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The role of science in fisheries management in Europe: from Mode 1 to Mode 2

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Abstract

The transformation of fisheries science in an applied context ('Mode 2') sciences is controversial within the scientific community. To investigate this issue, the conceptual shift from 'traditional academic science' (Mode 1 science) to 'modern post-academic science' (Mode 2 science) is used. The paper uses EU fisheries science with focus on ICES research as illustration for gaining new insights in the consequences and dilemmas of the transformation, in regards to the production of knowledge for policy-making in fisheries management. Hence the main question to be discussed in this paper is: what does the new kind of more applied 'Mode 2 science' mean for reliability, credibility, trustworthiness and quality assurance? This study, therefore, mainly demonstrates what such a transformation may imply to the scientific community and what consequences it might have for the way fisheries science is practised, and perceived in a political context.

Keywords: Fisheries management research, Europe, Policy-making, Mode 1 science, Mode 2 science, Commissioned research, Knowledge production, Quality assessment, Peer review

Introduction

Science seems to be undergoing a transformation in the way the knowledge production takes place (Bohme et al. 1983; Gibbons et al. 1994; Hackett et al. 2008; Nowotny et al. 2001; Ziman 1996, 2000a, 2000b). From being largely curiosity driven within academic institutions, now scientific research is increasingly oriented towards strategic policy goals (Amsterdamska 2008; Irvine and Martin 1984). Traditionally, knowledge production was theorised to have been motivated by scientific curiosity alone (fundamental research) and not bothered by the applicability of its findings (Gibbons et al. 1994). Science was characterised by relative homogeneity of skills, specific (academic) rules and values (Gibbons et al. 1994; Nowotny et al. 2001). Scientific knowledge was acquired through basic research which in the next instance led on to applied research, then development and, finally, policy application (Silbey 2006; Sismondo 2008; Turner 2008).

In recent times, however, when research has become more problem-oriented, multidisciplinary teams are organised for short periods of time to work on specific societal challenges (Limoges 1996; Turner 2008; Walt 1994). This approach ideally starts with a problem and then searches for solutions which lead to policy action (Georghiou et al. 2009). In practice, as argued by Jentoft and Chuenpagdee (2009); Rittel and Webber (1973), science planning often starts with the solution, i.e. decision-makers and planners often have a preconceived idea of the solution when they start the process, and they mobilise the research community to provide knowledge that is relevant for its implementation. Research is therefore perceived to be socially and societally constructed and intertwined with other spheres of society (e.g. policy-making) through different but overlapping social practices and values (Silbey 2006; Walt 1994). Consequently, issues concerning policy-making and governance are at the heart of success in modern science (Limoges 1996; Silbey 2006). This way of conducting research can partly be explained by the way research funds are distributed and what scientists must do to obtaining funding (commissioned research[1]). With commissioned research, the projects are both initiated and funded by the same funding agency, be it government or a private organisation (De nasjonale forskningsetiske komiteene; Mirowski and Sent 2008; Ottinger 2013; Sismondo 2008; Solomon 2007). This also seems to be the tendency of direction and practice in marine and fisheries science (Wilson 2009).

According to Gibbons et al. (1994) and Ziman (2000a), the transition described above is categorised as a move from 'Mode 1 science' (traditional academic science) to 'Mode 2 science' (modern post-academic science). While referring to Mode 1 and Mode 2 as a scientific practice for knowledge production, these models are not real, but the underlying conceptual frameworks that inform the beliefs, customs, or practices of science. Therefore, they are ideal concepts used as a practical tool to appraise and justify science and its products (the ethos of science). As Ziman and colleagues note, Mode 1 basically refers to traditional academic (university) science or basic science, whereas Mode 2 characteristics have primarily been important in applied science. Both these models have existed side by side. However, applied science (with Mode 2 features) currently seems to outgrow basic science. In this contextual process, as (Ziman 2000b) noticed, the normative ideals of applied science also seem to be influencing the way the traditional academic science is practiced and justified.

As indicated in literature, fishery science (at least the part of fishery science that is of interest herein) is an example of what Jasanoff calls regulatory science (Holm 2003). This implies that fishery science belongs with the applied sciences. As such, we would expect that it has important characteristics of Mode 2 science. Nevertheless, as Holm (2003) notes, Mode 1 ideals have been important to justify this science. This does not mean that the general transition from Mode 1 to Mode 2 as a generalised ideal is irrelevant for fishery science. In particular, International Council for the Exploration of the Sea (ICES), which is an organisation that develops science and advice to support the sustainable use of the oceans in Europe, has opened up and made a number of its processes transparent in response to certain concerns that are evident in the EU's Common Fisheries Policy (CFP) reforms (ICES website). This, therefore, portrays to be an important example of movement in production of fisheries science from Mode 1 towards Mode 2 ideals.

