on the potential effects of climate change in California, but let the union take the results to Capitol Hill. Others feel more comfortable singing in a choir—on National Academy of Sciences panels, for instance.

For those willing to go a step further and offer their scientific take on policy, one could offer a range of alternatives—for example, the odds that a salmon population will be wiped out if a dam is or is not built. "Scientists should be providing information rather than advocating any particular solution," says UW's Franklin.

The most aggressive scientist-advocates claim they can lead a successful double life. The key, they say, is to make it clear that when they are taking a stand, they are doing so not as a scientist but as a citizen, and that their views are based on values. "I try to make that distinction clear to people," says Environmental Defense's Wilcove. Many advocates who spoke with *Science* said they wear "two hats," as a scientist and as an activist. Watling, for example, says he has defended his reputation by continuing to publish research, even while writing commentaries—including ones comparing trawling to clear-cutting a forest—"termed rants by my colleagues," he says (*Science*, 18 December 1998, p. 2168). But he and others admit that reporters, particularly those coming in cold to report on an issue, often don't see the difference.

The debate isn't going away anytime soon. Pickett says he is preparing a white paper for the ESA aimed at lawmakers and others that will "clear up some misconceptions" about the differences between an ecologist and an environmentalist. (Rykiel of Washington State thinks the ESA should produce guidelines for its members on where to draw the line on advocacy, although society officials say they have no immediate plans for that.) Meanwhile, the Society for Conservation Biology has commissioned a panel of members to hammer out an issue paper on the topic—though they're still struggling to "define advocacy," says Gary Meffe of the University of Florida, Gainesville, editor of the society's journal.

Whether their colleagues are right or wrong, many ecologists staunchly defend the right to speak out, even when the science is unclear. "If some people didn't feel deeply about some of these issues, scientists never would have pursued them and we would not know the vast majority of what we know in science," says Tilman. "I don't think there's anything wrong with conveying these hunches when they're relevant to society."

—JOCELYN KAISER

CONSERVATION BIOLOGY
▶TRANSFORMING A DISCIPLINE

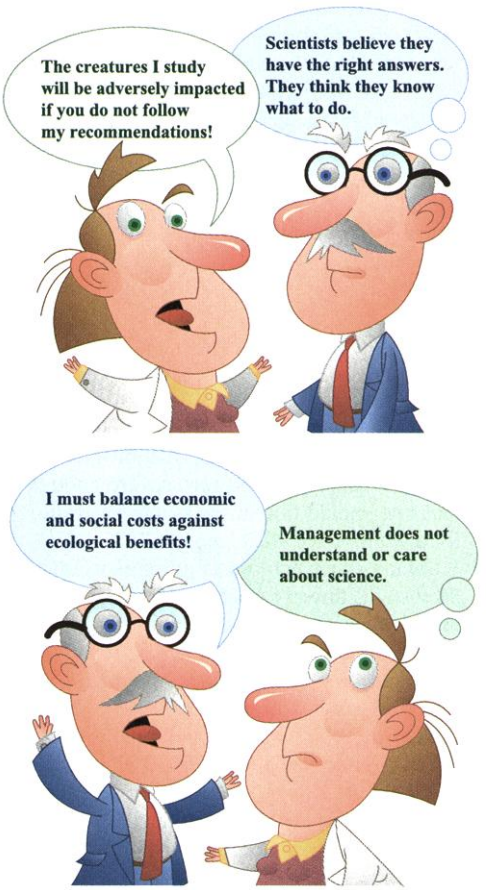
A New Breed of Scientist-Advocate Emerges

Conservation biologists clearly want to influence policy. After 15 years of frustration, practitioners are beginning to learn the fine art of making a difference

For months, David Wilcove peppered the U.S. Fish and Wildlife Service (FWS) with letters protesting the agency's plans to save the threatened Utah prairie dog. Wilcove, a conservation biologist, and his colleagues at Environmental Defense in Washington, D.C., argued that FWS was putting too much emphasis on protecting prairie dogs on federal lands, when most of the animals now live on private land and cannot be relocated easily.

In the midst of this typical conservation battle—scientist-advocates on one side, resource managers on the other—Wilcove made an atypical move. Conceding that his organization and the FWS were both shooting from the hip, making cases based on skimpy data, he flew a team from Princeton University to Utah last November to meet with agency managers and Environmental Defense officials. The Princeton group, led by biologist Andrew Dobson, began working up what the cash-strapped FWS could not afford to do on its own: a model on how various factors, from climate to disease epidemics, would affect Utah prairie dogs. "When the study is done this spring, we'll all have a better blueprint for determining the relative importance of public and private lands," Wilcove says.

