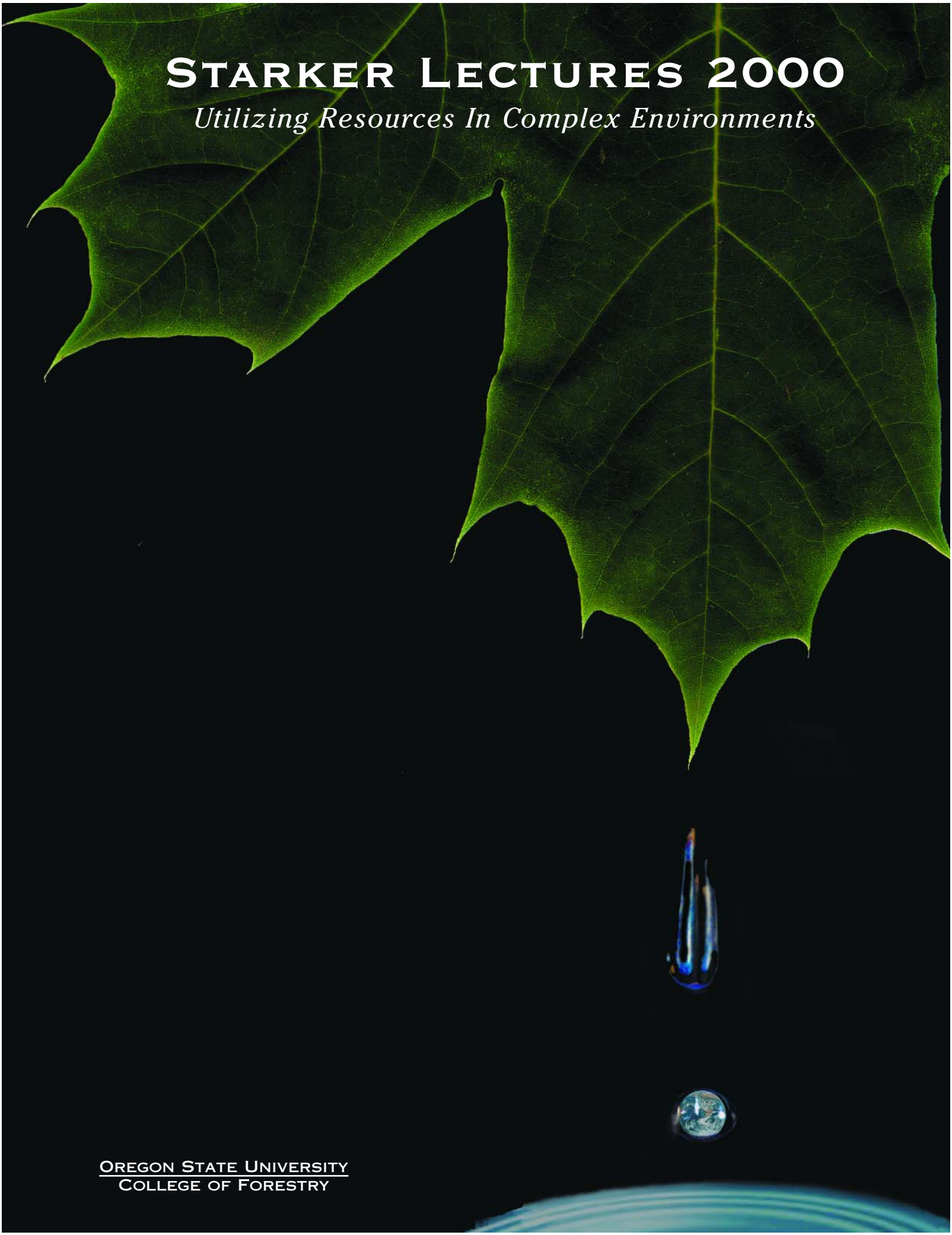
Starker Lectures 2000

Utilizing Resources In Complex Environments



Oregon State University
College of Forestry

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compiled by B. Shelby and S. Arbogast

Foreword

Natural resources are a crucial part of our world. This year's Starker Lectures theme, "Utilizing Resources in Complex Environments," offers a unique attempt to look at complex resource issues. Our speakers come from a variety of backgrounds and offer diverse and thoughtful views.

This lecture series requires a major effort on the part of the Starker Lecture Committee. I thank Tom Adams, John Bliss, Phil Humphreys, Jeff McDonnell, and Sandie Arbogast for the dedication and creativity that turned disparate ideas into a coherent theme and an outstanding group of speakers.

Manuscripts were edited by Rosanna Mattingly, PhD, Portland, OR, and designed by Sandie Arbogast, Forestry Communications Group.

We recognize the encouragement and commitment of College of Forestry administrators, students, and friends who support the lectures.

Dedication

T. J. Starker

Bruce Starker

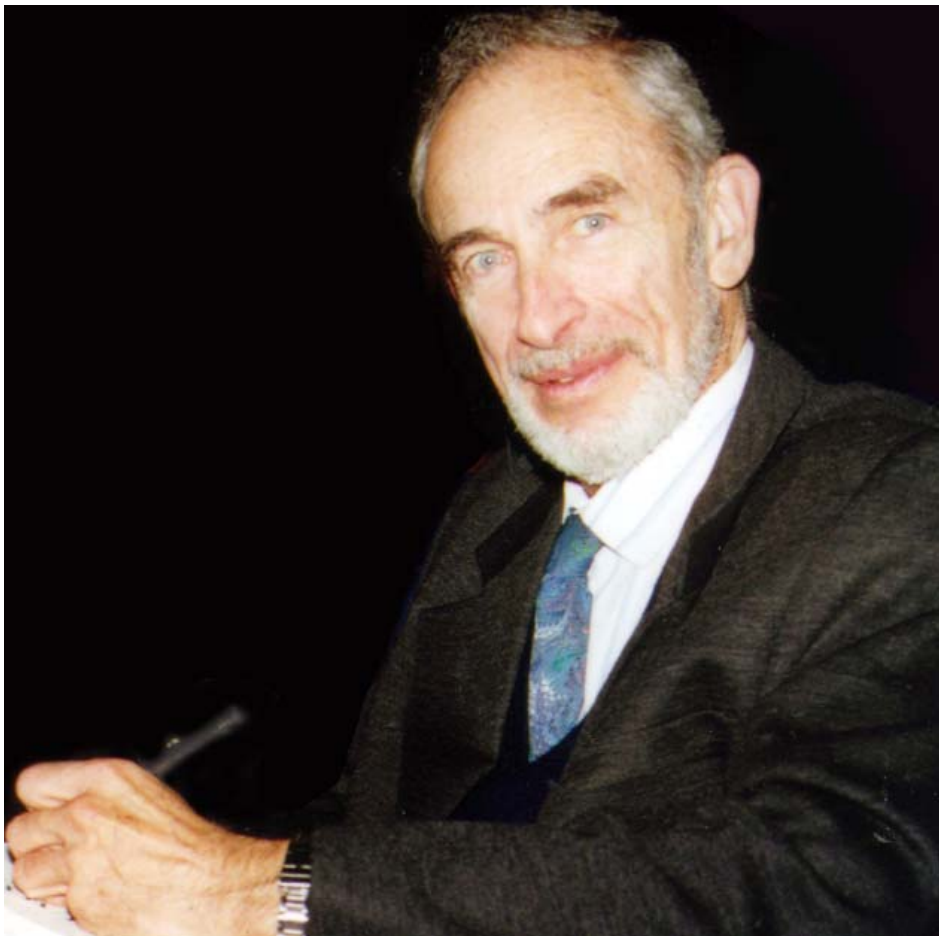
Thurman James Starker, known to all as T. J., was born in Kansas and spent his childhood in Burlington, Iowa. He moved with his family to Portland in 1907 and began working in and studying forestry. T. J. graduated in the first class of foresters at Oregon Agricultural College (OAC), now Oregon State University, in 1910. He then studied two years for an MS degree in forestry at the University of Michigan and returned to Oregon to work for the USDA Forest Service. Subsequent employment with the forest-products industry and a variety of summer jobs while he was teaching forestry at OAC/Oregon State College (OSC), gave T. J. broad and thorough experience in all aspects of forestry.

In 1936, T. J. began purchasing second-growth Douglas-fir land, the beginnings of Starker Forests. Through his work experiences and teaching forest management, T. J. had a major influence on sound forestry and community development in Oregon.

Bruce Starker studied forestry at OSC, earning a bachelor's degree in 1940 and an MS in 1941. After service with the Coast Guard, Bruce joined his father, T. J., in acquiring and managing Oregon forest land, always with an eye for careful management, sound reforestation, and conservation for multiple benefits and values. He worked with private industry and university, state, and federal forestry agencies to improve reforestation and management, and developed taxation systems that improve forest practices. Bruce continued the family tradition of active community service in many ways, including participating in civic activities and regional forestry work and contributing to the Oregon Forest Practices Act.

Forestry in Starker Forests has changed with advances in knowledge, technology, and public environmental issues. But the constant value of tending the land remains unchanged. The community spirit and sound progressive forestry of T. J. and Bruce Starker continue today.

Paul Ehrlich



The Tangled Skeins of Nature and Nurture in Human Evolution*

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The Tangled Skeins of Nature and Nurture in Human Evolution

When we think about our behavior as individuals, "Why?" is a question almost always on the tips of our tongues. Sometimes that question is about perceived similarities: why is almost everyone religious; why do we all seem to crave love; why do most of us like to eat meat? But our differences often seem equally or more fascinating: why did Sally get married although her sister Sue did not, why did they win and we lose, why is their nation poor and ours rich? What were the fates of our childhood friends? What kinds of careers did they have; did they marry; how many children did they have? Our everyday lives are filled with why's about differences and similarities in behavior, often unspoken, but always there. Why did one of my closest colleagues drink himself to death, whereas I, who love wine much more than he did, am managing to keep my liver in pretty good shape? Why, of two very bright applicants admitted to our department at Stanford University for graduate work, does one turn out pedestrian science and another have a spectacular career doing innovative research? Why are our natures often so different, and why are they so frequently the same?

The background needed to begin to answer all these *whys* lies within the domain of human biological and cultural evolution, in the gradual alterations in genetic and cultural information possessed by humanity. It's easy to think that evolution is just a process that sometime in the distant past produced the physical characteristics of our species but is now pretty much a matter of purely academic, and local school board, interest. Yet evolution is a powerful, ongoing force that not only has shaped the attributes and behaviors shared by all human beings but also has given every single individual a different nature.

A study of evolution does much more than show how we are connected to our roots or explain why people rule Earth—it explains why it would be wise to limit our intake of beef Wellington, stop judging people by their skin color, concern ourselves about global warming, and reconsider giving our children antibiotics at the first sign of a sore throat. Evolution also provides a framework for answering some of the most interesting questions about ourselves and our behavior.

When someone mentions evolution and behavior in the same breath, most people think immediately of the power of genes, parts of spiral-shaped molecules of a chemical called DNA. Small wonder, considering the marvelous advances in molecular genetics in recent decades. New subdisciplines such as evolutionary medicine and evolutionary psychology have arisen as scientists have come to recognize the importance of evolution in explaining contemporary human beings, the network of life that supports us, and our possible fates. And the mass media have been loaded with stories about real or imagined links between every conceivable sort of behavior and our genes.

Biological evolution—evolution that causes changes in our genetic endowment—has unquestionably helped shape human natures, including human behaviors, in many ways. But numerous commentators expect our genetic endowment to accomplish feats of which it is incapable. People don't have enough genes to program all the behaviors some evolutionary psychologists, for example, believe that genes control. Human beings have something on the order of 100,000 genes, and human brains have more than one *trillion* nerve cells, with about 100–1,000 trillion connections (synapses)

between them. That's at least one *billion* synapses per gene, even if each and every gene did nothing but control the production of synapses (and it doesn't). Given that ratio, it would be quite a trick for genes typically to control more than the most general aspects of human behavior. Statements such as "Understanding the genetic roots of personality will help you 'find yourself' and relate better to others" are, at today's level of knowledge, frankly nonsensical.

The notion that we are slaves to our genes is often combined with reliance on the idea that all problems can be solved by dissecting them into ever smaller components—the sort of reductionist approach that has been successful in much of science but is sometimes totally unscientific. It's like the idea that knowing the color of every microscopic dot that makes up a picture of your mother can explain why you love her. Scientific problems have to be approached at the appropriate level of organization if there is to be a hope of solving them.

That combination of assumptions—that genes are destiny at a micro level and that reductionism leads to full understanding—is now yielding distorted views of human behavior. People think that coded into our DNA are "instructions" that control the details of individual and group behavior: that genetics dominates, heredity makes us what we are, and what we are is changeable only over many generations as the genetic endowment of human populations evolves. Such assertions presume, as I've just suggested, that evolution has produced a level of genetic control of human behavior that is against virtually all available evidence. For instance, ground squirrels have evolved a form of "altruistic" behavior—they often give an alarm call to warn a relative of approaching danger. Evidence does indicate that this behavior is rooted in their genes; indeed, it probably evolved because relatives have more identical genes than do unrelated individuals. But some would trace the "altruistic" behavior of a business executive sending a check to an agency helping famine victims in Africa, or of a devout German Lutheran aiding Jews during the Holocaust, to a genetic tendency as well. In this view, we act either to help relatives or in the expectation of reciprocity—in either case promoting the replication of "our" genes. But experimental evidence indicates that not all human altruistic behavior is self-seeking—that human beings, unlike squirrels, are not hereditarily programmed only to be selfish.

Another false assumption of hereditary programming lies behind the belief that evolution has resulted in human groups of different quality. Many people still claim (or secretly believe), for example, that blacks are less intelligent than whites and women less "logical" than men, even though those claims are groundless. Belief in genetic determinism has even led some observers to suggest a return to the bad old days of eugenics, of manipulating evolution to produce ostensibly more skilled people. Advocating programs for the biological "improvement of humanity"—which in the past has meant encouraging the breeding of supposedly naturally superior individuals—takes us back at least to the days of Plato, more than two millennia ago, and it involves a grasp of genetics little more sophisticated than his.

Uniquely in our species, changes in culture have been fully as important in producing our natures as have changes in the hereditary information passed on by our ancestors. Culture is

the nongenetic information (socially transmitted behaviors, beliefs, institutions, arts, and so on) shared and exchanged among us. Indeed, our evolution since the invention of agriculture, about 10,000 years ago, has been overwhelmingly cultural because, as we shall see, cultural evolution can be much more rapid than genetic evolution. There is an unhappy predilection, especially in the United States, not only to overrate the effect of genetic evolution on our current behavior but also to underrate that of cultural evolution. The power of culture to shape human activities can be seen immediately in the diversity of languages around the world. Although, clearly, the ability to speak languages is a result of a great deal of genetic evolution, the specific languages we speak are just as clearly products of cultural evolution. Furthermore, genetic evolution and cultural evolution are not independent. There are important "coevolutionary" interactions between them. To take just one example, our farming practices (an aspect of our culture) change our physical environment in ways that alter the evolution of our blood cells.

Not only is the evolution of our collective nongenetic information critical to creating our natures, but also the rate of that evolution varies greatly among different aspects of human culture. That, in turn, has profound consequences for our behavior and our environments. A major contemporary human problem, for instance, is that the rate of cultural evolution in science and technology has been extraordinarily high in contrast with the snail's pace of change in the social attitudes and political institutions that might channel the uses of technology in more beneficial directions. No one knows exactly what sorts of societal effort might be required to substantially redress that imbalance in evolutionary rates, but it is clear to me that such an effort, if successful, could greatly brighten the human prospect.

Science has already given us pretty good clues about the reasons for the evolution of some aspects of our natures; many other aspects remain mysterious despite a small army of very bright people seeking reasons. Still others (such as why I ordered duck in the restaurant last night rather than lamb) may remain unanswerable—for human beings have a form of free will. But even to *think* reasonably about our natures and our prospects, some background in basic evolutionary theory is essential. If Grace is smarter than Pedro because of her genes, why did evolution provide her with "better" genes? If Pedro is actually smarter than Grace but has been incorrectly evaluated by an intelligence test designed for people of another culture, how did those cultural differences evolve? If I was able to choose the duck for dinner because I have free will, what exactly does that mean? How did I and other human beings evolve that capacity to make choices without being complete captives of our histories? Could I have exercised my free will to eat a cockroach curry had we been in a restaurant that served it (as some in Southeast Asia do)? Almost certainly not—the very idea nauseates me, probably because of an interaction between biological and cultural evolution.

Every attribute of *every* organism is, of course, the product of an interaction between its genetic code and its environment. Yes, the number of heads an individual human being possesses is specified in the genes and is the same in a vast diversity of environments. And the language or languages a child speaks (but

not her capacity to acquire language) is determined by her environment. But without the appropriate internal environment in the mother's body for fetal development, there would be no head (or infant) at all; and without genetically programmed physical structures in the larynx and in the developing brain, there would be no capacity to acquire and speak language. Beyond enabling us to make such statements in certain cases, however, the relative contributions of heredity and environment to various human attributes are difficult to specify. They clearly vary from attribute to attribute. So although it is informative to state that human nature is the product of genes interacting with environments (both internal and external), we usually can say little with precision about the processes that lead to interesting behaviors in adult human beings. We can't partition the responsibility for aggression, altruism, or charisma between DNA and upbringing. In many such cases, trying to separate the contributions of nature and nurture to an attribute is rather like trying to separate the contributions of length and width to the area of a rectangle, which at first glance also seems easy. When you think about it carefully, though, it proves impossible.