While this transition of science attracts considerable support, it has not been universally endorsed (Gibbons et al. 1994; Hackett et al. 2008; Jasanoff 2009; Limoges 1996). As such, this paper explores whether and to what extent the transition, from a classical science approach, that Gibbons et al. (1994) and Ziman (1996, 2000a) describe as 'Mode 1', to a new conceptualisation of science in an applied context ('Mode 2') sciences, has occurred within fisheries science in Europe. It investigates the implications of such a transition for the fisheries science community. The paper uses EU fisheries science with focus on ICES research as illustration: What signs can we find within these institutions of a possible transition from Mode 1 to Mode 2 science as far as fisheries management is concerned? What consequences might the shift have on the way science is perceived, practiced, legitimised, and converted into policy? Is this a move that should be criticised or supported? What works with the Mode 2 conceptualisation for ICES's science procedures, and what does not? Is there a way to reframe Mode 1 and 2 science for what's practically happening on the ground?

As a regulatory science, fishery science could perhaps never approach the Mode1 ideal of disinterestedness and autonomy in the first place. But this does not imply that Mode 1 science ideals have been irrelevant in the modern fisheries management. Due to the fact that there is a tendency of blurring of boundaries between science and politics within fisheries management, "Mode 1 ideals became all the more important" (Holm 2003: 6). The paper, therefore, in particular, aims at exploring and demonstrating the dilemmas that are involved in maintaining the reputation of science while avoiding dilution of the values that are associated with the move from Mode 1 to Mode 2 science.

In Section 2, the paper explores the ideas that guide Modes 1 and 2 science. The description is devoted to what characterises the difference between science and policy in Mode 1 and Mode 2 ideal concepts of science. Thereafter, the transition between Mode 1 to Mode 2 science is discussed. Section 3, 'Source of information', describes the information used to perform the analysis about the shift from Mode 1 to Mode 2 in fisheries science. The information used is primarily drawn from Wilson's study (2009) and other people who have written about ICES and the role it plays in EU fisheries management research and advice. As such, the analysis in this study is not extensively based on original empirical materials (primary data). Section 4 explores the role and approach of fisheries management research in Europe, and how the work that ICES does fits in. This section is followed by a discussion on the relationship between science and policy-making in relation to issues concerning the fisheries research projects in Europe. In the conclusion, a middle ground solution is suggested to cater for the problems and limitations pertaining to quality assurance involved by shifting from Mode 1 to Mode 2 science.

Theoretical context

The changes in scientific norms and practices that Gibbons et al. (1994) refer to as the shift from Mode 1 to Mode 2, by others are referred to as a shift from normal to post-normal science (Ravetz 2006), without these conceptual pairs being exactly overlapping.

It should be noted that Mode 1 and Mode 2 are 'ideal types' of science, i.e. heuristics, and not strict empirical representations (cf. Weber's concept (Burger 1987)). They are in other words perfect forms or states (types) of science used to compare reality and practicability of science against. As ideal types, Mode 1 to Mode 2 science concepts are measuring sticks that enable the demonstration of the implications, which the Mode 2 knowledge production may have on science that is used for fisheries policy-making and management.

Mode 1 science

According to Gibbons et al. (1994), Mode 1 science is what is call traditional academic science. This theory of science is about Merton's description of the 'ethos of science' (1996), according to which science is to a greater degree perceived as pure and separate from policy-making (Gibbons et al. 1994; Merton 1996).

Mode 1 assumes that science is institutionalised, where the goal of science is the extension of certified knowledge (Merton 1996; Ziman 2000a). How to conduct research should originate from the scientific community, and research methods have to be accepted by this community to qualify as a scientific research (Jasanoff 2009; Merton 1996; Ravetz 1999, 2006; Sismondo 2008, 2011; Turner 2008; Yearley 2005; Ziman 2000b). For instance, Merton (1996) pointed out that the procedures employed in so-called Mode 1 science have to provide the relevant definition of knowledge, one that is empirically confirmed and consist of logically consistent statements about regularities. Scientific research, according to him, is supposed to be governed by the four sets of institutional norms: communalism, universalism, disinterestedness, originality and scepticism (CUDOS). Although, 'originality' is not on the list of the Mertonian norms, it is included in the modified definition of CUDOS, which, as Ziman (2000b) observes, is most widely used in the contemporary academic debates.

