A Proposal for an Alternative Fisheries Management Regime in the Irish Sea

Identifying the failures with the existing system, especially with regard to the science, lack of data and methodology used.

V. 2.1

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Introduction

The purpose of this article is to propose an alternative approach to the management of groundfish, in general, and that in the Irish Sea, in particular, and to elucidate the main thinking behind the initiative to review of the current fishery management system and the underlying science. This E.U.-sponsored project involves cooperation between Anglo-North Irish Fish Producers Organization (ANIFPO) and the N.Irish Department of Agriculture and Rural Development (DARD), and should culminate in formulation of an alternative management system for the Irish Sea.

The present article is analysing of the methodology on which the prevailing fishery management is based on and which is used by institutions like the ICES. It explains the methods used and analyses fallacies that lead to mistaken management measures and resulted in demise of fish stocks and dwindling fishing industry.

Due to the fact that this methodology has been applied by scientists of large governmental institutions, there has been a lack of self-criticism from the science sector. Most of the criticism has come from fishermen and the industry. Since it is difficult to site research papers in support of those critics, we have to refer to common knowledge in fish biology, general ecology and general knowledge of the behaviour of fish and fish stocks.

	Small mesh				Normal mesh				Big mesh			
Age years	N. of fish in stock	Catch N.of fish	Weight g	Catch kg	N. of fish in stock	Catch N.of fish	Weight g	Catch kg	N. of fish in stock	Catch N.of fish	Weight g	Catch kg
1	1000				1000				1000			
2	900	510	80	41	900		80		900		80	
3	333	189	170	32	810		170		810		170	
4	123	69	250	17	730		250		730		250	
5	46	26	320	8	656	372	320	119	656		320	
6	17	10	370	4	243	138	370	51	590		370	
7	6	4	405	2	90	51	405	21	531		405	
8	2	1	435	0.5	33	19	435	8	478	271	435	118
9	1		450		12	7	450	3	177	100	450	45
10			460		4	3	460	1	66	37	460	17
11			465		2	1	465	0.5	24	14	465	7
12			470		1		470		9	5	470	2
13			473				473		3	2	473	1
14			475				475		1	1	475	0.5
Catch weight:	104				204				190			
Stock weight: Increase:	184 (1x)				751 (4x)				1987 (11x)			
Catch rate:	57%				27%				10%			

Table 1. Shows calculations that were used as an argument for the gain in catch that would be achieved by an increase in mesh size. What was not mentioned was the fact that by pushing the selectivity to larger (older) fish, the stock size would increase dramatically (red numbers) and the catch rate would decrease by half (lowest line) (Jónsson 1957).

When in the nineteen fifties Beverton and Holt introduced their models for fish stocks assessment, fishery scientists, who earlier relied more on general fishery biology and experience, started calculating fish stocks using this and other mathematical-statistical models. This methodology was greatly enhanced by the ascent of computers which enabled processing of large amounts of input data in very short time.

All those models are purely theoretical and do not take into account ecology, including environmental conditions and how they may change in time, food availability, competing species, predation and other factors that affect **natural mortality**. All these are ignored in the process.

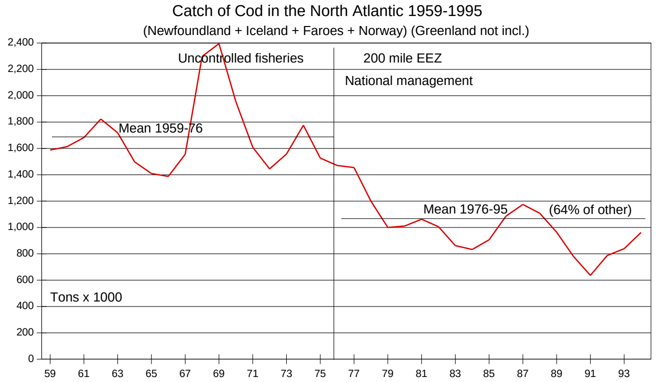

Fig. 1. Cod landings. Newfoundland, Iceland, Faeroes and Norway, 1959-1995.

Some management results

For decades, marine biologists have been assuming that reducing effort by increasing mesh size would allow fish to grow and multiply and yields to increase.

