

IV RAMON MARGALEF PRIZE IN ECOLOGY

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Acceptance speech

by

Daniel Pauly

The Honourable Mr. José Montilla, President of the Generalitat of Catalonia, distinguished Councillers, members of the Board and the jury of the Ramon Margalef Prize, distinguished representatives of the IUCN and the academic community, ladies and gentlemen,

My first words are of deep gratitude for having had the honour of being awarded the 4th Ramon Margalef Prize. I collect this award with great pleasure but also with humility because the person who has given his name to the same was an eminent figure in ecology but, however, a humble man without pretensions. I never had the privilege of meeting Ramon Margalef, nor corresponding with him, but all my colleagues who did were witnesses to his generosity, his creativity and, last but not least, his energy, all of which are reflected in the enormous number of scientific contributions, especially books of great importance which he continued to produce until long after he retired. I imagine that we would have understood each other well, in spite of the difference in our paths, especially because I feel great respect for generosity, creativity and especially for hard work.

If we had met, we would probably have spoken about many subjects, but especially about ecosystems. It seems an easy thing to say, now that everyone is talking about ecosystems and the need to manage them or, at least for some type of ecosystem-based fishery management. But ecosystems were not fashionable when Ramon Margalef, on this side of the Atlantic and the Odum brothers and others on the other side, began to write about their properties and the frontiers with other ecosystems, about their development and the capacity to adapt to changes and naturally, about the actions that humans could take to guarantee their survival.

It was in particular the translation into English, under the title of Information Theory in Ecology, one of his key studies at the end of the nineteen fifties, which made world aware of him. In this study, Ramon Margalef aimed to quantify the degree of organization in ecosystems, a subject which is still today a very fertile research field. This involves both now and then, the evaluation of the space-time structures of ecosystems and their relation with biodiversity and the relations between biological succession and the evaluation of communities.

When I was informed that I would receive the Ramon Margalef Award for 2008, I looked to see if I had quoted him, and there it was: in the chapter of a book from 1993, written in collaboration with my colleague Villy Christensen, which described the flow characteristics of aquatic ecosystems. I would like to have talked about it with Ramon Margalef.

Now, at the beginning of the 21st century, the theoretical debates about the existence of marine ecosystems have become superfluous, just like discussions about whether their self similarity throughout time was maintained thanks to some rules from a superior order embedded in the information on biodiversity. Ramon Margalef, who was one of the first ecologists who wrote about this, has been fully vindicated. But, at the same time, the continuing existence of aquatic systems that work, both in fresh water and in marine environments, is threatened. In the case of fresh water ecosystems, the main offenders are the modification of habitat and pollution. In the case of marine ecosystems, the main cause is fishing because, by and large the organisms that we fish (and eat) are (or were) the ecosystems, just the same as the trees in the tropical rainforests constitute the greatest part of forest ecosystems. What is left, therefore, when we have finished fishing, for example in the case of the ecosystem of a continental platform, is not the same ecosystem, but another that corresponds, in many ways, to the conditions that predominated over five hundred million years ago, when beings that were similar to jellyfish dominated the oceans. In fact, the pressure that fishing and other human stress factors impose on the marine ecosystems leads to an inversion of ecological successions (for example, towards smaller organisms) and simultaneously, towards more “primitive”

organisms (that appeared earlier in the course of evolution). This suggests that Margalef's idea of associating succession and evolution is not applied only to the vegetable plankton that he knew so well but to all animal and vegetable kingdoms.

Many old students of Ramon Margalef, many of whom are here in the audience today, and their own students, follow in the line of these ideas. Also, whatever it was that inspired these thoughts, makes us today realise that now we have to do something more than describe and even understand ecosystems. Now we have to contribute, also as scientists, to their protection, for example by means of protected marine areas-, because otherwise we risk losing them in the next few decades.

Permit me to finish but on a positive and very personal note. I was brought up in Switzerland where I had quite a difficult life. But I had a godmother – exactly like in fairy tales- who, when I was about ten years old, took me for two consecutive years to spend the summer with her family in Tarragona (yes, it was a Swiss woman married to a Catalan). These are the only summer vacations that I remember having and all the family loved me and spoilt me, something which should happen to all children; but this was all new to me. So, until a short time ago, every time I thought of Catalonia I remembered a marvellous experience.

Now, over fifty years later, the jury of the Ramon Margalef Prize and the Generalitat of Catalonia have added an episode to those memories that I will celebrate for the rest of my life. Thank you with all my heart.