The first norm, communalism (C) requires that the fruits of academic science should be regarded as 'public knowledge' (Ziman 2000a). It covers the practices involved in the communication of research outcomes to other scientists, students, and to the society at large. Science is closely associated with higher education and that academic scientists are concerned with the inadequacy of 'public understanding of science' (Ziman 2000a). The second norm, universality (U) requires that contributions to science should not be exclusive due to social status, religion, nationality, or other irrelevant criteria. The third norm is disinterestedness (D). This norm means that when scientists are presenting their work publicly, they must repress their natural enthusiasm for their own ideas and undertake 'pure' research without commercial applications as motivation (Merton 1996; Ziman 2000a). The norm underpins the philosophical objectivity of academic science. The fourth norm in Mode 1 science is originality (O), which is essential for energising the scientific enterprise (Merton 1996; Ziman 2000a). Lastly the norm organised scepticism (S), permits carefully controlled critical perspective and peer review. This norm, as (Ziman 2000a: 137) points out, "merely stresses the constructive role of refutation as the natural partner of conjecture in the production of reliable knowledge". Thus, the scepticism norm tests the claims of academic science in terms of rational qualities and logical and factual consistency.

The description above indicates that Mode 1 scientific research brings new, reliable knowledge to society, which can be used for policy implementation (Croissant and Smith-Doerr 2008; Gibbons et al. 1994). This knowledge is assumed to flow from scientists to industries or policy-makers as portrayed in Fig. 1, which shows a one-way direction of knowledge flow. However, there is also a reciprocal relationship where society provides funds and general support to the scientific community (Lidskog and Sundqvist 2002). Nevertheless, in Mode 1 science there is a clear demarcation between science and policy-making, and/or between scientists and those who provide funding (Croissant and Smith-Doerr 2008; Gibbons et al. 1994; Ziman 2000a). Thus, in Mode 1, a linear model, with a clear division of labour and sequences or steps, characterises the relationship between science and policy-making (Fig. 1).

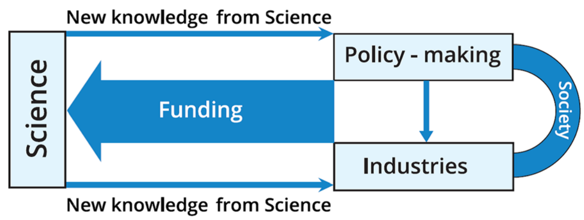

Fig. 1 Relationship between science and policy-making in Mode 1 science

Despite all the arguments for Mode 1 science as portrayed above, the concept of a definite 'traditional scientific method' is now considered highly questionable (Funtowicz and Ravetz 1992; Funtowicz and Ravetz 2015; Lam 2007; Mavi 2014; Styhre and Lind 2010; Weinberg 2005; Ziman 2000a). As Ziman (2000b) points out, most of the "metascientists"[2] will currently say that Mode 1 science generates a body of knowledge 'regulated' by certain general principles. These principles are usually considered quite abstract and 'philosophical'. Such critiques are well known within STS scholars. The linearity and predictability of the research process is the basis for the critiques (Letiche and Lightfoot 2014; Nowotny et al. 2006). Its imaginary autonomous knowing-self ideals, "with basic concepts that are clear and better grounded than is humanly possible", is the reason that called for the analysis as into why Mode 1 science is losing legitimacy in society (Letiche and Lightfoot 2014: 124). As such, notwithstanding the thought that Mode 1 science does provide useful, well-known and reliable new scientific knowledge for policy-making, it is now perceived to be losing its hegemony (Carolan 2006; Funtowicz and J. Ravetz 2003; Nowotny 1999; Styhre and Lind 2010; Ziman 1996) and is transforming into Mode 2 science (modern science) (Gibbons et al. 1994; Wilson 2009).

