CHAPTER 4

Conservation Economics

THE PROBLEM

Natural resources including land, water, wildlife, and minerals, can be preserved for future generations or developed into commercial products for current generations. These resources typically have many competing uses in any one time period, and there are many different periods in which they can be used. For example, ancient redwoods in northern California can be cut down to produce lumber for houses, they can be left standing for later timber harvest, or they can be designated as wilderness. Conservation economics deals with the problem of how to best distribute natural resources to provide more total benefit to people in current and future generations.

HARD CHOICES

Natural resource economics is about making hard choices when no single choice is best for all people in all generations. Since the beginning of recorded time, governments have tried to design institutions such as laws, policies, and regulations to help make better choices in meeting society's objectives. Government natural resource agencies in the United States are expected to improve the general welfare by choosing wisely among natural resource conservation proposals.

Adam Smith (1776), in his book *The Wealth of Nations*, was the first to demonstrate that *markets* are efficient mechanisms for allocating resources to maximize human benefits for current and future generations. This theme has been an important one in economic science ever since. For example, Howe et al. (1986) proposed that water markets be used for conserving water in the western United States. Under his approach people who need water could buy it from somebody who was willing to sell.

In this chapter, we apply basic economic principles to natural resource conservation. Underlying the chapter are two basic assumptions: First, environmental and natural resource management policies should produce the greatest possible total human benefits for present and future generations; and second, these policies should produce a fair distribution of those benefits. We will begin by considering hard management choices.

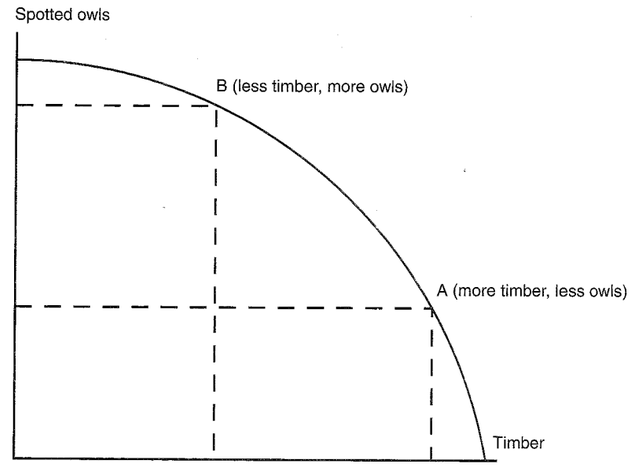

FIGURE 4.1 The trade-off between logs and spotted owls.

Timber versus Spotted Owls (Pacific NW)

In the Pacific Northwest there are only so many acres of land with ancient forests, called old growth trees. These trees are exceptionally valuable because they provide timber and high-paying jobs for loggers. However, the same trees also provide a critical habitat component for northern spotted owls. This species is so rare that in 1990 it was listed as an endangered species. Because the total supply of old growth forest land is scarce, it is essential that we make the right decisions in allocating it to these and other uses. Underlying the issue of logs versus owls is the more fundamental one of measuring the relative value associated with each use (Figure 4.1).

We are now at point A in Figure 4.1, producing lots of logs and few spotted owls. Montgomery and Brown (1992) have found that ensuring owl survival requires that high-quality forest not be logged, in other words that we move to point B, producing more owls and less timber. Choosing correctly in this situation depends on whether or not the benefits gained from moving to point B from point A outweigh the costs. Nobody knows the answer for certain, but a good part of it will be determined by attempts to measure those benefits and costs. Many hard choices like this are faced by natural resource managers.

Cheap Energy versus Functioning Ecosystems

How much more are you willing to pay in the price of gasoline to ensure that ecosystems are being protected? The U.S. Congress has considered passing laws to require oil companies to build double-hulled tankers so that accidents do not cause an ecological catastrophe such as the *Exxon Valdez* in Prince William Sound, Alaska. But that policy would raise the price of gasoline, because the double-hulled tankers are ultimately paid for by people who buy gasoline.

Clean Air versus Cheap Steel

People in many of America's biggest cities live with air pollution every day. This pollution can be cleaned up, but the costs are high. The Clean Air Act of 1970 and later amendments are strong laws restricting air emissions in many parts of our

economy. Achieving air pollution control objectives set up by Congress in the 1990 amendments to the Clean Air Act will require an estimated $25 to $50 billion each year to be spent by both the public and private sectors. Before the 1990 amendments, there were fewer than 20 regulated pollutants. The Clean Air Act currently regulates more than 380 pollutants at a considerable cost to industry. The steel industry is particularly hard hit by the new laws. They will require the steel industry to spend additional billions of dollars over the next 10 years. This will add substantially to the steel industry's operating costs and to the cost of steel products we all buy, like new cars. So Americans must face the question: Do we want cheaper steel or cleaner air?

Endangered Wolves versus Livestock and Wildlife

How much are you willing to pay in higher beef and lamb prices and decreased abundance of deer and elk to restore wolves to native habitat? Reintroductions of wolves in Yellowstone Park and in Arizona may result in lower sustainable abundances of large wildlife. We all may have to pay a price in fewer deer, elk, and other animals watched and hunted to restore wolves. Wolves also eat cattle and sheep. So reintroduced wolves might reduce the U.S. beef and lamb supplies in our grocery stores, which may increase the price of beef and lamb.

Wetlands versus Housing and Transportation

The executive branch of the U.S. federal government has followed a policy of allowing no-net-loss of U.S. wetland acreage and function since 1989. For each acre of functional wetland converted to another use, such as housing development and road construction, an acre of similar wetland must be created or restored. This added cost is passed on to the public through increased home purchasing prices and transportation taxes. In continuing support of this policy, the public has made the hard choice between sustaining wetlands and reducing housing costs and taxes.

Hydropower versus Recreation

Glen Canyon Dam, which backs up the Colorado River on the Arizona-Utah border, was completed in the early 1960s by the U.S. Bureau of Reclamation, mostly to produce cheap electricity. The best time to let water go over the dam's turbines for power production is on hot summer afternoons, when power demand is high because people need it to cool down their sweltering Phoenix and Las Vegas homes. However, the best time to let high flows go past the dam for environmental benefits is in March, when the value of hydropower is nearly zero. Water flow in March reproduces natural spring runoff needed by rare fish and natural riparian vegetation downstream.

Here is the hard choice. By sending water past the dam in March for environmental benefits, Phoenix and Las Vegas lose some high-valued summer electricity that must be made up with expensive coal burning. However, by holding the high flows back until summer, all the March environmental benefits are lost. As federal taxpayers, we and the Bureau of Reclamation must try to make the optimum choice.

Electric Power versus Productive Lakes

Much of the western United States is endowed with abundant and high-quality deposits of low-sulfur coal. An important use of that coal is burning it to produce electricity. An unfortunate by-product of burning that coal is sulfur dioxide, which travels in the air thousands of miles to the north and east. When it falls back to earth as acid rain, the precipitation combines with the chemical to produce sulfur dioxide, which is thought to damage recreational fisheries in many

lakes in Canada and the northeastern United States. How much are we prepared to pay in the value of lost lake recreation to ensure a continued cheap supply of coal-fired electric power?

Mining versus Recreation on Public Lands

People need coal and mineral products for their daily lives. However, mining activities of various kinds can conflict with outdoor recreation. One widely publicized conflict emerged in the late 1970s in southern Utah between coal development and nearby Bryce Canyon National Park. One of the proposed coal fields was suspected of damaging outdoor recreation by impairing scenic views at the southern end of the park. On the basis of an economic study that estimated recreational values displaced by the proposed mine (Haspel and Johnson 1982) by then Secretary of the Interior, Cecil Andrus, the coal mining project was shut down.

