



SCIENCE AND FISHERIES

Old and New Challenges

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1 The pre-math&models fishery science

In the 19th and the first half of the 20th century, scientists studied the biology and ecology of commercial fishes, their predators and prey, as well as their ambient physical and chemical conditions. They believed that following the fish life history and how they react to the environment's dynamics - can lead them to rational fishing practices.

The Norwegian fisheries oceanographer Johan Hjort wrote in a **1914** paper that **the hydrographical and biological conditions strongly affected the recruitment and strength of fish year-classes and, with respect to the fluctuation of fisheries and of strength of fish year classes, were at least as important as fishing.**

2 - WHAT SHAPES FISH STOCKS

Dr. Reuben Lasker was one of the mid-20th century marine scientists, who tried to understand what else apart from fishing affects fish populations. They studied the biology of commercial fishes, their predators and prey, and their ecology, their reactions to the dynamics of their environment ambient physical and chemical conditions to form a basis for rational management.

Lasker's, seaborne research of the California Current fisheries and in vitro study, showed the relationship between the survival of pelagic fish larvae, predation, and food availability at the right time and area, and established the dependence of the consequent recruitment on the above factors.

THE RUSSIAN APPROACH

- Russian marine and fisheries science that focused on the ecological conditions under which fish populations develop and behave was applied to direct Soviet fishing fleets to times and areas of best fishing opportunities.
- **Prof. F.I. Baranov**, pioneered the concept of single-species stock management that depended on a simple model - based on an assumption of equilibrium in a fished stock, and of quantitative evaluation of individual stocks to guide management. But Baranov had been unsuccessful in his attempt to introduce his model into the Soviet fisheries, and was criticized by famous Russian scientists **Nikolay Knipovich**, and later **G.V. Nikolskii**, for his departure from the ecological approach. Russian fisheries science long insisted that fisheries management must be closely associated with the fish life history and behaviour, and the dynamics of the environment.

4 - STRAIGHT FROM THE HORSE'S MOUTH

Since the 1960s, in the wake of Baranov's and later Beverton and Holt's propositions, **population dynamics** and **mathematical/statistical models**, supported by **acoustic surveys**, have become a comfortable option for the mainly **single-species** stocks assessment. *Fishing has been considered the almost sole cause for stock size fluctuations.* **But**, in his swan-song plenary lecture at the 1st World Fisheries Congress in Athens, 1992, Ray H. Beverton, who was one of the pioneers of application of models to fish stocks dynamics, complained about the misuse of his and Sydney Holt's model. **"The routinely applied VPA (Virtual Population Analysis) method - said Beverton - should rather stand as an acronym for "Very Provisional Assessment".**

5 - Ray Beverton:

"With the exception of the dramatic fishery collapses of the 1960s and 1970s, **natural factors have had a greater influence on the long-term abundance of many fish species than fishing.** The mechanisms are still largely unknown and should be given greater prominence in future fisheries research" – he said - **"If research aimed at gaining a better understanding of the biological basis of fish production in relation to the ecosystem generally implies a return to a more biologically orientated and longer-term strategy for the fisheries science of the future – said Beverton - it will be good for the science, for its practitioners and for its customers".**

6 - MORE AND MORE STUDIES DEMONSTRATE THE INADEQUACY OF THE CONVENTIONAL MODELS

In a study led by **David Richardson**, published on 8th August, 2011, in *Proceedings of the National Academy of Sciences (PNAS)*, researchers from the NOAA's Northeast Fisheries Science Center (NEFSC), concluded on the basis of a study of haddock predation on herring's eggs that: **“traditional single-species fishery models that assume only one equilibrium population size dependent on the level of fishing mortality don't agree with the observed trends in Atlantic herring”**.

Einstein was saying that "Not everything that counts can be counted, and not everything that can be counted counts".