Mode 2 science

Ziman, calls Mode 2 'post-academic science' (Hessels and Van Lente 2008) or 'post-industrial science (Ziman 2000a). Contrary to Mode 1, in Mode 2 science, the boundary between science and policy-making is fuzzy and more permeable, as both are perceived to be entangled (Barben et al. 2008; Epstein 2008; Irwin 2008; Jasanoff 2004; Latour 2004; Shapin 2008; Ziman 2000a). It denies the need of general rules by which to judge the validity of new ideas, or stable categories into which to place new data (Ziman 1996, 2000a). Mode 2 science includes a broader notion of 'excellence' than Mode 1 science. It favours wide definitions of knowledge and decentred diversity of science (Gibbons 2000; Hessels and Van Lente 2008).

A key aspect of the Mode 2 science idea is that it is contextualised towards the actual problem (in fisheries e.g. towards fish-stock management), and not as universally applicable knowledge as portrayed in the Mode 1 science ideal. In other words, Mode 2 science is problem-oriented, its knowledge is not easily reducible to any of the participating academic disciplines (Kraak 2000). The knowledge is constructed in accord with, for instance, commercial, political or other government and industry interests that underwrite its production (Cole 1992; Funtowicz and Ravetz 1992; Jasanoff 2004; Mavi 2014; Styhre and Lind 2010; Weinberg 2005). Mode 2 science, therefore, is not just a 'new mode of knowledge production' but a formula for a possible new research culture (Jasanoff 2004; Ziman 2000a). It relies on the needs of the society for the construction of the new knowledge (co-production of science and policy) (Jasanoff 2004; Latour 2004; Lidskog and Sundqvist 2002; Styhre and Lind 2010). In Mode 2 the idea of science is first initiated by industry or policy-makers, then the scientists are commissioned to undertake the research, which is useful to the contractors (Wilson 2009). The knowledge produced is then distributed back to the contractor. Therefore, knowledge flow is not linear as in Mode 1 science, but intertwined and circular, as portrayed in Fig. 2. Note that society in this context is reduced to the contractor who is formulating the practical research problem to be addressed and Terms of Reference (ToRs) or rules. Such a model for generating knowledge places emphasis on what happens when scientific advice is driven by the needs of clients rather than the ideas and desires of scientists. As Wilson (2009) notices, scientist and contractors come from different cultures and may therefore have very different ideas of what constitutes adequate science for use in the short term and for broader concerns like ecosystem health in the long term. This can for instance be related to ecosystem-based fisheries management (EAFM).[3]

The networks of communication and collaboration in Mode 2 science are often global, and the researcher does not need to move physically to the central research centre to be part of it. With the new communication technology, scientists from around the world located in government laboratories, charitable foundations, industrial firms, universities work together to solve the problem. Even though this may have wide theoretical implications, the knowledge produced is intrinsically 'local' rather than universal. Similarly to CUDOS, Ziman (2000b) among others has described Mode 2 science as proprietary (P), local (L), authoritarian (A), commissioned (C) and dependent on expert skills (E) at particular problem solving, rather than advancement in the understanding of the natural or social world in general, is what counts as 'good science' (Amsterdamska 2008; Funtowicz and Ravetz 1999, 2003; Irwin 2008); forming the acronym PLACE. It is 'proprietary' as research results are considered as 'intellectual property' and can be withheld from the public, by remaining unpublished, for instance for commercial reasons – this is in contrast to Mode 1 (Ziman 1996). It also means that knowledge produced out of Mode 2 science may lack significant items, which are only known to a selected group of people, such as the employees of a particular industrial organisation (Hong and Walsh 2009; Ziman 2000a).

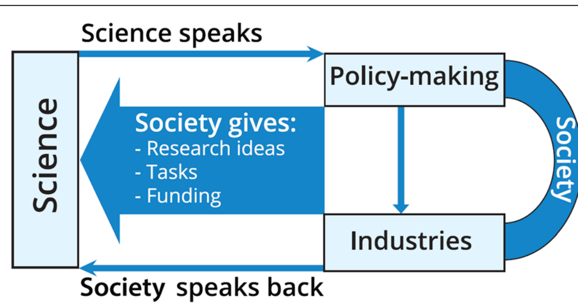

Fig. 2 Relationship between science and policy-making in Mode 2 science

The conflation of scientists and society (producer and consumer) characteristics of Mode 2 science, and the fact that the 'government science policy' (especially in the developed world) tend to support the privatisation of public funded research, commercialise the production of scientific knowledge (Nowotny et al. 2001; Sismondo 2011). With a Mode 2 research, a shift in government commitment, as noticed by Sismondo (2011), has been observed to emphasise markets and private ownership of intellectual property. As such the final outcome and purpose of Mode 2 science is often a 'propertisation' (authoritarian), which have led to a 'commercialisation' of science (Nowotny et al. 2003; Sismondo 2011). Knowledge is therefore patented, as in the case of pharmaceutical research (Sismondo 2008, 2011).