Diverse notions of inherited superiority or inferiority and of characteristic innate group behaviors have long pervaded human societies: beliefs about the divine right of kings; "natural" attributes that made some people good material for slaves or slave masters; innate superiority of light-skinned people over dark-skinned people; genetic tendencies of Jews to be moneylenders, of Christians to be sexually inhibited, and of Asians to be more hardworking than Hispanics; and so on. Consider the following quote from a recent book titled *Living With Our Genes*, which indicates the tone even among many scientists: "The emerging science of molecular biology has made startling discoveries that show beyond a doubt that genes are the single most important factor that distinguishes one person from another. We come in large part ready-made from the factory. We accept that we *look* like our parents and other blood relatives; we have a harder time with the idea we *act* like them."

In fact, the failure of many people to recognize the fundamental error in such statements (and those in other articles and books based on genetic determinism, such as Richard J. Herrnstein and Charles Murray's famous *The Bell Curve*) is itself an environmental phenomenon—a product of the cultural milieu in which many of us have grown up. Genes do not shout commands to us about our behavior. At the very most, they whisper suggestions, and the nature of those whispers is shaped by our internal environments (those within and between our cells) during early development and later, and usually also by the external environments in which we mature and find ourselves as adults.

How do scientists know that we are not simply genetically programmed automata? First, biological evolution has produced what is arguably the most astonishingly adaptable device that has ever existed—the human nervous system. It's a system that can use one organ, the brain, to plan a marriage or a murder, command muscles to control the flight of a thrown rock or a space shuttle, detect the difference between a 1945 Mouton and a 1961 Latour, learn Swahili or Spanish, and interpret a pattern of colored light on a flat television screen as a three-dimensional world containing

real people. It tries to do whatever task the environment seems to demand, and it usually succeeds—and because many of those demands are novel, there is no way that the brain could be preprogrammed to deal with them, even if there were genes enough to do the programming. It would be incomprehensible for evolution to program such a system with a vast number of inherited rules that would reduce its flexibility, constraining it so that it could not deal with novel environments. It would seem equally inexplicable if evolution made some subgroups of humanity less able than others to react appropriately to changing circumstances. Men and people with white skin have just as much need of being smart and flexible as do women and people with brown skin, and there is every reason to believe that evolution has made white-skinned males fully as capable as brown-skinned women.

A second type of evidence that we're not controlled by innate programs is that normal infants taken from one society and reared in another inevitably acquire the behaviors (including language) and competences of the society in which they are reared. If different behaviors in different societies were largely genetically programmed, that could not happen. That culture dominates in creating intergroup differences is also indicated by the distribution of genetic differences among human beings. The vast majority (an estimated 85 percent) is not between "races" or ethnic groups but *between individuals within groups*. Human natures, again, are products of similar (but not identical) inherited endowments interacting with different physical and cultural environments.

Thus, the genetic "make-brain" program that interacts with the internal and external environments of a developing person doesn't produce a brain that can call forth only one type of, say, mating behavior—it produces a brain that can engage in any of a bewildering variety of behaviors, depending on circumstances. We see the same principle elsewhere in our development; for instance, human legs are not genetically programmed to move only at a certain speed. The inherited "make-legs" program normally produces legs that, fortunately, can operate at a wide range of speeds, depending on circumstances. Variation among individuals in the genes they received from their parents produces some differences in that range (in any normal terrestrial environment, I never could have been a four-minute miler—on the moon, maybe). Environmental variation produces some differences, too (walking a lot every day and years of acclimatization enable me to climb relatively high mountains that are beyond the range of some younger people who are less acclimatized). But no amount of training will permit any human being to leap tall buildings in a single bound, or even in two.

Similarly, inherited differences among individuals can influence the range of mental abilities we possess. Struggle as I might, my math skills will never approach those of many professional mathematicians, and I suspect that part of my incapacity can be traced to my genes. But environmental variation can shape those abilities as well. I'm also lousy at learning languages (that may be related to my math incompetence). Yet when I found myself in a professional environment in which it would have been helpful to converse in Spanish, persistent study allowed me to speak and comprehend a fair amount of the language. But there are no genetic instructions or environmental

circumstances that will allow the development of a human brain that can do a million mathematical calculations in a second. That is a talent reserved for computers, which were, of course, designed by human minds.

Are there any behavioral instructions we can be sure are engraved in human DNA? If there are, at least one should be the urge to have as many children as possible. We should have a powerful hereditary tendency to maximize our genetic contributions to future generations, for that's the tendency that makes evolution work. Yet almost no human beings strictly obey this genetic "imperative"; environmental factors, especially cultural factors, have largely overridden it. Most people choose to make smaller genetic contributions to the future—that is, have fewer children—than they could, thus figuratively thwarting the supposed maximum reproduction "ambitions" of their genes.

If genes run us as machines for reproducing themselves, how come they let us practice contraception? We are the only animals that deliberately and with planning enjoy sex while avoiding reproduction. We can and do "outwit" our genes—which are, of course, witless. In this respect, our hereditary endowment made a big mistake by "choosing" to encourage human reproduction not through a desire for lots of children but through a desire for lots of sexual pleasure.

There are environments (sociocultural environments in this case) in which near-maximal human reproduction has apparently occurred. For example, the Hutterites, members of a Mennonite sect living on the plains of western North America, are famous for their high rate of population growth. Around 1950, Hutterite women over the age of 45 had borne an average of 10 children, and Hutterite population growth rates exceeded 4 percent per year. Interestingly, however, when social conditions changed, the growth rate dropped from an estimated 4.12 percent per year to 2.91 percent. Cultural evolution won out against those selfish little genes.

Against this background of how human beings can overwhelm genetic evolution with cultural evolution, it becomes evident that great care must be taken in extrapolating the behavior of other animals to that of human beings. One cannot assume, for example, that because marauding chimpanzees of one group sometimes kill members of another group, selection has programmed warfare into the genes of human beings (or, for that matter, of chimps). And although both chimp and human genetic endowments clearly can interact with certain environments to produce individuals capable of mayhem, they just as clearly can interact with other environments to produce individuals who are not aggressive. Observing the behavior of nonhuman mammals—their mating habits, modes of communication, intergroup conflicts, and so on—can reveal patterns we display in common with them, but those patterns certainly will not tell us which complex behaviors are "programmed" inalterably into our genes. Genetic instructions are of great importance to our natures, but they are not destiny.

There are obviously limits to how much the environment ordinarily can affect individual characteristics. No known environment, for example, could have allowed me to mature with normal color vision: like about 8 percent of males, I'm color-blind—the result of a gene inherited from my mother. But the influence on many human attributes of even small environ-

mental differences should not be underestimated. Consider the classic story of the "Siamese twins" Chang and Eng. Born in Siam (now Thailand) on May 11, 1811, these identical twins were joined at the base of their chests by an arm-like tube that in adulthood was five or six inches long and about eight inches in circumference. They eventually ended up in the United States, became prosperous as sideshow attractions, and married sisters. Chang and Eng farmed for a time, owned slaves before the Civil War, and produced both many children and vast speculation about the circumstances of their copulations. They were examined many times by surgeons who, working before the age of X-rays, concluded that it would be dangerous to try to separate them.

From our perspective, the most interesting thing about the twins is their different natures. Chang was slightly shorter than Eng, but he dominated his brother and was quick-tempered. Eng, in contrast, was agreeable and usually submissive. Although the two were very similar in many respects, in childhood their differences once flared into a fistfight, and as adults on one occasion they disagreed enough politically to vote for opposing candidates. More seriously, Chang drank to excess and Eng did not. Partly as a result of Chang's drinking, they developed considerable ill will that made it difficult for them to live together—they were constantly quarreling. In old age, Chang became hard of hearing in both ears, but Eng became deaf only in the ear closer to Chang. In the summer of 1870, Chang suffered a stroke, which left Eng unaffected directly but bound him physically to an invalid. On January 17, 1874, Chang died in the night. When Eng discovered his twin's death, he (although perfectly healthy) became terrified, lapsed into a stupor, and died two hours later, before a scheduled surgical attempt was to have been made to separate the two. An autopsy showed that the surgeons had been correct—the twins probably would not have survived an attempt to separate them.

Chang and Eng demonstrated conclusively that genetic identity does not necessarily produce identical natures, even when combined with substantially identical environments—in this case only inches apart, with no sign that their mother or others treated them differently as they grew up. Quite subtle environmental differences, perhaps initiated by different positions in the womb, can sometimes produce substantially different behavioral outcomes in twins. In this case, in which the dominant feature of each twin's environment clearly was the other twin, the slightest original difference could have led to an escalating reinforcement of differences.

The nature-nurture dichotomy, which has dominated discussions of behavior for decades, is largely a false one—all characteristics of all organisms are truly a result of the simultaneous influences of both. Genes do not dictate destiny in most cases (exceptions include those serious genetic defects that at present cannot be remedied), but they often define a range of possibilities in a given environment. The genetic endowment of a chimpanzee, even if raised as the child of a Harvard professor, would prevent it from learning to discuss philosophy or solve differential equations. Similarly, environments define a range of developmental possibilities for a given set of genes. There is no genetic endowment that a child could get from Mom and Pop that would permit the youngster to grow into an Einstein

(or a Mozart or a García Marquez—or even a Hitler) as a member of an isolated rain-forest tribe without a written language.

Attempts to dichotomize nature and nurture almost always end in failure. Although I've written about how the expression of genes depends on the environment in which the genes are expressed, another way of looking at the development of a person's nature would have been to examine the contributions of three factors: genes, environment, *and* gene-environment interactions. It is very difficult to tease out these contributions, however. Even under experimental conditions, where it is possible to say something mathematically about the comparative contributions of heredity and environment, it can't be done completely because there is an "interaction term." That term cannot be decomposed into nature or nurture because the effect of each depends on the contribution of the other.

To construct an artificial example, suppose there were a gene combination that controlled the level of a hormone that tended to make boys aggressive. Further, suppose that watching television also tended to make boys aggressive. Changing an individual's complement of genes so that the hormone level was doubled and also doubling the television-watching time might, then, quadruple some measure of aggressiveness. Or, instead, the two factors might interact synergistically and cause the aggression level to increase fivefold (perhaps television is an especially potent factor when the viewer has a high hormone level). Or the interaction might go the other way—television time might increase aggression only in those with a relatively low hormone level, and doubling both the hormone level and the television time might result in only a doubling of aggression. Or perhaps changing the average *content* of television programming might actually reduce the level of aggressiveness so that even with hormone level and television time doubled, aggressiveness would decline. Finally, suppose that, in addition, these relationships depended in part on whether or not a boy had attentive and loving parents who provided alternative interpretations of what was seen on television. In such situations, there is no way to make a precise statement about the contributions of "the environment" (television, in this case) to aggressiveness. This example reflects the complexity of relationships that has been demonstrated in detailed studies of the ways in which hormones such as testosterone interact with environmental factors to produce aggressive behavior.

The best one can ordinarily do in measuring what genes contribute to attributes (such as aggressiveness, height, or I.Q. test score) is calculate a statistical measure known as heritability. That statistic tells how much, on average, offspring resemble their parents in a particular attribute *in a particular set of environments*. Heritability, however, is a measure that is difficult to make and difficult to interpret. That is especially true in determining heritability of human traits, where it would be unethical or impossible to create the conditions required to estimate it, such as random mating within a population.

Despite these difficulties, geneticists are gradually sorting out some of the ways genes and environments can interact in experimental environments and how different parts of the hereditary endowment interact in making their contribution to the development of the individual. One of the key things they are learning is

that it is often very difficult for genetic evolution to change just one characteristic. That's worth thinking about the next time someone tells you that human beings have been programmed by natural selection to be violent, greedy, altruistic, or promiscuous, to prefer certain facial features, or to show male (or white) dominance. At best, such programming is difficult; often it is impossible.

Today's debates about human nature—about such things as the origins of ethics; the meanings of consciousness, self, and reality; whether we're driven by emotion or reason; the relationship between thought and language; whether men are naturally aggressive and women peaceful; and the role of sex in society—trace far back in Western thought. They have engaged thinkers from the pre-Socratic philosophers, Plato, and Aristotle to René Descartes, John Locke, Georg Wilhelm Friedrich Hegel, Charles Sanders Peirce, and Ludwig Wittgenstein, just to mention a tiny handful of those in the Western tradition alone.

What exactly is this human nature we hear so much about? The prevailing notion is that it is a single, fixed, inherited attribute—a common property of all members of our species. That notion is implicit in the universal use of the term in singular form. And I think that singular usage leads us astray. To give a rough analogy, *human nature* is *to human natures* as *canyon* is to *canyons*. We would never discuss the "characteristics of canyon." Although all canyons share certain attributes, we always use the plural form of the word when talking about them in general. That's because even though all canyons have more characteristics in common with one another than any canyon has with a painting or a snowflake, we automatically recognize the vast diversity subsumed within the category *canyons*. As with *canyon*, at times there is reason to speak of human nature in the singular, as I sometimes do when referring to what we all share—for example, the ability to communicate in language, the possession of a rich culture, and the capacity to develop complex ethical systems. After all, there are at least *near*-universal aspects of our natures and our genomes (genetic endowments), and the variation within them is small in relation to the differences between, say, human and chimpanzee natures or human and chimpanzee genomes.

I argue, contrary to the prevailing notion, that human nature is not the same from society to society or from individual to individual, nor is it a permanent attribute of *Homo sapiens*. Human natures are the behaviors, beliefs, and attitudes of *Homo sapiens* and the changing physical structures that govern, support, and participate in our unique mental functioning. There are many such natures, a diversity generated especially by the overwhelming power of cultural evolution—the super-rapid kind of evolution in which our species excels. The human nature of a Chinese man living in Beijing is somewhat different from the human nature of a Parisian woman; the nature of a great musician is not identical with that of a fine soccer player; the nature of an inner-city gang member is different from the nature of a child being raised in an affluent suburb; the nature of someone who habitually votes Republican is different from that of her identical twin who is a Democrat; and my human nature, despite many shared features, is different from yours.

The differences among individuals and groups of human beings are, as already noted, of a magnitude that dwarf the differences within any other nondomesticated animal species.

Paul Ehrlich

Using the plural, *human natures*, puts a needed emphasis on that critical diversity, which, after all, is very often what we want to understand. We want to know why two genetically identical individuals would have different political views; why Jeff is so loud and Barbara is so quiet; why people in the same society have different sexual habits and different ethical standards; why some past civilizations flourished for many centuries and others perished; why Germany was a combatant in two horrendous 20th-century wars and Switzerland was not; why Julia is concerned about global warming and Juliette doesn't know what it is. There is no single human nature, any more than there is a single human genome, although there are features common to all human natures and all human genomes.

But if we are trying to understand anything about human society, past or present, or about individual actions, we must go to a finer level of analysis and consider human natures as actually formed in the world. It is intellectually lazy and incorrect to "explain" the relatively poor school performance of blacks in the United States, or the persistence of warfare, or marital discord, by claiming that nonwhites are "naturally" inferior, that all people are " naturally" aggressive, or that men are "naturally" promiscuous. Intellectual performance, aggression, and promiscuity, aside from being difficult to define and measure, all vary from individual to individual and often from culture to culture. Ignoring that variance simply hides the causative factors—cultural, genetic, or both—that we would like to understand.

Permanence is often viewed as human nature's key feature; after all, remember, "you can't change human nature." But, of course, we can—and we do, all the time. The natures of Americans today are very different from their natures in 1940. Indeed, today's human natures everywhere are diverse products of change, of long genetic and, especially, cultural evolutionary processes. A million years ago, as paleoanthropologists, archaeologists, and other scientists have shown, human nature was a radically different, and presumably much more uniform, attribute. People then had less nimble brains, they didn't have a language with fully developed syntax, they had not developed formal strata in societies, and they hadn't yet learned to attach worked stones to wooden shafts to make hammers and arrows.

Human natures a million years in the future will also be unimaginably different from human natures today. The processes that changed those early people into modern human beings will continue as long as there are people. Indeed, with the rate of cultural evolution showing seemingly continuous acceleration, it would be amazing if the broadly shared aspects of human natures were not quite different even a million *hours* (about a hundred years) in the future. For example, think of how Internet commerce has changed in the past million or so minutes (roughly two years).

As evolving mental-physical packages, human natures have brought not only planetary dominance to our species but also great triumphs in areas such as art, music, literature, philosophy, science, and technology. Unhappily, though, those same packages—human behavioral patterns and their physical foundations—are also the source of our most serious current problems. War, genocide, commerce in drugs, racial and religious prejudice, extreme economic inequality, and destruction of society's life-support systems are all prod-

ucts of today's human natures, too. As Pogo so accurately said, "We have met the enemy, and they is us." But nowhere is it written that those problems have to be products of tomorrow's human natures. It is theoretically possible to make peace with ourselves and with our environment, overcome racial and religious prejudice, reduce large-scale cruelty, and increase economic equality. What's needed is a widespread understanding of the evolutionary processes that have produced our natures, open discourse on what is desirable about them, and conscious collective efforts to steer the cultural evolution of the more troublesome features of our natures in ways almost everyone would find desirable. A utopian notion? Maybe. But considering progress that already has been made in areas such as democratic governance and individual freedom, race relations, religious tolerance, women's and gay rights, and avoidance of global conflict, it's worth a try.

Question and Answer Session

Ehrlich: What I'm going to do now is to provide a personal opinion on the opinions from the scientific community on this. I think that a moratorium on genetically engineered foods would be very difficult. Of course, we eat genetically engineered foods all of the time. Everything I ate yesterday was genetically engineered by artificial selection. Very serious problems exist with gene transfer. And my own opinion is that all of these things have to be looked at case by case. Transparently, we have to be much more informed in all of these areas than we have had to be previously. The example I like to use is that, around 1928, Dupont discovered chlorofluorocarbons. The motto of the company in those days was, "Better things for better living through chemistry." And chlorofluorocarbons looked exactly like that. When they started using chlorofluorocarbons as working fluids in refrigerators, your life was no longer at stake if the refrigerator sprung a leak. Previous working fluids, like ammonia, were poisonous. It looked like a total win-win for a very inert compound that didn't hurt human beings.

