ON THE QUESTION OF FISHERIES MANAGEMENT SCIENCE

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The main scientific paradigm of fisheries management science is: 1 - that it can assess the state of the stock of a single commercial species; 2 - that it can predict the share of that stock that a fishery can remove, while maintaining optimum stock size; 3 - that fishing is the predominant factor affecting the assessed fish population; 4 - fish stocks can be fully managed by controlling separately the fishing rate of single-species.

fisheries management, science, factors, fishing rate, optimum stock size

Many marine scientists and fisheries managers have made their schooling or scholarships in fisheries science and management in Western European and North American countries. Some of them might've been coming southern and eastern countries, where native science either hasn't yet developed locally, or has developed with different, often traditional approach. Notwithstanding, they would be very impressed with what they were taught at the various Western fisheries institution. Coming back home they'd quite naturally be inclined to introduce in their national or local fisheries the knowledge they had acquired, lock, stock and barrel. They should be warned, however, to be very judicious about some of the western paradigms they've been taught (Ben-Yami, 2013).

As we'll see below, fish populations may expand, shrivel and even collapse, sporadically or in cyclic or semi-cyclic time-series, also without the “help” of fishing (Hilborn, 2012, Laevastu, 1992). They can also be impoverished due to coastal and upstream pollution or destruction of inshore habitats essential for their reproduction and growth. They can be collapsed by exotic pests, as it happened years ago in the Black Sea by blooms of the invading Atlantic comb-jelly indiscriminately feeding on all fish eggs and larvae, or by any combination of fishing and non-fishing factors (Ben-Yami, 1994). Still, the tunnel-vision science keeps being applied, and not only because of ignorance of such ecological processes and their effects on fish populations, but rather because of some more obscure reasons. In fact, however, most of the world's fisheries are not overfished, and many once overfished stocks are now rebuilding. Lessons from the management failures and successes if learned, should contribute towards fisheries' sustainability (Hilborn, loc cit).

Fishery ecosystems. Let's have first a good look on some of the basics. Fisheries management should allow fishing people exploit in sustainable manner fish-resources within fishery ecosystems. Those three, bound together in every fishery, are influenced by such external factors, as people’s cultures, economics, technology, and logistics, fishery-independent natural, biotic and non-biotic trends and fluctuations, as well as anthropogenic (caused by humans) changes in the water-quality and in other features of fish habitats (Klyashtorin and Lyubishin, 2007; Mann-Borgese, 1998). Joe
Borg, the former EU’s Commissioner for Fisheries, said once that management’s challenge is to find “a balance between economic growth from sea-related activities and the protection of the environment which is essential to their sustainability”.

What science. In the West, the ruling conception, often supported by law, is that fisheries management must be based on the best available science. This science, however, being inadequate, may lead to wrong management. For many years now I have written and lectured on that inadequacy, pointing to the absence of environmental parameters from the commonly employed models of the fish populations’ dynamics. The fallacious contention that fishing is the only or the predominant factor responsible for changes in fish populations brings the management to regulate fishing and nothing else. Neither those models nor the management take into account the experience and the generations-old traditional knowledge of the fishing people (Ben-Yami, 2011). An ecological analysis of the complexity of the ecosystem in which interrelated processes affect its various elements along a time scale is given by Jenning, Kaiser and Reynolds (2001).

When I was a young skipper and computers had yet to appear on our scene, fishery scientists used to sail on board research and commercial fishing boats, sample and identify fish, examine their food, take water, plankton and benthos samples, measure ambient temperatures, and listen to fishermen. Then, they were analyzing their samples in labs and tried to synthesize the lot into a meaningful pattern, somehow in a way similar to physicians diagnosing diseases. All this took the largest part of their working time. Now, fishery scientists spend the bulk of their working time at their computers, while the jury is still out on the question if fisheries knowledge and management are now better off.

**Straight from the horse’s mouth.** Not that the western scientists are unaware of this inadequacy. In 1957, R. J. H. Beverton and S. J. Holt published their seminal work on the dynamics of exploited fish populations. It dealt with several models describing population dynamics. The most famous model presented in their work was the simple yield per recruit model that has been since in a wide use in fishery science (Beverton and Holt, 1957). But, in 1992, Ray Beverton, told the participants of the World Fisheries Congress in Athens, that "it was well into the 1980s before fisheries science began appreciating the limitation of all the variants of the mathematical models of fishery dynamics, including the routinely applied VPA (Virtual Population Analysis).