Contrary to Mode 1, Mode 2 science is perceived as cost-effective, since the government and or industry as funders are putting strict financial ceilings on their patronage, and requires value for their money (Ziman 1996). They insist, as a condition, that scientists should become accountable and responsive to their needs and that they should be more directly concerned about the relevance and impact of their research. But more so, perhaps some allowance can be made for the ideas of Mode 2 science, because of its most important element that it is permeated with social interests (Fig. 2), and it is consciously reflexive. Science penetrates society and society penetrates science (Lidskog 2008).

Disregarding the boundaries between disciplines, Mode 2 science often involves multidisciplinary teamwork and inter-institutional networking (Ziman 2000a). Specialists from different disciplines with heterogeneous skills work together. Ideally, their different approaches to the problem give a comprehensive knowledge-base for the advanced solution. The risk, however, is that some of the grounds gained in respective of disciplinary sciences may get lost (Elam and Glimell 2004); what is gained by a broader multidisciplinary approach is lost in disciplinary depth.

Moreover, the problem with Mode 2 science is not the attempt to remove the distance between the society and science. The problem with Mode 2 is the removal of peer review, where scientists, projects and performance are quality-controlled by neutral outsiders who are also scientists and experts in the same field (Hessels and Van Lente 2008; Irwin 2004, 2008).

Although Mode 2 science also incorporates scientific values, another problem is that these values are controlled by interests outside the scientific community (Guggenheim 2006). According to Ziman (2000a: 145), the research quality of Mode 2 science "may be confused with its success in getting funding". The question then is whether or not Mode 2 produced knowledge can be trusted.

Transition from Mode 1 to Mode 2 science

According to the research literature (Dankel et al. 2015; Hackett et al. 2008; Hessels and Van Lente 2008; Jasanoff 1996; Ziman 1996, 2000a) the transition is drawing traditional science into a new sphere of activity, thus undergoing a cultural transformation, which involves radical change of many traditional practices and values. Some of these changes are simply reflecting scientific and technological progress (Ziman 1996, 2000a). This is for instance due to modern technology; communication is becoming increasingly global and more instant, but also makes science more expensive (Evans and Collins 2008; Levinson and Thomas 2013 Chapter 14; Mirowski and Sent 2008; Ziman 1996). What might be happening is that the transition of Mode 1 to Mode 2 is closing the gap between pure science and applied research. Scientific developments are blurring the distinctions between Mode 1 and 2, between fundamental and exploitable discovery. Such a merge not only raises issues of funding, intellectual property rights, disciplinary identity, criteria of excellence, career aspirations, and institutional management, just to mention a few; but also seriously threatens the most central value of academic science (Mode 1), namely, its objectivity (Ziman 1996). Objectivity makes science valuable to society because it gives the public a guarantee of reliable disinterested knowledge. Mode 2 science on the other hand has no place for disinterested practices and objective ideals (Ziman 2000a). As Ziman observes, the scientists will have neither the disinterested behaviour to emulate (cf. Mitroff 1974), nor formal standards of objectivity to live up to. Thus constructive reinforcement, i.e. the merge between science and society, may result into deconstructive decay (Ziman 1996, 2000a). The transition to Mode 2 science may erode the practices that strengthen the objectivity of science and transforms public knowledge into intellectual property. Research will mainly be directed with industrial or political interests (Ziman 2000a). Academic tenure may no longer be protecting researchers from commercial influences incurred by the major research-donors (e.g. industries and politicians). Hence scientists' work will usually deal with matters where social values are highly prioritised, e.g. safety, profitability and efficacy (Funtowicz and Ravetz 2015; Irwin 2008; Jasanoff 2004, 2009; Mavi 2014; Styhre and Lind 2010; Weinberg 2005).

