4

The Problem of Uncertain Knowledge

If we knew all the laws of nature, we should need only one fact, or the description of one actual phenomenon, to infer all the particular results at that point. Now we know only a few laws, and our result is vitiated, not, of course, by any confusion or irregularity in nature, but by our ignorance of essential elements in this calculation.

Henry David Thoreau[1]

Debating the merits of cutting old-growth forests, siting a hazardous waste facility in a small town, and cleaning up toxins in the biosphere are quite different controversies, though they share at least one important feature: the problem of environments and communities is inevitably linked to languages of expertise. Experts, however, rarely speak with a unified voice. On the contrary, biologists, chemists, ecologists, epidemiologists, toxicologists, and engineers, to name a few types of experts, are apt to see the environment and its problems in different, often contrasting, ways. Indeed, within a single culture of expertise, clashing voices are frequently heard. Two geological assays, for example, reach opposing conclusions regarding the probability of earthquakes in a specific geographic area sited to bury nuclear waste. The cacophonous chorus of science belies the promise of a world ordered by the rational, stepwise accumulation of knowledge.

Environmental conflicts are more often than not controversies over knowledge. They are disputes about knowing, about who can know, and what will count as valid and reliable knowledge in resolving differences. While there is always a visceral ingredient in any conflict, environmental conflicts are also noticeably cerebral.

This chapter examines the intersection of environmental problems, uncertain knowledge, and community conflict. It is a brief inquiry into the complicated relationships between individual knowledge and its role in configuring local environmental hostilities. It opens with a consideration of the uncertainty that plagues medical, ecological, and other rational inquiries into local environmental conditions. Next, borrowing from the language of lines and angles, we identify two key dimensions along which conflict develops: *vertical* and *horizontal*. Vertical disputes occur when local citizens and extra-local governmental or corporate experts reach opposing conclusions on the validity and reliability of tests, measurements, or experiments. Horizontal arguments are likely to occur *within* a community between competing citizens' groups with divergent claims to know something rational or scientific about local environmental troubles.

Both the vertical and horizontal axes of conflict over what will count as credible and dependable knowledge can occur simultaneously, and often do. But it is worth taking a look at each one separately for what it can tell us about the relationships between environmental troubles, uncertain knowledge, and community conflicts. Examples of the ways in which scientific uncertainty and the vertical and horizontal axes of knowledge disputes connect with material presented in previous chapters is provided in Box 4.1.

Sources of Uncertainty

The Northern Spotted Owl Controversy of the Pacific Northwest

In the late 1970s a battle erupted in the Pacific Northwest which would rage over the course of several decades, generate intense levels of acrimony and divisiveness, and become one of the best-known environmental controversies of the latter 20th century.[2] The conflict was over efforts to protect the northern spotted owl, and it pitted timber workers against environmentalists in a classic jobs-versus-environmental-protection standoff.

Box 4.1 Making Connections With Previous Chapters

The perplexing practical and political problems created by "the end of nature as we know it" are also the source of vexing knowledge problems. Combined with the scientific and technical basis of official environmental decision making (see Chapter 3), it is not surprising to find that scientists of all kinds figure prominently among conflict participants and that scientific statements of "fact" are a pervasive feature of environmental claims making (see Chapter 1, Box 1.2). Some frames may reflect scientific themes as well. In particular, frames which seek to cast some action as an "acceptable" or "unacceptable" risk are typically cloaked in the aura of science, as are efforts to label some claims "objective" and others "subjective" or "biased." Due to their central role in decision outcomes, scientific investigations are likely to figure prominently in the time line of a controversy (see Box 1.3 and Table 1.1.).

The vertical axis of knowledge disputes further develops the distinction between local versus extra-local conflict participants first seen in Chapter 1 (see Box 1.2) and more extensively developed in Chapter 3. Indeed, there is considerable spillover between this chapter and the previous one on trust and betrayal. The "official science" we talk about in this chapter refers to studies conducted by the many toxicologists, hydrologists, wildlife biologists, and other scientists employed by such government agencies as the U.S. Environmental Protection Agency. Battle lines in vertical knowledge disputes are frequently drawn between government scientists and local residents. Sources of uncertainty which plague all kinds of scientific endeavors can be a significant factor underlying what citizens perceive as intentionally slow and inadequate official response to local environmental problems. Uncertainty, in other words, can be a major contributor to structural betrayal, though it can also be used as a convenient excuse for premeditated betrayal.

In Chapter 1 (Box 1.4) we directed students to identify key points of human-environment contact, suggesting the potential of these to give rise to local knowledge claims. In the TEDs case in Chapter 3 we illustrated how such knowledge claims could clash with official scientific accounts, leading to accusations of intentional malfeasance. In the present chapter we undertake a more in-depth examination of local knowledge, allowing us to further unpack the complex relationship between uncertainty and premeditated, structural, and equivocal betrayal.

Knowledge disputes are inextricably linked to ambiguity, which has come up at several points in previous chapters. In the History as Invention section in Chapter 2, we discussed the inherent difficulty of determining which point in the past should provide the standard for ecosystem restoration projects, a theme explored again in this chapter in the Chicago Wilderness case. In Chapter 3, we discussed the ambiguity that can surround the intentionality underlying ostensibly craven, reckless, and self-serving acts (see Box 3.5). Ambiguity of all kinds can generate horizontal knowledge disputes; such disputes may manifest through the formation of contending grassroots groups (see Box 1.3).

Situating this conflict in broader historical developments is useful. Two of the accomplishments of the conservation movement of the late 19th–early 20th centuries were the creation of resource agencies like the U.S. Forest Service and the implementation of scientific management of natural resources. (For a brief history of the U.S. environmental movement, see Box 4.2.) The two primary goals guiding management decisions on public lands were to maximize extraction (though in a more sustainable way than the private sector) and to nourish game species for hunters. These two goals came together in the systematic war against predators waged by such resource agencies as the U.S. Department of the Interior, which protected both domestic livestock and the wild species targeted by hunters. Then, the conservation movement was almost exclusively focused on rural and wild areas and dominated by privileged, white sportsmen.[3]

Economic prosperity and the triumph of the "automobile culture" in the post–World War II era brought increasing numbers of individuals to national parks and other public lands. As a result, increased demands were made for nonhunting recreational uses of these spaces. These changing demands gained official recognition in the 1960 passage of the Multiple Use-Sustained Yield Act, which addresses the renewable surface resources of national forests. This act states, in part, "It is the policy of the Congress that the national forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes."[4] The act goes on to state that "some land will be used for less than all of these resources . . . and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output."[5] The 1976 Forest Land Policy and Management Act extended this multiple-use mandate to land managed by the Bureau of Land Management (BLM), also emphasizing wildlife (noncommodity) values.