**The overexploitation of marine ecosystems:
The consequences of duplicity and ignorance¹
by
Daniel Pauly²**

¹ A presentation that illustrates this text can be found at www.seaaroundus.org

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Summary

The three decades after the Second World War was a period of fast growth in fishing capacity and catches, and also spectacular collapses, especially in populations of small pelagic fish. It was also the period of the emergence of a toxic triangle of under-reporting of fishing catches, disregarding of the scientific recommendations and blame on the environment as standard responses to the continuous collapses of fisheries, collapses that (therefore) were increasingly more frequent and finally encompassed important fisheries in the North Atlantic.

The answer to the depletion of traditional fishery areas was the three dimensional expansion of fishing in the North Atlantic (and in the Northern hemisphere in general): towards the south to deeper waters and to new taxons; which is to say, the capture and the commercialization of species of fish and invertebrates which were previously rejected and generally lower in the food net. This expansion provided many opportunities for trickery, such as is illustrated in the “agreements” negotiated by the European Union to gain access to the fishery resources of North West Africa, the exploitation carried out by China on the grounds of agreement-commission and the fact that Japan blames the whales for the consequent reduction in resources. Furthermore, this expansion provided new opportunities for the mislabelling of species of fish little known to Americans and Europeans and to trick consumers, which reduced the impact of the guidelines on fish and seafood and similar efforts made for sustainability.

With the decline of catches, with an aquaculture that, in spite of all public relations efforts, is incapable of compensating for this decline, and with the fast increase in the cost of fuel, it is predicted that there will be structural changes both in the fishery industry as well as in the scientific disciplines that study it and influence its management. Principally, fisheries biology, which now regulates the fishery industry, will become the science of the conservation of fisheries, and its objective will be to

resolve the toxic triangle which we mentioned before, with the aim of maintaining marine biodiversity and the ecosystems that provide essential environments for the existence of fisheries. In the same way, fisheries economists will have to overcome their obsession with the privatization of fishery resources, because their declared objective of providing fishers with the necessary incentives can be reached without giving away resources that, at the end of the day, belong to the public.

On a global scale, the current fishing crisis can be considered to be an opportunity for renewing both the structure – far from large scale fishing with an elevated consumption of fuel- as well as the management, and for renewing the disciplines that study fishery, taking advantage of the process to create a science for the conservation of fisheries. Its main achievement will be the creation of a worldwide network of protected marine areas, because, as Ramon Margalef predicted, this is the way to ensure that controlled exploitation is compatible with the continuation of the existence of marine ecosystems that function.

Introduction

Preparing the ground

There have been statistics that have covered the “visible” part of world fishing since 1930, in which the unfortunately now disappeared League of Nations made the first attempt to investigate the world economy. The United Nations Organization, founded in 1944 continued this project (Ward, 2004) and, in 1950 the United Nations Organization for Agriculture and Food (FAO) published its first “Statistical Fisheries Yearbook”. The data in these yearbooks, revised and updated annually, is also available online (at www.fao.org) and both the FAO and other UNO agencies such as academics and researchers make great use of them with the aim of following the development of fisheries, per country and region and globally, and for formulating future perspectives.

However, the majority of these researchers are unaware of how this data is elaborated and the deficiencies that it presents, which leads to some of the “consequences” in my title and which we will have to face if we want to seriously approach the overexploitation of the marine ecosystems.

During the first decades after the Second World War, marine fishing increased rapidly, whether we measure it in terms of investments in fisheries (invested capital, ship tonnage) or in terms of production (weight or value of fish unloaded). This period, which established the world regulations for the industrialization of fishing, was also the time when it seemed that the fisheries industry was managed like any other sector of the economy, in which an increase in investment brought with it an increase in production. This is the logical basis behind fishing subsidiaries, a subject which we will come back to later.

The emergence of the “toxic triangle” of fishing

This was also a period of generalized fisheries collapse, in which it seemed as if fish populations which previously had fed whole fishing fleets, processing plants and thousands of workers with their families disappeared suddenly (Radovich, 1981). The capture of sardines in California is an example of one of these collapses, which appears in *Cannery Row* by Steinbeck. More prosaically, other fisheries had to be rebuilt a few years later, for example the Atlantic Scandinavian herring (Beverton, 1990), or the fishing of the Peruvian anchovy, the first general collapse of which took place in 1972 (Muck, 1987). And this last example is one which best illustrates a subject already predominant during the best moments of the Californian sardine fishing: the problem of the environment. In Peru it was the fault of El Niño; it doesn't matter if the real capture the year previous to the collapse was some twenty million tonnes (Castillo and Mendo, 1987), and not the twelve million tonnes that was officially declared, a quantity that already exceeded that which the best experts (John Gulland, Bill Ricker, Garth Murphy) had recommended as sustainable.