Yet, it was only through a series of lucky interventions that we discovered that chlorofluorocarbons were actually destroying the ozone layer. If they had gone far enough…. Some of you may be old enough to remember the road houses that had toilets with ultraviolet sterilizers over them. Life on Earth would have been just like that, living on a toilet seat under an ultraviolet sterilizer, if we hadn't caught what chlorofluorocarbons were doing.

The lesson is that we've got to be really careful. Some of these technological rabbits pulled out of hats have very noxious droppings, and that could be the case, for instance, with genes and some of the gene transfer. So, I don't think an overall moratorium would be practical, but I do think a great deal of caution is called for.

On the other hand, I think of it as a relatively minor problem compared to many other environmental problems. We have to be very careful, if we're environmentalists, to pick our battles in the right place. There are a whole series of things that are going on that I think are basically ridiculous like, for example, fluoridation—where it's worth getting into the battle.

Question: Dr. Ehrlich, I prepared this question before the lecture, and probably could

glean the answer from your comments, but let me ask you directly. The population of the United States is worsening by the years, yet the public at large seems to be indifferent and the problem has no political traction, as witnessed by the current campaign. What's your opinion as to the reason for this frustrating situation, and what can we do about it?

Ehrlich: Ah…. A simple question…. I think one of the reasons, of course, is that we have such an incredibly diverse society, much more so than many other nations which have successfully instituted various programs of government support of family planning, population control, whatever you want to call it. And there's always the fear in a country that's racist and sexist that, when people say, "We want to control the size of our population," what they really mean is, "We want you 'bad' people"—however defined—"to stop breeding."

I see this, for instance, all of the time in my circle of environmental groups, the issue of whether they want to take up a population issue or the immigration issue. I've seen it actually work counter to spreading the net of the organization. That is, they're also very interested in bringing minorities into the organization. Minorities are scared for good reason. So, I think that's a major source of the problem.

What Anne and I normally say on the issue in general, including immigration, is that scientifically it would be of great benefit to the United States to have a slowly shrinking population. The issue of whether you achieve this by much more of a reduction of our birth rate or by reduction of immigration rates is really an issue for social discussion and choice. I think you can see arguments in both directions. The main point is that, if you want to have that, the number of births plus immigrants has to be smaller than the number of deaths plus emigrants.

It's a tough issue. It's tougher in the United States, both because of our diversity, and because of the fact that we utilize the entire world to support ourselves. We're very effective at doing this. Therefore, the more serious impacts of the population of the United States are not as visible to us as they might be otherwise, and that's another serious part of the problem. It is the most serious population problem in the world. We are the third largest country and, of all the large countries, we have by far the highest level of per capita consumption. So, the pressure we put on the resources and life-support systems of the planet are just horrendous. The other issue, of course, is that we don't have any political leadership, in part because of post-Watergate laws. We've designed a country where somebody who is smart and honest can never run for higher office.

So, we're in deep trouble, and we have to look at our governments' institutions, I think, much more closely. I was involved 30 years ago in an attempt at the Center for Democratic Institutions to create a modern constitution of the United States. And the conclusion of the study was, "Forget it." That was based on two things. One, the document we already have is a wonderful document. Nobody argues about that. It has certain aspects that aren't really very good for the current times. Second, if you did want to get a new constitution for the United States, you'd have to have a constitutional convention.

What became crystal clear is that you would have a bloody battle ground on issues of, not governance of the United States, but gun control, abortion, the death penalty, things like

that, which would make the whole thing dissolve. So, we decided we'd better leave it the way it is. We have serious government problems in this country. We're really stuck on how to deal with it.

Question: You may have already answered this question somewhat, but I was just curious if you cared to elaborate on the ethics of having two children or fewer, which you mentioned earlier.

Ehrlich: Well, again, I think ethics requires a lot of discourse. My own personal view is that the rule in the United States ought to be, for political reasons, to stop at two. Two should be the maximum. On the other hand, if you wanted me to design a society in which we would do the right thing, I think the right thing would be very different. That is, what we want to do is have an average in the United States for the foreseeable future. It ought to be an average of one-and-a-half children. That average could very easily be achieved by many people going childless, which there's huge social pressure against, and a bunch of others, who are particularly good parents, having four or five kids.

In other words, the critical thing is the total fertility rate, not actually how it's achieved. From a point of view of equity and so on, I think the rule ought to be to stop at two. But, again, what is unethical is a push that in any way increases our population size, in my view. An increase is taking away from what our children and grandchildren are going to be able to enjoy, and I don't think we should do that. But, again, that is a personal ethical conclusion, and I don't expect many people to agree.

Question: You talked about the need for ways to discuss ethics around environmental issues. I wonder if you could talk about other ways, especially those that consider the land.

Ehrlich: One of the forums involves universities, and one of the places where we've failed is to get together in most places in interdisciplinary forums, and we should have, in order to discuss these things. I think universities show leadership in a lot of areas along departmental lines, and things like interdisciplinary forums are very difficult to start. It's really a tough, uphill battle.

Another thing is that there is an area in our society where there's emphasis especially on ethics and religion. I don't happen to be religious myself, but this can contribute a lot, particularly if it's done in an open way, realizing that there's going to be differences of opinion. Yet, I wish, for example, that there were many more discussions by the religious communities, and the sociologists and anthropologists and people in general, over the death penalty. Lots of these issues really need to be aired.

Here's an example of where my ethics sort of changed on the spot—a little bit of a cultural evolution. A case which some of you know involves a pair of Siamese twins born in England. They were both going to die, but they could be separated. If they were separated, one would live and one would die. What to do?

The parents, whom I suspect were Catholic—they were said to be from southern Europe—wanted to let the children die. They said it's not moral, not ethical, to kill one to save the other. The doctors, who want to do their technology, of course, wanted to separate the twins and save one. Why let two die when you can save one?

The case is now in the British courts. My first instinct on this was, "I guess I'll go with the doctors. It's a horrible situation, but, if the

choice is two deaths or just one, one's better."

Someone I was discussing this with in the American University of Washington said, "You know, what if they were identical twins, not joined together? What if one had a defective heart and was going to die, and the other had a defective liver and was going to die? Would you kill one and transplant to make the other one whole?"

Curiously enough, although it seems like an almost identical situation, in one case I feel swayed toward the doctors' solution, and in the other case I feel swayed toward the parents' solution. I really don't know what the answer is, but it certainly changed what seemed to me to be a fairly straightforward ethical problem into a much more complicated one.

I think we're running against this all the time in the medical field in particular. One of the most interesting seminars I ever attended was in the early 1960s. A bunch of us got together to discuss the ethics of transplantation, which has become just a horrendous thing. If you need a new kidney, you can go to Hong Kong, pay $50,000, and the Chinese government will take one of the people who are going to be executed and match you with them, shoot them in the back of the head, and give you the kidney. Highly immoral. Is it immoral for them to harvest the organs, which they do regularly, from people who are being executed? Is it immoral to support more and more premature—earlier premature babies who have a higher and higher chance of being burdens on society? Where do you draw the line?

These are not easy issues. But what bothers me more than anything else is that they're not really discussed openly. At least we might be able to open some protocols about who should make the decisions concerning these tough cases. I mean, again, with the Siamese twins, are the doctors who pressure to do more and more high-tech things to keep the kids alive, are you going to support them? I mean, really, these are tough issues, and we haven't approached them—I'm sorry. I didn't mean to give you a sermon.

Question: I was wondering if you could comment on sociocultural evolution, and the use of Hitler as an example on one hand and Stalin on the other. It seems that advertising, institutionalized and driven advertising, and all of the money that goes with it, is an example of sociocultural evolution. It's a huge experiment, yet it's not discussed in the context you're talking of….

Ehrlich: That's exactly correct. It's one of the reasons, as I think I've said, I think we understand a lot about how to solve the population problem. The consumption problem is horrible. The advertising industry is clearly a substantial junket. Yet, when I talk about this with businessmen or people in the advertising field, I often get the response, "Advertising doesn't increase consumption. It just doesn't." I say, "Why, then, are you willing to pay a million dollars for a half a minute during the Super Bowl if you don't believe that advertising increases consumption?" That usually ends the conversation.

But, again, what do we do about it? As you may know, there was more discussion of this 30 or 40 years ago when mass-media advertising first started up than there has been recently. It's an interesting cultural revolution that we've grown to accept in a way that—there are several very prominent books which basically

asked this question of manufacturing demand, manufacturing need, and so on.

To finish this off, I'll give you an even more depressing thought. Psychologists know very well that your feelings of well-being and so on depend on comparisons with others. If you're an Indian villager with an income $10,000 American in a village where the average income is $800 American, you're the richest man or woman in town. If you're in Palo Alto, California, with an income of $10,000 American, you're dead poor. You can barely afford a room in the dog house with no choice of breed to share it with. Depends on your comparative situation.

But what are we doing with our mass media? We are expanding our group when we should have empathy, when we should be feeling kinship. For example, look at the 6 million people who went to Princess Diana's funeral, and the people who are no longer comparing themselves socially to people in the village or in the town. They're comparing themselves to Bill Gates.

That's something powerful intending to drive the system in the wrong direction. So, if we're going to deal with the consumption problem, the only cheery news I can give you is that world-class economists are now involved. They see that it can be a problem, and are thinking about it—although the thinking hasn't gone very far.

You've been very patient.
Thank you.

Winifred Kessler

Sam McGee Meets Club Med: New Challenges for National Forests In Alaska

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and Watershed

Sam McGee Meets Club Med: New Challenges for National Forests in Alaska

Thanks so much for inviting my participation as a Starker lecturer. I am honored by the opportunity to contribute to the legacy of this extraordinary family.

I spent my past seven years in northern British Columbia—a vast, sparsely populated region where people and institutions are heavily dependent on the forest industry. I felt comfortable working with forest issues there because they are so similar to those in southeast Alaska, where I spent the early part of my career. What a surprise it was this year to return to Alaska and find that everything was so different! The changes, while reflecting unique Alaska circumstances, are part of larger forces that are rapidly reshaping relationships among people, land, and natural resources everywhere—and that continually challenge the Forest Service and other land-management agencies.

The Last Frontier

For much of the past century, people were drawn to Alaska because it was one of few remaining, truly wild places where living an independent, subsistence lifestyle was still an option. Adventurous newcomers joined the native peoples who had subsisted on Alaska's natural bounty for countless generations. The solitude and wildness of the place, and the need to harvest one's own food, fuel wood, and building materials, were the very characteristics that attracted the few while repelling the masses. Today, most Alaskans value untrammeled landscapes, peace and quiet, and the opportunity for those who so choose to practice a traditional subsistence lifestyle. The spirit of Sam McGee, the "sourdough" immortalized by poet Robert Service, is very much alive.

Typically, people who do not live in Alaska have a different notion of the "last frontier." They see Alaska as a pristine wilderness to be visited, rather than a place where people actually live and derive their livelihoods. Alaska is widely regarded as a world-class treasure, offering views of wildlife, glaciers, forests, and wild and scenic vistas that are unparalleled elsewhere. Until recently, the opportunity to experience this treasure was accessible primarily to the truly adventurous. This has changed. Today, an infrastructure of travel agencies, cruise-ship lines, ecotourism companies, commercial airlines, and resorts is geared to make Alaska accessible to even the most urban-oriented travelers. Although tourists bring significant wealth to their destinations, they also bring values and behaviors that differ markedly from those of people who call Alaska home. Crowding, convenience, tight schedules, and comfort—even luxury—are well within their concept of an Alaska adventure. Hence, the title of my presentation: *Sam McGee Meets Club Med.*

My talk is based on the observations of a wildlife ecologist who worked on the Alaska National Forests from 1978 to 1986, left for 14 years, and returned this year as director of Wildlife, Fisheries, Ecology, and Watershed. I'll relate to you how things were then, emphasizing the issues that challenged managers 20 years ago. We will then fast-forward to the present. What a difference two decades can make!

Let's begin with a brief overview of the two national forests in Alaska. At 17 million acres, the Tongass National Forest is America's largest. Established in 1908, the Tongass stretches 500 miles along the "panhandle" of Alaska. It consists of a rugged strip of mainland and thou-

sands of islands, all cloaked in rainforest, wetland, alpine meadow, rock, and ice. Although some places, such as Prince of Wales Island, have been extensively logged, about 90 percent of the forest remains roadless and in its original, old-growth condition. For countless generations, the forest's bounty of wildlife, fish, and plant resources supported a rich heritage of native peoples such as the Tlingit, whose language had no word meaning "starvation."

Today the Tongass is managed under the comprehensive Tongass Land Management Plan, completed in 1997 following more than ten years of hard work and contentious debate. This planning experience was unique in that it engaged scientists early-on, and subjected itself to a rigorous peer-review process to ensure that decisions in the plan were consistent with the best available scientific information.

The Chugach National Forest, at 5.6 million acres, is the second largest in the National Forest System, yet only a third the size of the Tongass. Situated in the Gulf of Alaska, it includes Prince William Sound, part of the Kenai Peninsula, and the fabulous wetland ecosystems of the Copper River Delta. The area's dynamic geology was illustrated by a 1964 earthquake of magnitude 9.2 that uplifted land as much as 20 feet and triggered significant hydrological and successional changes that continue today. The original occupants included Chugach Eskimo, Eyak Indians, Kenaitze, and other Athabascan Indian peoples. As on the Tongass, these peoples continue traditions of resource use that go back thousands of years.

From its early days, management of the Chugach always emphasized fish and wildlife conservation. Although intensively gold-mined at some locations, the Chugach never experienced the large-scale logging of the Tongass. A comprehensive Chugach Land Management Plan has been drafted and is awaiting final approval. This plan is also a "pioneer," but for a different reason. It threw the door to public involvement wide open, and allowed interested citizens to work side-by-side with the planners during all stages of development.

Looking Back: Turmoil on the Tongass

Let's turn back the clock to 1978, my first season of fieldwork on the Tongass. Arriving by jet in Ketchikan, Alaska's southern-most city, I was loaded onto a floatplane—the conveyance that substitutes for pick-up trucks in this island-dotted forest—and taken to Cape Pole, a tiny and remote logging camp on Kosciusko Island. Cape Pole consisted of about a dozen scattered trailers (all on huge logs that could be floated away), a tiny school, and a cook shack that doubled as a library. Not counting the black bears that regularly invaded the schoolyard, the residents consisted of women, girls of various ages, and very young boys. I learned that the men and older boys had moved on to the next active logging site, and would live there in company bunkhouses until the season ended.

In many respects, Cape Pole was a typical bush community on the Tongass National Forest. An isolated "company camp," it owed its very existence to the commercial harvest of Tongass timber. The people living there were connected to the outside by marine radio, and little else. The social event of every week was the arrival, on Fridays around midnight, of the *Island Trader*—a small cargo boat that brought supplies to the far-flung bush camps. Gathering

on the dock to check out everybody's stuff was the pinnacle of entertainment.

Back then, field assignments on these islands were referred to as "hardship duty," and the Forest Service took steps to make life more bearable. They allowed use of government trucks and boats during off-duty time, so we could fish the fabulous salmon streams and crab bays, or hunt deer or bear populations that we literally had to ourselves. We would order our groceries by radio, somebody would purchase and box up everything we needed, and these would be delivered by floatplane within a day or two. Hardship duty indeed! To most, it was more like heaven.

My first job in Alaska was to study what happens to forest birds when stands of old-growth rainforest were converted to young second-growth. This was the first of several wildlife-related projects I would become involved in, all tied to the highly controversial timber program on the Tongass National Forest.

Why so much controversy? Three major circumstances fueled the conflict.

First, there was the matter of scale. Essentially all timber harvesting was done by clearcutting large areas in the highest-volume, most easily accessible locations (for example, along shorelines). Although some would argue that clearcutting is inappropriate under any circumstance, it is a particularly poor fit for the coastal rainforest ecosystems of southeast Alaska. The normal forest condition is a continuous cover of big, old trees, which look fairly unbroken from above. It is just too wet for stand-replacing disturbances, such as fires, which in drier forest ecosystems maintain a natural mosaic of forest stands of different ages on the landscape. The disturbance ecology of the coastal rainforest is altogether different. Although stand-replacement events do occur (for example, the occasional windstorm or avalanche), the disturbance ecology is largely driven by processes *within* old forest stands. Individual trees or small groups of trees succumb to wind, disease, or insects—thereby creating gaps in the forest canopy. The gaps are filled quickly by herbaceous plants, shrubs, and young trees, thereby maintaining the patchy, uneven-age structure that is so typical of rainforest ecosystems. The natural appearance and ecology of the land reflect this pattern of extensive, unbroken forest when viewed from afar, and a highly patchy, multiple-layered structure when viewed from within the forest. Clearcutting creates large, even-age patches that dramatically change the appearance and ecological patterns of the landscape.

A second element of the controversy involved the impacts of forest management on wildlife and fish, which are well adapted to the old, structurally complex forests of the coastal rainforest. When logging began in Alaska, many people assumed that wildlife would benefit from the cutting of old forests—as had been found for deer, elk, and moose in forests "down south." To the contrary, as it turned out, the most critical habitats for important wildlife species were the same high-volume stands located along the shore that loggers targeted for harvest. Bald eagles, for example, chose these stands because they provided both large trees to support heavy nests and clear views of the shore area where food arrived on changing tides. Sitka black-tailed deer also required such stands in winter, particularly in deep-snow periods. The big trees kept much of the snow off the ground, where deer could find nutritious, herbaceous plants in the understory. Fisheries also were a huge concern with

respect to logging, as road building and clearcutting were known to increase siltation and otherwise degrade spawning and rearing habitats required by salmon and other fish species.