Table 1 shows calculations proving the benefit of bigger mesh. This approach, however, ignores the fact that by protecting younger and smaller fish and by focusing on capture of older and larger fish, the standing biomass increases. A population thus modified would require more food. In case of food shortage growth and condition factor would be reduced (slimmer fish).

During the age of 'uncontrolled' fisheries, national fleets roamed between fishing grounds in international waters, while territorial waters and national fishery limits were 3-12 miles. Only after in the mid nineteen seventies the 200-mile EEZ fishery limits had become common, national management could be experimented with.

Fig 1. shows the landings from the major cod stocks in the North Atlantic ocean before and after 1976. It can be seen that the average catch during the 20 years after 1976 was only 64% of that before 1976, during a period of practically no management. It had been expected that after the reduction in fishing pressure the catch would initially fall, then rise again, but it remained low. Evidently, the assumption that the stock would increase in size, did not hold water.

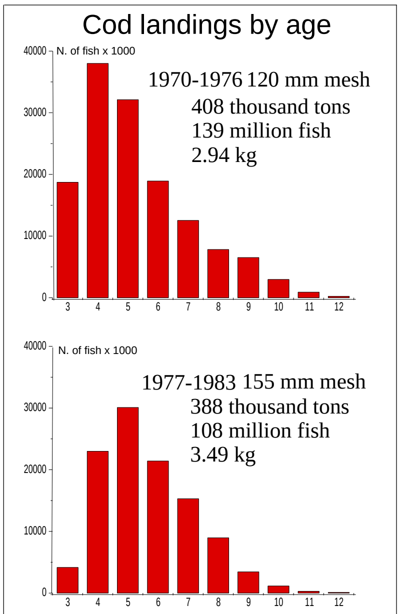

Fig. 2. Average landings by age of cod in Iceland during two 5 year periods, 1970-76, when the mesh size was 120 mm, and 1977-83, mesh size 155 mm. The effect of increased mesh size was a reduction in landings of 3 year old cod from 19 to 4 million fish.

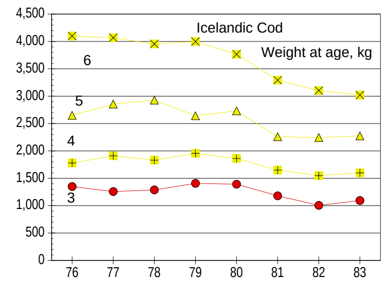

Fig. 3. Weight at age of Icelandic cod 1976-1983.

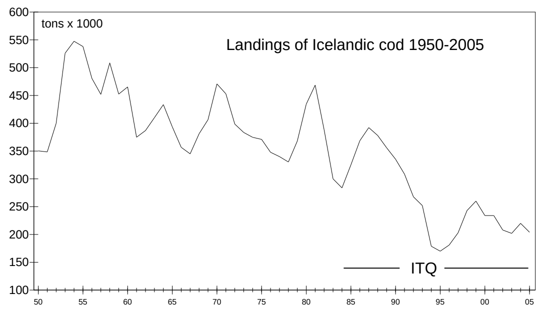

Fig. 4. Landings of Icelandic cod 1950-2003. The fishery has been managed by a quota system from 1984.

Iceland

Data from Iceland 1975- 1995 showed the changes in fishing pattern that took place when the mesh size in the codend of trawls was increased from 120 to 155 mm.

The immediate effect was that one year class was added to the stock; the age at capture moved from 3 year old to 4 year old fish (fig. 2). At the same time the growth (weight at age) slowed down, indicating shortage of food (fig. 3). The landings went down by 30% and an catch quota system was introduced in 1984.

At the start of this management experiment the average catch of cod at Icelandic grounds had been for a long time around 450,000MT/year tons. Later, however, the landings of cod have deteriorated to around 200,000MT/year and remained so for many years. No lesson had been learned, and instead of returning to the former fishing pattern, the management screws were tightened even more, the fishing pressure reduced still further, and since 1984 brought under an ITQ system (Fig. 4).

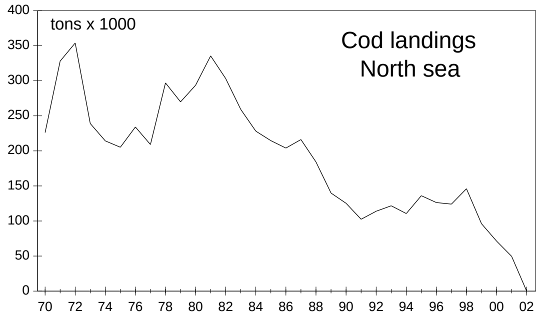

Fig. 5. Landings of cod in the North sea. Almost steady decline from 1988.