Riparian Ecosystems versus Livestock

Most of the southwestern United States is arid, which means that water for agriculture, cities, and wildlife is scarce and unreliable. Livestock in the deserts of Arizona and New Mexico congregate near the streams because that is where water and grass are most available. Livestock that are allowed to graze these areas affect wildlife and their habitat, such as the endangered southwestern willow flycatcher. Ensuring the survival of the flycatcher may require taking cattle off a large percentage of these streamside areas. So we are faced with the question of how many cattle we are willing to give up and how much more we are willing to pay for beef to guarantee survival of the flycatcher and other species that require dense riparian (streamside) habitats.

Hydro-Dam Relicensing

The Federal Energy Regulatory Commission (FERC) licenses all nonfederal power plants in the United States. Many of these licenses will soon come up for renewal. Changes in the amount and timing of water used for power generation can affect other uses of water downstream such as recreation, irrigation, and endangered species. The relicensing process gives environmental groups the opportunity to seek downstream flows more compatible with needs of outdoor recreation and endangered species. New licenses may contain terms and conditions relating to wildlife protection and enhancement (or may be denied in extreme cases). Typically, minimum flows will be required downstream from dams. In developing these terms and conditions, FERC must, by law, give equal consideration to power and nonpower values. So as a nation we are faced with the hard choice: Do we want cheaper electricity or more suitable flows for downstream recreation, fish, and endangered species?

CHOICES DISPLACE OPPORTUNITIES

Few decisions are easy to make because most entail costs as well as gains. Socrates as well as other historical figures taught us that people live happier lives when they continually reevaluate impacts of their choices, learn from their mistakes, and make better future choices. Socrates' famous quote is "the unexamined life is not worth living." Nowhere is this more true than in natural resource management. The common thread among all of the hard choices presented above is that every public or private choice involving natural resources creates certain opportunities while displacing others. The opportunity gained is the benefit. The opportunity displaced is the cost. Economics helps us think about which choices we should make to receive the maximum benefits with the least cost.

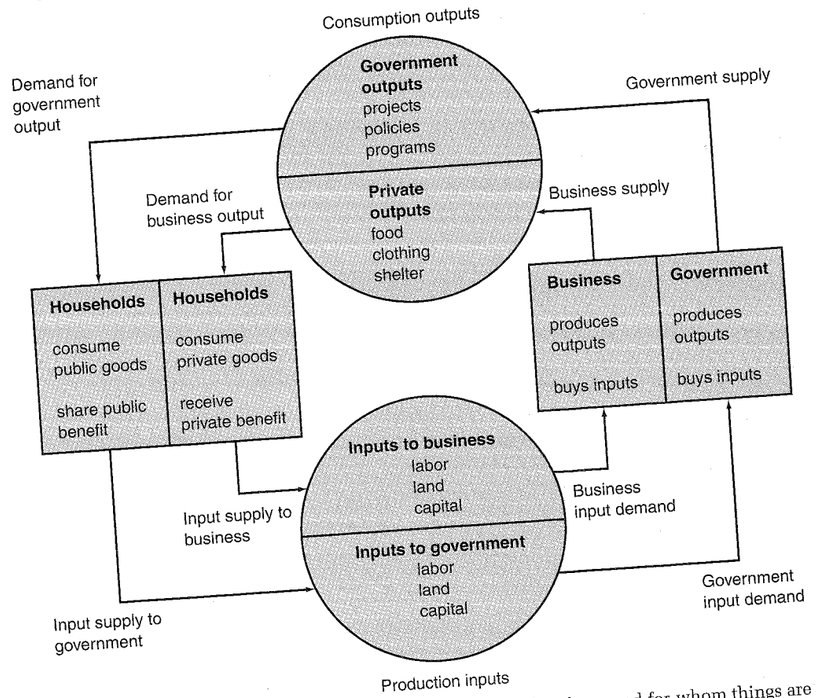

FIGURE 4.2 A general circular-flow diagram that illustrates what, how, and for whom things are produced in an economic system.

Economics Is About Choices

All civil societies invest a large amount of time, energy, and money in the *design of institutions* for assuring that good decisions are continually made, carried out, and judged. By institutions, we mean practices or organizations for governing peoples' behavior. The two main institutions used for solving a society's economic problems are *markets* and *government controls*. The way society goes about solving its economic problems tells us a lot about the way they approach their natural resource conservation problems. All societies face three basic economic problems that are about making choices (Figure 4.2).

First, societies need to determine **what** commodities will be produced and in what quantities. For example, will we use our public and private rangeland and forest land to produce only large quantities of timber and livestock with no outdoor recreation, water, and habitat (living area) for endangered species? Or will we use those lands to produce smaller quantities of livestock and timber, but more outdoor recreation, water, and endangered species habitat? Will we allocate our rivers to produce electric power and water for industry with nothing for recreation and endangered species, or will we use those rivers to produce smaller amounts of a greater number of products? Finally, should we let our rivers run wild to the ocean and take the inevitable floods and droughts that result, or will we take taxpayer resources (money, land, and water) and allocate them to building dams to reduce flood and drought damages?

Next, each society needs to determine **how** it will produce all these goods. By this we mean who, what resources, and what technologies will be used. For example, will businesses use environmentally friendly technologies for producing paper that keep

pulp from being dumped in blue-ribbon trout streams, but make a ream of paper cost $15, or will businesses use environmentally damaging technology that reduces the price of a ream of paper to $3, but dumps paper wastes into streams and rivers? Will houses be produced at low cost with lumber harvested cheaply from big trees that displace spotted owls, or will they be produced with more expensive bricks, stone, and adobe while preserving spotted owl habitat?

Last, all societies must decide for **whom** the goods shall be produced. In other words, who will enjoy the benefits of the nation's products? To put it differently, this asks who gets the income needed to buy those produced commodities. Will forest product workers receive high wages and live in expensive houses in unpolluted environments, or will sawmill owners pay low wages to the workers, reserving high profits and a clean environment for themselves? Will laws be passed that do not protect the environment, thus reduce wages to environmental science students and increase incomes earned by lumberjacks and ranchers, or will we pass laws that require environmentally friendly technologies that increase salaries of biologists and reduce incomes for farmers and miners?

Importance of Good Decisions

Where natural resources are unusually scarce or where their demand is high, it is essential we make the right decisions because the cost of making mistakes is so high. For example, in desert climates like Albuquerque, Phoenix, or Las Vegas, water is scarce. Therefore, it is essential to design and apply sound plans for finding, storing, saving, and using water. Similarly, the cost of a failed effort to save a species from extinction is high—the species is forever lost. Finally, in nations where protein is scarce, such as much of Africa, or in situations of war or famine, policies that trade off cattle ranching with other activities, such as tourism, must be carefully thought out because the wrong policy may cause many people to starve.

What the Market Mechanism Does

The market is more than a place where goods are traded like the New York Stock Exchange or the local livestock or automobile auction. It is a process by which buyers and sellers of any good or service interact to determine its availability (quantity) and value (price). The driving force of the market is the notion that everything has its price: each commodity, each service, and each natural resource.

How does the market accommodate peoples' desire for more of something, which economists call increased demand? If people want to buy more of something, such as thick, juicy, beef steaks, a surge of new orders will be placed for them (Figure 4.3). As buyers scramble to buy more steaks, sellers raise the price because they can do it without losing customers. The higher price sends a signal for all to see. This signal lures ranchers to raise more beef cattle, packers to pack more steaks, and grocery stores to buy and stock more steaks on their scarce shelf space. The market process, through the price and profit signal, rewards people who respond to buyers' desire for more steaks by producing more steaks.