The third element of the controversy was the unique business arrangement under which the logging was taking place: the Tongass long-term timber sales. From the forest's early years, its big trees were seen as the foundation for establishing a stable economy in southeast Alaska. However, the ruggedness and remoteness severely limited the economics of the timber industry. In the 1950s, a scheme was launched to entice larger companies to locate in southeast Alaska, establish mills, and hire Alaskans—in short, to jump-start the region's economy. Companies were offered long-term contracts for a guaranteed supply of cheap timber in return for establishing mills in southeast Alaska. One such contract went to the Ketchikan Pulp Company, and another to the Alaska Lumber and Pulp Company. In return for building and operating mills in Ketchikan and Sitka, the companies were guaranteed access to 13 billion board feet over 50 years. The plan was to systematically harvest 95 percent of the Tongass old growth to maximize pulp production forever. The deal was modified in 1980 with passage of the Alaska National Interest Lands Conservation Act, which established large areas as wilderness, i.e., off limits to logging. A trade-off was made to favor industry; it included large subsidies for the companies and a mandated harvest level from the areas not set aside as wilderness.

Let's consider these three controversial elements and picture southeast Alaska in the early 1980s. Imagine that you are a tourist from California, traveling the inland passage on a cruise ship. Or perhaps you are a New York investment banker who came for some sea kayaking in southeast Alaska. You see the rainforest broken up by recent, enormous clearcuts, and demand to know whose land this is and why they are allowed to treat it that way. You learn that this land, the Tongass National Forest, belongs to you and all other Americans. The cutting is being done by large companies who pay a pittance for the trees, process some of it in Alaska pulp mills, and send shiploads of logs to Japan and Korea. What's more, your hard-earned taxes are going to these companies to allow them to cut your forest for profit. You are furious! Never mind that the original intention of stabilizing local economies had been a good one, or that the subsidy was a trade-off for the creation of huge wilderness areas. All you see is a royal rip-off, and you want it stopped. You go back home to California or New York, join Greenpeace or the Sierra Club, and begin a letter-writing campaign to your representatives in Congress. These activities focus widespread national attention on the Tongass.

In southeast Alaska in the 1980s, many local voices also were calling for change. The Tongass timber issue spurred local and regional environmental groups into a monumental grassroots effort to end the timber deals. Within the Forest Service, biologists fought hard to save the best habitats for wildlife and fish. Although I left Alaska in 1986, I kept abreast of developments in the Tongass war. In 1990, passage of the Tongass Timber Reform Act did away with the subsidy and made significant changes in the contracts to better protect the rainforest. Within a few years, the pulp mills closed and the contracts were terminated. On the Tongass, energies were directed to the development of the new Tongass Land Management Plan, which

was completed in 1997 and ushered in a new era of forest management.

What is this new era of forest management like? During the height of the timber battles, we often imagined how great it would be if a *benign* industry, such as recreation and tourism, were to replace timbering and mining as economic engines for the region. As with most things, the changes have turned out to be more complicated than first imagined. The rest of my presentation will focus on these changes and the new issues they have created for national forest management in Alaska.

Today's Troubles in Paradise

Fast-forward to the current year. In June, I boarded the "Alaska Marine Highway" at Prince Rupert for the move back to Juneau. Immediately, I knew something was fundamentally different. Before, ferry passengers consisted mostly of local Alaskans traveling from town to town, plus the seasonal influx of young backpackers out for adventure. This time, the car deck was loaded with motor homes of all descriptions, and a distinctly different mix of visitors. The backpack-laden adventurers of earlier years seemed few in comparison to the Winnebago crowd. Arriving in Juneau, I was startled to see five enormous cruise ships crammed into the harbor, and behind them a tramway running people up and down the mountain that I used to hike for solitude and a good workout.

The full impact of change did not hit until I commenced my job and began delving into the issues that now dominate the attention of the Forest Service. Tourism, while bringing in lots of money and offsetting the demise of the timber industry, has impacts of its own. Sheer numbers is one aspect. Last year 632,000 cruise-ship passengers (roughly the entire population of Alaska) visited southeast Alaska. On a five-ship day, 10,000 passengers and crew swarm ashore to increase Juneau's population by more than a third!

Then there are issues of water, air, and noise pollution. The cruise-ship industry makes only part of its profits by wining and dining passengers on shipboard. The companies make more money by offering a taste of "adventure" during the few hours that the ships are in port. In Juneau, the most popular options include "flight-seeing" over the surrounding wilderness, sport-fishing trips, kayak lessons, whale watching, and helicopter landings on the ice field above town. Once on the glacier, hour-long trekking and dog-sled trips are options for the truly adventurous souls, such as Martha Stewart (whose Alaska adventures were aired recently on her television show).

You are probably asking, "Just how much of a problem can a few floatplanes and helicopters be?" Picture the actual situation: in the 1999 tourist season, there were 16,700 helicopter landings on glaciers above Juneau. From dawn to dusk (which is a long stretch in summertime Alaska), flocks of helicopters pass over the areas where Juneau residents live, work, and try to relax. Add to that the drone of floatplanes making their flight-seeing rounds. Unable to tolerate the noise any longer, some Juneau residents formed the Peace and Quiet Coalition and began a vigorous campaign to contain the problem. They succeeded in getting a referendum on this year's municipal ballot, including flight-free Saturdays and limitations on the number of permitted glacier landings. Although the measure failed, its existence clearly indicates the seriousness of the problem.

In case you are wondering what the Forest Service's role might be in all of this, we are the ones who issue the permits. It is one of those "damned if you do, damned if you don't" situations that make agency work so interesting. On the one hand, it's a good thing to accommodate the families and businesses whose livelihoods are tied to the developing tourist industry. On the other hand is the wrath of local residents whose quality of life is being affected. Caught in the middle, the Forest Service has engaged the opponents in formal mediation, aiming to find a mutually agreeable solution.

The noise dispute in Juneau is symptomatic of the broader issue of how the tourism industry is affecting the character and socioeconomics of southeast Alaska communities. Consider Ketchikan. The arrival of the cruise ships brought more than temporary visitors to this town. Where before there were none, T-shirt shops, tacky souvenir stands, and fast-food restaurants are now prominent fixtures on the marina. The Great Alaska Logging Show charges tourists $29 a head to "witness the excitement as Alaska's frontier woodsmen do battle!" A great success financially, the show is scorned locally for bringing in professional entertainers rather than employing "real loggers" from the surrounding islands.

Angst is evident in other southeast Alaska towns, such as Wrangell, that are not yet on the cruise-ship route. A recent event in Wrangell illustrates the depth of this concern. A wealthy couple had bequeathed the town $6 million for the development and long-term maintenance of a museum and cultural center to serve Wrangell residents and visitors alike. Architectural plans were drawn up, a site was selected in the heart of the harbor, and a concrete foundation was poured for the facility. By summer of this year, the project was well along. However, a rift developed within the community between those who supported the project and others who began to fear it. Those opposed to the project raised a number of questions. Do we really want to put out the welcome mat for cruise ships and other outsiders? What changes might these developments bring? What if the future brings an opportunity to build something really *important* on the prime harbor site occupied by the cultural center—for example, a new fish processing plant? The debates intensified so much that a special referendum was called. Despite the fact that over $1 million had been invested thus far, the "nays" won and the project was terminated. Today, a large concrete pad sits in the Wrangell harbor as a testimony to the angst and uncertainty created by rapid socioeconomic change.

When big tourism arrived in southeast Alaska, its impacts reached beyond seaports such as Juneau and Ketchikan. A key attraction of any Alaska cruise is to view the scenic wilderness for which the state is famous. Motorized boat tours and flight-seeing trips make this possible; however, is it possible to have a wilderness experience with boats and planes buzzing around? This question comes to a head in Misty Fiords National Monument.

Thinking back 20 years, I recall a kayak trip into Misty Fiords, a spectacularly scenic portion of the Tongass National Forest. The area had just been designated a national monument, and I wished to experience it before it got widely discovered. The result was a memorable trip of complete, sublime solitude. Today, many kayakers have abandoned Misty Fiords in favor of more remote areas. The popularity of the area has brought new headaches for the Forest Service. For example, a seemingly innocuous 15-foot by 15-foot floating dock appeared in one

particularly scenic corner, Rudyerd Bay, in 1992. Over the years, the little dock grew into a 100-foot by 75-foot, U-shaped structure that is pivotal in the operations of one fly-cruise business. Since 1998, the company has been taking 90 passengers on a three-hour cruise from Ketchikan into Rudyerd Bay, ending at the floating dock where a fleet of floatplanes awaits for the trip back to town. Disembarking from the planes are another 90 people who board the boat for the return cruise to Ketchikan. The Forest Service began receiving complaints about this operation, and looked into the permit status from the responsible state agency. It turns out that no permit had been issued. The company managed to avoid that complication by moving the dock approximately every two weeks. Meanwhile, the kayakers and other seekers of solitude went elsewhere, thus abandoning Misty Fiords to the tourist industry.

Rising Demands for Wildlife Viewing

Although many other issues could be described, I will focus on those in my specialty area: the management of wildlife and fish and their habitats. Back in the old days, our main responsibility was "timber support," whereby we worked to minimize adverse impacts of logging on wildlife and fish. There were some opportunities for habitat enhancement, especially for salmon. But, as Forest Service people, our work was limited to the assessment and management of habitats. Wildlife watching, always popular with visitors and residents alike, was not something we got involved in. Although many Alaskans depended on wildlife and fish for their food or livelihoods, management of populations and harvests was the responsibility of the Alaska Department of Fish and Game. How things have changed! Today, wildlife viewing and subsistence management are among the roles performed by Forest Service biologists.

Mountains and glaciers are always popular with tourists, and the chance to view and photograph wildlife is the highlight of most Alaska adventures. Wildlife and fish viewing is much in demand, and both the Chugach and Tongass national forests have responded by providing new opportunities for visitors. For example, the Williwaw fish-viewing platform in the Portage Valley of the Chugach National Forest affords an excellent opportunity to educate visitors about salmon life cycles while they watch the drama of spawning and dying. The growing demand for bear viewing is a bit more problematic. How to provide viewing opportunities in a manner that is safe for both people and bears? Bear encounters account for human deaths and injuries every year, and this is likely to grow as more people set out to view and photograph these charismatic animals. One approach is to provide safe conditions for bear viewing, such as the program at Pack Creek on Admiralty Island. Enthusiasts who are willing to charter a float plane and pay a $50 fee are allowed the chance for leisure viewing of bears in their natural setting, with the assistance of Forest Service personnel who provide both education and protection.

Whale watching is right up there with bear viewing on the visitor's agenda, and has spawned a thriving industry in many coastal towns. What could be more quintessentially Alaskan than the chance to photograph a humpback whale, with glacier-clad mountains in the background? An interesting occurrence in Juneau this summer warned that, even in this

seemingly genuine pursuit, the buyer must beware. It seems that a certain whale-watching guide decided to make creative use of a derelict boat that needed to be disposed of. He was inspired by certain of the boat's features, including its ribbed hull, encrustations of marine growth against dark paint, and a drain hole located in the stern. He towed the old boat to a quiet location, to which he would steer his whale-watching clients whenever a day of effort had failed to yield results. According to the press release, the upturned body of the boat had an impressive likeness to a real humpback, especially when wave action caused water to "spout" through the drain hole. When questioned by the Coast Guard, who were more concerned about boater safety than tourist fraud, the guide explained that he "just couldn't stand to see disappointment on the faces of his clients" when real whales failed to cooperate.

Managing Subsistence Uses

A core value of Alaska is that residents ought to be able to live off the land if they so choose. Both state law (the Alaska Constitution) and federal law (the Alaska National Interest Lands Conservation Act, or ANILCA) provide for the precedence of subsistence uses of wildlife and fish over sport and commercial uses. From statehood until 1990, the State managed subsistence uses, as well as sport and commercial uses, of wildlife and fish throughout Alaska. That had to change when, in 1989, the Alaska Supreme Court determined that the Alaska Constitution does not allow restriction of the subsistence privilege to rural residents. The Alaska National Interest Lands Conservation Act does require a rural preference, however. To make a long, convoluted story short, the federal law had to prevail in the matter of subsistence management on federal lands. Jurisdiction over the management of subsistence uses on federal lands was taken from the State and given to the five land-management agencies that manage federal lands in Alaska, including the Forest Service. Representatives from the five agencies make up the Federal Subsistence Board, which sets the regulations for harvest by subsistence users and governs all other aspects of subsistence management on federal lands.

Many subsistence users are native peoples whose uses reflect an ancient history of tradition, culture, and nutritional requirements. In addition to "bush people" scattered far and wide, many Alaskans who reside in towns prefer to feed their families on wild game, fish, and plant materials. The subsistence-management responsibility has created new responsibilities and experiences for agency employees. For one, they are required to work closely with regional advisory committees, who consult with communities of subsistence users and propose changes in the regulations for consideration by the Federal Subsistence Board. The Board's ability to regulate subsistence management requires good information on the populations and stocks affected. Forest Service biologists must be directly concerned with the assessment and management of wildlife and fish populations, which is a significant departure from their traditional roles in habitat management.

The job of providing for subsistence uses is not too difficult as long as the resources are plentiful relative to the people wishing to use them. In Alaska today, as elsewhere in America, the human pressures are growing. Increasingly, we can expect conflicts between rural subsistence users and those who use Alaska's

resources for sport and commercial uses. Already, in specific locations, those pressures are in evidence. In my field travels this past summer, I was amazed by the huge increase in fishing charters and resorts, and the sight of mountains of fish boxes being loaded into float-planes at remote docks. Most memorable was the spectacle of "combat fishing" on the Kenai Peninsula's Russian River. Crowds of anglers stood cheek-by-jowl in this most famous of salmon rivers. Several years of such use had caused serious degradation of the banks and riparian habitats along the river. A creative, major restoration program by the Chugach National Forest has stabilized the system in a way that provides for heavy use by people. Simply closing such areas is not an option. In nearby towns, such as Soldotna and Kenai, it is obvious that sport fishing is the backbone of the local and regional economies.

Summing it Up

Like it or not, the economic future of rural Alaska is increasingly bound to outsiders who visit but do not remain. "I came, I saw, I spent" pretty well sums it up. How are Alaskans dealing with the change? They cope in various ways, depending on the particular effects, both positive and negative, that they are experiencing. I will let these people have the final word, in their own voices.[1]

The mayor of Craig, a small fishing and logging town on Prince of Wales Island, comments on tourism:

> How much of your soul are you going to sell? How much are you going to take out of your local residents in order to give people their 'Alaska experience?' I've seen a lot of communities roll over. It's disgusting. Most people live here for a reason, for the character of the local community. But that kind of falls through the cracks when the masses arrive.

In nearby Klawock, the president of the board of the local native corporation has a different view:

> If we don't get on it, we will end up losing out. We will be sitting here watching everyone else make the money, and our shareholders will say, 'Why weren't you guys busy?' Some don't want any changes, but whether we like it or not, it's changing. All I see is the money sign.

Yet a different perspective from a long-time logger in Thorne Bay:

> Thorne Bay is a dying town. You can see it in people's faces. Tourism? I'm a logger and I always will be. I'll die a logger, I'll load the last log that's ever logged.

And finally, from Wrangell, a bumper sticker raises the simple question:

> If it's TOURIST season, why can't we shoot them?

[1] Quotations appeared in an article in the *Seattle Times* (October 8, 2000) entitled "Cruising for a bruising? Southeast Alaska weighs new tourism industry" by Lynda V. Mapes.

Question and Answer Session

Question: Do you foresee a salmon crisis in light of what we're going through in Oregon now? If so, is your agency preparing for that?

Kessler: Which aspect of the crisis?

Question: Just that people not being able to maintain a salmon-based livelihood—people's livelihoods with fishing for salmon, sport fishing.

Kessler: Well, in general, Alaska's got a very healthy fisheries. And, you know, one that, compared to British Columbia, for example, where I've been living for the last seven years, is in very good shape. That's not to say that every stock is perfect, but, compared to British Columbia, Oregon, and Washington, in very good shape. I think that the fishing industry will continue to be a very important industry in Alaska. Where we have a crunch is with certain failures of certain stocks. The issue is not just the economic one, the commercial one, but this whole thing of subsistence.

The Yukon and Kuskokwim systems, for whatever reason, had a very bad year. And, just to show you how that manifests itself in the unique Alaska context, a lot of the people who live there depended on the dog salmon run to feed their sled dogs, and they said, "Okay. There's only one solution. The dogs are going to starve. We're going to kill all of the dogs." So, they put out the word that they were going to have to kill all of their dogs. Ralston Purina came through and donated tons of dog food. The transportation was donated. So, it looks like they'll pull through. I'd say, in general, it's doing better than most places, but that's not to say we don't have issues that come up. When those issues come up, it's far more than just a commercial issue. It gets into a lot more—people's lives, lifestyles, livelihoods.

Question: Assuming that the Forest Service is involved in monitoring and research on the impacts of particular recreational activities, what are some of the things that are coming up that the state needs to monitor?

Kessler: The biggest issue for monitoring right now is air and water pollution. It's a huge issue, because the cruise ships have been dumping raw sewage. So, it's the sewage issue of the cruise ships, and also, when they're in port, the air-pollution issues. In Juneau, they required that the cruise ships have sewage-containment systems, and run on-shore electrical power while in port. That will help. The governor was absolutely furious when test after test showed that the cruise ships were polluting the water. So, he called a summit, and he told the five big cruise-ship companies, "You are coming in here. You are meeting with me. And we're going to reach some agreement here and put some measures in place, or you're out of here."

