CHAPTER

4

Common Property Resources and Public Goods

Chapter 4 Focus Questions

- Why are resources like fisheries and groundwater often damaged through excessive use?
- What policies are effective for managing open-access resources?
- How should we preserve public goods like National Parks, oceans, and the atmosphere?

4.1 OMMON PROPERTY, OPEN ACCESS, AND PROPERTY RIGHTS

As we saw in Chapter 3, clearly defined property rights can potentially be used for efficient resource allocation, even in the presence of externalities. In market economies, private property rights are central. This has not always been the case. In traditional or tribal societies, private property rights over resources are rare. Resources important to the life of the tribe are either held in common (like a common grazing ground) or are not owned at all (like animals that are hunted for food). Economically developed societies—we like to think of ourselves as "advanced" societies—have generally evolved elaborate systems of property rights covering most resources as well as most goods and services. But modern industrialized countries also have resources, goods, and services, which are difficult to categorize as property.

A free-flowing river is one example. If we think of the river simply as a quantity of water that flows past people's land, we can devise rules for "ownership" of the water, allowing a certain amount of water withdrawal per landowner. But what about the aquatic life of the river? What about the use of the river for recreation: canoeing, swimming, and fishing? What about the scenic beauty of the riverside?

Some of these aspects of the river might also become specific types of property. For example, in Scotland trout-fishing rights on certain rivers are jealously guarded property. But it is difficult to parcel up every function of the river and define it as someone's property. To some degree, the river is a **common property resource**—it is accessible to everyone and not subject to private ownership. Technically speaking, a common property resource is a **nonexcludable good** because people cannot easily be excluded from using it. The other characteristic of a common property resource is that it is a **rival good**, meaning that its use by one person diminishes the quantity or quality of the resource available to others.

common property resource a resource that is available to everyone (nonexcludable), but use of the resource may diminish the quantity or quality available to others (rival).

nonexcludable good a good that is available to all users, under conditions in which it is impossible, or at least difficult, to exclude potential users.

rival good a good whose use by one person diminishes the quantity or quality of the good available to others.

Consider groundwater as an example of a common property resource. Anyone can access groundwater by drilling a well; thus, it is nonexcludable. But groundwater is rival because each user depletes the aquifer somewhat, leaving less water available to other potential users.

How can a common property resource be managed to maximize social benefits? Is government regulation required to prevent the overuse of the resource, and, if so, what types of regulations can be effective? We address these questions using the example of an ocean fishery.

The Economics of a Fishery

A classic example of a common property resource is an ocean fishery. While inland and coastal fisheries are often governed by private, traditional, or government management systems, fisheries in the open ocean are typically **open-access resources**. An open-access resource is a common property resource that lacks any system of rules governing its use. Anyone who wants to can fish in nonterritorial waters, which means that no one owns the basic resource, the wild stock of fish. We use this example to apply some of the basic concepts of production theory to an open-access resource.

open-access resource(s) a resource that offers unrestricted and unregulated access such as an ocean fishery or the atmosphere.

How can we apply economic theory to a fishery? Let's start with common sense. If only a few fishing boats start operations in a rich fishery, their catch will certainly be good. This is likely to attract other fishers, and as more boats join the fishing fleet the total catch will increase.

As the number of fishing boats becomes very large, it is clear that the capacity of the fishery will be strained, and the catch of individual boats will diminish. We know from experience that if this process is taken too far, the output of the whole fishery can be badly damaged. At what point does it become counterproductive to put in more effort, in terms of more boat trips? Which forces can drive us past that point? Economic theory can give us some insights into these critical questions of common property resource management.

We can envision the fishery's **total product** as shown in Figure 4.1. The horizontal axis shows fishing effort, measured in number of boat trips. The vertical axis shows the total catch of all the boats, measured in tons of fish caught. As the number of boat trips increases, the total product curve shown in Figure 4.1 goes through three distinct phases.

The first is a period of **constant returns to scale** (here shown from 0 to 400 boats). In this range, each extra boat finds an ample supply of fish and is able to return to port with a catch of 10 tons. For simplicity, we assume that all boats are the same in this example. Thus each boat catches the same amount of fish. During the period of constant returns to scale, the fishery is not subject to rivalry, as each additional fisher does not reduce the quantity of fish that can be caught by other fishers.

The second phase is a period of **diminishing returns** to effort, shown from 400 to approximately 850 boats. It is now becoming more difficult to catch a limited number of fish. When an extra boat puts out to sea, it increases the total catch of the fishery, but it also reduces by a small amount the catch of all the other boats. The natural resource is no longer ample for all; now there is intense competition for fish stocks, which makes the job tougher for all fishers. In other words, the resource has now become rival.

Finally, there is a period of **absolutely diminishing returns**, above 850 boats, a situation in which having more boats actually *decreases* the total catch. Here it is evident that **overfishing** is taking place. Stocks of fish are being depleted. The fish population's ability to replenish itself is damaged, and we have the makings of both an economic and an ecological collapse.[1]