"The early life history (ELH) of fishes is crucial to the recruitment. It's been now well proven that ELH dynamics are interwoven with basic productivity, physical oceanography and even atmospheric dynamics, hence" said Beverton, "the broad correlation between year-class strength and physical oceanic conditions over wide areas". And: "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 proportion of the total amounts of fish consumed that is eaten by other fish, sea mammals, and birds is as great or greater than it is by man. This is true even in the heavily fished North Sea". said Beverton.

Our friends marine mammals. This brings me to estimates of the share of fish taken by some 9 million of various protected marine mammals counted in aerial surveys off the U.S. West Coast. According to Andrew Trites, Professor and Director of the Marine Mammal Research Unit, University of British Columbia: “consumption of marine organisms, expressed as a percentage of an individual’s body weight per day, ranges
from about 4–15% for zooplankton, to 1–4% for cephalopods, 1–2% for fish, 3–5% for marine mammals and 15–20% for sea birds”. My guesstimate is that between 12 and 20 million mt are consumed by marine mammals around the coasts of the USA.

The total commercial landings for all species (finfish and shellfish) from the U.S. East Coast and Atlantic Canada are 680,000 and 870,000 metric tons respectively, according to the Canadian Division of Fisheries and Oceans and the U.S. National Marine Fisheries Service. In perspective, in the Northwest Atlantic in 2006, marine mammals alone have eaten many times as much fish and shellfish as commercial fishermen have landed. And what are they eating? In large part, it’s what the fishermen are catching. If a fisherman wants to catch a fish, there’s an excellent chance that a whale or a dolphin or a seal want to catch it as well. According to Dr. de Brooke, Curator of Birds at the University of Cambridge, seabirds alone consume 70 mt of food as against the 80 million mt of global fish landings. More on the top predator-prey relationships wrote Baum and Worm (2009).

Environmental factors. In its 2003 Yearbook UNEP said that the 150 dead zones in bays and semi-enclosed seas worldwide are a greater peril than overfishing, and scientists at the Virginia Institute of Marine Science wrote: “...oxygen depletion is likely to become the keystone impact for the 21st Century, replacing the 20th Century keystone of overfishing.” Some of such dead zones extend up to 27,000 square miles. And a study of krill-salmon relationship in British Columbia carried out by Dr. Tanasichuk shows that it is the abundance of krill that’s critical for salmon abundance.

Unfortunately, none of the routinely applied in the West stock assessment methodologies are able to adequately, if at all, express environmental factors. In most of them practically the only variable is the fishing mortality, while natural mortality that among others should comprise the predation by birds and mammals is routinely and fallaciously assumed a constant (0.18-0.2). The mathematical models are fed with catch and effort data of often-questionable accuracy, and only sometimes with results of fish sampling and acoustic monitoring. Consequently, the mathematical models churn out
"precise" values that are results of calculations involving approximate, speculated, guesstimated, and assumed figures.

Why then the official western fishery science so stubbornly sticks to a methodology, although its scientists themselves must know better? In my view, the motives behind this behaviour should be sought in the economical-political character of the management system. The logic is, as follows:

There's a whole catalogue of management, technical, and administrative methods that managers can use to try to achieve targets set forth by the "best available science". The choice of the system, however, and the manner in which it is applied through legislation, regulation, enforcement, quotas allocation or limits set on effort, is the product of the political attitude of the powers in charge. The political moment consists in the choice of the management solution. For example, whatever is the prescribed TAC, allocating fishing rights to a large number of small-scale fishermen would call for a different management mechanism than allocating them to large-scale businesses.

Political and ideological persuasions of those in power, determine the management's approach. The prevailing trend in the western economics, promotes economic success and efficiency as measured in terms of profits (or rents). It preaches an all-out privatization. For this purpose it claims that fish stocks can only be sustainably exploited if they become a subject to free market forces through individual tradable quotas (ITQ) or other privatization options. Profits derived from the resource or the number of people making living of the fishery. Maximizing profits obviously benefits large scale owners and companies and management by marketable quota systems. This approach inherently favours the financially stronger and invariably leads to a gradual displacement of small-scale individually or family-owned fishing enterprises (Ben-Yami 2003).