The 1960s saw an upswing in public concern about environmental issues, as reflected in the growing popularity of the contemporary environmental movement. Books like Rachel Carson's *Silent Spring* helped to usher in a far more holistic understanding of ecosystems; the natural environment came to be seen as incredibly complex and interdependent, with apparently minor changes having the potential to reverberate into significant, unanticipated consequences. The contemporary environmental movement also championed the shift away from the exceedingly anthropocentric worldview of Western society; nonhuman species had intrinsic value, apart from any pragmatic uses they presented to humans.

These changing beliefs and values worked together to produce a new focus on nongame species. New appreciation was developed for the ecological role played by predators, and there was greater recognition that

Box 4.2 A Brief Look at the U.S. Environmental Movement

The dominant social paradigm of U.S. society is firmly rooted in Western cultural ideals about the relationship between humans and the natural environment. Humans are seen to stand outside of, and in a superior relationship to, nature. This separation, we contend, is based on our intelligence. Humans, we argue, are creative problem solvers who use technology to overcome ecological limitations. It is, furthermore, desirable that we humans bend nature to our will and utilize environmental resources to serve our needs. Through use of our intelligence, we can rest assured that the natural world will deliver up an endless supply of raw materials and waste disposal capabilities.

The U.S. environmental movement has challenged all of these core cultural beliefs. The first phase of significant environmental activity in this country occurred during the Progressive era of the late 19th and early 20th centuries and is typically referred to as the conservation movement. This movement was spurred by the closing of the western frontier, which challenged the popular belief that there would always be more land to farm, more forests to cut down, and more rivers to fish just over the hill and round the bend. As the "endless frontier" mentality hit up against the hard reality of a continent rapidly filling up, a few visionaries such as John Muir began championing wilderness preservation. The belief that the natural world might have an intrinsic value apart from the ways in which it served human uses began to gain a tenuous foothold.

Two world wars and the Great Depression in between reduced public interest in environmental issues, and it was not until the 1960s that a second upsurge in concern would transpire. Playing a crucial role in changing attitudes was the 1962 publication of Rachel Carson's *Silent Spring.* In this book Carson, a marine biologist and noted nature writer, condemned the widespread use of synthetic chemicals in the post–World War II era. A major focus of her critique was the popular pesticide DDT. *Silent Spring* helped to shift public environmental beliefs by drawing attention to the complexity, interdependency, and fragility of natural ecosystems. It also set the tone for the contemporary environmental movement by joining earlier conservationist issues with a new focus on the risks that advanced technologies pose to human welfare.

Over the four decades since Rachel Carson published *Silent Spring,* Americans consistently register moderate to strong commitments to environmental beliefs and values. Cultural change is occurring, but it has not yet taken the form of a wholehearted embrace of an environmental agenda. Indeed, Americans are the most prodigious resource users on the planet; we display a deep-seated commitment to a kind of hyperconsumerism where prosperity is measured by the amount and kinds of "things" we own. What Americans want, it appears, is both economic prosperity *and* environmental protection, tensions which have enormous implications for local environmental conflicts.

SOURCE: Cable and Cable (1995); Catton and Dunlap (1980); Dunlap (1992, 2002); Kline (2000); Mauss (1975); Milbrath (1984); Nash (1967).

species which had no immediate economic or recreational value for humans were still integral parts of ecosystems. Growing recognition of the need to protect all kinds of species of flora and fauna was codified in the 1973 Endangered Species Act (ESA).[6] The purposes of the act are to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such endangered and threatened species."[7] As Yaffee explains,

> The 1973 law went far beyond earlier efforts at endangered species protection. While previous laws recognized educational, historical, recreational, and scientific values in endangered species, the 1973 act added aesthetic and ecological values, and listed ecosystem conservation as the first of several purposes of the statute. It offered protection to endangered species, subspecies, or isolated populations of animals or plants in imminent danger of extinctions. . . . Decisions as to what species warranted being stamped federally "endangered" were to be based solely on biological grounds, and species could be added to the federal list if they were threatened by almost anything, including "the present or threatened destruction, modification, or curtailment" of necessary habitat.[8]

Into this historical milieu walked Eric Forsman, a graduate student at Oregon State University (OSU). Forsman followed the trend of increased attention to nongame species by choosing to conduct his master's thesis research on the northern spotted owl. At the time Forsman began his research, very little was known about this particular bird, including its population size and habitat needs. That the reproductive pairs studied by Forsman always nested in old-growth forest suggested early during the research process that the birds might be in trouble. Indeed, Forsman's research suggested the birds not only had very specific habitat needs but were also highly sensitive to any alteration to their environment. The owls responded to disruption in their habitat by relocating to another section of old-growth forests and usually did not reproduce the year following relocation. As more and more old-growth forests were cut down, it would make it harder and harder for the owls to find a new home. The suppression of fertility linked to relocation spelled additional troubles for the future of the species.

Old-growth forests in the Pacific Northwest contain trees that are centuries old (what the Forest Service, or FS, refers to as "overmature"), as well as much dead and decaying wood. Because of this, the FS at the time regarded the old-growth forests as fire hazards and as a harbinger of insects which could spread from there to infest surrounding forests. They were too inaccessible to be of recreational value and did not contain species of interest to hunters (indeed, they were looked upon as "biological deserts"). From the FS's view, the best strategy was to cut down the old-growth forests and replace them with stands of managed Douglas fir. Most of the owl pairs studied by Forsman lived in habitat already marked off for timber sales.

Forsman and his faculty adviser Howard Wight began lobbying for the owl's protection. The Oregon Endangered Species Task Force (OESTF) began looking into the issue, pressing Forsman to specify the minimum amount of old-growth forest owls needed to reproduce and survive. Forsman's best guess at this time was 300 acres. "At 300 acres per site, protecting known sites would involve some 21,000 acres of public land scattered across a BLM and FS land base of 31 million acres in Oregon."[9] After 4 years of work the OESTF came up with a management plan which would protect 400 pairs of spotted owls, 290 on FS lands, 90 on BLM lands, and 20 on land with other ownerships.

By 1980, researchers had expanded their original estimates of the amount of land needed for owl habitat. Studies showed the average amount of old-growth forest used by each owl pair was 740 acres, with a minimal home range (combined old-growth and newer-growth forest) of 1,009 acres. In the Coast Range, mean home range per owl pair was found to be 4,728 acres.[10]

As the size of the estimated owl habitat grew, so did the amount of forest which would have to be removed from timber production to protect the owl's environment. Eventually, it came to look like protecting the northern spotted owl "could require the elimination of timber harvest activities over 11.6 million acres of land."[11] Boxed in by legislative mandates, a battle of competing knowledge claims emerged: Just how was the species endangered and what is the accurate composition and range of its home range? The scientific facts put forth by owl defenders were countered by other participants, and throughout the controversy basic information about the owl was marked by much uncertainty. Consider the basic problem of even counting the number of owls out there.