If people want less, the market process does just the opposite. If people want less chicken, they place fewer orders for chicken. Chicken sellers, who are anxious to get rid of their unsold chickens rather than have them spoil on the shelves, lower their price. They then produce and sell less chicken. Instead they use those scarce resources like chicken feed, chicken pens, chicken packinghouse space, and chicken shelf space for something else, such as beef production.

How the Market Solves the Three Problems

What Things Are Produced. What things are produced is determined by consumers' dollar votes. If consumers want more housing, they vote with their dollars by buying more housing and less of something else. In the world of politics our votes lead

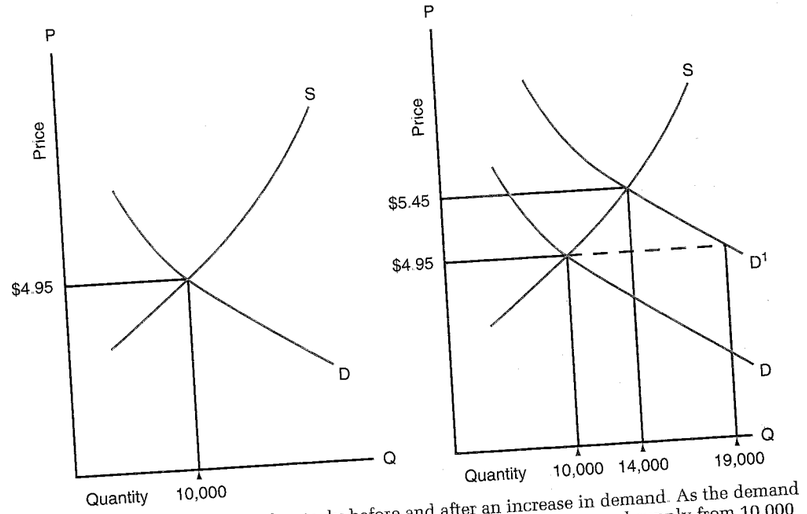

FIGURE 4.3 Market equilibrium for steaks before and after an increase in demand. As the demand for steaks increases (D to D^1), the price increases and stimulates an increased supply from 10,000 to 14,000. If the demand levels and the supply continues to increase to 19,000 steaks, the price will decrease to $4.95, the original price.

to action—they signal who will represent us and, indirectly, what actions we want our representatives to take. Dollar votes are in some ways similar to political votes. The size of dollar votes attracts added resources into producing more of what people desire.

How do those dollar votes attract resources to produce what people want? Business firms are enticed into producing goods in high demand by the higher potential to earn profit. Profit is what remains after a business subtracts its total cost from its total revenue. The opposite of profit is loss. Profit is the main reason businesses exist. It is the main measure of their success and lack of it is the main measure of their failure.

How Things Are Produced. The way things are produced is determined by the competition among different producers who must all minimize costs to stay in business. All businesses compete for a limited number of customers and their dollar votes. Any business that fails to minimize its production costs will need to charge their customers higher prices than a competing business that successfully minimizes its costs. Therefore, businesses that fail to minimize costs lose business to competitors who do minimize costs.

Producers maximize profits by minimizing their costs. To keep costs at a minimum, they minimize the use of expensive inputs and maximize use of cheap inputs. Agriculture provides a good example of how this works in different parts of the world. In the United States, land is relatively plentiful and cheap and labor is scarce, so land prices are relatively low and wages are high. For American farmers, the low price of land and high labor price signal the use of laborsaving technology for cotton, wheat, and livestock production. Where labor is abundant and land is scarce, as in Asia, farmers find they can minimize their costs by producing cotton, wheat, and livestock with labor-intensive technology.

For Whom Things Are Produced. In a market economy, goods are produced for people with income to buy them. The distribution of income in a market economy is

determined by who owns productive resources (land, natural resources, labor, and capital) and how well the production meets the wants of consumers.

Each person's income in a market economy equals the price of the product or service he provides times the quantity he chooses to sell to the market. The distribution of income among people depends on the quantities of all goods or services they sell, and the prices of each unit. Ranchers who sell the most beef with the least cost will accumulate the most wealth. This is why ranchers oppose hikes in grazing fees and reductions in numbers of livestock that they can graze on public lands. It is also why cattle ranchers want you to eat as much beef as you can buy rather than chicken, pork, or fish.

Who Controls the Market?

No one person controls the market. The three bosses of the marketplace are consumers, technology, and profits. Consumers are directed by their natural or learned preferences. They vote with dollars for those preferences. TV marketers try to change your preferences so you want to buy what they have to sell. Jeans producers will try to convince you that if you buy their jeans, you will be sophisticated, better looking, and well-loved. They will be delighted if you alter your preferences and spend your dollar votes on their jeans.

Technology sets limits on what can be produced and at what cost. About 150 years ago, lonely, tired, cold, wet California gold miners wanted to talk to their families in the eastern United States. The lucky ones were willing to pay lots of gold dust for those intimate conversations. But until the telephone was invented and the lines stretched, they could not do it, no matter how high the demand. Demand must be backed by the technology to carry it out.

Profits reward private businesses who make and deliver the goods in highest demand to consumers at the least cost. Profits lure firms into areas where consumers want to buy more goods and to exit enterprises where consumers want less. They also reward businesses who use the cheapest methods of production.

The Invisible Hand of the Market

Adam Smith wrote a classic book in 1776 titled *The Wealth of Nations*. In it he emphasized the importance of self-interest as a human motivator. This fact has led some people to call economics the dismal science. Smith tells us that every individual uses his resources to produce the greatest value for himself. Smith's idea was that in selfishly pursuing only our own personal interests, we all are led as if by an invisible hand to accomplish the best good for everyone.

Translated, this means that producers who attempt to maximize their own profits, consumers who buy where prices are the lowest, and workers who go where wages are highest do a great service to society. Further, they do it more efficiently than government bureaucracies or social planners who would try to do the same thing. Profit has been criticized because it is associated with greed and self-interest. Still, profit incentives are in some ways like a well-oiled machine that can perform some amazing tasks for us.

For society, profit encourages businesses to produce what people want to buy, motivates them to produce using the least costly methods, and rewards them if they conserve on scarce resources. The profit signal tells businesses how to get rich and tells them when they are rich. In short, the profit motive, combined with free-market competition for customers, ensures that products are made at minimum costs and with maximum choices for us as consumers.

Can Profit Incentives Protect Natural Resources?

Thousands of farmers, oil companies, foresters, ranchers, wildlife managers, and others ask daily whether profit can protect natural resources. The answer depends on whether or not there are property rights (i.e., rights to own, use, buy, and trade natural

resources) (see Anderson and Leal 1991). Where there are well-defined property rights to natural resources, the profit motive helps to protect private forests, private grazing lands, and private water. The following examples help explain why.

High timber prices encourage forest owners to plant more trees so they have something to harvest for the future. In places where wildlife can be privately owned (e.g., Texas), high tourist and hunter expenditures encourage landowners to invest in conservation of desirable wildlife.

Where water rights are secure and are marketable, high water prices encourage water right owners to use their scarce water carefully and/or to save it for possible sale to somebody else. Establishing an emergency drought water bank helped California get through a severe drought in the early 1990s with minimum hardship. California established high prices for farmers' water, if the farmers agreed to deposit it into a bank for resale to big cities. The California Water Banking Law included legal assurance that depositing water into the bank would not change farmers' permanent water right. This legislation was cheap, easy, and effective.