7 - Dr. Gary Sharp, fishery ecologist and physiological oceanographer wrote: Ecosystem Modelling has become an academic field of general interest, which based on inadequate empirical observations and data, produces unreliable and unverified results, not of real utility. Most models don't reflect changes other than simplistic Top-Down Trophic Energy Transfers. Such models cannot reliably either explain past changes, or project potential future changes. **“The last half century of poorly applied 'equilibrium-based' theories, and collapse of most or all the important contextual variables into a single 'parameter' - often held constant – wrote Dr. Sharp - has resulted in the chaos that we see everywhere in stock assessments, management decisions, and resource collapses”.**

8 - In 2003, Mikko Heino of ICES wrote that ecosystem approach entails:

“...continuing to improve understanding of how the marine ecosystem functions, including the effects of climate, oceanography, etc. Probably for as long as there have been scientists, there has been the recognition that part of the variability in the numbers of fish is the result of changes in their food supply. This is especially the case when fish are at the sensitive larval stage. Food supply is related in part to the physical environment in the sea — the variability in sunlight, winds, and currents...”

9 PRECISION ANTI-CORRELATES WITH RELIABILITY

Flaws in input parameters introduce uncertainties in the biomass-calculating models, while most environmental parameters, including predation levels that affect natural mortality are missing. The accuracy of echosounding surveys' may vacillate by tens of percent, for displacements of stocks over and beyond the surveyed and fished areas are hardly accounted for. In most cases, exploitation level recommendations lack accuracy, while **stock assessment in precise figures anti-correlates with reliability**. When ICES said that in 1997 the cod SSB was 80,264 mt and in the year 2000 – 46,369 mt, the very exactitude of those figures makes them a fallacy.

10 - BOOM AND BUST... WHETHER FISHING OR NOT

L.B. Klyashtorin and A.A. Lyubushin, showed in 2007 “*Cyclic Climate Changes and Fish Productivity*” (VNIRO Publ., Moscow) that multi-decadal 50-70 years variations in fish yields have been documented for 400 years in Japan and 1,000 years in the Skagerrak herring fishery. Such periodicity have occurred in seas and oceans in over a dozen of important commercial fish populations. 1,500 years old time series of environmental indicators suggested similar periodicity. Off California, for the last 1,600 years, sardine and anchovy have interchanged every 50 to 70 years. There’s significant coherency of climate and long-term stock dynamics of Atlantic-Scandinavian herring and Arcto-Norwegian cod with time series of 85 and 93 years, respectively. **Past and present overfishing/collapses of stocks were in fact "bottoms" of historic fluctuations, correlating with climatic cycles, and vice versa.**

Сравнительная динамика Температуры по Кольскому меридиану и пополнения стада сельди (13- летнее сглаживание)



11-IS LARGE SSB GOOD FOR RECRUITMENT?

- ICES seems to stick to the paradigm that large spawning stocks provide strong recruitment and vice-versa. But Jon Kristjansson demonstrated how the numbers of both cod and haddock spawners and their recruitment on the Faroe plateau during the 1961-2004 period had fluctuated in opposite phase, with the large spawning stocks producing poor year-class cohorts. The same could be deduced from the 2006 ICES data (see graphs below), <http://wwwmmedia.is/~jonkr/english/ocillate.pdf>.
- A pattern similar to the Faroese one appears also in the Scottish (FRS) haddock data. Nonetheless, SSB is consistently claimed to be the main vector controlling reproductive capacity of a stock.

12 - SPAWNING STOCK VS. RECRUITMENT MAZE

Maintaining large SSB above certain level often results in under-fishing and economic losses, and also in reduced recruitment and underfed fish. Whether SSB produces rich or poor cohorts depends on the external conditions faced by the spawners and/or young stages, from egg, through larval and post-larval, and ending with juveniles. Desirably, local research should look for the reasons (physical, biological) for the respectively poor and abundant recruitments that, in different years, resulted from similar, low or medium SSB levels. Results of such research may help to decide how to rationally react, under different ecological conditions, to low SSB estimates.

13 - SAITHE ON FAROESE PLATEAU → 2006 (ICES)