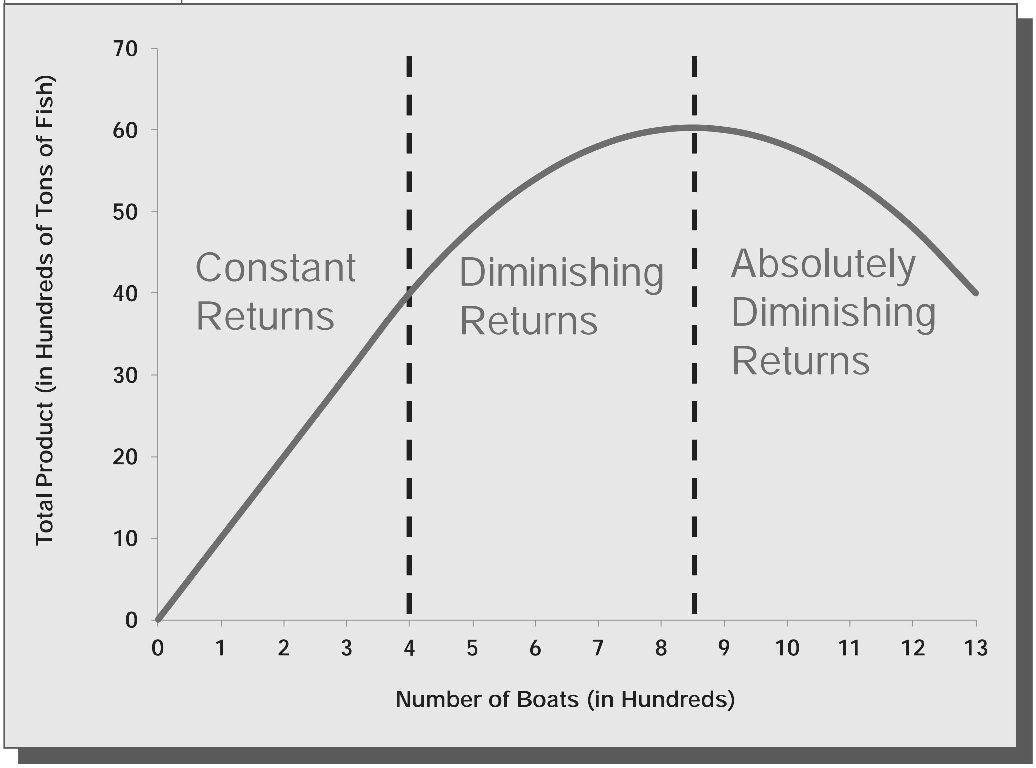
> **total product** the total quantity of a good or service produced with a given quantity of inputs.
>
> **constant returns to scale** a proportional increase (or decrease) in one or more inputs results in the same proportional increase (or decrease) in output.
>
> **diminishing returns** a proportional increase (or decrease) in one or more inputs results in a smaller proportional increase (or decrease) in output.
>
> **absolutely diminishing returns** an increase in one or more inputs results in a decrease in output.
>
> **overfishing** a level of fishing effort that depletes the stock of a fishery over time.

To understand the economic forces motivating the fishers, we must consider how different levels of total fishing effort affect their profits. We assume that fishers are interested only in making profits for themselves. The first step in determining profits is to convert the quantitative measure of tons of fish landed into a monetary figure showing total revenue earned. This can be done by simply multiplying the quantity of fish by the price per ton ($TR = P*Q$). We assume here that the price of fish is stable at $1,000 per ton. We are implicitly assuming that this fishery is small enough relative to the total market that its output does not significantly affect the market price. If this fishery were the only source of fish for the market, we would have to consider price changes also.

We can now calculate the **total revenue** of the fishery, as shown in Table 4.1. Next, let's assume that cost of operating a fishing boat

> **total revenue** the total revenue obtained by selling a particular quantity of a good or service; equal to price per unit multiplied by quantity sold.

Figure 4.1 **Total Product of the Fishery**



marginal costs the cost of producing or consuming one more unit of a good or service.

average cost the average cost of producing each unit of a good or service; equal to total cost divided by the quantity produced.

total cost the total cost to a firm of producing its output.

profits total revenue received minus total cost to producers.

is constant at \$4,000 per boat. Thus the **marginal cost** of a boat (i.e., the cost of sending one more boat into the fishery) is always \$4,000. Again, all boats are the same in this example, so the cost of operating each boat is assumed to be the same. Since the cost of operating a boat is constant, the **average cost** of operating a boat is also always \$4,000. The **total cost** for all boats in the fishery is equal to \$4,000 multiplied by the number of boats. By subtracting the total revenue in the fishery from the total cost (TC) of operating the boats, we can obtain the **profits** ($TR - TC$) of the fishery, shown in Table 4.1.

We can see from Table 4.1 that total profits in the fishery are \$3 million at both 600 and 700 boats. Figure 4.2 charts the total revenue, costs, and profits of the fishery at each effort level. We see that total fishery profits are maximized between 600 and 700 boats, or at approximately 650 boats. If fishing effort is too high (more than 1,200 boats), total profits of the fishery actually become negative.

Incentives for Overfishing

We know that the profit-maximizing level of effort, considering the entire fishery, is 650 boats. But in the absence of any regulations governing how the fishery is managed, what level of fishing effort will occur? We assume that each fisher is only concerned with his or her profits. Thus individuals will not consider how their activities affect the fishery as a whole, only whether fishing is profitable to them. So rather than looking at the values in Table 4.1 for the total fishery, we need to consider the perspective of the individual fisher.

Table 4.1 Total Fish Catch, Revenue, Costs, and Profit

Number of boats	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300
Total fish catch (hundred tons)	10	20	30	40	48	54	58	60	60	58	54	48	40
Total revenue (in million $)	1.0	2.0	3.0	4.0	4.8	5.4	5.8	6.0	6.0	5.8	5.4	4.8	4.0
Total costs (in million $)	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2
Total profits (in million $)	0.6	1.2	1.8	2.4	2.8	3.0	3.0	2.8	2.4	1.8	1.0	0.0	–1.2

average revenue the average price a firm receives for each unit of a good or service; equal to total revenue divided by the quantity produced.

We know that each boat costs $4,000 to operate. For each level of effort in Table 4.1, we can calculate the revenue for each fisher as the total revenue in the fishery divided by the number of boats. For example, with 800 boats operating total revenue is $6 million, and thus the revenue per boat is $7,500 ($6,000,000/800). This is the **average revenue** or revenue per boat, as shown in Table 4.2. In mathematical terms, $AR = TR/Q$. By subtracting the cost per boat of $4,000, we obtain the profit per boat, also shown in Table 4.2.

Suppose that 400 boats are operating. We see in Table 4.2 that each boat is bringing in revenues of $10,000, yielding an individual profit of $6,000. Other people will notice that fishing is rather profitable, and thus new fishers will be attracted to enter the fishery. So long as fishers have free entry to the industry, the number of boats will continue to increase. Either existing fishers will acquire more boats, or new operators will enter the fishery.