You know, those are the biggest issues. I would say that, aside from that, the noise, and the crowding, and the impacts of all of that activity on the areas that are supposed to be pristine wilderness are also issues. And there are socioeconomic issues, the source of some of the angst and anxiety that I talked about. You know, there's also the matter of Alaskans' convenience. You hear a lot of that in Juneau. "The tourists are clogging the buses…." Yet, it's not that simple. Alaska is a hard place to live and work. It can be a very dangerous place. One of the hard things about living there is losing people. People die and people get injured and people disappear. In coming back to Alaska, that was one of the things I had to think about. It's like, ah, there's going to be more colleagues and more friends that disappear in the line of work or whatever. In fact, if you want to read more about this there's a book called *Disappearance*[2] by Sheila Nickerson. Alaskans have this situation where their concept of Alaska is that it's a great place, but it's got this down side to it. It's tough to live there, and it can be dangerous sometimes.

And this whole clash of these people who come in on the cruise ships and run around and spend two hours doing things and claim that they've experienced Alaska…. I'm not a psychologist, but it appears to be a big cultural clash. I think it would be a wonderful thing for folks who study these kinds of things to investigate.

Question: From your presentation, I got that you were saying that in the old days there was logging and everybody was into the Earth and knew what they were doing out there. And then some city slickers came in and said, "We've got to stop this." And then the tourists came.

Kessler: The economics that surrounds the whole thing is the change from a natural-resource-extractive base to a natural-resource-nonextractive base. So, the assumption I had was, maybe naive, but I always thought that tourism would be much more benign. It's not benign. It creates a whole different set of pressures. I wasn't trying to say it was cause and effect.

Question: Winnie, I was wondering if you could comment on the standard of living that people in Alaska have in regard to the tourism industry. You mentioned the T-shirt shops and stuff like that. It's hard to imagine that you could really survive in Alaska selling T-shirts. Is most of the money being made by these five big cruise-ship companies that are undoubtedly based somewhere else?

Kessler: Well, the money that is associated with tourism takes various forms. For example, the average tourist that comes off of the boat and hits the shops, flies up in a helicopter, and does their thing—the average tourist spends $732 on a visit. That's a lot of money. If 10,000 tourists get off the boat in one day, we're talking about lots of money. But that's not the only source of money. There's also tax. Juneau got the idea of charging a tourist-head tax. They figured, "Well, tourists have impacts on us." So, they came up with the idea. The cruise-ship companies screamed, but they coughed up the money. And now, in fact, they've kind of turned it around. This year, they proudly joined hands and paid the check to the mayor. As well as the cruise-ship companies do, they have to keep people happy. They gave several million dollars to the United Fund and that kind of thing.

The diversity of businesses that have been spawned by this whole thing is amazing. I mentioned the obvious things like T-shirt shops. There's the whale watching, there's fishing resorts, there's all of this stuff that creates more and more jobs. So, it's a lot of money. They're not hurting economically. They're doing quite well.

Question: How much of Alaska is wooded with timber? And how much of that timberland is controlled by a government agency and how much of that is private?

Kessler: I don't remember these figures anymore. There's not that much private land in Alaska, and most of the private land is owned by the Native corporations.

Question: More in the north?

Kessler: The corporations are located throughout Alaska, but down in southeast Alaska, when you're talking about the forestlands, the corporations own big blocks of forestland. In fact, if you go up there now, you'll see recent clearcutting on Native corporation land. They've pretty much run full cycle, so that's coming to an end now. There's not much logging going on.

Winifred Kessler

Question: Alaska is just like the latest to see this influx of tourism in North America. What lessons have we learned from these changes from a timber-dependent economy to a tourism-dependent economy in places like Maine, even in the Pacific Northwest? What have we learned that we can apply to Alaska? Or is Alaska so unique that we have nothing to learn?

Kessler: I think there's probably things that could be learned. I don't think anybody really took what could be learned and applied it. It just happened. It snowballed. I think there are lessons that could be learned, but I also think that Alaska is unique. What attracts people to Alaska is this notion that it's wild and pure. From the standpoint of the visitor, it's spectacular. You visit it kind of like you would a museum. Yet, from the standpoint of an Alaskan, you're trying to make a living and survive there. You multiply that by the scale that's Alaska, and it makes for an interesting mix. I do think there's probably a lot of socioeconomic research that could have been applied there that wasn't. I think they got caught off-guard.

Question: In the scenario you paint, I can imagine there being a number of conflicts between local community interests and a national interest. I was wondering if you see those two different scales as being in conflict, and what the Forest Service perspective is on that. How do they balance those?

Kessler: That's an excellent question, because I don't think there's many places in the country where the attraction is so strong. When you look at who really cares about Alaska—it's unbelievable how people throughout the country love Alaska. They may never go there, but they love it. It's this whole concept that that's our last frontier. And, in fact, when forest planning is being done, like when the Tongass Plan was being developed, thousands of letters and postcards came from New York and Washington, DC. There aren't that many Alaskans, only 600,000 or so. So how do you balance that fact, that people throughout the US feel tremendous ownership towards Alaska, and the people who live there want to have some say? It's a very difficult thing to balance.

Another thing that makes a unique challenge for agencies like the Forest Service is that there's such direct political intervention from the highest level. Our politicians are very close to the people. If something goes on, they don't necessarily call the local Forest Service people. They'll call Washington, DC. They'll call the chief of the Forest Service. That's just a relationship and a history that exists there. So, the next thing we hear about it, it's coming down from Washington, DC. And it's direct, very direct. It's unlike any place else in that respect. It makes it interesting.

Question: An initiative that's on the ballot right now in Alaska is to take away the right of voters to put initiatives about wildlife on the ballot.

Kessler: Yes.

Question: Isn't that part of what you thought about, taking away that right from the voters, because the legislature is saying that it's taking away the power of the special interests in the lower 48? Personally, I feel that it's taking away our right to choose what we want to do with our wildlife. I was curious what the Forest Service, and what your position is.

Kessler: The Forest Service tries to stay out of issues like that, but I'll explain where that came from for those who don't know Alaska. It came from the wolf issue primarily. In

Alaska, there are situations where wolves can have what are felt to be rather dramatic effects on populations of big game. So, it's been the case in the past that one tool of wildlife management is to shoot wolves from helicopters.

There are people who feel that's really not a good thing to do and don't want it done. The approach of those who want to get rid of that tool, when they can't get the Fish and Game Department to respond to their concerns, is to seek resolution through ballot initiatives.

Now, the two sides to the issue are—on the one hand, you'd like to think that wildlife science and professional experience and judgment would be the main way to go about making decisions on wildlife. That's what you'd like. In an ideal world, we'd lay out all of the information to make the decisions. If there are controversial aspects, we'd engage the public and explain why the science approach should be the way it is. Yet, sometimes people feel very strongly about issues. They say, "I understand the scientific rationale. I just don't want you doing it." So, in that case, agencies do have to understand that the scientific arguments are ones of perspective, but there are other kinds of factors that they should listen to.

So, I think it's too bad—that's my own personal opinion. It's too bad it has to come to this, has to come to the fact where, first, citizens feel they have to put initiatives like that on the ballots to get resolution. That's a failure of management. And, second, that others feel that the public has overstepped its bounds and, "By golly, we're going to counter-attack by putting forward a resolution that says wildlife issues cannot be addressed by ballot initiatives."

Question: I was struck by how large the Tongass National Forest is, and was thinking, coming from California where there's a lot of emphasis on the Sierras and looking at the management of national forests over large areas, up there you've got them all broken up. Do you think that the Tongass is a good example of a way to manage the forest, given that here is an example that's covering a large area?

Kessler: That's a very good question. The Tongass was created by the stroke of Theodore Roosevelt's pen. He was working in the eleventh hour of his presidency to get these national forests established. Over the years, it has alternately gone from being managed as one big forest to being broken up. When I worked there before, it actually was managed as three forests. Even though it was called the Tongass, there were three supervisors' offices, so it would be managed as if it were three forests. And that was a bit more manageable. It's still a bit difficult in that the average district on the Tongass is bigger than a lot of national forests elsewhere. Now we see downsizing of the timber industry and some other changes. And, for reasons of efficiency, they've reconfigured the Tongass, not as three but as one.

The answer to your question about whether or not that is a good way to manage it, as one whole, is that we don't know yet. We're just now getting to the point of trying it. A lot of people fear that it is so huge, just so immense, that maybe it was better having it decentralized. I don't have an answer for you, except to say that there's quite a bit of concern that it may be too big, but we'll see in the next few years.

Question: I guess this kind of piggybacks on the previous question. How do you think the new Tongass, whatever that turns out to be, how it will weather? Will it be part of the

sustainability of the people of that region over time?

Kessler: Yes.

Question: What's your vision of what the outcome will be of that?

Kessler: Well, that's the ultimate question. We're trying our best to sustain the families and communities that live there, to help create conditions to help them sustain themselves. For example, we give tremendous attention to try to support the small timber enterprises, including the family operations. We're trying to use programs through the Small Business Administration, through the state Private Forestry Community Assistance Program. We've got a number of ideas. But it's very difficult just because of the uncertainty that's been created in all of this for people who live there.

One of the things I didn't mention about the Tongass Plan was that it took ten years to create and everybody reached agreement on things in 1997. Then, a bunch of lawsuits came along. And then, in 1999, an unprecedented thing happened. An amendment came from Washington, DC, from the USDA assistant secretary's office, that changed the rules yet again and created more uncertainty. It imposed a 200-year rotation on some of the areas. So, that uncertainty was created, and people started to try again to take that into account. The attitude was, "Let's try to work with people and help them position themselves."

The latest thing that's coming along is the roadless issue. The roadless rule, as you may know, includes a proposal to exempt the Tongass. And the reason is that the Tongass has been through so much turmoil up to this point, and people are finally at the point where they see some certainty in the next few years in their lives. If the roadless rule were imposed on the Tongass, then that brings everything to a screeching halt, because it's got so few roads to start with. Any of the scenarios to do some development requires building more roads, and most of the Tongass meets the definition of what a roadless area is, because there's so much that hasn't been roaded. That one has got people on pins and needles. I don't know how it's going to all shake out. It's been very tough for people. The biggest thing has been this uncertainty. You know, we think we see the future possibilities, everybody agrees, and then—wham. It's been very tough for people.

In the meantime, there are changes going on—like on Prince of Wales Island, where my career started. Back then, there were Forest Service people and a few logging camps and villages, and not much else. But it did have roads, because the roads network supported the timber operations. I went back this summer, and the roads are paved. There's a tremendous influx of people and towns and—and it's looking like the lower 48 more and more. The next few years will be very interesting.

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[2] Nickerson, S. 1996. *Disappearance: A Map: A meditation on death and loss in the high latitudes*. Doubleday, New York.

Howard Wheater

Utilizing Resources in Complex Environments: Assessing Impacts of Hydropower Development—The Gabčíkovo-Nagymaros Danube Project, Hungary versus Slovakia at the International Court of Justice

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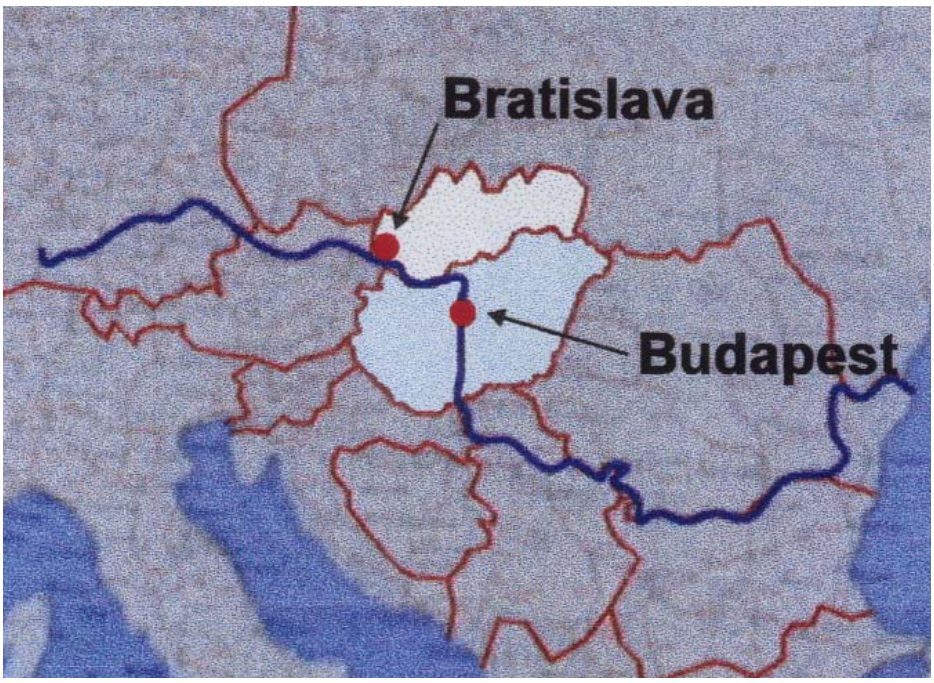


Figure 1. Delineation of the Danube River in Europe.

It is a great pleasure to be here in Oregon, and I am very honored to be invited to participate in the Starker Lecture Series. The lecture series provides an important opportunity to address wide-ranging issues of resource management, and I am aware of the many distinguished previous contributions. I hope my lecture will do the series justice. I've got what I believe to be an interesting story to tell you. I'm going to base my talk largely on a case that was heard recently at the International Court of Justice (ICJ)—the United Nations' World Court in The Hague, in the Netherlands. And I should declare my interest—I acted as counsel and advocate for the Republic of Hungary in this case.

What I want to do is to set that particular case in the broader context of environmental management, which can be represented as a triangular balance among the needs of the natural environment, the built environment, and society. We forget one of these at our peril. However, achieving an appropriate balance can be a difficult and complex task, and what is considered to be an appropriate balance is essentially a political decision, which reflects the perception of a society of its needs and values. So, for example, priorities in a developing country generally emphasize economic development. But, in the developed world, the priorities are likely to lie much more in the area of preserving the quality of the natural environment. One of the interesting features of the story I'm going to tell you is that it hinges very much on how society values the natural environment, and what happens when those values change overnight.

The case concerns a dispute between Hungary and Slovakia that came to the International Court of Justice in The Hague. The case involves a project to develop dams on the Danube. Two dams were envisaged, one at a place called Gabčíkovo, and another at a place called Nagymaros. Hence, we're talking about the Gabčíkovo-Nagymaros Barrage System.

Figure 2. Representation of the Gabčíkovo-Nagymaros Barrage System in Hungary and Slovakia.

The Gabčíkovo-Nagymaros Barrage System Project: Background & history

The Danube is one of Europe's major rivers. It rises in the south of Germany, and flows through many European countries. The section of interest lies between Bratislava, the capital of Slovakia, and Budapest, the capital of Hungary (Figure 1). The average flow down this reach is about 2,000 cubic meters per second. A major flood may reach 10,000 cubic meters per second.

The original project to develop the dams on the Danube dates back to the early part of the 20th century. Plans were progressively refined and discussed until 1977, when Hungary and Czechoslovakia agreed that they would proceed with this two-and-a-half-billion-dollar project. The essence of the project was to divert the Danube through a canal just downstream of Bratislava, and to use that canal, about 30 kilometers long, for power generation, with some 720 megawatts of installed capacity (Figure 2). There were other benefits of the project. There were benefits in terms of navigation, because there were some shallow areas that were kept open by dredging the natural river system. The increased capacity of this canal would allow, for example, the Soviet Union to transport major armaments up and down the Danube. The project aimed to maximize the utility of the power, and that involves generating power to meet peak demand. Hence, rather than a run-of-the-river scheme, there was the need to build a dam to store up the Danube water and then release it to generate peaks of energy production twice a day (to meet morning and evening peak demand).

One of the implications of this would be that, effectively, a tidal wave of water 3–4 meters high would be released down the Danube. As a result, the second part of the project comes into play—the idea to build a dam at Nagymaros. The river gradient in that area is

very shallow, so it was necessary to raise water levels by only 7 meters to create a backwater 100 kilometers long to absorb the impact of the peak power pulses. The location of Nagymaros is interesting for a couple of reasons. It's an important historical site for Hungary. Also, just downstream is Szentendre Island (Figure 2). Szentendre Island is where Budapest gets the bulk of its drinking-water resources. I'll explain how that's done a little later.

So, essentially, the original project was to create a dam just downstream from Bratislava, the power canal with a large installed power-production capacity, and then a second dam at Nagymaros to assimilate the impacts of the upstream power generation. The treaty confirming the parties' agreement to proceed was signed between Hungary and Czechoslovakia in 1977.

It took both sides quite a long time to raise the finances, and progress was initially slow. However, by the mid-1980s, construction was in full swing, and by 1989 the upper part of the project was almost finished. The canal system was almost complete, as was the original upper dam at Dunakiliti. A little work had started at the downstream Nagymaros dam site. The coffer dam had been constructed, prior to diverting the Danube to construct the main dam.

This project was designed to maximize the power from the Danube, and the original plan was to divert almost all of the average flow in the Danube (about 2,000 cubic meters a second) and to leave somewhere between zero and 200 cubic meters per second in the old Danube channel. This was, therefore, an extreme project in terms of environmental impact. The area affected by the diversion is a major wetland of international significance. In addition, there was a whole host of other aspects of the project concerning both the upstream and downstream developments that raised environmental concerns. So, during the long gestation of the project, people attempted to raise these environmental concerns. However, these were pre-1989 com-munist regimes and, if a government-employed scientist (and all career scientists were government-employed) chose to voice opposition to the project, then that scientist simply lost his or her career, as a number did. There was no room for opposition. The general view taken by both governments was the exact opposite of the precautionary principle—if there were problems, they would be overcome once they become apparent. That was the situation in 1989.

