



RESOURCES

RESOURCES FOR THE FUTURE

FALL 1994, NO. 117

CONTENTS

The Global
Environmental Effects
of Local Logging
Cutbacks 2

Roger A. Sedjo

Reforming the Rules
for Mining on Federal
Lands 6

Roderick G. Eggert

Is U.S. Agriculture
Sustainable? 10

Pierre R. Crosson

Inside RFF: News
and Publications 11

Environmental Values
and Water Use 19

Kenneth D. Frederick

To Strengthen and Sustain

RFF was established in 1952 to address a national concern that we might soon run out of some of our natural resources. Over the years, the question "Is there enough?" has transformed into "Can we produce what we need in an environmentally sustainable way?" RFF research has kept pace with these emerging concerns.

This issue of *Resources* contains four articles that show how the sustainability issue affects the conservation and use of four natural resources—forests, minerals, cropland, and water. Based on their many years of study, the authors consider whether and how we can maintain commodity production while meeting our responsibility to future generations.

Roger Sedjo examines how local restrictions on logging, designed to reduce regional environmental damage, may have just the opposite effect when the *global* picture is considered. Using a timber-supply model developed here at RFF, he predicts how and where timber production relocates to meet changes in demand and speculates about what the attendant environmental consequences might be.

Roderick Eggert from the Colorado School of Mines traces the development of mining by reviewing the history of the General Mining Law of 1872, still the overarching law governing mining activities on many federal lands. He shows the growing influence of environmental values on mining policies and outlines the key issues in the current debate over the Mining Law's reauthorization.

Pierre Crosson grapples with the question of whether demand for U.S. agricultural products can be met indefinitely at socially acceptable economic and social

costs. His conclusion—that the environmental costs of sediment from cropland runoff may turn out to be the one constraining factor for U.S. agriculture—points to a limitation of which few people are yet aware.

Kenneth Frederick's analysis of water use in this country shows how the emphasis on the marketability of water has been giving way in recent decades to an emphasis on its environmental value. The difficulty of balancing these two values, as he demonstrates, is nowhere more clear than in the environment versus development contests that have developed in the context of the Endangered Species Act.

Just as we have broadened the questions we ask about natural resources, we are expanding the frontiers of research and analysis. For instance, senior fellow Molly Macauley was honored recently for her work in space economics (see p. 11), a relatively new field in resource economics. We also are helping to open resource and environmental economics to new scholars, through academic programs and other activities that encourage students to enter the field and ease the way for young professionals (see p. 11). As always, we are grateful to the generous contributors who sustain us in all of these programs.

Robert W. Fri, President

The Global Environmental Effects of Local Logging Cutbacks

Roger A. Sedjo

The U.S. West has significantly cut back on its timber harvests as a result of logging restrictions. These restrictions, which are now being authorized in British Columbia as well, are intended to reduce regional environmental damage associated with logging activities. But the restrictions could simply relocate such damage because they are triggering increases in timber harvests elsewhere in the world. Ironically, the very environmental concerns that have led to decreased logging in the U.S. West could result in a net increase in global environmental damage.

According to a popular slogan, we should think globally and act locally—that is, regard the environment from a global perspective and act locally to protect it. In the context of land-use policy, however, acting locally often means that environmentally risky activities are curtailed in one locality only to be transferred to another. Depending on where these activities shift, a net increase in environmental damage could result. Such an increase might be the unforeseen consequence of restrictions on the volume of timber that can be harvested in western North America.

These harvest restrictions, which now are being authorized in British Columbia also, already have been imposed on both federal lands and private lands in the U.S. West (especially Oregon and Washington). In the case of federal lands, the restrictions are the outgrowth of environmental concerns, most notably those over the spotted owl. In the case of private lands, they have resulted from a general tightening of various western states' forest practice acts.

Even as timber harvest restrictions help to allay some environmental concerns in western North America, they should arouse similar concerns in other parts of the world. This stems inevitably from the response of the world timber market to timber supply reductions: decreases in the timber harvests of one region spur increases in the harvests of other regions. By identifying the location of these increases, we can begin to determine whether global environmental damage associated with logging will be greater than before regional harvest restrictions were imposed.

Using a timber-supply model (TSM) developed at Resources for the Future in 1990, my colleagues and I have assessed where logging is likely to increase as a result of timber-harvest decreases in western North America. Below, I identify these regions and explain why the severity of environmental damage from logging depends significantly on where that activity occurs. In addition, I make some preliminary speculations about net changes in such damage in those regions where logging is potentially on the rise. Taken together, these regional damages can begin to indicate whether a net increase in global environmental damage will result from a regional restructuring of timber production. Finally, I make several suggestions regarding policies that address the environmental concerns associated with timber harvests.

Predicting changes in the timber market

Because western North America is one of the world's largest producers and exporters of timber, major logging

restrictions in that region could be expected to reduce significantly the volume of timber sold on the world market. However, the timber market typically adapts to such cutbacks. Consequently, reductions in the timber harvests of the U.S. West, which began in the early 1990s, now are being offset by increases in the harvests of other regions. To pave the way for an estimation of any net change in logging damage worldwide, we used our timber supply model to identify the regions where harvesting would increase.

The TSM projects timber production in response to changes in overall timber demand over the fifty-year period, 1990–2040. Its estimates of harvests are based on the assumption that timber-producing regions fall into one of two categories: those that are expected to be responsive to supply and demand forces and those that are not. The *responsive* regions are the U.S. South, the U.S. West, British Columbia, eastern Canada, the Nordic countries, the Asia-Pacific countries, and the emerging plantation region, which includes New Zealand, Chile, Brazil, and other major producers of wood grown on plantations. The *nonresponsive* regions, which are assumed to be increasing their timber production slowly over time in accordance with historical trends, are the former Soviet Union, Europe (excluding the Nordic countries), and all other timber-producing regions of the world. Each of these two groups of regions accounted for about half the world's industrial wood production in the mid-1980s.

In the late 1980s, when we first ran our model to generate a fifty-year timber production forecast, the U.S. West had not yet reduced its timber harvests. In light of its subsequent harvest reductions and the reductions expected in British Columbia, we have revised our earlier forecast. To do so, we decreased the area and inventory of timber available for harvest in each region as originally specified in our model. Specifically, we decreased available inventory

levels by 30 percent in the U.S. West and by 20 percent in British Columbia.

In our revised forecast, the level of timber harvests in the U.S. West and British Columbia is lower throughout the entire fifty-year forecast period than in our original base case scenario, and the average real (inflation-adjusted) price of timber is about 5 percent higher. During the first twenty years of this period (1990–2010), the principal focus of the analysis, our revised projections of the average annual volume of harvest in each of the seven responsive regions indicate that the decline in U.S. West timber harvests will be largely offset by harvest increases both in the United States and abroad.

Location of increased timber harvests

Our revised projections suggest that the global timber-supply system can produce large volumes of wood in response to the incentive of higher prices brought about by harvest reductions. These higher prices are predicted to increase timber production in the Nordic region, the U.S. South, eastern Canada, the emerging plantation region, and other timber-producing regions. In turn, this increased production is predicted to replace about two-thirds of the harvest shortfalls created by harvest reductions in western North America. These forecasts are corroborated by recent experience.

Early in 1993, timber prices in the United States approximately doubled in a period of less than six months. During that period, rising wood prices around the world led to increases in timber harvests in the U.S. South and elsewhere. The upsurge in log prices was volatile, however, and fell rapidly after the initial rise, before rising once again. Today, timber prices have declined substantially from their peak levels, although they have yet to drop to their pre-1993 levels.

While prices were increasing in many other timber markets, they changed much less in the European

market. The soft European prices, together with devaluations in the currencies of the Nordic countries, reduced the competitiveness of many North American timber producers, forcing them to curtail their activity in the European market. These producers redirected their production to the North American market. Thus, eastern Canada and the U.S. South, both of which had increased their timber production in response to rising wood prices, have been able to offset much of the reduction in timber harvests in the U.S. West. Likewise, the 50 percent decline in the U.S. West's wood exports, which resulted from the reduction in the U.S. West's timber harvests, has been offset by yet other regions. New Zealand, Chile, and Russia have filled most of the gap left by the decrease in U.S. West timber exports to the Pacific Basin.

This restructuring of the timber market indicates that the market has adapted well to the harvest reduction in the U.S. West. As British Columbia also reduces its timber harvests, the Nordic countries, eastern Canada, the U.S. South, and the currently major forest plantation regions will be joined by other regions in increasing their timber harvests. Notable among these other regions are Latin America, parts of Asia and Oceania, and Europe.

Latin America is likely to be a major wood supplier during the next century because it has established highly productive plantation forests. Brazil has assumed a major role in the production and export of wood pulp over the past decade or so. Argentina, Venezuela, and Chile are becoming important wood producers, as well as actual or potential wood exporters.

Plantation forests are not the only source of timber in Latin America. The vast timber resources of the Amazon are also potentially exploitable. Traditionally, wood exports from the Amazon have been modest, due in large part to the high degree of heterogeneity in the region's timber species and the inability of markets to utilize effectively lesser

known species. These obstacles are being overcome, and tropical timbers are being used increasingly. Given limitations on supplies of tropical timbers from Asia, increased timber exports from the Amazon are anticipated. Nevertheless, environmental concerns might severely limit the volume of timber produced from the Amazonian native forest.

Like some countries in Latin America, several countries in Asia and Oceania may become bigger timber exporters in the near future. New Zealand, Vietnam, and Myanmar have increased their timber exports in recent years, a trend that is expected to continue. In Malaysia and Indonesia, timber from plantations and second-growth tropical forests could be for sale in major world markets within a decade.

Europe is already a major wood-producing region and is likely to remain so. Because its forests and wood production potential are expanding substantially, it could increase its timber harvests in the event that timber supplies become tight. The Nordic countries have already done so.

During the next twenty years, decreases in western North American timber harvests could be offset in part by increased timber harvests in parts of Latin America, Asia and Oceania, and Europe.

One European country with significant potential for increased wood production is Russia, whose timber exports have been declining since the mid-1980s. The question is whether Russia, the world's second largest producer of industrial wood, can recover as a major wood exporter. While opinions vary, the level of recent Russian wood exports to Japan offers evidence that it can. Russian wood

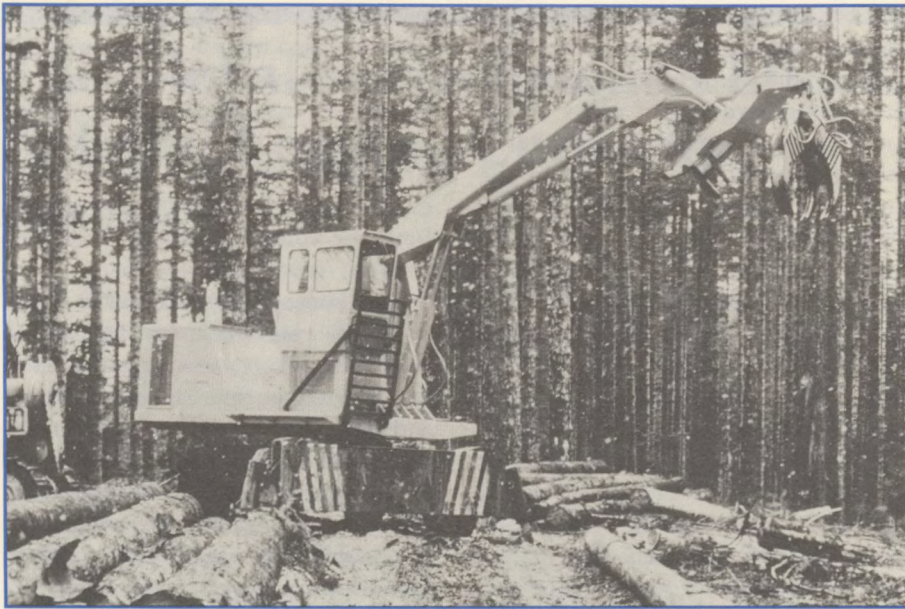


Photo courtesy of Dave Esola, Bureau of Land Management

Environmental concerns led to timber harvest reductions in Washington and Oregon. But the logging damage avoided there will only shift somewhere else. The question is whether the damage somewhere else will be greater than it would have been in the U.S. West.

exports rose 22 percent in 1993 and are anticipated to increase again this year. The future of these exports might be expected to depend in part on the advent of a reasonably orderly political process in that country. But given its vast timber inventories, Russia may not require democracy or even market capitalism for commercial exploitation of its timber resources. Ready markets, especially in the Far East, provide incentives for significantly expanded development of these resources under a variety of social systems.

