CAN THE KNOWLEDGE SOCIETY TURN AROUND 500 YEARS OF OVERFISHING?

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ABSTRACT

As early as 1491 in an Act of Parliament during the reign of Henry VII of England, overfishing and the capture of juveniles were recognized as root causes of declining fish catches, and since then, minimum capture sizes, closed seasons and areas, and gear restrictions have been implemented to address the problem. Over 500 years later, France has been sentenced by the European Court to pay €20 million in penalties for systematically ignoring minimum sizes set by the European Commission, and most stocks in European waters are at historically low levels and in danger of collapse. Clearly, fisheries management by authorities has not worked. Under modern top-down management, catches are often legalized above safe levels and below safe sizes because it is easier to risk the collapse of fish stocks than to generate short term social or political conflict. This practice has been termed "convenience overfishing" if observed in rich countries, where fishing is not economically important relative to the overall economy. In the face of such long-term, chronic failure of top-down management, maybe the time has come for a bottom-up approach to fisheries that is simple enough to allow stakeholders and the public to participate. The preconditions for such change seem good: consumers do care about seafood and the marine environment and there are several examples in other areas where consumer choice has altered the behavior of the food industry. Also, overfishing can be detected with a single fish in hand, because there is a body size at which most specimens of a given species have had a chance to reproduce, and where the catch is obtained with least impact on the population. These sizes are known for practically all food fishes, even for fillets, and can be easily controlled by traders, retailers and consumers with the respective knowledge. Details of and first experiences with such "common sense fisheries management" based on body sizes and stakeholder participation are presented.

Keywords: Fisheries management, size at maturity, seafood guide. size-based indicators, social marketing

INTRODUCTION

This paper provides a brief background on the consistent failure of fisheries management the world over, with particular emphasis on Europe, and discusses how using size-based fisheries indicators can help improve it. The focus is on management through a minimum length where 90-100% of fish are mature (Lm90-100). This size is known for most of the commercial fish species and can be easily checked by consumers and other stakeholders with a single fish in hand. Using this indicator can thus allow stakeholders and the public to contribute to the management of the stocks.

FISHERIES (MIS)MANAGEMENT

Five-hundred years of mismangement

Overfishing is not a modern phenomenon; ecosystem changes around the globe due to fishing by humans date back 10,000 years [1]. Fisheries management through official legislation is much more recent. A summary of early mismagement of fisheries in Europe can be found in a 1891 document from the Fishery Board for Scotalnd [2]: Official fisheries legislation in England dates back approximately to the reign of Edward I in 1284. Even in these early days, the "wasteful destruction of the fry and brood of fish" was recognized as a cause for declines in fish stocks in English rivers and various Acts of Parliament were passed to deal with the

matter. When such acts were enforced, the supply of fish was increased. Nonetheless, all of these early acts were quickly repealed, and by the 1800s, there was no restriction in Great Britain on the size of mesh used or the size of sea fish taken. In fact, in 1866, an investigation was made in order to determine if any of the methods used in sea fisheries involved a destruction of juvenile fish or spawn and, if so, if any legislative restriction upon such a method of fishing would result in an increase of the fish supply. Upon completion of the investigation it was found that, "while beam trawling, shrimping, the use of seine and circle-nets, and of stownets, and weirs involve the capture of a certain very variable proportion of small fish, there was no good grounds to believe that this destruction of small fish had diminished the supply of saleable fish." These conclusions found by the commission who carried out the study were reached almost solely by asking the opinions of fishermen gainfully engaged in the very fishing practices in question. Even at this early time, fisheries policy was ignoring scientific evidence—steered away from sustainable management by the vested short-term interests of the fishing industry.

Management today

Fisheries management today works mostly through top-down control structures for which fisheries biology provides the knowledge base through stock assessments [3]. Management usually consists of authorities setting Total Allowable Catches (TACs), mesh-size and other gear restrictions, and controlling fishing effort (number of boats, days at sea, etc.). However, this seemingly powerful and detailed type of management is still not effective, evidenced by the fact that overfishing and the use of destructive fishing gears is still in practice, many of the world's fish stocks are at historically low levels, and that global catches have been in decline since the mid 1980s [4] (Fig 1).

