims about the public's low estimation of invertebrates, and making no effort to cite scientific literature about their vital ecological roles. His repeated reference to supposed losses of "bacteria and viruses" is a particularly odious tactic in his belittling of the biodiversity crisis: the profligate and swiftly evolving nature of the bacterial world has, so far, preempted concern that human beings could significantly damage this realm; as for viruses, scientists are not even in agreement that they classify as "living"—but more to the point, the risk tropical deforestation poses is ferreting out potentially dangerous viruses, not driving them to extinction. Overall, Lomborg has zero grasp of the significance of dismantling ecosystems, the destruction of old-growth, or the eclipse of wilderness and wildness from the world.

In conclusion, I suggest that an exclusive focus—or even overemphasis—on quantifying extinction rates as the most incisive way to represent the biodiversity crisis can foil awareness of the ruinous overhaul underway: that the diversity of life is being jeopardized, at all its levels, by a consumption frenzy and population explosion that is making over the Earth into a *Homo sapiens* settlement of biologically impoverished and homogenized landscapes. ☾

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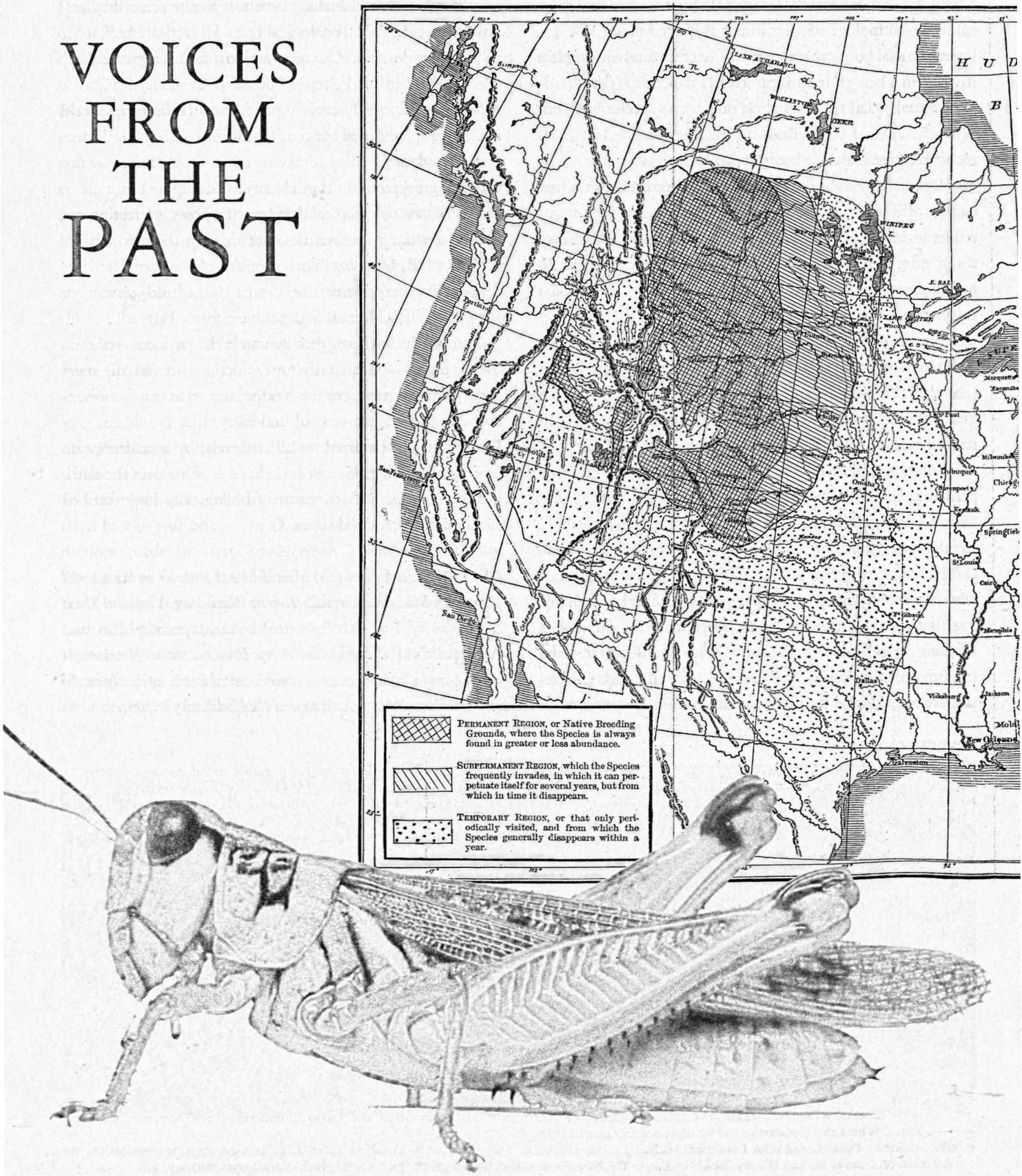
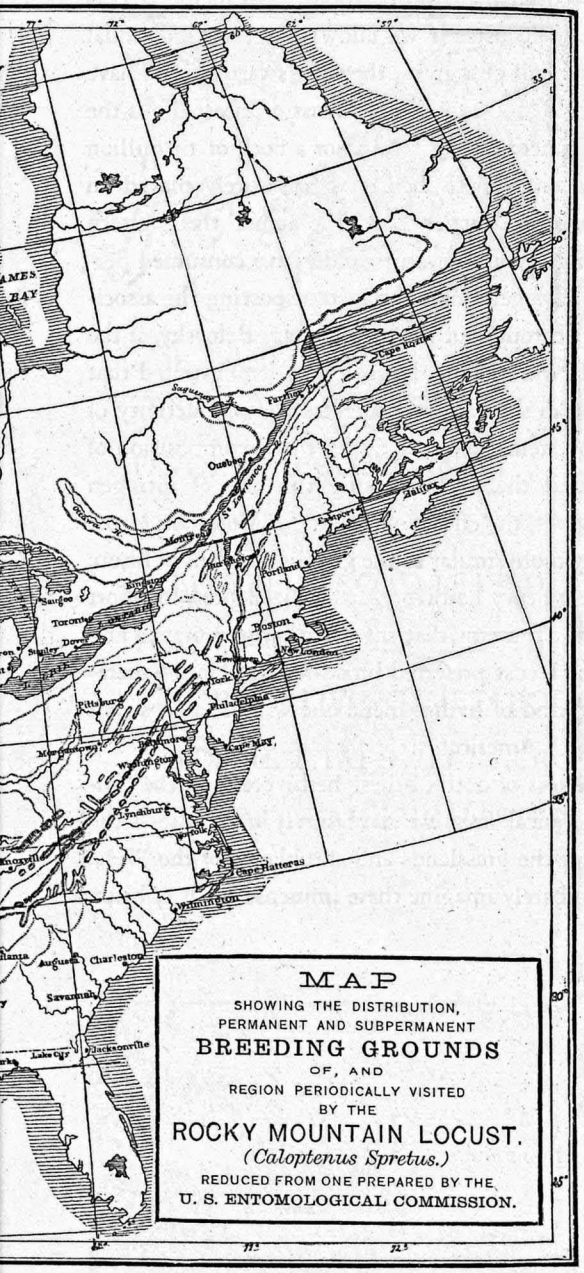
VOICES FROM THE PAST



Rocky Mountain locust relative, *Melanoplus sanguinipes* COURTESY OF R. PFADT



LEARNING FROM THE ROCKY MOUNTAIN LOCUST

by Jeffrey Lockwood

THE TINY, LIMP BODY had been violently mangled. Although the corpse had also begun to rot, it was not relegated to anonymity. Having spent the last four years honing my forensic skills while searching for precisely these remains, I was able to identify the body as being that of *Melanoplus spretus,* the Rocky Mountain locust.* This was the first incontrovertible specimen of this creature to be collected in nearly a century. The icy grave on Knife Point Glacier, high in the mountains of northwestern Wyoming, had served as an effective—if somewhat brutal—final resting place. Based on subsequent radiocarbon dating and geological analyses, we surmised that in the early 1600s (approximately the time that the pilgrims were landing at Plymouth) a swarm of Rocky Mountain locusts, probably originating 100 miles to the northwest in the river valleys that would one day become part of Yellowstone National Park, had been swept up the valley and blown onto the ice. Scattered across the ice in a seething carpet of brown-green bodies, some of the locusts may have managed to escape and continue their journey, but millions were probably immobilized by the cold. In the course of summer melting, rivulets washed them into the crevasses that split the top of the ice field. With time, they were frozen deep in the glacier and slowly transported down the side of the mountain. At a point approximately 750 feet below the crevassed section, the slope flattens rather sharply, and the ice—in a slow-motion version of the rapids that form at the base of a waterfall—becomes turbulent, churning its embedded contents to the surface. For the first time in nearly 400 years, the locust bodies emerge into the light.

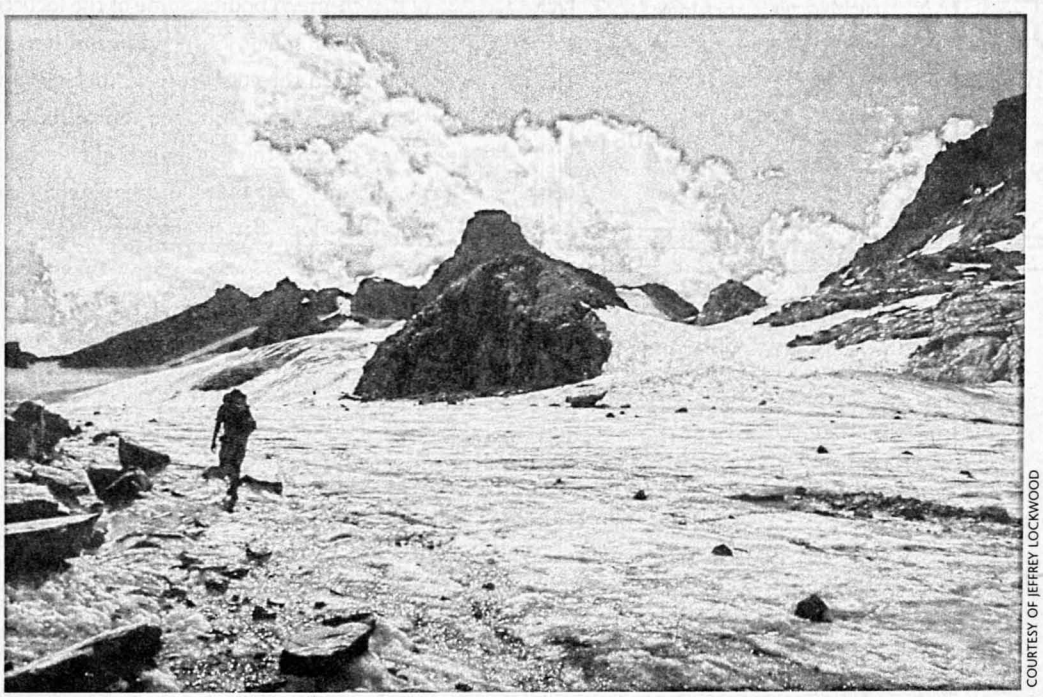
* The common name currently accepted for this species by the Entomological Society of America Committee on Common Names of Insects is the Rocky Mountain Grasshopper. Perhaps the reluctance to identify this species properly as a locust is related to the intuitive denial that a species with the vigor of the Rocky Mountain locust could disappear (as we shall see), and that we could have unwittingly caused a change of such magnitude. If it was just a grasshopper, then its loss would be a matter of quantitative depletion. With more than four hundred other species of grasshoppers in the United States (including dozens in the genus *Melanoplus* alone) the extinction of the Rocky Mountain "grasshopper" is an incremental loss. If we admit, however, that this species was the one and only locust found in North America, then its extinction represents the loss of a continental-scale process found on every other inhabited landmass and its disappearance is a profound, qualitative change.

map and engravings from *USDA Division of Entomology Bulletin No. 7* (1891)

As a child, I pored over the *Guinness Book of World Records,* plotting various schemes to attain immortality through this authoritative text. None of my plans was ever executed, in large part because my parents lacked the imagination necessary to provide me with the 200 hot dogs, 3 miles of string, or 500 pounds of gelatin needed to fulfill my dreams. As an adult, I finally found my path into the *Guinness Book.* Although you still will not find my name enshrined in this cultural record of human and natural marvels, I submitted and provided the substantiating documents for the record of the "Largest Locust Swarm." In the Second Report of the U.S. Entomological Commission, I came across an account of a swarm of the Rocky Mountain locust that staggers the imagination and bested the old record (a desert locust swarm over Africa) by a substantial margin. According to the first-hand account of Dr. A. L. Child, a swarm of Rocky Mountain locusts passed over Plattsmouth, Nebraska, in 1875. By timing the rate of movement as the insects streamed overhead for five days, and by telegraphing to surrounding towns, he was able to estimate that the swarm was 1,800 miles long and at least 110 miles wide. Based on his information, this swarm covered a swath equal to the combined areas of Maryland, Delaware, New Jersey, Pennsylvania, New York, Connecticut, Massachusetts, Rhode Island, Vermont, New Hampshire, and Maine.

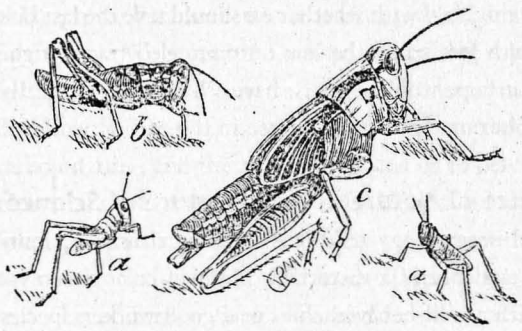
This record-setting swarm would have included perhaps 10 billion locusts. If we allow that each individual weighed about half of a gram, then the swarm would have weighed nearly 6,000 tons. Such a mass of insect life is the equivalent of a herd of 8,000 bison or a flock of 14 million passenger pigeons. These locust swarms surely played an important role in nutrient cycling across the western prairies. A more typical swarm would have consumed perhaps 50 tons of vegetation per day, transporting the associated nutrients throughout the region. Gary Belovsky, at the University of Notre Dame, has recently demonstrated that grasshoppers can substantially increase the productivity of grassland ecosystems by accelerating the decomposition of plant litter and thereby increasing the rate of nitrogen cycling. However, the effects of the Rocky Mountain locust were probably more similar to the grazing patterns of bison, with extremely heavy herbivory, at localized sites, for short periods of time. It seems that the bison favored grasses and apparently the locust preferred broad-leafed plants—thereby creating a kind of living, metabolic wildfire that swept across the North American steppe.

With the loss of both of these herbivores and the suppression of physical fires, we have surely undermined the productivity of the grasslands and shrublands of the West. Today, we can barely imagine these immense herds of bison



COURTESY OF JEFFREY LOCKWOOD

A view up the face of Knife Point Glacier. The rivulets in the foreground are carrying millions of locust remains into the drainage. The first well-preserved specimens of the Rocky Mountain locust to be discovered in glaciers were recovered just to the left of the rock outcropping in the center of the photograph. Note how the ice is much steeper above this area; the more level slopes alongside and below the rock outcropping slowed the flow of the ice, causing the embedded insects to be lifted to the surface.



IT SEEMS THAT THE BISON FAVORED GRASSES AND APPARENTLY THE LOCUST PREFERRED BROAD-LEAFED PLANTS—THEREBY CREATING A KIND OF LIVING, METABOLIC WILDFIRE THAT SWEPT ACROSS THE NORTH AMERICAN STEPPE.

or vast swarms of locusts. But, if we find it difficult to envisage such a mass of life, it is even more challenging to grasp that less than 30 years after Dr. Child's account, the Rocky Mountain locust disappeared forever. What happened at the turn of the last century to drive such a staggeringly abundant species to extinction?

The last living specimen of the Rocky Mountain locust was collected in 1902, and it had not since been seen in Nature—until my colleagues and I recovered the sodden and mangled bodies from Knife Point Glacier in expeditions organized during 1989–1991. We have learned a fair amount about the biology and fate of this species in the last few years, and such is the proper role of science. We even have begun to stretch beyond the raw data and direct interpretations to extract the rudiments of knowledge, recreating the events that likely led to the extinction of this species. But perhaps it is time to seek wisdom, to learn not just *about* the Rocky Mountain locust, but to learn *from* this remarkable species.

A Bull in Nature's China Shop

The loss of biological diversity in the world is proceeding at a startling rate. Although the details can be endlessly debated, we are undoubtedly losing species at a rate that is a thousand times faster than normal. In other words, a species disappears about every 30 minutes. Most of these losses are in the tropics, where humans are destroying vast swaths of forests. From our vantage point in North America, it is easy to shake our heads, cluck our tongues, and mutter about the senseless destruction rooted in economic myopia. How can these people justify trading in the biological legacy of our planet for a few more acres of crops, which will soon degrade to low-value grasslands? But then, how did our agrarian settlers rationalize the destruction of species? The answer is the same—there is no justification. Both events are tragic accidents induced by socioeconomic pressures, without the actors having malice or forethought.

The Rocky Mountain locust was inadvertently driven to extinction. The most spectacular "success" in the history of economic entomology—the only complete elimination of an agricultural pest species—was the result of unplanned, uncoordinated, and unintentional human activity. Without the power of modern earth-moving equipment or even chainsaws, a few thousand people with horse-drawn implements transformed the fertile river valleys of the West. These lands were converted into farms, cattle and sheep were introduced into riparian areas, beavers were eliminated along with their troublesome dams, the streams were diverted for irrigation, and plants and animals from the eastern portions of our country made their way to the West along the corridors we created. But how could these habitat conversions, concentrated into a relatively limited area of the vast Great Plains, have led to the extinction of an insect that during its outbreaks stretched from Canada to Mexico and from California to Iowa? Embedded in this question lies the answer.

During outbreaks, the Rocky Mountain locust could be found in an area of nearly two million square miles. But, as with other locusts, in most years the climatic factors necessary to elicit an outbreak did not develop, and the populations eked out a living in highly restricted habitats—the fertile river valleys of the West. These "Permanent Breeding Zones," a term used by the early entomologists, were precisely the lands that the early pioneers sought to convert to agricultural production. With the outbreak of the 1870s having collapsed, the Rocky Mountain locust was concentrated in these valleys and, therefore, vulnerable to intense, but spatially limited,

habitat destruction. The agriculturalists who arrived courtesy of the transcontinental railroad inadvertently managed to drive their most severe competitor to extinction in a matter of a few years, leaving North America as the only inhabited continent without a locust species. The capacity of the human species to destroy other life forms is not necessarily, or perhaps even usually, a matter of intentional or wanton disregard for Nature. But, one might wonder, at what point does our species become morally culpable for its actions—when can we no longer appeal to being big, dumb, clumsy beasts stumbling through yet another display of fine, living porcelain?

This question might be answered most effectively if we had been successful in our search for remnant populations of the Rocky Mountain locust in the 1990s. Our surveys of grasshoppers in the Yellowstone River valley (the last undisturbed haunt of the Rocky Mountain locust) yielded no specimens of this long-lost creature. There was a report several years ago of a number of grasshopper specimens collected in North Dakota that were similar to the extinct species, but it seems that these were probably the migratory phase of an extant, closely related species, *Melanoplus sanguinipes*. But what if we were to find a pocket of habitat still harboring the Rocky Mountain locust? Regulatory officials might well advocate their destruction, as the potential for a return to the swarms of the 1800s would be plausible. Even the vaunted Endangered Species Act exempts pests from protection, so perhaps this remnant population would be accorded the same status as the last vial of small pox.

In my fantasy scenario, however, I like to imagine that in an ironic pique, economic entomologists point out that "pest" is a label that can be applied only under appropriate conditions of population density. That is, a population of Rocky Mountain locusts that had not bothered us for a century could hardly be termed a pest, as their numbers have not attained outbreak levels. Conservationists might call for protecting these insects as important components of a native ecosystem that is struggling to sustain biotic integrity. There might be some appeals to the Rocky Mountain locust's capacity to serve as a reminder that we must share this world with other species (even those that we have not tamed or controlled), and a few advocates probably would invoke the powerful place of this species in the story of the West and the folklore of frontier America. But in the end, would our decision be any different from that being made by the people of Amazonia or that which would have been made had the early pioneers realized that they had reduced their nemesis to a single locale? If we struggle so mightily with whether we should save the last bits of old-growth forest and the few untrammeled tracts of the Arctic, what hope would a locust have? What have we really learned about ourselves and our place in the natural world?

The Science of Nature and the Nature of Science

My applied entomology textbook suggests that insect outbreaks are evidence of a disturbed or out-of-balance ecosystem. As with a well-behaved child or a good worker, species should refrain from extreme outbursts. This Victorian-era interpretation of the ideal emotional state—or perhaps the legacy of Darwinian uniformitarianism that emerged as a reaction to the Church's reliance on catastrophes to explain the history of the Earth—has lived on in our perception that an outbreak or crash of a population is an unnatural aberration, an indication of a troubled species.

The leitmotif of the Rocky Mountain locust was its phenomenal flights of reproductive fancy, with manic swarms sweeping over the plains only to subsequently collapse into pockets of exhausted survivors. Evidence of this was embedded in the annual layers of Knife Point glacier, which revealed a pattern of locust outbreaks extending centuries prior to European alterations of the western landscape. Although people, species, and ecosystems can manifest extreme dynamics during times of trouble, erratic—even explosive—population dynamics do not require anthropogenic disturbance nor do they necessarily reflect dysfunctionality. Large population swings are part of a natural range of variation in some species. All too often, we are alarmed by nonconformity not because of concern for another being but because of our self-interest in having a predictable world, our sociopolitical intolerance of radicalism, our economic objective of slow-but-steady growth, and our Protestant ideal of moderation. Sometimes the outburst of joy from a child, the cry of anguish from a neighbor, or the outpouring of life by a species does not need to be "fixed," controlled, or managed but understood, accepted, and honored.

The Rocky Mountain locust also has taught me some interesting lessons about the nature of science in the modern world. Upon returning from the first of four expeditions to glaciers in the Rocky Mountains, we had recovered only some soggy peat moss–like lumps of tangled legs and fragmented wings. Using a few intact structures and a bit of deductive reasoning, we concluded that we had extracted the 800-year-old rotting remains of the Rocky Mountain locust (the next three expeditions yielded even less encouraging debris,

although we became better at inferring the taxonomy of the fragments). We submitted a paper describing what we had found including the condition of the glacier, the location of deposits, the types of insect parts we had extracted, the radiocarbon dating, and the analyses that led us to believe we had recovered the remains of the Rocky Mountain locust. As the first report of such a study in nearly 50 years, we hoped that the manuscript would be well received. It was rejected.

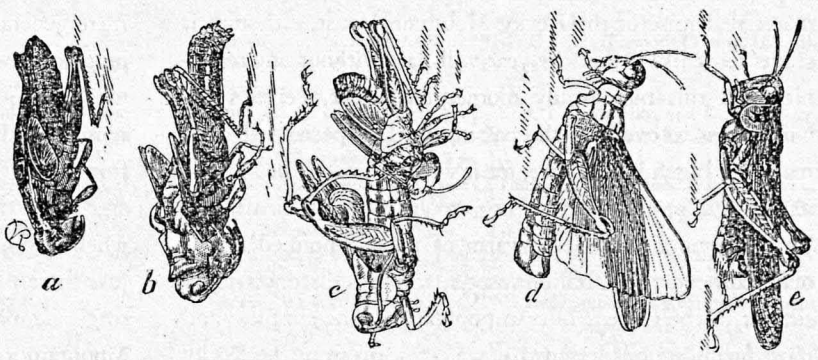
The editor of *Environmental Entomology* at that time explained that the study did not constitute a controlled experiment. Where were we supposed to find a "control glacier" and what experiment could we have done if we had located such a resource? My appeal to the editorial board (the only time I have had the guts to take such a step) was denied with the incisive summary, "You have mistaken natural history for science." It seems that replication, statistical design, and controlled experimentation defined science, at least at that time, for the entomological community. This suggested that initiatives such as the Human Genome Project (decidedly lacking a clear hypothesis), the entire field of cosmology (there is, after all, only one universe), and entire projects devoted to unreplicated discovery (NASA's deep space probes) were not science. It was as if nothing of value was left to describe in the natural world—a remarkable position for entomology, a field in which no more than 10% of its fundamental units of study (insect species) are even known.

Even more disturbing was the notion that science required manipulation of the natural world, rather than patient observation or thoughtful description. The Rocky Mountain locust is gone, and no experiment will ever show the course of events that led to its demise, explain the role it played in western ecosystems, or reveal what other species may have perished along with it. Its tale will be told, if at all, to those willing to listen rather than to those demanding answers. In the end, the paper was published in *American Entomologist,* and I have received more reprint requests for it than I have for any paper that involved a controlled experiment. Maybe this is because I do not develop very interesting experiments, but perhaps it is because even scientists are open to the lessons that the Rocky Mountain locust has to teach.

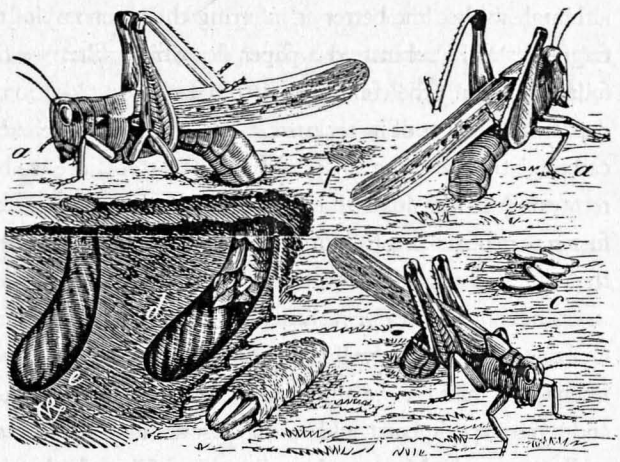
What I have learned from the Rocky Mountain locust suggests other important biases in the practice of science. That biases exist should not be surprising. After all, science is a completely human enterprise richly enmeshed with our culture, history, and philosophies. However, the metaphysical assumptions that define what is "real" for science are often not exposed. One of the long-lasting debates surrounding the Rocky Mountain locust has been whether it is truly a species or simply the migratory form of an extant species that no longer swarms (and hence might not be truly extinct but only quiescent). The arguments have been phrased in terms of scientific evidence, but I cannot help but wonder if the debate was grounded in a visceral disbelief that such an enormously abundant creature could actually disappear from the face of the Earth in a matter of a few decades.

Genetic, chemical, and morphological analyses now leave little doubt that the Rocky Mountain locust was a true species. But even this line of argument begs the question of what constitutes a species and raises the specter of our philosophical biases. We usually conceive of the world in material terms—for example, a species is a bunch of individuals with the capacity to successfully interbreed. But this presumes the meta-

IF WE STRUGGLE SO MIGHTILY WITH WHETHER WE SHOULD SAVE THE LAST BITS OF OLD-GROWTH FOREST AND THE FEW UNTRAMMELED TRACTS OF THE ARCTIC, WHAT HOPE WOULD A LOCUST HAVE?



physical truth of materialism—that to be real is to be made of matter. Ecology, however, is beginning to slowly shift focus with tentative explorations of what the world would look like if process, rather than matter, were the basis for reality. What if we defined a species in terms of its life processes? What if we suggested that a thing *is* what it *does*? In this light, the Rocky Mountain locust was an immense, aperiodic process of energy flow, linking life-processes across a continent. If we choose to describe the locust as a process, there is no doubt that this species was extinct in the late 1800s. That is, its ecological role and biological activities ceased well before the last, corporeal manifestation disappeared. This notion of life-as-process might seem unusual in a society in which material existence is primary. But such a perception informs our deepest understanding of life. For example, life-as-process underlies our notion of euthanasia. When a loved one is simply a body, devoid of the capacity to care, respond, or relate ever again in a way that we can recognize as being "them," we understand that they are gone even before they are dead.