Therefore, the toxic triangle (1) of under-reporting of catches, (2) of disregard for scientific recommendations (which is to say, ignoring the scientific recommendations at any time) and (3) blame on the environment for the resulting disaster, already existed long before the effects were noticed on a worldwide scale, the reality of which required a whole new set of terms to deal with, at least conceptually. Thus, the invention of the terms “*bycatch*” (unintentional catch) by W. E. Allsopp (Pauly 2007b) and “*IUU*” (Illegal, Unreported and Undocumented catches), terms without which the reality that they so crudely describe cannot be completely understood.

This toxic triangle was already firmly established when, in 1975, catches reached their maximum height in the North Atlantic and later began a slow decline that still continues today (Pauly and Maclean, 2003).

A triple expansion

In fact, this toxic triangle forged the logical base for expansion, which was three-dimensional:

Geographic expansion: Although pre-industrial fishing had the capacity to completely destroy some coastal populations of fresh water fish and other groups, as archaeological remains demonstrate, it wasn't until the arrival of industrial fishing that the sequential depletion, first of coastal populations and later of high sea fisheries, became the usual exploitation method (Roberts, 2007). In the North Sea, where British steam trawlers were deployed for the first time at the end of the nineteenth century, it only took a few years for coastal reserves replete with flat fish and other groups to be depleted and for the trawlers to be forced to move to the centre of the North Sea, and later even further to Iceland (Roberts, 2007).

Soon, through the development of industrial fishing in the incipient Third World, expansion towards the south also took place towards the tropics (Alder and Sumaila, 2004), often by means of working "in conjunction" with European companies (for example Spanish companies) or Japanese companies. Towards the end of the nineties the last continental platforms, which before had not been exposed to trawlers, had been depleted, as well as several submarine mountains and plateaus, including those around the Antarctic (Pauly *et al.*, 2005).

Batimetric expansion: The second dimension in the expansion of fisheries took place in the depths (that is to say, the submarine dimension) and affected both the pelagic and demersal kingdoms. In the pelagic kingdom, the fishing of tuna and other large pelagic fish with longline hooks eliminated large predators from the ocean systems (Myers and Worm, 2003), including sharks, which now feed an insatiable market for shark-fin soup (Clarke *et al.*, 2006). Furthermore, fishing with nets using floating objects (that is to say, fish aggregating devices) have made small tuna and other previously inaccessible associated organisms vulnerable, and have given rise to

the fear of a drastic decline in the populations of fish which were previously largely considered immune from human predators.

With regards the demersal kingdom, trawlers were deployed which could reach kilometres in depth. They produced catches in which there are increasingly more deep-water species, of slow growth, low productivity and which cannot be exploited in a sustainable way (Pauly *et al.*, 2003, Morato *et al.*, 2006). Here, with the lack of legal protection, they are subject to the tactic of “sweeping the sea bed” carried out by large fleets from several industrial countries (Bonfil *et al.*, 1998), that is to say, the rapid depletion of their biomass, without even the pretension of some form of responsible fishing.

We can illustrate in several ways the change in the structure of the demersal and pelagic systems which results from this continuous destruction (see, for example, Stergiou, 2002). One way is using the average trophic level of unloaded fish, which is reducing around the world, and which implies that globally fisheries depend more on the fish proceeding from the lower level of the marine food net (Pauly *et al.* 1998), which means from the catches of larger fish.

Taxonomic expansion: refers to catches and processing of previously disregarded taxons (Pauly *et al.* 2003). This form of expansion, which intensifies the effect of the other two, is the reason why in the North American and European markets there are increasingly more unknown marine products. Furthermore, this presents many opportunities for mislabelling products and cheating consumers (Jacquet and Pauly, 2007, 2008), which is another reason for the word “duplicity” in my title.

Digression I: Exclusive economic zones

At the beginning of the decade of the eighties, the negotiations that had been going on for ten years and that had resulted in several maritime countries declaring unilaterally large areas of coastal waters their own, were successful and culminated in the United Nations Convention on the Law of the Sea (UNCLS). As a result of the UNCLS, all maritime countries were permitted to declare exclusive Economic Zones of up to two hundred miles and, therefore (if they had sufficient political weight) they were permitted to expel large fleets that at the time were free to operate there. Some countries expelled large fleets that had operated on their coasts, but later began to

subsidise the development of national fleets that soon became as destructive as the foreign fleets had been. In the United States and Canada, this finally led to the collapse of the cod in New England and the Canadian maritime provinces. Others tried to expel “their own” large fleets, especially several countries in North-West Africa. However, as they had no political weight, they were open to blackmail (in some cases, their negotiators were honest) or bribery (if they weren’t) and the result was that large fleets from Europe and Eastern Asia still operate in the region (Kaczyński and Fluharty, 2002).

