The OECD Handbook for Fisheries Managers
Principles and Practice for Policy Design

Chapter 2

The economics of fisheries management

When fisheries management systems are designed with an understanding of how they will shape economic incentives the result is usually a more efficient and effective system with improved co-operation by all involved. This chapter will discuss several areas where economic theory and fisheries management overlap.

Fisheries management is a response to the tendency of unregulated fisheries to be overused and depleted. That tendency has its roots in the economic incentives faced by fishers using what is in essence a shared resource. Different approaches to management will influence the actions taken by fishers in terms of how the resource is exploited, the nature of the fishing fleet and much more.

Policy insights

- The problems of over-harvesting and over-capacity of fishing fleets in the absence of effective management is an expected outcome given the individual incentives facing fishers.
- Effective management means finding the right balance between economic, environmental and social objectives while taking into account the role and impact of individual incentives.
- Maximum sustainable yield (MSY) and maximum economic yield (MEY) are useful targets, but do not fully encompass the social benefits of a fishery. Fisheries managers should consider overall benefits to consumers and the broader economy.
- Restricting access is necessary to sustainably reduce fleet capacity. But limited entry is not enough to ensure high profits for fishers. Excess profits tend to become capitalised in the value of vessels, licences or quota such that new participants must incur costs equal to any increased profit. Only the original beneficiaries capture any gains.

The problem of shared resources

Most fisheries involve individual fishers jointly harvesting a stock of fish. The fish stock is a shared public resource. How to deal with such **common property** problems is a classic problem in economics, most famously dealt with in an article written in 1968 called "**the tragedy of the commons**" by Garret Hardin. The crux of this problem is that individuals acting rationally will deplete shared resources, even when they know this will ultimately hurt themselves and other users.

To understand how this happens, consider an individual who is thinking about entering a fishery. He will do so if the revenue he can generate is greater than his costs of participation. For that person, those costs are the usual direct ones, the cost of operating his vessel and so on. But there are additional costs of his participation that he does not bear and need not consider. Each individual's harvest reduces the stock left for others, raising the cost of harvest to all fishers (who must now use more effort to catch the same amount). Harvesting also increases the risk of the stock becoming depleted, the consequences of which are much greater to the fishery as a whole than to the individual fisher.

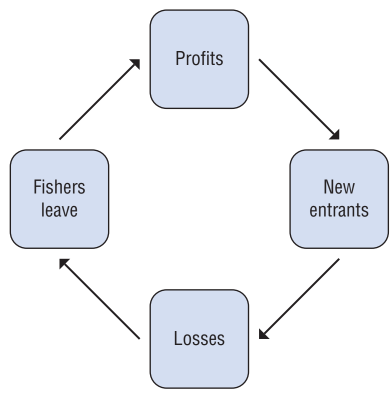
This suggests that resource depletion does not arise by mistake or miscalculation, but rather is an outcome of fishers acting in their individual interests. Solving the problem of resource depletion requires understanding and adjusting those interests and actions through the mechanism of fisheries policy.

Entry and exit

The above discussion of the problem of shared resources leads naturally into the question of entry and exit from the fishery, and how fishers decide whether it is sensible to enter into, remain in, or leave a particular fishery. The process of investing in or taking part in an industry is called "entry", while selling or abandoning capital and no longer producing in a sector is called "exit".

Entry and exit is a fundamental process leading to an **economic equilibrium**, which is defined as a stable economic situation where nobody has an incentive to change what they are doing. Free entry and exit from a sector is the mechanism by which profits are equalised across different sectors. Essentially, if the profits that can be earned in Sector A are higher (or less risky) than the profits in Sector B, individuals will move from Sector B to A to take advantage of the higher profit opportunity (Figure 2.1). However, the increased number of producers in Sector A will lead to lower average profits. This process continues until profits are the same in both sectors and nobody has an incentive to change sectors. Thus, higher profits in a sector are "dissipated" through the process of entry.