> [T]he wide ranging nature of the owl made information collection difficult. To count owls, researchers go into the woods and call to them. The fact that this is best done at night (in the dark) at regular intervals through often-steep, old growth forests makes this research labor-intense, demanding and dangerous. Moreover, the owl could potentially live in millions of acres of such forest adding to the difficulties in creating an accurate count. As a result of these inherent difficulties, estimates of the size of known owl populations varied considerably.[12]

Look at the seemingly endless array of facts we now possess about biospheres, atmospheres, ecosystems, and pollution levels. It seems we possess a wealth of knowledge about our environment and that science is the place to turn for answers when we have questions about conservancy, siting, and exposure issues. Take a closer look, however, and we notice both expansive gaps in scientific knowledge and a remarkable absence of consensus among scientists over what, in fact, is a definitive account of this or that aspect of nature. The Enlightenment dream of a science capable of providing once-and-for-all answers to life's incessant puzzles is proving to be incorrigibly elusive.

The first problem is with the seemingly simple "fact" itself. Consider the following quotation from the now infamous contamination of Love Canal:

> That there are chemicals with known toxic effects to humans present in the landfill is undeniable. That they had made their way to the surface of the landfill . . . is undeniable. That the presence of toxic chemicals was confirmed in and/or on the property . . . of landowners is undeniable as well. [W]hether the conditions at Love Canal had physically harmed or injured residents . . . was uncertain from the beginning.[13]

Students of environmental conflicts are wise to remember that facts are not incontrovertible statements of what is true. They do not exist like shells on the beach waiting for someone to pick them up. Although it might be of some comfort to assume that facts are simply obvious, it is a species of faulty reasoning. A fact is not *evident*. It is not self-evidently valuable or conclusive. A fact, rather, is more reasonably thought of as *evidence*. It is a fact because it supports some version of the world, the environment, people, events, and so on. A fact never speaks for itself; it always speaks for a scientific, theoretical, political, religious, or perhaps personal agenda. The modern fact, in short, is less a singular, concrete bit of information and more a part of an abstract version of the truth.

One study reports that creating a viable solution to old-growth harvesting and the protection of the spotted owl will result in the loss of 12,000 jobs; another study reports that 147,000 jobs will be lost. Move from these two quite different numbers back to the research methodologies that produced them, to the institutional affiliations of the investigators that created them, and to the funding source that paid for them. Viewed from this more abstract, inclusive vantage point, the 12,000 and 147,000 jobs lost represent two competing versions of the truth about employment opportunities and species protection. The idea that facts are evidence of some larger, more abstract set of assumptions, prejudices, and beliefs is of considerable assistance in understanding many local environmental controversies.

Experts can disagree among themselves because both the production and interpretation of "facts" rest on models and background assumptions that are open to dispute. Take the following statement, presented as an assertion of a fact: there are no significant human health risks from drinking water containing less than 17 ppb (parts per billion) polychlorinatedbyphenols (PCBs). Sounds authoritative. No fudging or hedging here. But, where does a fact like this originate? Probably from a leap of faith—scientists call it extrapolation—that begins with a few "data points."

Data points come from epidemiological field studies of exposed populations and toxicological laboratory experiments. Workers in factories producing chemical compounds are a prime target for studies on exposed populations. While such studies are needed for occupational safety reasons, workers are not representative of the broader population. Workers in hazardous facilities are adults, typically in the prime of life, and often male. Yet we know fetuses, infants, and children are more vulnerable to toxic chemicals and that there are sex differences in responses to medication, thus suggesting the potential for sex differences in chemical exposures.[14] Such studies do not take account of possible differences in exposure routes between workers and community residents (for example, inhalation and absorption through skin for workers versus ingestion for residents, if the substance is in their drinking water), nor do they address the problems of synergism (the interactive effects of a compound like PCBs with the multitude of other substances people are exposed to in their everyday lives).

There are, of course, ethical problems with conducting laboratory experiments which intentionally expose humans to a potentially harmful substance. Animals are used instead, but this also requires two important forms of extrapolation. First, because animal experiments are expensive, tests are not run on a wide range of exposure levels. Typically, tests are run at fairly high exposure levels, then dose-response curves are used to extrapolate health effects at lower exposure levels. The problem is that different dose-response curves yield quite different responses. One important difference is whether or not researchers use a threshold or nonthreshold model. The former assumes that health effects occur only after some threshold of exposure has been reached, while the latter model assumes *any* exposure will have health effects.[15]

These kinds of laboratory experiments also require extrapolating from animal species to humans. This requires the assumption that there are no species-specific responses to the substance. A study by Busch, Tanaka, and Gunter documented the fallacy of this assumption in one case. Beginning in the latter 1950s, researchers in Canada became concerned that erucic acid, a long-chain fatty acid naturally occurring in rapeseed (the oil-bearing crop that would eventually become known by the name canola) posed human health risks. Subsequent laboratory experiments on rats showed a compelling pattern of heart problems with animals who ate a diet high in rapeseed oil, and a plant breeding program was undertaken to eliminate erucic acid from rapeseed. It was only after this plant breeding program was completed that metabolic differences in how rats and humans break down long-chain fatty acids was discovered, indicating that humans would not have experienced the same heart problems. In this case, extrapolation from animal species to human was unwarranted.[16]

To provide one more example, extrapolation also occurs in fishery scientists' estimation of the population size of aquatic species. Think of the difficulty of counting fish stocks. Fishery scientists estimate populations of aquatic species by collecting the species present in a given location at a particular time, then extrapolating from that to develop a general picture of what the fish stocks of a given body of water looks like. The models on which such extrapolations are based incorporate assumptions, such as population movements of various species, which are open to questioning and dispute.[17]

One area in which extrapolation is necessary and inevitable is in efforts to predict the future. Such predictions present ample opportunity for contention. Consider the case of siting disputes. In this case, projections or extrapolations must be made about the likely consequences of activities. How much of a danger will the facility pose to the local community? Will there be accidents, such as fires, explosions, or releases of gases? How many new jobs will the facility create? The future—as-yet-to-be-decided—nature of these questions ensures conjectures, opposing science, and endless debate.

Future uncertainty is often couched in the language of risk. The idea of risk is inseparable from the idea of uncertainty.[18] If I am 100% certain of the outcome of a card game because I stacked the deck, I can't be said to be taking a risk by playing cards. In contemporary history, however, the "stacked deck" is conspicuously absent. We are far more uncertain than certain about things that matter to us. Pervasive uncertainty encourages us to think in the calculus of risk. Chance, fortuity, and contingency are ordinary modes of mental and social life. Risky foods, security risks, medical contingencies and dangers, environmental hazards, and the probability of loss are some of the more prominent areas governed by uncertainties.