Environmental effects of relocating logging

As suggested above, in a world where wood products are heavily traded internationally, logging restrictions in one region will simply be offset by logging increases elsewhere. The issue, then, is not *whether* to log but *where* to log. Moreover, even if logging were to decline worldwide, the environmental consequences would not be altogether positive.

The issue of where to log is important because the environmental damage

associated with logging may vary considerably from location to location. For example, damage that results from tree extraction (such as soil erosion) is greater on steep terrain than on flat terrain. Damage to old-growth and other unique forests, which are often highly prized for their preservation values, can be considered more serious than damage to either second-growth or plantation forests. Thus, the global environmental damage associated with logging can increase or decrease, depending on where the logging occurs.

Yet it would be a mistake to assume that net changes in environmental damage can be calculated simply by adding up damage in each locality where logging occurs. In assessing these changes, other factors must be taken into account, including the size of any particular type of forest being logged relative to the total area of forests of the same type. If the damage to a harvested forest is severe but the total area of that type of forest is large, the marginal damage to local and global biodiversity is likely to be modest. By contrast, if the damage to a harvested forest is modest but the total

area of that type of forest is small, the marginal damage to local and global biodiversity could be large. As these considerations suggest, the damage associated with logging is not limited to the areas where timber is actually harvested.

Nor is logging damage necessarily the direct result of timber harvests. If timber production were reduced significantly worldwide, the consequent decline in timber availability would likely promote the substitution of other materials for wood. Although such substitution may appear to be environmentally desirable, it is not an unmixed blessing.

Most, if not all, alternative materials create their own serious environmental problems. For example, metals, cement, and other substitute materials are obtained through potentially environmentally damaging mining or quarrying activities. In addition, most substitute products require considerably more energy to produce than wood products. Increased use of fossil-fuel energy raises the level of carbon dioxide in the atmosphere, contributing to global climate change. Finally, few wood substitutes are renewable, recyclable, and biodegradable.

Environmental effects of timber reductions in western North America

The magnitude and nature of the global environmental effects of harvest reductions in western North America will depend significantly, but not solely, on the location of offsetting harvest increases. Assessing these global effects will require additional research, but the predictions of the TSM enable me to speculate about net changes in regional environmental damage. Such speculation is a starting point for determining whether the harvest reductions in western North America will lead to a net change in global environmental damage.

As noted above, the TSM predicts that the harvest reductions in western North America will trigger harvest increases in parts of Europe (notably the

Nordic countries and probably Russia), parts of Asia and Latin America, and other parts of North America (notably the U.S. South and eastern Canada). Recent timber production and trade information suggests harvests have already increased in some of these regions. A consideration of the natural features of the forested area of three of the regions—the Nordic countries, the South American tropics, and eastern Russia—illustrates how increased logging could affect the severity of local logging-related environmental damage.

Increased harvests of the forests in the Nordic countries may generate only modest additional environmental damages. Logging in these forests does not cause serious erosion and water runoff problems because the forested terrain is generally flat. Since few of the forests contain old-growth timber, the loss of preservation value resulting from logging is negligible. Therefore, a sizable, but not huge, increase in harvest levels probably poses little additional risk to biodiversity.

Increased timber harvests in South America may involve either logging old-growth timber or expanding plantation forests. While the risk to biodiversity is great where old-growth habitat is destroyed, the risk to native habitat from plantation forests can be small. Contrary to popular impression, plantation forests are usually established on degraded agricultural lands, rather than on land cleared of native forests. Accordingly, the environmental effects of plantation expansion are usually negligible. Selection logging in tropical forests, in which only a few trees are harvested per hectare, could lessen damage, particularly if road building is minimized and if large areas of fairly inaccessible forest remain largely undisturbed. These precautions could be especially important in preventing erosion, although this problem is likely to be a small one in the Amazon, much of which is flat.

The environmental effects of increased logging are more difficult to assess in eastern Russia than in South America or the Nordic countries. Sev-

eral natural features of the forests in eastern Russia suggest that damage resulting from logging is likely to be modest. The areas of native forest are vast, and much of the terrain is relatively flat. In addition, Russian forests, like other forests in cold climates, contain considerably less, yet more broadly distributed, biodiversity than tropical forests. However, other natural features of eastern Russia's forests suggest that logging could have serious environmental consequences. The relatively low volume of timber in many of the forests necessitates logging over large areas. In addition, timber regeneration is difficult in many eastern Russian forests, especially in the more northerly regions. Land that remains without an adequate forest cover for a long period of time is at increased risk of susceptibility to environmental damage.

These speculations suggest the difficulty of making comparisons among different localities' logging-related environmental damage. In general, however, logging in plantation forests is likely to be the most environmentally benign, especially when these forests are established on former agricultural lands. Plantation sites are usually flat, and their volumes of old-growth timber and biodiversity are small. By contrast, logging in old-growth tropical forests is likely to be the most environmentally damaging, primarily because the biodiversity is greater in these forests than in any others.

Policy implications

At the beginning of this essay, I referred to the slogan "think globally and act locally," and I suggested that acting locally to protect the environment sometimes could lead to a net increase in global environmental damage. This is certainly a possibility in the case of timber harvest restrictions in western North America. Because much of the damage associated with timber harvests is localized, many people presume that reduc-

ing the harvests in their own region will be environmentally beneficial. What they often do not consider is that much environmental damage is, in its essence, global. Thus the charge to think globally should be emphasized in planning any local action that affects the environment, even in a seemingly positive way.

At a minimum, policymakers should understand that a decision to protect the environment by reducing timber harvests in one region will not necessarily shield that region from the environmental effects of logging. Ultimately, new or increased timber harvests in other localities will affect the global environment. Whether the environmental effects of these harvests is positive or negative depends in large part on where the activities occur.

For this reason, national policies to address the environmental concerns associated with logging ought to follow the example of international policies to control climate change and to protect biodiversity. These international policies recognize that the most efficient way to deal with global environmental problems is to identify the regions of the world where the problems are most severe and to concentrate mitigation efforts there. With regard to logging-related damage, then, the most efficient strategy is to identify the areas where this damage is likely to be greatest and to devise incentives that discourage timber harvests in these areas. Such a strategy may even encourage timber harvesting in areas where that activity is likely to be most environmentally benign.

Roger A. Sedjo is a senior fellow in the Energy and Natural Resources Division at Resources for the Future and coauthor of The Long-Term Adequacy of World Timber Supply, published by RFF in 1990. Information about the timber supply model discussed in this article can also be found in RFF discussion paper 94-13, "Global Forest Products Trade: The Consequences of Domestic Forest Land-Use Policy," by Sedjo, A. Clark Wiseman, David J. Brooks, and Kenneth S. Lyon.

Reforming the Rules for Mining on Federal Lands

Roderick G. Eggert

Over the past eight years, Congress has labored to reform the General Mining Law of 1872, the law that governs mining of hardrock minerals, such as gold and silver, on federal lands. When the law was enacted, mining was thought to be the highest-value use of any land containing substantial mineral deposits. Today, however, mining must compete with other potentially valuable land uses, including preservation. Indeed, environmental protection is one of several critical issues in the ongoing debate over mining law reform and mining on federal lands.

Since 1987, Congress has been struggling to reform the long-standing law governing the exploration for and mining of hardrock minerals on federal lands. Under both the Reagan and Bush administrations, attempts to revise the General Mining Law of 1872 were unsuccessful. Under the Clinton administration, however, these attempts are being given a new push as part of broader proposed changes in public lands policy—changes aimed primarily at increasing the fees for using federal lands and at protecting the environment.

Although this effort failed in 1994, some changes in the General Mining Law seem likely in the future. The extent of such reform is unclear. Critics of the law charge that it is outdated and philosophically inconsistent with rational management of federal lands and therefore requires major changes. Defenders of the law contend that only minor updating and modification are needed.

Below I examine the provisions of the General Mining Law and how the

implementation of these provisions has changed since 1872. Next I discuss the four critical issues on which debate focuses: rules governing land access for mineral exploration and mining, royalties, ownership of mineral resources, and environmental protection. Finally, I speculate about the likely outcome of the current efforts at reform.

The General Mining Law of 1872

The General Mining Law of 1872 allows explorers to search for and mine hardrock minerals—that is, metallic minerals (such as gold, silver, copper, lead, and zinc), as well as a few non-metallic minerals—on many (but not all) federal lands. The law's basic provisions have remained in effect for 122 years. Yet it would be a mistake to view today's law as the same law that nineteenth-century prospectors knew.

When enacted, the major aim of the General Mining Law was to promote mineral development and, more generally, economic development in the U.S. West. Implicit in the law at the time of passage was the belief that mining mineral deposits was always the best use of a tract of land. The provisions of the law included access to federal land on a first-come, first-served basis and established the right of explorers to stake a claim without asking permission from the federal government. Explorers then could maintain an exclusive right to that claim by performing a minimal amount of work on the claim each year. In addition, the law conferred upon claimholders the right to mine a valuable mineral deposit located on a valid claim. In a process

known as *patenting*, claimholders had the right to purchase claims on which they had discovered valuable deposits for a fee of \$2.50 or \$5.00 per acre, depending on the type of claim. Patented land became private property, and owners of such land were not required to pay any mineral tax (or royalty) on production. These generous provisions, not surprisingly, stimulated much mineral exploration and development.

Two important changes have resulted from judicial review and changes in the way agencies in the executive branch implement the law. First, a significant amount of federal land has been placed off-limits to activities under the General Mining Law. In 1920, for example, Congress removed lands containing oil and gas from the jurisdiction of the law and placed them, as well as coal, under a leasing system that provided royalties to the government. In the 1950s, Congress removed most construction materials. More recently, the Wilderness Act of 1964 and the Federal Land Policy and Management Act of 1976 withdrew access for mineral production to many other federal lands in order to protect environmental values.

Second, access to those lands still open for mineral exploration and mining has been made more difficult and costly to obtain, as well as less certain. Public policies now require miners to obtain assessments of environmental impacts, a variety of environmental permits, and other preproduction approvals before proceeding from exploration to mining.

These two changes in the way the General Mining Law is administered reflect the rise of other potential uses for federal lands. Demand for recreation and preservation uses, to name but two, has eroded free and open access for mineral exploration and mining. No longer are those activities automatically believed to be the highest-value use of land containing a mineral deposit.