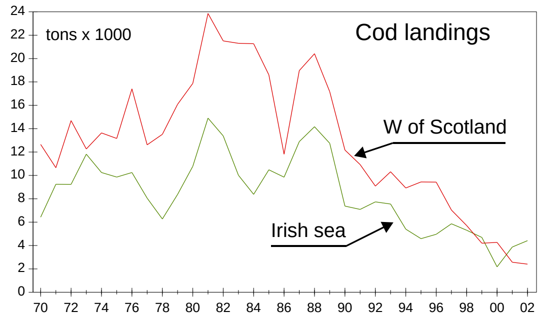

Fig. 6. Landings of cod from W. of Scotland and from the Irish sea 1970-2002. The landings from both grounds show a constant decline from 1988.

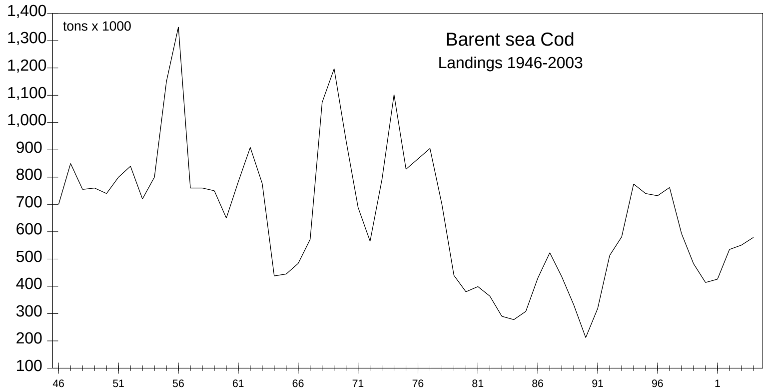

Fig. 7. Landings of cod from the Barent sea 1946-2003.

Similar reductions in cod catches have been reported for the cod stocks of the North Sea, Irish Sea and West of Scotland (Figs. 5 and 6) after increase in mesh size, cuts in quotas and general reduction of fishing pressure.

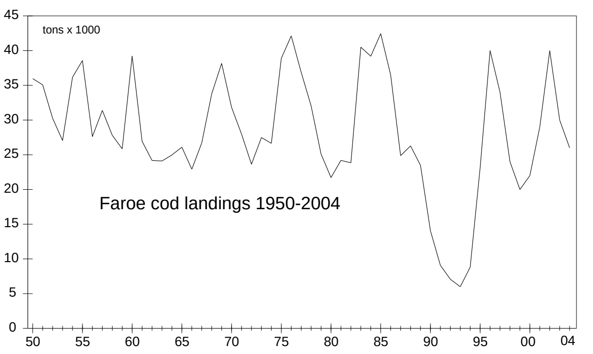

Fig 8. Landings of cod in Faroe waters 1950-2004. The catch has been oscillating fairly regularly, with a period of 8-11 years, except for a long dip in 1988-1995. That coincides with a period of TAC's and quotas. Since 1996 the Faroise have had days at see system with no TAC limit.

The fishing pressure is more or less similar through the 1950-1987 period, the catch reflecting the size of the stock. The downs are not caused by "overfishing", as the stock recovers under a constant fishing pressure. It is also known that individual growth is slow when catches are high and growth is fast when catches (stock) are low. There are other factors than just fishing that control the stock size. Faroe scientists have recently suggested that the food supply controls recruitment and growth in the stock (Steingrund et al. 2005).

Norway

Before 1977, the landings of the Barent Sea cod were oscillating around 800MT/year, then they declined. The landings under management fail to reach the pre-1975 ones, when access to the fishery was unlimited (Fig. 7).

The Faroes

The landings of Faroe cod show regular oscillations from 20,000 to 40,000MT, despite relatively small changes of fishing pressure from time to time (Fig. 8). It can be seen that the oscillations get more regular and stronger as time goes on.

Possibly, this can be related to the fact that more and more restrictions are imposed on the fishery through the years, as fishery gets more and more limited, first by closing fjords and bays as the closed coastal zone was extended from 3 to 4 nautical miles in 1955, then to 6 miles in 1959, 12 miles in 1964 and finally 200 miles in 1978. Mesh size was 100 mm in 1967, 110 mm in 1970, 130 mm in 1974, 135 mm in 1978 and 145 mm in 1990.

