

Determining Maximum Economic Yield from an International Fishery¹

LEE G. ANDERSON

Department of Economics

and

Rosenstiel School of Marine and Atmospheric Science

University of Miami

Coral Gables, Florida 33124

The economics of fisheries has been extensively reported in economic, scientific, and legal journals in the last 20 years. As a result, there has been an increasing amount of economic analysis in fisheries management. Unfortunately, there has been a time lag between the appearance of new economic ideas and their subsequent use.

One topic that has received comparatively little treatment until very recently has been the definition of a maximum economic yield of an international fishery. As part of my Sea Grant supported research at the University of Miami, I have been looking into that topic and have submitted my results to the various technical journals. But I think the real purpose of research is to get information to the people to whom it directly applies. For this reason, I am pleased to have this opportunity to address the GCFI meeting this year to present some of my ideas on this very important topic. The determination of the maximum economic yield of an international fishery is especially timely in view of the upcoming Law of the Sea Conference.

Let me briefly review the concept of maximum economic yield for a nationally operated fishery. Consider a country which has a stock of fish within its exclusive jurisdiction. What is the most beneficial way to use it? More formally, how many of its other resources should be used to obtain the fish? Working on the usual premise that an economy should use the inputs available to it in such a way that the value of total product is maximized, the answer is that more inputs (i.e., men and equipment) should be used on the fishery as long as the value of the fish caught is greater than the value the same inputs could produce if used elsewhere. This point is called maximum economic yield. In a smoothly operating market economy the value of things that could have been produced is represented by the cost of hiring the inputs. For instance, all else equal, fishermen will not go to sea unless their expected income is greater or at least equal to the income they could earn elsewhere. Therefore maximum economic yield is where the last unit of fish caught is just equal in value to the cost of obtaining it.

¹ This study was sponsored by the University of Miami's Sea Grant Institutional Program (grant # 04-3-158-27) which is administered by the National Oceanic and Atmospheric Administration of the United States Department of Commerce.

When no one owns the fish stock the market economy will, in all conceivable cases, improperly utilize it. Specifically it will use too many other inputs. This is because each boat will consider only individual costs and the size of the individual catch, but will not be concerned with their effect on the total catch of the fishery. That is, boats will enter a fishery as long as expected long-run boat revenue is greater than expected boat cost. (The specification of long-run revenue implies that the fishery will be operating on its sustainable yield curve.) When revenues equal costs, boats will no longer enter. This will be an economic and a biologic equilibrium. It can be called the open access equilibrium yield.

The effect of one additional boat on a fishery is to decrease the catch per unit of effort for the other boats. Therefore when a boat enters a fishery the increase in total fishery costs is measured by the costs of the boat, but the increase in the value of the total fishery catch is the net effect of the catch of that boat and the decrease in catch of the others. Because of this boats will continue to enter a fishery even when the total value of the increase in fish caught is less than the cost of catching it. The economy as a whole is losing if this happens, because fish are being produced when the inputs used to catch them could be producing items that are more valuable than the fish.

For this reason it is generally accepted that regulation is necessary for proper utilization of a fish stock. From an economist's point of view, regulation should be thought of as the reallocation of inputs from the fishery into other productive uses such that the value of total production increases. The value of fishery output will go down but the value of other output will increase by a larger amount. If the fishery is operating beyond maximum sustainable yield, it is even possible that regulation may result in an increase in the value of fishery output. In any event once maximum economic yield is reached, regulation is merely a matter of preventing fishing effort from increasing.

This view of regulation rules out decreases in effort by artificial restrictions on efficiency. Effort can be reduced only by the actual movement of inputs into other uses. This short description of regulation is not meant to downgrade its importance or the difficulty of achieving a rational and equitable arrangement because there definitely are many social and economic problems involved in shifting men and equipment from one use to another especially in the short run. The scope of my subject prevents a discussion of these in any detail, however.

The key thing to remember about regulation is that it concerns the whole economy and not just the fishery. An unregulated fishery will use too many inputs on the fish stock. Therefore the value of the total production of the economy can be increased by causing inputs to be used elsewhere.

Bearing this in mind, consider the case of two countries, country X and country Y, that both exploit the same fish stock. As before boats from each country will continue to enter the fishery as long as revenues per boat are greater than costs. In cases where there are differences in the price and cost structures of the countries the costs and revenues of each boat will depend upon their origin and where the fish are sold. Regardless of this, the revenue in one country will depend upon the amount of effort being used in the other. For instance, given a fixed price of output, revenue per unit of effort will fall in country X if country

Y increases its effort because of the subsequent decrease in catch per unit of effort.

An economic equilibrium in country X will occur when revenues per unit of effort equal costs per unit of effort given the amount of effort country Y is using. Likewise country Y's fishing industry will be in an equilibrium when revenues equal cost (on a per unit basis) given the level of effort country X is using. An international equilibrium will occur when there is a simultaneous equilibrium in both countries. The existence and the stability of such an international equilibrium is beyond the scope of this paper but it is not unreasonable to assume that one is possible (Anderson, 1973).

Recall that in the national fishery, regulation was viewed as the process of reallocating inputs from the fishery into other uses in order to increase the value of total production. In the international case it should be viewed in much the same manner. It is the process of each country reallocating its inputs in such a way that the value of total production in both countries is increased.

One difference is that there are interdependencies in the benefits of reallocating inputs. For example, if X reallocates inputs to other uses, up to a point the value of the increased production elsewhere will make up for the decrease in the value of fishery production. Country Y will also benefit from X's decrease because catch per unit of effort will improve and so the value of its fishery production will increase. By the way, this improvement will motivate Y to enlarge its fishing effort. The same type of thing holds true in reverse when Y reallocates some of its inputs.