Despite administrative reforms, the General Mining Law remains under fire. Its critics maintain that the law allows access to land for mineral exploration

and mining under terms that are too favorable for mining, making consideration of other potential uses difficult. They complain that the law does not require payment of a royalty for minerals produced on public lands and that it allows the purchase of public lands at prices far below market values. Moreover, they claim that the law does not adequately protect the environment. Below I examine each of these criticisms, as well as possible reforms.

Land access

Part of the controversy surrounding the General Mining Law concerns the rules governing access to land for mineral exploration and those governing how a miner proceeds from exploration to mining. In both cases, a critical issue is how much discretion the government should have to restrict or deny access for mineral exploration or mining. Because the General Mining Law allows free and open access for these activities, the right to mine is essentially automatic upon discovery of a valuable mineral deposit (subject to meeting other regulatory requirements), and the onus is on the federal government to close lands on which exploration and mining are deemed inappropriate.

Critics of the General Mining Law argue that free and open access is fundamentally inconsistent with the philosophy of federal retention and management of public lands that in the twentieth century has grown to undergird public-land policy. More specifically, these critics maintain that such access implicitly assumes that mining will always be the highest-value use of lands containing valuable mineral deposits.

Defenders of the General Mining Law argue that other federal policies already allow for (some would say, require) consideration of other possible uses of mineralized lands, including preservation. Moreover, they contend that the most environmentally sensitive lands have already been closed to mining and that

assessments of the environmental effects of mining on the remaining open lands usually are required under the National Environmental Policy Act of 1969.

For those who fear that free and open access will not ensure that lands are put to their highest-value uses, three alternatives exist. One approach would be to lessen the involvement of the federal government in the administration of access. This would mean selling large portions of the federal estate to the private sector or transferring them to states. To be sure, national parks and wilderness areas with large environmental or preservation values could remain under federal control.

Because the federal government is likely to retain and manage most of the existing federal estate for the foreseeable future, a second and more realistic way to provide access to minerals would be through a discretionary leasing system similar to that existing for oil, gas, and coal on federal lands. Under such a system, lands would be closed to mineral activities unless specifically opened by

Alternatives to free and open access include transferring large portions of the federal estate to the private sector or states and providing access to that estate through a discretionary leasing system.

the government, and explorers would need permission to initiate exploration and then to mine. Although a leasing system had considerable appeal when mining law reform was discussed in the 1970s, it has not figured in more recent debate. Among other problems, difficulties that have arisen in coal leasing have soured many people on this alternative.

A third alternative would be to allow free and open access to continue except

on those public lands specifically closed to minerals exploration, and then to make approval for mining on lands with valuable mineral deposits dependent on a formal review of other potential uses and environmental effects. In a way, this alternative simply reflects the existing system, under which the right to mine is circumscribed by judicial review and environmental regulation.

Proponents of this third alternative present two arguments for the continuation of free and open access for mineral exploration. First, the environmental consequences of exploration—those associated with geologic mapping, geochemical sampling, and geophysical surveying—are minimal. The most significant environmental damage from exploration (that associated with building roads to transport drill rigs to drill sites) is relatively inexpensive to remedy. Second, allowing free and open access for exploration would foster the collection of all kinds of geologic information, not just that pertinent to mining activities. The current lack of such information is a major problem for land managers trying to compare rationally alternative uses of federal lands.

From the perspective of mining companies, a system that makes the right to mine dependent on a formal review of other potential land uses and environmental effects is less desirable than one that makes this right almost automatic upon discovery of a valuable mineral deposit. As a matter of public policy, however, the outcomes of applications to develop a mine are not as important as the integrity of the process by which these applications are reviewed: what matters is that applications get a fair hearing and are not arbitrarily denied.

Royalties

The General Mining Law requires no royalty payments (or taxes) on mineral production on federal lands, although mining companies are subject to the same income-tax obligations as other

businesses. Critics of the General Mining Law argue that nearly all other owners of mineral properties demand royalty payments as compensation for the privilege of mineral extraction. The federal government does so for production of oil, gas, and coal, while states and private landowners do so for most minerals. Defenders of the law grant this point but counter that mining of hardrock minerals deserves to be treated differently from mining of other minerals. They argue that metal producers are less able than coal producers to pass along cost increases and that hardrock mining is only marginally profitable even in the absence of royalties, the imposition of which would cause many mines to shut down and many miners to lose their jobs.

Even most defenders of the General Mining Law acknowledge that some form of royalty payment is inevitable. Debate over royalties now centers on the exact nature of the tax base, as well as on the tax rate. Congress is considering one tax based on gross revenues and another one based on net income.

Royalties for coal, oil, and natural gas generally are based on gross revenues or production. Such taxes are relatively simple and inexpensive to administer because the only data needed to calculate tax liability are mine or well production and a sales price. They also tend to generate a more stable stream of revenues for landowners than taxes based on net income—mine production tends to vary less from year to year than mineral prices. However, taxes based on gross revenues have the serious disadvantage of not being based on ability to pay. Consider two gold mines with the same level of annual production but different costs and levels of profitability. With a royalty based on gross revenues, the mine that has high costs and is only marginally profitable would pay the same as the mine that has low costs and is highly profitable.

A tax based on net income has the advantage of taking into account ability to pay. Under such a tax, marginally profitable mines would have little or no



Photo courtesy of Ted Lowe, U.S. Bureau of Mines

This open-pit gold mine on public lands in Nevada pays no royalty on its mineral production. If critics of the General Mining Law get their way, that will change. While Congress is likely to include payment of royalties in reform of the law, the whole reform debate may be derailed by disputes over whether and how environmental rules should be made part of the law.

tax liability. Therefore, a net-income tax would not cause such mines to close, at least in the short term. However, this tax has the disadvantage of being more difficult and costly to administer than a gross-revenue tax. For instance, it requires accounting rules defining allowable costs, as well as intensive monitoring and enforcement. In addition, it is more open to creative accounting than a gross-revenue tax.

How a royalty payment would affect the U.S. mining industry depends, of course, on its precise nature. A payment based on gross revenues will cause greater reductions in mineral production and more unemployment than one based on net income. Perhaps more significantly, the effects of any royalty on mine output and employment will be greater in the long run than in the short run. As long as mineral prices are sufficient to cover out-of-pocket operating costs, most existing mines will continue to operate in the short term, although some mines may reduce employment or close. Over time, however, a royalty will discourage investment in exploration, development of new mines, and refurbishment and expansion of existing operations.

Patenting

The General Mining Law makes it possible for claimholders to purchase (or patent) claims containing valuable mineral deposits for a minimal price, after which the land becomes private property. In the debate over the law, the wisdom of allowing miners to patent federal lands with such deposits, as well as the surrounding land necessary for mineral production, has been questioned. Two possible alternatives have been put forward: doing away with patenting altogether and requiring that claims be purchased at market prices.

Critics of the General Mining Law cite two specific problems associated with patenting. First, some people abuse mining patents—for example, by using them for vacation cabins and real estate speculation. Second, the purchase price of \$2.50 or \$5.00 per acre, depending on the type of claim, is well below the price that would be paid in a competitive market for the lands in question. In addition and more generally, patenting conflicts with the current philosophy of government retention and management of federal lands.

Defenders of the General Mining Law say that abuses of patenting have not been as widespread as critics claim. More importantly, they argue, patenting is a form of privatization, which is thought to achieve more efficient use of public lands in general, not just for mining.

Given that patenting has never been necessary for mining to take place, one possible alternative is simply to end the practice. Relatively little patenting has occurred since the first decade of the 1900s, mainly because it costs money to file patent claims; patent requirements have become stricter as the philosophy of federal land management changed from disposal to federal retention and management; and many mining companies have preferred federal rules to the state and local rules that would have applied to private lands. In the last several years, however, companies hoping to avoid the anticipated royalty on mineral production on federal lands have filed an increasing number of patent applications.

The second alternative is to continue the practice of patenting but require that purchasers pay market values for claims—a requirement that would allow the government to be compensated up front for forgone royalty payments. One obstacle to this alternative is the difficulty of determining values in the absence of a market. Competitive bidding might be one way to overcome this difficulty, but it would have to occur prior to exploration or else the incentive to explore would be destroyed. If the number of potential bidders were small, negotiation would be another way to determine market value.

Environmental protection

In the debate over mining law reform, provisions for environmental protection are another source of controversy. The critical issue is the adequacy of existing federal and state environmental rules. Critics of the General Mining Law contend that existing rules are inadequate, while defenders counter that they gen-

erally are adequate or that environmental protection is better handled through environmental legislation than through mining law.

Mining operations currently encounter four types of environmental checks: preproduction rules (assessments of environmental impact, permits, and other environmental approvals that must be obtained prior to mining), rules that apply to ongoing mine and mill operations, postclosure reclamation requirements, and policies for dealing with the problems of abandoned mines. In general, the issues are the same as with other environmental policies: What should be the standards for environmental quality and how should they be determined? What policy tools—such as direct regulation or economic incentives—are best suited to meeting these standards? How should rules be enforced?

The prospect of environmental rules in a new mining law raises other issues. First, would the rules be flexible enough to accommodate site-specific differences in environmental damage from mining? The nature and extent of damage varies enormously from case to case depending on the type of mineral being mined (an oxide or a sulfide), climate (arid or humid), mining method (surface or underground), and the population density in the area surrounding mining operations. Second, how would new environmental rules relate to the large body of existing environmental regulations at both the federal and state levels? Will they complement or supersede existing federal and state rules? Or will they conflict with and complicate the implementation of existing federal and state rules?

Prospects for reform

When considering the prospects for mining law reform, it is worth remembering that once every decade or two since 1872, Congress has considered and ultimately rejected major reform or repeal of the General Mining Law. The possibility that the law will survive cur-

rent reform efforts therefore exists. Yet reform seems likely.

The Senate and House of Representatives both passed reform legislation in 1993. The House bill (H.R. 322), drafted by Nick Joe Rahall II (D-W.Va.), called for a royalty of 8 percent of the gross value of mineral production, an end to patenting, and the establishment of extensive new environmental regulations. The very different Senate bill (S. 775), drafted by Larry E. Craig (R-Idaho), required a royalty of 2 percent of the net value of mineral production, allowed patenting of surface lands but required payment of fair market value, and largely relied on existing state rules to ensure environmental protection. Both bills would have continued the practice of open access to federal lands for exploration. Efforts to pass a compromise bill collapsed in the dying moments of the 103rd Congress.

While predicting the outcome of the reform debate is risky, some changes in the General Mining Law should be expected in the next Congress. Open access to federal lands for exploration will probably continue, but the government is likely to have significant discretion in approving mine plans. Another likelihood is a royalty, probably on the gross value of mineral production and at a rate of 2–5 percent. Patenting is likely to be either eliminated or modified to require payment of fair market value; this issue is not a deal breaker. Disputes over environmental rules, however, could derail the entire reform effort. The Rahall and Craig bills differed entirely on this point, and positions are strongly held. If reform is to occur, the eventual bill may be limited to outlining general principles for environmental protection, leaving the details to be worked out later.

Roderick G. Eggert, an associate professor of mineral economics at the Colorado School of Mines, is the editor of Mining and the Environment: International Perspectives on Public Policy, a book published this year by Resources for the Future (see page 14).

Is U.S. Agriculture Sustainable?

Pierre R. Crosson

Sustainable agriculture could be defined in many ways, including the ability to meet indefinitely the demand for agricultural output at socially acceptable economic and environmental costs. By this definition, the U.S. agricultural sector appears to have performed well in the past with respect to economic cost criteria. But quantitative measures of environmental costs needed to complete this assessment are lacking. By examining past performance, we can imagine plausible scenarios for future performance and make tentative judgments about the continued acceptability of the economic and environmental costs of U.S. agricultural production. Of course, this acceptability may reflect, as it does today, the public's incomplete awareness of the relative size of different environmental costs.