It is a basic law of ecology that heavy fishing pressure (predation) reduces oscillations within fished (prey) populations, because it keeps the stock size clear of the conditions that would've lead to starvation, increased cannibalism, reduced growth and increased natural mortality (Kormondy, 1969).

Is overfishing the sole cause?

In our opinion, this dwindling of commercial fish populations and, consequently, of yields, is a result of wrong management based on faulty conventional 'management science', which ignores and even denies the fact that food is a limiting factor. Shortage of food leads to slower growth and increased natural mortality.

However, every time the role of overfishing as the main cause for stocks' depletion is disputed, the demise of the Northern cod is used as a proof of overfishing. But, it is quite possible that it was an oceanographic-climatic shift that brought down the cod. Catch data from the past show striking similarities between Greenland and Labrador. Both cod stocks collapsed,

Cod landings from V-Greenland and Labrador 1959-86

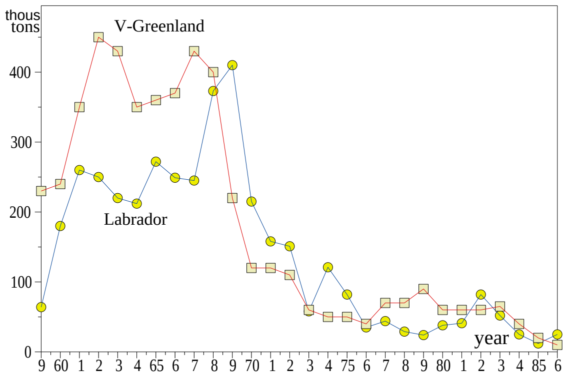

Fig. 9. Landings of cod from the grounds at V-Greenland and Labrador 1959-1986. Landings drop suddenly 1969 at Greenland and a year later at Labrador. This has been related to cold water anomaly moving south from Greenland.

with a one year interval, in 1969 and 1970 (fig. 9).

In 1990, just before the moratorium, the Canadian stock showed all symptoms of starvation, the fish had low condition factor, low liver index, showed reduced size at maturity, big fish were disappearing (dying) at a higher rate than small fish, etc. Interestingly, non commercial species also disappeared. Arctic char in Labrador suffered from starvation and high natural mortality.

Now cod is coming back in Greenland and according to Wappel (2005), at the coast of Newfoundland cod is plentiful.

"We have a large inshore stock in Bonavista, Trinity, and Notre Dame Bays that has been increasing yearly, in my view. Inshore fishermen cannot fish for any species with nets without having large bycatches. Last year, in a three-week blackback fishery, approximately 400 tonnes of cod were landed as bycatch. This year it was cut down to a two-week blackback fishery. We landed 1,000 tonnes of northern cod out of that fishery. In my view, this is a very positive sign of rebuilding – more fish spread over a larger area."

In fact, in Bonavista and Trinity Bay, the cod, as far as I'm concerned, is just as plentiful as when John Cabot landed there, if not more so. When the capelin come in there, the cod roll on the beaches chasing the capelin. In the years when there was plenty of cod, before the moratorium, we never saw that. Now I don't know if it's the actual overabundance of cod in the area that's causing it. They‹re not starved to death. They're healthy looking fish, and large fish, right."

Douglas Sweetland

"Fishermen are getting cod in lobster pots. They're getting them in herring nets. That never used to occur before."

Jacob Hunt

From: Wappel, 2005

Brief life history of the cod.

In Northern waters cod spawn between February and June. The timing is such as to have as many eggs as possible hatching in a window that will give the highest possible survival of the fish larvae. This coincides with favourable temperature and the occurrence of suitable stages of crustacean nauplii larvae and other food items vital to the cod larvae. The survival of the cod larvae is dependant on their density in relation to the concentration of the nauplii, and the success of spawning is related to food availability rather than to the amount of eggs produced by the spawning stock.

Other gadoids and some flatfish have similar early life history and may occur in the same water masses.

The cod spawn off bottom at 50-150 m depth and the spawning lasts for a few weeks. After fertilisation the eggs float toward the surface layer, unfertilized eggs gradually sink to the bottom and are lost.