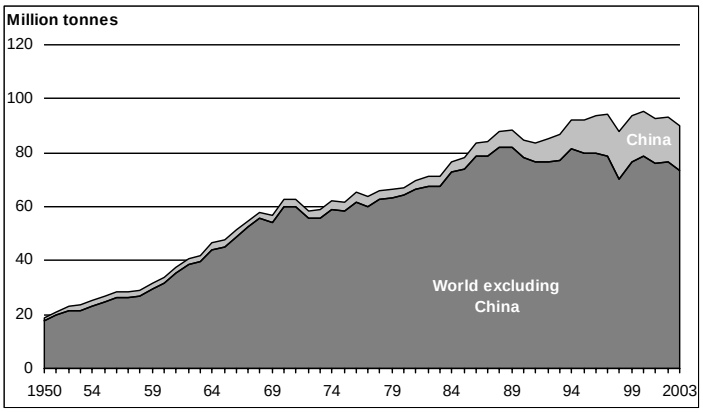

Fig. 1: Capture fishery production - World and China [4]. Catch reported by China is questionable.

Generally most failures in management arise from scientific advice being ignored by politicians, on the assumption that the biology of the fish can be negotiated, and by regulations being circumvented by fishers and stakeholders. With this in mind, the overriding failure of contemporary fisheries management can be attributed to two overarching factors:

(1) The failure of regulatory authorities to adopt and enforce the recommendations of fisheries scientists. In "wealthy" countries, where the fisheries sector is small relative to the overall economy, this is termed "convenience overfishing"— legalizing of catches above safe levels because it is easier to risk the eventual collapse of fish stocks

than to risk generating short term social or political conflict [6]. In developing countries, where fishing makes up an important income source and is often poverty-driven and an employment of "last resort" [7], this has been termed "Malthusian overfishing" [8].

(2) A lack of understanding and acceptance of management measures among fisheries stakeholders, resulting in various forms of "cheating." This is amplified by competition among fishers and in the industry, and weak enforcement by authorities.

The significance of convenience overfishing is especially evident in Europe, where there is more fisheries research and advice than anywhere else in the world [5] but many fish stocks are nevertheless heavily overfished and in danger of collapse. This argues that the solution to proper management will not be found through improving science alone. For example, between 1988 to 2001, about 77% of the scientific advice from the International Council for the Exploration of the Sea (ICES) regarding Total Allowable Catches (TACs) was correct or conservative [9]. However, lobbying by industrial stakeholders led to this advice being systematically ignored. ICES has even recommend a complete closure of the North and Baltic Sea Cod fisheries for the past 6 years [10], but the TACs are nevertheless increased [11] and Cod stocks in these areas continue to decline from overfishing, some even reaching historic lows.

On top of this, there are many instances of regulations which *are* adopted being thwarted. For example France was fined 20 million Euro in July, 2005 with a periodic 6 month 57.7 million penalty for failing to enforce its fisheries obligations to control landing and marketing of undersized fish. After the first 6 month period, the Commission still found that France has not been sufficiently effective in remedying the problem and the first periodic penalty was imposed [12].

A lack of understanding and acceptance of prevailing management measures often stems from the fact that their scientific basis is opaque and highly technical. Fisheries biologists are making predictions and recommendations based on complicated models which require ever-more data and components as the importance of ecosystem interactions becomes more recognized [3]. This means that stakeholders and policy-makers are asked to accept recommendations of scientific bodies at face-value, without understanding or participating in the process. This alienates those directly involved in or influenced by management decisions and leads to a lack of legitimacy in management institutions.

Studies (e.g [13]) have shown that institutions that are not considered legitimate by those having to comply with management measures will either have little impact because the measures are circumvented, or will need to invest heavily in policing and enforcement to be effective. This holds true in both developed and developing countries.

In Europe, this translates not only into fishers unlawfully landing small fish, exceeding their quotas, and discarding good fish to up-grade their catch, but also to the European Commission ignoring the advice of ICES. In this case, both the EC and ICES can be thought of as institutions which are not considered legitimate by those who should comply with their advice or laws, either because they aren't understood, or aren't respected.