That kind of cooperation is a novel way to get more science into resource management decisions. Week in and week out, managers dictate which sections of forest to sell to logging companies, which wetlands to pave over for houses, and which prairies to till into pastures. Such decisions often are justified by price tag or politics, but it's rare that more than lip service is paid to science. Part of the problem is that many scientists are hesitant, or unable, to participate in the process. "Academics don't know how to affect policy, and they don't communicate with managers very well," says Michael Soulé, a professor emeritus at the University of California, Santa Cruz.



Speaking in tongues. What a scientist says and a policy-maker hears *(top)*, and vice versa *(bottom)*.

CREDIT: TERRY SMITH

The disconnect between science and management is disconcerting to researchers who launched the Society for Conservation Biology (SCB) in 1985. "Our mission was to provide the scientific tools and ideas to protect nature," says Soulé, who served as SCB's first president. Fifteen years later, however, he and others say that scientists are still struggling to influence policy decisions. "The nuts and bolts of conservation biology just aren't working," says Barry Noon, a biologist at Colorado State University in Fort Collins.

Alarmed by their own irrelevance, conservation biologists are now taking steps to make their voices heard. While many ecologists agonize over whether to weigh in on policy issues (see previous story), conservation biologists are taking the offensive. SCB plans to unveil a magazine designed for resource managers that's packed with case studies and the latest biology. Meanwhile, a new program sponsored by The Nature Conservancy in Arlington, Virginia, plans to put some 50 biology postdocs into the field for 2 years at a time to learn from resource managers. And many seasoned conservation biologists are teaming up with resource managers to rethink endangered species re-

covery plans, evaluate marine parks, or simply get a dialogue going.

Different worlds. Like the Grand Canyon, the gulf between scientists and managers is deep and has been around a while. That's partly due to the mandate of many agencies to help the private sector access and exploit natural resources. The Forest Service, for example, clears the way for timber sales, the Department of Agriculture pushes the conversion of wild lands into agricultural fields, and the National Park Service establishes campsites and other services for tourists at scenic destinations. Ecologists, starting with Aldo Leopold, entered the scene in the 1930s and grew increasingly vocal in the 1960s. "That's when people started pushing for ecosystem management," says Jack Oelfke, a resource manager at Isle Royale National Park in Houghton, Michigan.

But this message is not sinking in, observers say. As a case in point, Noon, graduate student Jennifer Blakesley, and their colleagues have spent the last decade capturing and marking spotted owls in California's Lassen National Forest. By their count, about 8% of the territorial birds are disappearing every year. Their reports have repeatedly called on the Forest Service to save larger patches of old-growth trees, where the birds prefer to nest. "Our data are convincing, and the Forest Service has a legal responsibility to monitor this species," Noon says. But service managers have not responded to his team's findings, he adds.

Scientists also have a blind spot: They often ignore the politics and economics of resource management decisions, says former Forest Service director Jack Ward Thomas, who is now with the University of Montana, Missoula. "Researchers present results as if they were handed down from the heavens on inscribed tablets—the best scientific alternative is the only one," says Thomas. In reality, he notes, science is just one factor in conservation decisions: "It's up to the politicians and decision-makers to weigh the costs and benefits."

Two years ago, scientists handed down a major indictment of weak science behind management decisions. A study led by Peter Kareiva, an ecologist now with the National Marine Fisheries Service, found that weak data lay behind 233 habitat conservation plans (HCPs). These are federal agreements that allow private landowners and others to wipe out some members of an endangered species in return for substantial efforts to protect the population's habitat (*Science*, 19 December 1997, p. 2052). "FWS is much too comfortable with using expert opinion, assumptions, and guesses in place of hard empirical evidence," says Kareiva.

FWS managers respond that HCPs are a legal mandate, and they don't have the luxury of waiting for science to give them more definitive answers. "The bottom line is, we have to make a decision, and we have to use the best science we've got," says FWS biologist Deborah Crouse. "If we wait 5 years for better answers, the species might just be gone."

Getting the word out. Many scientists blame themselves for not getting political mileage out of their findings. "If you assume your findings will be translated into management or policy, you're wrong," says Gary Meffe of the University of Florida, Gainesville. Adds ecologist Peter Stine of the U.S. Geological Survey in Sacramento, California: "There's so much managers could gain from what researchers have learned, if only we could synthesize the information for them."

That's precisely what some scientists are aiming to do. For starters, the SCB this spring will launch a new magazine—*Conservation Biology in Practice*—that editor Kathryn Kohm of the University of Washington, Seattle, hopes will read like a *Harvard Business Review* for the conservation crowd. "Academics complain that managers don't read, but that's only because we haven't given them something worth reading," Kohm says. The bimonthly is intended to help managers ground conservation strategies in the latest science. "Dumping information from the ivory tower down clearly isn't working," she notes. "This is just one way to fill that gap."