The eggs float for 2-3 weeks before hatching. The larvae are 5 mm long and feed on small plankton. In the fall, as 4-5 cm long fingerlings, they descend and stay benthic for most of their life, until the spawning migration as grown up fish.

During the pelagic period, eggs and larvae suffer great losses from heavy predation by large predatory plankton species and fish. Herring and sand eels are very effective predators. Thus, high concentration of egg-and-fry feeding species can create huge losses. These fish often choose the largest pray so small fry may have an advantage is such situation.

Cod take up many niches during their life. Starting as a second order consumer, feeding on zooplankton, cod can occupy all stages in the food chain, up to being a second or third order predator.

Science for fishery management

Fishery management is supposed to act for the benefit of fishing people, their communities, and fishery and secondary industries. It involves also political issues and enforcement of fishing and management rules and regulations, aspects, which will not be dealt with here. Otherwise, however, it is based on scientific assessment of fish stocks and the resulting advice aimed at sustainable exploitation and, if necessary, improving the state of fish stocks.

In the process of advising on management the scientists have many puzzles to solve. The prevailing approach requires them to assess the stock correctly. Then they have to interpret the results from fishing surveys including biological, physical and chemical data.

They are supposed to answer such questions, as: How shall the stock be managed? Should the fishing pattern be changed and if yes, how? Should it aim at more, less, big fish, small fish, mature fish, immature fish etc?

Finally, the outcome of the changes in fishing pattern should be evaluated, and in the course of time, adjusted accordingly.

Stock assessment

In the nineteen sixties, mathematical models for calculation of fish stock appeared, basically postulating that if the fraction that the fishery removed from the stock was known, the stock size could be calculated, provided the fraction that died from "natural" causes was known. The main task for the scientists has been to find these parameters and below is a brief description of how it is done;

The average stock size can be calculated from Baranov's catch equation; $N = C/F$ (Ricker 1975).

Most often these values are on annual basis, so N is the mean stock size within a year.

N = Average stock size within the year

F = Instantaneous annual fishing mortality

M = Instantaneous annual natural mortality

Z = Instantaneous annual total mortality

We have: $Z = F + M$

The catch C is usually easy to obtain. The value of the fishing mortality F is impossible to obtain directly. However, it is possible to obtain estimate of the total mortality Z and calculate the fishing mortality F if the natural mortality M is known.

Estimating the total mortality (Z).

This can be done in various ways, basically by estimating how the year classes disappear from the catch as years go by. This can be done in two ways;

1. Estimate how catch per unit effort (CPUE) for the different year classes changes from year to year. Either data from standardized trawl surveys are used, and/ or CPUE data from certain fleets.

2. Obtain data on landings by age and compare them for year to year. This is a laborious task and involves massive sampling and age reading. Most often, combination of both methods give the final estimate. Results from both methods have large error margins, plus minus 20% or even more.

CPUE (catch per unit effort)

If catch per haul was very poor it would indicate that there were few fish on that fishing location. If the net had come out full with fish it would indicate that there were many fish in the water. This is the common interpretation of catch-per-unit-of-effort.

However, when it comes to calibrate the catch and relate it to the size of fish stocks, that is where the problems begin. This has been widely discussed through the years; this method is very inaccurate, to say the least. As an example, the catch of a baited line is not only dependent on the amount of fish but also on how hungry they are. Thus, food is lacking, the CPUE would be abnormally high and the stock would be overestimated. Such condition has been reported from the Faroes (ICES NWWG Report 2005).

Catch data from trawlers may lead to overestimating the stock size, as fishermen tend to fish where fish concentrations are high. On the other hand, catch data from the random or routine trawling by research vessels may give very different picture, most often considerably lower CPUE, simply because they are mostly trawling in areas of low fish densities and miss fish schools and aggregations.

Data from fishery-independent surveys

The usual method to estimate the relative abundance of year classes from year to year is to use CPUE data from the research vessels ("survey data"). However, in analysing the surveys data, emphasis is given to catch-per-unit-of-effort (CPUE) data, by species and age. Usually, information on biological parameters is ignored. Sex and maturity are recorded, but not used as such; growth/length at age is never sex differentiated, weight has until very recently not been measured, it has been calculated from length, and is mainly used to convert fish numbers into weight.

Table 2 shows survey data for cod in the Irish sea 1992-2002.