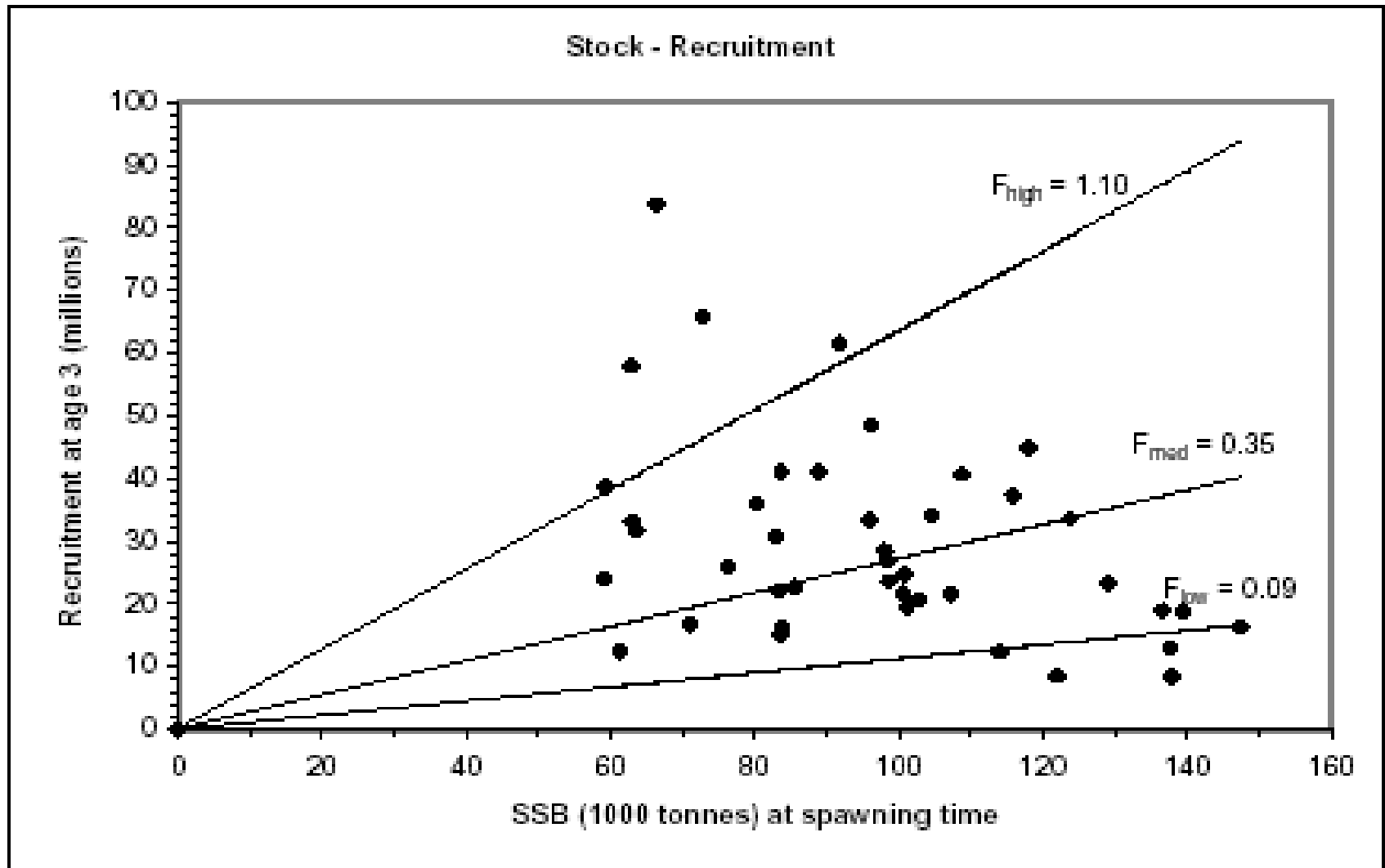