The continued presence of large fleets from countries of the European Union is based on access “agreements”, each of which is a victory of clear political power over the rhetoric of collaboration and development aid –one of the areas where duplicity reigns. With regards to the large fleets from Eastern Asia, the rhetoric is different. In fact, China does not have any rhetorical attitude: its fishing industry operates on the basis of what seems to be private agreements with local politicians which escape all controls, and that only appear in the press when their trawlers enter into conflict with local fishers. This has a lot to do with the situation of only a few years ago when China declared more catches than it carried out (see later).

Japan, on the other hand, manages to add insult to injury: its experts in fishing and its ambassadors to North-West Africa (and to other places, especially the Caribbean and South Pacific) argue that those responsible for the decrease in populations of fish are the whales and that, therefore, the countries in question should help to re-establish “the balance of the ecosystem” by means of, among other things, the vote before the International Whaling Commission, in favour of Japan killing more whales. This line of argument, which anywhere else would have been fallacious, is especially duplicitous in North-West Africa, where it has been proved that large fleets and “small scale” fleets that have grown more than they should have, are without doubt, the cause of the generalized decrease in marine populations (see contributions to Chavance *et al.*, 2004), and where mysticetes appear especially during the reproductive period, when they do not feed. Strange as it seems, and this makes reference to the word ignorance in my title, this line of argument works in such a way that, probably with help of other more practical persuasions, the few resources for the research of several countries in North-West Africa with regards the carrying out of

costly “studies on whales” have been redirected, and this is in a region that does not have observers on board the ships of large fleets nor, in fact, any practical means of calculating their catches (Pauly, 2008a).

The fisheries crisis³

Direct and indirect driving forces

The expansionist tendencies established in the decades of the eighties and nineties have led to the crisis that we are experiencing now at the beginning of the 21st century, the main elements of which we will now explain.

In the world fishing sector there is an enormous excess of capacity (which is to say, an excess in fishing vessels), estimated at double or triple that necessary to generate the current catches (Mace, 1997; Pauly *et al.*, 2002).

This estimation is probably too low, given the increase in efficiency of the vessels in locating and catching fish which is approximately from 4-5% per year in a wide range of vessels. This increase in percentage implies that, from now to some fifteen years time, the effective force of fishing of fleets will have doubled. (Gelchu and Pauly, 2007).

The biomass of the large fish that have been caught traditionally (cod and other demersal fish, tuna and other large pelagic fish) has been reduced at least in size from the beginning of industrial exploitation (Myers and Worm, 2003; Christensen *et al.*, 2003). The majority of these conclusions have been contradicted (see later), but anyone aiming to rebuild populations before the start of industrial exploitation could do so easily, as with for example the cod in New England, Rosenberg *et al.* (2005). Without this rebuilding, discussions on reduction will be essentially useless, because perceptions of abundance are lowered due to the changes in the baselines (Pauly 1995), a distortion that has been demonstrated empirically to be very strong (Saenz-Arroyo, 2005).

An aspect of fishing on a world scale –but which we do not often perceive to be as shameful as it is- is that approximately a third of the world catches (sardines, anchovies, mackerel and other small pelagic fish) is wasted to make dried food

³ This section includes text by Pauly (2008b)

(especially fish powder, half of which goes to fish farms) although it would be easy to convert it into human food (see contributions to Alder and Pauly, 2006). As such, it would contribute much more to human nutrition (also to the providing of omega 3 fatty acids) than it does through fish farming, which inserts a trophic step between fish and humans (and, in the worst cases, also inserts several much more persistent organic contaminants; see Hites *et al.*, 2004).

You will also observe that as it is not foreseen that the number of small pelagic fish will increase in the future, the expansion of fish farms will also be limited, unless we conceive fish farming as the breeding of carnivore fish (salmon, bass, tuna), which is how we generally understand it in western countries, (two thirds of the production of aquaculture takes place in China, where the main species of fish farms are fresh water herbivore fish and marine bivalve fish, neither of which require fish flour). For example, the expansion of fish farming of high trophic level fish in the Mediterranean, that is to say, the establishment of “shallow water aquaculture” (Stergiou *et al.*, 2008), contrasts with “deep water fishery” which is taking place around the world (Pauly *et al.* 1998). Therefore, large quantities of pelagic fish are caught with the aim of feeding a relatively small number of fish from a fish farm (mainly tuna), and no food is left for marine mammals (Bearzi *et al.*, 2006), and less fish is left for the people who cannot afford to eat albacore sushi.