Is U.S. agriculture sustainable? This question is generating increasing interest, as well as confusion. The confusion arises from the lack of a generally accepted definition of sustainable agriculture. Arguments about definitions are mostly a waste of time, because definitions are never right or wrong, only more or less useful. As a useful definition of sustainable agriculture, I propose the following: *a sustainable agricultural system is one that indefinitely meets demands for agricultural output at socially acceptable economic and environmental costs.*

Indefinitely is a necessary part of the definition because concern about sustainability reflects a sense that we have a moral obligation to manage our resources so as not to impair the welfare of future generations. *Costs* are part of the definition because they provide a

measure of whether each generation meets its obligation to subsequent generations. If costs rise beyond socially acceptable limits, whatever those limits may be, the obligation is not met.

Two principal questions arise in making this definition of sustainable agriculture operational: What is the maximum acceptable level of economic and environmental costs of agriculture? Who are the judges of acceptability? These questions have no clear answers. Reaching a social consensus about whether the environmental costs of agriculture are consistent with sustainability is difficult. Environmental costs, unlike economic costs, are not registered in markets. Hence they are not priced, and we lack quantitative measures of them. An additional difficulty is that many people do not agree on the criteria for judging whether environmental and economic costs are, or are likely to be, acceptable into the indefinite future. The criteria might differ with respect to the acceptable level of costs, the relative importance of various costs, and the distribution of the costs within and across generations.

How are these disagreements about the significance of economic and environmental costs to be reconciled? Who decides what level of costs is consistent with a sustainable agricultural system? In the United States, the decision ultimately is made by the social, political, and economic institutions through which those with a stake in agricultural performance—which is practically everyone—negotiate their differences to form a consensus sufficient for decisions to be made. The outcomes often are ambiguous, in some ways even contradictory, and are always subject to review and change over time as information accumulates and values change. The lack of reliable information about

environmental costs is a major contributor to the messiness of the decision-making process. Nevertheless, some tentative judgments about the sustainability of U.S. agriculture—as I have defined sustainability—can be made.

Below I make some judgments about the past economic and environmental costs of U.S. agriculture. I also summarize some findings from a 1992 RFF study for the U.S. Environmental Protection Agency (EPA), in which I explored three scenarios as a basis for making judgments about potential changes in the economic and environmental costs of U.S. agriculture between 1990 and 2010.

Economic costs— past performance

Between 1950 and the early 1990s, U.S. agriculture had impressive success in reducing the economic costs of production—as measured by declining real (inflation-adjusted) prices of farm commodities—despite an almost doubling in crop and animal production. The combination of lower prices and expanded output conveyed substantial economic benefits to consumers of U.S. farm output, both at home and abroad. The high natural fertility of much of the nation's agricultural land, greatly increased use of water for irrigation, and major advances in agricultural science and technology and in the managerial skills of farm people were the key elements in U.S. agriculture's strong economic performance.

It has been argued that the performance of U.S. agriculture since 1950 is not as good as it appears because the economic costs of erosion-induced losses of soil productivity are not reflected in prices of farm commodities. Concern about the effects of erosion on soil productivity goes back at least sixty years in the United States. Despite that concern and the billions of dollars spent since the 1930s to control erosion, it was not until 1977 that data collected by the

continued on page 16

INSIDE RFF NEWS AND PUBLICATIONS

RFF scholar named "rising star" of space age

Molly K. Macauley, a senior fellow in the Energy and Natural Resources Division at RFF, was named one of the twenty-five rising "stars" among people doing work related to the U.S. space program. The selections were made by *Ad Astra*, the bimonthly magazine of the National Space Society. The society recognized Macauley's achievements in space economics, noting that she has put into a new light issues once studied solely in engineering terms. In the *Ad Astra* article "On the Rise" (July/August 1994), Macauley said she would "like to see economic analysis credibly and routinely used in space policy."

While at RFF, Macauley's work in the area of space transportation prompted Congress to include an innovative launch-voucher pilot project in recent legislation pertaining to the National Aeronautics and Space Administration (NASA). Macauley helped develop the concept of launch vouchers, which would be financially backed by the government and distributed to space researchers for redemption on any mode of space transportation. She also



Molly K. Macauley

estimated the administrative costs that might be associated with a demonstration program for the vouchers.

On July 18, Macauley was a guest speaker at a symposium cosponsored by NASA and the University of Maryland on the value of space exploration. An essay based on her speech will appear in the next issue of *Resources*.

Applicants sought for RFF award programs

RFF is seeking applicants for its two award programs—the Joseph L. Fisher Dissertation Awards and the Gilbert F. White Postdoctoral Fellowship Program.

To honor the late Joseph L. Fisher, RFF president from 1959–74, RFF will award fellowships, each in the amount of \$12,000, for the 1995–96 academic year in support of doctoral dissertation research. To be eligible for these awards, students must be writing dissertations in economics or policy sciences and must have completed the preliminary examinations for the doctorate not later than February 1, 1995.

To honor Gilbert F. White, retired chairman of the RFF board, RFF will award one or more resident fellowships for the 1995–96 academic year. The fellowships are intended for postdoctoral researchers who wish to devote a year to scholarly work in the social or policy sciences in areas related to the environment, natural resources, or energy. The fellowships are open to individuals in any discipline who will have completed their doctoral requirements by the beginning of the 1995–96 academic year. Gilbert F. White Fellows are normally in residence at RFF for eleven months.

continued on page 12

Minority careers in economics target of Portney presentation

As part of RFF's effort to attract minority students to careers in research and policy analysis on environmental and natural resources, RFF Vice President Paul R. Portney spoke on July 29, 1994 to participants in a six-week program for minority undergraduates majoring in economics. The annual program, sponsored by the American Economics Association and held at Stanford University, provides advanced training in microeconomics, macroeconomics, and quantitative methods to Hispanic and African American students drawn from U.S. colleges. It also provides opportunities for participants to learn how practicing economists apply economics in their careers.

To illustrate the applications of environmental economics and policy analysis, Portney discussed recent RFF research projects that analyzed the most cost-effective way to reduce air pollution from cars, the relationship between economic development and environmental quality, and, finally, the distribution of environmental risks across races and income groups within individual communities. He ended his talk with a description of three RFF programs designed to advance the careers of individuals working or hoping to work in the field of natural resource and environmental economics: the RFF summer internship program for undergraduate and graduate students; the Joseph L. Fisher Dissertation Awards, which provide fellowships in support of doctoral dissertation research; and the Gilbert F. White Postdoctoral Fellowship Program, which provides eleven-month resident fellowships each year (see "Applicants sought for RFF award programs," at left).

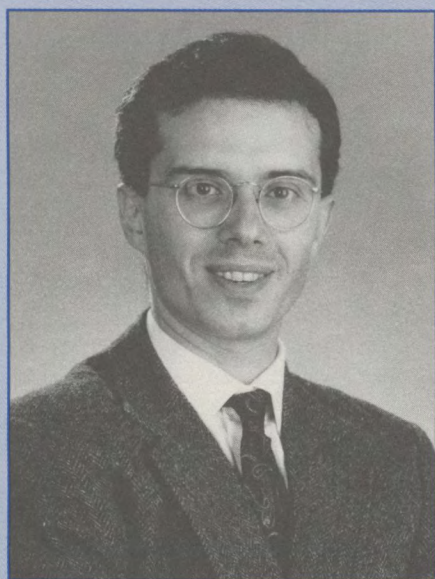


Each year, RFF selects about a dozen college students (mainly graduate students working on advanced degrees) to spend the summer working as research assistants on various RFF projects. Pictured here with RFF Vice President Paul R. Portney are some of the summer interns for 1994: Derek Douglas, Edmond Toy, and Jesse Schwartz (front row); Eric Haxthausen, Nadeja Kovalkova, Stephen Holland, and Theresa DiVenti (middle row); and David Cohen, Feng Liu, Amie Jackowski, Jian Xie, and Michael Newsome (back row).

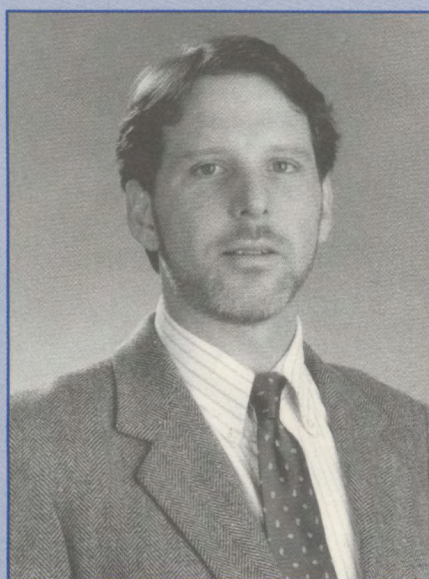
Two new fellows appointed to RFF

Eduardo Ley and Mark Powell joined the research staff of RFF this fall. Ley, who received a PhD in economics from the University of Michigan–Ann Arbor, was appointed to the Energy and Natural Resources Division. Among other efforts, he is working on an economic model that

explains pricing behavior at municipal solid waste landfills. Powell, who received a PhD in ecology from Rutgers University, was appointed to the Center for Risk Management. He is working on an analysis of the current environmental regulatory system.



Eduardo Ley



Mark Powell

continued from page 11

Applications for the Joseph L. Fisher Dissertation Awards and the Gilbert F. White Postdoctoral Fellowship Program are due by March 1, 1995. Awards will be announced no later than May 1, 1995. For more information about the award programs, write to the Assistant for Academic Programs, Resources for the Future, 1616 P Street, NW, Washington, DC 20036-1400. Telephone 202-328-5067. RFF particularly encourages women and members of minority groups to apply.

RFF on the Internet

RFF was connected to the Internet in April 1994. We can receive electronic mail at info@rff.org.

To order **books and reports**, add \$3.00 for postage and handling per order to the price of books and send a check payable to Resources for the Future to:

Resources for the Future
Customer Services
P.O. Box 4852, Hampden
Station
Baltimore, MD 21211
Telephone 410-516-6955

Books and reports may be ordered via telephone. MasterCard and VISA charges are available on telephone orders.

To order **discussion papers**, please send a written request and a check payable to Resources for the Future to:

Discussion Papers
External Affairs
Resources for the Future
1616 P Street, NW
Washington, DC 20036-1400

Canadian and overseas payments must be in U.S. dollars payable through a U.S. bank.

New books

Worst Things First? The Debate over Risk-Based National Environmental Priorities

Edited by Adam M. Finkel and Dominic Golding

Momentum is growing to improve the haphazard way in which America's environmental priorities are determined. Influential members of Congress and federal officials, among others, are asking whether regulators actually devote their greatest attention to problems presenting the greatest ecological and health risks. Priority setting that is more rational and dispassionate, the argument goes, would provide the way out of what some call the "ready, fire, aim" syndrome that characterizes a crisis-of-the-month approach. Increasingly, the technique of comparative risk assessment is advanced as the key to more efficient and sensible planning. Despite its growing popularity, however, some harbor serious doubts about the adequacy of risk assessment for setting priorities.

Worst Things First? The Debate over Risk-Based National Environmental Priorities explores the controversy over selecting an approach to set the nation's environmental priorities.

Even though broad agreement exists that change is necessary, some critics feel the scientific data-collecting procedures of risk assessment constitute an intolerable delay for addressing more obvious and urgent problems; others fear its widespread use in regulatory agencies would move Congress from the center of the advocacy process, replacing public participation with expert elitism. Additional major concerns are uncertainty (do we know a "bigger" risk when we see it?), commensurability (how can we compare cancers and whales?), and "asking the wrong questions" (is ranking problems an intellectual exercise when solutions are what the country really needs?).