How Markets Settle Conservation Questions

By and large in the United States we accept free markets for allocating natural resources between the present and the future. There is little likelihood that this practice will be abandoned (Herfindahl 1961). We do not, for example, impose a tax on copper production in order to save copper for use by future generations. We do it to raise revenue to run the government. The question of the total quantity of minerals extracted over time is left to the mining company, the smelter, and the refiner. Likewise, the production and distribution between present and future generations of food buyers is largely in the hands of private farmers, grain distributors, food processors, and retail grocery stores.

The market settles conservation questions by discovering, renewing, producing, and selling natural resources over time to maximize their owners' current and future incomes. A private forest is a good example. The opportunity for current and future profit tells the private forester when to plant new trees, when to harvest old trees, and how long to wait for little trees to grow into big ones. Will these profit-maximizing decisions lead to depletion of their forests? If the private forest owner has secure property rights, the answer is a resounding "no." Private forest owners have a strong financial incentive to take care of their trees. Cutting down all their trees and selling them today without replanting means they will have nothing to sell in future years.

The profit system can also help provide for future national timber needs. If a private forest owner expects population to be growing and people to keep buying houses with wood frames, they can plan on high future demands for timber and, as a result, high future prices. So they have every incentive to plant more trees now, wait for more tree growth, and harvest fewer trees now and save more for the future when they can get a higher price. Their personal self-interest acts like an invisible hand in providing for future generations' timber needs.

When Are Markets Best at Promoting Conservation?

Markets are best at settling conservation questions in those situations when all potential resource users can effectively voice their demands in a monetary form. Take forests for example. If they were auctioned so that private bidders could effectively voice their demands for all forest products, including spotted owls, timber, livestock, water, and recreation, then the market system would make it profitable for businesses to produce the right mix of timber, spotted owls, and other forest products.

The following is a good general principle: When all resource users are able to voice their demands monetarily, prices of all resources are set by current and anticipated future demands for and supplies of those resources. When that happens, anybody who decides to use a particular resource at a particular time is faced with a price equal to the value of other uses displaced by that use. Then natural resources will be

priced at their real cost, and private decisions will be made to use a resource now only when the public benefit of the use exceeds all public costs (Ward 1998). In that very special case, the market institution can be trusted to conserve natural resources.

Limits of the Market

There is one major limit to relying on the market system to settle conservation questions. Markets only account for private income produced by privately owned resources; they sometimes fail to account for all human benefits produced by natural resources. Many publicly owned resources, such as air and wildlife, are unpriced. The market system has little incentive to conserve them because it is unprofitable to do so. So the market system fails to conserve and therefore depletes or wastes any natural resource that is priced at less than its real cost.

Underpriced Resources. One good example of the market system failing to conserve an underpriced resource is reflected in the price of coal used to produce electric power in the western United States. In an unregulated market, burning coal to produce electric power causes acid rain, which damages lake resources in the northeastern United States and in Canada (see Chapter 6). Damages to these resources are not included in the cost of the coal-fired electricity charged to customers in Phoenix and Las Vegas. So electricity buyers in those cities are not facing the full cost of their power. Where there are underpriced resources, unregulated markets fail to signal people with the real cost of their actions. This discourages conservation.

Spillover Benefits. Spillover benefits are derived by society as a direct by-product of some economic trade between a business and its customer. An example of a spillover benefit is the pulp mill owner who considers spending money on controlling pollution from his pulp mill to reduce discharges into a blue-ribbon trout stream. However, he does not enjoy trout fishing and none of the anglers are likely to boycott his business. Even if the benefits to trout anglers and to society at large (e.g., people who provide angler services) exceed the costs to the mill owner, he will probably decide against the investment because he cannot make any money selling the cleaner water to anglers. Therefore, the mill fails to invest in pollution controls and the trout stream remains polluted.

Spillover Costs. Spillover costs are a third example of where market incentives discourage conservation. Spillover costs are costs sustained by society as a direct by-product of some economic trade between a business and its customer. A good example is provided by the logging company that clear-cuts a patch of forest and is not charged for silting up the downstream river. The effect of the muddy stream is of no concern to the logger if he does not have to pay for the downstream damages. But these costs are of prime importance to downstream water users because they have to live with the siltier water or clean it up. The presence of spillover costs dull the potential power of market incentives to promote conservation.

In the case of either spillover benefits or spillover costs, these externalities do not enter into the market-pricing calculations of the parties undertaking the activity. So letting the market system settle conservation questions blocks conservation whenever natural resources are priced lower than their real cost. Put more simply, underpriced resources are inadequately conserved by the market system.

THE FUTURE

In future years, three problems will magnify the limitations of the unregulated market to conserve natural resources in the United States. One is the increase in population with its dramatic effect on the supply of water and open space. The other

factor is the increasing per capita demand for many forms of outdoor recreation such as camping, hiking, and fishing. The third is the increased value people assign to endangered species.

HARNESSING THE POWER OF THE MARKET

Despite their limits, market forces have considerable power that can be harnessed to promote natural resource conservation (Anderson and Leal 1991). The idea is simple—business responds to profit opportunity. So making conservation profitable to business is a sound approach to natural resource management.

Concepts for Incentive-Based Pollution Control

By the 1960s, pollution problems in the United States were severe enough to warrant interest in finding ways to deal with them. One way of dealing with the pollution problem was environmental legislation, which reached a peak in the "green" decade of the 1970s. Politicians generally preferred to address environmental problems by passing laws that set limits on acceptable pollution. Their preferred method was "command and control" rules and regulations, such as design standards, which require firms to use prescribed technologies. Another example is performance standards, which specify the maximum amount of pollution that individual firms can dump into the environment.

Economists proposed that market incentives were a better way to control pollution than government regulations for two reasons. First, market forces could be harnessed to make pollution expensive to polluters. The effect of this is to both reduce pollution and make it profitable for businesses to search for production technologies that reduce pollution. Second, market forces would be used to lower the costs of pollution control by eliminating regulations and leaving decisions about the details of reducing pollution up to individual firms. The two most popular ways for harnessing the power of the market are *pollution taxes* and *marketable permit systems*.

Pollution Taxes

A pollution tax is levied on firms that discharge harmful waste such as raw sewage into environments such as streams, lakes, the atmosphere, or the soil. The tax is set equal to the damages the firm does. The power of the market is harnessed by setting the tax level according to the damage that the firm's pollution causes to society when dumped into the environment. A firm that emits a pollutant with low damages gets a low tax, but pollution sources that impose high costs to society are taxed more heavily. This is basically a resource use charge—just like paying to use the facilities in a national park.

An important advantage of pollution tax compared with rules and regulations is that the tax raises the costs of making the polluting product. Therefore, market forces make it profitable for the firm to invest in pollution control measures as long as the waste-dumping charge is more than the cost of controlling pollution. By investing in measures to reduce pollution, the firm reduces its costs of production because the pollution tax charge falls by more than the cost of installing pollution control.

Another advantage of pollution taxes is that they encourage firms to find the least-cost measure to reduce pollution. If there are several technologies for controlling emissions of raw sewage into a river, all of which reduce the pollution tax by X dollars, the firm has a profit incentive to find the cheapest pollution control technology. By contrast, regulations on pollution emissions specifying what kind of pollution control technologies must be used often are considerably more expensive because they do not give firms the freedom to search for ways to minimize the cost of compliance (Field 1994). With the market incentive, firms are encouraged to minimize their total pollution taxes and the cost of technologies required to reduce the taxes.