Consequently, specialized fishing companies, or large holding corporations for whom fishing may be only one branch of a multifarious business. It goes, usually, as follows: initially, fishing quotas (in terms of a fixed percentage of TAC) are assigned to all participants in the fishery at such rates that when fishing is good they can make their living. As soon as TAC is reduced, not necessarily for the right reasons, the individual quotas become insufficient for the smaller/weaker operators. This forces them to sell or rent out their quotas or their vessels to the financially stronger owners or big companies. Regulatory attempts to stipulate acquisition of quota by some maximum values, as a rule, fail to stop fishing rights accumulation. ITQ may present a suitable solution for distant-water fisheries accessible to only large fishing vessels involving major investments. But, introducing this system into small-scale or mixed fisheries carries socio-economic and political ramifications, such as the displacement of fishing people and impoverishment and deterioration in fishing communities witnessed in several western countries.

To sum up the above, I think that the western fisheries scientific and management system willy-nilly serves as an instrument for accumulation of fishing rights in the hands of a few powerful ones, at the expense of smaller-scale, private operators, mostly through the introduction of TACs, privatization of fishing rights and marketable quota system, under various names, such as ITQ, "catch shares", etc. Although taught and implemented in many countries as the "Holy Gospel", it is not the only way to manage fisheries.

Alternative management options. The question is whether, within a free-market system, fisheries can be run in a more equitable manner than that described above. As
already mentioned, there's a whole catalogue of options, most of which based on management by input, that is by controlling the amount and character of fishing effort, rather than fishing catches (output).

While TACs and quotas represent output management, input management may consist of limiting DAS (days at sea), closed areas, closed seasons or a combination of both, as well as limited access (number of vessels or fishermen or total/individual horsepower), gear limitation, such as number of nets set and meshsize, fishing grounds and seasons closed to certain sorts of gear, etc. (Christensen et al. 1999). See also: Rights-based management in Latin American fisheries. FAO Fisheries and Aquaculture Technical Paper (582). Rome, FAO. 2013, by Orensanz, J. M. & Seijo, J. C., specifying certain management steps that could fit many warm-waters fisheries.

Input management must be based on good understanding of the ecology and behaviour of the target species, as well as on good co-operation with the fishing people that can be achieved, for example, by co-management. But, altogether, to make it successful and withstand the opposition of powerful pro-privatization lobbies requires provided political will.

Fishery ecology. Every fishery represents only one element in a complex ecosystem. But fishery ecology is hardly exact branch of science. In the "commerce" that takes place in marine fishery ecosystems, values and vectors constantly change and interact in various ways, and we don't even know all the players in the game.

Fishery management must be alert for the role of anthropomorphic (due to human activities) factors and for the fluctuating environmental dynamics (Klyashtorin and Lyubishin, loc cit; Laevastu, loc cit). It must take into account, in addition to fishing, fish growth and survival rates, food availability, predation, as well as polluting and destruction of habitats essential to fish spawning, also. Hence, stock assessments are always approximate, and if used for choosing management steps, should be critically reviewed by independent experts and knowledgeable fishermen.

Fishery management: what for and by whom? Fishery management's tasks are: maintaining in the fishery ecosystem conditions that enable supply of fish to people and well-being of fish producers, prevent fish depletion, and is favourable to sustaining biodiversity. In some cases it should allocate access to selected fish resources to different fishery's sectors. Fishing people are often the only element that fishery management can manage, and those who'd enjoy or suffer from its consequences.

Do not cause harm! Over 800 years ago, Maimonides, the great physician and philosopher, taught his students: doctors' first and foremost duty is not to cause harm to their patients. The same should be reiterated to fisheries managers: don't harm fisherfolk. Wrong management can cost the fisherfolk their living, destroy or debilitate their communities, or cause them to risk life by forcing them to operate in dangerous conditions. The managers, who unintentionally, or not, have deceived them aren't required to pay for their follies. Only the "patients" pay for their managers' mistakes. There're various wrong management steps that may fail to prevent depletion of fish stocks by focusing on fishing and overfishing, while overlooking such important factors, as the boom-and-bust fluctuations due to physical environmental dynamics the inevitability and overwhelming influence of which described Shuleikin (1949), as well as spoilage and destruction of habitats essential for fish reproduction and survival, failure to curb pollution, and more, (McGoodwin, 1990).
Fishery management and non-fishing factors. Although western fisheries management is often paying lip service to non-fishing factors, its basic approach is that mainly fishing determines fish abundance. This may be right in a few instances, but wrong to various degrees in most others. There's a plethora of factors other than fishing and their various combinations, which affect fish abundance that are difficult or cannot be quantified at all. Fishery managers must keep them in mind while trying to understand the real-world dynamics of fishery resources.