In most developing countries, fisheries management only exists on paper because there is no money for enforcement, and relationships between fishing communities and the Departments

of Fisheries are distrustful or confrontational [14, 15] (lack of legitimacy). Fishing is usually an employment of last resort [7], and destructive fishing methods are widespread. In Costa Rica, for example, small-scale fishers in the Gulf of Nicoya regularly ignore the official ban on shrimp fishing in the upper portion of the gulf, and thwart enforcement by contacting each other by mobile phone when a patrol boat is spotted on the water or leaving the port. Shrimp are the only "valuable" species in the area, and fishers need the money for day-to-day survival.

De-facto fisheries management that actually functions in these countries is typically implemented by small non-governmental organizations or international projects working directly with selected coastal communities [16-18]. The relative success of these projects is due largely to the fact that fishing communities are informed about their fishery and empowered to make management decisions on their own, based on knowledge, rather than being forced to blindly follow orders.

Other problems attributable to the increasing complexity of fisheries models are that the predictability and validity of such models are compromised (fisheries biologists concede that they are reaching a "complexity wall" [19], and the economic cost of making useful predictions is greatly increased – sometimes to the point where it even approaches or exceeds the value of the landed fish [20].

The major problems of top-down fisheries management in the present-day context of rapidly declining stocks and a mandate for sustainability create the impetus for a fundamental change.

USING SIMPLE INDICATORS

Simple indicators are the necessary bridge between objectives and actions [21]. They mark a shift from a predictive and authoritarian to a "common sense" approach to management that is simple, transparent and easy to understand, thus overcoming the problems of opacity and complexity described above. Indicators can be briefly defined as variables (proxies, indices, values) that show the extent of completion toward predefined "performance" targets, which correspond to management objectives in fisheries [22].

In order for indicators to be effective, they must meet the following criteria (after [3]) by being:

1. Observable by stakeholders, either directly or through a transparent process.
2. Understandable.
3. Acceptable to fishers and public at large.
4. Efficient and within economic resources for research on a sustained basis (especially in developing countries).
5. Related to management and have associated reference values and responding management measures.
6. Valid—accurately reflecting condition of the resource.
7. Based on easily obtainable and reliable data.

Management by Maturity Length

The primary indicator under consideration here is the length at which all fish of a given species have had a chance to spawn at least once (Lm90-100).

In order to rebuild and maintain fish stocks, there should be no capture of juvenile fish, i.e. the minimum harvestable and marketable size should be set where all fish of a given species have had a chance to spawn at least once.

There have been two main arguments suggesting that this length is not a suitable indicator for fisheries management: 1) it isn't necessary to protect *all* juvenile fish to have a sustainable fishery, and 2) some fish in each stock mature well below the sizes indicated in the table.

These arguments may be valid if one considers a lightly exploited stock in healthy condition. However, most commercial fish stocks in the world are either fully- or overexploited [23] with severely truncated size-structures, meaning that in stocks where there were once many year classes coexisting, (up to 15 in the case of Atlantic Cod in Canada [24]), there are now rarely more than 2 or 3.

Even though some fish may spawn at small sizes, larger spawners have been shown to be more effective due to larger egg size and an exponential relationship between size and fecundity [25, 26]. In addition, in order to rebuild a healthy size-structure in the population, it is essential to allow the later, larger first-time spawners to pass on their genes.

It has been shown that, changing gear selectivity so that all fish can spawn at least once before being caught makes it *impossible* to overfish, even when fisheries mortality targets are exceeded [27]. This is a strong argument in favor of adopting a minimum landing size where fish can spawn at least once before being caught and is in keeping with the precautionary principle. Management by maturity length was very successful with the rebuilding of Chesapeake Bay Striped Bass, *Morone saxatilis*. After a severe decline (almost 90% during the 1980s) due to recruitment overfishing, a management plan was adopted which set the minimum harvest length where 95% of females could spawn at least once. This increased the age at entry to the fishery from 2 years to 8 years [28]. The stock was declared fully recovered in 1995 and is currently undergoing assessment for sustainability certification by the Marine Stewardship Council (MSC) [29].