RFF convened a major conference in November 1992 to present a forum where EPA could describe its current and future plans for pursuing risk-based planning and hear suggestions for improving its methods, process, and implementation. Advocates of paradigms that give risk assessment little or no role were also able to present their best arguments. *Worst Things First?* contains the papers of that important three-day meeting.

As the papers reveal, broad acknowledgment emerged that, despite EPA's emphasis on one particular paradigm to date, the nation is not yet ready to agree on how to set environmental priorities, let alone on what the priorities themselves should be.

Adam M. Finkel is a fellow and Dominic Golding a former fellow in the Center for Risk Management at RFF.

October 1994. 340 pages.

\$45.00 cloth. ISBN 0-915707-74-8

Pollution Abatement Strategies in Central and Eastern Europe

Edited by Michael A. Toman

Protecting environmental quality while pursuing economic development poses a particularly difficult challenge to the countries of Central and Eastern Europe, where political and economic systems are changing rapidly following decades of environmental neglect and economic mismanagement. This challenge also confronts advanced industrial nations as they approach difficult decisions about priorities and procedures for providing financial assistance to the region. In order to identify workable solutions, *Pollution Abatement Strategies in Central and Eastern Europe* investigates some of the leading pollution problems that these countries now face and examines the link between economic restructuring and environmental improvement.

The book's chapters, all but one of which were reprinted from several recent issues of *Resources*, assess the changes in the region's environmental conditions

likely to result from economic restructuring and the benefits that might arise from improvements. Contributors also consider the design of effective environmental policies for economies in transition, including the need to introduce or reform basic economic, legal, and regulatory constructs.

Comparisons of incentive-based versus command-and-control environmental policies suggest that, despite the difficulties in implementing them, incentive-based policy options are worth pursuing in Central and Eastern Europe.

Michael A. Toman is a senior fellow in the Energy and Natural Resources Division of Resources for the Future.

September 1994. 90 pages.

\$19.95 paper. ISBN 0-915707-73-X

Discussion papers

RFF discussion papers convey the preliminary findings of research projects for the purpose of critical comment and evaluation. Unedited and unreviewed, they are available at a cost of \$6.00 each to interested members of the research and policy communities. Price includes postage and handling. Prepayment is required.

The following papers have recently been released.

- "On the Measurement of Environmental Performance in Firms—Literature Review and Productive Efficiency Approach," by Daniel Tyteca. (94-28)
- "Industrial Wastewater Control in Chinese Cities: Determinants of Success in Environmental Policy," by Xiaoying Ma, Scott Rozelle, and Leonard Ortolano. (94-29)
- "Market Barriers, Market Failures, and the Energy Efficiency Gap," by Adam B. Jaffe and Robert N. Stavins. (94-30)
- "Discounting for Damage Assessment," by Raymond J. Kopp. (94-31)
- "The Energy Upheavals of the 1970s: Socioeconomic Watershed or Aberration?" by Douglas R. Bohi and Joel Darmstadter. (94-32)
- "Asymmetric Information, Credit, and Technology Choice in Developing Agriculture," by Allen Blackman. (94-33)

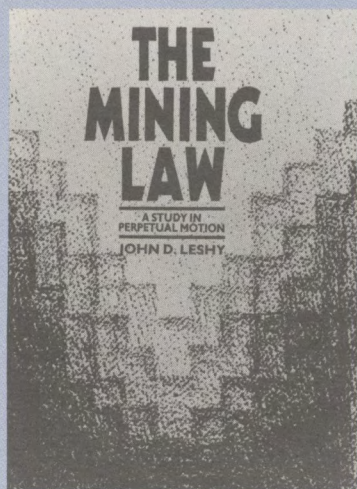
- "Random-Effect Models of Willingness to Pay Using Discrete Response CV Survey Data," by Anna Alberini, Barbara J. Kanninen, and Richard T. Carson. (94-34)
- "Intelligent Transportation Systems: An Economic and Environmental Policy Assessment," by Barbara J. Kanninen. (94-35)
- "Estimating Patent Value and Rivalry Effects: An Event Study of Biotechnology Patents," by David H. Austin. (94-36)

About contributions to RFF

Resources for the Future sustains its programs through its endowment and through income from government agencies, individuals, corporations, and foundations. RFF accepts grants on the condition that it is solely responsible for the conduct of its

research and the dissemination of its work to the public. RFF does not perform proprietary research. All contributions to RFF, a publicly funded organization under Section 501(c)(3) of the Internal Revenue Code, are tax deductible.

Mining and Minerals from RFF...



The Mining Law: A Study in Perpetual Motion

John D. Leshy

"A definitive account of federal mining policy from the era of the California Gold Rush to the present...Leshy concludes this lucid and judicious legal study with some constructive policy recommendations."

—*Western Library*

"Sufficiently technical and scholarly to be useful for lawyers and at the same time sufficiently free of jargon and clearly organized so as to be understandable to nonlawyers."

—*Rural Development Perspectives*

1987 / 521 pages (index)

ISBN 0-915707-26-8 (cloth) • \$35.00

The World Aluminum Industry in a Changing Energy Era

Merton J. Peck, ed.

"A worldwide history of the aluminum industry, with emphasis on the mobility of resources in a global market...The issue of scarcity of resources is highlighted very well by each author."

—*Journal of Energy and Development*

1988 / 231 pages (index)

ISBN 0-915707-42-X (cloth) • \$30.00

Mineral Wealth and Economic Development

John E. Tilton, ed.

"This is an excellent book, recommended for public policy makers, multinational mining company managers, international bankers, and anyone interested in the business of mining."

—*Forum for Applied Research and Public Policy*

1992 / 121 pages

ISBN 0-915707-62-4 (paper) • \$22.50

World Metal Demand: Trends and Prospects

John E. Tilton, ed.

Analyzes the decline in the long-run growth of metal consumption since the 1970s—a decline which, paradoxically, coincided with mounting concern about global resource adequacy.

1991 / 341 pages (index)

ISBN 0-915707-56-X (cloth) • \$45.00

Mining and the Environment: International Perspectives on Public Policy

Roderick G. Eggert, ed.

Noted analysts provide viewpoints from Australia, Chile, the U.K., the U.S., and the European Community on issues and challenges that heightened environmental concern is raising for metal mining.

1994 / 172 pages

ISBN 0-915707-72-1 (paper) • \$25.00

World Mineral Exploration: Trends and Economic Issues

John E. Tilton, Roderick G. Eggert, and Hans H. Landsberg, eds.

"Leaves the reader with a very good understanding of what drives world mineral exploration, and the recent trends in exploration productivity. This book stands alone in presenting and analyzing data on trends in mineral exploration."

—*Economic Geology*

"The high quality of the contributions ensures that this is, and for some years is likely to remain, the definitive work on the subject."

—*Resources Policy*

1988 / 464 pages (index)

ISBN 0-915707-28-4 (cloth) • \$75.00

Especially for RFF donors: Year-end tax considerations

Many people evaluate their charitable giving as the tax year comes to a close. For donors who are planning charitable gift contributions, the Resources for the Future Gift Fund is a good way to save on taxes in a year when personal income is particularly high. A single gift to the RFF Gift Fund will fund your charitable giving for the next several years, but the tax deduction is taken in the first year.

The RFF Gift Fund provides donors with two benefits. First, donors have the opportunity to make contributions that qualify for a current income tax charitable deduction. Second, donors can recommend future distributions from the RFF Gift Fund; these distributions may be to the RFF general fund or to other qualified tax-exempt organizations, such as hospitals, churches, or universities.

Gifts to the RFF Gift Fund are unconditional, with RFF retaining control over the use of the funds. The donor is encouraged, however, to advise RFF about the distribution of fund assets. Contributions to the RFF Gift Fund are placed under professional investment management and compounded until distributions are made.

Even if the RFF Gift Fund is not the most appropriate way for you to plan your charitable giving this year, keep in mind the benefits of making gifts of appreciated securities, which are deductible up to full market value, rather than cash.

For more information about the RFF Gift Fund, gift annuities, gifts of appreciated securities, bequests, or other types of planned gifts, please contact RFF Vice President-Finance and Administration Ted Hand at 202-328-5029 or check the appropriate box on the enclosed reply envelope.

Recent contributions from individuals

The following individuals made gifts of \$100 or more between June 10 and September 16, 1994, in support of research and education programs at Resources for the Future:

Anonymous (5)	Robert Haveman	Paul Rodzianko
Christopher C. Aitken	Kenzo Hemmi	John W. Rowe
Michael and Marilyn Barth	Robert L. Hirsch	Hisao Saka
Richard W. Beatty	Holland Hunter	Roger and Vicki Sant
Thomas H. Birdsall	Tetsuya Imai	Jack and Jean Schanz
G.S. Birkhead	H. Felix Kloman	Glenn R. Schleede
William A. Butler	John V. Krutilla	William R. Sizemore
Richard and Julie Carson	Thomas H. Lee	Flora Stetson
Emery Castle	Xiaoying Ma	Edward L. Strohbehn, Jr.
Marion Clawson	Jan W. Mares	Linda G. Stuntz
W. Meade Collinsworth	Dade W. Moeller	Russell E. Train
Robert and Nancy Dorfman	Madeleine Nawar	Charles L. Trozzo
Kenneth R. Farrell	Guy H. Orcutt	Pan-Long Tsai
Bob and Jill Fri	Edward L. Phillips and Laurel Murphy	Victoria Tschinkel
Tom and Sandy Friedland	Frank Press	Akihiro Watabe
Jerry D. Geist	Paul C. Pritchard	David L. Weimer
John D. Graham	R. Rajagopal	Macauley Whiting
Donald L. Guertin	William C. Rense	Eric Zausner
Jerry Harkins		

The following individuals made gifts between June 10 and September 16, 1994 in memory of former RFF President Joseph L. Fisher, in whose name RFF has established dissertation awards to support graduate students in the final year of their dissertation research on environmental and natural resource issues.

Anonymous	Kevin C. Gottlieb	J. Paxton and Shirley M.
Garry D. Brewer	John V. Krutilla	Marshall
		Robert C. Mitchell

Recent contributions from corporations and foundations

RFF received contributions from the following corporations and foundations between June 10 and September 16, 1994:

3M	Mitchell Energy and Development Corp.
AT&T Foundation	Olin Corporation Charitable Trust
AlliedSignal Inc.	Phillips Petroleum Company
American Petroleum Institute	The Procter & Gamble Company
BHP Minerals International	S.C. Johnson Wax
CF Industries, Inc.	Southern Company Services
Champion International Corporation	Sun Company, Inc.
Chemical Manufacturers Association	Texaco Foundation
Chevron Corporation	Uniroyal Chemical Company, Inc.
Consolidated Edison Company of New York, Inc.	WMX Technologies, Inc.
Eastman Chemical Company	
FMC Corporation	RFF also received matching gifts from the following:
Vira I. Heinz Endowment	
John W. Henry & Co., Inc.	The Freedom Forum
IBM	The Gillette Company
The James Irvine Foundation	Morgan Guaranty Trust Company of New York
The Manitou Foundation	WMX Technologies, Inc.
The Andrew W. Mellon Foundation	
Merck & Co., Inc.	

continued from page 10

Soil Conservation Service, an agency of the U.S. Department of Agriculture (USDA) permitted actual measurement of the effects.