In local environmental conflicts the uncertainty of novel risks is often mitigated by comparing that class of risks to far more familiar risks. Thus one side of a conflict might say, "You have more risk of being hit by lightning than developing lung cancer from breathing the particulate matter released by our smokestack." The other side might counter with, "Breathing the filthy, polluted air from this factory is just like smoking five packs of cigarettes a day for 20 years." Clarke describes the strategy whereby risks of hazardous technologies are minimized by creating apparent affinities with mundane events. Thus, evacuating a major metropolitan area in response to a meltdown at a nuclear power plant can be treated as analogous to the emptying out of the city, which occurs 5 days a week as commuters head home.[19]

It is important to remember that our focus here is on the process by which scientific facts are produced and translated into forms readily available for official use and public consumption. Scientists are trained to recognize, and report, the limitations of their study designs and sampling strategy. When publishing in scholarly venues, scientists use language which is cautious and circumspect in nature, such as "the research findings suggest that . . ." rather than "the research findings prove that . . ." Yet once entered into official and public forums, facts are more likely to be presented as self-evident and certain, a practice which obfuscates the investigative process by which the facts were produced, including the employment of background assumptions, limitations, qualifications, and hedging. In their public presentations of "the facts" of a conservancy, siting, or exposure dispute, conflict participants seeking to clothe their claims in the legitimation of science (which includes but is not necessarily limited to scientists) employ instruments, measurements, statistical charts, and other abstract representations of nature that affect precision and promise certainty. The problem, however, is that it is far easier to *appear* precise than it is *to be* certain.

Box 4.3 summarizes the types of questions students of local environmental conflicts might want to raise about the sources of uncertain knowledge in local environmental conflicts. We turn now to a consideration of how ambiguity and uncertainty can contribute to conflicts between local residents and outside experts.

Box 4.3 Adding to the Portfolio: Sources of Uncertainty

1. What is the existing state of scientific knowledge in areas relevant to the conservancy, siting, or exposure dispute? What are the institutional affiliations of the investigators generating relevant scientific knowledge?
2. What models and background assumptions underlie the "scientific facts" proffered in the case? Are these models the subject of criticism and questioning?
3. Are extrapolations about the future a source of controversy?
4. How is future uncertainty conveyed in the language of risk? What comparative (or analogous) risk profiles are offered, and do these serve to heighten or lessen the sense of impending danger?
5. Are instruments, measures, statistics, charts, and similar mechanisms used to couch "facts" in an aura of certainty and precision?

The Vertical Axis of Knowledge Disputes

Sheep, Radioactivity, and Contested Knowledge

Chernobyl is a small town in the Ukraine, 105 kilometers north of Kiev. A few kilometers from Chernobyl, the former Soviet Union operated four powerful nuclear reactors. On April 26, 1986, at 1:23 a.m., an accident occurred during a safety test in the fourth unit of the Chernobyl Nuclear Plant. An unexpected power surge caused a sudden burst of heat that destroyed the top half of the reactor, starting a nuclear fire that lasted 10 days.[20] The explosion and fire released an amount of radioactivity "equal to that from all the atomic bombs ever tested above ground."[21] Radioactive clouds, pushed by the winds, traveled east to Japan and west to Britain. Indeed, Chernobyl's radioactive debris fell on the United States. But our story occurs in the United Kingdom, specifically in the sheep farming district of Cumbria in the far northwest.[22]

Cumbria is a traditional farming culture. Its inhabitants labor at the difficult and taxing work of highland husbandry. Bound by a common history, long-standing traditions, and ancient dialects, residents of this rural district are among the last remnants of a pastoral way of life in increasingly industrialized England. But their provincial isolation was not enough to spare them the fallout of one of the world's worst industrial accidents.[23]

Less than a month after the nuclear fire at Chernobyl, thunderstorms carried radioactive caesium isotopes from contaminated clouds to the fertile soils of the Cumbrian hills. Two types of caesium isotopes fell to the earth during the storms: caesium 134 with a half-life of approximately 2.4 years and caesium 137 with a half-life of 28 years.[24] The raining caesium was a source of considerable concern for both the farmers and the British government.

> [A] sudden blanket ban on the movement and sale of sheep from defined areas [of contamination] in hill regions such as the Lake District of northern England . . . [would be] potentially ruinous to what was a marginal and economically fragile sector of British farming, because these farmers depended for almost all of their annual income on being able to sell a large crop of surplus lambs from midsummer onwards.[25]

At first, farmers heard reassuring accounts from scientists working for the Ministry of Agriculture, Fisheries, and Food (MAFF) who responded to the fallout by placing a 3-week ban on the movement and sale of sheep. Shortly after the 3-week restriction, however, the MAFF unexpectedly imposed an indefinite prohibition on movement to alternative pastures and the sale of all allegedly contaminated sheep. This confusing and frustrating change in directives initiated a cycle of conflict between the farmers and scientists over what would count as valid and reliable knowledge about sheep and contamination that continues today.

The source of the conflict is a melange of factors combining in unexpected ways to create intractable differences between farmers on the one side and government scientists on the other. The first error committed by government scientists was a miscalculation of the type of soil common to the Cumbrian hill country. Their initial 3-week ban was based on the belief that soil in the hills was alkaline based and would therefore trap the radioactivity, preventing it from reaching the grass. While some soil is alkaline based, a good deal of the hill soil is acid peaty based. Acid soil is porous, ensuring that radiocaesium remains mobile and accessible to uptake by plant roots.[26] Rather than admitting their error, however, the government scientists simply recalibrated their conclusions, and the MAFF switched its original 3-week ban to an indefinite ban.

The second error was the unwillingness of government scientists to listen to and accommodate the hard-won expertise of sheep farmers whose local knowledge was essential to the successful management of the problem. The sheep farmers quickly determined that the risk posed by fallout from Chernobyl was compounded by the preexisting problem of a nuclear processing plant operating a few kilometers from the hill country and itself a notorious polluter.[27] In 1957, the Sellafield nuclear reprocessing plant caught fire and released radiocaesium and other radioactive materials, contaminating the surrounding countryside. Farmers believed that fugitive emissions, announced by Sellafield, continued to escape the plant, and wondered aloud whether this might be an additional source of the caesium isotopes contaminating their sheep. Initially, however, the MAFF scientists vigorously defended their assertion that the contaminating isotopes were from the Chernobyl fire, not Sellafield. Local experience caused one farmer to question this assertion, his skeptcism based on his observation that the crescent-shaped radioactive hotspot was located at the same altitude where steam clouds rising from the Sellafield cooling towers hit the mountains.[28]

The sheep farmers' implication of the Sellafield plant in the total load of radioactive isotopes contaminating the hill country sheep was at least partially validated by an important datum that emerged over a year after the Chernobyl fire. The MAFF scientists were forced to admit that other sources, including Sellafield, accounted for roughly half of the radioactive caesium found in the area.[29] Using commonsense knowledge derived from visual observation and simple reasoning, the hill farmers constructed a more complicated and, in the end, more accurate account of the origins of radioactive fallout in the Cumbrian hills.