In Europe, the setting of minimum harvest sizes without maturity length in mind is a clear example of convenience overfishing and the failure of ICES to recognize and communicate the importance of maturity size to decision-makers. In a European Commission (EC) document entitled "Preserving young fish to ensure tomorrow's future, " it is written that in Europe today, minimum legal landing sizes are established in order to "ensure that very small fish will have no commercial value, as a disincentive for catching in view of the fact that they will generate no commercial return" in order to "preserve immature fish, giving them a chance to survive in sufficient numbers to spawning age to as to allow stocks to recover" [30]. However, in reality, the legal landing of juvenile fish is rampant.

For example, in a preliminary analysis using ICES ogives to determine Lm90-100, and ICES commercial catch data [31-33], we have found that 50-70% of commercial fish caught and landed in the North Sea are immature (below Lm90-100) (Froese et al in prep).

Table I. Maturity length (Lm90-100), EU minimum legal landing length [31], and percent of immature fish in the commercial catches for North Sea stocks. Lm90-100 and percent immature were obtained using data from ICES [28-30].

Species	Common name	Lm90-100 (cm)	EU Minimum legal landing length (cm) [34]	Percent Immature	source
Clupea harengus	Herring	27	20	36	[33]
Gadus morhua	Atlantic Cod	68	35	82	[32]
Melanogrammus aeglefinus	Haddock	35	30	61	[32]
Merlangius merlangus	Whiting	27	27	24	[32]
Pleuronectes platessa	Plaice	39	27	55	[32]
Pollachius virens	Saithe	62	35	83	[32]
Scomber scrombus	Mackerel	34	20	16	[31]

This is happening because the actual minimum legal sizes for fish in European waters are usually set far lower than the length at which most of the fish reach maturity [34] (Table I). The EC's rationale for this is that if the legal size were set too high, there would be too much discarding of otherwise marketable fish [30], i.e. the juveniles would be caught anyway, just that with larger minimum sizes, they would be thrown overboard instead of landed and marketed. In extreme cases, like that of the Cod in the North Sea, the size by which most fish have reached maturity is almost *double* the legal size. In addition, the legal EU 2000 trawl net, used to catch Cod, Haddock, and Whiting in the North Sea, has a mesh size which retains 50% of fish at 25 cm in length, and 100% of fish sized 35 cm or more [35]. This already leads to significant discarding, because, in the case of Cod, only those fish that are 35cm or larger can even be landed. Therefore in reality, legal minimum sizes are set at roughly the size of the smallest individuals that can be caught and accepted by the market, without regard for biological considerations or incentives to discard. As a result of the lack of adult fish, some retailers have even started advertising "baby Cod."

Fishers could target and catch only mature fish simply by changing the mesh size they use, and in many areas, they have already demonstrated the ability to influence catch composition through season, area, or gear modifications, or through changes in fishing patterns [11]. Until the stock structures are rebuilt and contain a substantial number of adult fish, there will be a decrease in yield if fisheries changed to target Lm90-100 and larger. Depending on the age at maturity, and the degree of depletion of the stock, this period will last 2 to 6 years. This transition period with decreased yields can be used to reduce overcapacities in the fleet. Remaining fishers can be trained and employed in monitoring stocks. Ultimately, in many cases, there would be no need to reduce catch, because healthy stocks will be able to support current catches on a sustainable basis. Also, for the remaining fishers, catch per unit effort and profitability will increase, so there will be no ongoing need for subsidies as exist today.

Instead of moving toward such a simple, common sense approach to managing fisheries sustainably, the European Commission is reinvesting in the notion of management by maximum sustainable yield (MSY) [36], a reference point all but abandoned a decade ago by fisheries biologist because it's impossible to determine precisely enough to be meaningful [3]. So the cycle of complex and data-hungry models and mismanagement continues.

We wouldn't tolerate bridges designed such that they are in constant danger of collapse, so why should we accept this kind of fisheries management?

Management from the bottom up--Preventing overfishing with a single fish in hand

It is clear that changes must be made in the way fisheries are managed, and that increasing the minimum landing size to Lm90-100 is a simple and effective way to start rebuilding fisheries. But why is this the right time to switch from centuries-long top down control by shifting the focus to consumers and putting pressure on the fishing industry from the bottom-up?