WHAT IF WE SUGGESTED THAT A THING *IS* WHAT IT *DOES*? IN THIS LIGHT, THE ROCKY MOUNTAIN LOCUST WAS AN IMMENSE, APERIODIC PROCESS OF ENERGY FLOW, LINKING LIFE-PROCESSES ACROSS A CONTINENT.

Confronting our Mortality

Setting aside the current wave of extinctions, the average species of bird or mammal has a life expectancy of about 10 million years. As such, *Homo sapiens* is still a young species in its metaphorical adolescence, a time at which individuals of our species pay little heed to their own mortality. As teens, the notion of dying is hopelessly abstract, distant, and irrelevant. Yet, this sense of immortality may contribute to the alarming frequency of accidental deaths, as adolescents shorten their lives by acts of foolish indiscretion, misplaced courage, and irrational risk-taking. Our species seems to manifest these same tendencies at this point in its development. But there are older, wiser voices to be heard in our biological community, including that of the Rocky Mountain locust.

This year, we can celebrate or mourn the centennial of the material demise of the Rocky Mountain locust, although it seems most likely that the year will pass without any recognition of this biologically momentous event. Perhaps our willingness to overlook the passing of this species will be a matter of blissful ignorance, for if we understood the story of its extinction, our complacency would be most disturbing. The *Guinness Book* record swarm of 1875 contained in the neighborhood of ten billion insects, which is disconcertingly similar to the current human population. The simplest and most unambiguous lesson that we can learn from the Rocky Mountain locust is that numerical abundance does not assure future survival. Having reached six billion people, we need only look back at the Rocky Mountain locusts that blackened the skies of North America or the enormous numbers of bison that dotted vast tracts of the West to realize that our future as a species is no brighter for our quantity.

One might optimistically contend that we are the ultimate generalists, capable of rapidly adapting to an immense range of environmental challenges and occupying new habitats. However, the Rocky Mountain locust might quietly remind us that it consumed no fewer than 50 kinds of plants from more than a dozen families (as well as leather, laundry, and sheep wool when hunger demanded), whereas the overwhelming majority of human caloric intake is derived from just three plant species—corn, wheat, and rice—found in a single family. Moreover, if the body size of the Rocky Mountain locust was increased to that of a human, available records suggest that it would be capable of traveling 36,000

miles, the same distance that our ancestors traveled in the process of circumnavigating and eventually colonizing the planet. It appears that being a highly mobile generalist is no insurance against extinction.

There does, however, seem to be a major difference between our condition and that of the Rocky Mountain locust. Although it could sweep across vast regions, this species periodically was restricted to a limited area. The ill-fated overlap of human activity and the remnants of the Rocky Mountain locust demonstrate the hazard of such spatiotemporal bottlenecks. As with the monarch butterfly, whose populations stretch across North America only to collapse back into a few pockets of overwintering habitat each year, the long-term viability of the Rocky Mountain locust was only as great as its most vulnerable link. In a matter of a few days or weeks, a handful of loggers armed with chainsaws could effectively eliminate the monarch butterfly by destroying its winter grounds in western Mexico, just as a small contingent of settlers equipped with horse-drawn ploughs, axes, and shovels transformed the fertile river valleys of the western United States.

One Last Lesson

After finding the first small body in the ice of Knife Point Glacier, we began an excited search for more, eventually recovering 130 largely intact remains. Each was catalogued, dried for preservation, and individually stored for future study. On the last day at the glacier, we set a drift net in one of the hundreds of rivulets that rushed down the face of the ice. In just 24 hours, we collected 140 fragmented remains of the Rocky Mountain locust. At this rate, at least 20 million corpses have melted from the glacier since that day in 1990, washing into Dinwoody Creek and perhaps being carried to the Wind River. The glaciers of the Rocky Mountains are retreating at a phenomenal rate. Based on our studies of Grasshopper Glaciers (several bodies of ice bear this name in recognition of their unusual contents), the glacier north of Cooke City, Montana, has receded 89% since 1940; the glacier in the Beartooth Mountains of Montana is 62% smaller now than in 1956; and the one in Montana's Crazy Mountains has diminished 90% in the last 16 years. Our discovery of grasshopper remains coming to the surface of these various sites is a direct result of global warming. A century ago, human alterations of the environment caused the demise of the Rocky Mountain locust; today, the ghosts of these insects warn us of an even more serious threat to the natural world. As the warming climate exposes our past act of destruction, I wonder what else we can learn from the Rocky Mountain locust. ☾

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ON PARASITES LOST— AND FOUND

PASSENGER PIGEON LICE REDISCOVERED

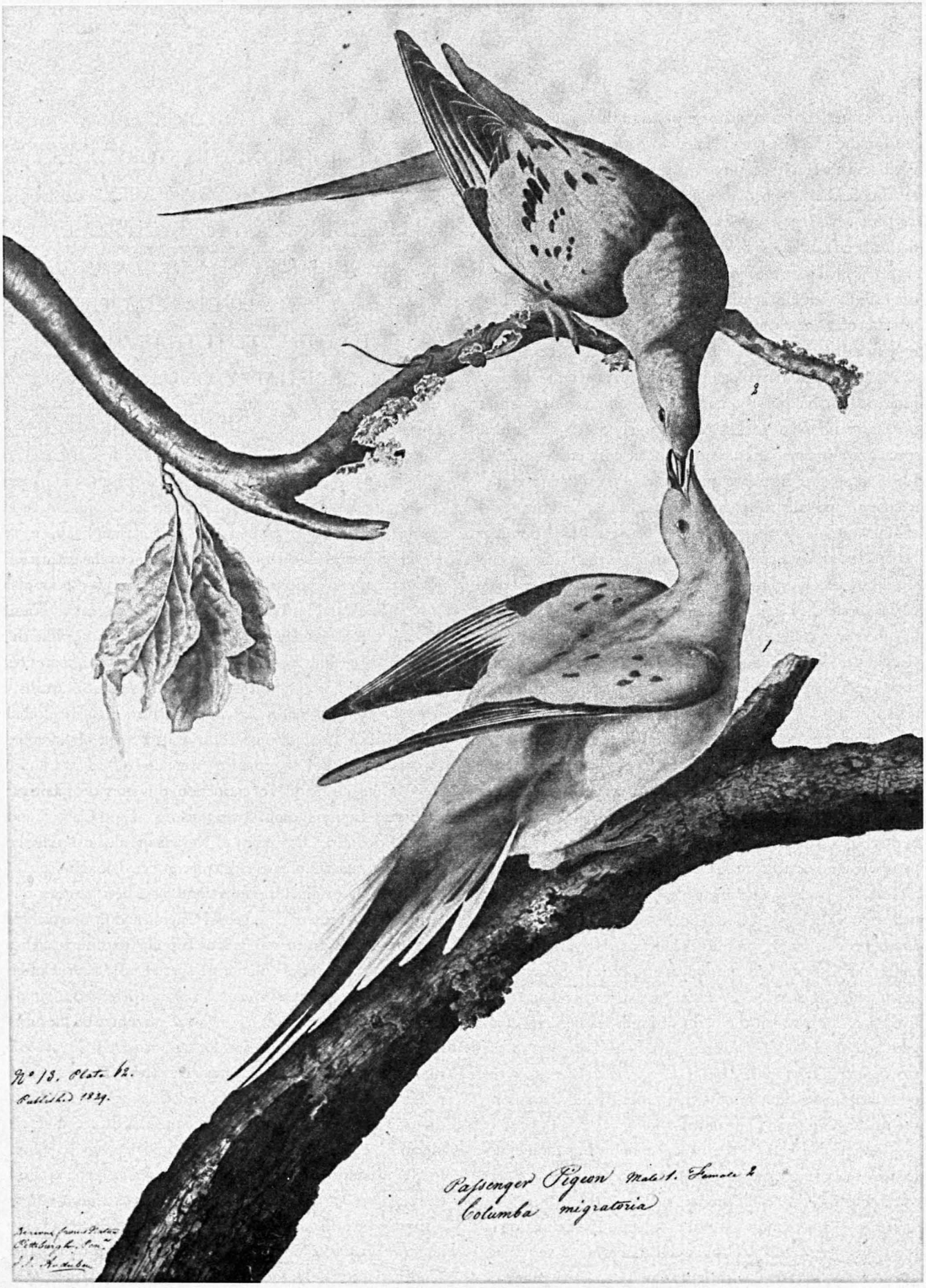
by Robert Dunn

IT IS THE ENTOMOLOGIST'S CURSE to always see the small in the large. I spent the morning flipping through a new book about extinct animals, *A Gap in Nature*. The animals are at once stunning and haunting, frozen like wax figures in eternal repose, but as I turned the pages, I could not help thinking of more minute creatures. Each of these mammals, lizards, and birds had parasites. Hidden somewhere in these pictures of extinct birds are hundreds of tiny creatures hanging tight (most birds carry between their feathers entire bestiaries of fleas, lice, and mites). The parasites went where their birds went: a louse might have ridden a passenger pigeon from Detroit all the way to Omaha without ever knowing the difference. The lifestyle of bird parasites is a sort of devil's deal, an all-you-can-eat buffet with great travel perks, but you can never leave. When bird species go extinct, their parasites may often go with them, but not always. In the case of the passenger pigeon, it turns out that the passenger pigeon lice live on, albeit in unexpected places.

Just a few hundred years ago, the passenger pigeon was the most abundant bird in North America. In the early 1800s, there were billions of passenger pigeons, a couple of pigeons for every person on Earth. Passenger pigeons darkened the sky as they flew, and when they landed, branches sighed and broke. For millions of years, the forests and skies bore the weight of passenger pigeons, yet it took fewer than a hundred seasons to decimate their populations. Americans shot passenger pigeons for food, for fun, and even out of boredom. By the 1890s, there were not enough passenger pigeons to form the massive aggregations that likely triggered them to breed. The birds that remained did not lay eggs and then either died or were shot. In 1899, a fourteen-year-old boy in Ohio killed the last known wild passenger pigeon.

When the passenger pigeon was still extant, many organisms depended upon it. These birds dispersed many different species of tree seeds into extremely rich patches of nutrients (Nature loves a good shit pile). Pigeon carcasses were probably an important food for the now endangered American burying beetle. Perhaps the group of organisms most directly dependent upon the pigeon, however, was their parasites. For parasites, the passenger pigeon was the promised land. If each bird had a few lice on it (probably an underestimate), there might have been 8 billion passenger pigeon lice in North America. There were probably nearly as many passenger pigeon fleas, mites, tapeworms, and bacteria.

Eight billion lice might seem like a nightmare scenario, but fortunately bird lice are only found on birds. In fact, the



passenger pigeons by John James Audubon, ca. 1842

life of a bird louse is so intimately tied to that of its host that most lice are found on only one or two species of birds. Bird lice begin their lives as tiny eggs that females carefully glue to bird feathers. When the lice hatch, they start chewing feathers, which they digest with the help of symbiotic bacteria in their guts. Some of the newly hatched lice move on to other birds in search of greener pastures, but to do this, the lice have to wait for their bird to touch another bird. The tiny lice can only get from bird to bird by running across contiguous feathers. (A strange but true exception to this restrictive movement is that some lice are able to catch rides on tiny parasitic flies, holding tight as the flies go from bird to bird.) Bird lice tend to be species-specific largely because most bird species rarely come into physical contact with one another. If a bird louse does not move quickly enough or hold on tightly enough and falls out of its host's feathers, it will die within a few minutes.

When the passenger pigeon still flew the skies, no one studied the ecology of its commensal lice—how they moved, what exactly they ate, or how abundant they were. Someone had, however, collected a few specimens, which sat for many years unstudied in a German museum. In 1937, more than two decades after the last known passenger pigeon had died (a captive bird named Martha, who succumbed in 1914 in the Cincinnati Zoo), an entomologist named Malcomsom found the lice specimens and suggested that one of those species, the feather louse *Colombicola extinctus*, had gone extinct with the passenger pigeon (hence its name). Malcomsom had to do all of his work based on a set of three preserved individuals in the German museum, but *C. extinctus* did not appear to be the same species as any living lice he had seen. Thirty years later Tendeiro (1969) announced that another passenger pigeon feather louse preserved in the same collection, *Campanulotes defectus*,was also extinct. Based on its morphology, *Colombicola extinctus* was a feather louse that lived and ran between the barbs of flight feathers. Its elongate body and long legs would have helped it cling in the face of ferocious winds and beaks. *Campanulotes defectus,* on the other hand, was a down louse that probably hid out among the passenger pigeon's fine down.

Few people noticed the papers announcing the extinction of the two species of passenger pigeon lice and fewer cared. For those who did notice, however, the missing lice were harbingers of more general problems. The extinction of the passenger pigeon lice suggested that when a vertebrate goes extinct, it carries with it its stowaways—its parasites.

UNLIKE MOST STORIES OF EXTINCTION, THIS STORY DOES, HOWEVER, HAVE A HAPPY ENDING. CLAYTON AND PRICE CONCLUDED THAT *COLOMBICOLA EXTINCTUS* LIVES ON HAPPILY (TO THE EXTENT THAT A LOUSE CAN BE HAPPY) ON ANOTHER SPECIES OF PIGEON.

Using the passenger pigeon lice as an example, in 1993 Nigel Stork and H. C. Lyal called attention to the extinction of parasites and other mutualists in a paper in the journal *Nature*. Stork and Lyal posed the slightly rhetorical question, "If each extinct vertebrate had two host specific lice like the passenger pigeon how many thousands of species of parasites have we lost?" Stork and Lyal termed the loss of mutualists when hosts go extinct *co-extinction* and turned the neglected story of the passenger pigeon lice into a quiet plea for the plights of parasites.

Unlike most stories of extinction, this story does, however, have a happy ending. Two years ago, Dale Clayton and Roger Price at the University of Nevada decided to study the two known species of passenger pigeon lice. Based on careful analysis of the original specimens and more lice that they collected off dead passenger pigeons, Clayton and Price concluded that *Colombicola extinctus* lives on happily (to the extent that a louse can be happy) on another species of pigeon. Unlike many bird lice, *C. extinctus* was not restricted to a single species of bird (maybe it knows how to hitchhike on flies). As is usually the case with extinct insects that are rediscovered, there was no celebration, no big news story. The passenger pigeon louse was quietly reborn under the name *Colombicola columbae* and continues to ride the band-tailed pigeon across North American skies.

The story of the other passenger pigeon louse, *Campanulotes defectus,* is less straightforward. *C. defectus* probably never even lived on the passenger pigeon. Price and colleagues have concluded that somehow the entomologist Tendeiro incorrectly identified *C. defectus* as a passenger

pigeon louse. Despite searching many hundreds of skins, Clayton and Price never found more individuals of *C. defectus* on passenger pigeons. All of the relatives of *C. defectus* are Australian, and it is hard to imagine an Australian louse hitching a ride on the North American passenger pigeon. The more likely scenario was that *C. defectus* was a mislabeled Australian louse. In fact, in a careful comparative study, Price and colleagues actually found *Campanulotes defectus* living in Australia on the common Australian bronzewing. Its real name is *Campanulotes flavens* and like *Colombicola extinctus,* it never knew it was missing.

It is unclear how a few individuals of *Campanulotes flavens* were misidentified as having been found on the passenger pigeon. The entire lice collection, which contained both the real and the mislabeled passenger pigeon lice, had apparently been mishandled for many years. The namesake of the collection, Rudow, was at best not very careful, and at worst just made things up. Rudow was eventually disbarred from the collection and his successor, Poppe, relabeled all of the collection's specimens with what was probably a varying degree of accuracy. To make matters worse, during World War II Allied forces bombed part of the collection. Given the confusion of bombed lice, switched labels, and poor work, it is impossible to know what actually happened, but it is easy to see how a louse might have become mislabeled. The whole episode might best be filed under the category of "least known consequences of war."

Although passenger pigeon lice are not an example of co-extinction, co-extinction is undoubtedly still common. When animal species go extinct, some of their parasites go extinct, as may some of their mutualists. There were probably lice on the dodo, the Raiatea parakeet, the Tahitian sandpiper, the mysterious starling, and on many of the hundreds of other extinct birds on the pages of my book. On average, the world probably loses a louse species for every two birds that go extinct. The same is true of mammal lice. These parasitic fauna are still an unexplored wilderness. We misunderstood the story about the passenger pigeon lice in part because the wilderness of parasites is so unknown. The search for new species of birds receives lots of press, but in terms of morphological and behavioral strangeness, new bird species pale relative to the diversity of parasites we have yet to study and name.

Even those parasites that do have names have been poorly studied and are rarely the subjects of conservation efforts. The poet Charles Simic has argued that poets are guilty of ignoring the most interesting parts of Nature, the despicable parts, the parts that are not polite for dinner tables. Conservationists, I suppose, are guilty of the same. It is easy to sell furry things, but it is harder to pitch the darker sides of Nature. Yet Nature abounds in darker sides. Many of them, like lice, are tiny parasites. Contrary to their slothful image, parasites are constantly working to keep from being evicted by their hosts. On an evolutionary time-scale, it is this race to survive that has led to the myriad of strange and often bizarre tools of the parasitic trade—hooks, suckers, hairs, and even appendages we have yet to understand. Each time we lose a vertebrate species to extinction, we lose not only its entire evolutionary history, we also lose the history of all the other organisms that evolved with it and their interactions.

Over millennia, lice have been shaped by natural selection: they have lost their wings; their eyes have been reduced; their legs have been stumped; their exoskeletons have been thickened. Different species of bird louse differ in part because different bird species scratch differently, fly differently, and roll differently in the dirt. The same could be said of mites, fleas, or tapeworms. To see the adaptations of bird lice or parasites to their hosts is to see the real diversity that evolution can create. To look into a gallery of parasite faces is to see all of the strange beings we could ever imagine and many we could not. Many of those species are gone. Most never even had names. ☾

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Wolves, Landscapes, and the Ecological Recovery of Yellowstone

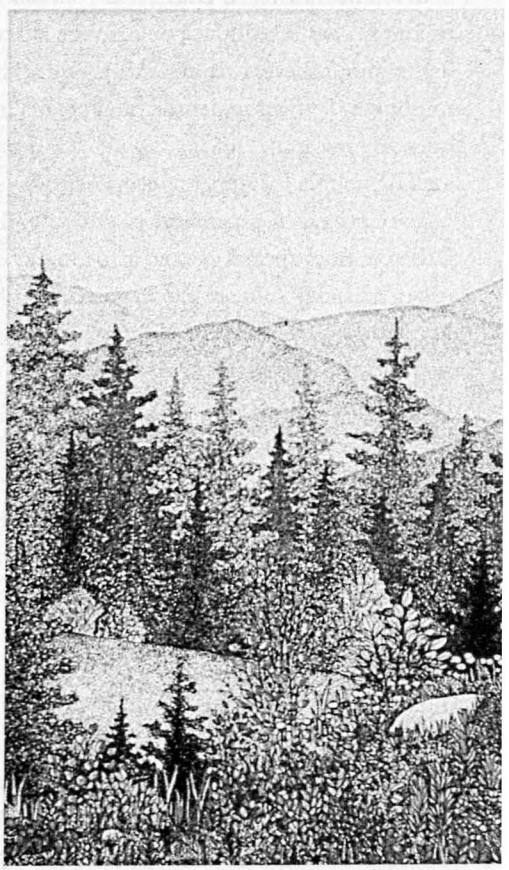
by Joel Berger

FOR MILLENNIA WOLVES ROAMED the 2.2 million acres of stunning mountainous habitat now known as Yellowstone National Park. Their elimination 60–70 years ago left a gaping void in an otherwise mostly pristine ecosystem. The loss of wolves from Yellowstone has been lamented by Americans, but considerably less attention has been paid to how the loss of large carnivores generally affects ecosystems. For example, large social canids have been absent from much of the contiguous United States far longer than they've been gone from Yellowstone; their extirpation dates back more than a hundred years in some areas. Given this prolonged dearth of effective predation from an area that extended between New Mexico and New Jersey and from North Dakota to Texas, why is it that only now the reintroduction of wolves to small portions of Wyoming, Idaho, Montana, and the Southwest is such a cause for celebration?

Some wolf advocates tout reasons related to environmental ethics, suggesting that Yellowstone wolf recovery is an example of a maturing society now actively restoring a species long persecuted by humans. Others point to local economic gains associated with tourists hoping to glimpse wolves. Some articulate a scientific rationale, suggesting that wolf restoration will result in a more balanced, healthy ecosystem.

Wolf opponents speak differently. The familiar refrain of wolves as depredators of livestock, as cunning killers of big game, and as potential child slayers still resounds. (The first two charges are, of course, true.) Personal values aside, a central fact underlies contemporary discussion of wolf recovery: despite recent gains through natural colonization and active reintroduction, wolves currently occupy less than 5% of their former range in the contiguous United States.

What happens when wolves return to a landscape? Answers are not as easily forthcoming as we might hope. They must stem either from comparing systems where wolves have been exterminated, or from areas where wolves once occurred, have been lost, and have subsequently recovered. To understand how the return of wolves is reshaping ecosystems a huge

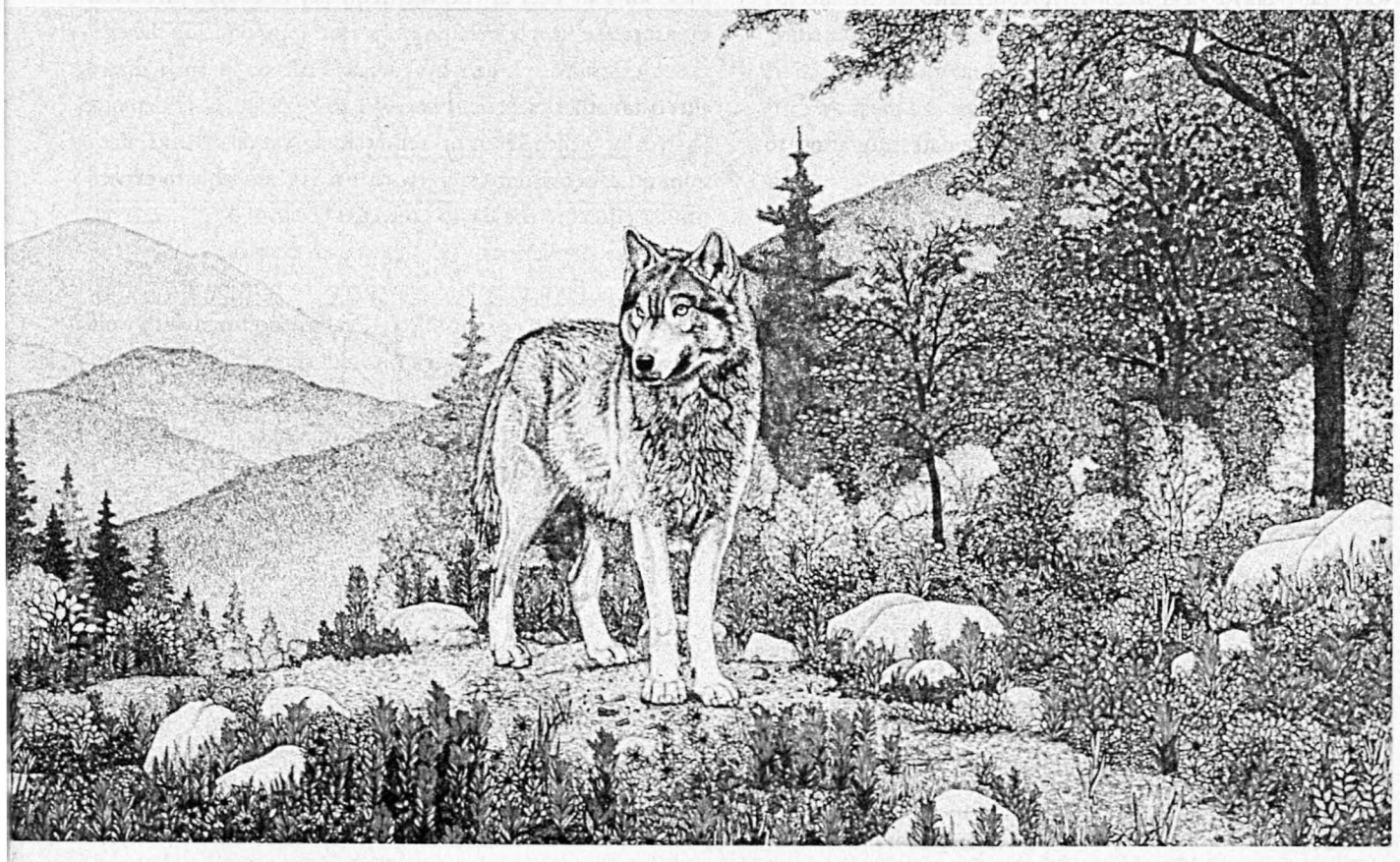


experiment is necessary—one involving comparisons across broad landscapes and with appropriate controls.

Information on this subject is now beginning to emerge, but it is trickling in because ecosystems are complex, variability due to weather and other factors can be great, and changes across landscapes are typically slow rather than rapid. This much we know from comparative study of predators and prey in their environments from Africa's Serengeti and Selous to Patagonia and the distant edge of the Gobi. To more fully comprehend how wolves are being integrated into Yellowstone, answers to two questions are essential:

- To what extent and at what pace are ecosystems modified when carnivores return?
- At what point can we assume systems are recovered? For instance, just because wolves now exist in Yellowstone Park, and elk may run fearfully at the sound of wolves, is it fair to conclude that the ecosystem is fully recovered?

THE GREATER YELLOWSTONE ECOSYSTEM (GYE) is the area for which the most information currently exists to answer these questions, but it is also a region that generates considerable complexity. The initial wolf reintroduction began in the mid-1990s, and wolves were mostly contained naturally within the boundaries of Yellowstone Park because of its prey base—vast numbers of ungulates including elk, bison, moose, bighorn sheep, mule deer, and pronghorn. However, areas suitable for wolves also exist well beyond the park's borders. The entire Greater Yellowstone Ecosystem is roughly 20 million acres, an area larger than Massachusetts (see map on page 35). The GYE contains a mosaic of land designations representing varied levels of protection—seven national forests, two national parks, three national wildlife refuges, the Wind River Indian Reservation, and private lands. For wolves to live beyond the two national parks, Yellowstone and Grand Teton (for simplicity, called here Teton Park), will likely prove contentious. Despite federal legislation that nominally protects wolves, many threats and



marker and ink by Steve Oliver

conflicts exist. Wolves are killed on highways, shot, and poisoned, and when wolves have preyed on domestic livestock (both on public and private land), government agents have removed entire wolf packs.