Another strategy is a quarterly forum hosted by the Sustainable Ecosystems Institute (SEI), a nonprofit in Portland, Oregon, that analyzes ecological issues. SEI forums bring together scientists, managers, politicians, and industry officials to debate imperfect information, Robinson says: "By the standards of experimental science, a lot of management recommendations are based on pretty flimsy evidence. Data are often correlative and inconclusive. But we have to be willing to enter the decision-making arena with the best advice we have." Sometimes the key is simply finding the right ear to bend. "It's important to single out the open-minded managers," says Robinson. "They're out there."

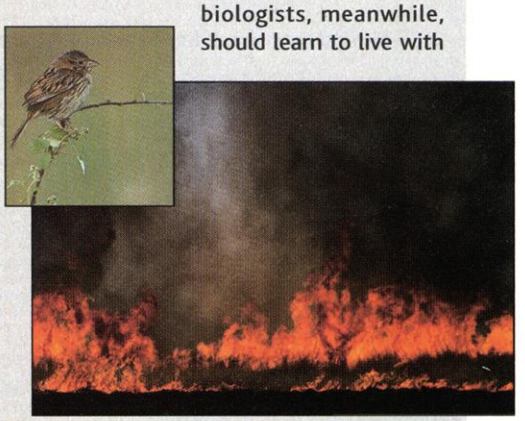
–K.S.B.

At Home on the Range

If there is a Shangri-La where conservation biologists and resource managers work in harmony, it just might be Illinois. While the two worlds often are out of sync elsewhere (see main text), a close-knit collaboration has nurtured the prairies and forests in this midwestern state. "We don't just publish a paper and send it out to resource managers," says Scott Robinson, a biologist who divides his time between the University of Illinois and the Illinois Natural History Survey in Champaign. "We talk to them, we give presentations, and it makes a difference. We also get a lot of good ideas from them."

One recent victory for the team is a safer home for the Henslow's sparrow. In decline nationwide, these birds tend to avoid nesting in recently burned grasslands. That's a problem for Illinois managers, who burn substantial areas of prairie every year to keep the land healthy. In 1991, biologist James Herkert of Illinois's Endangered Species Protection Board wondered if there was a way to reconcile the two conflicting conservation goals. For 5 years, he and William Glass, a resource manager with the Illinois Department of Natural Resources, tested the effects of various fire regimes on Henslow's sparrows at Goose Lake Prairie, a 650-hectare haven for the birds. They discovered that the birds favor certain patches of the prairie, establishing more nests in preferred areas not burned in back-to-back years. "It was good science, and we changed our management scheme to reflect it," says Fran Harty, a resource administrator with the department. The two sides have brought their partnership to bear on other conservation issues as well, such as deciding which parcels of forest to buy up as habitat for native warblers, herons, and hawks in the Cache River watershed.

Both camps say they have learned a lot along the way. Managers should not be shy about telephoning scientists, Harty says: "If you just start talking, you can get a wealth of information." Conservation biologists, meanwhile, should learn to live with



Razed on the prairie. Managers staggered their controlled burns after scientists raised concerns about how fires may affect the Henslow's sparrow (*inset*).

CREDITS: (LEFT TO RIGHT) MIKE COFFEEN; JAMES HERBERT

issues—and get past their mutual mistrust. At a forum 2 years ago on science in resource management, for instance, SEI president Deborah Brosnan broke the ice with a skit in which she played "the scientist from hell"—nose in the air, demanding endless cash and time for experiments, and offering ambiguous results in return. Across stage, arms folded, was "the manager from hell." She had zero money—and less patience—for slow-moving science. Shakespearean comedy it was not, says Brosnan, but "it opened the floodgates." Scientists came up with a proposal to rate their degree of confidence in conservation recommendations in order to help managers weigh the options. At SEI, this practice has become routine.

Such efforts toward rapprochement are a good start, say conservation biologists, who are counting on stronger advocates from the next generation to narrow the divide even more. The Nature Conservancy just launched its $9.5 million David H. Smith Conservation Science Fellowship Program, sending the first seven of 50 postdocs to work with managers in the field. The idea, says program director Guy McPherson, is "to grab the best and brightest headed into academia and expose them to the culture of on-the-ground conservation."

One Smith fellow, Jake Vander Zanden, a postdoc at the University of California, Davis, is plucking nonnative fish and amphibians from streams in the Sierra Nevada to help native populations rebound. "This is get-your-hands-dirty work," says Vander Zanden, who earned his Ph.D. studying food webs in lakes.

Progress may be halting, but scientists are beginning to find their voice, says Meffe. "Conservation biology is growing up."