Once we exceed 400 boats, in Table 4.2 profits per boat begin to decline as we enter the region of diminishing returns. But as long as operating each boat is profitable, there is an incentive for more boats to enter the industry—even into the region of absolutely diminishing returns. For example, when 1,000 boats are operating, the profits per boat are still $1,800. So even though additional boats actually reduce the total catch, and total revenue, of the fishery, there is still an economic incentive for individual fishers to send more boats into the fishery.

open-access equilibrium the level of use of an open-access resource that results from a market with unrestricted entry; this level of use may lead to depletion of the resource.

Only when we reach 1,200 boats do profits per boat finally fall to 0. If any more boats operate above 1,200, then profits per boat actually fall below 0 (i.e., every boat is losing money), and there would be an incentive for some fishers to leave the industry. Above 1,200 boats, the market is sending a "signal," through unprofitability, that the industry is overcrowded. Thus the **open-access equilibrium**

Figure 4.2 **Total Revenue, Costs, and Profits for the Entire Fishery**

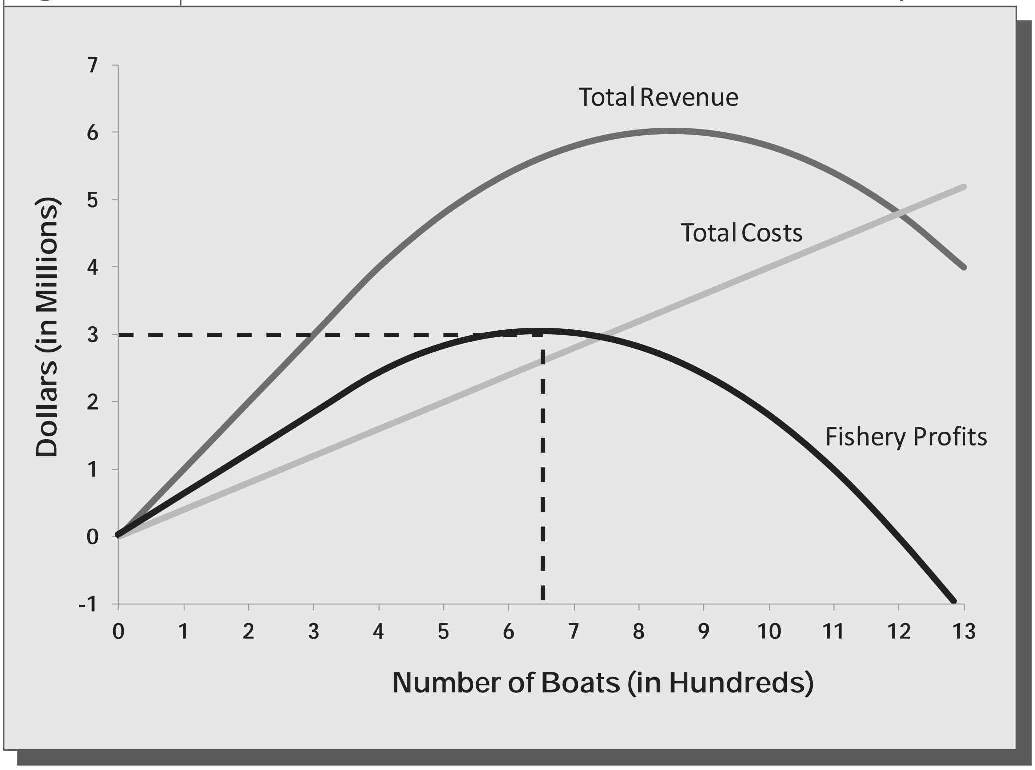


Table 4.2 **Revenue, Costs, and Profits for Individual Fishers**

Number of boats	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300
Revenue per boat (in thousand $)	10.0	10.0	10.0	10.0	9.6	9.0	8.2	7.5	6.6	5.8	4.9	4.0	3.1
Cost per boat (in thousand $)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Profit per boat (in thousand $)	6.0	6.0	6.0	6.0	5.6	5.0	4.2	3.5	2.6	1.8	0.9	0.0	–0.9

is 1,200 boats, which is the point at which there is no further incentive for entry to or exit from the market.[2]

The open-access equilibrium is clearly not economically efficient. A formerly profitable industry has become unprofitable, and total fish catch has fallen, reducing overall social benefits. The market signal that the industry is overcrowded comes far too late—well above the profit-maximizing level of 650 boats. Looking at Table 4.1, we see that total profits in the industry at 1,200 boats are 0. Industry profits can actually be increased by *reducing* fishing effort.

In addition to being economically inefficient, the open-access equilibrium is also not ecologically sustainable. As the open-access equilibrium is in the region of absolutely diminishing returns, eventual collapse of the fishery is a likely outcome. The forces of free entry and profit maximization at the individual level, which usually work to promote economic efficiency, have exactly the opposite effect in the case of a common property resource. These forces encourage overfishing, which ultimately eliminates any profitability in the industry and destroys the natural resource. The economic explanation is that fishers have free access to a valuable resource—fish stocks. Economic logic tells us that an underpriced resource will be overused, and a resource priced at zero will be squandered.

This phenomenon is sometimes referred to as the **tragedy of the commons**.[3] Because common property resources belong to no one in particular, no one has an incentive to conserve them. On the contrary, the incentive is to use as much as you can before someone else gets it. When resources are ample, as in precolonial America when the stocks of fish were far beyond the needs or fishing abilities of the small population, there is no problem. When the population and demand are large enough, and fishing technologies more sophisticated, the economic logic that we have sketched out leads to a critical danger of overfishing and even complete collapse of the fishery.

> **tragedy of the commons** the tendency for common property resources to be overexploited because no one has an incentive to conserve the resource while individual financial incentives promote expanded exploitation.

Marginal Analysis of a Common Property Resource

Economists seeking to determine efficient outcomes focus on comparing **marginal benefits** and marginal costs. This is really just common sense—if the benefits of doing something exceed the costs, then it normally makes sense to do it. So in our fishing example, as long as the benefits of one more boat exceed the costs of one more boat, then it makes sense for the industry as a whole to keep increasing the number of boats. In other words, if the **marginal revenue** of a boat exceeds the marginal cost, it is efficient to increase the number of boats, which will have the effect of increasing total industry profits. However, when the marginal costs equal or exceed the marginal revenue, we should stop adding boats, which would decrease total industry profits. Thus the economically efficient outcome occurs where marginal revenue equals marginal cost. Note that in this example we define efficiency in terms of only industry profits—we are not considering consumer benefits or externalities.