A study that a colleague and I did at RFF used these and other data to examine the effects of soil erosion on the trends of yields (output per acre) of corn,

If farmers have not undertaken additional erosion control measures, it must be because the cost of doing so would exceed the returns from eliminating erosion-induced soil productivity losses.

soybeans, and wheat in some 600 counties in Illinois, Iowa, Kansas, and Nebraska between the early 1950s and the early 1980s. The study showed that erosion had no significant effect on the trend of wheat yields. The effect on yield trends for corn and soybeans was significant, but small: over the thirty-year period the average annual increase in corn yields—1.98 bushels—was 4 percent less than it would have been absent erosion. The average increase in soybean yields—0.44 bushels—was 1.5 percent less.

These erosion effects must have tended to increase the economic costs of corn and soybean production in the region studied. It does not follow, however, that the costs of these crops would have been lower, and farm and national income higher, if farmers had taken additional measures to control erosion. Such measures would increase farm costs, and farmers are highly cost-conscious in managing their operations. If farmers did not undertake additional erosion control measures, it suggests that the cost of doing so would have exceeded the returns received from eliminating erosion-induced productivity losses.

This assertion assumes that farmers were aware of both the cost of erosion-induced productivity losses and the cost of erosion control measures. The assumption may be wrong, but I do not think so. Farmers have a strong incentive to protect the long-term value of land because land is their most important single asset. If erosion were a significant threat to the land's value, farmers would know it. Moreover, soil conservation districts, which provide advice and (through the USDA) financial support to farmers for the control of erosion, would have alerted farmers to the threat of soil erosion. Thus, farmers have had the tools they needed to control erosion in those circumstances where control would serve their economic interest. It follows that had farmers sought to eliminate all the effects of erosion on corn and soybean yields, their production costs would have been higher than they were. Accordingly, judgments about the performance of agriculture in meeting the economic cost criterion of sustainability would be less favorable than they are.

Economic costs— future performance

Whether U.S. agriculture will continue to have success in meeting the criterion of economic sustainability into the indefinite future is problematic, since future events are inherently uncertain. Despite this uncertainty, recent experience suggests plausible scenarios for changes in the economic costs of U.S. agriculture. In a 1992 study for EPA, I explored three such scenarios, which I called business as usual, competitive edge, and environmentally friendly. Under each scenario, I investigated the economic costs (as well as the environmental costs) in the period 1990–2010 of producing grains and soybeans, the crops that are the main users of land and other resources. Below I outline these scenarios and their implications for future cropland erosion and for the

future adequacy of supplies of land and water for grain and soybean production.

The *business-as-usual* scenario is based on continuation of 1980s trends in domestic and foreign demands for U.S. production of grains and soybeans, in prices of production inputs, and in technical and managerial improvements in grain and soybean production. The *competitive edge* scenario assumes that improvements in technology and management would proceed at a more rapid pace than under the business-as-usual scenario. These rapid advances would permit U.S. farmers to increase their penetration into foreign markets, resulting in more production than under the business-as-usual scenario. The *environmentally friendly* scenario assumes that dietary changes in the United States would result in less growth in domestic demand for grain and soybeans for animal feed and that foreign demand would slacken because of developing countries' continued success in producing these crops. As a result, grain and soybean production in 2010 would be only slightly greater than that in 1990.

None of the three scenarios would be likely to put enough pressure on U.S. agricultural capacity to increase the economic costs of grain and soybean production, unless the nation's agricultural research capabilities were greatly diminished. Although real public spending on agricultural research has increased little if at all over the last decade, private research outlays have continued to rise. Moreover, the increases in technological and managerial advances underlying the three scenarios are comparable to the relatively modest increases experienced over the last decade or so.

Supplies of land appear to be quite adequate to accommodate the production levels stipulated in the three scenarios, given the modest increases in crop yields expected from future technological and managerial advances. The United States now has over fifty million acres of cropland in reserve programs. The economic costs of returning this land to crop production would be low.



Photo courtesy of U.S. Department of Agriculture

Sediment carried in runoff from farmer's fields can damage the quality of surface water. Farmers have little incentive to control sediment damage costs because these costs are borne mostly by nonfarmers.

When returned to crop production, much of the land now in reserve would be subject to higher erosion than land presently in production. However, studies done in the early 1980s by me at RFF, by soil scientists at the University of Minnesota, and by soil scientists and economists at the USDA show that if cropland erosion were to continue at early 1980s rates for 100 years, crop yields at the end of the period would be only 3–10 percent less than they would be in the absence of erosion. Such small productivity losses could not significantly affect the future economic costs of production.

Future supplies of water for irrigation are likely to be more constraining than supplies of land. Studies done at RFF and elsewhere indicate that present rates of groundwater use in the High Plains of Texas, Oklahoma, Kansas, and parts of Nebraska will exhaust the economic life of that resource within a few decades. Indeed, that outcome is already evident in the Texas Panhandle and other parts of the southern High Plains.

Rising urban demands for water and for maintenance of instream flows to protect aquatic habitats are also likely to constrain future supplies of irrigation water (see "Environmental Values and Water Use" on p. 19). The result would be an increase in the economic costs of

irrigation in the arid and semiarid west, where most irrigated crop production now occurs. Studies show, however, that significant opportunities for expanded irrigation exist east of the Great Plains. These opportunities, plus the availability of land in that region for additional rainfed production, suggest that the increasing scarcity of water for irrigation in the west will not significantly affect the future economic costs of production in the nation as a whole.

Environmental costs— past performance

In discussions of the sustainability of U.S. agriculture, environmental costs (or the damage done to the environment) excite more concern than economic costs. I deal with three of these costs: losses of plant and animal habitat, damage to groundwater quality from the use of pesticides and nitrogen fertilizer, and damage to surface water quality from sediment carried in runoff from farmers' fields.

Losses of habitat. Wildlife habitat (quite) probably suffered from the decline over the past fifty years in the amount of U.S. land in grassland pasture and range and the conversion of much of this land to cropland. The

quality of habitat is positively related to vegetative diversity, and grassland pasture and range generally are vegetatively more diverse than cropland.

Wildlife habitat probably also suffered from changes in cropping practices and farm size. Until the 1950s, the typical U.S. crop farm raised animals. It also rotated a cash crop, such as corn or soybeans, with a soil-nutrient-restoring leguminous crop, such as alfalfa. But in the 1950s, crop farms began to shift away from this system toward one featuring only a single cash crop, such as corn, or a rotation of two cash crops, such as corn and soybeans. This shift in farming systems reduced the vegetative diversity on the land, with adverse effects on wildlife habitat. The shift in farming systems was accompanied by increasing farm size and the removal of fences and hedgerows. The removal of hedgerows and the vegetation around fences eliminated excellent wildlife habitat.

The drainage of wetlands to plant crops also has had unfavorable effects on wildlife habitat, especially for migratory waterfowl. At present, the nation has 90–100 million acres of wetlands, roughly 15 million acres less than in the mid-1950s. More than 85 percent of the wetland losses since the 1950s have resulted from the conversion of wetlands to agricultural uses, mostly crop production.

It would seem clear that increases in agricultural production and changes in agricultural technology have degraded wildlife habitat in the United States over the last fifty years. Yet studies done at RFF and elsewhere show that, with the important exception of waterfowl, populations of most species of wild animals in the country increased, or at least did not decrease, in number during this period. Populations of waterfowl seem to have stabilized since the late 1960s. The apparent anomaly of degrading farmland habitat and of generally increasing or stable numbers of wildlife may be explained in two ways. One is that the productivity of the remaining wildlife habitat on farms may have been

increased by federal and state government programs designed for that purpose. The other is that wildlife habitat on nonfarm rural land probably has improved over the last forty or fifty years. For example, land in wildlife refuges under the jurisdiction of the U.S. Fish and Wildlife Service increased from a little more than nine million acres in 1950 to forty-three million acres in 1975. Moreover, since the 1940s, land in forests in the country has increased slowly but steadily, especially in the northeast. Among the various kinds of land cover, forests provide the best wildlife habitat.

Pesticides and nitrogen in groundwater. Over the last forty or fifty years the quantities of pesticides and fertilizers that American farmers apply to their fields have increased manyfold. Many people have been concerned about the environmental consequences of these materials, particularly for human health and wildlife. The human health concerns have focused largely on pesticide and nitrate contamination of groundwater used for human consumption. A survey of such contamination undertaken by EPA and published in 1992 suggests that

If sediment damage to water quality were charged against the farm income account, the performance of the agricultural sector would appear less favorable than it now does.

these concerns are less well-founded than is commonly believed. The survey found that about 1 percent of the nation's wells had pesticide concentrations high enough to pose a threat to human health. It also showed that some 4.5 million people (2 percent of the U.S. population) drink wellwater in which nitrate concentrations exceed the U.S. Public Health Service's standard of 10

parts per million. About 67,000 of this 4.5 million are babies under one year old—the population most threatened by methemoglobinemia (“blue baby syndrome”), which is caused by high nitrate concentrations in drinking water. Before 1960, infant deaths from methemoglobinemia attributable to nitrates in farm wells were occasionally recorded. Today, occurrences of blue baby syndrome are so rare that major health organizations no longer keep statistics on it.

Sediment damage to water quality. This damage includes the loss of water's value for recreation, the loss of fish spawning sites as a result of sediment deposition, the cost of dredging ports and navigable rivers, and the cost of cleaning water for industrial and household users. According to a 1989 USDA study, the annual costs of damage to water quality from sediment originating on farmers' fields was \$4–5 billion in the mid-1980s. This amount was 20–25 percent of net farm income exclusive of direct government subsidies paid to farmers. These percentages suggest that, if the sediment damage to water quality were charged against the farm income account, the performance of the agricultural sector would appear much less favorable than it now does.

Moreover, the costs of sediment damage likely rose over the last forty or fifty years. The quantity of sediment delivered to waterways probably did not increase and may have decreased. However, the real (inflation-adjusted) value of surface waters was much greater in the 1980s than in the earlier years because the growth of the population and the economy greatly stimulated the demand for the various services of the water, the supplies of which were little changed. Consequently, the environmental cost of sediment damage *per unit of sediment delivered* probably rose over the last several decades. My guess is that the rise in unit costs of damage probably was greater than the possible decline in quantity of sediment delivered, so that the total cost of the damage rose.

It is worth pointing out that if I am right about the two kinds of erosion

costs—losses of soil productivity and off-farm damage from sediment—then the costs of sediment damage are a substantially greater threat to the sustainability of American agriculture than the costs of productivity loss. The balance of the evidence, as I read it, indicates that the costs of productivity loss are both trivial *and under socially acceptable control* by farmers. In contrast, the costs of sediment damage are much higher, *and farmers have little incentive to control them because they are borne mostly by nonfarmers.* The policy implications seem clear: leave farmers to deal with the soil productivity problem and focus publicly funded efforts on dealing with the sediment damage problem.

Environmental costs— future performance

Charting the future of the three kinds of environmental costs discussed here—losses of wildlife habitat, pesticide and nitrogen contamination of groundwater, and sediment damage to water quality—must be highly speculative. But, again, the three scenarios of future agricultural performance I have explored make some tentative judgments possible.