As many of you will recall, 1989 is the year in which the Berlin Wall came down, and the whole of the Eastern European scene changed almost overnight. Hungary elected a new democratic government, and it was a time of great excitement and unrest. A sense of freedom pervaded Hungarian society. This project became a major focus of this change. There were massive demonstrations in the streets of Budapest against the continuation of the project, based on the environmental concerns. So the Hungarian government took the view that it could not proceed with the project, and argued that work had to halt while further consideration was given to the environmental problems. However, Hungary's treaty partner, Czechoslovakia, which then became the independent state of Slovakia, would have none of this. They were determined to pursue the project, and completed the upstream development independently by constructing a dam slightly farther upstream at Čunovo (Figure 2), where they controlled both banks of the Danube.

This work took place in the three years or so following 1989, and Slovakia unilaterally diverted the Danube, taking most of the flow down the power canal in 1992. At that point in time, Hungary was left with loss of control of the Danube flows, no economic benefits from the project, and a whole host of environmental disbenefits.

Both sides agreed to take the case to the International Court of Justice in The Hague. The ICJ is an arm of the United Nations, and has a panel of 15 judges, representing diverse ethnic groups and sociopolitical systems. The current president is an American. They have some European members—a Frenchman, a German, an English woman, a Russian—and representatives from many other parts of the world, including China, Japan, and Africa. One or two of the representatives are former foreign ministers, and, collectively, they have immense political and legal experience, but no technical background.

The court took written evidence over the period 1994–1995. This evidence was voluminous. There were three stages of written argument, and something like half-a-dozen volumes of evidence and legal arguments were produced by each side for each stage—a shelf full of material for the judges to assimilate. The proceedings were heard orally in 1997, and this was a very rapid affair. Both sides had two sets of presentations, one set to present their case and a second set to counter the other side's arguments. Each set was typically on the order of three days in court. The judges made a site visit (a somewhat tense experience for the two sides). And then they handed down a judgment in September of that year.

That's the history, and what I'd like to do is to take you through some of the background in terms of environmental concerns and the impacts that were observed. We will then go back to the Court and its decision, and see what lessons we can draw from this story. I'm going to talk, first of all, about the upper part of the system, and then we'll turn our attention later to the lower dam and its implications.

Environmental Concerns

As the Danube passes Bratislava, a large reduction in river gradient occurs, creating a braided river—effectively an inland delta. Historically, this complex, braided system of channels was inundated regularly by seasonal flooding, creating a unique habitat in terms of wetland ecology. The system was changed over the last century or more, with the creation of distinct main channels and lesser side-arm river branches. Dikes were built for flood protection, and channels were dredged to maintain navigation. However, the whole system was flooded regularly within the inundation dikes, and good connections remained between the main channel and the side-arm systems.

One of the effects of a reduction in river gradient is that sediments are deposited. And so, over geologic time, 600 meters of sands and gravels were laid down, creating a large aquifer of high-quality groundwater. An important interaction exists between the Danube and that groundwater. There is a gradation in mean groundwater levels away from the Danube, and a strong annual cycle of groundwater levels. The Danube flows were recharging this alluvial groundwater system. Some interesting work was done on the geochemistry, looking at tritium profiles. This work showed the extent to which bomb fallout in the 1950s had moved

through the groundwater, and illustrates an important point about groundwater and groundwater pollution. We are talking about very long time scales for subsurface water movement—in terms of decades and centuries, when we're thinking of groundwater quality problems and their remediation.

Now, many twists exist in this story, and I'll try not to confuse you. One of these twists was that the proposers of the project argued that it was necessary to build the dam to protect the environment, because river levels had been changing over time. Between 1966 and 1990, a 2-meter reduction in river levels near Bratislava occurred, threatening the connections between the main channel and side arms, and, hence, the wetland functioning. It was argued that this was the consequence of Austrian dams upstream, which were reducing the sediment load downstream, thereby causing riverbed erosion. But Hungary was able to show fairly conclusively that Slovakia had been mining the riverbed gravel for construction. In fact, the river is still a naturally aggrading reach. So, the reduction of those river levels was entirely human-made. And it wasn't just Slovakia. Hungary also had used gravels mined from the riverbed to support various construction activities.

Another myth was that groundwater levels had been reduced, and it was necessary to implement this scheme to restore them. But, actually, groundwater data showed a cone of depression just around Bratislava, where groundwater is being pumped out to contain a major pollution incident. The reduction in groundwater levels was mainly the result of a combination of reduced river levels and Slovakian groundwater pumping because of the pollution problem. It was, therefore, not the case that the scheme was essential to protect the natural environment from continuing natural processes. These degradations were human-induced and could be halted.

What were the environmental concerns of Hungary? Well, obviously, taking flow in one of the Earth's major rivers and reducing it to a trickle would have a whole series of consequences in terms of the aquatic ecology and the riparian wetlands. Yet, there were more far-reaching effects as well, because the Danube feeds the groundwater in the underlying aquifer. The floods in the Danube occur in the early summer, fed by spring snowmelt in the Alps. So, river levels are high in the summer, and that means the groundwater levels are high in the summer. In fact, the groundwater rises from the coarse alluvial aquifer to wet the overlying fine soils, and provides an important and benign natural subirrigation. Many hundreds of square kilometers of highly productive agricultural land are supported by this process. One of the concerns was that, after the diversion, that process would be lost.

Other important issues were associated with groundwater quality. At the Altenworth Dam in Austria, downstream from Vienna, the impoundment of the Danube had started to have a significant impact on groundwater quality; dissolved oxygen levels had started to decline. The significance of this is that, if oxygenation is reduced, the groundwater can move to a reducing chemical state, and this can then release iron, manganese, and ammonium into the water. So, instead of a pristine groundwater system, high concentrations of dissolved contaminants can occur throughout the aquifer. This was observed at the Altenworth Dam. Hence, Hungary's concern was that, instead of

having the main Danube channel recharging the groundwater system, that source of oxygen-rich recharge would be lost. Groundwater would be recharged from the reservoir and the side-arm systems. The reservoir would lead to deposition of fine sediments that contain organic material that consumes oxygen when it decays. It was expected that the oxygen content of the infiltrating water would be lost, and the chemical problems observed at Altenworth would appear in the pristine and very large groundwater system. So, there were important concerns for groundwater quality. These concerns were supported by computer-modeling studies.

There were also a number of concerns for surface water quality, because an impoundment can increase the possibility of eutrophication. Slowing down the water flows affects temperature profiles, and that means that there is a likelihood of increasing the biomass of algae. That increase, in turn, can consume oxygen and cause damage to the aquatic ecology. There was another concern, too, for water quality. The city of Györ discharges its wastewater into a tributary of the Danube. The effect of this twice-daily discharge in the canal associated with peak power generation would be to cause a flow reversal at Györ, so, instead of the pollutants being flushed downstream, they would be moved alternately upstream and downstream. That could cause a serious pollution problem in the tributary river. A final point on the upstream part of the project is that Slovakia argued strongly that the whole natural system could be managed. All that was needed was to set up a series of weirs in the main channel and the side-arm systems, creating effectively a cascade of ponds to maintain groundwater levels. Hungary argued strongly that this was not an acceptable solution, because, by replacing the natural, free-flowing river section with a series of ponds, a complete change of the aquatic habitat would occur, and rare fish would be lost. In addition, the groundwater quality problems would still arise. These are some of the concerns for the upstream section.

The downstream section is interesting. I talked briefly earlier about the water supply for Budapest. This comes from bank-filtered wells. These are wells that are constructed alongside the river channel, and tap into the gravels that sit underneath the riverbed. When water is pumped from the well, river water is drawn through the gravels, and a natural purification process occurs. The result is very cheap, high-quality drinking water.

Now, there were various concerns. First of all, Hungary had been doing its own gravel dredging near Szentendre Island. The riverbed levels had been dropping, and the level of gravel that was available was getting quite thin in certain places. There was a real concern that building a dam upstream and then releasing the water would create further erosion and further removal of that gravel layer. In addition, it could create pockets that could be filled up by fine sediments, and cause the same sort of problems of decay of fine sediments and changing water quality that were already of concern upstream. Historical data indicate that precisely this effect occurred at one of the sites in the lower Danube. A pocket was created as a result of dredging. That pocket filled up with silt, which decayed and gave a dramatic increase in ammonium and manganese levels. The problem increased over a decade, and only 20 years later started to reduce. Even then the concentrations were in excess of drinking water standards. So, once again,

there is evidence of long-term effects. Hungary felt that this was potentially a very serious concern because, after all, this was the major water supply to the capital city.

The whole dispute had many facets—economic, political, and social, and included some ethnic tensions. My focus here is purely on the environmental issues.

Impacts of the Diversion

Now, we return to the history, and to what has happened to the Danube. It was diverted in 1992, and flows were reduced dramatically. They weren't reduced to the level of zero, as proposed in the original project, but typically they ranged between 200 and 400 cubic meters per second instead of the average 2,000 cubic meters per second. Apart from the reduction in average flow levels, the Danube lost its annual inundation.

Of course, the lower dam had not been built, and, although the project was no longer operated in peak-power mode, it was continuously generating power. There was nothing to absorb the impact to this return of flows to the main channel. As a result, over a two-year period, the riverbed degraded 6 meters at that confluence.

Groundwater levels were affected also. The extent to which they were affected depended on the flow levels in the Danube. Under high-flow conditions, the decreases in groundwater close to the river were well in excess of 3 meters, and that effect gradually spread out over the rest of the alluvial system. The effects were similar in nature, but less in magnitude, under low-flow conditions. So, we have a major loss of groundwater levels. And the areas of natural subirrigation were significantly reduced—by several hundred square kilometers. It turned out, coincidentally, that, over this period, the reduction didn't have a huge effect on Hungarian agriculture. There were two reasons for this. One was that a series of quite wet summers followed the diversion. And the other was that, after 1989, the whole of the Hungarian agricultural sector was in economic turmoil. This was because of a significant loss of production as a result of economic restructuring and the loss of state farms.

Reluctantly (given the opposition to weirs), Hungary agreed to build one underwater weir, as it was called, in the upper part of the Danube, so that it could raise water levels and, hence, feed some water through the side arms of the wetland system. That underwater weir was constructed. As predicted, there was deposition of fine sediments, and, also as predicted, changes in groundwater quality. By 1996, manganese concentrations were starting to increase, and dissolved oxygen concentrations were quite significantly decreasing. Thus, the long-term groundwater degradation effects that were expected appeared to be occurring. The same kinds of effects were happening, but at a slower rate, in groundwater underneath the main channel, which was no longer recharging groundwater, but rather acting as a drain. Once again, there was a progressive reduction in dissolved oxygen leading to an increase in manganese, and potentially in iron and ammonium.

The Judgment

Our history of the project started in 1977 with the treaty. We've moved to 1989, to the partial completion of works and Hungary's change in attitude toward the project. We then have Slovakia's completion of the project, the natural diversion, and then the case finally com-

ing to the Court in 1994 and 1995 with a judgment in 1997. So what did the judges say?

The judges were keen to uphold the law of international treaties, and so they found that Hungary had acted illegally in withdrawing from the treaty. Despite its environmental concerns, Hungary should have tried to negotiate its way through them. So, in principle, Hungary owed Slovakia damages. On the other hand, Slovakia had acted illegally in unilaterally diverting the Danube and taking control of the whole infrastructure. So, in principle, Slovakia owed Hungary damages. It would be convenient if the damages cancelled each other out. The Court decided that both sides should get together and agree on a suitable operating strategy, bearing in mind the environmental concerns and joint ownership of the infrastructure. They set a date of six months for negotiations to proceed to conclusion.

We now have some political twists in the story, because, during the time that the case was before the Court, the Hungarian government changed and the former Communist government came back into power. Their attitude toward the whole project was entirely different, because they basically supported the original concept. Negotiations started to proceed with Slovakia, but at a very slow pace. The Hungarian government changed yet again before negotiations were concluded, and, as yet, no agreement has been reached. Meanwhile, the Danube, unfortunately, still has almost no water in it.

Some Technical Issues

One of the technical issues that came before the Court, I'll just mention, because I think it's quite significant. There had been a major European Union-funded project that had built various modeling tools to evaluate the impacts of this project. And this had been carried out by Slovakia with assistance from European consultants, particularly the Danish Hydraulics Institute. They built a fairly comprehensive set of models, and produced a very large report, which was submitted in evidence just a few weeks before the final court hearings. This led to a lot of sleepless nights on the Hungarian side, as we had little time to assimilate this evidence and come to grips with its implications.

In fact, the report was quite balanced, because it pointed out the complexities of the problem and the limitations of the data and the problems of trying to validate and calibrate complex models with limited data. However, in court, the chief hydrologist of the Danish Hydraulics Institute said that this modeling showed that there were no long-term concerns over groundwater quality or surface water quality. Now, the models that we're talking about involve simulating highly complex interactions among surface water flows (including two-dimensional flows in reservoirs) and the transport of fine sediments, surface water quality (including biological processes), surface water-groundwater interactions and groundwater flows, and geochemical interactions in sediments, soils, and groundwater. This is a very complicated chain of complicated models, based on limited data. So, the Hungarian position, which was supported by a number of international experts, was that this modeling was simply incapable of producing a reliable result in terms of defining the long-term project impacts. It was a very important tool in gaining insight into the processes, but the results were sufficiently unreliable that they should be disregarded. This is a very central point, I think, in the assessment of complex

environmental systems: we have to be aware of the limitations of our modeling tools, and, in fact, come up with much better techniques for illustrating the uncertainty in our predictions.

This particular project raised a number of important scientific issues, and probably some of the more difficult ones had to do with the interactions between the flows and the ecology. There simply was not the basis of scientific knowledge to prescribe what would be a satisfactory flow regime to maintain the wetland ecosystems on a long-term basis. There is a tremendous need to bring together hydrology and ecology to answer these types of questions. There also is a whole series of technical issues, and I think what I've just mentioned is the key one: that we have very complicated problems that we can model only with relatively high degrees of uncertainty. The current, state-of-the-art situation is that a modeler will produce a best-shot simulation of a very complicated system, and you can take it or leave it, whereas, in fact, we know that the process descriptions are uncertain, the parameters that we use to define them are uncertain, and probably the data are uncertain. We have to have improved methods of representing that uncertainty. We have to have the technology to be honest and convey the uncertainties in our understanding of the problem to the decision-making process.

Concluding Remarks

This is a complex story, with many facets not discussed here. We have mentioned some technical and scientific needs raised by the case. However, at the heart lies a fundamental issue. It concerns the balance between the benefits of economic development, in this case power generation, with its readily quantified economic value, and the intangible environmental values associated with a rare wetland system. On the face of it, this might appear to be a technical question of how to assign value to the environment. But, more fundamentally, the issue is a disagreement between societies on how they value environmental systems.

We commonly see such differences arising at the local or national level. We have interest groups that take different perspectives within local communities. This was a very stark case, where we had two nations, at least at an official level, taking a view of the environmental benefits and damages, which in the case of Hungary changed overnight. In my view, this case is a clear demonstration of the essential interlinkage between science and technology and the social aspects of decision-making in environmental management. To return to my original observation, environmental management is fundamentally a balance among the built environment, society, and the natural environment. Science and technology must recognize and involve society to achieve sustainable environmental management.

Thank you for your patience.

Question and Answer Session

Question: I notice that most of the groundwater area that we were concerned with and most of the wetland area seemed to be on Hungary's side of the Danube. Now, what factor do you think that employed in deciding the issue as far as the politics behind the project?

Wheater: Actually, the system underlies both sides. The view of Slovakia was simply that it

could be managed. I don't think the geographical distribution was significant. I think it was really the quite different perspectives on environmental values that constituted the problem. The original project was conceived under the old Stalinist-regime view that you build a big project and then worry about it afterwards. Hungary had moved a step beyond that by saying, "Hold on. We need to think of the precautionary principle here."

Comment: There was a case in the US at Woburn, just north of Boston, in the 1980s about groundwater contamination. It was made into a book called *A Civil Action*, and later a movie.

Wheater: I read the book, saw the movie.

Comment: There's a great quote in the book by one of the lawyers. I think it was Jan Schlichtman who said that environmental cases like that proved to be found at the bottom of a bottomless pit. It's really difficult to get to the processes that are controlling the environmental problem that's being discussed.

Wheater: Yes.

Question: In your case, it sounds like there was really rational debate going back and forth between the two sides. I'm curious to know how the judges were able to handle that level of discussion, how they were able to make decisions without the technical background.

Wheater: Well, there are a few points to make. I think, first of all, both sides had invested a huge amount of effort over a number of years in collecting data and also carrying out various scientific studies. Yet, none of it had been project-managed, so, when it came to assimilating all of this data, there was always something missing. There had never been an overall concept driving the research studies. They'd been done piecemeal by different institutes as they saw their own concerns. So, we had a lot of information. Both sides had a lot of information. But it had never been put together. It was a jigsaw puzzle with big pieces missing. There's a lesson there: there has to be integrated management. And that's another role for models, because it's really only with modeling that you can get to a sufficiently integrated view to understand what the data requirements are. But the key point that you were making was how did the judges cope with all of this? One judge was inclined to doze off in the oral proceedings. He didn't do too well. But most of the judges were very seriously interested. The difficulty that we had was in determining how to pitch the scientific level, how to carry the judges along with the technical argument. So, in fact, what we did was to make a movie of about 20 minutes to illustrate a lot of the concerns, and that was very useful. Then, we had to be very careful in the text that we produced and the images that we produced. I think the judges followed the arguments very well, actually.

Question: Your role, were you an expert witness?

Wheater: No. I was counsel and advocate, which was an unusual arrangement. So, I was making speeches to the Court. It's not really like an American court or an English court. It's very formal. You have a panel of the 15 judges. Each side had its allotted time, which was very, very short. I was nominated by Hungary as one of three people who spoke on the technical issues and essentially presented the arguments to the judges.

Question: So it's not adversarial?

