Hungry oceans or hungry people: who really suffers from overfishing?

Overfish - "TRANSITIVE VERB: "To fish (a body of water) to such a degree as to upset the ecological balance or cause depletion of living creatures.

INTRANSITIVE VERB: To fish a body of water so extensively as to exhaust the supply of fish or shellfish."

The American Heritage® Dictionary of the English Language: Fourth Edition. 2000 "

Last month we started to discuss the fairly complex and often emotional topic of "overfishing". We argued that the common perception of overfishing as being synonymous with smaller and fewer fish in the sea is not necessarily accurate. This is because any exploited renewable resource will inevitably be reduced in size and number, to become "leaner" but nevertheless more productive than it was in its pristine state, even though a substantial proportion of the pristine stock may have been removed, i.e. as much as 50% or even 70%. The following article focuses on the difference between the biological and economic characteristics of overfishing. We argue that contrary to common belief (see the attached American Heritage dictionary definition of the verb "overfish") the ecological and biological impact of overfishing is often less profound than its economic impact. To do so we would like to focus this article on the distinction between biological and economic overfishing, and to highlight the risk associated with different types and degrees of overfishing.

Biological versus economic –overfishing

When the size of a resource is reduced below the size which produces the maximum surplus production, then the resource is said to have been **biologically overfished**. The problem with this state of the resource is that if one now tries to harvest a catch equal to the maximum sustainable yield, this will lead to further declines in resource size, i.e. the catch will not be sustainable. In order to be able to harvest the MSY on a sustainable basis, one would have to allow the resource to recover to a larger size.

When the size of a resource is reduced below the size which yields maximum economic rent (value of catch minus harvesting costs), then it has reached a state of **economic overfishing**. In all cases, the biomass which generates maximum economic rent is larger than the biomass which generates maximum sustainable yield. The reason for this is that it is easier and cheaper to fish when there are more fish in the sea, so that harvesting costs are less at a larger biomass level.

This highlights the fact that a resource can be experiencing severe economic difficulties, yet not be biologically stressed.

It is useful to define four different states of the resource from a biological and economic point of view. These are as follows:

i) Resource biomass is between the carrying capacity and the resource size which gives maximum economic rent: in this region the resource is being under-utilised.

ii) Resource biomass between the size which gives maximum economic rent, and the size which gives the maximum sustainable yield: in this region the resource is economically overfished, but not yet biologically overfished.

iii) Resource biomass less than the size that gives maximum sustainable yield, but larger than the size at which economic break-even (zero economic rent) occurs: here the resource is both biologically and economically overfished, and this is the most common state of mature modern commercial fisheries around the world.

iv) Resource biomass less than the economic break-even point: the resource is once again both biologically and economically overfished, but in addition it does not generate any positive economic rent (i.e. operating at a loss).

Biological risk versus economic risk and the trade-off between the two

Fishing is by nature a risky business. It is physically risky, it is biologically risky and it is economically risky. The development of fisheries requires considerable investments, and often very little guarantee of a stable income. Risk is compounded by the uncertainty of rights of access to the resource, which is often at the whim of self-motivated politicians. However living marine resources are self-renewing, and therefore are, under proper management, potentially profitable in perpetuity.

Risk is a combination of uncertainty about future events, and consequences of incorrect decisions based on predictions about the future. The reasons for the high level of uncertainty associated with fisheries ventures are:

i) It is difficult to assess the size and the production potential of the resource. The living resource is often inaccessible, spread over a large area, and very little is known about its life history.

ii) What we know about the resource is only as good as the data we have. These are mostly data collected from the commercial catch, which is often scattered and unreliable.

iii) Any living resource is extremely vulnerable to environmental changes and it is very difficult to predict the direction and magnitude of the response by the species to these changes.

iv) Other factors such as pollution, marine mining, coastal development and other fishing activities might have a direct or indirect effect on the resource.

v) The analytical tools which are used to analyse the data and to make predictions are inherently inaccurate and imprecise, with a fairly large probability of error.