Pollution taxes also have advantages over fines commensurate with damages done. This is because fines typically involve court battles and presume some measure of guilt. Pollution taxes are treated like any other cost of production, and the firm will take steps to invest in pollution control that minimizes the tax.

Some of the better-known pollution taxes in the United States include the excise taxes on hazardous chemicals enacted in 1980 to fund the Environmental Protection Agency's superfund. A related reason for the superfund concept was that pollution problems often could not be assigned to a specific polluter. Similarly, after the 1989 *Exxon Valdez* oil spill, Congress imposed an added tax on petroleum products to pay for the Oil Spill Liability Trust Fund. One could argue that this added tax reflected the expected cost of ecological damages from future oil spills. More recently Congress has considered legislation to impose a carbon tax on fossil fuels like gasoline which, when burned, release carbon dioxide into the atmosphere, possibly increasing the greenhouse effect and contributing to global warming. However this approach has been rejected by President Bush and his administration.

Pollution taxes are not perfect. To make them an effective way for dealing with pollution, policymakers need to know the cost of the damages caused by the pollutant before setting the level of the tax. Otherwise, it would be easy to set the tax too low or too high. In fact, for several reasons it is difficult to know the cost of damages caused by the pollutant. First, it is hard to determine which activities (e.g., oil, chemical production) cause how much pollution. It is also hard to determine how much of the pollutant stays in the environment for how long, and how harmful the pollutant is to people who are exposed to it. It is also most difficult to determine the monetary cost of damage to health and premature death (Turner, Pearce, and Bateman 1993). Should those costs be based on lost lifetime income, lost days of work, or people's willingness to pay to avoid the pollution? This makes it difficult to determine what pollution taxes should be. Another problem with pollution taxes is that if one country imposes them on its own economy, they put their own firms at a disadvantage compared with foreign competitors.

In concept, taxes also could be levied to create market incentives for protecting endangered species and ecosystems. Once a tax is levied on further reduction of a species or ecosystem, a developer will be encouraged to restore habitat elsewhere, if the option exists and is cheaper. The basic problem remains, however—determining how much an endangered species or ecosystem is worth and what the taxes should be.

Marketable Waste Emission Permit Systems

The idea of marketable waste emission permits is simple: The government decides on how much waste the atmosphere or water body can assimilate safely (i.e., is nonpolluting) then issues waste emission permits (quotas) for no more than that amount (Figure 4.4).

This method of preventing pollution harnesses market forces by allowing the emission permits to be tradeable—that is, they can be bought and sold in the open market. Emission permits are especially attractive for many reasons (Pearce and Turner 1990): They are cheaper than command and control regulations, they allow for firms entering or leaving the area, they can be bought by environmental groups, they adapt to inflation or other changes in values, they adapt to geography, and they have low administrative costs.

Lower Cost. Marketable permits let those who emit wastes (emittors) trade permits for cash. So emittors with low costs for abatement will find it cheaper to abate their emissions rather than buying permits. However, emittors whose technology is locked in and who find abatement very expensive will find it cheaper to buy the marketable permits from somebody. By giving emittors a chance to trade cash for permits on the open market, the total cost of preventing pollution is reduced compared with the regulatory approach of setting standards.

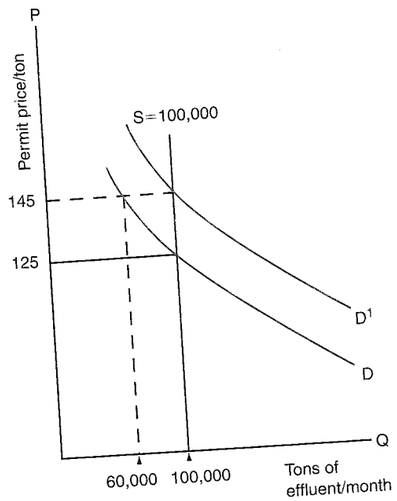

FIGURE 4.4 Supply and demand for marketable effluent permits, before and after new firms move into an area.

Entering or Leaving the Area. Suppose we are dealing with a high-growth area like southern California, and new emittors move in. The effect of the new emittors coming to town is to increase the demand for permits. If the total capacity of the environment to assimilate wastes is unchanged, the authorities may wish to keep the total number of permits fixed to allow 100,000 tons per month (Figure 4.4). If new emittors want to come to town and do business, they will invest in the cheapest combination of buying new permits and waste emission abatement. Similarly, if existing emittors decide to leave the area, their waste emission permits can be marketed to others. If, for example, the government discovered that the pollution standard needed tightening up to 60,000 tons per month (Figure 4.4) they could buy some of the permits themselves, thereby taking permits out of the market. So the permit system makes it easy for the government and for individual waste emittors to adapt to changes in scientific knowledge or economic need.

Environmentally Friendly. An open market in waste emission permits allows anybody to buy them including groups like environmentalists, sportsmen, or departments of game and fish. This option is most useful when a difference of opinion exists about the appropriateness of the standards. By buying permits a group could use the market to apply its own standards. If an environmental group such as the Sierra Club wanted to lower waste emission in the area, they could enter the market and buy some of the permits, keeping them out of the market for as long as they wished. If the group was a private fishing club and the permit was to limit waste emission that impaired a water body's capacity to support the most sensitive fish species, they could allocate some of their annual operating budget to buy permits, thus saving the need to stock large numbers of fish in poor-quality waters.

Adapts to Economic Changes. In periods of high inflation or rapid changes in technology in the polluting industries, the initial allocation of permits may change in value or need to be changed to adapt to new technology. Because the price of the permits automatically adjusts to changes in supply or demand, these outside changes can be handled efficiently and quickly.

Geographical and Spatial Flexibility. The region in question may have complex dispersions of wastes, which may vary considerably with weather patterns, time of year, and the kind of firms that buy the permits. In principle, these conditions can all be handled under a permit system. Different quantities of permits could be issued for different seasons of the year, different weather patterns, different types of wastes, and more, and each kind of permit could operate in a fairly independent market. As long as the markets were open, flexible prices would clear the market and the costs of abating waste emission could be minimized.

Low Administrative Costs. Under a pollution tax system, the authority must estimate the cost of pollution damages and the costs of various abatement technologies. However, the authority can easily make mistakes that have high economic and political costs. Under a permit system, the authority does not need to estimate the cost of complying, but they need to know how many permits to initially issue. The waste emitting industries themselves are the only ones who need to know the details about the cost of abatement. They can buy the permits at the going price if abatement is expensive, and invest in abatement if the permits are more expensive.

APPLICATIONS OF INCENTIVE-BASED REGULATIONS

Pollution Taxes

Solid Waste. The main U.S. experience with real-world pollution taxes has been in the arena of ordinary garbage disposal. In Highbridge, New Jersey, the city altered its flat fee for garbage hauling of $280 per year with a price that increased with the amount of trash picked up by haulers (Hanley 1988). Each 30-gallon can set out at a curbside each week had to have a sticker before it would be hauled away. Each household could buy 52 stickers for $140, about $2.75 per sticker. The effect of the experiment in raising the price of garbage hauling was to reduce the amount of trash put outside people's houses by 25%. Because the cost of disposing of large recyclable items like used furniture could use four or more stickers, more trash was recycled than before.