Wheater: It's a controlled adversarial situation, because both sides had two goes. So, Hungary went first, and then Slovakia came second. As a result, Slovakia already had the opportunity to attack the Hungarian case, but through formal presentations. And then Hungary came back, and Slovakia had the last word. There wasn't cross-examination, but there was very heavy criticism. In fact, when I started to present criticisms of the Slovakian modeling studies, I received quite a vitriolic attack.

Question: What was the nature of the lawyers? Were they from Hungary and Slovakia, or were they international?

Wheater: Well, it's an interesting story, because there's a close community of international lawyers, and in this case both sides were led by professors of international law from the University of Cambridge. But there's a very careful balance in a number of senses. Both sides had lawyers from the two countries. Hungary had Hungarian lawyers as part of its team, and indeed so did Slovakia. Formally, the head of the legal team was effectively the head of the ministry of foreign affairs in Hungary and Slovakia. The Court hears proceedings in two languages, English and French. So, although all of the judges speak very good English, it's absolutely essential that the case be presented in English and French. We had French-speaking lawyers as well as English-speaking, and a careful balance of the timing.

Question: I'm curious. The court proceedings were one way in which information was delivered to the Court, but the other way was this enormous stack of documents that you were writing. The question I have for you is: does the Court have technical staff to help them understand or with whom they can converse to gain an understanding of what it is they're reading?

Wheater: They didn't have that kind of technical support. I think the Court is not well resourced, so the judges are pretty much on their own. They ploughed through it. I think, in principle, they could call for expert scientific support of an independent nature, but they didn't choose to do that.

Question: I'm curious about the effects on the agricultural activities in the region. You mentioned that the wet summers may have masked some of the more subtle effects. Has a long enough time elapsed now to get a clearer picture of what the longer-term impacts are going to be?

Wheater: It probably has, but I don't know what they are, and I'm not sure that Hungary does either. There were various tensions within Hungary over the case, as I'm sure there were in Slovakia. For example, the water ministry was supportive of the constructed project, and the environmental ministry thought it so self-evidently damaging that you didn't need to prove it, it was obvious. I was working for the ministry of foreign affairs that had to fight the case. So, there were tensions internally as well as externally. Money for data acquisition was a big issue. We argued right the way through that Hungary should have set up its own internal commission and had its own professional team, employed full-time on the project, and should invest a lot of money into data acquisition and so on. Hungary never found itself able to do that. I'm not sure that the resources went in after the court hearings to continue monitoring at what I would consider

to be at an appropriate level. Certainly, it hasn't been pulled together recently.

Question: Were there other major sources of concern?

Wheater: The issues were mainly associated with wetland species and environmental protection. Perhaps there was an element in the sense that there is an ethnic Hungarian minority that lives in Slovakia just to the north of the affected area. There is certainly a very strong feeling in Hungary that this minority is discriminated against—they're not allowed to use Hungarian as their language and so on. So, there were a few fringe issues like that, but they were minor rather than being the main concern, I think.

Question: Were there protest groups in Hungary?

Wheater: Well, there were movements. There was a group called the Danube Circle that ultimately became very influential. They held meetings and propagated information.

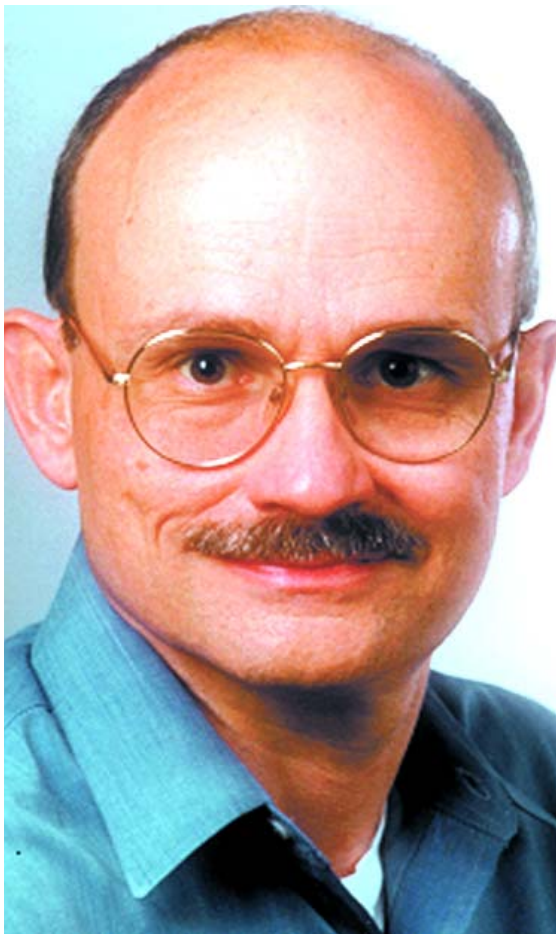
Question: Did the Court make any sort of ruling on the lower dam?

Wheater: This was left rather vague. I think, by implication, the judgment was that it was not necessary. One of the consequences for Hungary could have been that the lower dam was an essential part of the original treaty, and Hungary could have been ordered to complete it. The Court didn't make any such order. When we took the judges on the study tour, field trip, they were very impressed by the scale of the problem, the potential problem to Budapest's drinking water. So, they let that point lie, which, I think, was actually acceptance of the fact that the dam did not need to be built.

Question: What, from your perspective, was the most difficult task in presenting the case and the scientific uncertainties?

Wheater: I think we did quite a good job of laying out where the complexities were, and built a strong case. We already talked a little bit about acceptance of science and difficult descriptions, but the judges also relied quite a lot, I felt, on the perceived credibility of the people who were advising them. I think we managed to convince them by use of some quite strong and fairly clear arguments, plus support from well-known authorities in the field. Concerning the uncertainties, technically, it's extremely difficult to convey those in analysis, and we need a lot of research in that area. It's very computationally demanding, but we can do it now with fast computers—that's the way modeling is moving. I think that, on the whole, the judges managed very well to assimilate the essence of the technical arguments—they're very bright people, and they have had a lifetime of experience in assimilating miscellaneous information.

Christine Dean & Peter Farnum



Science in Service to Society: Utilizing Scientific Resources in Complex Social Environments

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Science in Service to Society: Utilizing Scientific Resources in Complex Social Environments

Like Corvallis, the town where we live has strong agricultural affiliations. We live in downtown Puyallup, in the shadow of Mt Rainier. The soil in our backyard is rich, organic, and about 2 meters deep—first-class horticultural soil by any standards. The shame of it all is that it has houses and warehouses all over it.

When you enter Puyallup, you see a welcome sign that acknowledges the long horticultural and agricultural history of the area. Puyallup has been famous for hops, orchards, berries, and bulbs—a history still celebrated in the annual daffodil parade. The sign also shows the forest, for it, too, has been a very important part of the local region's ecosystem and economy. Puyallup is even famous amongst us forest geneticists as the home of Reini Stettler's hybrid poplar. In the 1980s, Puyallup was renowned for a stand of these hybrids that contained the highest-yielding growth plot in temperate North America.

It is really hard to imagine how this now largely suburban town with strong agricultural roots could become a center of scientific controversy. But it did so happen. Almost a year ago, a group of ecowarriors broke into a greenhouse at the Washington State University extension center in Puyallup—a facility they assumed was involved in research on genetically modified hybrid poplars. Once inside, they confronted row upon row of potted plants. They smashed the pots, stomped on rootballs, and broke water pipes and glass, all to ensure the research was set back as far as possible.

The following day the group issued a communiqué. "The professors and students whose research was destroyed will likely raise a hue and cry," the message read, "but we would respond with the following: scientists have become mercenaries in the war against the earth and the impoverished…. There is no such thing as 'pure' genetics research, it all goes towards commercial applications such as lifeless, monocultured poplar tree farms." The communiqué ended with the promise of "more to come...."[1]

Alas, our brave ecowarriors would have benefited greatly from an elementary class in botany. The plants they destroyed were, in fact, raspberries being grown for experiments on cane disease. Their ecoblunder produced some mocking headlines in the local press, one of which read: "Innocent bushes martyred in war."

As amusing as this story may be, it underscores what is, in fact, a growing problem. The fruits of research, and sometimes the research itself, are increasingly coming under attack, both rhetorical and physical—and not just in Puyallup. Over the last year or so, such attacks have occurred on a variety of crops in different places all around the world. A small sample taken from the web page of the Biotechnology Action Network reveals that attacks have been made on potatoes in New Zealand, pineapples in Queensland, strawberries and wheat in California, maize in Belgium, and forest trees in Canada. Just last summer, an attack took place on the cornfields at Cold Spring Harbor Laboratory where Barbara McClintock's pioneering genetics work was done.

As scientists, we feel that these attacks strike perilously close to home. The goals of many of these research projects are fairly straightforward. Much like our own work, these projects generally involve increasing yield and thereby reducing the ecological footprint of agricultural or forestry systems. Some people are outraged by this research, so much so that they trample crops, destroy experiments, and harass scientists. And these attacks are on the increase. Where does this hostility come from?

Not that any of this is new. Most of us know the story of Galileo Galilei. He believed that the observations he made with his improved telescope supported his theory that the Earth and other planets circled the sun, and that conclusion brought him into conflict with the Catholic Church. Admonished by Cardinal Bellarmino in 1616, Galileo was unrepentant. Tried, sentenced, and sent into exile, he spent almost ten years under house arrest. Only in 1992 did Pope John Paul II reverse his condemnation. At least no one smashed his telescopes—two survive today.

If Galileo suffered from this controversy, why should we think we would be different? Science has evolved under controversy. Many aspects of the scientific method are adaptations to controversy. That is why science is strong and relevant today.

We believe that science can remain strong and relevant, and that we can learn from the controversies in which it is embroiled. This belief is embodied in the central theme of our talk: scientists cannot live in an ivory tower, holding onto pure science and professing disinterest in the social world around us. Consider what Robert Merton, a prominent twentieth-century sociologist and one of the first to consider the sociology of science, noted in 1957[2]:

> Precisely because scientific research is not conducted in a social vacuum, its effects ramify into other spheres of value and interest. In so far as these effects are deemed socially undesirable, science is charged with responsibility. The goods of science are no longer considered an unqualified blessing. Examined from this perspective the tenet of pure science and disinterestedness has helped to prepare its own epitaph.

If we ignore controversy, we only fuel it and we *will* write our own epitaph. Our talk today will answer two questions we believe every scientist should address:

1. What is my social responsibility?
2. How do I carry it out, remaining true to the scientific method?

These are not the only relevant questions, of course, but we think they are two very important ones. We will address them from the perspective of applied scientists; those involved in basic research may come up with different answers.

In answering these questions, we will propose a model of scientific inquiry that we call the Cognizant and Transparent Scientist. A scientist following this approach adopts the rigor of the scientific method, but, by working in multidisciplinary teams and with nonscientists, understands and learns from controversy. She then takes this learning and uses it to do better, but still rigorous, science.

The Scientist's Social Responsibility

In their simplest form, the fruits of applied scientific research contribute to social progress in two ways: they offer us "better" methods or products, and they help us identify and quantify the consequences of our actions. Finding better methods and products, i.e., getting more from less, enables society to make technical progress by improving the utilization of scarce resources. Identifying and quantifying consequences, choosing between more or less, promotes social progress by clarifying the possible ways society can utilize those resources.

In taking this rather limited, applied view, we do not deny the value of basic scientific research with goals not immediately connected to social concerns. Those forms of research often end up contributing practically to social welfare through one of the two categories.

Getting More from Less

Improving the utilization of scarce resources through scientific research has definitely been the case in forestry. Consider the global demand for industrial wood. According to statistics from the Food and Agriculture Organization in 1999, the world consumed almost 1.5 billion cubic meters of wood in 1996. The expectation is that, within a decade, it will consume close to 2 billion cubic meters.

Until the latter half of this century, most wood came from harvesting natural forests, often as part of the conversion of land from forest to agricultural use. Today, about one-third comes from these natural stands, whereas more than half comes from actively managed forests with the help of the many technologies we've developed along the way.

Meeting the increasing demand for industrial wood will be a challenge, but not one that is unmanageable. The important question is not *if*, but *how* the demand will be met. This is surely part of our social responsibility.

Taking different approaches to forestry can produce equivalent amounts of wood with very different impacts on world forests. In 1997, Roger Sedjo and Daniel Botkin showed that meeting today's demand only through the harvest of natural forests would require 1.5 billion hectares of forest land, or up to 40 percent of the world's forests. Growing and harvesting wood from managed forests could decrease the amount of land needed tenfold to 150 million hectares, or 4 percent. Switching to intensively managed, high-yield plantations could decrease it still further to 2 percent, and leave even more of the world's forests in their natural state.

This is one way that scientific innovations can contribute to society. Much of that innovation will come from research in genetics. Most genetics programs in forestry are based largely on traditional selection, breeding, and testing methods with targets for gene conservation, adaptability, and increased yield and quality attributes. These genes make it into the forest through various propagation options, depending on the biology of the particular species concerned.

The key message is that genetics—or any other forestry technology for that matter—is a building block and part of a system. Any single technology area should not be considered in isolation from the rest of the tree-growing-and-processing system. Unless we have the technology and know-how to plant and grow trees, manage them through the rotation, and then process them, all the good genes in the world will not help us make the predicted impacts and meet our responsibilities to society.

Some representative genetic changes have been made in Weyerhaeuser's Douglas-fir program. Increasing changes in growth have been achieved so far by selection, as we moved through plus-tree selection combined with increasing control of pedigree-through-propagation options. Capturing the genetic changes requires an understanding of the implications for tree growing, harvesting, and manufacturing. As a result, we also monitor the changes in our population at an operational level. When we

operationally plant out this selected material, there is no change in the observed range between the selected and wild populations, but there is a shift in the distribution such that a greater proportion of big trees are in the selected group. We monitor these distributions for a number of productivity and adaptability traits.

As the science of biotechnology unfolds, it offers tools with the potential to make even more change. Some view such potential as further progress, whereas other elements of society see only the potential for ecological disaster from such changes. Dismissing these people as alarmists misses the point, even if we disagree with the way in which they make their point. To the extent that scientific research makes changes to the world—in our case, to the forest ecosystem, unintended consequences are always possible and may be detrimental. If we fail to consider and understand the passions that these consequences sometimes evoke, we will slow progress in both scientific and social endeavors.

Choosing between More or Less

A second way that scientific research can contribute to social progress is to help society choose between options that entail getting more or less of something society values. An example again comes from forestry, but this example involves more than just growing trees for industrial wood production. Forestry today is concerned with the whole landscape in which we operate. For us, fish are an important part of that landscape. Because forest practices affect fish habitat, protective regulations in Washington and Oregon govern actions that take place next to streams. One such regulation covers riparian buffers, with greater restraints placed on forestry practices on land next to fish-bearing streams than on land next to nonfish-bearing streams. Wide strips of vegetation may be left around a stream that has fish present, whereas much narrower strips of vegetation may be left around streams that have no fish.

Applying these regulations raises a scientific question: where are the fish? It is a tough question to answer, because there are many thousands of miles of streams in the Pacific Northwest. Yet, answering this question accurately is important. Leaving only small buffers where there are fish has the potential to increase the risk to the fish, whereas leaving large buffers where there are no fish means extra cost to the landowner and no additional benefit to the fish.

Three ways have been used to determine where fish are in Washington State. Under the original system used by the Washington State Forest Practices Board, streams were "typed," as it was called. They were predicted to have or not have fish based on the width and gradient of the stream, as measured from aerial photos. Validation studies later showed these predictions to be wrong 5.9 percent of the time.

A second system replaced the original one after data were collected that showed that nearly all the error came from predicting the absence of fish when fish were actually present. A consensus committee representing advocates for the fish, landowners, and regulators (who after all have to apply the system) then developed an "emergency" system, based mostly on expert evaluation. This second system predicts the presence or absence of fish based on the gradient of a stream and the size and number of pools that are present. Further research has shown that this system predicts fish presence and absence incorrectly 12.3 percent of the time.

A third system, which may be considered at some future point as a replacement for the current system, is a mathematical model with predictive variables, based on geomorphic parameters layered together in a Geographic Information System. Field data show that this proposed system wrongly predicts fish presence and absence only 5.6 percent of the time.

If we took a vote on which was the "best" system to predict the presence or absence of fish, the third system likely would be chosen. It has the lowest total error, making it more "scientific." Yet, this conclusion would be defensible only if we first adopted the point of view that "an error is an error," or that all error is the same. Do the people with interests in forests and fish have this point of view? It seems unlikely. To look more closely at this, let's decompose the total error for each model into false positives and false negatives.

When a model predicts that no fish are present and they are (a false negative), it results in small buffers and less protection for fish in places where protection is needed. When a model predicts fish are present and they are not (a false positive), it triggers regulatory protections that entail extra costs to the landowner. Because landowners and fish advocates (the tribes and the general public) have different interests and values, each has a stake not only in the total error but also in the distribution of error.

As it turns out, these three models produce quite different distributions. The original model produced no false positives, implying no impact to landowners; instead, all of the 5.9 percent error was borne by the fish. Under the emergency system, false positives account for almost all of the error: 11.9 percent false positives versus 0.4 percent false negatives. This means that the error in this system almost always triggers buffers where they are not needed, imposing extra costs on landowners. Finally, the proposed system produces more false positives (4.1 percent) than false negatives (1.5 percent), which means that relatively more of the error is borne by landowners, but not as much as with the emergency system.

Now science has done its job. It has laid out three options for typing streams, presenting policy makers with three possible regulatory systems. The choice of which model to use is then a social decision, not a scientific one.

This example also illustrates how results of research under particular political and social conditions can impact the research itself. Each party bears different costs and benefits from use of the different models. The incentive to conduct further research is at least in part determined by those costs and benefits.