For this reason independent regulation may be ineffectual since when one country cuts back its fishing effort, the other will be motivated to increase its effort. Therefore while the regulating country will benefit from the increased production in non-fishery output, the value of its fishery output will fall for two reasons; fewer inputs will be devoted to it and the increase in effort in the other country will decrease catch per unit of effort from what it otherwise might have been. If this second effect is large enough it is possible that unilateral regulation may lead to a net loss for the country.

But if the countries involved can agree to mutually reduce fishing effort, both can gain. These gains can be divided into two parts. First there is the gain in the value of total production resulting from the reallocation of inputs given that effort in the other country remains constant. Second there is the increased value of fishery production due to increased catch per unit of effort caused by the reduction of effort in the other country.

In the national case the regulation rule is to reallocate inputs until the cost of the last unit of effort being produced is equal to the value of its catch. In the international case, there are many points at which this condition applies because the value of the catch in one country depends upon the level of effort in the other. Which one of these points that is chosen will have to be a matter of negotiation among the countries. If the countries decide to so negotiate, the process might go somewhat like the following. Country X will offer to reduce its level of effort (i.e., it will reallocate inputs from the fishery to other uses) by 50 units if Y will agree to do the same. In doing so X will be fully cognizant of the

size of both types of gains it will receive. Country Y will determine if such a move will be to its benefit (i.e., if it will result in a net increase in the value of its total product) and if so it might agree to the proposal. Or if Y is a hard bargainer it might request that X reduce its level of effort by 60 units before it will reduce its by 50.

The process may involve more than one step if after the first mutual reduction, the countries find that further gains are possible from supplementary bilateral reductions. If so it would be to their advantage to agree to them. The negotiations should continue until there are no further bilateral reductions that are mutually beneficial.

At the conclusion of these negotiations, both will be better off in that the value of their total production will be larger than at the open access international equilibrium. This must be so or they would not have entered into the agreement. The relative size of their gains will depend upon their bargaining skills.

These negotiations have the effect of distributing property rights to the fishery. Each country will have the right to use a specific amount of effort per period with the assurance that the other one will not use more than a certain amount.

But just because these countries have the right to fish these amounts does not mean that it will always be to their advantage to produce this effort at home. If country X can produce fishing effort at a lower cost than can Y, it will be to Y's advantage to reduce its own production of effort, thus freeing resources to be used elsewhere in the economy, and "buying" effort from X to catch its allotted amount of fish. Because effort is cheaper in X, the value of the goods produced in Y by the inputs released from fishing will be more than the cost of buying the effort. Similarly there will be a net gain to X from shifting resources to the production of effort. In order to produce more effort to lease to Y, it will have to reduce its production of other goods. However the value of the goods Y will trade for the effort will more than make up for this.

In this same case, country X may wish to buy fishing rights from Y in order to take advantage of its cheaper production of effort. The effect would be the same as if Y bought effort from X.

Both countries would gain from such internal reallocation of inputs no matter how they are brought about, through a trade in effort or a trade in fishing rights. In all cases, however, the total amount of effort applied to the fishery remains constant at the level set by negotiations, only the origin of production will change. By letting effort be produced by the lowest cost producer, more of other goods can be produced which can make both countries better off than if they produced their allotted amounts of effort at home.

This trade in fishing effort will not necessarily mean that one country will do all of the fishing anymore than trade in textiles between the U.S. and Japan means that Japan produces all of the textiles used in this country. Countries can benefit from trade in fishing effort only as long as it is produced more cheaply abroad.

To be precise, it should be mentioned that further gains to both countries may be possible through trade in final products. This is actually beyond the scope of fishery regulation, but without free trade the countries involved may be operating at a suboptimal position.

To summarize, regulation for a maximum economic yield in an internationally managed fishery should be viewed as the reallocation of inputs in each country such that the value of the total production in both increases. Specifically it involves mutual reductions in effort from the open access equilibrium point until no further reductions can be made that will be beneficial to both. These mutual reductions will have to be the result of negotiations and so their exact composition will depend upon bargaining skills. At the conclusion of these negotiations, each country will have the right to apply a certain amount of effort to the fishery each period. Further, to ensure that the fishery is being used to the best international advantage, it should be possible to engage in trade in fishing effort or fishing rights. If one country can produce effort at a lower cost, then the savings obtained by letting it do the fishing can be used to produce other goods that can be distributed such that both countries can benefit.

The above is a description of the process of obtaining maximum economic yield for an international fishery. It does not necessarily mean that the countries will act in this manner.

Let me close on a practical note. The ideas presented here are, in my opinion, very useful for considering international management of fisheries. But this does not mean that they will be easy to apply. The effects of the changes in the level of fishing effort within a country that are called for by the mutual reductions or the trade in effort are very complex. First, there may be a long time lag between these changes and the change in the production of other goods. Second while it is clear that there may be net gains to a country from such a policy, certain sectors may suffer a net loss. Third, if there are more than two countries involved, the negotiation process is more difficult. Finally, there is also the problem of how to handle new entrants. These types of things should definitely be kept in mind when applying these principles, but the principles should not be discarded out of hand merely because these complexities exist.

REFERENCES

Anderson, Lee G.

1973. Criteria for Maximum Economic Yield of an Internationally Exploited Fishery. Paper prepared for the American Society of International Law, October 1973.