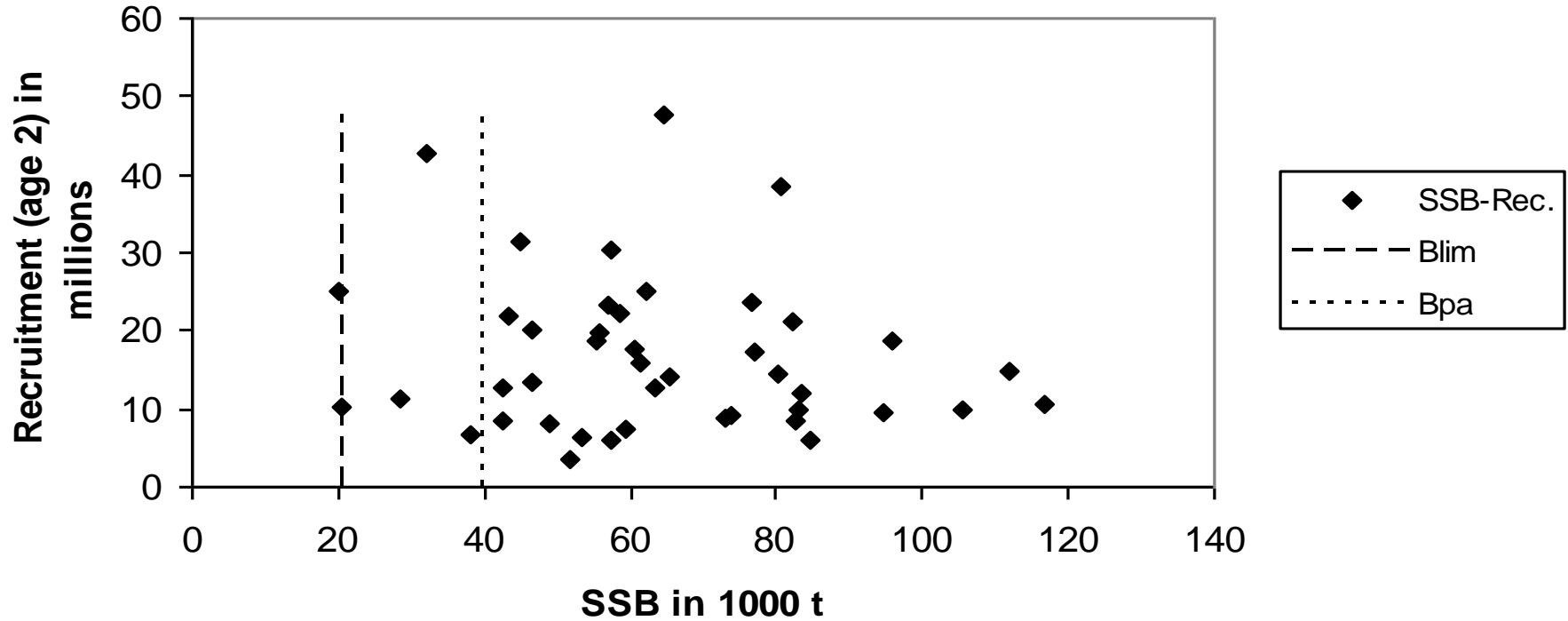