> **marginal benefit** the benefit of producing or consuming one more unit of a good or service.
>
> **marginal revenue** the additional revenue obtained by selling one more unit of a good or service.

We know the marginal cost per boat is constant at $4,000. To calculate the marginal revenue for each level of fishing effort, we calculate the additional revenue for each change in effort (effort being measured by the number of boats). We normally speak of the marginal change from one level of effort to another; thus, we would calculate the marginal revenue *between* two levels of effort.

Table 4.3 Marginal Revenue and Cost Analysis of Fishery

Number of boats	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300
Total revenue (in $ million)	0.0	1.0	2.0	3.0	4.0	4.8	5.4	5.8	6.0	6.0	5.8	5.4	4.8	4.0
Marginal revenue per boat (in $ 000)		10	10	10	10	8	6	4	2	0	–2	–4	–6	–8
Marginal cost per boat (in $ 000)		4	4	4	4	4	4	4	4	4	4	4	4	4

Let's consider the marginal revenue that results from increasing the number of boats from 400 to 500. Total revenue in the industry increases from $4 million to $4.8 million, an increase of $800,000. Since an additional 100 boats increases revenues by $800,000, the marginal revenue per boat when the number of boats increases from 400 to 500 is $800,000/100 = $8,000.[4] Expressed mathematically, $MR = \Delta TR/\Delta Q$.

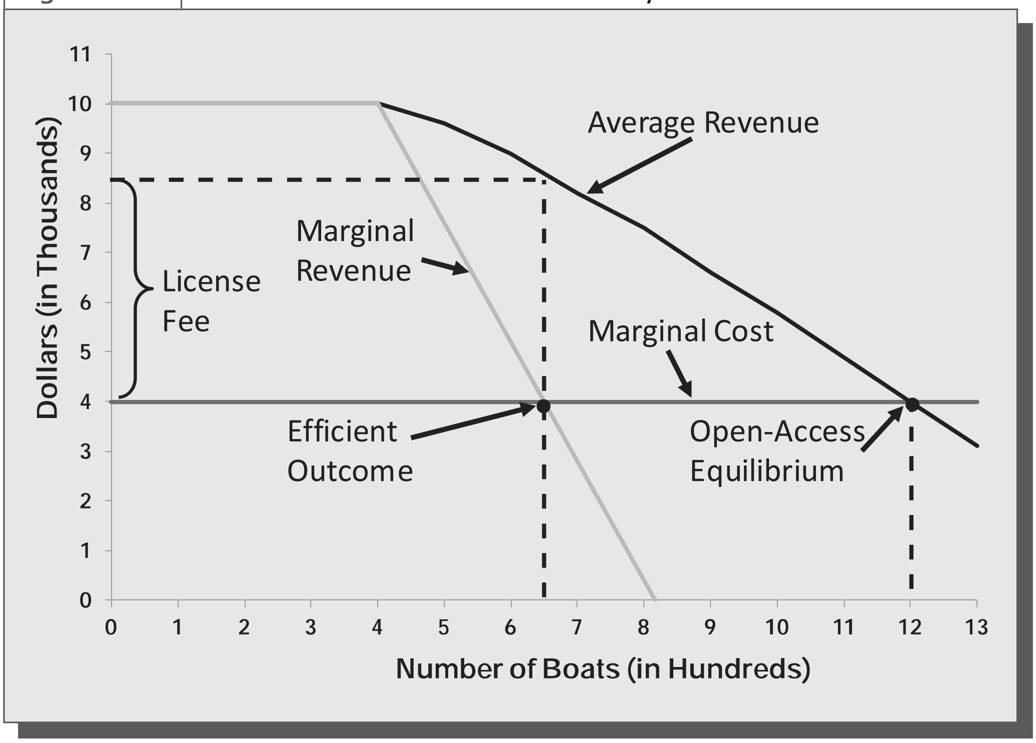
It makes economic sense to increase from 400 to 500 boats, because marginal cost is $4,000 per boat. In other words, marginal revenue exceeds marginal cost, so raising the number of boats from 400 to 500 increases overall profits in the fishery.

Table 4.3 calculates the marginal revenue per boat between each effort level, along with the marginal cost. Between 600 and 700 boats, the marginal revenue is exactly equal to the marginal cost of $4,000 per boat. So we can conclude that the efficient level of effort is between 600 and 700 boats, as illustrated in Figure 4.3.

The efficient outcome is where marginal revenue equals marginal cost, at approximately 650 boats. But the open-access equilibrium occurs where *average* revenue equals marginal cost (the cost of an additional boat). This occurs at 1,200 boats. In this example, due to our assumption of constant marginal costs, the marginal cost of $4,000 per boat is also the average cost (i.e., the cost for each boat owner). Note that the difference between average revenue and average cost at 650 boats is about $4,600 in Figure 4.3. This represents the profit that each boat makes at the efficient level of effort. We will see why this is important in the next section. If 650 boats each obtain a profit of about $4,600, then total industry profits are maximized at $3 million. Obviously this represents a big improvement over total profits at the open-access equilibrium, which are zero with 1,200 boats operating.

The efficient outcome is also more likely to be ecologically sustainable. Referring back to Figure 4.1, we see that at 650 boats we are in the region of diminishing returns, rather than the area of absolutely diminishing returns. While fishing effort is high enough to cause some reduction in individual yields, it is unlikely to cause collapse of the fishery.

Figure 4.3 **Economic Conditions in the Fishery**



Economic Policies for Fishery Management

What policies might be used to achieve the efficient outcome, as well as protecting the fishery by reducing effort? One option may be for all the fishers to agree voluntarily to limit fishing effort to 650 boats. But the problem is that each fisher will still have a strong economic incentive to send one more boat out, which may cause the agreement to break down. Also, new fishers will be enticed to enter the fishery and would not be bound by the voluntary agreement.