Over 50% of fish caught in the world is the object of international exchanges and many industrialized countries either have large fleets (such as Spain, for example) or they purchase the majority of the fish they consume (for example, Germany and Japan). In either case, there is a great flow of fish from developing countries towards industrialized countries, with serious consequences for food safety in developing countries, where there is a lack of protein (Kent, 2003; Alder and Sumaila, 2004).

Here we could talk about ecological labelling, which involves the public in the purchase preferably of fish proceeding from sustainable fishing. The Marine Stewardship Council (MSC), with headquarters in London, is the most outstanding initiative in this area, and together with information provided in a space the size of a credit card which, in the United States, informs clients if the species that restaurants

are offering are “good” or “bad” in terms of the sustainability of the fishing grounds they proceed from (see also www.seafoodguide.org). However, the effectiveness of this with regards to reaching the proposed aim of changing the destination markets (in western countries) is still to be seen (Jacquet and Pauly, 2006; 2007). Furthermore, even if we reach this objective, this will still not solve the problem of food safety caused by the transfer of fish from developing countries to industrialized countries.

And to round this off, governmental fishing subsidies –the fuel that keeps the system working- were recently recalculated at 30-34 billion dollars per year, which is an increase on the previously established figure of 20 billion dollars per year (Milazzo, 1998). Of the 30-34 billion dollars, some 20 billion dollars are “bad” subsidies, because they increase the capacity of fisheries (Sumaila and Pauly, 2006; 2007). This is applied especially to fuel subsidies, which permit the profitable exploitation of depleted populations and, therefore, contribute directly to the before mentioned problems. These subsidies, which are responsible for the excess of capacity of many fishing fleets, are also its Achilles heel. Globally, these subsidies reach 30-34 billion US dollars. Therefore, the World Trade Organization, the organization in which the possible abolition of all governmental subsidies lies, has in its hands the means to deal with the problem of excess capacity (Sumaila *et al.*, 2008).

Subjective factors and masking effects

As well as the objective factor or the before mentioned driving forces, there are various subjective elements –some of which verge on duplicity (and some pass the frontier)- that contribute to the masking of the crisis or, at least, make it misunderstood and therefore contribute to the decline in marine biodiversity and the overexploitation of ecosystems.

The first of these factors was the generalized over-declaration of catches by China during the nineties and which tricked the FAO and the world into believing that worldwide catches were increasing while, in fact they were decreasing slowly (Watson and Pauly, 2001). This happened because China does not have an independent statistics system; which means that any average public servant who wants promotion can write up statistics of favourable production, and this includes statistics on the fishing sector (Pang and Pauly, 2001). We note that the FAO, which is now

presenting statistics on world fishing with and without China, is now having doubts on Chinese aquaculture (www.fao.org).

Another masking factor is that consumption per capita in industrialized countries, especially in the European Union, the USA and Japan is increasing. Given the stability or decline of world catches, this implies that consumption per capita in developing countries (except China), should decrease. There is not reliable data on the consumption of fish in developing countries to verify this (which may be very convenient for some). Meanwhile, it is permitted for consumers in the European Union and the USA to enjoy themselves albeit with *frissons* of guilt when they order food that their numerous guides on fish and seafood do not sanction (see above).

However, the most powerful masking factors, because they provide the government with the excuses that it needs not to intervene and stop negative tendencies are, as in the case of global warming, contrary statements from the self-named “sceptics” and the use that is made of “uncertainty”. Sceptics are effective because science needs scepticism and must recognize uncertainty, and fisheries science is not an exception.

Ludwig *et al.* (1993), in a brilliant study now repudiated by its second co-author, puts into relief how scientific uncertainty is used, in the case of fisheries, to avoid intervention until it is too late to avoid the collapse of populations; that is to say, scientific uncertainty is not used as a preventive measure. When, furthermore, opinions contrary to those of the sceptics are combined with insinuations doubting the ethics of scientists that inform of negative tendencies, on the ethics of the magazine that has published his research and on the donors that have financed it -like Lomborg (2001), or Hilborn (2006) in the case of fisheries–, there can be considerable obstacles to the solution to the problem on the table.