Figure 2.1. **Entry and exit**



Sometimes entry and exit can be **sticky**. That is, when investments are specific to an industry and the market for trading capital is **thin**, it can be difficult or time consuming to move capital in and out of a sector. For example, it may be difficult to sell a fishing vessel of a certain type. This is also true of specific expertise: if it is difficult to acquire the skills required for a particular sector, and if those skills are not used in other sectors, it will be harder for labour to move in and out. If there are not a large number of alternative opportunities in a local area, it could be the case that profits or wages are lower in local alternatives but higher elsewhere. For example, a fisher may not have good job alternatives in a small fishing town, but could find higher a wage if he moved to the city. If he wishes to remain in the small town, he must forgo the higher wage available in the city and is "stuck" in the fishery.

Entry and exit decisions have to do with relative profitability, and not existing capacity. Entry can take place in a fishery even when the technical capacity of the fleet is already larger than that needed to harvest the allowable amount. The result is often **capital stuffing**, where the amount of capital (vessels and gear) in the fishery greatly exceeds that required to harvest the available amount of fish.

Ultimately, the lure of higher profits will give people the incentive to overcome barriers to entry, just as persistent losses will force sector participants to look for new opportunities elsewhere. Complications like thin or lumpy markets can delay entry and exit decisions, but cannot overcome the underlying logic.

For the fisheries manager, the lesson is that ultimately, fishers will follow their incentives. They will enter a fishery when profits are available, and leave when they are not. Maintaining high profits in a fishery as a policy objective is difficult in practice, as those profits lead new participants to enter the fishery, thereby dissipating those same profits. Moreover, without effective limits to entry, adjustment policies such as decommissioning schemes cannot be successful. As decommissioning schemes promote exit and increase sector profits, the incentives for new entrants will grow, negating any progress.

The only way to prevent new entrants from dissipating profits is to have strong limits to entry, such as licences or individual quotas and other technical requirements to be a fisher (e.g. specific educational requirements to be a fisher). Whether that is good or not will be discussed under the heading "maximising social welfare" below. Meanwhile, the idea of limited entry increasing profits in the fishery leads to the question of what happens next, when returns to fishing are larger than returns available elsewhere. The next section discusses this question.

Rents and capitalisation

If entry into the fishery is limited or controlled by the fisheries management system it becomes possible for the profits in the fishery to become sustainably higher than profits elsewhere. This additional profit over what is possible in the best alternative opportunity is termed **economic rents** or simply rents.

When entry is limited, profits are not dissipated by new investment in the fishery. However, the rents that result still produce incentives that tend to lead to their dissipation, by becoming capitalised in the input that is most fixed or most directly connected to the restriction yielding the rents. In this way, rents become built into the value of the quota (when ITQs are used) or the value of the vessel (when individual vessel quotas, IVQs, are used). Economic rents in a fishery can only rarely be expected to turn completely into extra income for sector participants – the licence would have to be non-tradable (so that its price could not be bid up), assigned to a fisher (not a vessel), and revert to the government upon the fishers retirement or death.

For example, if a fisher purchases a licence for a fishery where his or her activities yield an economic rent of USD 1 000, that licence is effectively worth USD 1 000 – the fisher would be willing to pay this amount to purchase this licence, and others would pay the same to acquire it from him. If the licence is tradable, it quickly acquires a value equal to the rent, such that the cost of obtaining it cancels out the benefits. If the licence is not tradable, the value passes to the vessel or other capital asset whose ownership ensures possession of the licence or the right to fish (Box 2.1).

If the limitation to entry in the fishery is not connected to a quota, licence or vessel then rents will likely be dissipated in the form of extra cost or lower revenues as a result of competition between fishers. Olympic fisheries are a good example; participants will invest in more capable vessels and gear in order to harvest more rapidly, incurring a higher cost to do so. Intense fishing competition will lead to short seasons, which in turn causes lower prices for catch as local processors are overwhelmed, as most of the catch must go to frozen and not fresh markets, and fish are of lower quality due to poor handling.