As with the problem of externalities, achieving the efficient outcome requires government intervention. One policy option is to use a **license fee** to discourage overfishing. The correct fee can be determined by referring to Figure 4.3. We want fishing to be profitable up to the efficient level of 650 boats, but we want to discourage fishing beyond this level. So the fee needs to be high enough to make the 651st boat unprofitable, but still allow the 650th to be profitable. At 650 boats, average revenue is $8,600 per boat, and profits are $4,600 per boat. The potential profit per boat at 651 boats would be slightly less than $4,600. So if we charge a license fee of $4,600, then the 651st boat would be unprofitable, and fishing effort would reach a new equilibrium at 650 boats. In other words, even with a license fee of $4,600 per boat, fishing remains profitable up to 650 boats, but then becomes unprofitable above 650 boats. Thus the "correct" license fee is the difference between average revenue and average cost at the efficient level of effort. The license fee effectively moves us from the inefficient open-access equilibrium to the efficient outcome. The $3 million difference between total costs and total revenues is now, however, collected by the government as fees, rather than going to the industry participants as profits.

> **license fee** the fee paid for access to a resource, such as a fishing license.

At 650 boats, each fisher will now be in the position of a perfect competitor, making a minimal or "normal" profit.[5] But with the license fee in effect, the logic of competition now works to protect the ecosystem, not to destroy it. In effect, fishers will be charged a fee for the use of a previously free resource—access to fish stocks. The government acts as a "landlord," charging a "rent" for access to the ocean. This policy might be politically unpopular in fishing communities, but it will prevent the industry from destroying the means of its own livelihood.

By charging $4,600 per boat, the government effectively collects the potential industry economic profits of $3 million. From a social point of view, this can be justified by observing that the ocean "belongs" to all of us—but of course it is important that these revenues be used wisely. Fee revenue could be used, for example, to improve the habitat of the fishery, to compensate those who are forced out of the fishery when the fee is imposed, or to invest in technologies that reduce fishery damage.

Another policy to achieve the same goal would be the use of a **quota**, or catch limit. Government officials can determine a quota for the entire fishery, but determining who receives the rights to a limited fish catch can become controversial. If the right is allocated to current fishers, new entrants will be barred from the industry. Alternatively, fishers might receive **individual transferable quotas (ITQs)**, which could be sold to someone entering the business. In some cases, limited rights to hunt or fish certain species are allocated to indigenous peoples. Aleut people, for example, have the right to hunt a limited number of endangered bowhead whales (See Box 4.1 for another example of ITQs in practice). An advantage of the ITQ system, from the point of view of the fishers, is that the revenues from the fishery remain with the fishers who hold the ITQs, rather than being collected by the government as in the case of a license fee.

> **quota/quota system** a system of limiting access to a resource through restrictions on the permissible harvest of the resource.
>
> **individual transferable quotas (ITQs)** tradable rights to harvest a resource, such as a permit to harvest a particular quantity of fish.

Box 4.1
COMMON-PROPERTY RESOURCE MANAGEMENT IN PRACTICE: INDIVIDUAL TRANSFERABLE QUOTAS

Iceland has one of the most extensive systems of individual transferable quotas for its marine fisheries. In 1990 Iceland passed the Fisheries Management Act, which established ITQs for all fisheries, with permits allocated to each fishing vessel based on its proportional share of the national catch during a baseline period. Each year the total allowable catch is determined based on the current scientific evidence regarding the health of each fishery. For example, the allowable cod catch each year is set equal to 20 percent of the "catchable biomass" of the stock. As the health of the cod fishery has improved, the allowable catch has increased—from 130,000 tons in 2007 to about 230,000 tons in 2015.

The ITQs are fully tradable, and even divisible into smaller shares if a fisher wishes to only transfer part of his or her total allocation. Iceland has also implemented regulations that prohibit one company from obtaining an excessive proportion of the permits for a fishery. For example, one company cannot have the rights to more than 12 percent of the national cod allowable catch, or 20 percent of the halibut catch. A separate quota system is in place specifically for smaller boats, to allow the coexistence of both small- and large-scale fishing operations.

According to Sigurdur Ingi Johannsson, the Minister of Fisheries and Agriculture, the ITQ system has been very successful. In 2015 he stated that the approach has both improved the health of Iceland's fisheries and led to an increase in fishery revenues. He said, "We need to use responsible, science-based analysis, but I would say it's a case of so far, so good. Cod, our most valuable fish-stock, is stronger than it has been for 50 years. We are also using fewer vessels, too, which is having less of an environmental impact."

Sources: Davies, 2015; Icelandic Ministry of Fisheries and Agriculture web site, http://www.fisheries.is/management/fisheries-management/individual-transferable-quotas/.

Yet another possibility is for the government to sell fishing quota rights at auction, which will lead to an economic result similar to that for the license fee. Suppose that the government correctly determines that 650 is the efficient quantity of boats and makes this number of permits available in an auction. What would be the ultimate bidding price for these permits? If fishers can correctly estimate that potential economic profits at this effort level are $4,600 per boat (average revenue minus average cost), then the permit price would get bid up to $4,600. In essence, the quota produces the same outcome as the license fee, both in terms of the number of boats and government revenue of $3 million. Whichever method is chosen, it requires a consciously planned government intervention. Although economists often argue that markets operate more efficiently without government intervention, here is a case in which government intervention is *required* to achieve an economically efficient (and ecologically sustainable) solution.[6]

Managing Common Property Resources

We have not considered externalities yet in our analysis. It may be that high levels of fishing effort cause negative externalities, such as water pollution or reduced recreational opportunities. If this were the case, then the socially efficient outcome might be less than 650 boats, and we would also need to take these externalities into account when setting the license fee or the quota. If we could monetize the externality damage, we would add this amount to the fee to further reduce effort.

The need for social regulation to manage common-property resources has been well recognized throughout history. Many traditional societies have maintained flourishing fisheries through the implementation of socially accepted rules governing fishing activity. This approach reflects a longstanding principle of limited catch and conservation of resources.