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Evaluation and assessment are typically occasions for lively debate: What should be measured? How should it be measured? Who should conduct the measurement? What does a specific measurement mean? Suggested in the controversy over the origins of radiocaesium is the fault line between community ways of knowing and scientific ways of knowing. Experts see risks in the narrow grammar of probabilities and numerical coefficients. Communities, on the other hand, see risks embedded in their ways of life, woven into the cloth of day-to-day routines.[30] Scientists, in other words, think and talk about an environmental problem in one fashion, local community residents think and talk about that same problem in a quite different fashion. Communities identify issues and raise questions that are not part of the scientific approach to the problem, while scientists survey, measure, and calculate what is either irrelevant or unimportant to communities, or worse, perceived as error-ridden and wrong.[31]

Yet over the last several decades, ordinary people have become increasingly vocal about having their own experiences treated as a credible source of knowledge in the decision-making process.[32] Moreover, the National Research Council recently advised against decision-making approaches which treat members of the lay public as simple recipients of scientific knowledge, advocating instead for an approach to knowledge production that brings citizen experiences and knowledge in at the ground floor of problem definition and study design.[33] Community residents are uniquely placed to generate several types of knowledge about local environmental troubles. As outlined by Allan, these include

- Direct observation of a working practice, e.g., of smoke plumes emanating from disposal sites. . . . It is also commonly observed that emissions are more severe at night when formal inspection tends to be limited—the local community is well placed to make such observations.
- [Local observations] that health has been directly affected—as when workers at a neighboring site claimed they are suffering from incinerator emissions or members of a community noted unusual patterns of illness. . . .
- Comparisons with other sites . . . run by the same company or where similar industrial processes are in operation. This can involve the establishment of community networks where groups build upon the experience of others elsewhere.

- Systematic data collection—in one case, through a round-the-clock "toxic watch" recording activities and pollution levels.[34]

This grounded, experiential knowledge is typically viewed by residents as useful in mitigating at least some of the uncertainty surrounding environmental troubles, and indeed, as we saw above in the Cumbria case, may be used as a basis to counter scientific knowledge claims. To provide another example, let's consider the case of 2,4,5-T.[35]

During the 1980s, the herbicide 2,4,5-T was a source of controversy between British regulatory authorities and British farmers. Produced since the 1940s, 2,4,5-T (under its wartime name Agent Orange) acquired a notorious reputation from its use as a defoliant in the Vietnam War. The herbicide is suspected of causing, among other things, chloracne, birth defects, spontaneous abortions, and several types of cancer.

In spite of its less than wholesome reputation, 2,4,5-T was commonly used in Britain. Homeowners used it to control weeds in their gardens. Railway employees sprayed it on tracks to kill troublesome vegetation. Farmers and forestry workers regularly used it to protect crops and clear underbrush.

The British government took the position that the herbicide was safe to use if applied correctly. Its Advisory Committee on Pesticides concluded a review of the scientific literature on 2,4,5-T, proclaiming that it "can safely be used in the UK in the recommended way and for the recommended purposes."[36] The committee acknowledged that the public was concerned, but also pointed out that the public was not informed about the science of the issue.

The committee approached its task as if it were operating in a laboratory, free from outside noise and interferences. Deliberating on the fate of the herbicide as if it existed in a vacuum, the personal experiences of people who really worked with the substance could be safely ignored. The committee claimed that "its own knowledge and experience is backed up by a valuable body of medical and scientific expertise" far more legitimate than ordinary people can discover on their own.[37]

The position of the National Union of Agricultural and Allied Workers (NUAAW), however, approached the herbicide from a quite different epistemic vantage point. For those nonexperts, laboratory studies and literature surveys were inadequate sources of knowledge about their personal experiences with 2,4,5-T. In its report to Britain's Minister of Agriculture, Fisheries and Food, the NUAAW concluded that the personal experiences of people who use 2,4,5-T could not be replicated in the laboratory. "It is the Union's conviction, distilled from the experiences of thousands of members working in forests and on farms, that the conditions envisaged by the Advisory Committee are impossible to reproduce in the field."[38]

In other words, experimental data generated in laboratories cannot reliably predict the seemingly endless personal habits, experiences, serendipitous events, and so on of the seemingly endless number of people who come into contact with this caustic chemical agent. The NUAAW questioned the idea that government and industrial regulators could foresee all the particularities, unusual circumstances, or chance occurrences typically encountered in a normal work environment. Normal or routine from the vantage point of the worker in the field is best captured in Murphy's infamous law. Perhaps the most reliable approach to recommended use instructions is to base an application protocol on the assumption that what can go wrong probably will.

Reflected in this controversy is a more complicated conflict between two quite different ways of knowing, each claiming to be based on instrumental, rational knowledge. Blurring the traditional distinction between layperson and expert, farm and forestry workers are claiming to know something about the use of an industrial chemical that should be the basis for government regulation of the substance. The basis of their knowledge claims is the subjective human experience. For the scientific committee, on the other hand, valid and reliable knowledge in the modern world is the product of experimental science and pointedly not subjective experiences. Laypeople, of course, can trust their senses as sources of knowing. It is simply that when they do so, they cannot claim to know something scientific or medical about themselves or their world. Or so the advisory committee argued.

For the farm and forestry workers, however, professional scientific knowledge is incoherent, unable to account for their personal experiences. The conflict, it seems, is between a local, concrete knowledge based on systematic observation and analysis and a remote abstract knowledge based on experimental design and statistical coefficients. Such local, practical knowledge has always existed, of course; what is new is the public's role in challenging the validity and reliability claims of institutional science.

The problem between community knowledge and scientific knowledge is more than the different stances each takes toward what should count as important to know about an environmental problem. It is also the problem of *power*. The fact is that corporate or government scientists typically exercise jurisdiction over environmental questions. This jurisdiction is expressed in the capacity of institutional science to both set the agenda of research, deciding what variables will and will not be included in analysis, the size of the study population, and so on, and to control the expressive arena for the dissemination and discussion of the data.[39] Despite the call for changes from the National Research Council and similar groups, official science almost always enjoys both the first and the last word. Community ways of knowing might receive a hearing but are unlikely to be incorporated into the scientists' methods, studies, or reports. Indeed, knowledge claims by local people are more likely to be viewed by government or corporate researchers as "spurious" or "anecdotal," as seen in the following example.

As readers may recall from previous chapters, Centralia is a small town in northeast Pennsylvania plagued by a fire burning out of control in the mazeway of underground shafts and passageways constructed to mine anthracite coal. At a meeting between community residents and mine engineers, experts observed that a significant problem in abating the fire was the absence of good maps showing the exact locations of the shafts and passageways underneath the town. At this juncture a middle-aged man in the audience stood up and offered the following counsel: "Of course those maps are worthless, they were made to get mining permits not map the real ground below. You had to have them. But I'll tell you, I have walked under this town for fifteen years. I know where the air is getting in to feed the fire and the location of the tunnels carrying the fire. I'll work with you if you want." The mining engineer in charge of the meeting thanked the man and noted that "it was getting late. I wonder if there are any more questions."[40]

Illustrated in this brief exchange is the voice of power silencing an alternative, and presumably rational, approach to acquiring sorely needed information. In this exercise in power, two ways of knowing the world fail to collaborate on a solution to a complex environmental hazard. Mining engineers remain puzzled and the mine fire a riddle with no apparent solution. The retired miner knew something about the fire and offered to join his local expertise with the expertise of the scientists. Together, perhaps, a solution could be found. It is true, of course, that community expertise without mining engineering is not sufficient to mount a successful project to extinguish or abate the fire. But common sense suggests that mining engineering without the assistance of local knowledge would continue to propose solutions that prove both expensive and unworkable. Exercising their institutional authority to pick and choose what knowledge would count as useful in solving the riddle of the mine fire, the engineers chose to ignore the retired miner. The Centralia mine fire has burned for over 30 years with no end in sight.