Digression II: the under-declaration of fishing catches

Apart from China, which has a political system that encourages the over-declaration of domestic catches, and apart from a few cases of powerful politicians

that insist on the increase of catches in countries that they believed they controlled (for example, Marcos in the Philippines at the beginning of the eighties), data on catches that citizens and the majority of scientists can access is rounded downwards and against small scale fishing. This takes place in two stages: (1) governmental scientists only study (and the statistics system that they establish generally only controls) commercial fishing, not recreational fishing or small scale fishing, or artisan or subsistence fishing, although all together these unload the greatest part of the national catch (Pauly 2006); (2) the national agencies that inform the FAO (which compiles and maintains the only world database of fisheries statistics) of national captures are not generally the Ministry of Fisheries or other similar entities, but the Ministry of Agriculture or Finance, or their statistics offices, which also tend to emphasise the “cultius commercials” –which is to say, exportable products such as prawns and tuna– while they cover up and, in the worst cases, completely ignore small scale fishing catches although these are the catches that feed their rural populations (see, for example, Jacquet and Zeller, 2007 and another contribution from Zeller and Pauly, 2007).

These two problems are so extensive that the Project *Sea Around Us* (Pauly, 2007c) has initiated the systematic reconstruction of real catches (which is to say, including the IUU) of all maritime countries in the world. This project is due to be finished in 2010.

The global fisheries crisis as an opportunity for renovation

The renovation of fisheries science

It is evident that we are currently in a situation in which a substantial part of the fisheries industry is prepared to sacrifice the future of fishing; a future that can only be sustainable if we permit subjacent resources to recuperate and reconstruct their biomass. The most important task for the recovery of fisheries and fisheries research will consist, therefore, in the reduction of the fisheries force. Without this, nothing will work. Considerations based on the ecosystem will also have a role to play (Pikitch *et al.*, 2004; Cury *et al.*, 2008). This implies ensuring, among other things, that there will be no attempt to try to maximize catches or predators or the organisms that feed them. Here, marine reserves where fishing will be totally prohibited must be perceived not as

a few dispersed concessions made to conservationists, but as a tool of legitimate and evident management designed to re-establish the natural refuges lost due to the geographic and bathymetric expansions previously described (Pauly *et al.* 2003).

In fact, avoiding the extinction of species previously protected by their inaccessibility to fishery procedures should be a principal objective of future management regimes. This would link fisheries scientists with the vibrant communities of researchers who are now working in terms of marine diversity and conservation. This link, however, is not easy to achieve, as we will explain in the following paragraphs.

Changes that it is time to make

One of the few good things about growing older is that one develops a very fine appreciation of the various forms of change. One of these forms is the insidious gradual movement of our baseline, which affects so much the perception that we have of the state of biodiversity (Pauly, 1995). Another type of change is that which is produced when intuitions accumulate in a society but there is no way out unless there is a sudden event or a “critical point” (Gladwell, 2000). Examples of these events of which I was able to form part (a very small part) are the Parisian revolt in 1968 against an increasingly autocratic Charles de Gaulle and the revolution of Power to the People in 1986 in Manila against the dictator Ferdinand Marcos.

Another change of this type was the civil rights movement in the United States, of which I only saw the tail end but which announced the emergence of a new way of thinking that now cannot conceive of how the old way of thinking had ever been acceptable. Another less dramatic change, but important for daily life, is the radical drop in society’s tolerance towards smokers. As a non-smoker, for most of my life I have thought of smoking as I thought of bad weather; which is to say, as something that I could do nothing about (which is how we now conceive uncontrolled carbon dioxide emissions). However, recently, while someone in a meeting was complaining that things would “never” change, a colleague asked “Where are all the ashtrays in this room?” This made us realise that, in one generation, a deeply rooted habit backed by the support of a very powerful industry has been rejected in a large part of the western

world, and the victims of this habit have been reduced to pathetic individuals who cough around the entrance doors to public buildings.

In the profession that I chose, fisheries science, there have also been changes. When I was a student, I was taught that the work I taking on would be at the service of fisheries managers, who would ensure the optimization of fisheries and would base it on rational foundations in such a way that society would benefit. I first worked in developing countries, many of which with large fishing industries but the fisheries scientists whom I worked with and for whom I adapted the classical methods of population evaluation had no connection at all with those who took the decisions on fishing. Specifically, they had no relationship with the heads of fisheries companies (often called “fishers”), nor with the financiers of the fisheries companies, not to mention the politicians that permitted and subsidised the projects. In other words, those fisheries scientists had no way of carrying out changes based on scientific ideas.