Besides errors stemming from the clustered non random distribution of the fish, there are other sources of error in this process. Statistically calculated variations are hardly relevant, in view of the much larger variations produced by geographic, biological and ecological factors.

There are distortions caused by the gear employed in surveys. A standard survey trawl only catches fish which is up to two fathoms off bottom. Often, or not at all

	NIGFS (March)							NIGFS (October)		
Year	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+gp	1-gp	2-gp	3-gp
92	2325.7	500.5	196.5	24.8	0.0	3.1	1.7	1109.4	50.1	47.6
93	138.1	648.8	44.6	10.4	1.4	2.8	0.0	553.2	146.4	0.8
94	1380.4	109.7	120.3	8.4	1.4	0.0	0.0	1672.5	25.4	10.4
95	700.7	386.2	20.0	10.8	0.0	1.0	0.0	1206.8	33.3	0.0
96	1106.1	329.3	111.7	1.4	8.8	0.0	1.3	486.6	50.1	6.5
97	537.3	415.8	66.7	21.4	1.4	0.0	0.0	1322.2	97.2	0.0
98	169.4	769.2	56.9	12.0	0.0	0.0	0.0	376.5	163.9	5.7
99	49.5	253.1	241.9	15.3	2.8	0.0	0.0	58.5	32.5	9.5
00	629.6	101.1	34.6	33.0	0.0	2.3	0.0	301.6	2.0	0.0
01	406.7	561.4	18.4	5.8	4.0	0.0	0	506.8	109.9	0.0
02	662.2	253.3	333.5	0.0	0.0	1.1	0			

Table 2. Cod in Vlla. Groundfish survey indices (CPUE) of abundance. Stratified mean nos. per 300 nautical miles. The red numbers show the relative strength of the 94- year as measured in the survey from year to year. (from Table 8.2.2. wgnsds 2003\ section 8.doc)

only part of the fish stays so close to the bottom. Experience from the Irish Sea shows that fishermen, who used semi-pelagic trawl –achieved much higher catches than those obtained by the survey vessel, at the same time and in the same area. Also, recent experiments have shown that up to 33% of small fish escape under the footrope of a bottom trawl. The small mesh panels used in the belly and codend of a survey trawl in order to catch the smallest fish, increase the pressure wave in front of the trawl, making it easier for larger fish to "ride" on the pressure wave and escape.

Large fish catching the large pray, such as herring, swim higher in the water than the smaller benthic feeders that swim close to the bottom. Therefore, a survey trawl tends to underestimate the amounts of large and old fish, thus introducing a dynamic bias, which varies due to changes in the behaviour of the fish, location, and time.

Diurnal, vertical migrations of fish are a well known phenomenon. However, many survey vessels only operate during day time. Often their tows are very short, sometimes only 20 minutes (DARD , Cruise report CO 4105, December 2005). As cod can swim ahead of the foot rope for some 15 minutes before it gets exhausted and falls into the trawl, this factor alone induces serious underestimate of the amount of fish present.

Separating the catch into age classes

Separating the fish from each tow into age classes is a major task. This is usually done by aging fraction of the catch (sub sample) and then the rest of the catch is converted to ages from its length distribution. When growth changes with length this is bound to be incorrect, which is thoroughly discussed in Chapter 2 of: W. E. Ricker 1975, Bulletin 191, Computation and Interpretation of Biological Statistics of Fish Populations.

Calculation of the total mortality Z

After the CPUE of the various year classes has been obtained, the routine is to calculate how their relative abundance changes from year to year. The total mortality can be calculated using survey data, commercial catch data and landings. Then, following the formula, F = Z – M, the natural mortality M is subtracted from the total mortality Z to obtain the fishing mortality F.

The natural mortality M

Natural mortality is the instantaneous mortality or discrepancy rate in a fish stock from all other causes than fishing, such as death from predation, diseases, senility, parasites, etc.

Natural mortality **must vary constantly** by time, location, size, maturity, and feeding- and environmental conditions.

There are many methods for estimating the natural mortality based on information on catch and effort over time (Ricker 1975), and long time tagging series have also been used for the same purpose (Jónsson 1996).

But these methods can only estimate the mean value of the natural mortality over long time for many year classes of fish, while short time changes pass undetected, as do differences due to size or maturity.