As the distinction becomes more indistinct between science and policy-making, Ziman (1996, 2000a) says that the role of systematic intellectual criticism, which is the key to the validity of academic Mode 1 science, will be downplayed. Assurance for quality justification of science using what Merton called 'organised scepticism' (Cole 1992; Merton 1973, 1996), i.e. peer review, could be lost. Even if peer review may be perceived as the only real mechanism for protection of science against serious errors in the knowledge that is produced, 'experts' technical skills (extension of peer review), as Funtowicz and Ravetz (2003) argue, will eventually take its place for evaluation of 'good scientific knowledge'. But, as Weingart (2011) points out, the lack of demarcation between science and policy-making may encourage science to become aware of the public interest, which is good because it will make the produced knowledge more useful, accepted and productive to society. It may influence the policy-makers to adapt their way of thinking to the produced scientific knowledge. Thus, while politicians will try to influence science for policy development, following the logic of the scientific knowledge, it may also make policy development more science-based (Lidskog 2008).

Source of information

The relevance of Modes 1 and 2 for the field of fisheries science in Europe is drawn using published materials. The conceptual shift from Mode 1 to Mode 2 science is used as a theoretical lens for gaining insights into the consequences and dilemmas of changes in the relations and how they apply to the fisheries sector and ICES. The illustration relies heavily on Wilson's study (2009) of the ICES science community, titled, "*The Paradox of Transparency: science and the ecosystem approach to fisheries* *management in Europe.*" For triangulation purposes, additional information from studies and discussions where the issue of fisheries science in an applied context has been taken up, such as Dankel et al. (2015); European Commission (The EU Framework Programme for Research and Innovation); Griffin (2013); Linke and Jentoft (2014) are also used. The European catch quota management (CQM) trials research with satellite monitoring vessel is another source of information used. Information from Holm's study (2003), and from ICES and Directorate-General for Maritime Affairs and Fisheries (DG MARE) websites also provides insights. Finally, literature within the field of sociology of science and shifting model of knowledge production; including the concept of the role and place of science and technology studies (STS) in modern society, are used for theoretical analysis.

Fisheries management research in Europe

Due to the growing concern over the decline in the number and health of the North Sea stocks in the late 19th century, the International Council for the Exploration of the Sea (ICES) was established in 1902 (ICES website); and ICES remains the world's oldest intergovernmental science organisation. The ICES headquarters are in Copenhagen, Denmark, where its multinational Secretariat staff provides scientific, administrative and secretarial support to the ICES client community (ICES website). ICES has two main functions: one is the general promotion of quality marine science in Europe and the North America region, and particularly in the North Atlantic. The other is to provide specific scientific advice to clients for government decision-making in marine and fisheries management. In other words, ICES is an international organisation that develops science and advice to support the sustainable use of the oceans (ICES website).

In Wilson's study, focus is on ICES as a single organisation and as a research network. ICES responds to demands for policy-making advice, which is formulated based on a broad and varied input from a number of approximately 1600 scientists (ICES website ; Wilson 2009). Most of ICES's scientific advice is related to the Common Fisheries Policy (CFP) (Wilson 2009), i.e. problem-oriented and demand driven.

Until the introduction of Regional Advisory Councils (RACs), (now Advisory Councils (ACs)) as additional stakeholder advisory bodies of the CFP, only ICES researchers to the greatest extent gave scientific advice to policy-makers of the EU fisheries (Linke and Jentoft 2014). RACs were introduced due to the implementation of a policy of stakeholder consultation with regard to the reform package by the European Commission. Before this, there was no formal stakeholder input to the CFP management system, but the linear relationship (direct link; cf. Fig. 1) between scientists and policy-makers (ICES-Commission interaction) played an important role in subsequent progress towards the management system; which is a characteristic of Mode 1 science (Linke and Bruckmeier 2015; Linke and Jentoft 2014).

While the introduction of RACs/ACs portrays a step in the direction of Mode 2, the change in linear science-policy model of ICES-Commission interaction, if any, is a fairly modest one. More so, even though the recent reform of ICES's advisory system could be described as a transformation within fisheries science toward a new type of more applied 'Mode 2 science', it is hard to interpolate that the earlier practice, for instance, under ACFM, ACE, ACME and MCAP[4] conform to Mode 1 ideals. Holm (2003) and

Wilson (2009) point out that fisheries research has always been problem-oriented, which suggest Mode 2 science (in an applied management context).