Nevertheless, the number of wolves in the GYE has increased to more than 200 since their reintroduction into Yellowstone Park. Arguably, Americans care about the success of the reintroduction effort and its effects for historical and ecological reasons. Not only was Yellowstone the world's first national park, created in 1872, but in addition, the Greater Yellowstone Ecosystem has been lauded as one of the most intact northern temperate landscapes in the world. With wolves missing as a top carnivore, the system had been incomplete. Other species and processes have also come and gone, with important implications for ecosystem health. White-tailed deer are now rarer in Yellowstone Park than they were when the first surveys were published in the nineteenth century. In the Jackson Hole region to the south, which contains Teton Park, white-tailed jackrabbits have become extinct within the last 25 years. Beavers are still rare in Yellowstone but not in Teton Park. Some ecologists speculate that the absence of effective predators in the north allowed herbivores (especially elk) to become overly abundant, which affected riparian vegetation (the beavers' food source)—thus making the absence of top predators a key factor in beaver decline. Why the hare has disappeared in the south is a mystery.

Human land use has modified ungulate migration to such a great extent that for some species it is no longer possible to move across huge sweeping landscapes as they did historically. Bison cannot disperse freely from Yellowstone to the north or east because they are blocked by private ranchettes and policies implemented by the State of Montana ostensibly to protect domestic livestock from bison-spread disease. Throughout the ecosystem, pronghorn also experience fractured migration corridors.

A Ripple of Ecological Effects

Although natural systems are perplexing and interactions dynamic, wolves can—as large, effective, social predators—be key actors. Unlike grizzly bears, which are primarily omnivorous, wolves are obligate predators: they must either scavenge meat or kill prey directly. In Yellowstone National Park, the primary targets of wolves have been elk, constituting almost 90% of the kills. Of the total elk kills, two-thirds were of females and calves. Among other ungulates killed by wolves, biologist Doug Smith and his colleagues report that bison, moose, and deer combined accounted for less than 6% of the total number of ungulates killed in the year 2000. Apparently, the patterns of wolf predation on native ungulates in the park have changed very little since they were reintroduced in 1995.

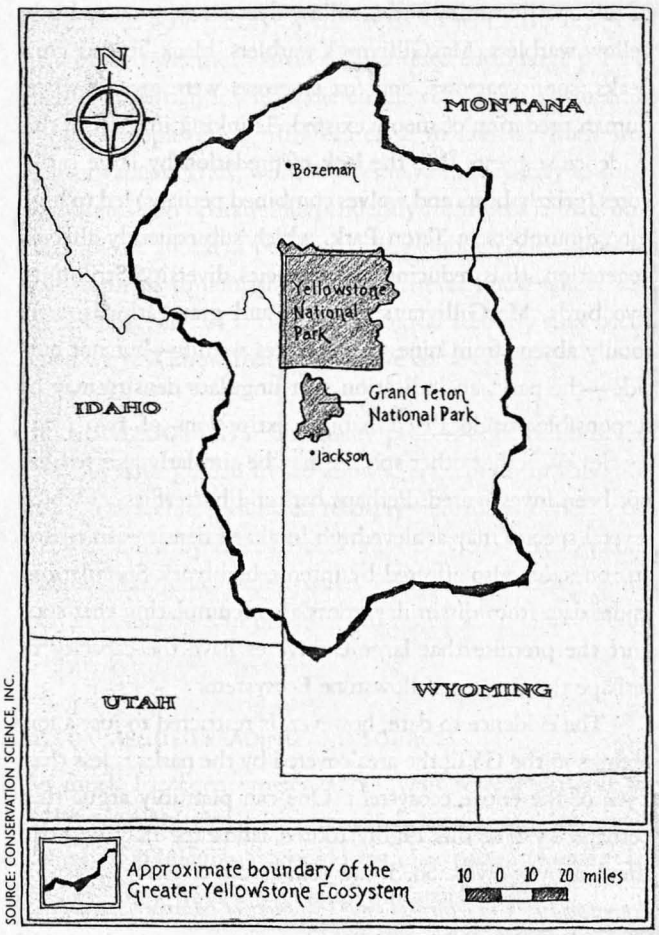
The Yellowstone wolves soon dispersed from the park, arriving in Jackson Hole to the south three years later. Patterns of predation were essentially similar, with more than 95% of the known kills being elk. This does not mean that other ungulates may not be strongly affected, but from what is known, elk, perhaps due to their greater abundance than other species, are taken most frequently.

The ecological effects of wolf recovery can ripple through an ecosystem. In both Yellowstone and Teton Parks, wolves have killed coyotes and displaced cougars from their kills. With coyotes either displaced from some areas or reduced in population size, it is possible that red foxes may increase, because coyotes are major predators of foxes. If wolves consistently kill coyotes and fox populations do increase as a consequence, both the nests of waterfowl and some ground-nesting birds may experience increased failure as foxes are deft predators of nestlings. The kill rates of cougars tend to increase if the cats are displaced from their own ungulate kills. Whether these kills are deer or elk, the frequency of cougar predation may increase simply because wolves are appropriating the carcasses of animals killed by cougars. Although such direct effects on other carnivores have yet to be definitively demonstrated for either Teton or Yellowstone National Parks, data from other ecosystems suggest that it is reasonable to expect similar effects in these two protected enclaves.

These predictions aside, new data bear directly on the behavior of both prey and scavengers in relation to wolves. Several changes in predator detection have occurred with wolf reintroduction; initially, wolves could sometimes walk up to naive elk and 300-pound moose calves, which had no fear of them. There had been a virtual cessation of behavioral avoidance to wolves in elk and moose. In a few cases wolves killed these animals in the absence of flight. In fact, both species lacked a demonstrable response—visual, auditory, or olfactory—to wolves. This may have occurred because elk and moose confused wolves with coyotes, which have not been major predators of either ungulate (or their calves), or because they formerly had little to fear from any predator when living in open habitats. In Jackson Hole, where studies of predator avoidance are underway, elk in areas with wolves are now hypersensitive to the howls of wolves. But moose living in areas with wolves are still virtually unresponsive unless they

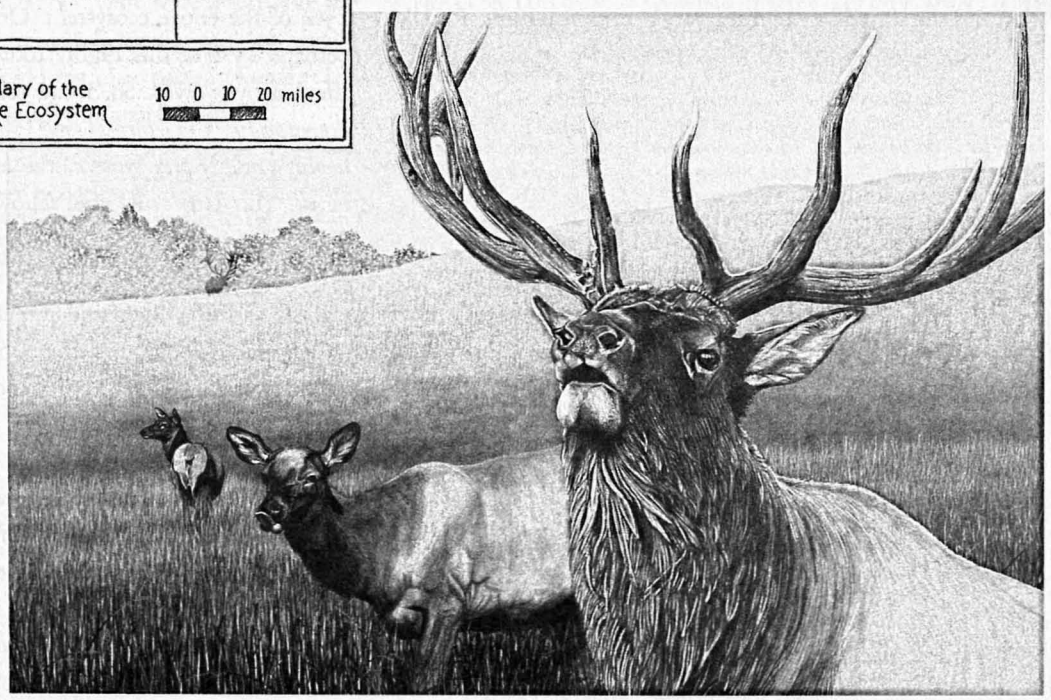
have already lost offspring to wolves. This indicates that mothers are learning about the threat wolves pose to their young, and the speculation that wolves might drastically reduce moose populations may be overstated. Unlike their kin to the south, moose in Alaska who have lived in the presence of top carnivores are so predator-savvy that the feces of grizzly bears or the urine of wolves can cause them to abandon local feeding areas. Whether wolves in the Greater Yellowstone Ecosystem will similarly affect densities, group sizes, and habitat preferences of congregating moose is not yet certain.

What is clear is that scavenger communities are responding rapidly to wolves. Yellowstone Park ravens now appear on average within two minutes of a wolf kill, and up to 70 ravens have been seen on the same carcass, along with magpies and bald and golden eagles. It has been estimated that more than three times as much carrion will become available to other members of the family Carnivora—grizzly bears, foxes, and coyotes included—than prior to wolf recovery.



SOURCE: CONSERVATION SCIENCE, INC.

BEYOND SINGLE SPECIES EFFECTS, there is at least as much interest in government circles, among scientists, and by the public about ecosystem health, particularly because in national parks off-limits to hunting, herbivore densities may be much higher than in areas beyond park borders. Winter moose densities in Teton Park, for instance, are about five times greater than on outlying Forest Service lands. And in Yellowstone Park, the area known as the Northern Range has been the topic of acrimonious debate for nearly half a century because of potential damaging effects of elk and bison populations. The central issue has been the extent to which herbivore densities versus other factors have influenced plant



elk, acrylic and colored pencil by Steve Oliver / map by Todd Cummings

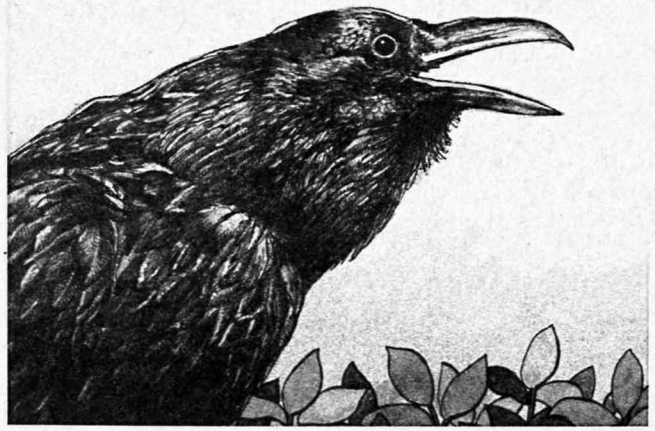
community structure. This issue is significant because in the montane and arid West, biological diversity tends to be higher in riparian zones around wet meadows, streams, and river corridors. If herbivores attain abnormally high densities because of a lack of effective predation, then aspens, cottonwoods, and other woody vegetation can be greatly reduced. A cascade of ecological interactions may be triggered, undermining ecological processes and affecting the diversity of life across the landscape.

Studies using very different approaches in Yellowstone and Jackson Hole are beginning to produce evidence about the important and perhaps long-lasting effects of predators. In Yellowstone National Park and on the National Elk Refuge, the regeneration of young aspen trees has been hampered by high levels of elk browsing. Comparing aspen sucker heights in regions of high and low wolf density yields interesting results. Where wolves occur more frequently, the presence of elk and attendant browsing is lower than at sites with fewer wolves. Concomitantly, sucker heights are greater. Although these findings have not been uniformly recorded across all of Yellowstone Park's upland and wet meadow habitats, they suggest that wolves are already affecting elk foraging, movements, and associations—thereby affecting vegetative structure.

In Jackson Hole, researchers studying the effects of predation are considering the relationships between predators and prey, between prey and vegetation, and between vegetation and the abundance of migratory neotropical birds. Recall that moose densities in Grand Teton National Park were about five times higher than those in adjacent national forests, where humans shot almost 11,000 moose during a 20-year period. On these national forest lands, willow riparian vegetation was more abundant and showed lower levels of moose herbivory than did park sites. Similarly, the nesting densities of calliope hummingbirds, willow flycatchers, gray catbirds, yellow warblers, MacGillivray's warblers, black-headed grosbeaks, song sparrows, and fox sparrows were greater where human predation of moose existed. Thinking in reverse, this evidence suggests that the lack of predation by large carnivores (grizzly bears and wolves combined perhaps) led to high moose numbers in Teton Park, which subsequently affected vegetation, thus reducing avian species diversity. Strikingly, two birds, MacGillivray's warblers and gray catbirds, were totally absent from nine transect sites within—but not outside—the park, an indication that ungulate density may be responsible for localized habitat extinctions of two avian species. Whether other species may be similarly affected has not been investigated. Perhaps bats and butterflies, of which several species may achieve high localized densities in riparian zones, are also affected by intense herbivory. Speculations aside, data from dissimilar fronts are accumulating that support the premise that large carnivores have the capacity to reshape the Greater Yellowstone Ecosystem.

The evidence to date, however, is restricted to just a few regions in the GYE; the area covered by the parks is less than 15% of the entire ecosystem. One can plausibly argue that perhaps 85% of this highly touted landscape may be little affected by wolves. So, if we ask, *Is the Greater Yellowstone Ecosystem likely to return to some semblance of balance with a functioning predator-prey system?,* the answer—surprisingly—may be *no*. This is because the Yellowstone wolves will soon be delisted under the Endangered Species Act, losing protection by the federal government, and the states of Idaho, Montana, and Wyoming will assume formal management jurisdiction. When that action occurs, the public may assume that population recovery has occurred. Indeed, the assumption would appear to be sound if based solely on demographic grounds.

But the issue of ecological change is quite different from that of ecological recovery. If wolves beyond park boundaries are limited to artificially low densities, then their ability to influence other carnivores, prey numbers and attendant behavior, and other community processes and components will be limited; strong ecological differences will persist inside and outside of the parks. Inside, ecosystems may be



common raven, acrylic and ink by Steve Oliver

structured to a greater or lesser extent by the action of predators. Outside the parks, ecological restoration will be seriously hampered. Somewhat unwittingly—and incorrectly—the public may assume that ecological recovery has occurred because wolves have been removed from federal protection.

Whether the entire Greater Yellowstone Ecosystem is to be reshaped ecologically by the return of its native large carnivores, and whether wolves will be restored to large parts of their historic range, will hinge on the voices of the American public—people living in areas close to and far from wolf recovery zones. Thus, while wolves have the capacity to shape ecosystems and operate independently from people, it is only through the action of people creating public policy allowing these animals to flourish that we will ever know when, how far reaching, and at what pace ecological recovery may occur. Then we will know that wolves have come home. ☾

ACKNOWLEDGMENTS Too many people, organizations, and agencies have guided me to allow due mention in this short space. The architects for wolf recovery were the American public, facilitated by the National Park Service in Yellowstone. People like John Varley, Mike Phillips, and Doug Smith played heroic roles in bringing wolves back. In Grand Teton, Steve Cain, Carol Cunningham, Mason Reid, and Bob Schiller greatly enhanced my work during the past seven years. Collaborators, cooperators, co-authors from prior work, and intellectual mentors include, in addition to the above, Lori Bellis, Joe Bohne, Terry Bowyer, Doug Brimeyer, John Byers, Derek Craighead, Franz Camenzind, Jodi Hilty, Mike Jimenez, Matthew P. Johnson, Brian Miller, Kerry Murphy, Glen Plumb, Reed Noss, Sanjay Pyare, Kent Redford, Barry Reiswig, Tom Roffe, Toni Ruth, Bruce Smith, Michael Soulé, Peter Stacey, Ward Testa, Bill Weber, Kevin White, and Louisa Willcox. I thank my wife, Kim Berger, for reviewing this manuscript, and the following agencies for support: Denver Zoological Foundation, the National Elk Refuge (U.S. Fish and Wildlife Service), the National Park Service (Grand Teton, Denali, Yellowstone), the National Science Foundation, the Engelhard Foundation, Beringea South, Wyoming Game and Fish, and the Wildlife Conservation Society.

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by Steven Platt, Christopher Brantley, and Thomas Rainwater

The canebrakes stretch along the slight rises of ground, often extending for miles, forming one of the most striking and interesting features of the country. They choke out other growths, the feathery, graceful canes standing in ranks, tall, slender, serried, each but a few inches from his brother, and springing to a height of fifteen or twenty feet. They look like bamboos; they are well-nigh impenetrable to a man on horseback; even on foot they make difficult walking unless free use is made of the heavy bush-knife. It is impossible to see through them for more than fifteen or twenty paces and often for not half that distance. Bears make their lairs in them, and they are the refuge for hunted things.

THEODORE ROOSEVELT (1908)

THEODORE ROOSEVELT'S ACCOUNT of his bear-hunting expedition into the canebrakes of northeastern Louisiana stands as one of the best—and last—descriptions of an ecosystem that has largely vanished from the southeastern landscape. Cane (*Arundinaria gigantea*), a member of the grass family, is the only bamboo native to the United States and occurs throughout most of the Southeast (see map on page 40). Growing from rhizomes (below-ground root-like structures), the culms (above-ground stalks) support thick evergreen foliage, may reach 9 to 10 meters in height, and crowd together in dense stands called "canebrakes" by the early settlers (from the Middle English word "brake" meaning "thicket"; Fulcher 1999).

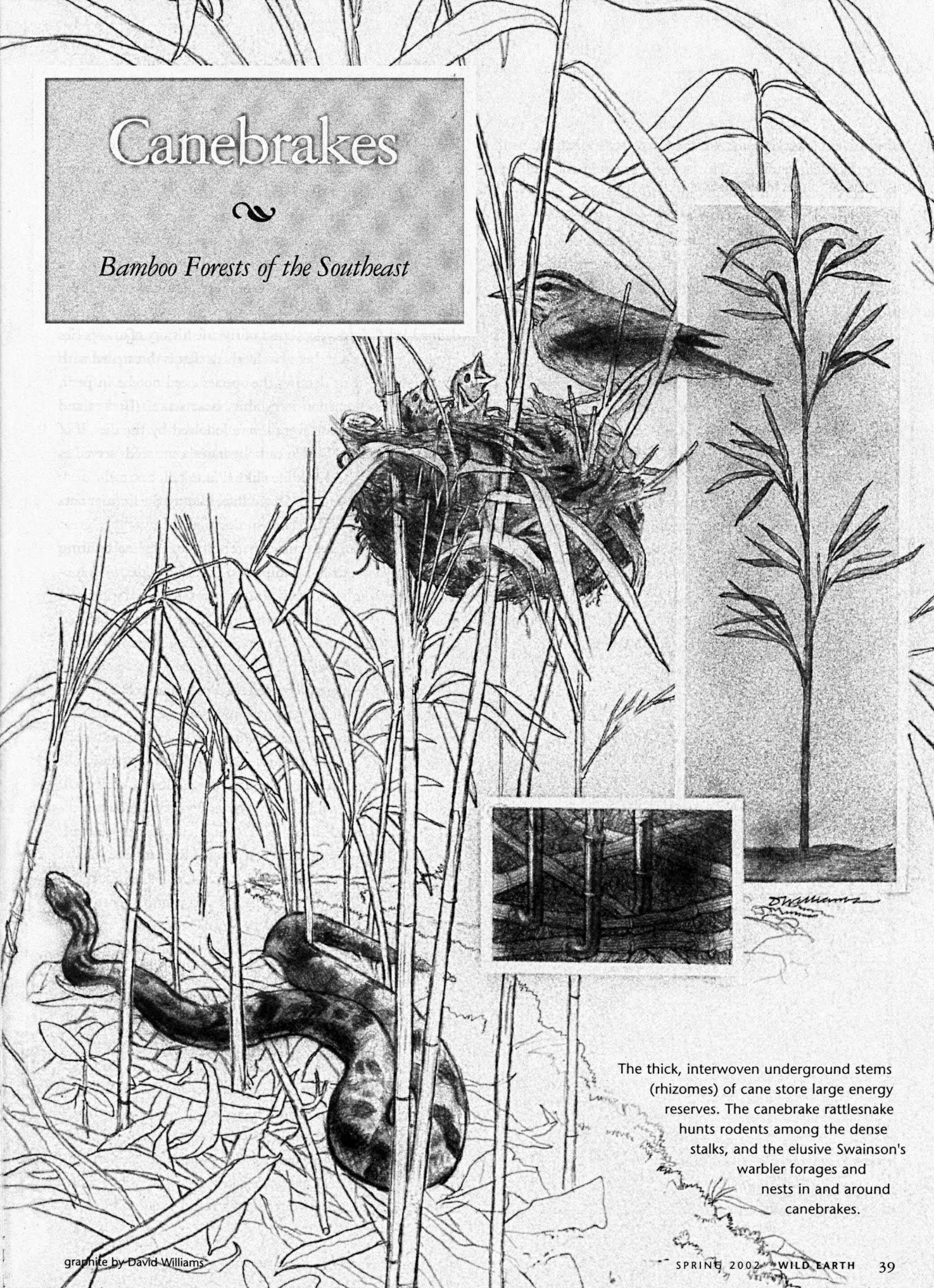
Canebrakes were a dominant feature of the presettlement southeastern landscape, and period accounts indicate that hundreds of thousands of hectares were characterized by this ecosystem (Platt and Brantley 1997). Eighteenth-century naturalist William Bartram encountered "vast cane meadows," "an endless wilderness of canes," and "widespread cane swamps" during his travels (Van Doren 1928). Bartram traveled for "20 miles through...cane meadows in Alabama," and "eight miles in a cane forest" in Louisiana. Writing of frontier Kentucky, Fortescue Cuming (Cuming 1810) stated that "the whole country was then an entire canebrake," and early maps of the region show many areas labeled as "fine cane lands" (Jillson 1930). One canebrake in Kentucky was estimated to cover 30,000 hectares (Campbell 1985), and those in neighboring Tennessee were said to be "many miles in extent" (Buttrick 1831). The largest canebrakes occurred on natural levees in the Mississippi River floodplain, on a chain of bluffs above the Mississippi River (formerly known as the "cane hills," extending from western Kentucky to southeastern Louisiana), and in pine communities of the Atlantic and Gulf Coastal Plains (Delcourt 1976; Campbell 1985; Bryant et al. 1993).

Early accounts describe some canebrakes as treeless areas, and others as open woodlands with thick cane growing beneath scattered trees. Canebrakes were amazingly dense; as many as 160,000 canes per hectare have been reported in modern studies (Platt and Brantley 1997). Pea-vine (*Amphicarpa bracteata*) and greenbrier (*Smilax* spp.) were often intertwined among the cane, presenting a formidable barrier to travel (Tingle et al. 2001). Canebrakes near Vicksburg, Mississippi were thick enough to seriously hamper Union troop movements during the 1863 siege (Grant 1885).

Like bamboo forests elsewhere, canebrakes will not thrive under a closed forest canopy, and some form of natural or anthropogenic disturbance was necessary to maintain this ecosystem (Campbell 1985). Natural disturbances included lightning fires, scouring by riverine flooding, and windstorms (Brantley and Platt 2001). Passenger pigeons (*Ectopistes migra-*

Canebrakes

Bamboo Forests of the Southeast

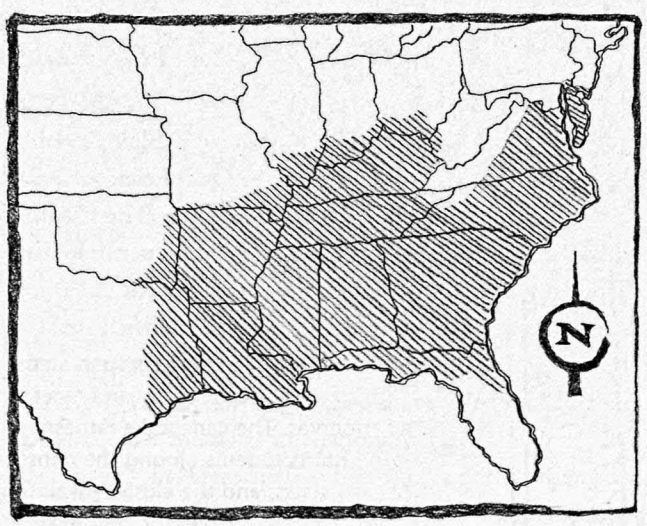


The thick, interwoven underground stems (rhizomes) of cane store large energy reserves. The canebrake rattlesnake hunts rodents among the dense stalks, and the elusive Swainson's warbler forages and nests in and around canebrakes.

graphite by David Williams

torius) were a major source of landscape-scale disturbance in the presettlement forest. Flocks numbering in the millions roamed the southeast every winter in search of acorns, and formed temporary roosts covering thousands of hectares. Dung accumulating beneath these roosts deadened the overstory and provided a rich source of fertilizer that favored the vegetative expansion of cane into these openings (Platt and Brantley 1997). Extensive canebrakes were also said to have developed when the New Madrid Earthquake felled vast stands of timber during the winter of 1811–1812 (Shackford and Folmsbee 1973).

Some of the largest canebrakes originated when cane became established in abandoned agricultural fields following the collapse of Native American populations exposed to the ravages of introduced European diseases (Platt and Brantley 1997). The nearly 1.7 million Native Americans inhabiting the Southeast immediately prior to European contact practiced an intensive system of floodplain agriculture based on corn (*Zea mays*). Because about one hectare of cropland was required for each person, extensive deforestation occurred along riverine corridors throughout the region (Delcourt et al. 1993). However, within 50 years of European contact, as much as 90% of the population had perished and large tracts of agricultural land lay abandoned (Dobyns 1983). Vegetative expansion of cane into these lands occurred quickly, and many historic accounts mention canebrakes growing in what were once corn fields (Platt and Brantley 1997). Additionally, the surviving Native Americans used broadcast fire to create and maintain significant areas of grassland and canebrakes as hunting grounds (Rostlund 1960). Canebrakes were burned every 7 to 10 years, a practice that favored this ecosystem by eliminating competing woody vegetation (Platt and Brantley 1997).



Distribution of cane (*Arundinaria gigantea*) in the southeastern United States.

map by Todd Cummings

Canebrakes underwent periodic mast seeding (synchronized production of seed at long intervals by a population) every 50 to 60 years (Janzen 1976; Platt and Brantley 1997). Owing to the current rarity of canebrakes, mast seeding is now considered an endangered phenomenon (Platt et al. 2001a), defined as a "spectacular aspect of the life history of a...species involving a large number of individuals that is threatened with impoverishment or demise; the species need not be in peril, rather the phenomenon it exhibits is at stake" (Brewer and Malcolm 1991). Mast events were followed by the die-off of entire canebrakes. High in carbohydrates, cane seeds served as food for humans and wildlife alike (Platt et al. 2001a).

Canebrakes were rich in wildlife, leading the frontier naturalist Dr. Gideon Lincecum to describe them as the "great *sanctum sanctorum*; the inner chamber of the great hunting ground" (Lincecum and Philips 1994). Records gleaned largely from historic sources indicate that at least 23 species of mammals, 16 birds, 4 reptiles, and 6 invertebrates inhabited canebrakes (Platt et al. 2001a). Cane foliage was important forage for bison (*Bison bison*), and most records from east of the Mississippi River mention these bovines in association with canebrakes. The widespread availability of canebrake habitat coupled with the precipitous decline of Native American populations played a significant role in the eastward expansion of bison from the Great Plains after 1600 (Rostlund 1960). Canebrakes also provided escape cover and browse for white-tailed deer (*Odocoileus virginianus*) and elk (*Cervus elaphus*). Black bear (*Ursus americanus*) constructed dens or "cane-houses" in the dense recesses of canebrakes and fed on culms, being especially fond of "mutton cane" as the young shoots were called. Cougars (*Puma concolor*), bobcats (*Lynx rufus*), and wolves (presumably *Canis rufus*, although not stated in most accounts) were attracted to canebrakes by an abundance of white-tailed deer and smaller prey. Cane foliage has even been found among the stomach contents of a buried mammoth (*Mammuthus* sp.) (Hay 1914).