Population growth, high demand, and advanced technology have complicated the implementation of such sound principles. As demand for fish increases globally, and more areas become overfished, the price of fish will tend to rise. A higher price will make the problems of open access worse, since it increases the profitability of fishing and encourages more entry. Improved technology also worsens the problem of overfishing. Usually increased productivity is good for society, but in the case of an open access resource, it hastens the pressure on the resource and makes ecosystem collapse more likely. For example, sonar systems that enable tracking of fish make it easier for large fishing boats to increase their catch—but also accelerate the depletion of fish stocks.

The economic policies of license fees and ITQs discussed above are not the only potential approaches for preventing the exploitation of common property resources. One alternative is to privatize such resources, based on the perspective that private owners will have an incentive to manage them sustainably. But as we'll see in Chapter 19 when we discuss the economics of forest management, private ownership of a natural resource doesn't necessarily ensure environmentally sustainable management. In particular, an owner of a forest, or of a private fishery, may still have an economic incentive to overexploit the resource.

An alternative to policies such as ITQs and private ownership is the potential for users of a common property resource to devise their own agreement to prevent the tragedy of the commons. Elinor Ostrom won the Nobel Prize in Economics in 2009 for her pioneering research on the ways different societies have addressed the management of common property resources.[7] She identified many instances where resource users were able to work out a cooperative strategy for effective and sustainable management without the need for government regulation or privatization. She found that local users often hold important knowledge that may not be available to government officials when setting allowable harvest levels. Also, she discovered that local users are likely to be quite aware that individual financial self-interest in the short term can lead to ecological and economic collapse in the long run, and thus take preemptive steps.

Ostrom ultimately identified the conditions under which cooperative local management of a common property resource can be effective. Among the conditions she recognized are:

- Most users of a resource should be involved in devising rules for managing the resource.
- There should be monitors of the resource, accountable to the resource users, who periodically evaluate conditions.
- There should be mechanisms to resolve conflicts that are responsive and low-cost.
- Rules for managing the resource should be adapted to local conditions.
- There should be graduated sanctions for resource users who violate the rules.

We should also note that Ostrom's framework is not necessarily incompatible with government involvement. She notes that for large-scale common property resources a "nested" approach may be needed, involving organizations at different levels. For example, a state or federal government might be needed to administer and enforce an ITQ system, but a local group of fishers might be integral in designing the system and handling disputes. Thus a broader lesson is that effective management of natural resources is often based on a participatory approach that incorporates diverse viewpoints, including local (possibly indigenous) knowledge, history, and culture. Effective management of common property resources that are national or global in scale will clearly require government involvement (as we'll discuss at the end of this chapter), but should still be mindful of varying local contexts.

4.2 THE NVIRONMENT AS A PUBLIC GOOD

public goods goods that are available to all (nonexcludable) and whose use by one person does not reduce their availability to others (nonrival).

nonrival good a good whose use by one person does not limit its use by others; one of the two characteristics of public goods.

free riders an individual or group that obtains a benefit from a public good without having to pay for it.

We now consider the economics of **public goods**. Like common property resources, public goods are nonexcludable, meaning that they are available to everyone. But while common property resources are rival, public goods are **nonrival**. If a good is nonrival, its use by one person does not reduce its availability or quality to others.[8]

One example is the National Park system of the United States. National Parks are open to all, and (except where overcrowding becomes a significant problem) their use by some people does not reduce others' ability to enjoy them. Public goods are not necessarily environmental in character: The highway system and national defense are often cited as examples of public goods. Another nonenvironmental example is public radio, because anyone with a radio can listen to it and additional people listening to public radio do not reduce its availability to others. Many aspects of environmental preservation, however, do fall into the public goods category, since virtually everyone has an interest in a sound and healthy environment.[9]

Can we rely upon private markets to provide us with the appropriate level of public goods? The answer is clearly no. In many cases, private markets will not provide public goods at all. With market goods, the ability to charge a price, along with recognition of property rights, acts as a means to exclude nonbuyers from the benefits that buyers enjoy. Because of the nonexcludable and nonrival characteristics of public goods, no individual consumer has an incentive to pay for something that everyone else can freely enjoy.

A second possibility is to rely on donations to supply public goods. This is done with some public goods, such as public radio and television. Also, some environmental groups conserve habitats that, while privately owned, can be considered public goods (see Box 4.2). Donations, however, generally will not raise sufficient funds for an efficient provision of public goods. Since public goods are nonexcludable, each person can receive the benefits of public goods regardless of whether they pay. So while some people may be willing to donate money to public radio, many others simply listen to it without paying anything. Those who do not pay choose to be **free riders**. It is obvious that a voluntary donation system would not work for, say, the provision of national defense or the highway system.

Although we cannot rely upon private markets or voluntary donations to supply public goods, their adequate supply is of crucial interest to the whole society. Once again, the solution to the dilemma requires some degree of government involvement. Decisions regarding the provision of public goods are commonly decided in the political arena. This is generally true of, for example, national defense. A political decision must be made, taking into account that some citizens may favor more defense spending, others less. But a decision must be made, and after the decision is made, we all pay a share of the cost through taxes.

Similarly, decisions on the provision of environmental public goods have to be made through the political system. Congress, for example, must decide on funding for the National

Box 4.2
THE NATURE CONSERVANCY

While voluntary donations cannot be relied on to provide an efficient level of public goods, voluntary efforts can effectively supplement government efforts. A successful example is The Nature Conservancy, an environmental group founded in 1951. Rather than focusing on political lobbying or advertising, The Nature Conservancy directs most its efforts toward purchasing land with the donations that it receives. This approach essentially creates a voluntary market in which people can express their preference for habitat conservation.

The organization started in the United States and now operates in more than 30 countries. The Nature Conservancy has protected over 119 million acres globally—an area equal in size to the U.S. state of New Mexico. Most of its protected areas are open for recreation, although it also allows logging, hunting, and other extractive uses on some properties.