In the environmentally friendly scenario, all three environmental costs decline over the period 1990–2010 because of small increases in production and the increasing adoption of environmentally friendly technologies, such as integrated pest management. But this environmentally benign future is built into the scenario. Of greater present interest are the business-as-usual and competitive edge scenarios. Both scenarios hold the potential for increased environmental costs. But present trends in policy, and in the environmental thinking reflected in policy, suggest that, even in the competitive edge scenario (under which agricultural production is relatively high), the environmental costs of habitat loss and of pesticide and fertilizer damage to groundwater will be held within socially acceptable

limits. The Endangered Species Act and strong policies to control drainage of wetlands already are in place. These policies reflect the nation's awareness of the importance of protecting wildlife and the habitat on which it depends. To be sure, these policies are not always enforced to everyone's satisfaction, but they are evidence of the country's commitment to protecting wildlife values.

The country has expressed high and sustained concern about the potential environmental costs of pesticides. Present trends toward reduced use of these substances and adoption of integrated pest management reflect this concern. I expect these trends to continue.

In contrast, the environmental community is not much exercised by present and potential threats of sediment damage to surface water quality. Muddy water does not arouse moral indignation, even though its damage to the social welfare may be considerably greater than some other environmental threats. I do not expect amounts of sediment delivered to surface water to increase much, if any, under either the business-as-usual or competitive edge scenarios. I do expect the cost of sediment damage to increase, however, because of continuing increases in the economic and environmental value of water and because of the absence of effective policies to deal with the damage.

Is U.S. agriculture sustainable?

As I indicated at the outset, the question of whether the U.S. agricultural system is sustainable has no clear answer. In my judgment, however, U.S. agriculture has met and will continue to meet the economic criteria of sustainability. The much harder part of the question concerns the environmental part of the equation.

Environmental costs almost surely rose over the last forty or fifty years, thus becoming a greater proportion of total costs (since economic costs declined). The American people decided at least a couple of decades ago that, in the absence of controls, the agricultural-

ly imposed environmental costs of habitat loss and pesticide damage would be socially unacceptable, and control policies were adopted. I believe the policies will continue to do the job over the next several decades. No comparable policies have been adopted to control sediment damages. The public evidently is prepared to accept this damage even though its costs, present and prospective, arguably are substantially higher than the costs of habitat loss and pesti-

cide damage. If so, then, by the definition of sustainability adopted here, the costs of the damage are consistent with the sustainability of the country's agricultural system. Whether acceptance reflects full public awareness of the relative size of the sediment costs remains, for me, an open question.

Pierre R. Crosson is a senior fellow in the Energy and Natural Resources Division at Resources for the Future.

Environmental Values and Water Use

Kenneth D. Frederick

During the first seventy years of this century, investments in water resources were driven largely by a desire to control water flows and ensure their availability for domestic, industrial, and agricultural users. In contrast, water-related investments and legislation during the last quarter-century have been driven largely by a desire to protect and restore the nation's water resources and aquatic environments. The first approach took a heavy toll on the environment and instream water uses; the second is imposing high economic costs, in many instances with little indication that the social benefits exceed those costs. The importance as well as the difficulty of balancing the economic and environmental values associated with water use are evident in the litigation over the implementation of existing environmental legislation—in particular, the Endangered Species Act. This balancing of values is key to the debate over reauthorization of the act.

Philosophies guiding the development and use of water resources in the United States have changed greatly during this century. In the early

1900s, rapid construction of dams, reservoirs, and canals proceeded in line with the utilitarian view that dominated water development and use decisions. In that view, leaving water resources unused would be wasteful if those resources were capable of producing crops, power, and other valued products. By the early 1970s, however, growing concern about the effects of rapid growth in water use and development on water quality, fish and wildlife, and natural habitats began to be reflected in environmental legislation. Today, the conflict between water development and environmental protection is evident in controversies surrounding the implementation of much of that legislation. But that conflict is not merely a product of the greater environmental awareness of the last few decades; it has existed throughout the history of water development projects in this century.

Below I examine that history, paying particular attention to the environment versus development contests that have arisen in the context of the Endangered Species Act. I also examine two specific instances in which the difficulty of balancing the economic and environmental interests associated with water use is perhaps most evident today—the develop-

ment of the Columbia River basin and the relicensing of hydroelectric power plants.

Transforming the nation's waters

The nation's first major struggle between environmental interests and water development began in 1901, when the city of San Francisco initiated plans to dam the Tuolumne River in the northern part of Yosemite National Park. San Francisco's plans to develop water supplies and hydroelectric power would flood Hetch Hetchy Valley, extolled as one of the nation's most beautiful and inspirational sites. But efforts to preserve the valley eventually proved futile when Congress approved the flooding of Hetch Hetchy in 1913.

Although preservationists were successful in thwarting subsequent proposals to flood sections of national parks and monuments such as Yellowstone, Glacier, Kings Canyon, and Echo Park, builders encountered little opposition to most dam projects for the next half century. Water projects were promoted and often subsidized to encourage development of the U.S. West; to increase employment, first during the Great Depression and then during the economic transition following World War II; to reduce flooding; and to provide cheap power, transportation, and abundant, reliable water supplies for homes, farms, and factories. Large-scale projects in particular were touted as examples of enlightened use and development of the nation's water resources; they represented a triumph of technology and human enterprise over the uncertainties of nature. And as the demands for the outputs provided by water development mounted, ever-larger projects were proposed to reduce conflicts associated with management of a multiple-purpose dam.

The rate of dam construction accelerated to a frenetic pace following World War II. More than 35,000 new dams were completed between 1945 and 1969, nearly four per day over the twenty-

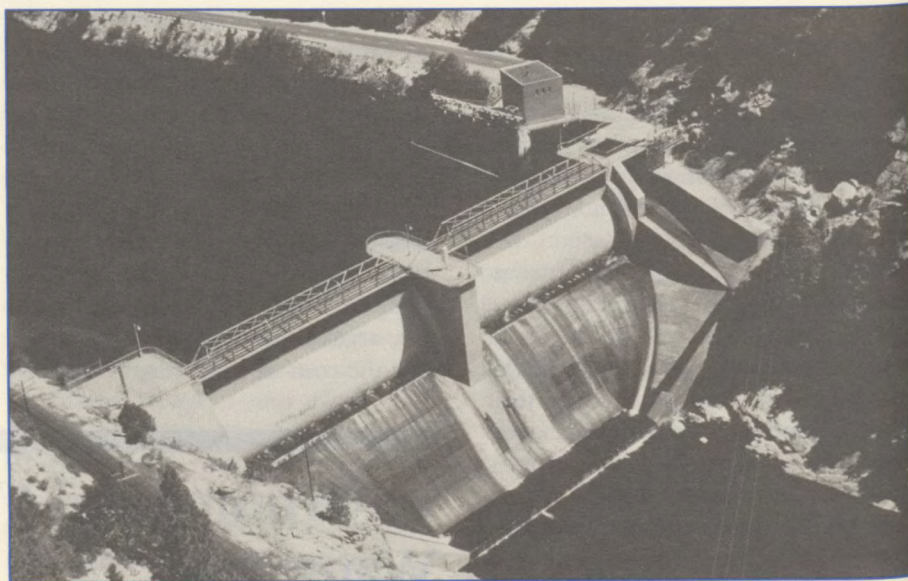


Photo courtesy of the Electric Power Research Institute, Inc.

Most of the country's power plants that use dams to generate electricity operate under federal licenses. Utilities that manage plants with expiring licenses are being required to balance the plants' potential power benefits with their potential nonpower benefits, such as the provision of fish and wildlife habitat.

five-year period. The United States' water infrastructure now includes about 75,000 dams; 869 million acre-feet of reservoir storage; 25,000 miles of inland and intracoastal navigation channels supported by more than 200 locks and dams; tens of thousands of groundwater pumps; and millions of miles of canals, pipes, and tunnels for transporting water.

This hydrologic transformation produced many benefits. Streams that once alternately flooded their banks and dried up were controlled to provide dependable sources of supply. Tens of thousands of recreational reservoirs were created, former wetlands and flood-prone areas were developed for urban and agricultural purposes, and deserts were converted into vast urban areas spotted with green lawns, golf courses, and lakes. Virtually everyone had access to relatively inexpensive water at the turn of a tap. By 1980, water was being withdrawn from the nation's surface and groundwater sources at a daily rate of 440 billion gallons (more than 1,900 gallons per person). Nearly one-third of the value of the nation's crop production was being

produced on 50 million irrigated acres, and hydropower provided about 11 percent of the nation's electricity and 4 percent of its total energy.

Construction of dams, reservoirs, canals, and so on, supplemented by research to develop new technologies (such as desalinization and weather modification), were widely accepted as the way to provide for growing water demand. And as water became scarcer, development schemes became more grandiose. The North American Water and Power Alliance, conceived in the 1950s and enthusiastically promoted in the 1960s, proposed transporting 110 million acre-feet of water annually (about eight times the average natural flow of the Colorado River) from Alaska and northern Canada to the western United States and northern Mexico. The Bureau of Reclamation's Pacific Southwest Water Plan, presented to the president in 1964, recommended seventeen projects and programs, including a plan to pump Colorado River water over the mountains into central Arizona for Phoenix and Tucson, two big dams on the Trinity River in northern California, a tunnel to divert water from the Trinity to the

Sacramento River, a wider aqueduct to deliver more water from northern California to the central and southern parts of the state, and two large hydropower projects at Bridge and Marble Canyons, which are located at opposite ends of Grand Canyon National Park on the Colorado River.

Introducing environmental values

Threats to the Grand Canyon and other national parks helped galvanize resistance to these and other large water projects and focused attention on the increasing financial and environmental costs associated with the traditional approach to meeting water demands. At the start of this century, large quantities of water could be developed at relatively low cost. In addition, water was sufficiently plentiful relative to demand that extracting it for one use had little effect on the availability of water for other uses. Finally, there was little concern about the loss of free-flowing streams as a consequence of the construction of dams and the diversion of water flows. By the 1960s,

The Clean Water Act has made water quality, rather than water supply, the driving force behind the nation's water-related investments.

however, the financial costs of developing additional water supplies had increased sharply because the best reservoir sites had already been developed, and the quantity of water controlled (or the safe yield produced) by additional increases in reservoir capacity on a river was subject to sharply diminishing returns. Moreover, as water became scarcer, the implied trade-offs among alternative water uses became more stark.

The strongest objections to proposed new water supply projects were based on their environmental impacts. By 1970, the legacy of environmental degradation associated with past water developments and uses was extensive, and water projects were less likely to be acclaimed as examples of wise resource use. Such projects were increasingly criticized as expensive proposals to quench the insatiable thirst of farmers, cities, and factories, and to provide hydroelectric power at the expense of instream flows and the fish and wildlife habitat and recreational opportunities they support. Thousands of miles of once free-flowing streams had been lost; Grand Coulee Dam alone eliminated a thousand miles of salmon spawning streams in the Columbia River basin. The quality of many of the nation's rivers and lakes had deteriorated to the point that they were unusable for most purposes. Water projects also contributed to the sharp decline in the nation's wetlands, which store floodwater, control erosion, provide fish and wildlife habitat, improve water quality, and furnish recreational opportunities.

In response to this sad legacy and to the nation's growing desire to protect and restore water quality and aquatic environments, the rules governing the use and development of water resources began shifting against water developers. This shift is evident in federal legislation such as the Wild and Scenic Rivers Act of 1968, the National Environmental Policy Act of 1970 (NEPA), the Federal Water Pollution Control Act Amendments of 1972 (commonly known as the Clean Water Act), and the Endangered Species Act of 1973 (ESA). Development activities that would alter significantly an area's natural amenities now are precluded on thousands of miles of rivers and streams that are preserved under the Wild and Scenic Rivers Act. NEPA requires all federal agencies to give full consideration to environmental effects in planning their programs. As a result, critics of a water project no longer have to prove that the project would have major

adverse environmental effects. Instead, project proponents must demonstrate that a water project is environmentally benign, or they must undertake efforts to mitigate the project's adverse effects.