The rents generated when the management system limits entry can be distributed in unexpected ways. When quotas are distributed rather than auctioned to sector participants, the initial quota recipients capture the benefits. Newcomers who want to purchase quota

Box 2.1. **The value of licences**

Capitalisation is when the value of a future stream of benefits – such as profits – becomes embodied in the price or value of a fixed input. The input could be physical capital – such as a vessel – or a right to do something, such as an assigned quota or licence. The capitalised value of a quota that yields a certain amount of economic rents tends to follow the "net present value (NPV) formula", expressed as follows:

$$NPV = \sum_{t=0}^{N} \frac{R_t}{(1+i)^t}$$

Where R_t is the economic rent available in year t, i is a discounting factor reflecting the rate of time preference (often taken as the prevailing interest rate), and N is the number of years the rents are available. This is a forward-looking formula, as the value of R_t in the future is unknown; the fisher must form an expectation of this value based on the information currently available. It is possible for the *NPV* to increase or decrease over time as expectations of R_t are updated. The discount rate also takes into account future expectations; if the fishery or quota system is not expected to persist, the discount rate will be higher to reflect this more short-term view of the quota's value.

For example, the value of quota for the Sablefish fishery in western Canada was about CAD 20 per kg when it was introduced in 1990, reflecting a *NPV* of the fishery's future profitability of about CAD 0.60 per kg per year, assuming a 3% discount rate. By 2004, the value of quota had increased to CAD 100 per kg, equivalent to about CAD 3 per kg per year (OECD, 2010). The increase stemmed from improved stock expectations under the new system. The annual value of the rent generated by the quota can also be observed when the quota is leasable on an annual basis. For example, in 1993, halibut quota allocations in western Canada were leasing for CAD 3.30 per kg for a single year (Casey et al., 1995).

must pay the present discounted value of the expected future rents in advance – which they are willing to do as the rents justify this. The purchaser may be willing to pay more when they have a cost advantage over the seller. Improvements in technology or stock abundance may increase rents over time, leading the value of quota to appreciate as an investment. When the quotas are initially auctioned to fishers, the government captures the initial economic rents, with later increases accruing to quota holders.

The key message here is that market forces will tend to dissipate rents even when entry is limited. They become capitalised in the value of licenses or fixed capital such as vessels, or else it is competed away in the form of extra costs or lower revenue. Capitalisation can change the distribution of benefits, with initial beneficiaries capturing most of the benefits while newcomers and others benefit less. What happens to rents depends on the nature of the management system, so the fisheries manager has an important influence on who benefits from fishing, whether or not that is part of their mandate. How fisheries managers can maximise the social benefits of fishing is the subject of the next section.

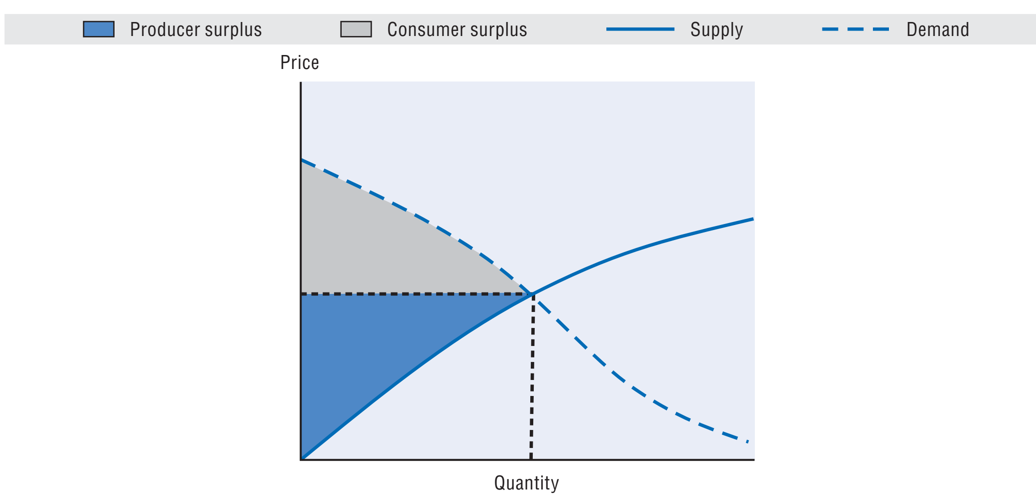
Maximising social welfare

The common property problem is the main feature of fisheries that drives the need for government management of effort or harvest. There is no management system for the production of ball-point pens that sets the optimal level of pen production. This is because the normal forces in the economy determine the right amount of pens to be produced to optimise welfare; this is free-market economics in a nutshell.