In addition to directly purchasing and managing land, The Nature Conservancy also works with landowners to establish *conservation easements*. In a conservation easement agreement, a landowner sells the rights to develop his or her land in certain ways (e.g., creating a housing subdivision), while still retaining ownership and continuing with traditional uses such as ranching and timber harvesting. Other efforts include their "Plant a Billion Trees" campaign to plant trees in the tropical rainforest of Brazil. Each $1 donated is used to plant one tree.

The Nature Conservancy's nonconfrontational, pragmatic approach is widely respected and generally considered effective. It is normally ranked as one of the most trusted nonprofit organizations and is praised for its efficient use of donations. While some environmentalists are critical of some of its policies, for example, selling parcels of donated land for a profit rather than conserving them, its efforts provide a means for individuals to use the market to promote habitat conservation.

Source: The Nature Conservancy, www.nature.org.

Park system.[10] Will more land be acquired for parks? Might some existing park areas be sold or leased for development? In making decisions like this, we need some indication of the level of public demand for environmental amenities. Can economic theory be of any help here?

Economics of Public Goods

The problem of public good provision cannot be solved through the ordinary market process of supply and demand. In the fishery example discussed above, the problem lay on the production side—the ordinary market logic led to overexpansion of production and excessive pressure on resources. In the case of public goods, the problem is on the demand side. Recall that in Chapter 3 we referred to a demand curve as both a marginal benefit curve and a willingness-to-pay curve. A consumer is willing to pay, say, up to $30 for a shirt because that is his or her perceived benefits from owning the shirt. But in the case of a public good, the marginal benefits that someone obtains from a public good are not the same as their willingness to pay for it. In particular, their willingness to pay is likely to be significantly lower than their marginal benefits.

A simple example illustrates this point. Consider a society with just two individuals: Doug and Sasha. Both individuals value forest preservation—a public good. Figure 4.4 shows the marginal benefits each person receives from the preservation of forest land. As with a regular demand curve, the marginal benefits of each acre preserved decline with more preservation.

We see that Doug receives greater marginal benefits than Sasha does. This may be because Doug obtains more recreational use of forests, or it may simply reflect different preferences.

vertical addition adding the price of more than one demand curve at the same quantity demanded.

The aggregate, or social, marginal benefits from preserved forest land are obtained by the **vertical addition** of the two marginal benefit curves. In the top graph in Figure 4.4, we see that Doug receives a marginal benefit of $5 for an additional acre of forest preservation if 10 acres are already preserved. Sasha receives a marginal benefit of only $2. So the aggregate benefits of an additional acre of preserved forest are $7, as shown in the bottom graph. Note that the aggregate curve is kinked because to the right of the kink the curve only reflects Doug's marginal benefits, since Sasha's marginal benefits are zero in this range.

social benefits the market and nonmarket benefits associated with a good or service aggregated across all members of a society.

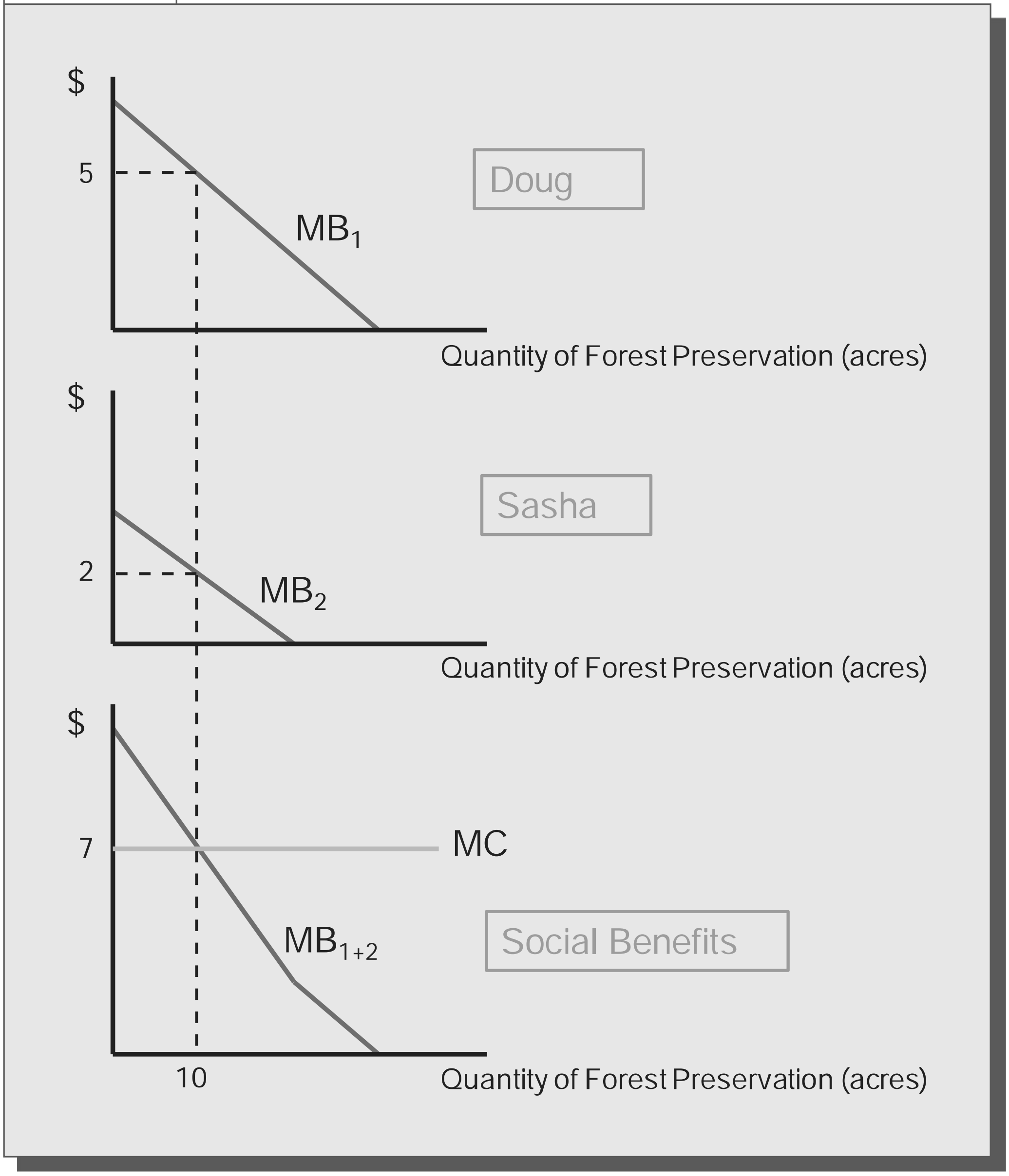
Suppose for simplicity that forest preservation costs society a constant $7 per acre, in terms of administrative and management costs. This is shown in the bottom graph in Figure 4.4. In this example, the optimal level of forest preservation is 10 acres—the point where the marginal **social benefits** just equal the marginal costs. But we have not addressed the question of how much Doug and Sasha are actually willing to pay for forest preservation. In the case of a public good, one's marginal benefit curve is not the same as his or her willingness-to-pay curve. For example, while Doug receives a marginal benefit of $5 for an acre of forest preservation, he has an incentive to be a free rider and he may be willing to pay only $3 per acre or nothing at all.