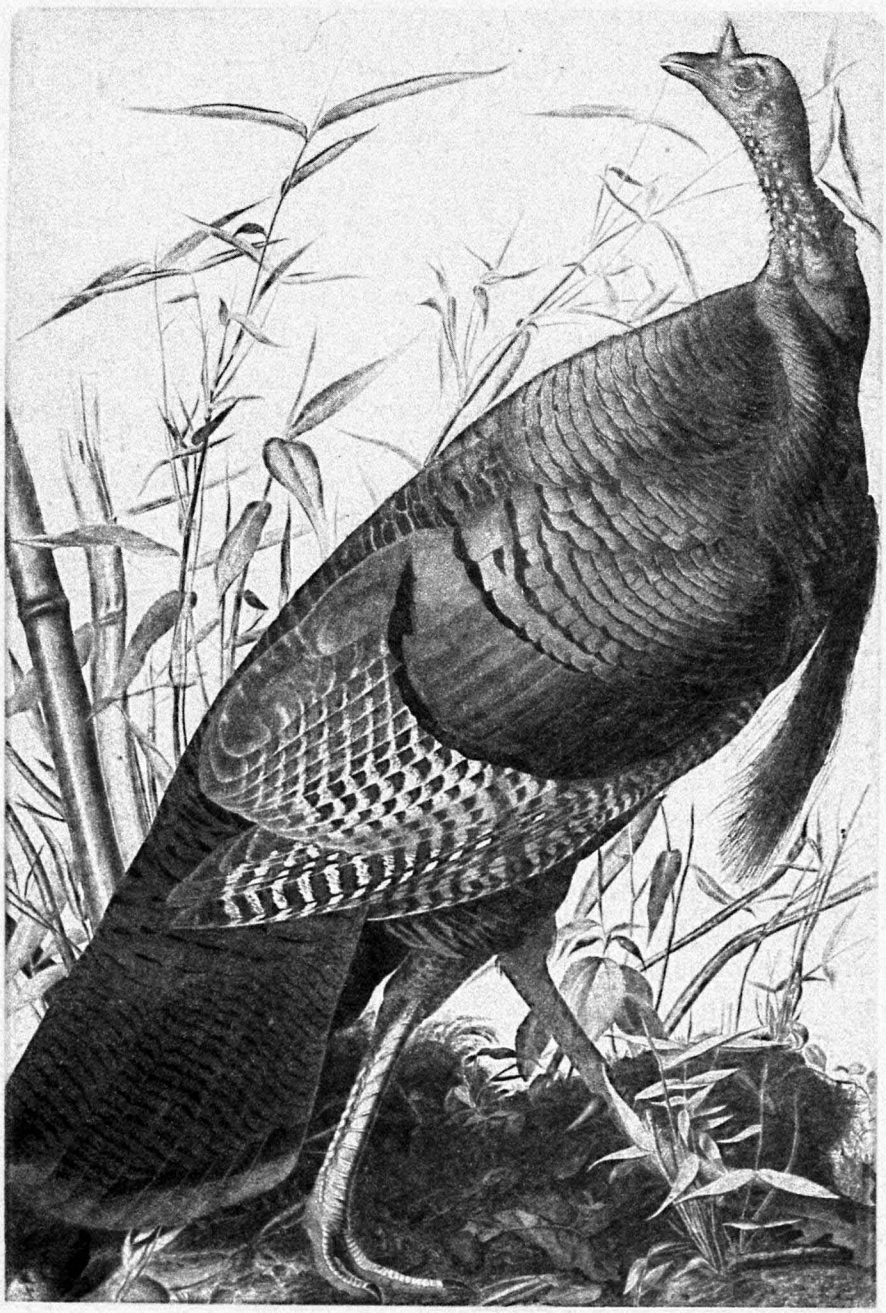
The smaller canebrake fauna is poorly documented (Platt et al. 2001a). Swamp rabbits (*Sylvilagus aquaticus*) inhabited canebrakes throughout their range, and now appear restricted to this habitat in southern Indiana and southeastern Missouri. Cane serves as food and cover for the species, and the vernacular names "cane cutter" and "cane Jake" reflect the rabbits' affinity for canebrakes. Overwinter survival of tree squirrels (*Sciurus*

spp.) was enhanced by the availability of large quantities of cane seed following mast events (Deam 1929). Cane seeds were also a major food source for passenger pigeons (Lincecum 1874). Many historic accounts mention large flocks of wild turkeys (*Meleagris gallopavo*) in canebrakes, and Audubon depicted wild turkeys together with cane (Audubon 1967).

The now extinct (or nearly so) Bachman's warbler (*Vermivora bachmanii*) was probably a canebrake specialist; in addition to nesting in cane, its thin decurved bill is believed to be an adaptation for foraging among bamboo foliage (Remsen 1986). Cane remains an important nesting habitat for lowland populations of Swainson's warbler (*Limnothlypis swainsonii*). The southern subspecies of the timber rattlesnake (*Crotalus horridus atricaudatus*), commonly known as the canebrake rattlesnake owing to its predilection for cane habitats, was once common in canebrakes, no doubt attracted by the abundance of rabbits and small rodents, its preferred prey (Platt et al. 2001b). Six species of butterflies are considered canebrake specialists; the larvae of the Creole pearly eye (*Enodia creola*), southern pearly eye (*E. portlandia*), southern swamp skipper (*Poanes yehl*), cobweb little skipper (*Amblyscrites aesculapius*), cane little skipper (*A. reversa*), and yellow little skipper (*A. carolina*) all feed on cane foliage and the adults are restricted to this habitat (Platt et al. 2001a).

Canebrakes were rich in wildlife, leading the frontier naturalist Dr. Gideon Lincecum to describe them as the "great *sanctum sanctorum;* the inner chamber of the great hunting ground."

FRONTIER LAND-USE PRACTICES were incompatible with the continued existence of canebrakes, which succumbed to the twin onslaughts of grazing and farming (Owsley 1945; Platt and Brantley 1997). The South was a major livestock-producing region: as many as 12 million cattle and perhaps four to five times as many hogs were present on southern rangelands just prior to the Civil War (Clark and Guice 1989). Canebrakes were highly regarded as pastures because the evergreen foliage provided livestock with shelter during inclement weather and year-round grazing. Cattle that grazed



wild turkey and cane by John James Audubon, ca. 1825

on cane exhibited significant weight gains, produced a 95% annual calf crop, and gave superior milk and butter. Horses fed cane were said to be able to work as well as those fed corn, and the carbohydrate-rich rhizomes were avidly sought by hogs (Platt and Brantley 1997).

Cane, however, is extremely sensitive to even moderate levels of infrequent grazing, and continuous grazing leads to rapid stand decline. Research in the 1950s found that just a single season of moderate grazing resulted in a decrease of foliage and culm production, and heavier grazing led to culm death (Shepherd et al. 1951). Hogs furthered the devastation by destroying rhizomes, thus preventing vegetative regeneration of stands. And annual fires ignited by stockmen to encourage the growth of new forage acted in concert with

The Eccentric Naturalist

by John James Audubon

EDITOR'S NOTE *Constantine Samuel Rafinesque, the brilliant, prolific (he described and proposed scientific names for over 6,000 plants and hundreds of animals and fishes), and decidedly eccentric naturalist, visited John James Audubon in Henderson, Kentucky, in the 1820s. Audubon later described their meeting and subsequent collecting adventures in "The Eccentric Naturalist," published in his* Ornithological Biography *(1831), using the pseudonym "M. de T." for Rafinesque.*

One day, as I was returning from a hunt in a cane-brake, [M. de T.] observed that I was wet and spattered with mud, and desired me to show him the interior of one of these places, which he said he had never visited.

The cane, kind reader, formerly grew spontaneously over the greater portions of the State of Kentucky and other western districts of our Union, as well as in many farther south. Now, however, cultivation, and introduction of cattle and horses, and other circumstances connected with the progress of civilization, have greatly altered the face of the country, and reduced the cane within comparatively small limits. It attains a height of from twelve to thirty feet, and a diameter of from one to two inches, and grows in great patches resembling osier-holts, in which occur plants of all sizes. The plants frequently grow so close together, and in course of time become so tangled, as to present an almost impenetrable thicket. A portion of ground thus covered with canes is called a *cane-brake.*

If you picture to yourself one of these cane-brakes growing beneath the gigantic trees that form our western forests, interspersed with vines of many species, and numberless plants of every description, you may conceive how difficult it is for one to make his way through it, especially after a heavy shower of rain or a fall of sleet, when the traveller, in forcing his way through, shakes down upon himself such quantities of water as soon reduce him to a state of the utmost discomfort. The hunters often cut little paths through the thickets with their knives, but the usual mode of passing through them is by pushing one's self backward, and wedging a way between the stems. To follow a Bear or a Cougar pursued by dogs through these brakes is a task the accomplishment of which may be imagined, but of the difficulties and dangers accompanying which I cannot easily give an adequate representation.

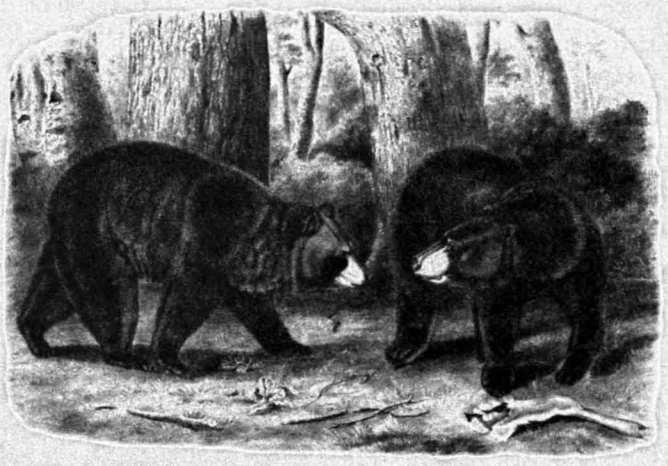
The canes generally grow on the richest soil, and are particularly plentiful along the margins of the great western rivers. Many of our new settlers are fond of forming farms in their immediate vicinity, as the plant is much relished by all kinds of cattle and horses, which feed upon it at all seasons, and again because these brakes are plentifully stocked with game of various kinds. It sometimes happens that the farmer clears a portion of the brake. This is done by cutting the stems—which are fistular and knotted, like those of other grasses—with a large knife or cutlass. They are afterwards placed in heaps, and when partially dried set fire to. The moisture contained between the joints is converted into steam, which causes the cane to burst with a smart report, and when a whole mass is crackling, the sounds resemble discharges of musketry. Indeed, I have been told that travellers floating down the rivers, and unacquainted with these circumstances, have been induced to pull their oars with redoubled vigor, apprehending the attack of a host of savages, ready to scalp every one of the party.

A day being fixed, we left home after an early breakfast, crossed the Ohio, and entered the woods. I had determined that my companion should view a cane-brake in all its perfec-

heavy grazing to destroy canebrakes. Culms that resprouted after fires were highly palatable and consequently heavily grazed, but frequent resprouting quickly depleted rhizomal nutrient reserves and resulted in culm death (Hughes 1957). As canebrakes disappeared, stockmen gathered their herds and pushed into unsettled areas, eventually repeating the cycle many times over. In the early 1800s Stephen Long observed that "when the canes are fed down and destroyed...[the stockman]...goes in search of a place where all the original wealth of the forest is yet undiminished" (Long 1819–1820).

Farmers who followed in the stockmens' wake found that canebrakes were indicative of soil quality. "Cane growth [was]...the standard by which settlers estimated the value of

tion, and after leading him several miles in a direct course, came upon as fine a sample as existed in that part of the country. We entered, and for some time proceeded without much difficulty, as I led the way, and cut down the canes which were most likely to incommode him. The difficulties gradually increased, so that we were presently obliged to turn our backs to the foe, and push ourselves on the best way we could. My companion stopped here and there to pick up a plant and examine it. After a while we chanced to come upon the top of a fallen tree, which so obstructed our passage that we were on the eve of going round, instead of thrusting ourselves through amongst the branches, when, from its bed in the centre of the tangled mass, forth rushed a Bear, with such force, and snuffing the air in so frightful a manner, that M. de T. became suddenly terror-struck, and, in his haste to escape, made a desperate attempt to run, but fell amongst the canes in such a way that he looked as if pinioned. Perceiving him jammed in between the stalks, and thoroughly frightened, I could not refrain from laughing at the ridiculous exhibition which he made. My gayety, however, was not very pleasing to the *savant,* who called out for aid, which was at once administered. Gladly would he have retraced his steps, but I was desirous that he should be able to describe a cane-brake, and enticed him to follow me by telling him that our worst difficulties were nearly over. We proceeded, for by this time the Bear was out of hearing.



black bears by John James Audubon, ca. 1840

The way became more and more tangled. I saw with delight that a heavy cloud, portentous of a thunder gust, was approaching. In the mean time, I kept my companion in such constant difficulties that he now panted, perspired, and seemed almost overcome by fatigue. The thunder began to rumble, and soon after a dash of heavy rain drenched us in a few minutes. The withered particles of leaves and bark attached to the canes stuck to our clothes. We received many scratches from briers, and now and then a switch from a nettle. M. de T. seriously inquired if we should ever get alive out of the horrible situation in which we were. I spoke of courage and patience, and told him I hoped we should soon get to the margin of the brake, which, however, I knew to be two miles distant. I made him rest, and gave him a mouthful of brandy from my flask; after which, we proceeded on our slow and painful march. He threw away all his plants, emptied his pockets of the fungi, lichens, and mosses which he had thrust into them, and finding himself much lightened, went on for thirty or forty yards with a better grace. But, kind reader, enough—I led the naturalist first one way, then another, until I had nearly lost myself in the brake, although I was well acquainted with it, kept him tumbling and crawling on his hands and knees until long after mid-day, when we at length reached the edge of the river. I blew my horn, and soon showed my companion a boat coming to our rescue. We were ferried over, and on reaching the house, found more agreeable occupation in replenishing our empty coffers.

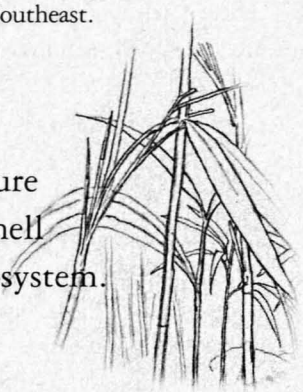
M. de T. remained with us for three weeks, and collected multitudes of plants, shells, bats, and fishes, but never again expressed a desire of visiting a cane-brake....

lands. If it grows no higher than five feet...the soil was...ordinary, but a growth of twenty or thirty feet indicated the highest degree of fertility" (Logan 1859). Clearing was difficult and time consuming, but deemed worth the effort. Culms were cut, rhizomes dug out with mattocks and heavy iron plows, and the debris burned just prior to spring planting. Clearing for agriculture sounded the death knell for the canebrake ecosystem; cane might gradually recover from overgrazing, but because of its dependence on vegetative reproduction, once rhizomes were eliminated it could not become reestablished (Platt and Brantley 1997).

Canebrakes disappeared rapidly before the tide of frontier settlement. As early as 1778 Simon Girty, a white adoptee of the Seneca tribe, cited canebrake destruction by the fledgling Kentucky settlements as *causus bellum* (cause for war) (Faragher 1992). Thirty-two years later Fortescue Cuming found canebrakes only in remote regions of Kentucky (Cuming 1810), and John James Audubon, writing of the same region in the 1830s, noted that "the progress of civilization...reduced the cane...[to] comparatively small limits" (Audubon 1897). By the turn of the century large canebrakes had disappeared from Kentucky (Shull 1921). This pattern of destruction was repeated throughout the South. Only in a few thinly settled and remote river bottoms, such as the Tensas Basin of Louisiana and along the Ocmulgee River in Georgia, did large canebrakes persist into the first half of the twentieth century (Meanley 1972).

The demise of the canebrake ecosystem proved devastating to several species of wildlife (Platt et al. 2001a). The near-extinction of Bachman's warbler is believed largely the result of the disappearance of this ecosystem. Five of the six butterflies found in canebrakes are listed as species of conservation concern due to habitat loss. Canebrake destruction has also been cited in the decline of the swamp rabbit in many parts of its range. And while secondary to over-harvesting, canebrake destruction was an important factor in the decline of bison and black bear in the Southeast.

Clearing for agriculture sounded the death knell for the canebrake ecosystem.



TODAY CANE IS A COMMON understory plant in a variety of forest types and occurs in small patches along fencelines, roadsides, and powerlines throughout most of its historic range (Platt and Brantley 1997). While cane is certainly not threatened with extinction, the canebrake ecosystem is critically endangered, and large canebrakes are mostly nonexistent, probably occupying less than 2% of their former abundance. Such degraded ecosystems must not be considered "lost causes" but should instead be accorded the highest priority for conservation and restoration (Noss et al. 1995).

Restoring canebrakes to their former prominence will be a daunting task for land stewards. Although restoration sites are widely available, attempts to reestablish cane using various vegetative planting methods have to date proven largely unsuccessful. Transplanted cane grows slowly and is especially vulnerable to competition from herbaceous and woody vegetation. Furthermore, the techniques needed to economically produce large numbers of seedlings, culm sprouts, or rhizomes have not been developed. Until proven methods are available, attention should be focused on protecting and expanding existing stands of cane as these have the potential to produce significant areas of habitat in a relatively short time (Brantley and Platt 2001).

An immediate state-by-state inventory of extant canebrakes and smaller cane patches is urgently needed. The latter should not be overlooked—cane patches could serve as foci for developing larger stands through vegetative expansion. Successful canebrake restoration will depend on recreating moderate disturbance regimes that favor the plant. Because cane growing under a forest canopy declines over time, some level of overstory removal is probably necessary to restore vigor and encourage vegetative expansion of existing stands (Eddleman et al. 1980). Likewise, burning established canebrakes every 7 to 10 years will ensure the elimination of woody competitors. Because these treatments have yet to be tested empirically, future management actions should be designed such that experimental evaluation of various levels of disturbance is possible (Brantley and Platt 2001).

Indeed, canebrake restoration presents us with a daunting—but not overwhelming—task. Until appropriate restoration technologies are developed, our attempts will likely be checkered by failure, but we must heed the words of the dispossessed Cherokee Chief Lone Watie (played by Chief Dan George in the classic western "The Outlaw Josey Wales"), and "endeavor to persevere." Only then will Roosevelt's serried ranks of graceful canes once again stand tall upon the land, providing refuge for the hunted things. ☾

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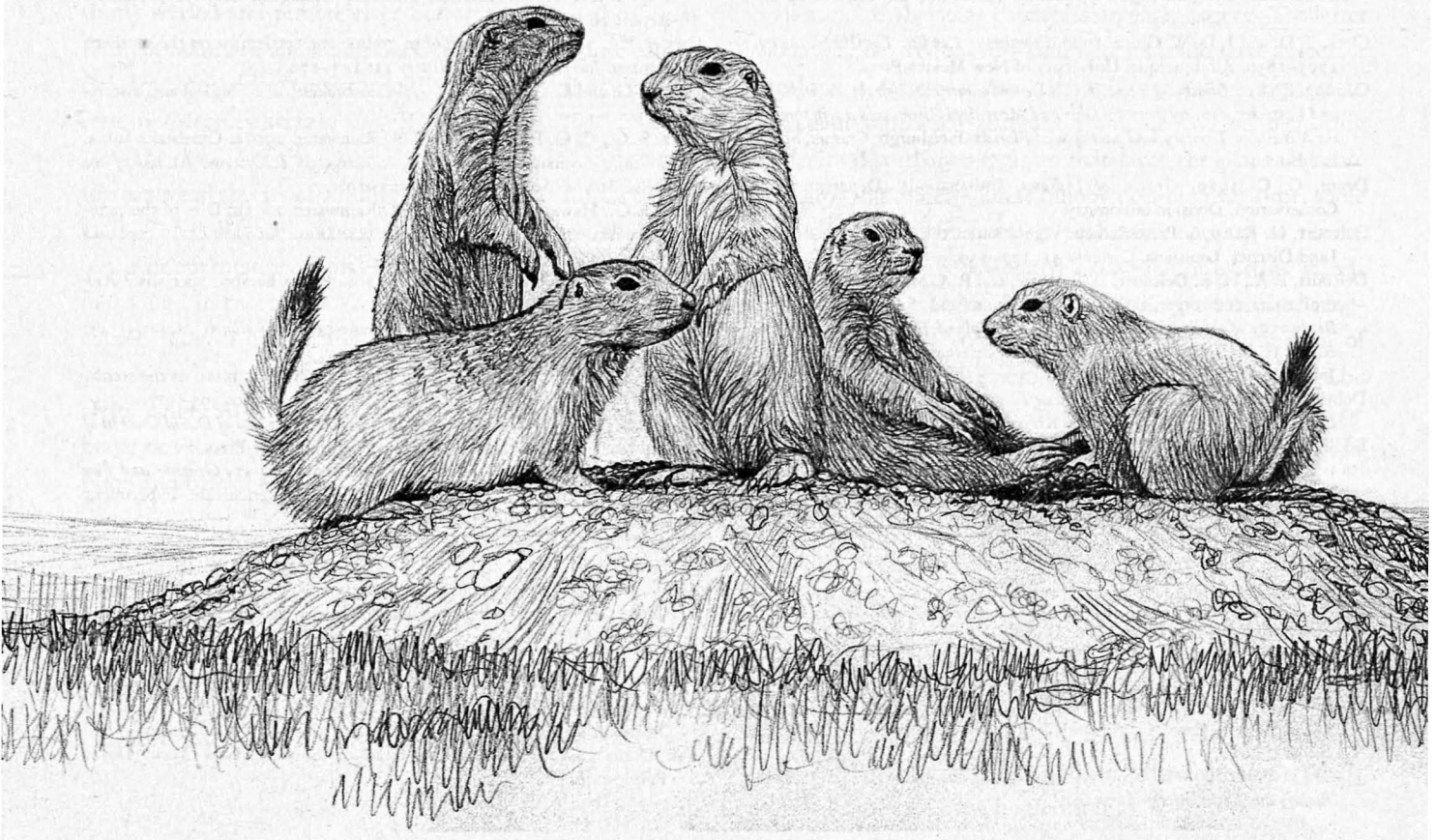
Threats to the Black-Tailed Prairie Dog

and a Plan for Conservation



black-tailed prairie dogs, graphite by Martin Ring

BLACK-TAILED PRAIRIE DOGS (*Cynomys ludovicianus*) are communal, ground-living squirrels—and an indispensable resident and symbol of North America's Great Plains. They have declined dramatically since European settlement of the prairies due to land conversion (for agriculture and urban development), poisoning, exotic disease, and shooting. Today, black-tailed prairie dogs survive in small, fragmented populations scattered across most of their former range.

Because of these severe declines, the species was petitioned for federal protection on the U.S. Endangered Species List in the summer of 1998 (in separate actions by the National Wildlife Federation and the Biodiversity Legal Foundation). On February 4, 2000, the U.S. Fish and Wildlife Service (USFWS), ruled that the species warranted listing as threatened, but that such a determination was precluded by other, more pressing concerns. This automatically put black-tailed prairie dogs on the Candidate Species list for ESA consideration and in its first review of that status in 2001, the USFWS maintained the species on the list. In the meantime, this "warranted, but precluded" ruling has mobilized people on both sides of the issue into a flurry of activity. For now, the black-tailed prairie dog hangs in regulatory limbo awaiting protection under the Endangered Species Act.

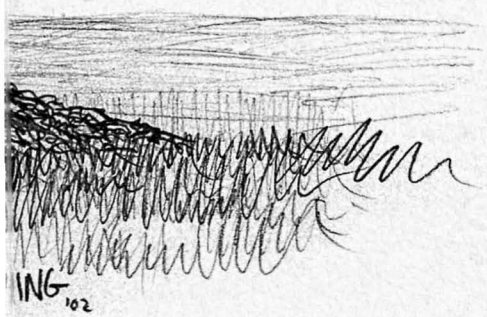
Nevertheless, this may be a step forward: until recently, black-tailed prairie dogs were legally defined as a pest species in every state they inhabited. Montana and South Dakota have now changed the black-tailed prairie dog's status to a "species in need of management" and other states are considering similar actions. The main force behind such changes has been the threat of listing under the ESA, rather than genuine concern for the species by the agencies in question. In addition, most western states retain legislation that encourages or even requires prairie dog control.

If we follow the present course, trends indicate that the species will soon be federally listed. The USFWS should conduct a review of the "warranted, but precluded" designation every year, and unless there is a change in population trends, those reviews eventually will grant federal protection to prairie dogs or there likely will be litigation toward that end. Similar situations with other species suggest that litigation would bring about full protection under the ESA.

Distribution

Before European arrival, prairie dogs were one of the most numerous mammals of the prairie, occupying an area from southern Alberta and Saskatchewan to northern Chihuahua. Their range included parts of 11 U.S. states, and explorer Merriwether Lewis described them as "infinite." Around the turn of the eighteenth century when Lewis and Clark's Voyage of Discovery made such reports, prairie dog colonies existed in a shifting mosaic covering about 20% of the western grasslands. Within this vast distribution, black-tailed prairie dogs inhabited short- and mid-grass prairies of the Great Plains at altitudes of 700 to 1,700 meters. They generally avoid slopes steeper than 10%, areas with tall vegetation, and poorly drained soils.

Today, black-tailed prairie dogs occupy only 0.5% of their original range and have probably experienced a greater than 98% decline in population numbers throughout North America. The species is completely extirpated from Arizona; throughout the rest of its range, remaining populations are severely fragmented. Indeed, conservationists working to recover the endangered black-footed ferret (*Mustela nigripes*), a species wholly dependent upon prairie dogs for its survival, have been unable to identify prairie dog complexes (i.e., clusters of colonies) of sufficient number and size to support viable ferret populations.



by Brian Miller and Richard Reading

Natural History

The family Sciuridae originated in North America during the middle Oligocene Epoch (roughly 30 to 31 million years ago). Prairie dogs probably descended from rodents that colonized the rapidly spreading Miocene grasslands about 20 million years ago. During the Recent Epoch (11,000 years ago to present), prairie dogs represented a primary instrument in the evolution of prairie grasslands.

Prairie dogs construct elaborate burrows that can be 4 meters deep and extend 10 meters horizontally. Black-tailed prairie dogs are highly social, and their burrows are found in aggregations, called colonies or towns. Within these colonies, distinct groups of individuals occupy and defend small "coteries" which contain an average of slightly more than six individuals; groups are age-structured and usually consist of one breeding male, two or three adult females, and several yearlings of each sex.

Female prairie dogs reproduce once a year with litters averaging about 3 emergent young (range 1 to 6) and about half of those young survive to yearlings. Over their lifetime, females produce an average of slightly more than 4 emergent young (range 0 to 20) and 2 yearlings (range 0 to 12). Survival can be higher in some circumstances, for example when prairie dog densities are low. These figures counter the myth of high reproductive potential in prairie dogs. Dispersal is poorly understood, but appears to be generally limited to a maximum of 5 kilometers or less, and usually into an already established colony.