Water Pollution. Europe has more experience with pollution taxes than the United States According to Hahn (1989), Germany, France, and Holland have all set charges for various water pollutants to compensate for their social costs. The effect of the taxes has been twofold—to encourage pollution reduction and to help pay for the cost of cleaning up pollution. France (1960s) and Germany (1970s) have both enacted emission charges on water pollution. These charges seem to be accepted by the French people as a way of doing business to improve water quality. In Germany, the charges seem to be improving water quality (Hahn 1989). In Holland, the effect of water pollution taxes (administered on both volume and concentration of pollutants) has been to cause a slow but steady increase in water quality (Bressers 1983).

Environmental Adders for Electric Power. Electrical power generation makes use of unpriced environmental resources. However, it is difficult to attach monetary values to these damages. So some have suggested adding taxes to the price of electric power, called "adders." However, these taxes are used only for selected electric-power capacity expansion projects and are not actually charged to the consumer. The advantage of using adders is to promote cleaner electric-power sources through design and selection. Utility regulators in more than half the states are either using adders or are considering using them. However, because the monetary value selected for the adder can be arbitrary and because the consumer never actually pays for it, the debate on the use of adders is far from over and is likely to continue (U.S. Department of Energy 1995).

Marketable Permit Systems

The United States has had some experience with marketable permit systems since the mid-1970s. Amendments to the 1990 Clean Air Act have many features designed to clean up air pollution as efficiently and cheaply as possible. They allow businesses to make choices on the best way to reach pollution cleanup goals. Because businesses must make a profit, they have an incentive to clean up their pollution at the lowest cost possible. These new flexible programs are called market or market-based approaches. For example, the acid-rain cleanup program offers businesses choices as to how they reach their waste reduction goals and includes waste allowances that can be traded, bought, and sold. Consider the following examples of marketable permit systems.

Lead Banking. Lead causes developmental problems in children and heart disease and strokes in adults. Lead in gasoline is dispersed into the atmosphere when burned by cars. In 1985, the Environmental Protection Agency (EPA) set up a program that required lower lead standards for leaded gasoline. To reduce the very high cost to industry of complying with these standards, EPA set up a lead banking program (Hahn 1989). Under the banking program, gasoline refiners who were able to reduce the lead content in their gasoline by more than the legally required standard for a given period of time were allowed to bank the difference in the form of "lead credits." These credits could then be used or sold in any following time period up to 1987, at which time all refiners had to meet the new standard. This proved to be a successful program. More than half of refiners participated in the banking program. Hahn found that the cost savings from the program may have exceeded $228 million. The costs were saved by allowing old refineries, for whom complying was expensive, to trade banked credits with more modern refineries who could comply at a lower cost. Requiring all refineries to meet the standards, without allowance for the differential cost of compliance, would have been considerably more expensive.

Emissions Trading. The EPA has been experimenting with emissions trading since 1976 for five air pollutants. These include volatile organic compounds (VOCs), sulfur dioxide, carbon monoxide, nitrogen oxides, and particulates. The EPA allows credits to be earned whenever a polluting source reduces emissions by more than the legally required amount.

Sulfur Dioxide Allowance Trading. The 1990 Clean Air Amendments set up an ambitious system of tradeable permits for emissions of sulfur dioxide (SO_2), a chemical that can cause acid rain. Acid rain is formed when SO_2 and nitrogen oxide, released when fuel is burned, are transformed into sulfuric and nitric acids. These acids ultimately return to the earth dissolved in rain. Scientific studies over the last 20 years have shown that acid rain causes increased levels of acid in lakes and streams. Scientists suspect, but do not know for sure, that these acids may also damage forests. The acids can also erode buildings, bridges, and statues.

In establishing the Clean Air Amendments, Congress wanted to reduce SO_2 emissions by 10 million tons from 1980 levels. The EPA harnessed the power of the market by allowing sulfur dioxide allowances to be traded. Namely, the holders of allowances for SO_2 emissions—mostly electric utilities east of the Mississippi River—were allowed to transfer their permits among one another. Therefore, utilities who could reduce their emissions at the least cost had an incentive to do so. They were also able to sell their unused allowances to utilities who would save money by purchasing the allowance rather than reducing emissions. Allowances can also be banked for later use. The result of this banking plan was that the incremental cost of reducing SO_2 emissions was made equal across all sources. Making these incremental costs equal across all pollution sources has the effect of achieving total SO_2 abatement at minimum total cost. Utilities can also offer SO_2 emission allowances for sale at an annual government-sponsored auction.

This SO_2 allowance trading program has turned out to be quite successful. Desired reductions in emissions have been accomplished and even exceeded. More important, total SO_2 abatement costs have been much less than what they would have been without the trading provisions. Stavins (1998) estimates that tradeable permits for SO_2 have resulted in a cost savings of nearly $1 billion per year over the regulatory alternatives that Congress had considered in earlier years.

GOVERNMENTS AND CONSERVATION

How Government Settles Conservation Questions

When government gets involved in conservation, the instruments for resolving natural resource conflicts enter the political arena. Participants in this arena include elected officials, interested voters, government agency employees, lobbyists, the press, environmentalists, agriculture, mining, and more. Obviously some sort of resolution comes out of this process, but it is not always clear if the results promote better conservation and human welfare.

Limits of Government In Settling Conservation Questions

Despite the good intentions behind attempts to set up government conservation policies and plans, four kinds of "government failures" stand in the way of conservation. These failures include rent seeking, taxpayer ignorance, empire building, and abuses of economic analysis.

Rent Seeking

Rent seeking occurs when special interests use their private resources in lobbying and other activities aimed at getting government to pass laws that economically benefit the group. Successful rent seeking (i.e., getting the group's favorite laws passed) increases net benefits for the special interest group, typically at a cost to the larger society. An example with a long history is the iron triangle, a group who sponsored and completed Western water projects. This triangle consisted of Western politicians, irrigated agriculture in connection with banks and real estate, and the federal water management agencies.

Taxpayer Ignorance

Taxpayer ignorance occurs because we find it more bothersome than beneficial to stay informed about issues that do not affect us directly. For example, New York taxpayers have little interest in investing the time and money to become informed on proposed legislation that would develop a new irrigation reservoir on the Colorado River. This is because the reservoir costs the New York taxpayer only pennies per person. It simply is not worth their time to scrutinize public actions that have little direct bearing on them. Many federal water projects were built that had little chance of promoting the national interest simply because the local beneficiaries wanted the legislation that paid for the project and the rest of the nation simply did not care enough.

Empire Building

Empire building involves a government agency purposely increasing its own power and influence for its own sake. Empire building, especially when combined with a bureaucratic desire for job security, can impede programs aimed at conservation. Few government agencies or employees can resist the temptation to increase their own influence or power. They often do too much of it and for too long.

Government gets away with building empires because there is no market check to stop them. Private business loses money if people are not willing to pay for the products produced by their expansion. The owner of a bicycle shop will not open new stores unless there is enough customer demand for bikes to support them. However, if the government builds too many dams or drains too many swamps, there are no negative profit signals that require them to stop building and draining. The only support needed for government projects is a legislative majority, which can be bought by the small minority by financing political campaigns of key legislators.

Once initiated, government programs and agencies can take on a life of their own. The same agencies that made mistakes based on scientific ignorance were "rewarded" with a chance to correct those mistakes. After World War II, for example, the U.S. Congress gave the Army Corps of Engineers and Natural Resources Conservation Service (formerly the Soil Conservation Service) large budgets to drain and fill wetlands. Beginning in the 1980s, these agencies received budgets from Congress to create or restore wetlands. This problem typically starts in social impatience with careful research and planning, which often is looked upon by special interests as costly "foot dragging."