The Clean Water Act affects water development in several important ways. First, together with the Safe Drinking Water Act of 1974 and other legislation regulating the use and cleanup of toxic materials, it has made water quality rather than water supply the driving force behind the nation's water-related investments. The United States has spent more than \$500 billion on water pollution control since 1972. Second, the U.S. Environmental Protection Agency (EPA) has used section 404 of the Clean Water Act to veto on environmental grounds more than a dozen water projects. Third, as a result of a May 1994 Supreme Court ruling, the Clean Water Act gives states broad authority to impose minimum stream flow requirements in order to protect water quality.

Development and the Endangered Species Act

Like the Clean Water Act, the Endangered Species Act has become an important factor in many water management decisions. The act's potential influence over water use achieved national attention in 1978, when the Supreme Court issued an injunction halting construction on the Tellico Dam in Tennessee (even though more than \$100 million had already been spent on the project, which was 90 percent completed) because the dam threatened the only known habitat of the snail darter. More recently, the U.S. Fish and Wildlife Service evoked the ESA in halting the \$590 million Animas-La Plata project in the Colorado River basin one day before construction was scheduled to begin, because the project might harm the endangered Colorado squawfish. The ESA has resulted in delays, modifications, and cost increases in scores of other proposed dam projects.

The ESA has also been used to alter the management of existing projects. The operation of dams on the main stem of the Missouri River has been modified, to the detriment of some water users, in order to protect the nesting grounds of the endangered least tern and the threatened piping plover. In California, the Bureau of Reclamation has sent large quantities of water around the power-generating turbines at Shasta Dam, resulting in millions of dollars in forgone power revenues, in order to provide colder water for the spawning of the threatened winter-run chinook salmon.

In March of this year, the U.S. Fish and Wildlife Service granted special protection to nearly 2,000 miles of the Colorado River and its tributaries in order to protect four species of endangered fish—the Colorado squawfish, the bonytail chub, the humpback chub, and the razorback sucker. This particular action is likely to require the Bureau of Reclamation to alter the operation of its dams and to make new water projects in the Colorado River basin even more difficult to undertake.

The Delta smelt, found only in California's Sacramento-San Joaquin Delta, is under consideration for ESA listing. If the smelt is granted protection, the ability to export water from the Delta to the millions of people who depend on its supply for domestic, agricultural, and industrial uses could be severely limited.

ESA impact on the Columbia River basin

The ESA is having its greatest impact on water use within the Columbia River basin, where dams have produced cheap power and enhanced recreational opportunities, irrigated millions of acres, and provided towns located hundreds of miles inland with ports accessible to the ocean. These achievements, however, have come at the expense of the salmon stocks that once inhabited the region's rivers in great numbers.

The Northwest Power Planning Council has spent more than \$1.7 billion in taxpayer and ratepayer money since 1980 to rebuild salmon stocks. Measures include making more water available during critical migration periods (and thereby forfeiting power revenues), retrofitting dams with screens that guide fish away from turbines and into channels that lead them past dams and into water below the dams, barging fish around the dams, and constructing fish ladders. Nevertheless, three stocks of salmon that spawn in the Snake River

Water development within the Columbia River basin has produced many benefits, but these benefits have come at the expense of the salmon stocks.

(the principal tributary of the Columbia River) are listed as threatened or endangered, petitions have been filed for listing several other stocks, and as many as eighty-five salmon stocks throughout the Columbia River basin are so weakened that they could be granted protection under the ESA.

While almost everyone agrees that stronger measures are required to protect salmon, no consensus has been reached as to what measures would adequately protect the fish, how much the measures would cost, and who would pay. A review of proposals to facilitate one stage in the life cycle of salmon—smolt migration from the Snake River to the ocean—suggests that the costs and impacts on current water users of restoring the Snake River salmon would be high. The length of time it takes the smolts to migrate downstream is considered critical to the number and health of the juveniles eventually reaching the ocean. Currently, slackwater pools behind the dams can disorient the fish, leave them more exposed to preda-

tors, and delay their journey to the ocean. Passage through turbines further reduces their numbers and leaves the survivors weakened.

One proposal for helping the smolts is to increase substantially the rate of water flow and to allow more water to bypass the turbines during the critical migration months. This approach would cost tens of millions of dollars in forgone hydropower revenues and might require irrigators to reduce water withdrawals during low water-flow years. As an emergency measure, in May of this year federal officials opened the spillways on eight dams in the Columbia-Snake river system to push chinook salmon smolts over the tops of the dams. But the experiment was terminated when it appeared that increased nitrogen levels caused by the spills were detrimental to the fish.

Another proposal for helping smolts is to increase streamflow velocity (rather than the volume of flow) by dropping reservoirs to their spillway crest levels during critical downstream migration periods. Preliminary estimates of the costs of modifying the four lower Snake River dams to implement the drawdown strategy range from \$600 million to \$1.3 billion. In addition, hydropower production, navigation, and reservoir recreation on the Snake River would be adversely affected during the drawdown period.

The most extreme proposal, and perhaps the one that would offer the Snake River salmon the best prospects for recovery, is to remove the dams hindering passage between their spawning grounds and the ocean. All the region's water and energy users would be affected by this strategy.

Dams on the Columbia and Snake rivers are not likely to be removed to protect the salmon, but dam removal for environmental purposes is receiving increased attention. The U.S. Department of Interior, with congressional support, proposes to remove two hydroelectric dams on the Elwha River on Washington's Olympic Peninsula. These dams, which were constructed early in

this century, eliminated the river's native fish population. A major obstacle to the proposal will be finding \$140-\$235 million to remove the dams and restore wild salmon to the river. This estimate does not include the cost of forgone hydropower revenues associated with removal of the dams.

Relicensing of hydroelectric plants

Conflicts over environmental and developmental objectives may be more complicated when hydroelectric power is involved because of hydroelectric power's dual environmental effects. On the one hand, hydroelectric power provides a renewable and clean source of power. Unlike fossil fuels, for instance, it does not pollute the air or contribute to the atmospheric concentration of greenhouse gases. On the other hand, the construction and operation of dams to produce hydroelectricity transforms aquatic environments in ways that adversely affect indigenous fish and wildlife and perhaps other water users.

The United States has more than 2,300 hydroelectric power plants with a total capacity of 73,500 megawatts and an annual production of more than 300 billion kilowatt hours. Most of these plants operate under federal licenses issued as many as fifty years ago, when fewer questions were raised about the effects of alternative uses of water resources on fish and wildlife habitat. As the licenses expire (234 lapsed during 1993 alone), the utilities are faced with a complex, costly, and time-consuming relicensing process under the Electric Consumers Protection Act of 1986.

This act requires the Federal Energy Regulatory Commission (FERC) to give power benefits and nonpower benefits (such as the provision of fish and wildlife habitat and recreation) equal consideration in its licensing and relicensing decisions and to award new licenses to the applicant with the plan that is best adapted to the broad public interest.

Consequently, an application is likely to require a detailed environmental assessment that includes an evaluation of a power plant's impacts on fish and wildlife habitat, water quality, recreation, land use, local communities, and cultural resources. The relicensing process provides new applicants, as well as environmental interest groups and other parties, an opportunity to voice objections and propose other options.

FERC is considering two new policies that might expand the alternatives to this relicensing process. One policy would identify the circumstances under which a dam should be decommissioned, and the other policy would introduce ways to assess the cumulative effects of several dams in a single river basin. From the perspective of the utilities and power users, the relicensing process itself may result in significant costs, and new licenses (assuming they are eventually granted) may be encumbered with restrictions that diminish the flexibility and productivity of hydroelectric power plants. But the relicensing process might contribute to an improved use of the nation's water resources. Moreover, the environmental and other benefits stemming from any new license restrictions at least might offset the costs associated with any inefficiencies the restrictions introduce in power production.

The remaining challenge

The National Water Commission's final report to the president and Congress in 1973 criticized past failures to incorporate adequately ecological processes and environmental values into decisions affecting water development and use. The commission believed that developmental and environmental values frequently can be accommodated with careful planning. But in instances where these values necessarily conflict, the nation needs to develop procedures for striking a balance that serves the public interest fairly and promptly, thereby

avoiding the social, economic, and environmental costs attending delays in reaching decisions.

Since publication of the commission's report, the federal government and most state governments have elevated environmental concerns to a prominent role in decisions affecting the development and allocation of water. Investment in new dams and reservoirs has virtually ground to a halt while hundreds of millions of dollars have been spent to improve water quality. Although the ambitious goals of the Clean Water Act have not been fully met, thousands of miles of streams have been protected, and the condition of many of the nation's streams and lakes has improved significantly in spite of increased pressures from an expanding population and economy.

But the nation has not lived up to the National Water Commission's challenge to create procedures that provide for an expeditious balancing of environmental, social, and development values. In some instances, environmental values are introduced preemptively through the Endangered Species Act. In other instances, environmental values are introduced through long and costly judicial or administrative proceedings that may or may not serve the public interest. And in other instances, these values continue to be ignored or short-changed by institutions rooted in an era when water left in a stream was assumed to have no value. Reauthorization of the Clean Water Act and the ESA provides Congress with another opportunity to address the commission's challenge of introducing environmental values into water use and investment decisions in a balanced and expeditious manner.

Kenneth D. Frederick is a senior fellow in the Energy and Natural Resources Division at Resources for the Future. He is also co-editor, with Roger A. Sedjo, of America's Renewable Resources: Historical Trends and Current Challenges, published by RFF in 1991.

Published by Resources for the Future

1616 P Street, NW
Washington, DC 20036-1400
202-328-5000 (telephone)
202-939-3460 (fax)
info@rff.org (e-mail)

Managing editor, Richard Getrich
Senior editor, Betsy Kulamer
Associate editor, Melissa Edeburn

Board of Directors

Darius W. Gaskins, Jr., *Chair*; Paul C. Pritchard, *Vice Chair*
Anthony S. Earl, Lawrence E. Fouraker, Robert W. Fri, Robert H. Haveman,
Donald M. Kerr, Frederic D. Krupp, Henry R. Linden Thomas E. Lovejoy,
Karl-Göran Mäler, Frank D. Press, Robert M. Solow, Linda G. Stuntz,
Linda C. Taliaferro, Victoria J. Tschinkel, Mason Willrich

Officers

President, Robert W. Fri
Vice President, Paul R. Portney
Vice President—Finance & Administration, Edward F. Hand



RESOURCES FOR THE FUTURE
1616 P Street, NW
Washington, DC 20036-1400

ADDRESS CORRECTION REQUESTED

Published since 1959, *Resources*® (ISSN 0048-7376) is a quarterly publication containing news of research and policy analysis regarding natural resources and the environment. The views offered in *Resources* are those of the contributors and should not be attributed to Resources for the Future, its directors, or its officers. Unless otherwise noted, articles appearing in *Resources* may be reproduced, providing appropriate credit is given and a copy of the reproduced text is sent to *Resources*.

Resources is sent to individuals and institutions without fee. To receive copies or to change an address, write to *Resources*, Resources for the Future, 1616 P Street, NW, Washington, DC 20036-1400, or call 202-328-5025. The publication is also available in microform through University Microfilms International, 300 North Zeeb Road, Dept. P.R., Ann Arbor, Michigan 48106.

Resources for the Future, founded in 1952, is an independent organization that conducts research on the development, conservation, and use of natural resources and on the quality of the environment.

Nonprofit Org.
U.S. Postage
PAID
Washington, DC
Permit No. 5005