Figure 2.5.6.2 Saithe in the Faroes (Division Vb). Stock- recruitment.

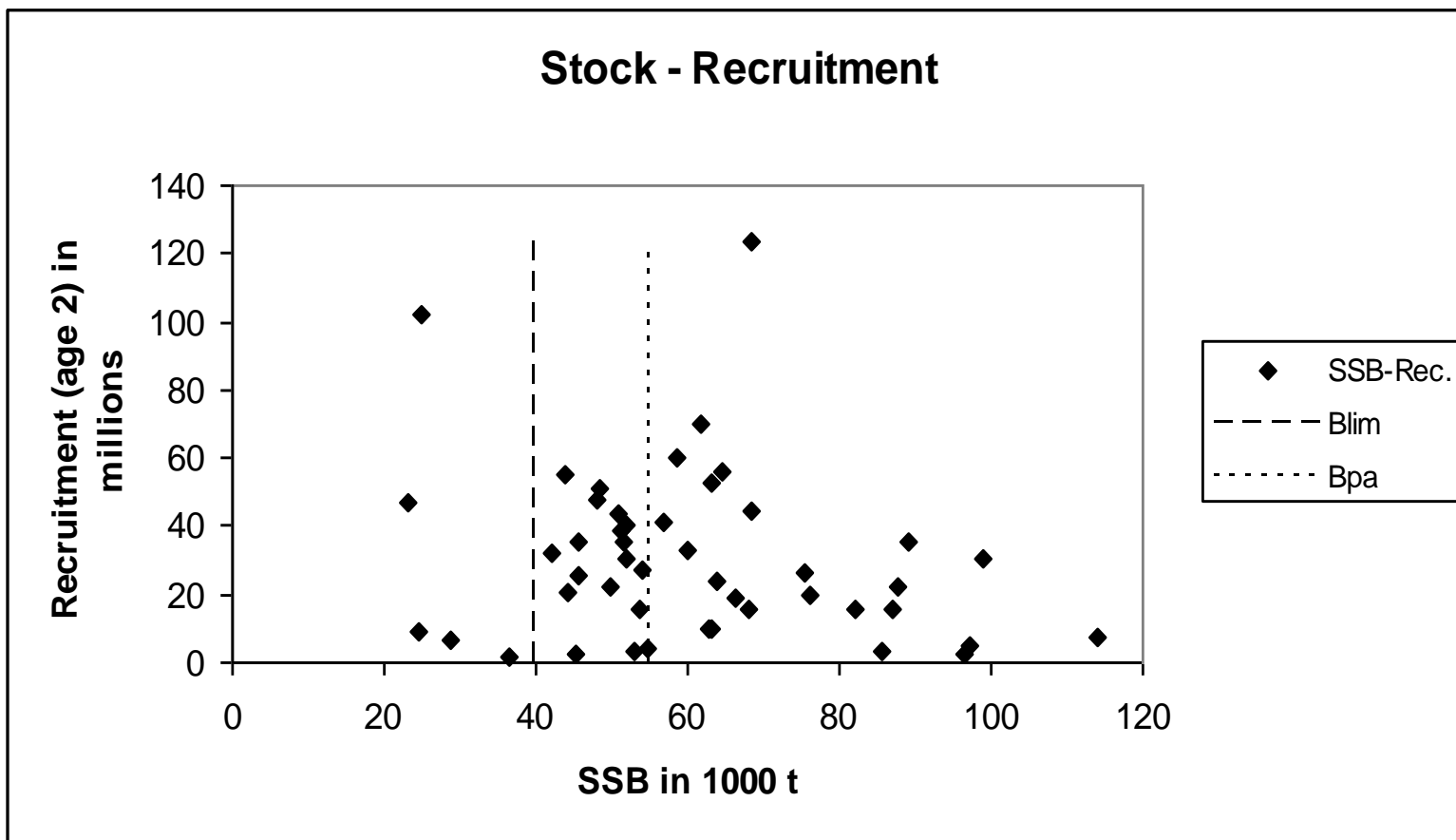
Stock - Recruitment



Haddock on Faroese plateau → 2006

14

15 - COD ON FAROESE PLATEAU → 2006 (ICES)



16 - Selectivity's consequences

- Sustained creaming off of; the larger and more prolific individuals impoverishes stock is leaving in the stock mostly smaller fish with inferior reproductive qualities. They spend their energy on sexual products and spawning activity, at the expense of growth and body condition, are more vulnerable to predation, **their natural mortality increases, and production/food intake rate – low.** In many fishes, big, old females produce exponentially more eggs than the younger, smaller ones, and their offspring have a far greater chance of survival. **It is the smaller SSB with bigger and older spawners in the stock, that can increase the number of stronger recruits in the next generation and revive impoverished stocks (see: Jon Kristjanson's site) .**

17 - COMPETITION FOR FOOD/SPACE IN MULTISPECIES FISHERIES

The practice of managing multi-species fisheries by the weak species, may well become counter-productive, especially if competition over food and space, or mutual predation take place within the fishery. For example, **at various stages of their life history cod and haddock indeed feed on similar organisms and even on each other. In such cases, the right way may be rather to increase or maintain the fishing pressure in a mixed, such as cod-haddock fishery, because** reducing effort would favour the larger population and further depress the weaker one.

18 - NATURAL MORTALITY DOGMA

- The arbitrary value of **natural mortality** $M = 0.18$ to 0.2 is apparently still used in ICES models by sheer inertia. Picked up some 100 years ago by a German scientist, probably for a specific case, it was censured by outstanding scientists, among them Ray Beverton (1992), who estimated non-human predation in the North Sea as exceeding fishing yields. **Nonetheless**, *one hundred years ICES projections for the stocks of Faroe Plateau cod, haddock and saithe were made assuming $M=0.2$. (!!!). This makes natural mortality a constant...and the Earth - flat...* 18

19 - Fishing mortality doesn't follow trends in fishing effort.

A recent ICES document on Faroese haddock stock says: ***“linearity in the relationship between fishing effort and fishing mortality has been assumed”***.