When the evidence showed that the original system imposed risks mainly to the fish, fish advocates used scientific data to get the emergency system adopted. Because this emergency system is still in effect, these advocates are quite content to leave it in place, despite its lower accuracy, because fish do not bear the burden of the errors. Further research is not a high priority for them. For the forest landowners, the opposite is the case. As a result of the high cost of the emergency system, landowners have developed the proposed system to bring the regulations back towards balance.

Carrying Out the Scientist's Social Responsibility

This example now leads us to the second question: how does a scientist carry out her social responsibility and remain true to the scientific

method? One answer is to appeal to what might be called the Ivory Tower Model. In this model, a scientist hides behind the tenets of pure science, believing she is avoiding the influence of values through her professional detachment and disinterestedness.

Thomas Kuhn and others have shown that this is impossible. Values always impact science. They often determine the very problems we choose to study, as in the last example, through their influence on those who fund our research.

Even though values have an impact, this doesn't mean they should lead us to abandon the scientific method. That's what happens in a second model that has been offered as an answer to our question. This model can be called the Precautionary Scientist Model, based, as we shall see, on the precautionary principle.

Recall what that principle states: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically."[3] The first thing to note is that the precautionary principle is a political and social principle, not a scientific one. It recommends a certain course of political action, but it does not tell science itself how to act.

Nevertheless, a model of scientific inquiry in the spirit of the precautionary principle has been developed by Katherine Barrett, a botanist, and Carolyn Raffensperger, an environmentalist,[4] and it is this model we shall consider. The Precautionary Scientist, they write, focuses on "indirect, secondary, cumulative, and synergistic interactions"; emphasizes "acausal relationships such as correlation, pattern and association"; does not insist that "data are quantifiable and replicable"; relaxes the "stringent requirement" that "all theories are predictive across wide-ranging circumstances"; and minimizes Type II errors. The model of the Precautionary Scientist, they argue, "provides a solid basis for the goals and values of the Precautionary Principle."

In other words, this is a scientist who exists to provide support for a particular political philosophy. More importantly, this is a scientist whose whole scientific method is determined by the need to support a particular political and social end. She totally infuses values into science until those values determine her scientific method itself. To us, this isn't science anymore.

Perhaps the best way to illustrate the problems with this model is to consider a corporate analog. Suppose we considered a corporate principle. It might read: "Take whatever action makes the most money for shareholders." The analogous model of the Corporate Scientist is one who would provide a scientific basis for this principle and adjust his scientific method accordingly.

We don't find the Corporate Scientist Model acceptable, and believe most other scientists wouldn't either. Yet, it is just the mirror image of the philosophy that underlies the Precautionary Scientist Model. In short, the scientific method is not the means to achieve a particular political or social end, and that's what's wrong with this model.

We want to present an alternative model of a scientist who can function in a society filled with controversy, what we call the Cognizant and Transparent Scientist Model. This model borrows the best from both of the previous models: rigor from the Ivory Tower Scientist,

not retreating from controversy from the Precautionary Scientist.

Our scientist is *cognizant* because, similar to the Precautionary Scientist, she works in interdisciplinary scientific teams and listens to nonscientists and their points of view. She understands the role of values and uses this understanding to do better science. Further, she acknowledges their influence on her choice of problems, paradigms, and the hypotheses she tests. She doesn't let this understanding warp her rigorous scientific method or turn her science into advocacy. From the Ivory Tower Scientist, she maintains the rigor of detached science. This is where she gets the *transparency* in her methods. She documents and tests ancillary assumptions, submits her results to rigorous peer review, and encourages others to repeat her work.

Here are some attributes of the scientific method that we think are crucial to the functioning of science in today's world of controversy. The Cognizant and Transparent Scientist understands the "fallacy of affirming the consequent"; prefers tested theories that explain mechanisms; relies mostly on quantifiable and replicable data; attempts to replicate tests in multiple environments; and gives equal attention to Type I and Type II errors. Clearly, we can't summarize the entire scientific method. We chose these few points because they are important, *and because we think they are underrepresented and underappreciated in the forestry literature.*

The first characteristic recognizes that an experiment that does not reject a hypothesis, or equivalently appears to support it, does not prove the truth of the hypothesis. Neither do 50 such experiments in different environments prove it. Science has the power to convince, not to prove, and we owe it to society not to claim such proof. Regarding the second, the scientist wants to know why and how, not just whether or not a model successfully predicts. Further, the Cognizant and Transparent Scientist recognizes that replication is the foundation of credibility; she asks others to replicate her work in a wide variety of environments, and over multiple years, to get broad inference space. Finally, she is informed by Type I and II errors, both in the design of her experiments and in interpreting the results.

Our model of the Cognizant and Transparent Scientist is particularly apt for the complex social environment in which we find ourselves today. When do such times occur? During times of "scientific revolution" (per Thomas Kuhn); when new paradigms have been proposed; when scientists disagree on the acceptance of those paradigms; and when the changes in scientific paradigms have profound implications for larger social paradigms.

Note how all four of these criteria were strongly present during the time of Galileo and the Copernican Revolution regarding the physical structure of the universe. They all are present today, as science and society grapple with the effects and implications of the Genetic Revolution. During both of these times, elements in society attacked the institution of science. Almost four centuries ago, the Church (not only Catholic, but Luther and Calvin as well) attacked Copernicus and Galileo; today, ecoterrorists attack scientists conducting research on biotechnology. Science has proven strong enough to withstand such attacks over the years. One of the main reasons for this, we would argue, is because its practitioners have held on to proven scientific

methods—no matter how much pressure we get from society for results.

Conclusions

So here we are. Consider an image of the sun on the horizon. Is it a sunrise or a sunset? Things are not always what they seem. The sun appears to rise and set, and common sense says it travels around the Earth. Likewise, it may seem to some that we are in a time when science is declining in social value and is not meeting society's needs. If that is your view, then you believe the image is a sunset.

We don't think this is true, and are more optimistic than that. We have looked briefly at examples in forestry where science can meet its social responsibilities of getting more from less and clarifying options for choosing between more or less. In terms of how to go about this, we have offered a model of the Cognizant and Transparent Scientist. Such a scientist understands the controversies that occasionally embroil her research; the strength of the scientific method with its emphasis on rigor, replication, and review; the roles that stakeholders, educators, policy makers, regulators, and the general public play in her research; and the need to keep the lines of communication with all these parties open. If scientists adopt this model in these complex social times, we believe the image is a sunrise.

Science has evolved in complex social environments surrounded with controversy and its methods are strong enough to handle it. As we in the forest research arena develop into Cognizant and Transparent Scientists, we can continue the long tradition of scientific contribution to forestry and to society.

Question and Answer Session

Comment: It seems that by arguing against the Precautionary Scientist, we are arguing against the precautionary principle….

Farnum: I say, absolutely not. I would equally say that we argue against the corporate principle, because they are perfect analogs of each other. The corporate principle would say make money for shareholders and construct a science in order to do that. And we don't accept that any more as a way of doing science than we accept precautionary science as a way of doing science. We did not make any comment—and this is very important—we did not comment on the precautionary principle itself, because that's a political view, a social view. It's not a scientific one.

Question: As a political, social view, what do you think about the precautionary principle? Do you think it's made a significant contribution toward analyzing social problems and reaching decisions, using scientific information? Or would you rather not comment on that? I'm wondering about your thoughts on that.

Farnum: I'm not going to comment on the precautionary principle. There's a lot going on in society today that is very valuable for us to learn from. There are a number of things that Barrett and Raffensperger said that, if you notice, we incorporated in the Cognizant and Transparent Scientist. They stressed the importance of listening to society, being aware of society, not trying to hide away from it. That happens in industry, as well as other places. And they stressed the importance of Type II errors. A lot of research that's been done has completely ignored Type II errors. We at Weyerhaeuser

have incorporated into our scientific method much more emphasis on Type II errors. There's value in what they've contributed. There's value in the questions about genetic engineering that people are raising. We're just saying: listen to those questions. Learn from what other people are saying. But don't let it warp your scientific technique. Again, I didn't comment on the precautionary principle.

Question: What kind of scientist was Galileo? You said he recanted.

Farnum: We've got to be easy on Galileo and on the established church, because Galileo existed at a time before all this philosophy of science had been developed. So, he made claims that the sun was really at the center of the universe, and he had evidence for that. But, if you read his work, he had some terrible claims that he made that were just plain wrong. He claimed that tides were caused by the rotation of the earth and the water was just sloshing around. He had claims, and he stood by those claims as proof when in fact he had none. In fact, I would argue that he was a naive scientist, because what he got in trouble for, I don't think, was so much what he said about the structure of the universe. He wrote a long letter about the theological implications of the biblical interpretation of his findings. If you study it, he really got in more trouble for that. Now, we also have to be easy on the Catholic Church, because the Protestant Church, both Luther and Calvin, did a number on Copernicus. I don't want this to be choosing between religions. I think I'd go easy on both of them. We have 350–400 years of hindsight that we have learned from.

Question: Your model of the Cognizant and Transparent Scientist…. One of the tenets—I don't remember exactly what the wording was—was giving equal attention to Type I and Type II errors. I'm wondering if I should take that literally to mean equal attention, or to just be cognizant that both are possible? And if you have any perspectives on how we might view Type I and Type II errors? And if there's some kind of weighting we might give to your perspectives, how we make those kinds of decisions?

Farnum: I think that weighting is really one that should be done by society. The first obligation of the scientist is to try to illustrate what those errors are. The scientist can then go further and explain the implications of those errors. In the original system, it was all Type II errors. It was all risk to the fish. We ought to be able to point that out. Now, if society decides to make the choice that that's acceptable, then that's fine. Our main contribution is to say that that's where all the risk is, and here's the size of the risk. And let society choose. Now, we're members of society and can put a different hat on if we want to participate in that. And that's fine.

Comment: You're apparently on your way to a larger role in Weyerhaeuser research, vice president of research….

Farnum: If I get through this all right….

Question: Weyerhaeuser has a reputation for doing a lot of proprietary research—at least in the past. What will change operationally?

Farnum: That's a good question. Starting in 1996, we made the decision not to do any proprietary research in the environmental area, and, in fact, to do all environmental research collaboratively. And, if you were to go check those research programs, every bit of them is being done collaboratively. Some here at

Oregon State University, some with the National Marine Fisheries Service, some with the Forest Service. That's one area where we decided that being transparent was the only way to go.

Question: What proportion of the budget is that?

Farnum: Forty percent. Now, we got a very good question from the forestry students earlier about Swiss needle cast, and what we've learned about needle cast. That's being published soon in *Silva Genetica*. There are things we're going to hold proprietary—our growth and yield models, and our economic analysis. But we've got to test ourselves every bit of the way as to what the costs and the benefits are. You guys are testing a lot of our wildlife models here. If you just study the trend, you'll see that we're becoming a lot more open and transparent. And you ought to keep calling us on it. That would be a helpful thing to do.

Question: Is there encouragement inside of Weyerhaeuser to interface more with researchers?

Farnum: Encouragement might be one word. There are some people who have said in the environmental area, "You know, the fact that you blankety-blanks haven't gotten that paper published means it's not accepted in society. So, we can't talk about it and use it in the public arena." So, we sometimes get beat on by not being quick enough to get our results out and publish them collaboratively. So, yes, we get encouragement. And sometimes we get criticized for not publishing enough. But keep challenging us. It would be very helpful.

Question: Some scientists have gotten into the habit recently of writing letters to the President, to Congress, and to newspapers, and circulating them on the Internet and getting long signature lists of scientists exhorting policy makers on subjects. Do they exemplify your model of the Cognizant and Transparent Scientist?

Dean: No, I think they exemplify the model of the Precautionary Scientist. And I think it's a misuse of power. I think there's a kind of aura that comes with being a scientist, a kind of credibility that comes with wearing a white coat, with having a PhD or some other series of letters after your name, and that there's a responsibility that comes with that. Part of being a Cognizant and Transparent Scientist is recognizing that sometimes the weight of your opinion can sway people who don't really understand the issues.

Farnum: However, every time a scientist has asked within Weyerhaeuser if they can they sign one of those things, we've said yes. That's up to them as private citizens to do. We don't control that.

Question: Would you comment on the process that Weyerhaeuser uses to listen to society?

Dean: I think there are many layers to the way in which we try to sense information from society around us, and, if we try, to collect information from all of the layers of our organization. For example, scientists are encouraged in the environmental area, as we've just heard, to participate in collaborative research, to go to conferences, to be reading the literature, to be reading and understanding the less-scientific literature—newspapers and so on, and to be taking part in discussions. So, that's one way we collect information. We do structured surveys. We do town-hall type meetings, where our business

leaders will go and talk to the communities in which we operate. We participate in professional societies—the American Forest and Paper Association, for example, and use the tools and instruments that those groups put together to collect cross-sections of information from the public and other stakeholders. So, there's a whole gamut of ways in which we try to collect information. And then we have internal processes in which we try to make use of that information, and help direct either the way we carry out or communicate our business, and, indeed, the way we do our research.

Farnum: We listen to deans and other people from Oregon who are asking: what is sustainable forestry? I have on my computer talks given by Hal Salwasser and Jim Brown concerning sustainability and certifiability. Clearly, these are the issues we are listening to and going to address. The question being raised here in Oregon is: what is sustainable forestry and how do you document that? That's an example of listening. If we put our heads under a bushel and pretend these questions don't exist, we're not being very smart.

Question: You said you rejected the model of the Precautionary Scientist and gave an example of a Corporate Scientist, and you said you've rejected that, too. But I'm curious. Working for a corporation that's profit-driven must have some kind of an impact on your science, one way or another….

Farnum: Yes, and what we tried to say is that it has a very definite impact on the problems that we study. The proposed model—the fish model—was one that was developed originally by a Weyerhaeuser scientist because the emergency rule put so much extra cost on the landowner. We had the incentive to try to come up with a model in the middle. So, in fact, we did. And the fact that we are industrial, that it was costing us a lot, influenced the problem that we chose to study. It didn't influence the method. He still did very good sampling. He did impeccable logistic regression and GIS work. And let the results fall where they may. Values influenced the choice of problems, but not exactly how we did the science. And that's the distinction that we're trying to make. Most of what we study is driven by the needs of the company.

Question: Would you see social responsibility that went beyond just accommodating the existing regulations as part of what a scientist might be involved in to meet the needs of society?

Farnum: Yes. For instance, the work on Swiss needle cast and the publication of that work. The findings are very significant and should be very helpful to the public. And that's an important issue here in Oregon.

Dean: There's clearly a production forestry problem in terms of some parts of the Swiss needle cast problem. Part of the formation of the question to ask was: what is the impact to us? We have a social responsibility to our shareholders, the people who pay our salaries and so on. But we also have a responsibility in terms of the material that we are putting out on the ground that's going to be there for 40 or 50 or 60 years. We have to understand the impact of Swiss needle cast across our land base, and also its impact on the material we choose to plant out that's going to be sitting out there, or standing out there, for a number of years. And so we framed the questions in those ways. We had a production forestry question, which is: what is the impact on the growth of our forests? And we had an adapt-

ability question: what is the impact on the range of material that we plant out and where we choose to put it? So, I think it's multifaceted, and the choice of questions is driven by a set of inputs. The corporate requirement to make money for our shareholders is one of those, but so are stewardship and other responsibilities to the land that we hold.

Question: Given the resource constraints, if you were to use less forest, what are the implications of that?

Farnum: You can go onto the web and go to *Reason* magazine on the web and look up an article in the April 2000 issue, an interview with Norman Borlaug. I don't remember the exact numbers.[5]

Question: I'm a little confused about your example of scientists signing letters or in other ways contacting politicians, about the precautionary principle as being very different than questions about the scientific method. How would you view Transparent Scientists who would be involved in a public process? Obviously, Weyerhaeuser has things in place. What about people in an academic situation who want to contact policy makers? Are they then considered to be your "bad" examples of Precautionary Scientists?

Farnum: I think the exact words Christine used were "abuse of power." Because of the credibility that society gives us, because of our education or what we've been able to do, we have a lot of power. And what Christine was questioning was: will scientists use that power to unduly influence public policy?

Question: But when it is unduly? That's the question. There are issues of policy moving forward that I have the expertise in, and that I know are based on unsound science or very weak science. And then I come forward. Based on your definition, am I a Precautionary Scientist?

Farnum: If you're basing it on sound scientific results, then I think it's fine. I don't see any problem with it.

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[1] Please contact author for source of quote.
[2] Please contact author for additional information on quote.
[3] From: Lessons from Wingspread. In: C. Raffensperger and J. Tickner, editors. *Protecting Public Health and the Environment*. Island Press, Washington, DC, pp. 349–355, at 353–354.
[4] From: Barrett, K. and C. Raffensperger. 1999. Precautionary Science. In: C. Raffensperger and J. Tickner, editors. *Protecting Public Health and the Environment*. Island Press, Washington, DC, pp. 106–122 (all quotes).
[5] From: Bailey, R. 2000. Billions Served: An interview with Norman Borlaug. *Reason* (April 2000). http://reason.com/0004/fe.rb.billions.shtml (July 24, 2002):

> In 1960, the production of the 17 most important food, feed, and fiber crops—virtually all of the important crops grown in the U.S. at that time and still grown today—was 252 million tons. By 1990, it had more than doubled, to 596 million tons, and was produced on 25 million fewer acres than were cultivated in 1960. If we had tried to produce the harvest of 1990 with the technology of 1960, we would have had to have increased the cultivated area by another 177 million hectares, about 460 million more acres of land of the same quality—which we didn't have, and so it would have been much more. We would have moved into marginal grazing areas and plowed up things that wouldn't be productive in the long run. We would have had to move into rolling mountainous country and chop down our forests. President Clinton would not have had the nice job of setting aside millions of acres of land for restricted use, where you can't cut a tree even for paper and pulp or for lumber. So all of this ties together.