Here's an abbreviated list of such factors: (1) Availability of food; (2) poor recruitment caused by unfavourable climatic fluctuation, and by diseases often resulting from overcrowding in a population, especially where associated with food scarcity; (3) changes in species composition due to exotic immigrants on one hand, and departure of native fishes, on the other; (4) loss of genetic variability; (5) pollution and eutrophication by fertilizers seepage; (6) coastal and estuarine habitat degradation incl. destruction of spawning or nursery areas; (7) blockage of migration routes; (8) diversion and drying of streams; (9) seismic testing; (10) oils slicks and the chemicals used to clean them; (11) dumping industrial and agricultural waste and dredge-spoil. There are more.

Management without figures? Not quantifiable information, ignored in the present models, can be explained in qualitative, descriptive terms and incorporated in stock assessments. Fishery managers should study life history and ecology of the targeted fishes, their interaction with other species, and listen to the traditional knowledge and experience of the participants in the concerned fishery. Last January, scientists of the U.S. NOAA's Northeast Regional Science Center were the first from the American official establishment to admit that the methodology employed throughout their system is inadequate, and called to consider formerly ignored data and information from industry, from their own social science division, and from the Massachusetts University's studies.

Scientists and managers working for governments and international institutions are often forced by the "system" to quantify stock abundance, maximum and optimum sustainable yield (MSY and OSY) and TACs on the basis of inadequate data and shaky models. The results are only too often – miserable.

To get more reliable figures, scientists should at least on experimental basis employ "fuzzy logic". It's a methodology, introduced in the U.S.A. by L.A.Zadeh, who pointed out that the more complex is a system the less is our ability to make precise and significant statements about its behaviour. Undeniably, there's hardly a system more complex than a fishery ecosystem. With roots firm in the real world, fuzzy logic enables to break out of the cult of model-driven precision paradigm dominating the "western" fisheries management (Mendel, 2001).

The following is a layman’s example how fuzzy logic can represent a given stock assessment: The biomass of a stock is estimated at 100,000 to 200,000MT. There's a little chance, say 10%, that it is between 100,000 and 120,000 and between 180,000 and 200,000MT. There's more chance, say, 20%, that it is between 120,000 and 130,000 and between 170,000 and 180,000MT. There's more chance (about 30%) that it is between 130,000 and 140,000, and between 160,000 and 170,000MT. And, finally, the best chance is, say 40% that the biomass is between 140,000 and 160,000MT.

The law and fisheries management. It's not for national/international authorities to make general laws that set targets and/or specifies management ways and means for different fisheries. Forcing the management to apply a general methodology of quantitative assessment of all fish stocks, MSY, TAC, etc., as prescribed by the U.S.
fisheries law is one example that shouldn't be followed. Governments, instead, should set up discrete local/regional regulatory bodies for specific fisheries and areas. Governments may prescribe the membership composition of such bodies, their terms of references, procedures, etc. Species-related rules, catch targets, gear and effort limitations, input or output management, etc., would be the task of such local/regional fisheries regulatory bodies. They may be based on tribal authorities and community councils, or be state appointed, through various co-management schemes, etc.

It often happens that decisions by local bodies depend upon who the managers side with and, consequently, politically determine who’s going to gain and who’s going to lose. From the point of view of social justice and true social-national benefits, the right approach is to allocate access to fisheries so that maximum number of people and families can make their living of. Accordingly, in my report to India's National Workshop on Low Energy Fishing (Kochin, 1991), (Fish.Technol. Spec.Issue), p.122), I set forth what I call the MB-Y's Allocation Principle:

(i) fish that can be caught by inshore artisanal fishermen should be caught only by them;
(ii) fish that cannot be caught by artisanal fishermen, but can be caught by small-scale commercial fishermen in coastal waters should only be caught by them;
(iii) fish that cannot be caught by small-scale commercial fishermen, but can be caught offshore by medium-scale commercial fishermen should only be caught by them.
(iv) only such resources, which are not accessible to any of the above fishery sectors, or which cannot be feasibly caught, handled, and processed by them, should be allocated to industrial, large-scale fisheries.

This, of course, can't fit every fishery, but it could be used as a sort of guiding principle.