Abuses of Economic Analysis

The final government failure comes from agencies that ignore the economic consequences of their decisions. Sometimes a government agency chooses to ignore important costs or benefits because it is in the business of promoting one type of resource use (Herfindahl 1961). In fact, stimulating use of the resource may be implied in the agency's mission statement. Beginning in the early twentieth century, hundreds of dams were built in the western United States by the Bureau of Reclamation and Corps of Engineers whose missions were, respectively, irrigation development and flood protection.

Certain costs or benefits were ignored in major decisions because they could not be quantified in monetary terms or could be described only in vague nonquantitative terms. Several dams built in the 1950s and 1960s were subjected to poor benefit-cost analyses that assigned high values to lake recreation behind a dam while presuming that riverine recreation and wildlife habitat displaced by the dam had zero value, simply because those values were hard to measure.

Government programs promote conservation only if benefits and costs are properly measured and used. Only then is the public protected against rent seeking by special interests, taxpayer ignorance, and empire building. Nevertheless, economic analysis is expensive and often difficult to understand. It is seen by some as unreliable and often is unpopular with politicians. In summary, government regulations and public resource management have the potential to promote more inferior conservation plans than the imperfect market system whenever proposed public actions are not based on objective economic analysis.

What Government Can Do to Protect Natural Resources

Benefit-Cost Analysis (BCA) is an economic tool for comparing in monetary terms the desirable and undesirable impacts of proposed natural resource policies where desirability is measured in human welfare. It is a method for ranking the economic performance of natural resource projects, policies, and programs in which impacts are measured in nontechnical terms and estimated by scientific methods. It is a way to compare, in common units, all the gains and losses to people resulting from some action. BCA is required by a number of laws, but far from all.

BCA organizes information in a way that promotes the conduct of rational policy analysis. Rational policy analysis considers all the relevant alternatives and identifies and evaluates all the consequences that would follow from the adoption of each alternative. It then selects the alternative that would be preferable in terms of maximizing society's overall welfare.

In the Flood Control Act of 1936, Congress required that the gross benefits of water development projects, "to whomsoever they may accrue," should exceed all costs. Since that time, BCA has been used widely to decide whether any federal water project should be started. In more recent years BCA has been used to help make three kinds of public natural resource decisions: (1) a simple ranking of the comparative benefits of several possible actions, (2) the optimal size or scale of a project produced by a decision, and (3) the optimal timing or sequencing of several elements of a decision.

BCA uses a simple decision rule. If, for some proposed plan, the sum of its human benefits exceeds the sum of the human costs by a larger amount than any other proposed action with the same aim, the plan with the greatest gross benefit for the cost should be adopted. Otherwise it should not. This assumes that all people are treated equally, so that an additional dollar of benefit accruing to a rich person is valued the same as a dollar of cost paid by a poor person. An advantage of BCA is that the dollar, as a unit of measure for ratings, is easily understood by everyone.

For the concept of revenue to the private firm, BCA substitutes the notion of benefit to society. For the cost of the private firm, BCA substitutes the concept of opportunity cost—or the value of benefits displaced when resources are taken from other economic activities to support the proposed plan in question. For the profit of the business firm, BCA substitutes the concept of net benefit, which means the difference between gross benefit and cost.

BCA values all natural resource services in the common denominator—money. Consider the huge range of services produced by natural resource decisions: electric power, water quantity, water quality, critical habitat for endangered species, timber, forage for cattle and wildlife, recreation, fish, minerals, and others. By expressing all these outputs in a common denominator, it allows all natural resource policy decisions to be compared on a level playing field. Although most natural resource benefits can be valued in monetary terms, some values remain resistant to monetization.

Whenever choices can be made among project outputs of equal perceived value, the least-cost alternative is preferred. For example, if the fate of an endangered species can be improved the investment that returns the greatest improvement for the cost (e.g., number of individuals in the population) is preferred.

Why Measure Benefits and Costs?

Why spend all the effort and money necessary to conduct a benefit-cost analysis? Why not use plain honest-to-goodness profit and loss accounting used by any business?

One answer is that what counts as a benefit or a loss to one part of the nation—to one or more persons or groups—does not necessarily count as a benefit or loss to the whole nation. Therefore, with BCA, we are concerned with the economic welfare of the nation as a whole rather than some small part of it. BCA for natural resource decisions asks the same question that private companies ask of their accountants. However, instead of asking whether the owners of a private enterprise will be made better off by the company's proposed decision, BCA asks whether society as a whole will be made better off by undertaking the action.

BCA helps make better management decisions by using a time-tested economic framework for organizing economic data. In natural resource management, there are plenty of ways governments can make bad decisions. Management by tradition is a widely applied method for making poor decisions. Resource agencies pursue activities, such as stocking X pounds of trout at a Y water or leasing Z board feet of timber on some national forest, simply because that is what they have done for years. Without information on benefits and costs, resource agencies often have no choice but to manage by tradition.

Another way to make bad decisions is through fear of change. In his small but mighty book entitled *The Prince*, the fifteenth-century Italian writer Nicolo Machiavelli warned us there is nothing more difficult to take in hand, more perilous to conduct, or more uncertain of its success than to take the lead in the introduction

of a new order of things. This is because the innovator faces as enemies all who have done well under the old conditions, and lukewarm defenders in those who may do well under the new. While change is resisted by virtually everybody, BCA gives a quantitative way to decide which changes are worthwhile by government and which ones should be left to the private sector or screened out altogether.

Poor conservation decisions are promoted by the necessity of government resource agencies to appease special interests. These special interests abound. In the western United States, for example, Congress sets prices for federal timber, water, energy, and livestock forage below market levels because powerful special interests (rent seekers) benefit economically, not because these low prices are good economic decisions for the nation as a whole.

Finally, unsound decisions happen when public resource managers' personal biases are allowed to influence decisions. America is "a nation of laws and not men." In the realm of natural resource policy this means we do not want some local Forest Service official deciding the mix of grazing and recreation on federal lands based on personal biases or political connections. The decision should be made through the consistent and objective application of time-tested economic and environmental principles. These principles should be set up at the national level and applied to resources and resource issues at the local level. Because not all environmental resources are readily expressed in monetary terms, economic principles have to be combined with environmental standards based on sound science and clear public choices.

HOW TO MEASURE BENEFITS AND COSTS

Basic Principles

Willingness to Pay. In principle, *the benefit of any natural resource conservation decision is measured by what people are willing to pay for it. Costs are benefits displaced by the decision.* These concepts apply to both goods and services that are sold in markets and those that are not.

Consider the case of market goods. Suppose the U.S. Secretary of Interior proposes limiting logging in the Southwest to produce a more critical habitat for the Mexican spotted owl. The benefit lost (cost) from such a policy is the timber left unharvested. Timber is sold in markets. So the total cost is the sum of prices times quantities of timber displaced by the decision.

As another example, consider the example of a nonmarket good in which Congress considers passing a law that requires shipbuilders to build double-hulled oil tankers in order to reduce future damages from oil spills. The benefit is the value of fish not killed, beaches not fouled by spilled oil, marine wildlife not killed, and ecosystems not damaged. While the concept applies to both market and nonmarket goods, for the latter, prices typically must be estimated by some indirect method. This might involve contingent valuation surveys, in which people are asked directly what the resource is worth to them.

Scarcity, Demand, and Benefits. Both market and nonmarket goods share an important characteristic. When they are scarce and in high demand, they are in great value, and the benefits of policies that supply more of them are quite high. For example, a policy that brings water (which is scarce) to growing cities in the desert to produce high-quality drinking water (which is in high demand) is likely to produce great benefits. Similarly, the policy that brings water to a humid, cool region like Minnesota (where water is abundant) to produce habitat for an obscure species (which is in low demand) is likely to produce negative human benefits.