Later, when I examined fisheries in Europe and North America and on a world scale, I discovered that this was the norm and well managed fisheries were the exception. I could also see the damage that these fisheries were doing to marine ecosystems and biodiversity, and that my discipline, fisheries biology, did not have the necessary conceptual devices to deal with problems related to biodiversity. In fact, these were not considered acceptable subjects for research. In several forums, especially at the annual meeting of the ICES (Independent Centre for Environmental Studies) in 2000 and at the 4th World Fisheries Congress in Vancouver, where in both cases I was the main speaker, I tried to defend, from the inside, the need to extend our discipline from a discipline implicitly interested in maintaining the running of fisheries fleets to a wider discipline dedicated to maintaining ecosystems and the resources that are embedded there and on which, in the last instance, fisheries depend. I did this because I consider the argument presented by ecologists who see ecosystems as something more than a pantry where we can take what we please, to be legitimate.

For some time I believed that these efforts, parallel to those of many other colleagues, principally Jackson *et al.* (2001) and Ransom A. Myers and his collaborators, would be successful and would generate a new consensus. Who can deny the need to conserve fish, which is the objective of fisheries? Now, with the

publication of a contrary article on “Faith-based fisheries” by Hilborn (2006) and the apparently positive reception that it has had among several of my colleagues, I realise that it isn’t at all clear.

On the other hand, what has been produced in our discipline is a debate on the standards of evidence and, naturally, on what constitutes evidence. This “metadiscussion”, which is to say, this discussion on how we ourselves should behave, is an indication of a deep disagreement over the fundamental changes that have taken place in our discipline, in which two schools are now fighting for supremacy; in an attempt to dominate the entire discipline.

One school is based on the profitability of fishery companies and on fishing “rights” (see later); the other on the marine ecosystems and their capacity to generate services, including the fish that we catch. And between them it has become the fashion to trade insults in such a way that that would have been impossible when Ray Beverton and other men, I suppose (yes, they were all men) founded fisheries science.

This is not a characteristic of normal fisheries science such as that cited by Thomas Kuhn (1962). In “normal” science, as he defined it, scientific standards (and the standards of behaviour) are limited and there is no conflict over what is considered to be evidence. Nor are there disputes on supposed conspiracies that involve the editors of *Nature* or *Science*. Given that now it seems that these disputes form a large part of the action, I must conclude that we are not at a stage of normal science, but rather that we are at a culminating moment of a paradigm shift, according to Kuhn’s definition.

There are colleagues that readily evoke the paradigm shift for trivial matters (for example, “a paradigm shift in the interpretation of the construction of the nests of the “lesser-spotted gobies”); but I believe that a paradigm shift is really taking place in our discipline, creating a crisis in the rules of social relations and on the agreement on how to interpret evidence and, naturally, what *is* evidence. Thomas Kuhn remarks that the crisis involved in the interpretation of these standards is an indication of a paradigm shift in progress.

In this I am not in any way a neutral observer; but I do think that it is evident that the next generations look forward to fisheries that work not only in operational and financial terms, but also in ecological terms and that, therefore, they will be able to carry out normal science.

Fisheries economists and their obsessions⁴

It is evident that fisheries should be able to access resources easily, using catch quotas, which would make it unnecessary to build up the excess of capacity that competition causes (Costello *et al.*, 2008). However, the majority of fisheries economists surprisingly describe this as “fishing based on rights” and in this way convert a clear proposal (that it is better that fishers and fisheries companies can predict their catch and, therefore, deploy their ships in an optimum manner) into an ideological discussion, which is to say, we must privatize public resources before being able to manage them adequately; see Macinko and Bromley (2002, 2004). Among fisheries economists, the notion prevails that the fisheries crisis can be solved by giving company owners (timidly named “fishers”) fishing “rights”.

This word, “rights”, is not only used by economists, who I fear did not consult law specialists before throwing this ball; it is also used by fisheries biologists, who perhaps do not fully appreciate what it means. Here it is: the right to fish is a euphemism for the privatization of fishery resources, currently a public resource in most countries. Furthermore, according to this point of view, private property is a *conditio sine qua non* for the successful management of fisheries and by extension, of any natural living resource. Finally, according to this point of view, public property is not a “real” property, because it leads (or, it is better to say, “it might lead”) to conditions similar to those that result from the absence of property. Why should fishing “rights” –which is to say, the non-transferable individual quotas (NTIQ), the mantra of the defenders of “fishing rights”- be entitled to *give away* to individuals and, furthermore, for ever? It would be much fairer and more compatible with public interests to apply, for example, fishing privileges that are auctioned periodically, as suggested by Bromley and Macinko (2002). In this book, and also Bromley and Macinko (2004), the authors expose the disagreeable proposals in the arguments in

favour of fishing rights and they reduce them to what in essence they are: a justification for the way the rich and powerful and their allies in the government and universities appropriate themselves of the resources.