As is demonstrated in Figure 1 a risk only becomes a consideration when the uncertainties are high and the consequences are severe (square 4 in the figure matrix). However, as will be discussed below, a very safe strategy (square 1 in the figure matrix) might be economically unacceptable.

Risk can be categorised as:

Biological risk: The consequences are detrimental to the resource and its production potential, e.g. a dangerous reduction in the spawning biomass, growth overfishing, or virtual extinction.

Economic risk: The consequences affect the utilisation of the resource for economic benefit, despite the fact that it is not in a state of biological risk, e.g. growth underfishing, using very selective fishing gear, operating on the periphery of the resource distribution, etc.

Superficially, exploitation with low uncertainty and mild to moderate consequences (square 1 in the matrix on Fig. 1) of any erroneous decision is the most attractive option for management. For a variety of reasons (low political risk and low biological and environmental risk), this option is often supported by conservationists and government institutions.

However there is an economic cost of adopting low risk management options. This cost can translate into a substantial percentage of the potential yield of the resource. In certain cases the price of a foolproof resource utilisation strategy is simply too high. In other words, the resource is so under-utilised that the cost in financial terms and in terms of lost potential employment is socially unacceptable. This is illustrated in the discussion that follows.

Fisheries can be classed as either recreational, subsistence or commercial. Although one cannot ignore the purely nutritional importance of marine products and social importance of fishing as a livelihood, it would be wrong to overlook the basic commercial incentives for fishing. One could argue that a narrow financial objective is not an adequate goal. However, if the fishing industry is to provide economic upliftment for a significant number of people, it must be run on sound economic principles. Social objectives should not therefore be pitted against economic objectives, but should rather be integrated with them. It is accepted around the world that most marine resources should be exploited for economic gain within acceptable social (and biological) boundaries. Once this principle has been accepted, one has to accept that they should be exploited for maximum economic gain, again within acceptable social guidelines and levels of biological risk.

Figure 2 demonstrates this conflict using a real life example (from the South African lobster industry). Catching females increases the potential yield of the resource, but reduces the spawning biomass and hence egg production.

In this example two important egg percentage (where egg percentage is egg production as a percentage of the egg production in the pristine population) levels were defined. The first is the 30% level (red line) - any reduction below this level is considered to be a biological high risk region (recruitment overfishing). The second is the 50% level (safeguard line) - this can be viewed as a safety level - by minimising the number of times one crosses this level, the chance of crossing the 30% level might be completely excluded. However, it is still regarded as risky if the resource is between the 30% and the 50% level too often.

Each part of figure 2 illustrates the chance of dropping below either the safeguard level or the red line level, when different target egg percentage levels are used, i.e. 40%, 50%, 60% and 70% respectively. With the 40% target, the chance of crossing the biologically unacceptable red line level is 5/20 (i.e. 25%), and too much time is spent between the red line level and the safeguard levels. On the other hand with the 70% egg target, there is no risk to the resource, however the economic losses are very great. The correct egg percentage level to aim at must be somewhere between the biologically unacceptable target of 40% (a), and the economically unacceptable target of 70% (d).

One must bear in mind that certain biological crises which start to develop can be addressed by a timeous response - for example by lowering the quota, or shortening the fishing season. On the other hand, it is a mistake to build up a production and processing infrastructure based on overoptimistic scenarios, and later to argue that it is too costly to give up quota even when the resource is under biological threat.

Quantification of biological versus economic risk: In evaluating the trade-off between biological and economic risk, it is very important to try to develop a common currency (so that one compares apples with apples). For example, it is very useful to be able to express a reduction in a particular biological risk, as a particular cost in economic terms. It is also essential to try, insofar as is possible, to develop a consistent approach to how one treats biological risk. Failing this, in the same way that there is continual pressure for economic concessions, there is often continual pressure for biological concessions for a more conservative approach. Consistency and quantification will help to diffuse these tensions.