The problem is that we do not have a market in which people accurately indicate their preferences for public goods. Perhaps we could use a survey to collect information on how much people value certain public goods (we discuss economic surveys in Chapter 6), but even then people might not provide accurate responses. Ultimately, decisions regarding public goods require some kind of social deliberation. One possibility is to rely on elected officials to make public goods decisions for their constituents. Another is to rely on a democratic process, such as direct voting or local town meetings.

Even if we reach the "correct" level of provision from a social perspective, another problem arises due to differences across individuals. Suppose that we correctly determine that the appropriate level of forest preservation in Figure 4.4 is 10 acres. At a cost of $7 per acre, we need to raise $70 in revenues to pay for preservation. We might tax Doug and Sasha $35 each to cover these costs. Doug receives at least $5 in benefits for every acre preserved, or a total of at least $50 in benefits, so he might not object to the $35 tax. However, Sasha receives significantly lower benefits and she may view the tax as excessive.

Suppose that we extend our two-person example to the entire population of the United States—about 125 million households. If preferences in the general population are similar to Doug and Sasha's, we will need to raise about 125 million × $35, or over $4 billion for forest preservation in order to reflect the true social benefits in the country. This could be done with a tax of $35 per household. But, of course, marginal benefits vary across households. It is clearly impractical to assess the actual marginal benefit of each household and adjust the tax per household accordingly. A society-wide decision must be made. Some people might think that they have to pay too much; others, that the allocation of money for forest preservation is inadequate. But assessing a tax on everyone is essential to achieve the goal. The tax might be a constant $35 per household, or it might vary according to income or some other criteria. Debates regarding efficiency and fairness in the case of public goods are, thus, inevitably both political and economic in nature.

Figure 4.4 **The Economics of Forest Preservation**



4.3 THE GLOBAL COMMONS

In examining common property resources and public goods in this chapter, we have extended the scope of our resource and environmental analysis. A little thought should make it clear that these cases are closely related to the theory of externalities discussed in Chapter 3. In a sense, we are dealing here with special cases of externalities. The fisher who adds an extra boat to the fishing grounds imposes an external cost on all the other fishers by slightly lowering the average catch. An environmental organization that purchases and conserves important habitats confers an external benefit on all the rest of us, who may not have contributed to the effort but who gain a slightly improved environment.

The extension of the analysis to these examples, however, seems to raise another question. Can we really continue to define all these environmental issues as "externalities"? The use of the term seems to imply a secondary role in economic theory—external costs are added to economic analysis after the rest of the theory is essentially complete. But are these numerous externalities really symptoms of something more fundamental?

As we consider the multitude of environmental problems that have gained increased attention in recent years, we see the rising importance of cases involving common property resources and public goods. Global warming, ozone layer depletion, ocean pollution, freshwater pollution, groundwater overdraft, and species loss all have clear similarities to the cases discussed in this chapter. The increasing prevalence of such examples has led to a new focus on the concept of the **global commons**. If so many of the earth's resources and environmental systems show the characteristics of common property resources or public goods, perhaps we need to revise our way of thinking about the global economy.[11]

global commons global common property resources such as the atmosphere and the oceans.

Rather than focusing on the goals of economic growth and dealing with externalities as an afterthought, we need to recognize that the global economic system is highly dependent on the health of global ecosystems. Evaluation of the state of these systems and an assessment of how economic development can best be adapted to planetary limits is essential. This implies the need for new approaches to economic policy and new or reformed institutions at the national and international level. Clearly, this raises issues that go beyond the management of individual fisheries or national parks.

Proper management of the global commons poses special challenges because of the need to secure agreement among many different governments. Despite the many possibilities for conflicting views and free-rider temptations, several important international agreements, such as the Montreal Protocol on depletion of the ozone layer, have been put into place to deal with threats to the global atmosphere, oceans, and ecosystems. In other cases, such as the international negotiations on global climate change, effective agreements have been harder to achieve, as many countries wait for others to act or disagree about who should bear the costs.

We examine some of the implications of this broader perspective on common property issues in Chapter 9 and consider some issues of managing the global commons in later chapters, in particular in relation to the issue of global climate change in Chapters 12 and 13.

Summary

Common property resources are those that are nonexcludable and rival. Various systems are possible for managing such resources, including traditional understandings and government management. When no rules limit use, the resource is open access, meaning that anyone can use it without restriction. This situation leads to overuse of the resource and sometimes to the collapse of its ecological functions.

A classic case of the tragedy of the commons is overfishing of the oceans. Since there are no restrictions on access to fisheries in the open ocean, economic incentives lead to an excessive number of boats in operation. Depletion of the fish stocks results, with declining revenues for all fishers. But until economic profits (revenues minus costs) reach zero, there will continue to be an incentive for new participants to enter the fishery. This open-access equilibrium is both economically inefficient and ecologically damaging.

Possible policies to respond to overuse of the open-access resource include the use of licenses or quotas. Quotas can be assigned to individual fishing boats and can be made transferable (saleable). While there may be situations where local-level collective action can be effective in