As most fish populations fluctuate, in the absence of fishery, some with cyclic or semi cyclic periodicity, others irregularly, some violently, natural mortality must be variable.

According to recent information from Canada total mortality for Northern cod is 40-60% per year at age 4 and 60-80% at age 6, calculated from bottom-trawl survey (DFO 2003. Stock Status Report 2003/018). As no commercial fishing was taking place, this was the natural mortality.

It is impossible to measure the natural mortality within the present fishing year. Therefore, scientists do not even try to estimate the natural mortality in the present, they have agreed upon a certain value, usually 18% per year for groundfish, for all age classes of 'grown' fish.

Put in plain words: **The true natural mortality rate during each fishing year is unknown, and the value used, 18% (M = 0.2)**, is no more than a semi-intelligent guess – at best.

The fishing mortality F

The value used for fishing mortality (F) is obtained from the formula above, by subtracting the "agreed" natural mortality (M) from the estimated total mortality (Z).

Since the F-value used in calculation of fish stocks is based on inaccurate and guessed values it is useless, and often misleading.

Calculation of stock size

In order to calculate the stock size, when the fishing mortality F has been estimated, reliable information on the catch (C) is necessary.

During the author's investigation of the fisheries in the Irish Sea 2003 (Kristjansson 2003), it was found that the landing figures were inaccurate, in particular the catches of quota species were grossly underreported.

Recently, the general secretary of ICES stated in a letter to Fishing News that: " The available landings data for the Irish Sea, are so doubtful that we simply can’t build up a picture of the state of these stocks" (David Griffith in Fishing News 9 December 2005).

When all factors in the stock equation are wrong the result must be wrong and useless for management purposes. A lot of damage, both to the stocks and the industry would be avoided, if these procedures were abandoned and replaced by more appropriate methodology.

Interpretation of the data

To obtain figures for population models, the conventional methodology is putting its main emphasis on separating the catch in survey's and landings into year classes.

Determination of sexual maturity is used solely for estimation of the spawning stock, and is done by age rather than by length, although some authors maintain that the length is the important parameter for determining the onset of maturity (Kristjansson and Tomasson 1991, Pauly 1981).

Usually, fish is not weighed at sea, lengths are converted to weight by tables made from "known" age-length relationships. The importance of the condition (fatness) of the fish as reflecting the feeding conditions is not recognized. Growth rate, size at maturity, liver index and condition of the fish are vital parameters when the condition of a fish stock is evaluated.

Single-species management

The present methodology of managing multi-species fisheries by single species, often the weakest species, without considering the interaction among the populations of the different species, while keeping the level of a multi-species fishery according to the state of the most depleted species is flawed. Where several species coexist in a full or even partial overlap of their ecological niches, such management may be totally ineffective, or even detrimental (Kormondy, 1969).

This, because multi-spp fishery managed by the weakest species reinforces the biomass of the prevailing species that compete with the weakest one over food and habitat. What happens in such instances is that the larger populations of the weakest species' competitors remain, in fact, protected by this management. Those species, such as whiting and haddock, in case of cod management, simply thrive on the management protection, procreate, and make the recovery of the thus "protected" species even more difficult. With such sort of management, only a change in environmental conditions that would favour cod and depress the other species might enable cod's recovery - a recovery that would have little to do with the single-species management.

Conclusions

The scientific recommendations refereed to managers is the prevailing management system are mainly based on the calculated fishing mortality F. In the rare cases when F decreases, scientists as a rule suggest status quo or reduction in fishing pressure. If, for undetected or ignored by the conventional science non-fishing reasons, the total mortality increases to higher than average values, that is that the natural mortality has become much higher than the arbitrary "standard" value of 18%, the conventional science would explain such decline by increase of F. For management purposes, fisheries would be blamed and overfishing proclaimed. Management recommendations based on biased, wrong data must be wrong, and in consequence, the management itself goes wrong.

Therefore, stock assessment, while desirable, should not be applied to fishery management where inadequate science is unable to produce reliable assessment, even if it is "the best available" science.

The conventional and prevailing fishery management strategy focuses on catching large cod and on protection of smaller individuals through size-selective fishing. But removal of large predators reduces predation on small fish other than cod, which in turn increases competition for food and reduces food available to the remaining cod. In extreme cases this strategy can lead to stunting; a population consisting of small, slow growing individuals, a situation often wrongly interpreted as overfishing. Some scientists theorise that long-term application of such strategy may also cause genetic dwarfism, through consistent elimination of the fast-growth strain from the fished population (see, e.g., Ernande et al, 2002; Heino & Dieckmann, 2003; Heino, 2004; Heino & Engelhard, 2004: Olsen et al., 2004).