But, constraining fishing time or capacity wouldn't automatically reduce fishing mortality within a mixed, multi-species, multi-gear fishery, although it certainly might reduce catch.

Continued on the next slide

20 - FISHING EFFORT AND FISHING MORTALITY

Such linearity would mean that the share taken out of the stock increases and decreases with effort at a constant rate. The probability that this would actually happen is variable at best and very low at worst, hence any **calculations-estimates based on such assumption can only provide questionable results.**

Recruitment influences fishing mortality much more significantly. For example, an appearance of a very strong year-class **may reduce the fishing mortality, even if the effort is increased** by many percent.

21 - CATCH SHARES (FISHING QUOTAS) POLICIES NOT BASED ON ADEQUATE SCIENCE

- **Prof. Steven X. Cadrin** of the U. of Mass. in his October 3 testimony to a **U.S. Senate Committee** concluded that most stock assessments are too infrequent and too inaccurate to derive annual catch limits that avoid overfishing while allowing optimum yield, and economic data and analyses are insufficient to evaluate risk-based catch limits. **Altogether** – he said - **scientific information required to support the fishery management system and NOAA's catch shares (quotas) policy is greatly inadequate.**

FUZZY LOGIC

- Apart from lacking environmental inputs, models are often fed with ambiguous and incomplete data. The precise figures in stock-assessment reports obscure the inherent degree of uncertainty. Some critics of this methodology quote *Prof. Lofti Zadeh*, the proponent of “**fuzzy logic**”, who pointed out that **the more complex is a system the less is our ability to make precise and significant statements about its behaviour.**

23 - THE PROBLEM WITH CONSENSUAL SCIENCE

Two years ago, **Thomas Bouchard**, a widely respected psychologist, said that “Academics, like teenagers, sometimes don’t have any sense regarding the degree to which they are conformists.”

“What’s wrong with consensuses is not the establishment of a majority view, which is necessary and legitimate, but the **silencing of skeptics**”... - he said - “academic monocultures sabotage scientific creativity”.

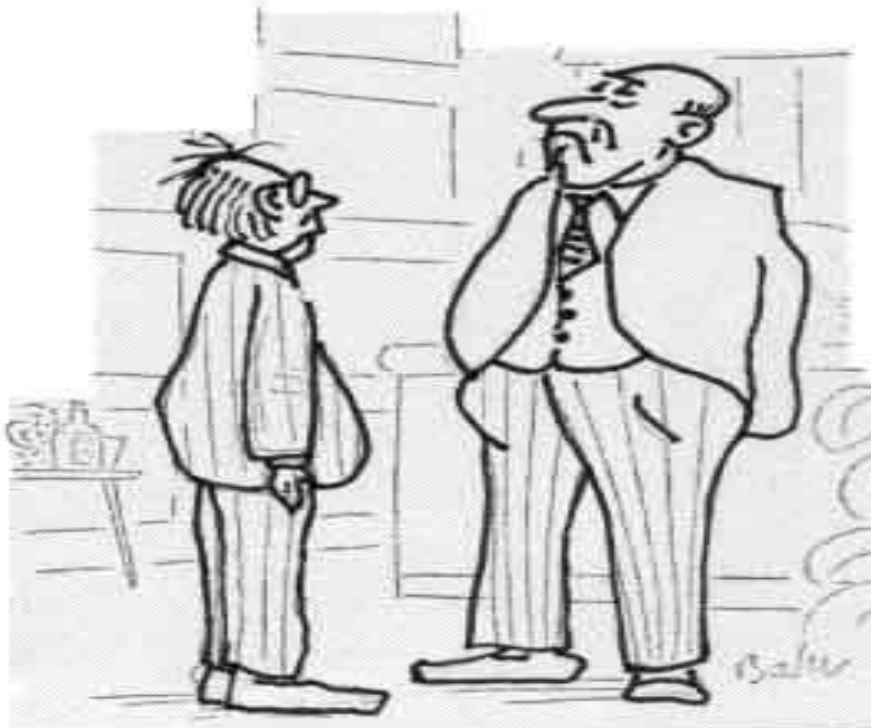
24 - VOW TO THE DISSIDENTS...

Good fishery science must involve multi-disciplinary and inter-disciplinary, experimental, sea-borne and in-vitro research, **and** integrative reasoning. Mathematical modelling is helpful only if appropriately used.