Past and present evidence suggests that fisheries authorities, together with the over-reaching lobby of the industry, are unable to properly manage fisheries. Current top-down management systems are so complex, costly and inefficient that, in most cases, they just can not manage fisheries, as evidenced by the status of many commercial stocks. As a result of long-term overfishing, many stocks are at historically low numbers and in danger of collapse. Also, in the face of climate change, overfishing has deprived commercial stocks of their main defense against increasing environmental variability: long reproductive lives with exponentially increasing fecundity, which has allowed them to successfully reproduce after many years of adverse conditions in the past. This combination makes the issue of effective fisheries management especially critical today.

At the same time, consumers care about what they eat, and are willing to influence industry if they are armed with the information and means with which to do so. Interested media, consumer protection agencies and the internet are providing these means. There has never been a time in history where there was so much information available directly to the general public from decentralized sources. Among those who actively seek out advice, roughly half of turn to the internet for information about sustainable consumer choices, and prefer it over any other means [37]. Seafood choices are no exception to this. Seafood has been recently heralded by health food advocates as one of the healthiest foods there is, being one of few sources for the critical omega-3 fatty acids. This has brought the issues surrounding seafood health to the fore, and as the public relies more and more heavily on fish as a food source, people tend to become more concerned with fisheries sustainability issues as well. It has recently been shown that 86% of European consumers prefer to buy sustainably caught seafood [38]. FishBase, the world's most comprehensive online database on fish, receives about 20 million hits per month, 37% of which are from the general public [39]. People are clearly informing themselves about fish.

The fact that there is such wide appeal for sustainable fisheries, and such a failure on the part of fisheries authorities to adopt and enforce policies which see to this makes this issue especially appropriate to bring to the public and other stakeholders through "social marketing." Social marketing is marketing designed to alter consumer behaviour for a social cause, rather than a purely selfish one [40]. Good social marketing includes among other things, promoting a single, doable behaviour explained in clear terms and incorporating and promoting a tangible object or service to support the behaviour [40].

In the US, sustainable seafood social marketing campaigns have been underway for years. For example, the Monterey Bay Aquarium produces a seafood buying guide which categorizes fish species as "healthy choices" "good alternatives" and ones to "avoid," using a corresponding traffic light color scheme. Restaurant owners and fish marketers have already responded to consumer pressure from people informed by these guides to change the fish they cook and market.

A social marketing campaign around the maturity length indicator is easy too, because consumers can prevent taking of juvenile fish by not buying those which are too small. They

can be informed as to the appropriate minimum size easily, with a "fish ruler," that has the Lm90-100 demarcated for several fish species as well as their corresponding headless and filet lengths. This tool can be brought to the market when buying fish to ensure only adults who have had a chance to spawn are bought. It can also be used to incite dialogue with the fish sellers about this issue to broaden awareness and concern.

Altering fish-consumption behaviour using a fish ruler as a tool has already seen success in Germany. After rulers distributed locally in Kiel received national press attention, the German Consumer Protection Agency (*Verbraucherzentrale*) hired a professional firm to redesign the rulers and print 5000 of them for free distribution Germany-wide. The lengths of eight commercial species found in the Baltic Sea and North Sea with their corresponding whole, headless, and filet lengths are presented on the ruler (see www.fisch-o-meter.de). In Kiel, most consumers who received rulers have indicated that they will use them to buy only mature fish and were very surprised to learn that so many fish at the market are juveniles. These early signs of interest and concern on the part of consumers are good indications that this campaign will be a continued success. Additionally, in developing countries, management by minimum sizes and closed areas are the most acceptable by small-scale fisher people [16]. This reinforces the fact that these types of management intuitively make sense and are easy to implement. This also shows that a fish-ruler consumer campaign in these areas is also likely to be naturally accepted and successful.

CONCLUSION

Fisheries authorities have a track record of failure to manage fisheries sustainably, despite much scientific expertise advising policy. It has been shown both theoretically and practically that a fishery can be managed successfully by allowing only the capture of adults, and that this type of management is easy to understand and enforce, yet policy makers steer away from it and instead continue to cling to complex and ineffective methods. However, the public, who is motivated and armed with information like never before, forms an empowered group who can affect change through consumption choices. Given the simple task of buying only adult fish, and provided with a fish ruler to help them, the public can begin reversing the global trend of overfishing and declining resources; letting the fish have children, so their children will have fish.

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