Also, indiscriminate pursuance of single-species management may depress such species, by creating favourable feeding conditions for its competitors.

Are there other methods?

Hofstede, (1974), in view of the difficulties of determining absolute stock size, suggested a solution for freshwater fish in Netherlands. At that time, the so called virtual population analysis (VPA) was used to calculate the stock back in time. He said that since it was difficult or impossible to find out the present absolute stock size, other methods had to be used. Hofstede pointed out that growth was related to food supply and the food available to the individual fish was inversely related to their number. Thus the growth rate was a measure of the relative size of the fish stock. A normal stock had a normal growth rate, small stock had a good growth and so on. If the growth was good it indicated that the stock was low and food in overabundance. In such a situation the fishing pressure should be released in order to let the fish use their growth potential to the full extend.

If on the other hand growth was slow, it indicated that the fish stock was lo large in relation to its food resource and fishing pressure should be increased.

He suggested that a growth reference was made, growth curves from good times should be compared to present growth curves and the fishing pressure adjusted accordingly.

All this, however, is based on the assumption that the food base remains more or less constant and, again, ignores the environmental factors that may dramatically influence the amount of food available to the stock. Therefore, while growth parameters should be key figures in management, the costly and complicated assessments could be abandoned in favour of more ecological approach. Such approach is nowadays gaining popularity and is called ecosystem-based management. However, this term is still poorly defined, and often misused.

Ecosystem-based management – a definition

Ecosystem-based management (EBM) represents an attempt at an analysis of the dynamics of ecological inter-relation (biotic and a-biotic), and of influencing this dynamics through effective control of the main factors. EBM, thus precludes managing fishery ecosystems by single-species management.

At this time, most of the factors acting in a fishery ecosystem and their mutual influence cannot be quantified to a degree allowing reliable modelling. Nonetheless, we can establish the main factors affecting the ecosystem, e.g., pollution from various sources, changes in habitats essential to the system's biota, fisheries, nutrients and planktonic food availability, climatic and hydrographic conditions, and more. This, again, needs a major reform in the manner in the research methods employed, and resources spent.

Combining qualitative and quantitative analysis would enable compilation of recommendation for ecosystem management, which would be aiming at controlling pollution, regulate fisheries, and restore habitats. While hardly anything can be done about environmental conditions and their changes, their trends and fluctuations along time should be detected, described and taken into account in any management considerations.

The resulting recommendations must cover improved control, and if necessary also new regulation/ legislation, aimed at reduction of harmful upstream, coastal, and marine pollution, further deterioration of coastal, inshore, and marine habitats, dredging and mineral extraction industries, and fisheries. In the last case, good assessment of the desired level of production (expressed either in the terms of input or output, or a combination of both) worked out and agreed on together with the fishing sector is necessary for successful management.

Recommendations

The recommendations from the scientists are mainly based on the calculated fishing mortality F . In the rare cases when F decreases the scientists suggest status quo or reduction in fishing pressure. If the natural mortality for unknown reasons would be higher than the guessed value 18%, the difference is written on the fisheries and called overfishing. **All recommendation based on wrong data must be wrong.**

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Alternative fishing management for the Irish sea

Collection of data

A fisheries laboratory in Kilkeel run by the FPO's is in its starting phase. There, biological data (growth, condition, length at maturity, stomach content etc) collected by fishing vessels would be assembled and analysed. Samples will be taken for DNA analysis. Tagging of fish will be initiated and returned tags would in the long run provide information on fish migrations and on fishing and natural mortality.

Management plan

Some suggestions aimed at improving the fisheries data and reducing the practices of “renaming” and discards), have been outlined in an earlier report, (Kristjánsson 2003). It recommended effort management and technical control instead of TAC's and quotas. Such a system has been in operation in the Faroe Islands since 1996 with very good results. The most important thing there is that all parties are satisfied to operate under the system.

The details of the fisheries management plan for the Irish Sea will be worked out and submitted to the authorities by the FPO’s that are to work under the system. It will be based on data and information integrating those routinely collected with the new ones collected and analysed by the project.

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