If the common property problem in fisheries necessitates management to control harvest or effort, it does not tell the fisheries manager what is the right level of control for the fishery. Controlling harvest to obtain maximum sustainable yield (MSY) has been a common choice, and maximum economic yield (MEY) is growing in popularity. Other objectives have been to reduce the probability of stock collapse below a certain amount (by a certain date). All of these are attempts to maximise the benefits that derive from a fishery; their differences have to do with differing views on how to define "benefits" and policy objectives more generally.

To think about what is the best way to maximise the social benefits of the fisheries resource, it is necessary to introduce the concepts of **consumer** and **producer surplus**. **Consumer surplus** is the amount consumers benefit from being able to purchase a product for a price that is less than the highest price that they would be willing to pay for it. Producer surplus is the amount that producers benefit by selling at a market price that is higher than the least that they would be willing to sell for. If a demand curve maps out the price consumers are willing to pay for each incremental amount of a product, then consumer surplus is the distance between the demand curve and the market price. Similarly, producer surplus is the area below the market price and above the supply curve (Figure 2.2).

Figure 2.2. **Producer and consumer surplus**



Consumer surplus is the total benefit accruing to consumers, and producer surplus is the total benefit accruing to producers. Their sum (the total shaded area in Figure 2.1) is net social welfare. In the standard economic model, the equilibrium point where the supply and demand curves meet is also the point where social welfare is maximised, as it is impossible to make the shaded area larger by increasing or decreasing output from that point. Likewise, for fisheries managers who wish to maximise the social benefit of the fishery, it can be helpful to use some of the lessons from consumer and producer surplus.

Looking at MSY, we can see that this choice of harvest will maximise consumer surplus. This is because the most possible fish will be put on the market at the lowest possible price (because of downward sloping demand, more fish means a lower price). There is no way to sustainably produce more fish than the MSY amount. Thus, the area of consumer surplus is the largest possible at MSY.

MEY maximises profits for fishers. This is not exactly the same as maximising producer surplus, which is a broader concept of economic benefit. Think of it this way: if fishers were earning zero profit, the fishery would still deliver economic benefits to the community, through fishers' purchases of fuel and other inputs, and through the wages paid to crew. Producer surplus includes these benefits.

There is no easy way in fisheries to ensure that producer and consumer surplus are jointly maximised through any particular harvest rule that a manager may set. It is more important to realise that MSY, MEY, or other harvest rules achieve specific objectives, and it is an oversimplification to say that they are optimal in a social welfare sense. For this reason, having clear and agreed objectives for the management of the fishery is more valuable than simply choosing MSY or MEY as a target.

Trading and efficiency

Trade and exchange play a central role in economics as this is the mechanism that delivers **allocative efficiency**. Allocative efficiency is achieved when resources are used in a way that delivers maximum value, and is characterised by the relationship marginal benefits=marginal costs; this means it is not possible to be better off by moving resources from one use to another.

Trade delivers allocative efficiency because the value of an input such as a fishing license to a producer is equal to the increase in profits its use delivers. If one fisher, by virtue of better management or investments, can earn more from a fishing license, it will value it more highly than others. If the two fishers trade the license they will both be better off as a result; the seller gets more money from the sale than they can earn on their own, and the buyer is able to use the licence profitably at the price they have to pay the seller.

More efficient fishers are more competitive. They compete better for labour and capital with other sectors of the economy and they compete better in the marketplace for fish. Frequently, the objectives set for fisheries managers involve preserving local or traditional small-scale fisheries. Achieving this objective should not come at the cost of reduced efficiency on the part of fishers and overall for the fishery. Otherwise, the long-term sustainability of the sector will be impaired as it fails to deliver returns equal to other parts of the economy.