Ecosystem Interactions

A grassland inhabited by prairie dogs provides a greater mosaic of vegetation structure, an abundance of prey for predators, burrow systems, and altered ecological processes (e.g., increased nitrogen content, succulence, productivity of plants, and macroporosity, as well as other changes in soil chemistry) than uninhabited grasslands. Such changes enrich patterns of species diversity for prairie plants and animals. For example, black-footed ferrets, mountain plovers (*Charadrius montanus*), ferruginous hawks (*Buteo regalis*), and various forbs profit from prairie dog activities. On the other hand, prairie dogs limit species like mesquite (*Prosopis* spp.) and vertebrates associated with tall vegetation. The matrix of ecological boundaries cre-

ated by prairie dog colonies improves overall diversity of life across a landscape (*sensu* Paine 1966).

In a recent review of 206 vertebrate species seen on prairie dog colonies, Kotliar et al. (1999) found that nine had quantitative data indicating dependence on prairie dogs. An additional 20 species had abundance data indicating opportunistic use of prairie dog colonies, and another 117 species had no abundance data on or off colonies, but their life history indicated that they could potentially benefit from prairie dog activities. The prairie dog thus fits the general classification of a keystone species. They affect ecosystem structure, function, and composition in a way that is not wholly duplicated by any other species—and in a way that other species depend upon. Because of their role in maintaining structure, function, and composition, we must think of prairie dog restoration in numbers that allow them to exert their ecosystem influence, and not just in terms of a few colonies for taxonomic representation. As one example, it would be possible to protect a small number of prairie dogs without conserving sufficient prairie dog area to maintain a viable population of black-footed ferrets.

Threats

The numerous threats that prairie dogs face can be placed into eight categories, as listed below. Threats 1–5 parallel the five categories used by the USFWS to evaluate status of a species. The presence of a threat in any one of these first five categories legally qualifies a species for federal protection. Prairie dogs face threats in all five. We also add three additional categories that pertain to process and values (threats 6–8).

THREAT 1: HABITAT DESTRUCTION OR MODIFICATION. Approximately 33% of the black-tailed prairie dog's historic range, and 37% of the suitable habitat within its present range, have been converted to cropland. In the eastern part of the historic range, conversion to cropland is nearly complete and the black-tailed prairie dog has been largely eliminated. Urbanization presents a locally significant loss of habitat near some metropolitan areas. Denver is one of the fastest growing cities in the U.S., and the Colorado Division of Wildlife predicted in 1994 that some 17,200 hectares of prairie dog habitat could be affected by urbanization.

black-footed ferret, graphite by Martin Ring

Habitat is also lost due to vegetative changes and structural deterioration of unoccupied prairie dog burrows. Following prairie dog eradication, mesquite and brush invade grasslands at rates of 1.5 to 2% a year. Such habitat changes also serve to fragment and isolate remaining colonies.

Throughout their range, there is an overall trend of prairie dog habitat loss and fragmentation, where once-large colonies are broken into smaller, isolated colonies. Conversion to cropland and urban development largely takes place on private land, and such trends are likely to continue as present economic factors favor both. Negative impacts befalling small and isolated populations have been well documented. Such impacts render smaller colonies more vulnerable to extirpation and reduce the long-term viability of the species. In addition, once a prairie dog colony is abandoned, the burrows collapse, greatly decreasing the likelihood that dispersing prairie dogs would reoccupy the area. It is thus increasingly more difficult to reconnect fragmented pieces.

THREAT 2: RECREATIONAL KILLING. Recreational shooting may not be a factor in range-wide decline, but heavy shooting can be locally detrimental to prairie dogs. A heavy loss to the adult population, shooting females that are pregnant or nursing, or shooting in combination with other factors causing decline (e.g., poisoning or plague) could seriously damage the population dynamics of a colony. In addition, shooting disrupts prairie dog social systems and changes their behavior.

Until recently, shooting was unregulated except on some tribal lands, and indiscriminate, large-scale recreational shooting has been locally common in several areas of prairie dog range. Although a few states are implementing or considering some regulations on shooting (for example, Colorado has banned contest shoots and shooting on public lands), most recreational shooting will remain unregulated. Without strict regulation and enforcement, shooting will continue to locally impair prairie dog recovery.

THREAT 3: DISEASE. Sylvatic plague is an extremely virulent, exotic disease for prairie dogs. Mortality appears to be high following infection and occurs so quickly that it often precedes any symptoms of the disease. Other species can serve as hosts and reservoirs for the disease (e.g., deer mice, *Peromyscus maniculatus*), and some wide-ranging species, such as coyotes (*Canis latrans*), serve as carriers of the infected fleas. Thus prairie dog colonies that are too widely separated to allow genetic and demographic interchange by prairie dogs are often close enough to allow the spread of plague from one colony to the next by other vertebrate hosts.

Approximately 66% of the black-tailed prairie dog's range has been affected by sylvatic plague. Although the distribution of plague remains more or less stable, most of the unaffected portion of the prairie dog's range (i.e., the eastern third) has been converted to cropland. The picture is therefore dire. The only state where prairie dogs are largely free from plague is South Dakota, but outbreaks of plague could spread there in the future.

While some areas of prairie dog range may be less vulnerable to plague than others, no area is safe. Plague alone could halt prairie dog recovery, and contribute to extinction of the species. Barring medical advances, such as an oral inoculation that can be broadcast into an area, there is little that land managers can do to prevent the spread of the disease. Dusting prairie dog colonies with an insecticide to kill the fleas can temporarily stem the spread of the disease, but that is time intensive and requires re-application.

THREAT 4: LACK OF REGULATORY MECHANISMS. Through early 2001, all states within the historic range of the black-tailed prairie dog classified the species as a pest and allowed or required eradication. At least one government agency in each state promotes eradication. Local or statewide mandatory eradication under certain circumstances (i.e., so-called "good neighbor" laws) is in effect in Colorado, Kansas, South Dakota, and Wyoming. Alternatively, the Cheyenne River Sioux Tribe does not classify prairie dogs as pests, and the Crow Creek Tribe does not allow chemical control. With the threat of federal protection, some states have recently considered changing prairie dog status, and Montana and South Dakota have just done so.

THREAT 5: PRAIRIE DOG ERADICATION PROGRAMS. Poisoning campaigns began in the late 1800s because prairie dogs were considered an agricultural pest. These were large-scale, well-organized efforts that severely reduced and fragmented the range and distribution of prairie dogs. In 1915, the federal government began allocating money for rodent control, and by the 1920s, millions of prairie dogs and ground squirrels were being poisoned annually. Poisoning policy became further institutionalized when the Biological Survey formed the Division of Predatory Animal

and Rodent Control in 1929. Passing the Animal Damage Control Act in 1931 provided statutory authority for poisoning, trapping, and shooting on and off federally owned land, and that act remains the primary statute for animal damage control today.

Early estimates of competition between livestock and prairie dogs were not based on scientific evidence. For example, Merriam suggested that prairie dogs used 50–75% of the productivity available to grazers, but recent research indicates that was a 10-fold exaggeration. Yet, poisoning continues despite evidence that it is not cost-efficient. Indeed, poisoning is mandated in some circumstances and, at present, it appears that about 10 to 20% of current black-tailed prairie dog habitat is poisoned annually by federal, state, and private entities. Even agencies with a mission to conserve wildlife often view poisoning of some prairie dog complexes as a necessary trade-off to preserve other prairie dog complexes. Without an end to poisoning on public lands, and an end to the government subsidies for poisoning on private lands, prairie dogs will continue to decline.

THREAT 6: LACK OF AN ADAPTIVE RESPONSE TO THREATS. Ecosystems stay healthy only when the species and processes remain intact. While ecosystems are not stable *per se*, the natural variation that they experience usually occurs within bounds, and species have adapted over time to thrive within that particular range of variability. When a new event pushes an ecological system outside of its normal range of variability, that system degrades.

Throughout their evolutionary history, prairie dogs existed in a shifting mosaic of colonized and uncolonized prairie across the Great Plains grasslands, often in association with heavy grazing by bison (*Bison bison*). Prairie dog populations were large, and the social nature of the species served well against historical threats. Present day threats to the species (e.g., poisoning and plague) are very different from those faced by the species during its evolutionary history (e.g., predation and native diseases). In addition, prairie dogs must cope with new threats while their population numbers are greatly depressed. In short, they have no adaptive response to the threats and thus are vulnerable.

The sociality of prairie dogs, which was advantageous for historical threats like predation, actually works against the species in the face of poisoning campaigns or plague. Predation acts upon each individual prairie dog as an independent unit. By living in colonies, prairie dogs reduce their risk to that threat. The independent unit for threats like poisoning or plague, however, is the entire colony (or complex of prairie dog colonies). Because 36% of the remaining black-tailed prairie dog habitat resides in just seven complexes larger than 4,000 hectares, the long-term viability of the species is unclear. Seven poisoning efforts (or plague outbreaks) could eliminate one-third of the remaining black-tailed prairie dogs very rapidly.

The story of the passenger pigeon's demise provides an important lesson for prairie dogs. Habitat destruction and over-harvesting of passenger pigeons (*Ectopistes migratorius*) reduced their numbers from billions of birds to only a few million by 1880. This highly social and colonial species was faced with new threats that were outside its historically adaptive responses, and they went extinct in the wild 20 years later.

THREAT 7: LACK OF ADAPTIVE MANAGEMENT FOR CONSERVATION. Management strategies have not addressed the biological problems faced by prairie dogs, let alone the ultimate problem of how humans regard the species. Present management has been ineffective at halting the decline of prairie dogs (and the other species that depend on them). Often, wildlife agencies responsible for managing prairie dogs fail to ask the hard questions. Problem definition has been incomplete and dominated by agricultural and development interests. Failure to completely define a problem is analogous to traveling without an accurate map. Without a definition that includes all parts of the problem (biological, social, political, economic, human values and beliefs, etc.) solutions will likely not address the root causes of the situation.

Prairie dog management policies have not established clear goals. Indeed, the policy process has produced plans with contradictory goals. For example, the mission of some agencies is to eradicate prairie dogs and the mission of other agencies is to protect wildlife, such as black-footed ferrets, that depend on prairie dogs for survival. Coordination has been lacking. Because goals have been unclear and not measurable, there is no easy way to evaluate trends and learn from experience, a prime requirement for adaptive management. Evaluation to date has been largely forced by petitions to list black-tailed prairie dogs as threatened and through the black-footed ferret recovery program.

Adaptive management has been further hindered by a lack of monitoring. Very few states had even a vague idea of the total area occupied by prairie dogs until the recent pro-

posals for listing under the ESA. Monitoring techniques were not standardized. It was therefore difficult to recognize or understand important trends. This lack of monitoring holds for both the biological situation and the policy process used to make plans of action. Without monitoring we cannot learn which strategies worked and why, thus preventing us from learning how to make future decisions more proactively, effectively, and efficiently.

In sum, continuing to make policy decisions within the same paradigm that originally created the problem, and without adaptive management, will only further prairie dog decline.

THREAT 8: HUMAN ATTITUDES TOWARD PRAIRIE DOGS. The ultimate threat, underlying all of the previous threats except plague, is the way humans value Nature generally, and, in this case, the prairie dog specifically. Dominant attitudes toward a species form the base for political choices made about that species. The attitude that prairie dogs are pests—varmints—continues to be legally entrenched and financially subsidized. It has widespread support among ranching communities, and poisoning has been institutionalized as a mission for several government agencies.

Negative attitudes toward prairie dogs among livestock producers result from several factors. One is the belief

black-tailed prairie dog, graphite by Martin Ring

that prairie dogs compete with livestock for forage. Many people believe that grazing by prairie dogs produces severe economic losses to the livestock industry despite research to the contrary. While the standing biomass on prairie dog colonies is reduced, that loss in quantity of vegetation is apparently compensated by an increase in forage quality. Yet, personal experiences and associated perceptions usually exert more influence on attitudes and beliefs than does information provided by others.

Concerns over range management, particularly public land management, probably lie at the heart of the belief that prairie dogs are pests. Ranching interests have dominated the politics of the West for more than a century. As the demographic composition of the Rocky Mountain region changes, ranchers have seen a gradual erosion of their traditional power over public grazing lands and increasing threats to their lifestyles. To most ranchers, prairie dog conservation represents a threat to their power and traditions, particularly when it is associated with increased federal regulation via the Endangered Species Act. Prairie dogs (and wolves, etc.) are pawns in the battle for control of land.

Negative attitudes toward prairie dogs among other sectors of the public are associated with concerns over contracting plague, limitations to urban development, and injury to livestock. Alternatively, some of the public hold positive attitudes toward prairie dogs, based primarily on moral, ethical, and ecological values. In addition, many people apparently enjoy watching prairie dogs, which are active during the day and relatively easy to see.

To this day, people holding negative attitudes toward prairie dogs have dominated policy and management processes. Scientific data on the ecological value of prairie dogs has had little effect on attitudes of agricultural interests or policymakers responsible for prairie dog management. As long as the government financially subsidizes actions that support the viewpoint that prairie dogs are pests, it will be very difficult to change attitudes and values toward prairie dogs.

Recovery and Conservation Plan for Black-Tailed Prairie Dogs

An overriding goal for black-tailed prairie dog conservation is to maintain prairie dog numbers and distributions at temporal and geographical scales that allow for functioning ecological processes and evolutionary potential. An obviously correlated goal would be to gain public support and acceptance for such a vision. Doing so will require interdisciplinary approaches that address the political, regulatory, organizational, attitudinal, and ecological aspects of the problem. A full discussion of a recovery and a conservation plan that includes such approaches is obviously beyond the scope of this short paper. Instead we provide an overview of our ideas and suggestions, which we hope will serve as the basis for further discussion.

Halting Population Declines

Black-tailed prairie dog numbers have declined drastically over the last 100 years, and that trend continues. A goal of *no net loss* of prairie dogs in each state is therefore an important first step for eventual recovery of the species. In other words, we must ensure that black-tailed prairie dog populations do not continue to decline. Such a policy would imply that any losses due to plague or other factors must be restored.

One method for stabilizing prairie dog populations is to end prairie dog poisoning on federal lands and end government subsidies for poisoning on private lands. Toward that end, legal pest status for prairie dogs must be abolished. On federal lands, any uncertainty about the impact of resource extraction activities on prairie dog conservation should be resolved in favor of prairie dog recovery (i.e., using the precautionary principle). Decisions have consistently gone in the other direction for the last century. Recently, some managers have considered moving prairie dogs to accommodate development. To our knowledge, land managers have never considering altering development to accommodate prairie dogs.

We further suggest a moratorium for prairie dog shooting on public lands. The ban should continue at least until data are collected to assess the impacts of shooting on prairie dog populations. Any future shooting on federal lands should be regulated according to scientific data. In addition to ethical considerations, unrestricted shooting reinforces the image of prairie dogs as pests and obscures their value in maintaining healthy grassland ecosystems.

Plague is a wild card that could prevent prairie dog recovery. Efforts to develop an oral inoculation against plague bacteria deserve high priority. At present, large prairie dog complexes (i.e., recovery zones) should be closely monitored for plague outbreaks and population declines, so that a flea insecticide can be applied quickly once the disease appears.

Because agricultural interests dominate the prairie dog policy arena, financial incentives will be critical for reversing the decline in prairie dog numbers. A cost-neutral plan to

compensate ranchers who manage for both livestock and prairie dogs was outlined by us (and Forrest) in 1996. We suggested turning existing subsidies for prairie dog poisoning into a subsidy for conserving the prairie dog ecosystem. Currently, an interstate committee of state wildlife agencies is recommending a similar approach via the Farm Bill. Such options are supported and encouraged by the Endangered Species Act.

Incentives must be directly linked to the cause of the problem, and be aimed at changing management practices and underlying values and attitudes. If incentives only serve to replace lost income without changing the management regimes and values that lead to black-tailed prairie dog declines, then the incentives merely reinforce the image of prairie dogs as a pest. On the other hand, if incentives move management practices toward ecologically sound approaches, benefits accrue to society as a whole. Indeed, without incentives, it is likely that recovery will require federal protection before true conservation actions occur. Because this is a slow process, protection may not arrive until the species is nearly gone. The ecological cost to prairie dogs and their associated species could thus be high, not to mention the higher economic costs to recovery programs.

At present, the USFWS recommends that each state and tribe within the former range of the black-tailed prairie dog work toward obtaining populations that cover 1% of potential prairie dog habitat (see table). That number might be a good preliminary target for conservation efforts, but it should be viewed as a floor and not a ceiling. For prairie dogs to function as keystone species throughout their range, a higher occupancy than 1% of potential habitat is likely needed. Historically, prairie dogs utilized about 20% of existing grasslands. Reaching the preliminary target of 1% may be a good benchmark to begin financial incentives (which could increase in an incremental fashion as higher goals are attained).

Adaptive Conservation and Management

Current prairie dog conservation and management practices have not stemmed losses of prairie dogs nor changed the attitudes and behaviors that lead to those declines. To improve

Historic and present estimates of black-tailed prairie dog (*Cynomys ludovicianus*) habitat in hectares (1 hectare = 2.5 acres). As more surveys are conducted, the numbers for present area occupied by prairie dogs change somewhat, but not enough to change the declining trend. The recovery target was calculated by USFWS as 1% of potential black-tailed prairie dog habitat (see USFWS 2000 and references therein). This potential habitat does not include cropland. Historic estimates generally state that 20% of the prairie dog's range was covered by colonies, excluding land with characteristics unsuitable for the species.

				% REMAINING OF	
STATE	**HISTORIC AREA**	**PRESENT AREA**	**1% RECOVERY TARGET**	**HISTORIC**	**1% TARGET**
Arizona	260,000	0	27,926	0	0
Colorado*	2,000,000	37,200	108,892	1.86	34.16
Kansas*	890,000	16,800	150,064	1.89	11.20
Montana*	1,495,000	26,000	213,349	1.74	12.19
Nebraska	2,400,000	24,000	180,422	1.00	13.30
New Mexico	2,656,000	15,600	179,000	0.59	8.72
N. Dakota	800,000	10,000	44,012	1.25	22.72
Oklahoma	380,000	3,600	92,496	0.95	3.89
S. Dakota	702,800	58,800	128,216	8.37	45.86
Texas	23,200,000	28,400	334,063	0.12	8.50
Wyoming	6,400,000	100,000	115,718	1.56	86.42
Overall	**41,183,800**	**320,400**	**1,574,158**	**0.78**	**20.35**

*Average of 2 estimates.

this situation, we suggest moving conservation and management toward more adaptive, comprehensive approaches as outlined by Holling (1978) and Clark (1997, 2000). Relatively small prototypes (i.e., experimental programs; see Clark et al. 1995) could be developed and tested on federal lands, such as Thunder Basin National Grassland and Buffalo Gap National Grassland. Specifically, a prototype might be a local-scale experiment with prairie dog conservation or a broad-scale approach toward standardized mapping and census techniques. In any case, ideas should be posed in an experimental design that minimizes confounding variables. Methods should be implemented rigorously so that results can be frequently evaluated and compared. Results can then be used to evaluate progress toward goals, and strategies adjusted accordingly.

Local-scale experiments, however, should focus on more than just biology. Several threats to prairie dogs are non-biological, such as how land-use policy is made, how conservation programs are organized, and the role of stakeholder values and attitudes. Successful experiments with variables in the policy setting process could improve conservation and management practices, and that could help other threatened and endangered species recovery programs. For example, local-scale experiments contributed to biological and policy changes in the eastern-barred bandicoot (*Perameles gunnii*) program in Australia.

The importance of being inclusive in conservation and management programs cannot be overemphasized. Good ideas and valid concerns can emanate from any source. So, all opinions should be heard and respected equally, but we also caution that opinions without factual support are not equivalent to reliable scientific evidence to the contrary and therefore should not carry equal weight in decision-making.

Unless we change the present course, trends indicate that the black-tailed prairie dog will soon be federally listed either by the U.S. Fish and Wildlife Service or through litigation. ❮

Brian Miller *is coordinator of conservation biology and* **Richard Reading** *is director of conservation biology at the Denver Zoological Foundation. They co-authored the recent book* Endangered Animals *(see review on page 77).*

RECOMMENDED READING AND SOURCES

See Hoogland (1995) for a thorough description of prairie dog population dynamics and life history information. Case studies about other endangered species that provide useful examples can be found in Clark et al. (1994), Clark (1997), and Reading and Miller (2000).

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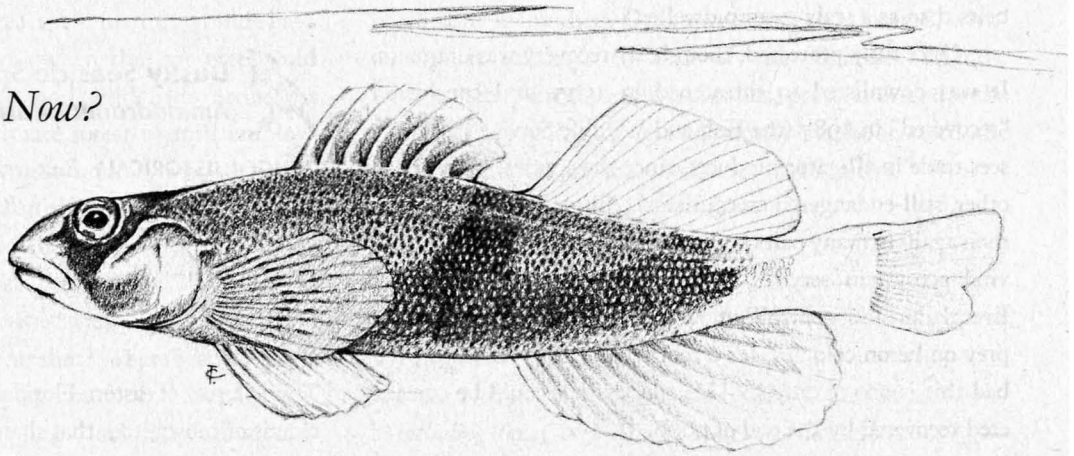
MATT BOHAN

Celebrity Endangered Species

Where Are They Now?



by Peter Friederici

IN 2003, THE CURRENT VERSION of the Endangered Species Act (ESA) turns 30, an age at which people and institutions often start to look back a little and tally their successes and failures. The ESA was conceived as something like a welfare act: the idea was that listed species would receive special protections for a while—until they could get back on their own two or four feet again.

Once listed, though, most species haven't been too quick to make their way off the list and to some presumed independence. By the end of 2000, 1,244 U.S. animals and plants were listed as endangered or threatened (species that occur only in other countries are sometimes listed under the act too), and only a handful of U.S. species had made it off the list, being considered fully recovered. A plethora of other species—perhaps several thousand—probably should be listed, but haven't been due to the U.S. Fish and Wildlife Service's funding constraints and to politics.

Here's a brief look at some of the ESA's more famous members or alumni. They show that the act has done a lot of good, but also that the law often isn't quite enough to overcome the vagaries of politics.

American Alligator
Alligator mississippiensis

RANGE (HISTORICAL AND CURRENT) *Coastal and lowland areas from North Carolina to northeast Mexico.*

SIZE OF POPULATION *Estimated at more than one million.*

CONSERVATION STATUS *Considered recovered, but listed as threatened due to similarity of appearance with other, rare crocodilians.*

HABITAT *Swamps, marshes, riverbanks, and other often seasonally inundated areas; in some areas, creates small wetlands by excavating its own shallow depressions.*

Imagine a cartoon alligator, with a long reptilian grin, saying "reports of my demise have been greatly exaggerated." In this case, fortunately, they were. When this species endemic to the southeastern states was listed as endangered under the forerunner to the ESA in 1967, many thought it wouldn't make

dusky seaside sparrow, watercolor by Matt Bohan / snail darter, graphite by Todd Cummings

it, so thoroughly had its population been decimated by market hunting and habitat change, especially the draining or channeling of wetlands. To many Americans, an alligator seemed considerably more charismatic as parts of shoes or belts than as a scaly swamp dweller.

Once fully protected, though, its recovery was dramatic. It was downlisted to threatened in 1975, and considered "recovered" in 1987 (the Fish and Wildlife Service still oversees trade in alligator products, since the species is similar to other, still-endangered crocodilians). Alligators are now common again in many parts of the Southeast, where they perform vital ecosystem services such as excavating ponds in the Everglades and controlling raccoons that would otherwise prey on heron colonies. It's a toothy success for the ESA; too bad this is one of only six U.S. species that could be considered recovered by the end of 2000.

Snail Darter
Percina tanasi

RANGE (HISTORICAL AND CURRENT) *Upper Tennessee River system of Tennessee and north Alabama and Georgia.*
SIZE OF POPULATION *Unknown, but of nine populations identified in one review, six were marginal.*
CONSERVATION STATUS *Threatened.*
HABITAT *Shallow sand and gravel shoals in rivers, where it feeds on snails and aquatic invertebrates.*

The ESA was passed in 1973, and in that same year a new fish was discovered in gravel beds on the Little Tennessee River. The snail darter would have remained an ichthyological footnote had not its habitat been the planned site of the new Tellico Dam. Suddenly politicians realized that the ESA was going to protect not only showy and popular animals such as bald eagles and peregrine falcons, but also obscure species that no one had ever heard of. More significantly, it was going to dam the flow of progress and pork barrels.

Something had to be done, and it was: Congress passed a law specifically exempting the construction project from the ESA. The dam was built, and the snail darter's critical habitat was entirely flooded.

The story has a surprise ending, though, as surveyors ended up finding a few more populations of snail darters. Their populations remain isolated due to large-scale hydrological alterations, and the species is still considered threatened. And some politicians (and their campaign contributors) still consider extinction a small price to pay for the supposed benefits of developing wild lands and waters.

Dusky Seaside Sparrow
Ammodramus maritimus nigrescens

RANGE (HISTORICAL) *East-central Florida.*
SIZE OF POPULATION *More than 2,000 pairs in the 1940s, zero today.*
CONSERVATION STATUS *Extinct.*
HABITAT *Coastal salt marshes.*

This sparrow of eastern Florida salt marshes was as dark as the clouds of mosquitoes that shared its habitat. Once abundant, it was reduced by the late 1960s to small populations by habitat alteration and by the use of aerial spraying of pesticides, especially DDT, against those mosquitoes. It was listed as endangered in 1967.

In this case, protection (and the banning of DDT) came too late. Populations continued to decline, and in 1979 and 1980 the last few wild duskies, all male, were captured and bred with females of a related subspecies. Though a few hybrid individuals were hatched, the effort was too little, too late. The last dusky seaside sparrow died in captivity on June 16, 1987, joining the passenger pigeon and Carolina parakeet on the melancholy list of species whose extinction can be pinpointed to a specific day. (Unlike the pigeon and parakeet, however, which were full species, the sparrow was a subspecies of a widespread species.)

Northern Spotted Owl
Strix occidentalis caurina

RANGE (HISTORICAL AND CURRENT) *Forest areas from southern British Columbia to just north of San Francisco, inland through the Cascade Range.*
SIZE OF POPULATION *Estimated at 3,000 to 4,000 pairs.*
CONSERVATION STATUS *Threatened.*
HABITAT *Old-growth forests with complex structural attributes that provide large cavities for nest sites and abundant rodent prey.*

No other listed subspecies has generated as much paperwork, or as many jobs for itinerant field biologists, or as

many bumper stickers reading "Save a Logger, Eat a Spotted Owl" as this denizen of the Northwest's deep woods. The owl became famous because the ESA was the strongest legal tool that could oppose rampant clear-cutting of ancient forests. Sure, the cutting would have stopped without the owl, too—when the last of the old growth outside national parks and wilderness areas was gone. The owl never did decimate forest or mill employment as its detractors stated; most workers who lost their jobs did so for other reasons, thanks to changing economics and increased mechanization in the timber industry.