As the several cases presented in this section illustrate, sometimes residents advance their own local knowledge, couched in fairly mundane terms, to counter the scientific claims of powerful social actors such as corporations and government agencies. Activists have learned, however, that their efforts are likely to be more successful if their claims are cloaked in the technocratic language of expertise. As a result, groups and organizations are unhinging the languages of expertise from expert systems, taking them into their communal worlds, tinkering with them sufficiently to make rational sense of their miseries, and appealing to significant institutional others based on a rhetoric of community rationality.

Ordinary people are fusing a moral appeal to safe or healthy environments with a popular appropriation of expert knowledge to make a particularly pervasive claim on institutions to change or modify behaviors and policies. It is one thing for a young woman cradling an infant to appeal to a government hearing board in the language of home, hearth, and children, for example; it is quite another when this same woman clutches her child to her breast and talks in the complicated language of toxicology, discussing the neurotoxic or teratagenic effects of boron or dichlorotetrafluoroethane on her child's cognitive development.

In such cases, people are doing more than relying on a rhetoric of civil rights or environmental justice, as important as these appeals are; citizens are also arming themselves with the lingual resources of toxicology, environmental impact assessment, biomedicine, risk inventories, nuclear engineering, and other instruments of reason. The emergence of citizen science to challenge the assertions of a corporate- or government-sponsored science is a key flash point in local environmental controversies.[41] One type of citizen science sometimes found in exposure disputes is that of popular epidemiology.

Defined as a "process by which laypersons gather scientific data and other information and also direct and marshal the knowledge and resources of experts," popular epidemiology challenges the paradigm of conventional epidemiology, accusing it of failing to identify anything but the most gross environmental origins of disease.[42] Emotionally and technically charged questions about environments and health are often beyond the purview of conventional epidemiology. "Are we in an environment in which invisible contamination is present? Is this contamination actually being absorbed by body tissue? Is the absorbed dose dangerous?"[43] Increasingly, communities are resisting state- and corporate-sponsored epidemiology, arguing for the validity and reliability of their own, homegrown version. Let's return to the case of 2,4,5-T.

For the NUAAW, statistical rates of such health problems as chloracne and miscarriages were unable to account for why a neighbor was inflicted with painful skin rashes after using the herbicide or why a woman whose husband carried chemical residue home on his clothes spontaneously aborted what appeared to be a healthy fetus. The frequency of these personal, nonstatistical experiences prompted the NUAAW to sponsor a survey among its membership to discern what laypeople knew about how to apply the herbicide and how to avoid physical contact with it or its gaseous vapors. Additional questions included frequency of use and symptoms after use. A total of 40 questions were asked.

In addition to the survey results, the report, which was submitted to Britain's Minister of Agriculture, Fisheries and Food, also included 14 case studies of people who suffered from medical problems after being exposed to the herbicide. In developing its case studies, the NUAAW relied on medical records, family histories, and employment records documenting contact with the herbicide. The intention was to "establish the level of exposure involved and the scale of alleged effects" for each case.[44]

The NUAAW constructed its own standard of validity to oppose the tests of significance clusters relied upon by the committee's experts. Based on its survey and case study data, the NUAAW proposed a principle for assessing the particular danger associated with the use of potentially risky substances. The concept, "balance of probabilities," was introduced as a reasonable approach to the inherent difficulties in foreseeing all of the ways in which 2,4,5-T would be used in mundane, uncontrollable situations.

The balance of probabilities test asked the British government to consider how the herbicide is used in local settings and to make a reasonable determination whether or not it is possible to control for all the contingencies and unexpected, chance events in applying the chemical. Note their reasoning:

> In our view the decision to ban the herbicide has to be made on the balance of probabilities. . . . [W]here lives are at stake a responsible body cannot wait, as was the case with asbestos, until there is a sufficiently impressive death toll.[45]

The NUAAW's appeal to the British government for the right to work in a safe environment is based on an accounting of personal experience, mundane or practical knowledge, and its own sociomedical study. Making epidemiological knowledge is often critical to forging a timely and medically judicious approach to environmental contamination. But making this knowledge is not the straightforward process it seems. Citizens whose health and well-being are at stake in these cases are rarely passive when faced with epidemiological studies that seem to be asking the "wrong" questions, attending to "insignificant" facts, and harping on unsound "standards of proof." More important, as this case illustrates, their responses might include conducting their own epidemiological studies.

Box 4.4 is a summary of the key issues identified in the study of uncertain knowledge, environmental troubles and community conflict viewed from the vertical axis. We turn our attention now to the other axis along which knowledge disputes develop.

Box 4.4 Adding to the Portfolio: The Vertical Axis of Knowledge Disputes

1. Are local residents questioning the veracity of expert (scientific) claims?
2. Do community residents advance their own local knowledge about environmental conditions?
3. Are experts willing to consider the potential validity of local knowledge, or do they summarily dismiss it as "anecdotal" and "spurious"?
4. Are residents appropriating the language of expertise to incorporate into their own local claims?
5. Do local residents conduct any popular epidemiological investigations?

The Horizontal Axis of Knowledge Disputes

The Chicago Wilderness Controversy

The words *Chicago* and *wilderness* might at first glance appear unsuited for one another. Chicago, after all, is the third largest city in the United States. What on earth could it have to do with wilderness? A good deal actually, as we will see, and much of it contentious.[46]

In the early 1900s, reflecting the progressive politics of the time, Illinois set aside 98,000 acres of municipal Chicago land as legally protected forest preserve. More important, "these preserves were not conceived as city parks, but as wild land preserves with a conservation mission."[47] In 1996 a new initiative was launched in Chicago. Dubbed "Chicago Wilderness," this project seeks to restore more than 200,000 acres in and around the city to its pre-European historical state of tall grass prairie. Dozens of local citizens were "trained" to recognize the flora and fauna from different historical periods and to work to enhance their growth while limiting and eliminating the growth of other species. The project met with considerable opposition from other citizens who placed a high value on the aesthetic and environmental utility of the contemporary landscape.