Flexible fisheries

Fisheries management tools are generally divided into input controls focussed on effort and output controls that target harvest. Both can be effective means of managing a fishery, but they don't always perform equally well in all circumstances. Much of this has to do with the degree of flexibility available to fishers in pursuing their operations. In economics this is termed **substitutability of inputs**; in the context of fisheries it is called **flexible** vs. inflexible fisheries. A fishery is inflexible if there are few opportunities to replace one input for another, or if there are few available fishing technologies.

This is important because effort controls tend to focus on one or few specific components of fishing effort – vessel length, gross tonnage or engine power, for example. By limiting this specific component, the intention is to control the overall amount of fishing effort. But if fishers can "get around" the restriction by changing the way they operate, effort controls will only poorly control overall fishing effort and harvest. An example is when season length is used to control effort, seasons tend to get shorter as fishers increase fishing power to compensate.

When considering a management system based on effort controls, the ability of fishers to maintain overall effort despite controls is important to gauge. Fishers will always wish to maximise profits, and their ability to adapt to effort controls tends to increase over time, requiring that effort restrictions must be continually increased to be effective.

The main reason to prefer effort controls over output controls has to do with the different distributional implications, including the desirability of restricting access to a public resource. But in the case of a highly flexible fishery, it may be more effective to address distributional or other social considerations through complementary policies that target these directly, e.g. tax policies.

The following chapters will expand on the economic aspects of fisheries and fisheries management discussed above. Chapter 3 covers capacity and investment in fisheries, and more explicitly incentives to invest in fisheries and overcapacity as an equilibrium outcome. Chapter 4 addresses management mechanisms, focusing particularly on market-based economic instruments and demonstrating how different systems can work with or against fishers' incentives. Chapter 5 discusses the economics of rebuilding fisheries.

Glossary

Allocative efficiency: When resources are allocated in a way that ensures their highest value in use. Characterised by the condition marginal benefit=marginal cost such that resources cannot be reallocated in a way that improves welfare.

Capital stuffing: The tendency for excessive investment in productive inputs in response to regulations reducing fishing effort.

Common property: A common property is a resource whose size or characteristics makes it costly to exclude potential beneficiaries from obtaining benefits from its use. The principal effect of common property is to create technological external diseconomies resulting in a greater allocation of resources to the fishing industry than would result from a private property right structure (Agnello and Donnelley, 1976).

Consumer surplus: Consumer surplus is the amount consumers benefit from being able to purchase a product for a price that is less than the highest price that they would be willing to pay for it. It is based on the idea that willingness to pay decreases as more is consumed (declining marginal benefit), but that there is only a single price for all units consumed.

Economic equilibrium: Economic equilibrium is a state of the world where economic forces are balanced and in the absence of external influences the values of economic variables will not change. For example, in the standard text-book model of perfect competition, equilibrium occurs at the point at which quantity demanded and quantity supplied are equal.

Economic rents: Accounting profits minus opportunity cost; profits in excess of what is available in the next best option. Economic profits are zero under normal circumstances and only occur when entry to a market is restricted.

Flexible fisheries: Flexible fisheries are characterised by high substitutability of inputs in the production of fish.

Producer surplus: Producer surplus is the amount that producers benefit by selling at a market price that is higher than the least that they would be willing to sell for. Producer surplus is a social welfare measure and is not the same as profits for a firm.

Substitutability of inputs: The ease with which one input may be substituted for another in a production process (also termed elasticity of input substitution).

Tragedy of the commons: Over-exploitation of the fishery through unlimited access. In general, the tendency for common or public resources to be used beyond the optimal amount.

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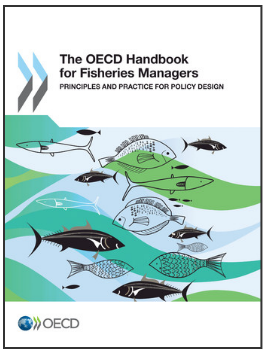

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