–KATHRYN S. BROWN

Kathryn S. Brown is a writer in Columbia, Missouri.

MEETING VSOP SYMPOSIUM

Knotted Jets and Odd Quasars Reveal Secrets by Radio

SAGAMIHARA, JAPAN—More than 100 radio astronomers from around the world gathered here last month* to review early results of the first radio observation program that makes use of a space-based antenna and related topics. The Highly Advanced Laboratory for Communications and Astronomy (HALCA), launched by Japan's Institute for Space and Astronautical Science in 1997, was designed to make observations at three frequencies—1.6, 5, and 22 gigahertz. Unfortunately, the highest frequency band never worked properly, and problems with orienting the spacecraft and with its power supply have left it capable of making observations only at certain points in its orbit. Even so, HALCA, in combination with ground-based telescopes, is helping answer some long-standing puzzles.

Telltale Jets

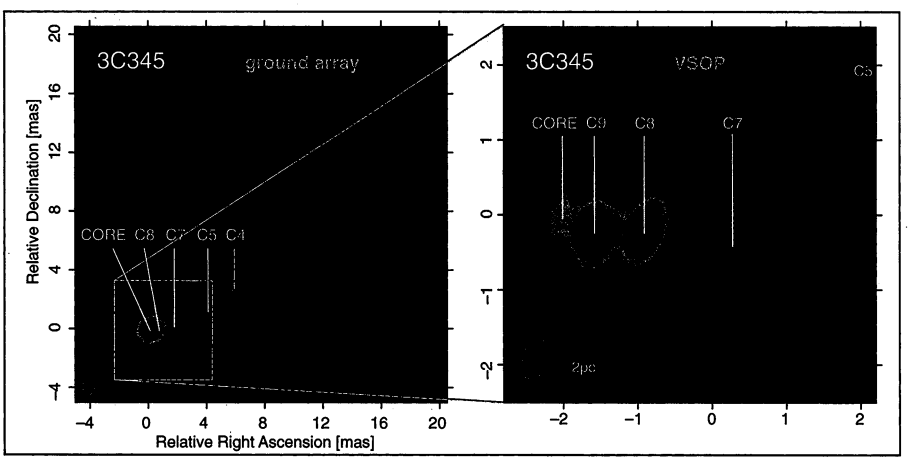
Active galactic nuclei (AGNs) are among the most fascinating and puzzling structures in space. An AGN packs the energy output of an entire galaxy of stars into a region smaller than the solar system. At the center of each AGN, scientists believe, lurks a black hole that sucks in gas and dust from a surrounding accretion disk of rotating matter. Perpendicular to the disks, enormous jets of gases hundreds of light-years long spurt from the AGN's core at velocities near the speed of light.

How AGNs form and what drives them are puzzles. But scientists are getting a closer look at the jets and how they change over time from the Very Long Baseline Interferometry (VLBI) Space Observatory Programme (VSOP), which uses HALCA in combination with ground-based radio telescopes to generate images with a resolution that earthbound equipment alone cannot approach.

Ground observations had shown that the jets are made up of bloblike knots of material that seem to emanate from the core and move lengthwise along the jet. Now, VSOP has added a wealth of extra detail. "We can see it's not just a blob [of material in the jet] but that it's extended and moving around," says Bernard Burke, a radio astronomer at the Center for Space Research at the Massachusetts Institute of Technology.

One of the clearest examples of the increased resolution of VSOP images was presented by Jens Klare, a doctoral student in astronomy at the Max Planck Institute for Radio Astronomy, in Bonn. He and colleagues are studying the quasar 3C345. In a jet from the quasar, VSOP revealed that what looked like a single large blob (a "component," in astronomer-speak) in images from ground arrays actually consists of three separate components. What's more, images captured a year apart seem to indicate that the knots are moving away from the core and that one is getting brighter while another dims. Klare suspects that the knots are following a helical spiral along the axis of the jet, dimming and brightening as they veer away from and toward Earth.

But other observations suggest knots do not move away from an AGN's core. William Junor, an astrophysicist at the University of New Mexico in Albuquerque, and colleagues have been using both ground-based arrays and VSOP to study M87, the central galaxy in the Virgo cluster and one of the first radio galaxies in which a jet was observed. "We didn't see much movement" in the components of M87's jet, Junor says. This raises the possibility that jets from different sources behave differently, suggesting that the jets change over time or that different forces are at work depending on the scale of the AGN.



CREDIT: J. KLARE

Kinky. Trained on a jet from quasar 3C345, VSOP split what had looked like a single knot of material *(left)* into three.

*The VSOP Symposium, "High Energy Astrophysical Phenomena Revealed by Space-VLBI," 19–21 January.