But even the best results would need unbiased and wise interpretation. The management demands *precise figures* that the science is unable to and shouldn't provide, but dissident scientists, within and without the state-controlled systems, are often **ignored, silenced, left unemployed, not given research grants, etc.**

25 –

I admire you for your integrity, Dr. Fishwise, and for speaking your mind... You're honest, courageous, forthright and fired !



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...AND FIRED !**

26 - FOR A CHANGE....

In 1994, **William Ward and Priscilla Weeks**, put under the anthropologist's magnifying glass, for a change, not an exotic tribe, but a group of fishery science & management workers. They found that much of those workers' approach is made up of concepts and presumptions inherited from the old hands in the system. They keep professing more of the same, scorning other concepts and new ideas. They tend to extrapolate rather from established models and theories than from actual research and findings, and ignore fishermen's knowledge. They were taught to employ statistical models and aged monitoring programs, to consider themselves stewards of the resource, and to believe in the "tragedy of commons".

27 - FROM QUANTITATIVE TO REALISTIC MANAGEMENT

Apart from the simplest systems, **fisheries science should consider parting with quantitative stock assessments and catch limitations** and, instead, invest its resources in studies of the specific characteristics of target species in each separate fishery. Knowledge of fish biology, physiology, ecology, behaviour, and environment would enable protecting fish **at the right time and place**, and choose realistic input controls, **fitting the species' life history and environmental dynamics**.

28 - RECOMMENDATION:

Fishery science on which the future management is to be based needs to enhance biological and oceanographic research at sea, on-going monitoring and analysis, considering the external conditions that are favourable and those that are not, and to what degree. It must investigate all possible correlations between those factors and fish populations. Fishery ecology should become an important if not the main topic of research. Massive stomach and gut analysis of commercial fishes would contribute towards understanding of competition and prey-predator relations in the ecosystem.

29 - **RECOMMENDATION: INDEPENDENT REVIEW OF THE MANAGEMENT'S SCIENCE**

Fishing people don't comply voluntarily with rules based on science which they don't believe. Therefore, management authorities should have management decisions and the underlying science peer-reviewed and verified by independent scientists, this also to avoid misuse by in-groups promoting and protecting their own position.

“Fishery independent” self-sampling practice reduces both - contact with fishing people and understanding of what's really going on on the fishing grounds. **It should be, therefore, reinforced by parallel sampling and observation by scientists sailing on board fishing vessels.**

30 - RECOMMENDATION:

Invest resources to estimate *true mortality rates* in different fisheries using, e.g., conventional and ultrasonic tags, as reported recently by scientists from N.Carol. St.Univ., and substantial studies of stomach and gut content also of marine piscivores, **other than fish**.

RECOMMENDATION:

Introduce to fishery science *fuzzy logic*, as suggested also by the late Dr. William Silvert, Dr.Mackinson and others. *Fuzzy logic* offers a set of methodologies that would enable both - to break out of the precision paradigm and bring fishery science closer to the real world. Reportedly, ICES/IOC Steering Group on GOOS considered in 2002 the use of fuzzy indicators, but I doubt that it was implemented by ICES.

31 - TEMPORA MUTANTUR...

As any scientific theory and not a religious (or para-religious) dogma, the prevailing quantitative fishery science can be scientifically disproved. Yesterday's scientific truth may become today's misconception, today's scientific gospel scorned yesterday probably would be scorned tomorrow, and that what's scorned today may become the teaching of tomorrow.

The winner of this-year's Nobel Prize in chemistry, couldn't have his discovery of semi-crystals published for over 2 years. It couldn't pass the peer review...

32 - BY-CATCH

Finally, as a sort of by-catch, let me add this: the current fisheries management policy that's favouring the various quotas systems, willy-nilly or not, is serving the interests of large and corporate owners, at the expense of small-scale fishermen and pop-and-mum, owner-operator fishing businesses. Unfortunately, still dominant official fishery science has been harnessed to that wagon... A subject for the next conference?...

- Well, by-catch – can't be landed. But, I can refer you to my essay: “**How neo-liberal economics hijacked fisheries management**”, published in 2004 in *Post-autistic Economics Review* (27) in **SAMUDRA** and on www.benyami.org. **THANK YOU.**