In fact, I am amazed at the almost total consensus among fisheries economists in this matter. It is almost as if the whole guild has been employed by the fisheries industry, as in those Swiss villages where all the young men went *en masse* to become mercenaries for an Italian prince during the Renaissance. Where are the fisheries economists who, aware that they are paid by the public (most of them work in state universities), take into account the good of the public and how it could be improved? Or do they really think, like Margaret Thatcher, that “society does not exist”, only individualism and therefore, there is no public good? What would we think, for example, of economists that, when asked to deal with, let’s say, the pollution and the problem of the congestion of large cities (for example, London where an innovative plan to charge motorists who want to drive in the city was applied) suggest that only “driving rights” could solve the problem (which is to say, give to five corporations, for ever, the ownership of the access roads and the exclusive right to charge the people who use them)?

These are important questions, because they illustrate how an argument, regardless of how absurd it is, can rule in an academic discipline and, at the same time, disassociate itself from its social and ethical roots. In fact, the almost total hegemony of the argument on privatization is quite frankly frightening with a view to the challenge in the form of global warming which humanity is facing, and in which the good of the public and the interests of some large corporations, especially in the energy sector, collide head on. Once again, we see that the professional economists will watch it all from the fence or pontificate on the elevated costs that the fact of dealing with the problem would involve for the corporations. As if their main task were to find ways to avoid costs for the corporations, and not to avoid an uncontrolled climate warming and the horrible consequences that this would have for humanity.

Therefore, the debate on fishing rights is one more of the many that

⁴ This section is based on Pauly (in press)

demonstrate that, in the last decades, we have followed a dangerous road on which the problems involved in managing public goods such as health and education, radio frequencies, fields or marine fishing represent, remain without a solution until the goods in question can be privatized. These privatizations, often presented as more “options” or “rights” (for example, the option to choose the provider of medical care, or a school, or fishing rights), are increasingly accompanied by an increase in wealth for some and fewer options and fewer rights for those that are not rich. The universities and open spaces still provide the means for improving the public welfare and are a great obstacle to the general appropriation of public affairs by corporations (they already own the communications networks and the results are evident). With this situation, we should expect that each scientific discipline, each student, asks himself whether he wants to be a Trojan horse or to contribute actively to this gradual appropriation of all aspects of our lives, and if corporate logotypes should be stuck on the few walls that they still do not adorn. And we should also ask why fisheries economists promote NTIQs, even though they know, or should know that there are other fairer ways of reducing the fisheries capacities and that there is no legal basis for them to state that it is a “right” to fisheries resources.

Conclusions

For fisheries science and management, two different futures can be easily identified: in one, everything would continue to run as always, including the present tendencies of excess capacity and the continuous depletion of fishing resources, as can be seen in the practice of fishing lower down in the marine food web, together with the denial that that these things are happening (see above). The other future would take fisheries science and management far from the establishments of quotas of annual catches as its main task and move towards a management of fisheries based on ecosystems and firmly grounded in the closing of areas (including the protected marine areas, where fishing is totally prohibited, see later) as a tool for the conservation of resources. Eventually, this would lead to the emergence of a “fisheries conservation science”, with Ransom A. Myers as one of its founders (Pauly, 2007a). This implies, furthermore, a change in the present perception, common among fisheries scientists, that the “commitment” to the environment –which is to say, to the maintenance of the ecosystems that sustain fishing– means a loss of scientific credibility. In the end, no one would ever suggest that the enthusiastic commitment of

the doctor to the health of his patients means a debased science. In fact, it is precisely this commitment that encourages better medical research. There is no doubt that it is an example that fisheries science would do well to emulate.

I will finish by reaffirming my conviction that Protected Marine Areas (PMA) must be at the heart of any plan that aims to establish fishing on an ecologically sustainable basis. Currently, PMAs cover a total area of only 0.7% of the world's oceans and with the annual increase of this area –approximately 5%– is not enough to reach the several objectives internationally agreed upon, for example, a cover of 10% in 2010, as was agreed in the Convention on biological diversity (Wood *et al.*, 2008).

Therefore, if we want to maintain marine biodiversity and re-establish ecosystems that are victims of uncontrolled exploitation, then we will have to establish larger PMAs and at a faster rate, as has also been demanded by the majority of marine ecologists and all non-governmental organizations that work in the marine environment.

It is comforting that Ramon Margalef (1968, p. 50) had already anticipated this idea long before it had become popular:

“Probably the best solution would be a balanced mosaic or, better said, a grid of exploited and protected areas. Conservation is also important from the practical point of view: the lost genotypes are unrecoverable treasures, and we need natural ecosystems as a reference for the study of exploited ecosystems.”

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