But the owl became the focal point of controversy, and one of the motivators of President Clinton's 1993 Northwest Forest Plan. The upshot? There's a bit more planning in the woods now—planning for biodiversity protection and planning for logging, including some old-growth trees. And the owl is still listed, with no graduation from the ESA club in sight.

Southern Sea Otter
Enhydra lutris nereis

RANGE *Formerly Pacific Coast from central California to Baja California, and Channel Islands; today restricted to northern portion of this range.*

SIZE OF POPULATION *Estimated at 2,400 in the mid-1990s.*

CONSERVATION STATUS *Threatened.*

HABITAT *Rocky coastal areas, often with kelp beds, that support healthy populations of the otter's favored prey items, especially mollusks.*

Floating in the kelp beds, smashing abalones with rocks, sometimes even leaping onto a startled kayaker's stern, the sea otter is a perfect model for stuffed toys, and virtually the definition of a charismatic species. But it also shows that being photogenic isn't the same as being popular with everyone, or being easy to save.

It's remarkable that the subspecies survived the excesses of the fur trade, but a few hundred individuals remained off the Big Sur coast at mid-century, and were listed as threatened in 1977. With full protection, their population rose to 2,400 or more by the 1990s. Since then it's mainly been on the decline, likely due to some combination of the following factors: disease, lack of food, entanglement in fishing nets, or just plain overmanagement. Shellfishermen regularly complain about sea otter appetites, and to address their concerns an otter-free "management zone" was demarcated along the southern California coast. Otters that strayed south into it were captured and moved back to the north. But many died. Otters were also translocated, without great success, to one of the Channel Islands. Unfortunately for these sea mammals, protection under the ESA is likely going to remain mostly symbolic until the otters themselves are able to choose where to live.

Jaguar
Panthera onca

RANGE *Northern Argentina to the southern United States, including Texas, New Mexico, Arizona, and southern California. Today extirpated or very rare in northern parts of its historic range.*

SIZE OF POPULATION *Estimated at up to 10,000.*

CONSERVATION STATUS *Endangered.*

HABITAT *A wide array of habitats from dense jungles to dry woodlands to riparian corridors and rocky, arid areas.*

This was a case of "whoops, we forgot about it." Despite records of occurrence in Arizona past mid-century, when the Fish and Wildlife Service listed the species as endangered in 1972 it did so only for individuals south of the border. That made the agency powerless to impose significant penalties when a jaguar was shot in southeast Arizona in the mid-1980s, and left it toothless again when two turned up there in 1996.

Fortunately, those two jaguars, after being cornered by hounds, were photographed and released to roam the rugged borderland mountains again. And their presence was enough to impel the agency, in 1997, to at last list the jaguar as endangered north of the border too. Since then, biologists have found a breeding population of jaguars in Mexico's mountains not too far south of the Arizona/New Mexico line—cause enough for conservationists to hope that a few more individuals might just travel north again in search of javelinas or deer. ☾

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CALIFORNIA CONDORS

At Home in Arizona

On Easter Day, 1987, extinction loomed for the California condor. That day, the last wild condor was taken into captivity to join the 26 remaining members of its species, *Gymnogyps californianus*. The final blinking out of these huge New World vultures seemed close at hand, a forlorn end behind the bars of a zoo.

But the dead might live again. In a bold recovery program (started in 1980) the remaining condors are being bred in captivity and their young fed through hand puppets shaped like condor heads (to prevent their equating people with food). Condor numbers are now growing, ever so slowly. Today, the world population of California condors stands at 184. Happily, 63 of these are living in the wild.

First noted in the fossil record from the Middle Pleistocene, the California condor's nine-and-a-half-foot wingspan carried it on thermals in search of the recently dead: a whale washed up, a mastodon taken down by sabertooth tigers, or a fallen American camel. Though today it is the largest flying bird in North America, in earlier eras it was overshadowed by its huge teratorn relatives, including *Teratornis incredibilis* whose wings stretched 15 feet tip-to-tip (which were themselves puny compared to a South American teratorn whose wingspread reached an astonishing 35 feet).

The extinction of the Pleistocene megafauna—whether by a cooling climate, Clovis-era spear hunters, massive epidemics, or a combination of factors—left California condors as the sole avian survivor, relics of an age of giants. In a landscape no longer populated by beavers the size of bears, huge dire wolves that could run down antelope, American lions, and massive ground sloths, condors were likely hard-pressed for food except on the coast. The fossil record shows that, though its range once stretched from British Columbia to Mexico and throughout the southwest to Florida and north to New York State, about 10,000 or 11,000 years ago condor populations crashed. By the time Europeans crossed into the American West its breeding range was confined to a narrow strip near the Pacific.

Condors may have returned to the Southwest as early as the 1700s, perhaps subsisting on herds of cattle, horses, and sheep that replaced their historic sources of carrion. But this range expansion was short-lived; in the nineteenth and twentieth centuries, shooting, predator control programs (like poisoned "coyote stations"), powerline electrocutions, eating carrion tainted with lead shot, DDT, egg collectors, and vehicle collisions—compounded by habitat destruction—decimated their populations. They were federally listed as endangered in 1967, received protection under the U.S. Migratory Bird Treaty in 1972 (though it is unclear if they are true migrants), and came under the Endangered Species Act in 1973.

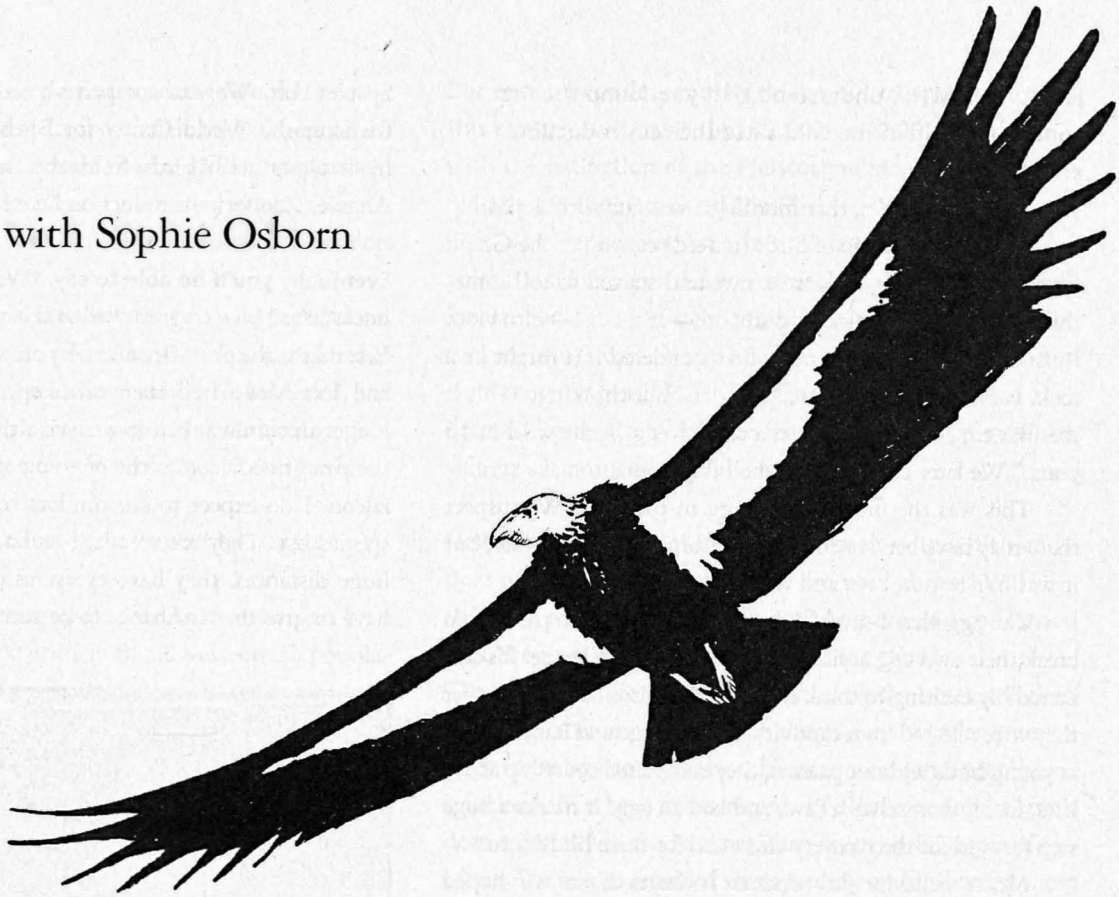
In 1992—five years after David Brower had protested the capture of the last condor and called for them to be allowed to "disappear with dignity"—the U.S. Fish and Wildlife Service started releasing captive-bred condors in the Los Padres National Forest north of Los Angeles and then at several other sites in southern California. These birds are holding on, but the survival of the California condor in ever-urbanizing California is far from secure.

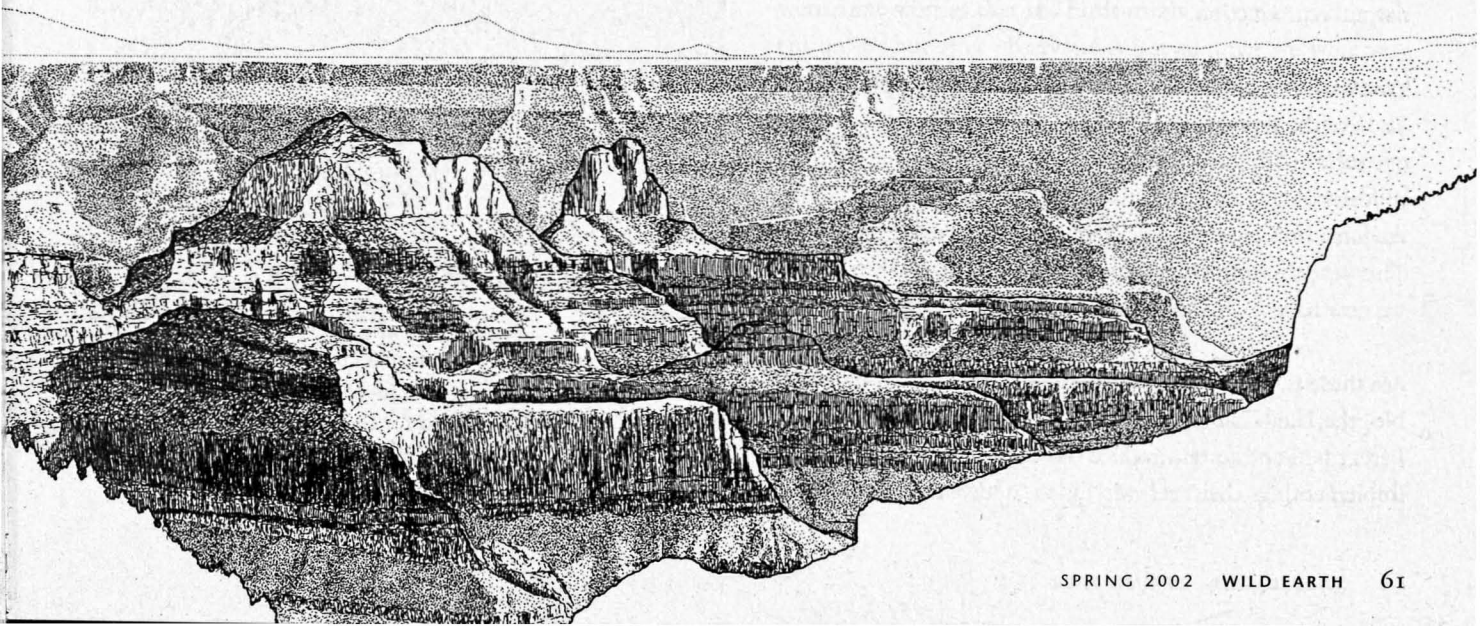
Looking to develop a second—geographically distinct—condor population, a group of six birds was released on the Vermilion Cliffs north of the Grand Canyon in December 1996, 72 years after the last sighting of a wild condor in Arizona. Secure cliff habitat, historical breeding caves, and the long-term protection of being within a national park may mean that the California condor finds its best chance to survive in Arizona.

The Peregrine Fund runs the California Condor Restoration Project in Arizona. Ornithologist Sophie Osborn is currently Field Manager for this effort. She has worked on conservation efforts for numerous birds including Hawaiian crows in Hawaii, parrots in Guatemala, ducks in Argentina, various raptors in the West (peregrine falcons, prairie falcons, golden eagles, and goshawks), as well as the creek-loving American dipper. *Wild Earth* assistant editor **Joshua Brown** spoke with her in March of 2002.

California condor, pen-and-ink ©1999 by Zackery Zdinak / Grand Canyon, pen-and-ink by Gus diZerega

A Conversation with Sophie Osborn





JOSHUA BROWN: I understand that you found the first condor egg laid in the wild since the reintroduction effort began.

SOPHIE OSBORN: Yes, that morning I was out with a spotting scope monitoring a trio of birds in a side canyon of the Grand Canyon. The male went into a cave and started to roll something white and elliptical and smooth—and large—into view. I just couldn't believe it and at first wondered if it might be a rock. I stayed glued to the scope for an hour thinking, "This is the first time anyone has seen a condor egg in the wild in 16 years." We later collected the shell fragments to make sure.

This was the first *confirmed* egg in the wild. We suspect there may have been one laid in California the year before, but it was in a remote area and was never confirmed.

The egg that I saw was broken, but first-time pairs often break their own egg accidentally or lay an infertile one. It's still incredibly exciting to think how far these birds have come: after they were released from captivity five years ago and reintroduced as young birds without parents, they completed courtship activities, found themselves a cave, and laid an egg. It marks a huge step forward for the recovery effort and for these birds' future.

Much behavior in condors is learned, so we hoped courtship and finding caves were instinctive. Before that moment, though, we didn't know. Now the next logical step is for them to raise young in the wild. We think we have two pairs starting to incubate in caves, which is a very good sign.

In 10 years, what do you see as the best-case scenario for the condor?

That we have breeding birds in the wild in California and Arizona—who don't need any help from us. The population will be increasing through reintroductions, but also through natural reproduction.

What are the population goals of the recovery plan?

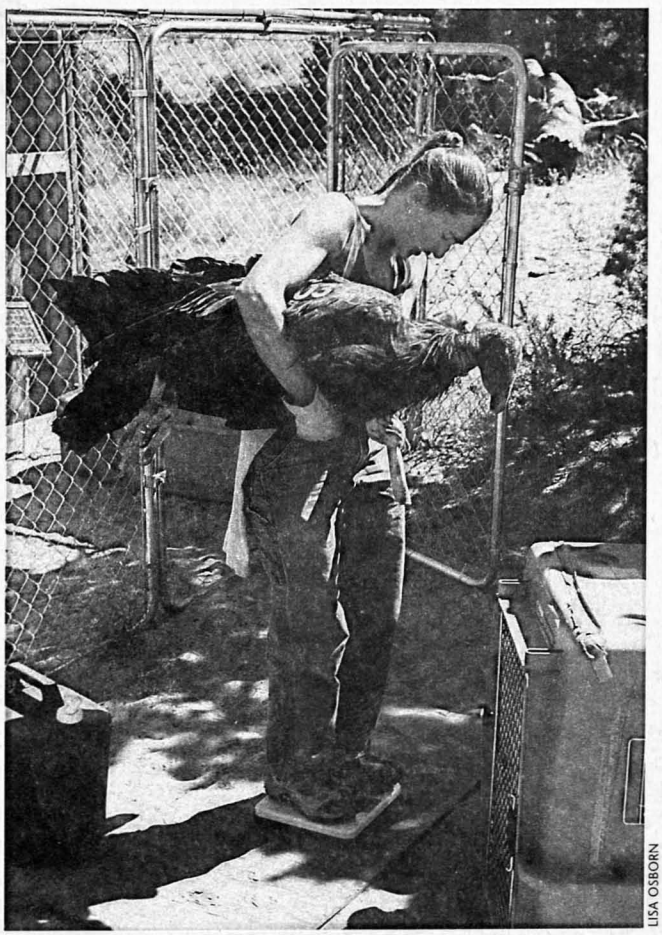
To have three populations of 150 each—one in captivity and one each in California and Arizona. We have a long way to go to reach that goal; it took us six years to get 25 birds here in Arizona, but we are learning and seeing better survivorship. This year we expect the overall population to reach 200, and we now have 31 free-flying birds in northern Arizona.

Are these target numbers established by the Peregrine Fund?

No, the U.S. Fish and Wildlife Service contracted with The Peregrine Fund to reintroduce the condor in Arizona; we are implementing their recovery plan under the Endangered Species Act. We run a captive-breeding program in Boise, Idaho at the World Center for Birds of Prey and use those birds along with birds from the San Diego Zoo and Los Angeles Zoo for reintroduction here in Arizona.

Eventually you'll be able to say, "We're done; they are back." Yes?

Yes, that is the goal. Because they are such a long-lived species and less hard-wired than other species, this will be a bit longer in coming than it was with the successful recovery of the peregrine falcon or the ongoing effort with the aplomado falcon. I do expect to see condors come off the endangered species list. They are so adept at finding food and covering huge distances, they have every reason to make it. We just have to give them a chance to be successful.



LISA OSBORN

Sophie Osborn weighs a California condor above the Vermilion Cliffs in Arizona. This juvenile male was captured for behavioral problems, held for several months, and re-released on December 14, 2001. Prior to his release, he weighed 20 pounds.

Full recovery is a tough line to draw. We don't know enough yet to be fully certain about their natural population dynamics, but it seems reasonable to look for self-sustaining, stable populations as a measure of recovery. I expect that at a minimum this would mean having several hundred condors in different locations.

Though the main goal is to have the two wild populations, there are efforts underway to release additional condors in adjacent areas. There is talk of releasing birds in New Mexico, and the San Diego Zoo is developing a plan to release birds in Baja, Mexico. These birds may well join up with the other birds.

How has the recovery effort been viewed by people in your region?

Unlike the California reintroductions, Arizona condors have been designated an "experimental, non-essential" population. At first some local communities would see maps of the "10j" area (referring to the section of the ESA that designates populations as experimental within a particular boundary) and say, "Ahh! We don't want to be within that boundary!" But support has grown, since within the 10j area it is mandated that no changes in land use result from the condors' presence. At public comment meetings before the reintroductions began there was incredible hostility and anger. Now Fish and Wildlife is conducting a five-year review and about six people attended the meetings. In this case, indifference is a big step up!

The condors spend most of their time in the summer at the South Rim of the Grand Canyon, where thousands of visitors view them everyday. The positive feedback that comes into the Park Service and Peregrine Fund is overwhelming and numerous letters of support have been sent in as part of the five-year review.

Some conservationists consider the condor to be ecologically extinct; what do you make of this assessment?

In a sense they are a relict, but seeing them in the Grand Canyon where they spent thousands of years is to see them at home. If we keep up our efforts, they can again be successful in the wild. One of the major reasons condors almost went extinct is because they were persecuted by people and their slow life cycle didn't allow them to recover from such persecution. They don't start reproducing until age six or seven and have only one egg every year or two. Once the population was knocked down by humans shooting and poisoning them, it was very hard for them to recover.

But weren't condors mostly driven out of Arizona not in this century by people, but 11,000 or 12,000 years ago with the extinction of the Pleistocene mammalian megafauna that provided food?

This is a very complex issue, but we shouldn't obscure the key points: condors are native to Arizona, they lived here for millennia, and they can once again be a natural part of desert canyon ecosystems. We don't know for sure which factors were most responsible for their range contraction and their decreased presence in Arizona. They are showing us now that this area is eminently suitable for them.

Nevertheless, many of the large animals with which condors once shared the landscape are now absent. Will there be enough for them to eat? And are you concerned that they are dependent on people for food?

The condors quickly learn to find food on their own and there is plenty of food out there for them, a spectacular amount. They are not reliant on livestock carcasses, as some people have imagined. We have more records of them feeding on mule deer, especially in the summer, than on any other types of carcasses. We've also recorded them feeding on big-horned sheep and elk carcasses and even on dead coyotes and squirrels.

However, lead in their food is the most insidious problem that they face. The female that laid the wild egg had lead poisoning twice—but fortunately was captured and treated successfully. However, we had a devastating incident in the summer of 2000 where as many as five birds died from feeding on a carcass that was inundated with lead shot. Since then, we have changed our strategy somewhat by putting food out more often at the release site, in the hope that the birds will return more often and feed on this clean food source. There were some worries that the birds might become too dependent on us, but after observations last summer we were very much reassured. We have several birds that are hardly coming back to the release area at all and are doing very well. Right now it is just a percentage game; with populations so low we want to minimize the chances that they encounter lead-filled food. Once the population numbers rise, the condors have shown us that they will be able to find food on their own in the long haul.

What are the long-term genetic prospects for these birds? Do they have enough diversity to survive?

There is reason to be concerned. The geneticists on the project are working very hard to maximize diversity in captive breed-

ing pairs. There are a few problems identified that may be a product of a population bottleneck or small population size. We don't know whether certain problems are genetic. I suspect that the tendency we've seen in some adult birds to form trios (two females and a male) rather than pairs is a function of the small population size, but we've also seen male-male pairing behavior which could be a genetic problem. We don't know how the condors will fare in the long run. We are holding our breath.

What is a day in the life of a condor scientist like?

Each bird wears two radio transmitters, so a lot of our work is just tracking birds from afar. They travel extraordinary distances. We have had birds do 100-mile roundtrips in two hours. They just pop across the canyon, whereas we may have to drive three or four hours to follow them. Each day we try to receive each bird's radio signal and monitor each bird's movements. We also try to get a visual on each bird every day. At night, a few times a week, we put out food for them. We have garbage can backpacks that we load up with calf carcasses and hike out to the cliff rim. We always feed the condors at night so they won't associate us with food. The food is mostly for the younger birds, because it takes them a while to learn to find food on their own.

It seems that a good bit of effort is required to condition the birds to avoid dangerous situations. How is the effort progressing?

Many of the traits that make condors what they are also create a recovery problem: they are exceptionally curious and aren't inherently wary of people. I don't know if this is because they have very few predators, or if it is because they were drawn to large aggregations of animals in their evolutionary past—since that is where food was usually found. Condors are attracted to and use other scavengers like ravens to help them find their food, and ravens are often attracted to the food available in populated areas. So by default, the condors end up in people areas too. Condors also get their food by being persistent; no matter how much they are harassed at a carcass by coyotes or wolves, they keep coming back. Much of what we do is try to condition them to keep their distance from people. We are there on the ground to haze them off, to give them the lesson that people are dangerous.

Are they learning?

Yes, as a population—some faster than others. With older birds out there we are starting to see fewer problems. Nevertheless, with each release it seems that there is at least one bird that is just not wary enough and it is usually recaptured and given some more growing-up time; it seems that the adolescent birds are especially curious.

I know that ravens are particularly smart. Where do you put the condor on the IQ scale?

Right up there with ravens. They are incredibly smart.

They are also exceptionally social and gregarious. I was once looking for the condors and saw this black lump on the beach: it was 11 condors piled together, lying on the beach in a huddle. They are also unbelievably playful. They have places that they go back to just for the toys: they come to play with the same blue bucket or old rubber boot year after year.

Because they are scavengers, anything that they can mess with they will. I have seen similar play behavior in ravens and turkey vultures; it's adaptive. Behavior that makes us laugh, like playing tug-of-war with a piece of driftwood or dragging around heavy objects, is building up pulling and tugging muscles for feeding at carcasses.

I have heard criticism of the recovery effort for being too expensive. What makes this effort worth the millions?

I don't know if those people have ever had a condor flying over them. The more we get to know and observe condors, the more we are in awe.

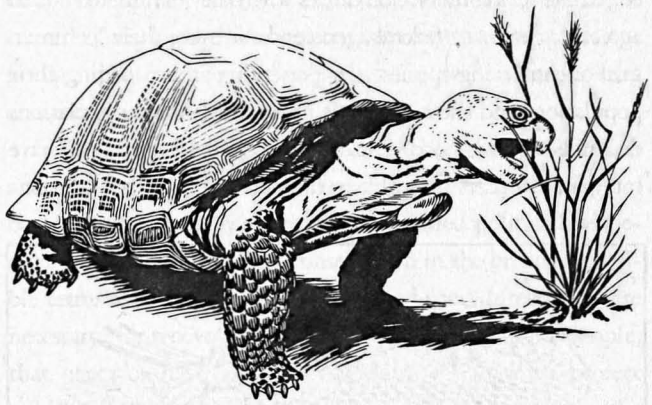
Personally, just seeing them on the wing makes it worth the cost. It is also worth noting that much of our work is funded from individual donations. But from a larger strategic perspective, if we are successful with condors—as we have been with peregrine falcons and bald eagles—people will gain confidence in the Endangered Species Act. It benefits all endangered species and the act to recover a flagship species like the condor that is easily viewable by the public and spectacular to watch.

People see them perched and say, "Wow, that's an ugly bird," but then it gets up and flies and they can't stop exclaiming how beautiful it is! I have been at the South Rim, when the sun was setting and the light was spectacular and five adult condors were circling around before heading down to roost, and several hundred park visitors began clapping. There are not many wildlife spectacles that have people cheering out loud. This was not a program; it was just the birds getting ready to go to bed. They are masters of the air—there is nothing more beautiful than a condor overhead, with the wind in its wings. ☾

A Duty to Conserve

The Moral Meaning of the Endangered Species Act

BY SAM HITT



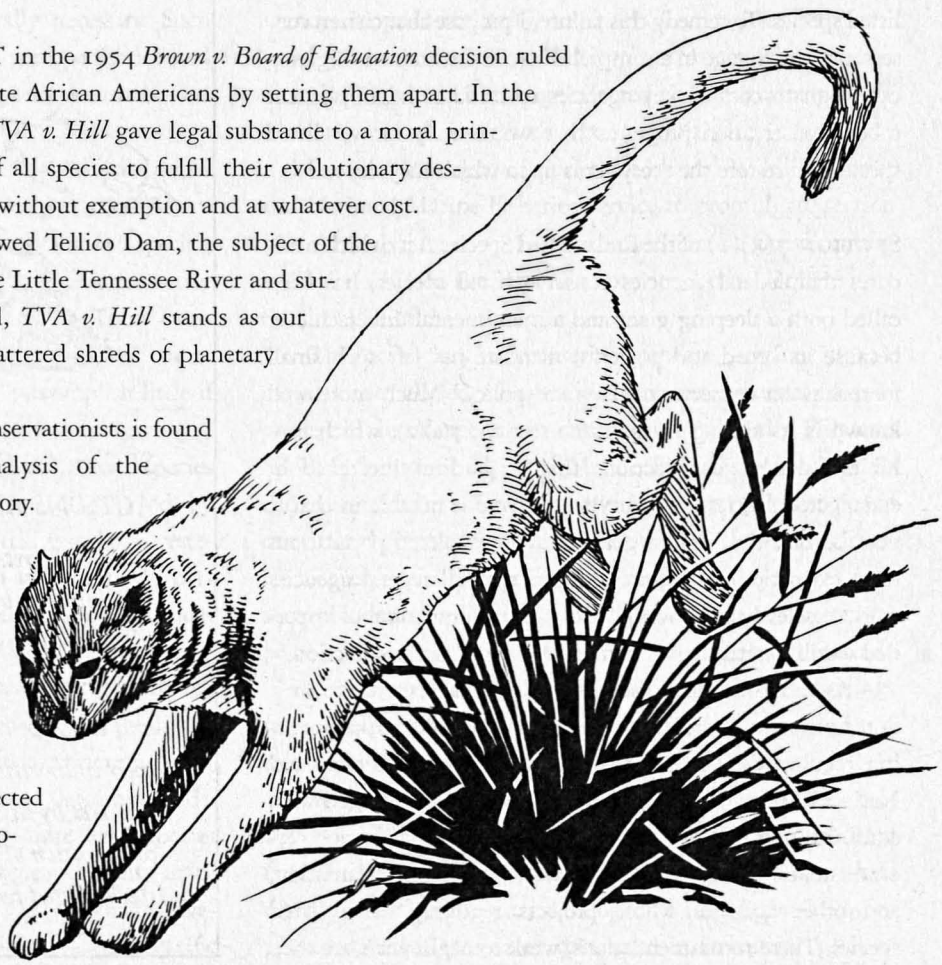
The Endangered Species Act of 1973 represented the most comprehensive legislation for the preservation of endangered species ever enacted by any nation.