Co-management. Enforcing “top-down” management rules contrary to fishing people’s knowledge, experience, and common sense, which they cannot materially support and comply with, is both expensive and ineffective. In, countries, which are not prepared or can't afford to employ expensive monitoring and policing of every fishing boat and vessel, it simply doesn’t work. It's practically useless, especially, in the south, where most fisheries are typically multi-species, and the authorities try to impose "western" methods of single-species management, such as output management, quite nonsensical in warm-water environments. It's also highly advisable to shun any regulation, which is perceived by fishing people as erroneous, wrong, unjust, etc., for it'll never work. Whatever the methodology applied, the managers concerned should always make sensible use of local knowledge (Ruddle, 1994), which may be the key to a success or failure of their management steps.

Prof. Elinor Ostrom got the Nobel Price for showing that while governance by state of ocean resources is flawed, many inshore fisheries have been handled very well by local communities managing access, fishing rights and ways, etc. Local and traditional institutions and regulation often can do better than state or privatized systems. Bureaucratic mythology says that “locals can never organize/manage themselves”, but Elinor Ostrom proved that they're wrong (Ostrom, 1990).

Japanese management system with its large community-based cooperative organizations seems to operate quite satisfactorily. This system developed to the present form, since, as Dr. Mitsutaku Makino of the Japan's Fisheries Research Agency illuminated: "Due to the complexity of the system and its intensive nature, fisheries coordina-
tion and resource conservation cannot be implemented effectively in a top-down, command-and control manner" (Makino, 2011).

Japan's management system, however transformed with time during its hundreds years long history, has remained quite different from Western variants. Nowadays, some 190,000 fishermen, which form almost 90% of the total, operate in inshore and coastal waters. Doubtless, Japan's fishery management system, is working without the Western ITQs, catch shares, etc., which, Dr. Makino writes, "are costly, crude and hardly adjustable to species' life cycle, and to fluctuations and assessment errors".

In Japan, management of coastal fishery resources has the form of input and technical controls, with the resource users in charge. In the offshore, industrial fisheries, the national government plays a principal role in the plans and rules making, and fisheries organizations participate in their implementation. Presently TAC, directed at only 8 stocks of mostly pelagic species, is based on the results of seaborne fishing surveys, and set in a participatory process with fishermen's organizations. In the sea-cucumber dredge fishery, TAC is set by the fishermen themselves.

China. China uses input control as a major strategy. Regulations issued in 2002, prescribe overall fishing capacity (vessels, gear and fishing permits). Since 1994, China has been also imposing a hot season moratorium in the Yellow Sea and the East China Sea that affects 120,000 fishing vessels and one million fishermen. During this period, trawling and stake-net fishing are banned, and setnets are closed for at least two months in all marine areas. From 2004, only gillnets with mesh size over 90 mm, are allowed in Bohai Bay from mid June to September. (Huiguo and Yunjun, 2008).

Closing warning. Even a most successful management scheme in one fishery, where unsuitably applied to another fishery may result in a total flop. To turn out well, before applying a locally untried management scheme, it must be critically considered and the pros and contras carefully evaluated at the background of all the existing knowledge on the fishery and species targeted, as well as on the fishermen concerned and their industry. To secure compliance, its details should be worked out in cooperation with the operators of the fishery, for details are where the devil hiding is.

Abbreviations used:

<table>
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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>DAS</td>
<td>days at sea</td>
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<tr>
<td>ITQ</td>
<td>individual transferrable quotas</td>
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<td>MSY</td>
<td>maximum sustainable yield</td>
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<td>OSY</td>
<td>optimum sustainable yield</td>
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<td>TAC</td>
<td>total allowable catch</td>
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НАУЧНЫЕ ПРОБЛЕМЫ МЕНЕДЖМЕНТА РЫБОЛОВСТВА

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Главная научная парадигма менеджмента рыболовства: 1 - можно оценить государственные ресурсы отдельного объекта рыбного промысла; 2 – возможно предсказать объем добычи, который может изъять рыболовство, поддерживая оптимальный размер промысловых запасов; 3 – промышленное рыболовство - преобладающий фактор, затрагивающий популяцию рыб; 4 - рыбными ресурсами можно полностью управлять, управляя уровнем рыболовства отдельных объектов промысла.

менеджмент рыболовства, наука, факторы, интенсивность рыболовства, оптимальный размер промысловых запасов