How Benefit and Cost Information Should Be Used. Benefits and costs are measured and reported to facilitate sound conservation decisions. By sound, we mean the

decisions are worth more to a nation than they cost. There are many wrong ways to use information about benefits and costs, but only one right way.

Implementation Principles

An Almost Right Way. Requiring the ratio of total benefits to total costs to exceed 1.0 is almost right. According to that rule, resources should be committed to support a conservation decision if the ratio of the present value of benefits to the present value of costs exceeds 1.0. This method is almost right but not quite. It is not quite right because it is too conservative. Only having the benefit-cost ratio equal 1.0 lets one implement decisions for which benefits are no greater than costs. A private business cannot stay in business if its revenues do not exceed its costs by a safe margin. For public natural resource decisions, benefits should exceed costs by the greatest amount possible.

The term *benefit-cost ratio* is widely heard in policy circles such as in Washington, D.C. It is easily understood by Congress and the press because it is expressed as dollars of benefit per dollar of cost. When Congress and other decision makers enact laws or make appropriations for their projects, they want to know if the benefitcost ratio exceeds 1.0. Once the ratio exceeds 1.0, these decision makers may consider the economics to be acceptable and then use its political attractiveness to make the final decision.

The Right Way. The *maximum net present value* (MNPV) gauge is the one right way to use information on benefits and costs. According to this rule, natural resource conservation should be carried out to maximize the present value of net benefits. If carried out, the MNPV rule will produce the decision that maximizes the economic performance of the available resources. With the MNPV decision rule, only plans with net present value greater than zero are accepted as economically performing. If a management decision has a negative net present value, society gives up more than it gets over the life of the action, or society is paying more for the plan than it is worth.

Implementation Practices, Incremental Benefits, and Costs

The incremental (marginal) benefits of a proposed decision should always be compared to its incremental cost. How does marginal benefit translate into the natural resource management decision process? Depending on restrictions imposed by law or custom, managers and policy makers with a goal of economic efficiency emphasize those products generating the greatest additional public benefit for the added cost of management.

If additional logging resulted in less additional benefit than the added cost of implementing the logging, efficient actions would make other choices, such as outdoor recreation, livestock grazing, flood reduction, or improved functioning of ecosystems to support clean water, clean air, and biodiversity. As long as the gain in benefits exceeds the added costs compared with logging, other actions should be selected over more logging. Managers can increase total economic benefits by choosing policies for which the marginal benefits exceed marginal costs.

Measurement Problems

Unfortunately, all of the benefits and costs generated by management are not equally easy to measure. Some benefits cannot be accurately estimated given the present state of economic knowledge. For example, the benefits from restoring ecosystems and recovering most endangered species cannot yet be accurately estimated. Also, the real cost of managing for timber, grazing, recreation, and flood reduction may not be estimated because the negative side effects on other ecosystem services are not fully known. That does not mean ecosystems and endangered species are worth zero or worth whatever they cost to produce. The continuation of the Endangered Species

Act, along with a majority of public support, suggests its value to society is at least as great as its costs. Thus, in the political arena, the willingness to pay for the benefits of nonpriced goods and services is negotiated through the political process and legislation. The legislative decision about how much to regulate use or to allocate to nonmonetized benefits is harder than it might be with some reliably monetized benefit.

SCOPE AND LIMITS OF BCA

The Bad News

BCA is difficult for most people to understand. Most politicians and other decision makers do not really understand it, nor does the average voter. It is technical and requires a good deal of economic theory. So people who read a BCA report either must accept the numbers on faith or ignore them.

Measurement problems plague BCA. Dollar values of things like endangered species habitats are hard to measure because one cannot buy them at the downtown grocery store. So the accuracy of monetary values of natural resource programs is questionable when the natural resource is not traded in commercial markets. Many of those nonmarket benefits require a contingent valuation analysis. Here people are asked what they would be willing to pay for the service even though such payment is rarely required and people have no previous payment experience. For that reason many decision makers do not believe some contingent valuation numbers. Therefore, BCA often ignores most important parts of government projects, such as saving wildlife habitat or wilderness land, because these resources are not traded in markets. So, unless a lot is spent on estimating benefits of the decision, the most important values are not necessarily included in the BCA.

Ethical problems also plague BCA. It may be morally wrong to use BCA to evaluate policies such as the Clean Air Act, which restricts technologies used by coal companies. How can the added length of miners' lives be valued in cold money terms? When a politician or other decision maker sees dollar values placed on such a proposed piece of legislation, it may confuse rather than enlighten. Being fair to future generations is another ethical issue poorly handled by BCA. Valuing future benefits requires using a discount rate to deflate future benefits so they can be expressed in a common denominator with the current generations' benefits. Any discount rate greater than zero may be unfair because it assigns a lower value to future generations than to current generations.

Some say that BCA is unfair because it ignores the distribution of benefits and costs. It only measures total benefits and total costs of an action. A proposed policy that does well on a BCA may be consistent with an economic arrangement that makes the rich richer and the poor poorer.

Finally, government agencies who do their own BCAs are like foxes guarding the hen house. These agencies have every incentive to cheat by inflating the benefits of their programs and ignoring costs. By inflating their own program's benefits, they may get a bigger budget in the future. Federal water construction agencies such as the Army Corps of Engineers and Bureau of Reclamation have been accused of this practice in past years.

The Good News

BCA is an objective way to judge proposed policies by connecting economic principles to policy actions. It is based on an established body of economic theory that has been scrutinized, debated, and improved by many economists over the past 100 years. It attempts to measure the values of all the people who benefit from and who pay for a government policy decision, and not just a select few. Therefore, it is democratic and not elitist. By valuing impacts in dollars, it measures impacts in units that are understandable to both decision makers and the average adult. Other policy evaluation measures use some sort of indices, which typically are arbitrary. There is a vast body of literature on applications of BCA to various natural resource conservation issues.

Regardless of how BCA information is abused, the information allows the public, government employees, and elected officials to separate truly inferior alternatives from ones that have some merit. It can also be used to help isolate economically weak features of proposed plans that should be dropped so that the stronger ones can be carried out.

Summary of BCA

The use of BCA permits government to use economic information to design better natural resource conservation proposals, defined as those for which the economic benefits exceed the costs. It can play an important role in legislative and regulatory policy debates on how natural resources should be managed. Although formal BCA should not be viewed as either required or sufficient by itself for designing good public policy, it can provide a powerful framework for consistently organizing diverse information. In this way it can greatly improve the process and therefore, the outcome of natural resource policy analysis (Arrow et al. 1996). Moreover, even if the data available for a BCA are poor, the steps required to carry it out force analysts to raise the right questions. It is more important to measure the right thing in a crude sort of way (doing the right thing) than to measure the wrong thing with impressive refinement (doing the thing right).

CONCLUSION

Economics gives us insight about and better understanding of human behavior. Through that understanding we can design more efficient and equitable private and government programs for natural resource management. By influencing that behavior, particularly with economic incentives, we can better meet the needs of current and future generations of people. Economics also informs us about how we can better allocate scarce resources among people competing for them. If you think a career in natural resource conservation may be for you, we believe the investment you make in economics courses will produce a high return (high BCA). For further reading on natural resource economics, the authors recommend Anderson and Leal (1991), Field (1994), Tietenberg (1996), and Schiller (2000).

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