Ecological restoration, as the name implies, seeks to reclaim deteriorated or extinct ecosystems, re-creating what once was, or at least thought to be. Preservation, on the other hand, signals a quite different stance toward the environment. To preserve is to protect an existing ecosystem, to shield it from alteration and change. The restorationists assumed their vision of the future Chicago was a landscape reminiscent of a time long past and one worth reconstituting. More important, they made their arguments using both ecological and emotional appeals. The other faction, the preservationists, argued to the contrary that ecologies are not so much historical as they are contemporary, evolving systems that require nurturing, not wholesale reversion to some arbitrary point in the past. They too made their arguments in both the languages of ecology and emotions. The Chicago Wilderness Project quickly became an emotional dispute among the citizens of Cook County over the definition of "nature and science."[48]

By 1996 most of the flora and fauna present during the pre-European settlement history of this region was extinct or near extinction. Only in a few archipelagoes spared from the plow and the backhoe were found the original prairie and tall grass savannahs characteristic of the 18th-century Midwest. The Chicago Region Biodiversity Council (CRBC) announced in April of 1996 that it was sponsoring a major restoration initiative to reconstruct the ecosystem the early settlers encountered more than 200 years ago. The CRBC is an umbrella organization representing more than 90 local groups interested in restoring and protecting Chicago's wilderness. Two of its member groups, the Nature Conservancy and the Volunteer Stewardship Network (VSN), trained citizen volunteers in the science of restoration ecology. These trainees thought of themselves as citizen experts experienced in identifying flora and fauna and their appropriate ecological niches.

Ecosystem restoration, however benign and nurturing it might sound, is often a source of local conflict. For some of Chicago's residents, restoration meant clear-cutting woodlands they had lived beside for years. Restoration and destruction, in other words, go hand-in-hand; before the past can be re-created, the present must first be eradicated. For people who enjoyed the existing landscape, protecting the "natural areas" of woods and parks from restoration efforts made sense. By the fall of 1996 at least three citizen opposition groups had emerged: the Association of Let Nature Take its Course, Trees for Life, and the Voice for Wilderness.[49]

Among the tactics of the preservationists in their struggle with the restorationists was calling the claims of the citizen experts into question. A leaflet distributed by members of Trees for Life, for example, exclaims: "How are these amateurs experts?! They have no formal training or credentials!"[50] But more than questioning the legitimacy of credentials fueled this conflict. Preservationists questioned the science of the restorationists. A student of this controversy writes:

> During the painful growth period, when VSN [Volunteer Stewardship Network] attempted to establish themselves as expert "knowers" of the land, criticism was focused on just what made these lay volunteers favored members of the public who could create privileged stories about the local landscape's condition and needs.[51]

"Data wars" broke out between Chicago's preservationists and restorationists.[52] Restorationists claimed a specialist knowledge, won by hands-on training, of the area's contemporary and pre-European flora and fauna. From the perspective of the restorationists, area residents who did not educate themselves in the science of restoration "could not be expert knowers of the land or be in a position to justifiably pass judgement on restorationists."[53] For many preservationists, on the other hand, restoration science is at best misleading, and at worst, a risk to humans and wildlife. As one critic noted:

> [I]t sounds wonderful to say, "We're going to restore those woodlands . . ." Restoration doesn't sound like "We are going to cut down 158 black cherry trees . . ." [Restoration] includes girdling trees . . . burns that create pollution . . . and loss of some wildlife.[54]

Restorationists and preservationists in Chicago still cannot agree on a scientific definition of ecosystem, on what are truly "native" and "foreign" flora, what is a true "forest canopy," and so on. "Neither side can step outside the limits of its commitment to differing concepts of appropriate science."[55]

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The boundary disputes between citizens and experts over what will count as valid and reliable knowledge of local environmental troubles is often a source of marked and obdurate conflict. But this vertical pattern often occurs in tandem with another, more problematic, pattern of conflict. Residents of a town or neighborhood can find *themselves* in disagreement over the appropriate rational or scientific response to an environmental puzzle or danger. To understand the reasons for this, we need to examine both the useful distinction between Arcadian and historical communities and the continuation of ambiguity into the local level. Let's begin with the first of these tasks.

There are at least two meanings of the word *community*, and they are often confused. One meaning is grounded in the romantic, sentimental notion of the Arcadian community. Tranquility, peace, and harmony prevail here. We find the Arcadian community in film and literature (see, for example, Wordsworth's *Evangeline*). A second meaning is grounded in the blunt, enduring politics of everyday life where understanding is countered by misunderstanding, giving by taking, solidarity by alienation; in short, the historical community. As we specified in Chapter 2, communities do not enter into local environmental controversies as blank slates, but rather bring with them tools and liabilities from the past. It is useful here to extend this discussion. Historical communities may aspire to be more Arcadian, or they may romanticize a past they thought was more Arcadian. Actual historical communities, however, do not conform to the romantic notions of peace, harmony, and fellowship (though, of course, communities do differ in terms of how close or how far they fall from this ideal). Dissent, difference, opposition, and objection are among the prosaic realities of life lived in the company of others.

The idea of the historical, political community prepares us to expect to find differences *within* communities regarding how, in fact, environmental issues should be considered, indeed thought about. Combine the real politic of historical communities with the often confusing, perplexing character of environmental troubles, and it is not difficult to imagine a local public unable to reach consensus on the scope and degree of their troubles and what should be done about them, if anything.

There is one moment or event, however, in which the historical community does become something akin to the Arcadian ideal: the immediate aftermath of an acute natural disaster. Students of natural disasters point to the emergence of "therapeutic communities" in the wake of hurricanes, floods, and other "acts of God."[56] These communities, albeit short lived, are remarkable for their solidarity, cooperativeness, and expressions of empathy. So predictable are the emergence of therapeutic communities following natural disasters that sociologists refer to these types of calamities as "consensus-type" crises.[57] Reason suggests that a consensus is easier to achieve when the evidence of destruction is visible, unavoidable, and incontestable. A tornado touches down and ravages a street, leaving little doubt about damage.[58]

If the strong consensus immediately following a natural disaster is based in part on irrefutable evidence of destruction, perhaps the strong dissensus accompanying many local environmental troubles is based, at least in part, on the equivocal, ambiguous, contentious quality of much environmental evidence. People share a sensorial connection to visible, tangible physical destruction. Most environmental questions and issues, however, require cerebral, abstract, deductive connections that invite different points of view and opposing conclusions. Several studies of local environmental controversies point to the role of uncertain knowledge in creating community divisiveness.

The equivocal evidence of chemical contamination at Love Canal, for example, encouraged the emergence of three grassroots groups, each organized around a different "scientific" perception of the amount and kind of risks posed by the contaminants.[59] Similarly, seven local protest groups emerged in the wake of the radiation accident at Three Mile Island, each lobbying for a different assessment of the problems posed by the contamination.[60] Asbestos contamination in Globe, Arizona, split a community. "The nonvictimized" evaluated the evidence of risk far differently from their neighbors whose houses and yards were registering high rates of fiber exposure.[61]

As we saw in the Chicago Wilderness controversy, citizens in these cases differed over the validity and reliability of their respective claims to expertise. Complicating the vertical conflicts between citizen experts and corporate or government experts, horizontal disputes are waged between citizen groups who argue for the truth value of their specific expertise. Neighbors face one another as competing "experts."