U.S. SUPREME COURT,
TENNESSEE VALLEY AUTHORITY V. HILL, 1978

THE U.S. SUPREME COURT in the 1954 *Brown v. Board of Education* decision ruled that white Americans could not humiliate African Americans by setting them apart. In the same way, the nation's highest court in *TVA v. Hill* gave legal substance to a moral principle—affirming the paramount right of all species to fulfill their evolutionary destinies free of human-caused extinction—without exemption and at whatever cost. While a legislative rider eventually allowed Tellico Dam, the subject of the case, to be built and over 30 miles of the Little Tennessee River and surrounding scenic valley to be inundated, *TVA v. Hill* stands as our nation's noblest attempt to weave the tattered shreds of planetary life into whole cloth.[1]

Much of this precedent's value for conservationists is found in the Supreme Court's detailed analysis of the Endangered Species Act's legislative history. Of particular importance is the finding that all federal agencies have an intrinsic duty, above and beyond their primary missions, to recover species found to be at the brink of extinction and avoid actions that may cause harm.[2]

This was a legal landmark. The earlier 1966 Endangered Species Act directed agencies to protect listed species only insofar as practicable and consistent with their primary missions. All of the bills introduced during the historic



desert tortoise and jaguarundi (federally listed as threatened and endangered, respectively), pen-and-ink ©1999 by Zackery Zdinak

1973 debate had similar qualifications. But when the Sierra Club and other conservation groups protested, this qualification was dropped. The final version says simply and without exemption that agency actions must not jeopardize listed species.

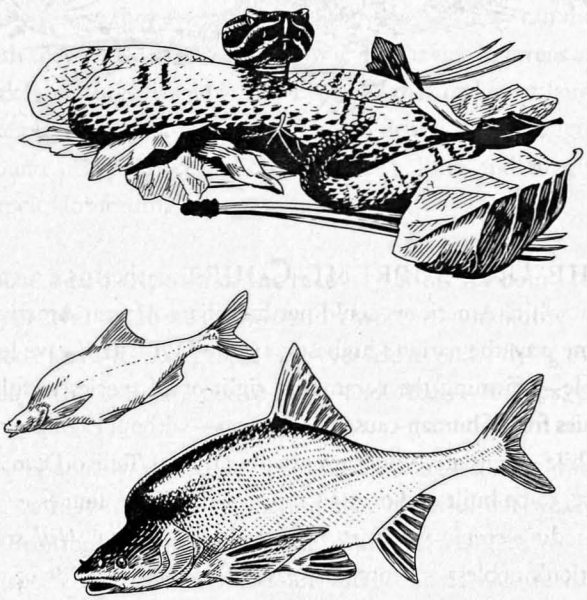
While the Endangered Species Act (ESA) has had its successes—many species would have disappeared into the dark night of extinction without its legal protections—few would argue that the act has lived up to its highest moral aspirations. Only a handful of listed species have recovered to the point where self-sustaining populations flourish in the wild. In fact, more species have been removed from the endangered species list because they went extinct than have been removed because they recovered.[3] The federal agencies charged with implementing the law bear much of the responsibility for this failure. If these agencies, which manage over 600 million acres of public lands, had made their conservation obligations under the act equal in importance to their primary missions, we would be well along the path to recovering species as the ESA intended.

Here I focus on just one aspect of this failure—federal agencies' persistent avoidance of their duty to conserve and recover listed species. To remedy this failure, I propose that citizen conservationists engage in a comprehensive and sustained litigation campaign to compel key agencies to initiate and implement robust conservation programs that would fully recover listed species and restore the ecosystems upon which they depend.

SECTION 7(A)(1) of the Endangered Species Act, which mandates that federal agencies conserve listed species, has been called both a sleeping giant and a monumental underachiever because its broad and powerful mandate has left such small footprints on conservation law and policy.[4] Much more well known is its sibling in the same section, 7(a)(2), which prohibits federal agency actions that jeopardize threatened or endangered species. The duty to conserve is notable in that it goes beyond the limited goal of saving depleted populations from extinction. It requires instead that all federal agencies work ceaselessly to recover self-sustaining populations of imperiled wildlife until they no longer require the act's protection.[5]

As an indication of the agencies' anemic response to their duty to conserve, there are still no section 7(a)(1) implementing regulations. Instead, the Fish and Wildlife Service and National Marine Fisheries Service, the agencies charged with administering the ESA, make discretionary "conservation recommendations" to the Forest Service, Bureau of Reclamation, and other agencies whose projects regularly harm listed species. These recommendations, weak to begin with, are then generally ignored in the rush to cut trees, build roads, and dam rivers. In contrast, the courts are universal in their agreement that Congress intended to make the duty to conserve a binding—not discretionary—requirement on federal agencies.[6]

Perhaps in response to these rulings, the Fish and Wildlife Service and National Marine Fisheries Service in 1994 acknowledged the act's conservation duties when they hammered out an agreement with 12 federal agencies confirming their "common goal of conserving species...by preserving and managing their populations and the ecosystems upon which those populations depend."[7] Sounds good. But eight years later few agencies have integrated conservation duties into their day-to-day decision-



SEC. 7. (a) FEDERAL AGENCY ACTIONS AND CONSULTATIONS.

(1) The Secretary shall review other programs administered by him and utilize such programs in furtherance of the purposes of this Act. All other Federal agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to section 4 of this Act.

New Mexico ridgenose rattlesnake and humpback chub (federally listed as threatened and endangered, respectively), pen-and-ink ©1999 by Zackery Zdinak

making. The interagency process, however, has been useful for acknowledging the Endangered Species Act's link between recovery and conservation, a key legal principle.

Several commentators have also noted the intertwined nature of the duty to conserve and species recovery in the act; some have suggested that recovery plans are the primary devices for implementing the duty to conserve.[8] At least one court has made the link between recovery and conservation, finding that the failure to implement recovery plans violates an agency's duty to conserve.[9]

The implications of forging a link between conservation and recovery are great. Species recovery efforts could no longer be constrained to only those actions deemed politically expedient since the ESA defines conservation in the broadest possible terms as "the use of *all* methods and procedures which are necessary" for recovery.[10] Then it could be argued, for example, that agencies have a *legally enforceable obligation* to protect wildlife corridors for large mammals such as the grizzly or the winter nesting habitat of the golden-cheeked warbler.[11] Both actions have proven to be politically controversial but there is broad agreement that they are biologically necessary. Such actions would help the ESA focus on ecosystem protection and recovery instead of a reactive species-by-species approach.

SINCE *TVA v. HILL,* the Endangered Species Act has been a citizen-enforced law. Major campaigns using the ESA have been mounted to stop harmful federal projects, list species, designate critical habitat, and, to a limited degree, force better habitat conservation planning on private lands. These campaigns must not be abandoned or curtailed. However, court-ordered listing and habitat protection will accomplish little if federal agencies continue to ignore their duty to conserve.

New threats demand meaningful protection once species are listed. Particularly disturbing is the threat posed by endocrine-disrupting chemicals to the fertility of large vertebrates.[12] Such relatively new threats are in addition to the better-known problems of inbreeding and outbreeding depression, which, for dangerously small and isolated populations, greatly increase the probability of extinction over time. Clearly, the longer that recovery efforts are delayed, the greater the likelihood that wildlife populations will slide into extinction.

Other wildlife laws cannot address these alarming trends. The ESA is the only law with a strong, if unrealized, species recovery mandate. For example, the biological diversity mandate of the National Forest Management Act, which effectively slowed the destruction of ancient forests in the Pacific Northwest, requires the maintenance of viable wildlife populations on national forests. However, the Bush administration is currently considering regulations that would make even this limited purpose unenforceable.[13] Laws protecting biological diversity are virtually non-existent at the state and local levels, and (as discussed above) administrative reform through interagency agreements at the federal level has failed to bear fruit.

Therefore, the last and only hope—barring the unlikely enactment of new legislation protecting imperiled wildlife—is robust citizen enforcement of the ESA's conservation mandate.

A PRIMARY GOAL of a species conservation campaign would be to require that all federal agencies maximize their authority to implement scientifically credible recovery plans. This would require each agency to develop independent programs to implement recovery plans. The U.S. Fish and Wildlife Service and National Marine Fisheries Service would then provide oversight via programmatic and project-level consultations to ensure recovery goals were being achieved. Compliance with recovery goals would be limited only by the agency's scope of authority.

I propose a two-pronged litigation strategy whereby conservationists would challenge selected agency actions that are currently violating the act's section 7(a)(1) duty to conserve and, in a separate case, compel the Fish and Wildlife Service and National Marine Fisheries Service to promulgate section 7(a)(1) regulations consistent with the Supreme Court's ruling in *TVA v. Hill*. In the interest of brevity, I consider here only the first half of this strategy.

The act's duty to conserve mandate, section 7(a)(1), requires that all federal agencies carry out conservation programs for listed species in consultation with the Fish and Wildlife Service or National Marine Fisheries Service. Other commentators have argued wisely that to compel agencies to carry out their conservation duties, plaintiffs should characterize recovery plans as programs implementing the duty to conserve mandate.[14] In *Defenders of Wildlife v. Andrus,* the court supported the proposition that agency duties under 7(a)(1) include species recovery. However, a major obstacle will be the findings from several courts that agencies have broad discretion in determining how and when to implement recovery plans.

At least one court, however, has found that such discretion is not boundless.[15] In *Sierra Club v. Lujan,* the court ruled that the U.S. Department of Agriculture (USDA) abused its discretion by refusing to develop and implement recovery plans on behalf of species that were in imminent peril of

extinction. At some point, therefore, agencies have a duty to implement recovery plans.[16]

Sierra Club v. Glickman is a more recent case that may finally awaken the 7(a)(1) sleeping giant.[17] Here the court held that the duty to conserve should be interpreted broadly and that the USDA failed to conserve five endangered species dependent on Edwards Aquifer water in Texas. In this case, USDA relied on incidental benefits from existing projects to meet its conservation duties. The court ruled, however, that specific measures developed in consultation with the Fish and Wildlife Service are required for each species.[18]

SHARPLY CONTRASTING VIEWS have emerged from nearly three decades of debate over the ESA. On one side stands the clarity and purpose of the Supreme Court and the continuing strong support for the act among ordinary citizens. On the other side stand the agencies—frozen by inaction and ruled by political expediency—that have made a hollow promise out of our bold national commitment to species preservation.

The duty to conserve is a mandate whose time has come. Conservation biology has made enormous advances since passage of the ESA in 1973. Now science can provide substantive support for species preservation and protection for the ecosystems on which they depend. Simply avoiding jeopardy, the cumbersome and ineffective process that is the ESA today, must become a measure of last resort. First priority are enforceable recovery measures that protect habitat, expand depleted populations, and break down bureaucratic resistance to proactive conservation programs.

The Environmental Protection Agency has shown what is possible. The EPA has commissioned and endorsed studies advocating that section 7(a)(1) allow the agency to administer its pollution control authorities with ecosystem goals in mind.[19] By integrating the duty to conserve into their day-to-day activities, the EPA answers critics who wonder how species recovery will be financed and implemented: by spreading the burden of recovery over the entire federal government and applying agency expertise to on-the-ground projects on a continuous basis. If applied widely, this approach would make the duty to conserve a ubiquitous part of our public life.

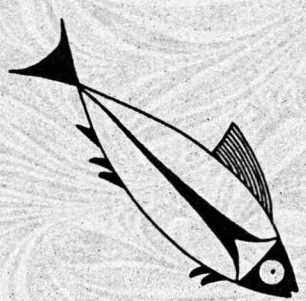
Today we have no excuse for inaction. As we know all too clearly, delay means death for much of Earth's living diversity. Fully recognizing and enforcing the Endangered Species Act's duty to conserve provisions could mean life—not only for individual species, but for entire natural communities. ☾

Sam Hitt *(sam@wildwatershed.org) is the founder of Forest Guardians and Wild Watershed, a new group working on aquatic conservation in the Southwest. He is currently working on a book about the Endangered Species Act.*

NOTES

1. See Zygmunt J.B. Plater, 1986, In the wake of the snail darter: An environmental law paradigm and its consequences, *University of Michigan Journal of Law Reform* 19: 805. Currently teaching at Boston College, Professor Plater was dismissed from the University of Tennessee for his role in leading the seven-year legal campaign to stop Tellico Dam. He is currently writing a book on *TVA v. Hill*.
2. See *TVA v. Hill*, 1978, 437 U.S. 186. "The legislative history...reveals an explicit congressional decision to require agencies to afford first priority to the declared national policy of saving endangered species...[and] give endangered species priority over the 'primary missions' of federal agencies."
3. See Frederico Cheever, 1996, The road to recovery: A new way of thinking about the Endangered Species Act, *Ecology Law Quarterly* 23: 1,11. As of 1992, only five out of over six hundred species listed as threatened or endangered within the U.S. had been removed from the list because of recovery; seven were removed because they became extinct.
4. See J. B. Ruhl, 1995, Section 7(a)(1) of the new Endangered Species Act: Rediscovering and redefining the untapped power of federal agencies duty to conserve, *Environmental Law* 25: 1107, 1109, 1128; and Thomas France and Jack Tuholske, 1986, Stay the hand: New directions for the Endangered Species Act, *Public Land Law Review* 7: 1.
5. The ESA states that federal agencies "shall, in consultation with and with the assistance of [Fish and Wildlife Service and National Marine Fisheries Service] utilize their authorities in furtherance of the purposes of [the ESA] by carrying out programs for the conservation of endangered species and threatened species." 16 U.S.C., 1994, Section 1536(a)(1). Several other sections of ESA require agencies to conserve listed species. For example, section 2 explains that the purpose of the Act is to "to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved [and] to provide a program for the conservation of such endangered and threatened species." 16 U.S.C., 1988, Section 1531(b).
6. The Fish and Wildlife Service has speculated that section 7(a)(1) is discretionary for all agencies. See Federal Register, 1986, 51: 19,926. For a review of the case law on this issue see Brian L. Kuehl, 1995, Conservation obligations under the Endangered Species Act: A case study of the Yellowstone grizzly bear, *University of Colorado Law Review* 64: 607, 628 note 118.
7. See Memorandum of Understanding Between Federal Agencies on Implementation of the Endangered Species Act, Sept. 30, 1994, Daily Env. Rep. (BNA) No. 188, at E-1.
8. See Oliver A. Houck, The Endangered Species Act and its implementation by the U.S. Departments of Interior and Commerce, *University of Colorado Law Review* 64: 277, 350. Also, see Ruhl, 1151.
9. *Defenders of Wildlife v. Andrus*, 428 F. Supp. 167 (D.D.C. 1977)
10. 16 U.S.C., 1988, Section 1532(3). See also 50 C.F.R., 1992, Section 424.02(c).
11. See Kuehl, 627 note 114, and Ruhl, 149.
12. See Eric Helmy, 2000, Teeth for a paper tiger: Redressing the deficiencies of the recovery provisions of the Endangered Species Act, *Environmental Law* 30: 843, 848.
13. For background on the Forest Service's failure to protect biological diversity, see Greg D. Corbin, 1999, The United States Forest Service's response to biodiversity science, *Environmental Law* 29: 377, 407.
14. See Helmy, 859.
15. *Sierra Club v. Lujan*, 36 Env't Rep. Cas. (BNA) 1533, 1541 (W.D. Tex. Feb. 1, 1993).
16. Courts typically find that agency delay is unreasonable if plaintiffs can demonstrate that the delay has been extensive and its consequences to listed species severe. See Helmy, 843, and Ruhl, 1151.
17. *Sierra Club v. Glickman,* 156 F.3d 606 (5th Cir. 1998).
18. For a complete analysis of this case see Elizabeth Kristen, 2000, *Sierra Club v. Glickman*, *Ecology Law Quarterly* 27: 699.
19. See Ruhl, 1162.

EDITOR'S NOTE *There are many versions of the Hispanic legend of La Llorona. This version tells of a poor woman in love with a rich man. She bears him children, but he marries another. In spiteful fury, she tosses her children into the river only to haunt the waterways of the Southwest in regret, searching and moaning.*



La Llorona
Why Do You Weep?

La Llorona, the great mother,
you frighten us with your keening
the intensity of your loss.

La Llorona, why do you weep?
Is it for the lost children of the river,
the fish, the mammals, the birds, the plants,
so many of them, so many?
We too weep.

Shovelnose sturgeon, we weep for you.

American eel, Mexican tetra, speckled chub, we weep for you.

Flathead chub, silvery minnow, Río Grande shiner, we weep for you.

Río Grande bluntnose shiner, phantom shiner, we weep for you.

Fathead minnow, gray redhorse, blue catfish, we weep for you.

Longnose gar, roundnose minnow, Río Grande chub, we weep for you.

Flathead catfish, we weep for you.

La Llorona, why do you weep?

I see, I see, these, your children are lost.

Your lost children,
too easily we have forgotten them.
But you, you do not forget.
You recall the riverbottoms
brimful of life
skyfull of birds and
the sheltering shade of cottonwoods,
the cool flutter of their leaves
on too-hot desert days.

La Llorona,
Remind us with your weeping,
the keen edge of your cry,
the direful moan on still nights
we hear at the edge of hearing as
the river purls along in darkness.

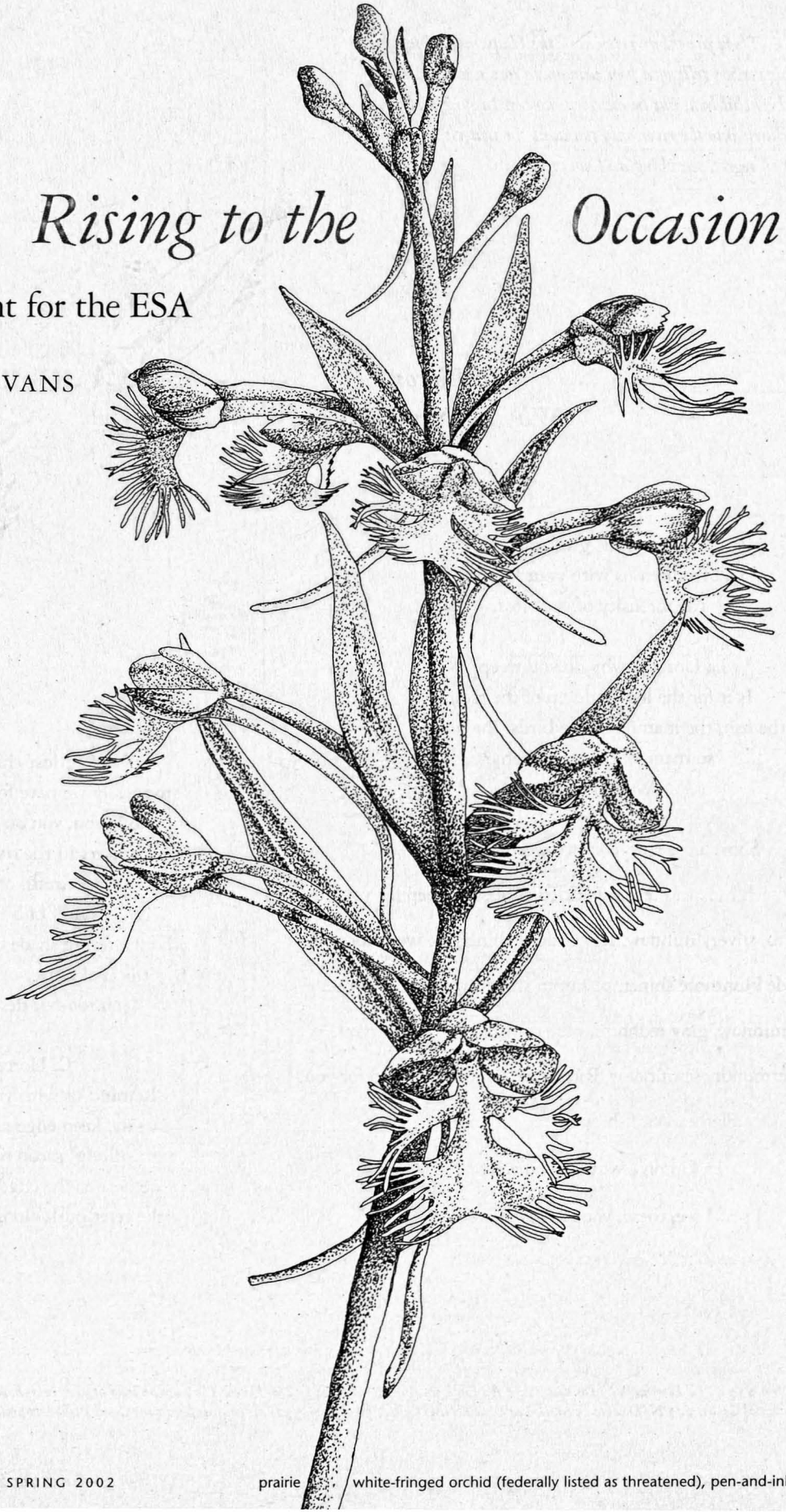
~ Tom Lynch

These excerpts are drawn from "La Llorona Why Do You Weep? An Ecological Fable," ©2000 by Tom Lynch. The complete poem appears in a chapbook available from the Southwest Environmental Center, 275 N. Downtown Mall, Las Cruces, NM 88001, 505-522-5552; all proceeds benefit the Center's efforts to protect the Río Grande.

Rising to the Occasion

Today's Fight for the ESA

BY BROCK EVANS



prairie white-fringed orchid (federally listed as threatened), pen-and-ink by Gary Eldred

THREE HUNDRED FIFTY-FIVE...TO FOUR.

That's the margin by which the Endangered Species Act (ESA) passed the U.S. House of Representatives 29 years ago. The vote was 355-4 in the House, 92-0 in the Senate. Our most revolutionary, our strongest—and certainly our most denounced—environmental law enjoyed nearly unanimous support in Congress and was signed by President Nixon with little fanfare on December 28, 1973.

Some who voted for it, like Senator Ted Stevens and Representative Don Young, Republicans from Alaska and fierce opponents ever since, now say they didn't realize what they were doing. True, the buzz then was about saving the bald eagle, the alligator, the peregrine falcon, the brown pelican—the high-profile endangered species of the time. But the bill didn't come out of nowhere. Its newfangled notion of protecting biodiversity had already been codified in two earlier versions of the law, in 1966 and 1969. The ESA's legislative history made it plain that *any* species in danger was to be protected, not just charismatic ones, and President Nixon's Environmental Message a few months earlier had called for stronger action "to save...vanishing species."

I was in Washington then, heading up the Sierra Club's office. Our attention in 1973 was focused almost exclusively on other issues: the struggle over the Alaska oil pipeline, followed by a battle over the country's first alleged "energy crisis," spawned in a climate of fear initiated by an Arab oil embargo in October. In an eerie preview of today's "crisis" atmosphere, the oil industry and their shills in Congress then too saw an opportunity to strike back at the newly enacted environmental laws, blaming them for the "crisis" and demanding their repeal.

Protecting pelicans and peregrines seemed positively dull compared to the strongly felt terrors and passions of those times. That word "impeachment," just seeping into everyone's consciousness, was soon to overwhelm everything else in the capital.

How little we understood of the enormous potential of the ESA then: we did not foresee the incredibly positive effect it was to have on our country far into the future. Only because of it do hundreds of species that share the American landscape with us still exist. Just as significantly, millions of acres of wild forests, wetlands, beaches, and grasslands—those species' essential habitats—therefore also survive.

That's because the Endangered Species Act is more than just a wildlife protection law. It is also a *land use* statute. It is the only law we have that gives the national government a say over what landowners, private or public, can or cannot do with their property, if the land harbors a species sliding toward extinction. Because the ESA exists, many beautiful, wild places still exist that surely would have been developed otherwise. Moreover, the strict requirements of the law have spawned new cooperative planning initiatives in many U.S. localities, serving as a useful check on urban sprawl.

Why is the Endangered Species Act such a powerful tool for those who struggle to rescue this lovely American earth and its wild plants and animals? It has three key features, which together distinguish it from other environmental laws:

SCIENCE RULES. If scientific evidence shows a species to be gravely imperiled, it must be listed (i.e., granted the protection of the law) as "endangered" or "threatened" depending on the level of threat of extinction.

HABITATS, AS WELL AS INDIVIDUAL CREATURES, MUST BE PROTECTED. The ESA was the first law of its time (and still one of the few in the world) that defines "harm" to an endangered species as damage to its essential habitat, and also prohibits such damage.

CITIZEN ENFORCEMENT. Aware that government agencies are often subject to fierce political pressures, the framers of the ESA allowed for citizen enforcement of its strong provisions, through the "citizen suit" provision.

Today there are nearly 1,300 U.S. species on the list. There ought to be more: many candidate species await listing, many less charismatic yet imperiled creatures require conservation action, and the whole enterprise needs better funding and support. It's not a perfect law. But we should ask ourselves: what if the Endangered Species Act had never existed? How many species of wildlife, how many precious wild places that are now protected would have disappeared? If the ESA falls, how many more will be lost?

We may soon find out, because as I write these thoughts, the ESA is under the fiercest and most sustained assault in its history. How can this be?

Fast forward 22 years from the act's passage to 1995. The far right controls both chambers of Congress for the first time since 1954. This is the year of Newt Gingrich and the Contract On America (as my battered fellow conservation lobbyists called it), the year that timber Republicans rammed through the infamous "salvage (a.k.a. logging without laws) rider," opening the national forests to virtually unrestrained logging. The ESA is under full assault too, and disaster in the form of a repeal bill is narrowly averted only after frantic backroom maneuvers in December. The main attack was repeatedly renewed, then fended off, again and again in the six

years following. Anticonservationists turned to their favored legislative device, "appropriations riders," attaching language exempting specific species or rules to "must pass" money bills—about 50 times by my count. These all failed too, defeated by Bill Clinton vetoes or veto threats until 2001, and turned back last year in a series of close battles in the Senate.

BUT ESA OPPONENTS sense victory at last in 2002. Their websites are humming with chatter about getting rid of the ESA in the name of—what else?—"national security." Not the least reason for the chortle is a Secretary of Interior who has asserted that the ESA is unconstitutional and who is surrounded at every political level by like-minded associates. Appointed by a president with close ties to extractive industries and with industry-favored appointees in every key post, carefully disguised "administrative reforms" are already being crafted to ensure that fewer or even no wildlife species and their critical habitats will ever receive the act's strong legal protections again.

The Bush Administration is also turning to the courts for aid in this campaign of attrition. On February 20, administration attorneys asked a federal judge to invalidate protection of several hundred thousand acres of designated critical habitat for two imperiled species in southern California. This action follows on the heels of refusals to defend habitat protections for endangered owls in Arizona and salmon on the West Coast, presaging an ominous trend of sweetheart settlements of industry lawsuits, which effectively nullify already granted protective rules.

The hounds are baying in Congress too. Recently, House Resources Committee Chairman James Hansen (R-UT) went on the attack: "The ESA has become a wrecking ball in this country...we must reform this law." Hansen's idea of reform can be seen in a series of bills introduced at the same time by his House ally Representative Richard Pombo (R-CA), another long-time foe of the ESA. To read through these bills is an education in law-gutting. The title of one, "The Sound Science Saves Species Act of 2002," is its only benign part. The bill would inject multiple layers of "peer review" and appeals for every conservation action, essentially guaranteeing that no species will ever be protected by the ESA again. The rumor mill has it that even the military services will seek an ESA exemption.

Hearings are scheduled soon, and the battle will be joined for the rest of the year, in Congress and in the bowels of the Department of Interior. Given the current political climate of the country, I would not venture to predict the final outcome. I only know that it will be a struggle. I only believe that we must not fail. We must not permit the Endangered Species Act to succumb to a rising tide of hostility toward wilderness and wildlife within the Bush Administration and the House of Representatives. If the ESA is lost, we lose something even more precious than the marvelous and wondrous creatures that will surely go extinct without its protections. We also lose our hopes for a better, a more gentle, future for a wild and natural America.

The Endangered Species Act has been more than just a magnificent tool for conserving wildlife and habitat: it is a profoundly *moral* statement, uniquely American in its vision, its optimism, and its promise. Back in 1973 the legislators of a great nation said—for the first time in history—that henceforth, that nation would not permit any of the living species of plants and animals which shared its national territory to become extinct, not if we could prevent it.

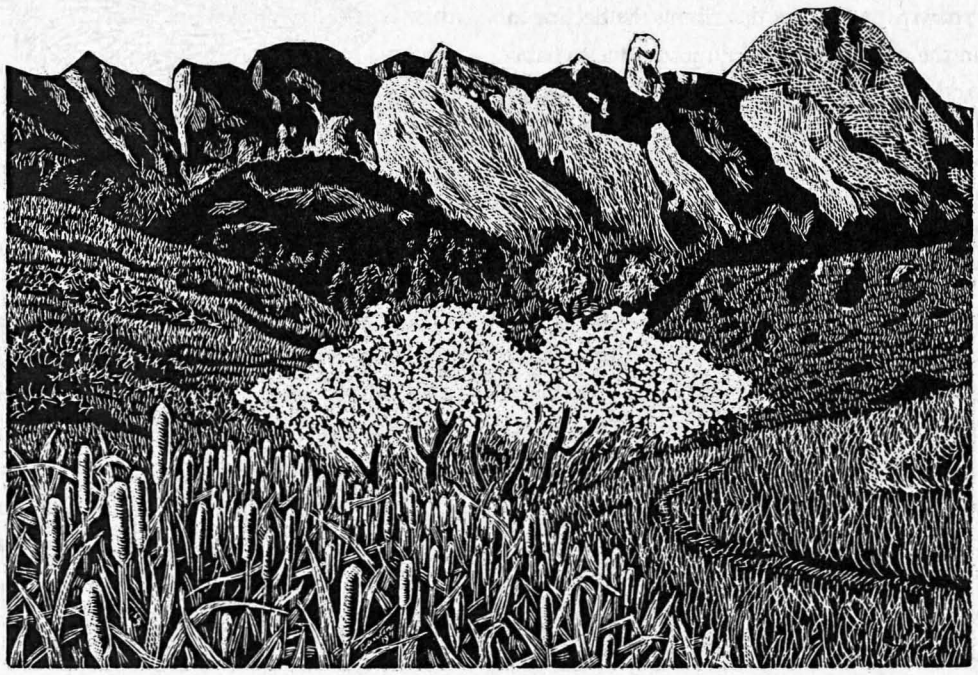
I have always believed that this commitment spoke to the inner hearts of the American people just as powerfully as the first expression of the national park idea (Yellowstone's designation in 1872) or the wilderness idea (with the passage of the Wilderness Act in 1964). And that *moral commitment* is the true reason why the ESA has survived so long, despite unceasing opposition from developers across the land.

It is hard to imagine a more powerful educational tool, either. The existence of the ESA has profoundly altered the American psyche about the importance of biodiversity to human health and national well-being. Each battle over listing, over critical habitats, and over regulations has educated more citizens about the web of life around us—plants and mice and mussels, as well as the larger "charismatic" animals. Yes, there have been tough, often controversial struggles. (Duking it out is the American way!) But the result, if the polls are to be believed, is that millions more Americans recognize the value of endangered wildlife than would have had there been no strong law passed to assure their protection.

For conservationists who love America's wild places and the wildlife they sustain, the path ahead is clear: we must fight to keep the vision and promise of the Endangered Species Act intact, protecting our natural heritage for this and future generations. ☾

Brock Evans, *a leader in the struggle to protect America's wilderness and wildlife for over three decades, is executive director of the Endangered Species Coalition (1101 14th St. NW, Suite 1400, Washington, DC 20005; 202-789-2844 ext. 132; bevans@defenders.org; www.stopextinction.org).*

Boulder County's Land Use Code



Wildlife Amendment Protects Habitat on Private Lands

BY NAOMI RACHEL

In 1915, Woodrow Wilson said, "The law that will work is merely the summing up in legislative form of the moral judgment that the community has already reached." The local government in Boulder County, Colorado, has been expressing this Wilsonian wisdom for years, and with the adoption of a requirement for property developers to prepare a wildlife impact report, the county commissioners continue to reflect the community's moral values.

Section 7-1700 of the Land Use Code—commonly called the wildlife amendment—was adopted January 26, 1999, because, as the introduction to the amendment explains,

> ...the loss of wildlife and plant habitats leads to the inevitable disappearance of wildlife and plant species themselves. This resultant loss of environmental diversity weakens the system as a whole, since diversity is an indication of the health of our environment....Through preservation and conservation of critical habitats we recognize the importance of an ecosystem approach in protecting all species and habitat types currently found in Boulder County, in order to balance natural systems and human use.

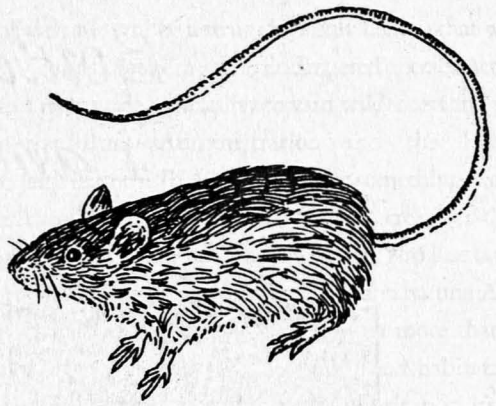
Devil's Thumb, Boulder County, Colorado, scratchboard by Evan Cantor

This general statement of conservation biology principles in the statute was given local detail through a wealth of supporting documentation: the Department of Wildlife's *Colorado Listing for Endangered, Threatened Species and Species of Special Concern,* which identifies birds, mammals, fishes, amphibians, reptiles, and invertebrates at greatest risk in Boulder County; newspaper articles describing the decline in hawks arriving in the area in the winter, mostly due to habitat destruction and the decline of prairie dog populations; articles on the threatened species listing of the Preble's meadow jumping mouse; and the Biodiversity Legal Foundation's lawsuit to protect the black-tailed prairie dog.

In short, the amendment elevates the importance of considering wildlife when planning human developments. In particular, a wildlife study paid for by the landowner is required when a proposed development falls within critical wildlife habitats, significant natural communities, rare plant areas, riparian corridors, natural areas, or natural landmarks—as identified in the Boulder County Comprehensive Plan. Not surprisingly, these designations rely on extensive natural community mapping.

This same requirement applies when the proposed development serves as significant habitat for any "Species of Special Concern in Boulder County." The study must be completed whether or not the species is actually found on the property in preparing the report. The statute covers any proposed subdivision, subdivision exemption, planned unit development, special use, limited-impact special use, or rezoning that falls within the designated areas. For single-family home site applications, the county land use director has the discretion to determine if a report is required.

The wildlife impact report must be done by one of the experts on a list that was approved by local scientists, land use planners, and naturalists and that integrated input from the Boulder County Nature Association. (At first only a Ph.D. was required, but activists pointed out that observers with local field knowledge could be better qualified than those with simply academic training.) Reports include an inventory of any "Species of Special Concern" found on the subject property; an assessment of the property as significant habitat for any of those species; an assessment of the proposed development's impacts on the species; a review of possible mitigation measures to reduce negative impacts; and a recommendation on whether the proposal can proceed without harming species or habitats. The report is submitted to the Board of County Commissioners and is available to the public. If a proposal is controversial, any Boulder County resident can call it up for a public hearing before the county commissioners (and the press).



Preble's meadow jumping mouse, pen-and-ink by Evan Cantor

The wildlife amendment makes explicit the types of mitigation measures that the county can require of applicants. Additionally, the commissioners have the authority to deny any proposal that they decide "will have a material adverse impact on a Species of Special Concern, or may materially and adversely impact habitat which is determined to be significant for such Species." The board also has the authority to approve the proposal with mitigation measures such as relocation of a development, avoiding sensitive areas, landscaping, and provision of replacement habitat.

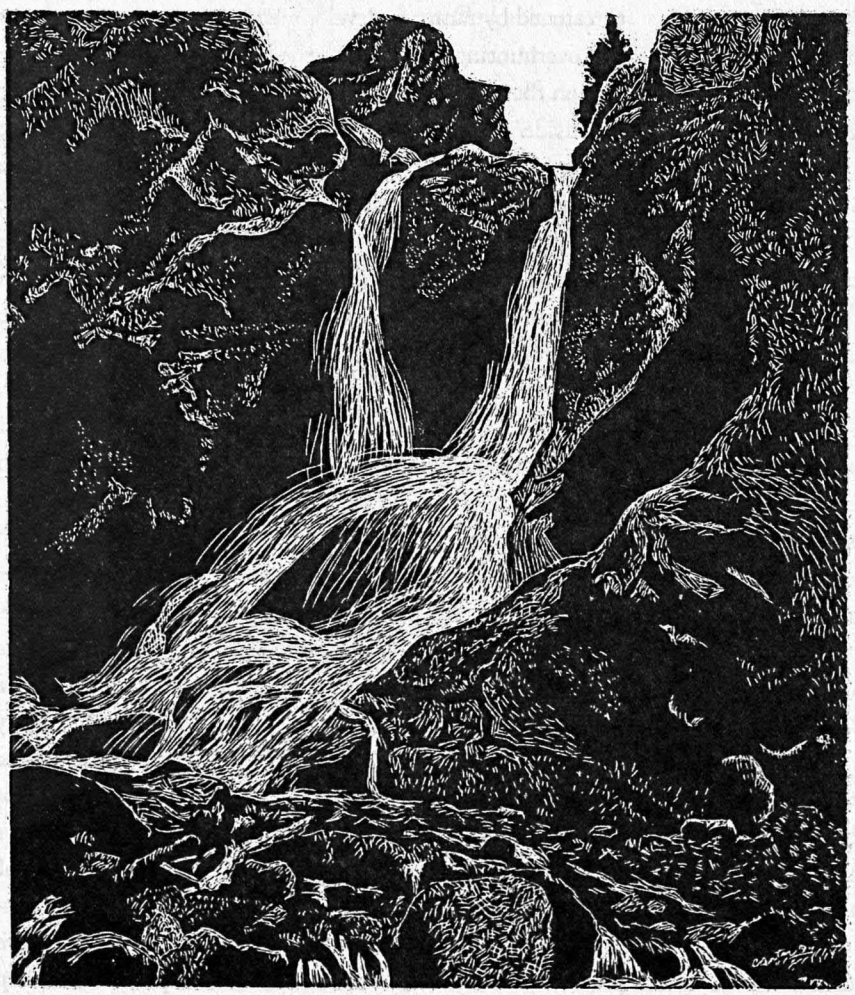
Graham Billingsley, Boulder County's land use director, strongly supported the adoption of the wildlife amendment, noting,

> It is clear there are no easy solutions...to allow man to occupy spaces new to him—but old homes to wildlife. We used to say, disturb less, make it small, don't put up bright lights and whatever is out there will be just fine. [Now the] wildlife regulations make sure that the small part of the ecosystem which might be disturbed temporarily, and the even smaller part that might be occupied forever, occur where the least damage to wildlife will occur. It also enables us to understand the larger ecosystem and the cumulative effects of development. Our regulations do not allow us to prohibit all construction, but they do allow us to get all the information necessary to determine what the best approach should be. It also puts the burden on the person who wants to build to pay for the study and, in a sense, vest themselves in the decision. Because of the regulations, applicants now look at wildlife issues before starting their plans, instead of trying to fit already created plans into new information later in the process. This has actually reduced the number of applications which require a wildlife study, instead of increasing the number of studies as assumed by the opposition when we proposed the regulations.

It is now legally possible for the Board of County Commissioners to prohibit a development if there is no practical way to mitigate the impacts. For example, they could refuse to allow development in an area inhabited by prairie dogs. However, since the Colorado legislature is infamous for passing "takings" legislation, the more probable scenario might be the denial of a specific application combined with a request that the applicant reapply. As with many land use decisions, it is a matter of public pressure. If many people show up at a hearing to demand that an area be protected, that happy result is more likely. In aid of this grassroots effort, it is crucial to have good land use regulations on the books. If they are ignored, the regulations make a court challenge possible.

I think it is (past) time for conservation activists to work with—or against, if the case demands—their local land use departments, planning commissions, city councils, and county commissioners to improve land use codes with the goal of protecting flora and fauna on private lands. In particular, the Boulder County wildlife amendment should be imitated by city and county governments across the country. If we want to prevent habitat fragmentation and wildlife loss, we need to find innovative ways to protect biodiversity on private lands. It can be done, and in some places such action may even be more achievable than substantive reform of public lands management. ☾

Naomi Rachel *lives in Boulder, Colorado, where she teaches creative writing at the University of Colorado and is the director of Residents Against Inappropriate Development (RAID). For more information (and the exact wording of the wildlife amendment) contact the Boulder County Land Use Department at www.co.boulder.co.us/lu/lucode.*



Boulder Falls, Boulder County, Colorado, scratchboard by Evan Cantor

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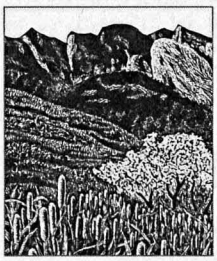

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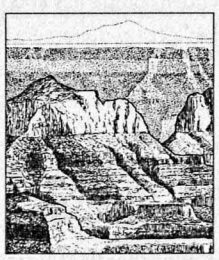

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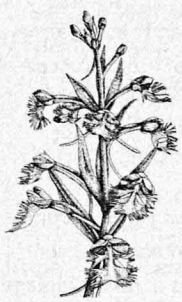

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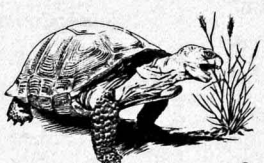

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A NOTE ON ART REPRODUCTION *Many of the works that appear herein are originally created in color. Any loss in a piece's visual integrity is due to the limitations of printing color work in grayscale. For more information on obtaining a particular original or print, or to commission artwork, please contact the artist directly.*

BACK ISSUES

Thirty-one back issues are available, beginning with our spring 1991 edition. For a more complete listing, visit www.wildlandsproject.org. Order online or use the reply form insert in this issue. See form for addjtional publications.

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

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.

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"

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

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

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

Spring 2000 • *The Wildlands Project Special Issue* E.O. Wilson offers a personal brief for TWP, Harvey Locke suggests a balanced apands 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

Summer 2000 • *American Parks and Protected Areas* Foreman on resourcism vs. will-of-the-land, historical perspectives from John Muir & Gifford Pinchot, Richard West Sellars on the history of national park management, American environmentalism 1890–1920, David Carle calls for expanding national parks by shrinking national forests, Andy Kerr & Mark Salvo critique 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

Fall 2000 • *Little Things* Resurrection Ecology by Robert Michael Pyle, Tom Eisner interview, Microcosmos, Return of the American Burying Beetle, Forgotten Pollinators, Laurie Garrett on the Coming Plague, Tom Watkins tribute by Terry Tempest Williams, Hunting & Nature Conservation in the Neotropics, Rockefeller's Philanthropy and the Struggle for Jackson Hole, critique of land exchanges, A Wilder Vision for the Texas Hill Country, Central Texas Forest Restoration, Fiction Folio: Dave Foreman's Lobo Outback Funeral Home

Winter 2000/2001 • *10th Anniversary Edition* Exceptional excerpts from *Wild Earth*'s first decade, the wilderness legacy of Robert Marshall, philanthropy aids rewilding in Florida, Michael Soulé asks if sustainable development helps Nature, Dave Foreman & Kathy Daly's ecological approach to wilderness area design, Connie Barlow sees ghosts of evolution, the dilemma of ecological restoration in wilderness, Sprawl vs. Nature by Mike Matz

Spring 2001 • *Wild, Wild East* Dave Foreman on "Pristine Myths," an Eastern turn for wilderness, Eastern Wilderness Areas Act legislative history, Doug Scott reviews Congress's criteria for wilderness, David Foster interview, biotic homogenization in the Northwoods, eastern cougar recovery, David Carroll on turtles and trout, Tom Wessels on beaver recovery, lichens and ancient forests, biodiversity on the Appalachian Trail, wildlands philanthropy in Maine

Summer 2001 • Dave Foreman on cornucopianism, Tom Butler on smart growth and sapsuckers, David Olson calls for conservationists to speak with one voice, long-nosed bats and white-winged doves, saving the sagebrush sea, Lyanda Haupt delights in the winter wren, Cascades Conservation Partnership, battling invasive fungi and insects, genetically engineered trees, farming with the wild, ecolabeling, wilderness restoration forum, US population stabilization

Fall/Winter 2001–2002 (combined issue) **• *Citizen Science*** Thomas Fleischner on natural history, Reed Noss considers whether citizen scientists are amateur naturalists, Rick Bonney suggests citizens collecting data help science, profiles of projects that monitor birds, mammals, fish, butterflies and more; Foreman on Early Awareness of Extinction, Biological Crusts, Sonoran Jaguars, Restoring Scotland's Caledonian Forest, Doug Scott examines words of the Wilderness Act, a lament for Florida, Pedaling Conservation Biology Across America, Saving School Trust Lands

A Twice-Lost Legume?

Holmgren Milkvetch

KINGDOM	Plantae
DIVISION	Magnoliophyta
CLASS	Magnoliopsida
SUBCLASS	Rosidae
ORDER	Fabales
FAMILY	Fabaceae
GENUS	Astragalus
SPECIES	holmgreniorum

HOLMGREN MILKVETCH is a dwarf, short-lived, tufted, stemless, perennial—and wholly unassuming—member of the bean family. It is easily overlooked. Originally (and sometimes still) called paradox milkvetch, it was collected in 1941 by Melvin Ogden, who did not know that the species was undescribed. His specimen languished in a herbarium for decades, possibly with an incorrect identification. No one took note of the modest milkvetch again for 38 years. In 1979, it was discovered by Rupert Barneby and his fellow botanists, Drs. Patricia and Noel Holmgren; Barneby formally described the species and named it *Astragalus holmgreniorum* after his colleagues (see sidebar). He later joked that it was still a "pair a docs" milkvetch.

Now, this warm-desert locoweed may be lost forever, extinguished by buildings, exotic annuals and grasses, cattle, and the wheels of off-road vehicles.

The plant occurs on erosional slopes and washes of gravelly limestone near St. George, Utah, and in neighboring Mohave County, Arizona. Compound leaves branch from the root crown, and in April and May it sends up several pinkish-purple flowers with white-tipped wings. The fruit pods are 1–2 inches long and fully open at both ends.

Holmgren milkvetch was placed on the candidate list under the Endangered Species Act as early as 1980—and (like hundreds of other candidates caught in this legal limbo) there it stayed. Finally, in August of 2001, the Center for Biological Diversity and several other

Rupert Barneby and the Discovery of the Holmgren Milkvetch

BY NOEL H. HOLMGREN

Rupert Barneby, who passed away last winter at 87, is one of the best-known plant systematists of our time. He described 621 new species and 371 new varieties, many of which he discovered in the field—including the Holmgren milkvetch.

One late afternoon, in the spring of 1979, driving down a dusty road on the Arizona Strip, it was time to find a place to camp. Rupert had the perfect spot in mind, a place where he once stopped to collect plants near St. George, Utah. As I drove on I kept expecting him to tell me where to turn off, and finally I stopped at the Utah border and asked if he still had this "perfect place" in mind. He reiterated how nice a place it was. "When were you last there?" I asked.

A brief pause. "It was 1942. Why?"

"Was it anywhere near the Virgin River?"

"Yes," he said, "it is a lovely place on the left bank of the Virgin River."

Turning the truck around, I had to tell him what the last 37 years of urban sprawl had done to the town of St. George and the Virgin River. The lovely place he remembered was now covered with housing developments.

It was getting late so I took the first side road, a pair of tire tracks heading across the creosote bush desert. I chose an open, sparsely vegetated spot for camp. Rupert was out the door before I came to a stop. While maneuvering the truck, I could hear Rupert shouting. My first thought was that I had run over his foot. I quickly set the brake, jumped out, and ran around the truck. He was jumping up and down with excitement holding a plant in his hand. My wife Pat just shrugged, "He says he has never seen this species of *Astragalus* before." Rupert was ready to begin collecting; I was tired, hot, dusty, and hungry. I thought I doused his plans by saying "we can collect it after breakfast."

The next morning, as usual, Rupert took off on foot to explore. After Pat and I climbed out of the camper, we realized that Rupert's evening had not ended as early as ours. Next to each suitable plant was a carefully placed rock cairn, the tallest and neatest stack of pebbles by the individual which became the holotype for *Astragalus holmgreniorum.* I felt a twinge of guilt that I hadn't let him collect the plants the previous night before supper. We made the collection and he named the plant for us, but the honor is all his.

Noel and Patricia Holmgren are authors of Intermountain Flora, *an eight-volume account of the vascular plants of the region that includes the Great Basin and most of the Colorado Plateau. For an excellent biography of Rupert Barneby, see Douglas Crase's 2001 article in* Brittonia, *"Ruperti Imagines: A Portrait of Rupert Barneby" (53[1]: 1–40).*

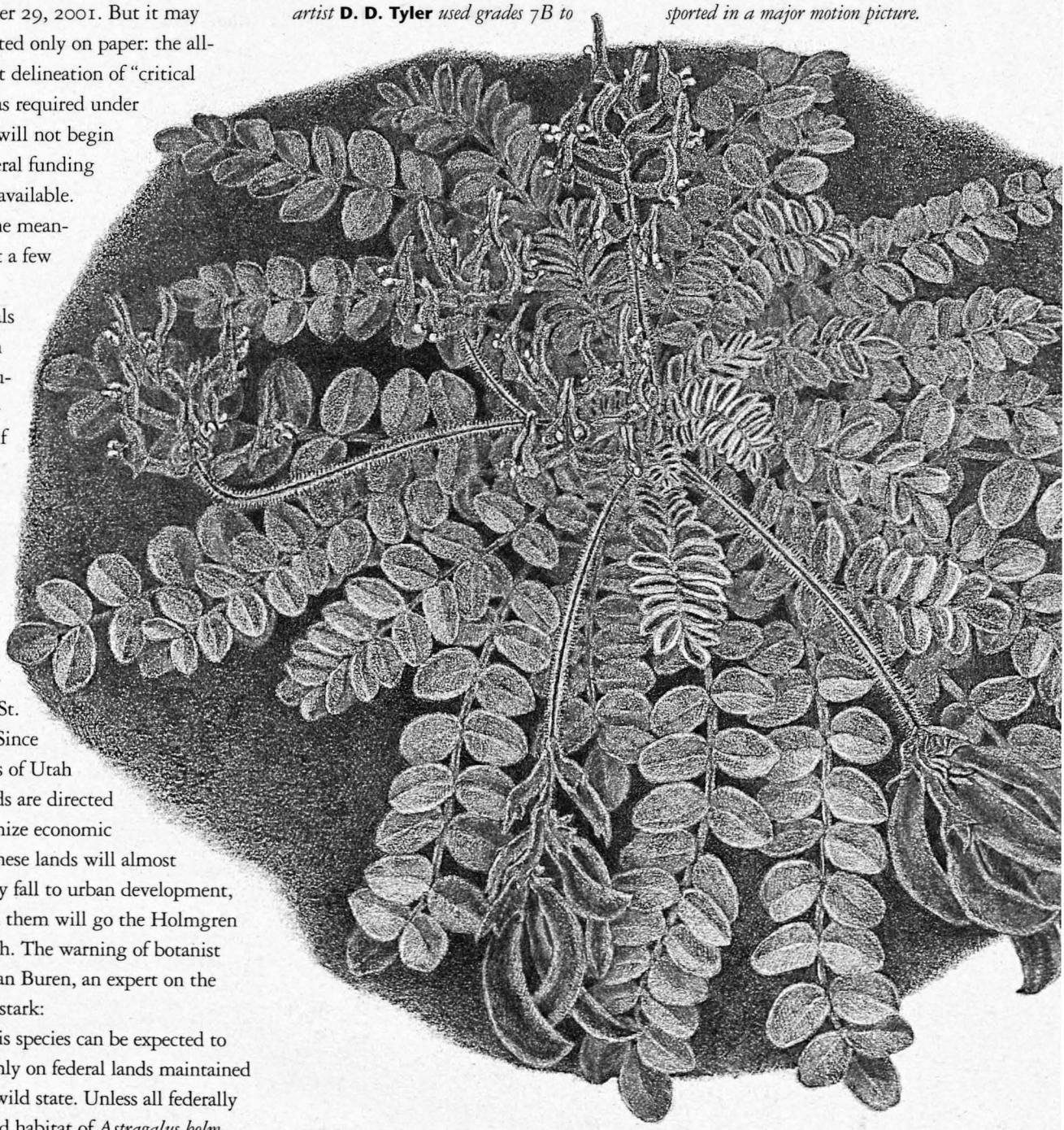
Species Spotlight

groups reached a remarkable agreement with Interior Secretary Gale Norton to expedite the protection of 29 highly endangered species across the country. As part of the settlement, the milkvetch received a final listing on October 29, 2001. But it may be protected only on paper: the all-important delineation of "critical habitat" as required under the ESA will not begin until federal funding becomes available.

In the meantime, just a few thousand individuals are left in four populations—about half of which occur on land owned by the State of Utah, near burgeoning St. George. Since managers of Utah state lands are directed to maximize economic return, these lands will almost inevitably fall to urban development, and with them will go the Holmgren milkvetch. The warning of botanist Renee Van Buren, an expert on the plant, is stark:

"This species can be expected to persist only on federal lands maintained in their wild state. Unless all federally controlled habitat of *Astragalus holmgreniorum* is retained in public ownership and closed to all forms of human-related disturbances, the continued existence of this species is unlikely." ☾

Joshua Brown *is* Wild Earth*'s assistant editor. Long-time contributing artist* **D. D. Tyler** *used grades 7B to 2H pencil to create this drawing. For 30 years, she has interpreted natural history in book illustrations, paintings, posters, and over 100 t-shirt designs. Some shirt designs—to her delight—have been sold at the Louvre, spotted around the world, and sported in a major motion picture.*



Sources: Renee Van Buren, PhD, Biology Department, Utah Valley State College, Orem, Utah
Center for Biological Diversity, www.biologicaldiversity.org

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