Horizontal axis conflict can occur in tandem with vertical axis conflict. Citizen groups organized around varying explanations of an environmental issue or trouble are likely to find allies in extra-local organizations who are promoting an interpretation similar to their own. This occurred in the controversy between the restorationists and the preservationists in the Chicago Wilderness Project. The two contentious positions on the development of Chicago's open spaces found support in a variety of state and national organizations promoting either restoration or preservation. Ambiguity, uncertainty, and disagreements among the experts can spill over into the local arena.

At the horizontal level, disputes over what are valid ways of knowing local environmental problems can quickly slide into personal invective. In their study of Love Canal, for example, Fowlkes and Miller report:

> For the most part . . . families that believe that chemical migration was of limited seriousness do not so much marshal a body of evidence in support of their position as they discredit any and all claims that migration [was] widespread. They discredit those claims by categorically discrediting the people who make them.[62]

Indeed, we suspect the emotional intensity of horizontal axis conflicts is higher than those typically found in vertical axis disputes. Perhaps this is because the varying stakes in these disputes are experienced as threatening the preservation of the historic community and perhaps ripping apart any pretense to Arcadian tranquility. If my mundane reasoning leads me to conclude that the local water is potable, my neighbor who concludes it is contaminated might be seen as a threat to my way of life.

Readers can find a summary of the major highlights raised in this section in Box 4.5.

Box 4.5 Adding to the Portfolio: The Horizontal Axis of Knowledge Disputes

1. How ambiguous are the signals about environmental initiatives or troubles?
2. Do some residents join forces (form grassroots groups) to launch organized attacks on other residents' knowledge claims?
3. Do local residents disagree over who among them can authoritatively speak on (claim to be an expert on) knowledge issues?
4. Are disagreements among outside experts carried over into disagreements among contending factions of local residents?
5. Do local residents use personal attacks to discredit contending knowledge claims made by other residents?

A Concluding Word

Students of local environmental conflicts will almost inevitably encounter the complex problem of uncertain knowledge and dissension. Look for this conflict in both its vertical and horizontal expressions. A local citizen-based knowledge is likely to differ in significant ways from the knowledge of corporate and government scientists. Combining observation and experience with a calculating reasoning, citizens "know" their local environment in a quite different manner than the hydrologist, biologist, or epidemiologist sent to study their backyards. Local conflicts which incorporate both horizontal and vertical struggles over the certainty of competing knowledge claims are especially complicated and dynamic, and worthy of serious investigation.

Knowledge claims represent the cerebral side of environmental conflicts, though they may sometimes be joined with emotional appeals or become conflated with other issues. Especially along the vertical axis, science brings to disputes the language of rationality and the belief in an obdurate external reality which (at least from the scientific worldview) is theoretically capable of being studied, measured, and ultimately known. These underlying assumptions provide the milieu in which discussions about knowledge claims occur, and at least provide an impetus toward objectivity and emotional distance even in situations characterized by extreme ambiguity.

In the following chapter we shift our attention from the cerebral to the emotional side of local environmental conflicts. Disputes over justice, fairness, and values cannot be settled by even the pretense of an appeal to empirical conditions; the burning issues here deal not with questions of *what is* but rather *what should be.* While there are many aspects of local environmental conflicts which fuel anger, hostility, frustration, and outrage, there is probably nothing that can more quickly lead to volatile emotional responses than local residents' perceptions that they are being treated in an unjust manner.

STUDENT EXERCISES

1. Go back to one of the case vignettes presented in previous chapters. Imagine you are employed by a government regulatory agency charged with making key decisions in the case (for example, whether or not to allow timber to be harvested, how to clean up a contaminated site, whether or not to grant discharge permits, or whether or not to proceed with the construction of a dam). Write a report for your supervisor about what type of scientific investigations need to be conducted in this case. In other words, what kinds of information does the agency need to know before rendering its decision? To the best of your ability, specify which kinds of disciplinary specialists (e.g., toxicologists, hydrologists, economists) would be needed to conduct these investigations.
2. Imagine that you work for a national environmental organization and you have been sent to collaborate with community activists trying to get something done about local groundwater contaminated by a manufacturing plant. Both the corporation which owns the plant and the state Department of Public Health maintain that the toxins in the water are at levels too low to be a threat to public health. How would you help local residents go about launching an attack on the corporate and government scientific investigations used to back up claims of limited risk?

Notes

1. Thoreau (1952), 310–311.
2. Case material from Yaffee (1994).
3. Kline (2000); Gottlieb (1993).
4. *Selected Environmental Law Statutes* (1995), 126.
5. Ibid., 127.
6. This act was first passed in 1966, but without the regulatory teeth of the 1973 version.
7. *Selected Environmental Law Statutes, 1995–1996 Educational Edition* (1995), 156.
8. Yaffee (1994), 12–13.
9. Ibid., 24.

10. Ibid., 53.
11. Ibid., xvii–xix.
12. Ibid., 171.
13. Fowlkes and Miller (1982), 44.
14. Endocrine disrupters would also lend support to this suspicion; see Colborn, Dumanoski, and Myers (1997).
15. Harte, Holdren, Schneider, and Shirley (1991).
16. Busch, Tanaka, and Gunter (2000).
17. Dobbs (2000).
18. Beck (1995).
19. Clarke (1999).
20. Maples and Snell (1988), 19.
21. Weisaeth (1991), 53.
22. Case material from Wynne (1992, 1996).
23. Wynne (1992, 1996).
24. Weisaeth (1991), 54.
25. Wynne (1996), 62.
26. Wynne (1996), 64.
27. Wynne (1996); McSorley (1990).
28. Wynne (1992).
29. Wynne (1992).
30. Freudenburg (1988).
31. Stern and Fineburg (1996).
32. Glazer and Glazer (1998).
33. Stern and Fineburg (1996).
34. Allan (1992), 4; as summarized in Irwin (1995), 119.
35. Case material from Irwin (1995).
36. Irwin (1995), 17.
37. Ibid., 112.
38. Ibid., 113.
39. The second and third dimension of power, as discussed by Lukes (1974).
40. Kroll-Smith and Couch (1990), 146.
41. Couch and Kroll-Smith (1997).
42. Brown (1991), 135.
43. Vyner (2000), 32.
44. Irwin (1995), 20.
45. Ibid., 21.
46. Case material from Alario (2000) and Helford (2000).
47. Alario (2000), 491.
48. Helford (2000), 125.
49. Alario (2000).
50. Helford (2000), 125.
51. Ibid.
52. Alario (2000).

53. Helford (2000), 126.
54. Quoted in Helford (2000), 136.
55. Helford (2000), 137.
56. Mileti, Drabeck, and Haff (1975).
57. Quarantelli and Dynes (1976).
58. Couch and Kroll-Smith (1985).
59. Levine (1982).
60. Walsh (1981).
61. Kasperson and Pijawka (1985).
62. Fowlkes and Miller (1982), 6.