The ICES advisory system mainly responds to the requests from the member countries, and in Europe the largest client is the European Commission (EC), particularly through the Directorate General of Maritime Affairs and Fisheries (D-G MARE 2011). In addition, ICES also receives advice requests from the government of Norway, the Oslo-Paris (OSPAR) and Helsinki Commission (HELCOM) Regional Seas Conventions (RSC), the North East Atlantic Fisheries Commission (NEAFC), and the North Atlantic Salmon Conservation Organization (NASCO). Like other clients, Directorate General of Maritime Affairs and Fisheries (DG MARE) directs funds to ICES. Most of the science that goes on within ICES is funded through the national marine laboratories of the client states (like Institute of Marine Research in Norway) in relation to the European Union policies. Once the Commission approves the funding, it is up to the national authorities to decide how to use it (ICES website). As such this may imply that the cost of producing the requested scientific advice may not be wholly paid for by the contracting client, as in commissioned research.

Nevertheless, contracting clients, such as DG MARE, commission the research when the funds are channelled through Horizon 2020, i.e. the EU Framework Programme for Research and Innovation (Horizon 2020 website), and this (commissioned research) is a Mode 2 feature. In this case, however, the funding comes with strict rules in order to secure freely sharing of research results and open access, but more so to encourage gender equity in research and innovation. The intension is to promote quality of the scientific knowledge produced, which is much in line with Mode 1. Out of this context, it implies that both Mode 1 and 2 ideals are practiced in fisheries science of Europe. Despite the transformation of fisheries science towards a new context of applied science (Mode 2) in Europe, Mode 1 ideal is still strong within the system and among its scientists.

It should also be noted that besides having the responsibility of directing funds for fisheries research, DG MARE is the Commission department responsible for the implementation of the CFP and of the Integrated Maritime Policy (IMP) (D-G MARE 2011). According to Wilson (2009: 96), "DG MARE's output is proposals to the Council of Ministers for decision-making". This context, as previously analysed, suggest that the same policy-makers (DG MARE) whose idea initiates the research, funds the project, consults the scientific community to conduct the research, has also the power to apply it in policy decision-making. This indeed portrays a Mode 2 science model.

The catch quota management (CQM) trials with satellite monitoring vessels are a good example of EU research projects operating within this model (Mode 2). The research idea for the CQM trial-projects is initiated by the Danish, United Kingdom, Germany and the Netherlands government (Msomphora and Aanesen 2015), in response to the annual assessment of the state of the North Sea cod stock, undertaken by ICES in Copenhagen (Marine Scotland 2011; Needle et al. 2015). Thus the CQM projects are initiated as part of trials to determine the potential efficacy of the EU fisheries policy, i.e. 'a land-all policy' (or discard ban) for North Sea cod (Dalskov et al. 2012; Needle et al. 2015; van Helmond et al. 2012). More so, the CQM trial-projects are funded by the initiators of the research idea, i.e. the European fisheries fund (EFF) and respective governments where the project takes place in Europe

(Dalskov et al. 2012; Marine Scotland 2011; van Helmond et al. 2012). It is also the respective governments that have the responsibility for commissioning the scientific community to do the research (Kindt-Larsen et al. 2011; Msomphora and Aanesen 2015). The explanation of the research model is problem-solving oriented, i.e. discard reduction in EU fisheries, and therefore appealing to policy-makers within the CFP (Needle et al. 2015). This is in other words a Mode 2 characteristic.

Wilson (2009) also notices that the review procedure for quality control in fisheries science with ICES-CFP context can be quite challenging, especially when it comes to the determination of the credibility of the scientific advice produced. In one of the interviews conducted by Wilson, a high-level officer at DG MARE noted (Wilson 2009: 56):

> "I think we in the Commission are very careful before we choose to deviate from scientific advice, but in taking that position we are aware that the quality of advice is very uneven. And that could be for many reasons; it could be that scientists simply haven't been given worthwhile or reliable data on which to make any analysis at all. It could be that the number of people involved in the analysis has been maybe too small to allow the injection of alternative ideas or alternative approach, it could be that ICES itself has not really applied some form of quality control peer review, to make sure that everybody is working to the same standards in terms of quality of data. It may be that scientists aren't being honest enough".

This, Wilson holds, suggests that data for fisheries advice are not available in either adequate quality or quantity to clients such as DG MARE. Hence, the struggle with poor reliability, credibility and quality of scientific knowledge produced for advice. So, what does this imply for fisheries management policy-making?

However, due to the last two reforms of the CFP (in 2002 and 2012 or 2013), where stakeholder participation has been recognised as a key ingredient of good governance, a shift towards even more of Mode 2 science in fisheries research has been noticed (Wilson 2009). The reforms encourage incorporation of all stakeholders, including scientists and non-scientists such as fishers and fish workers, to provide knowledge for policy-making. The idea to involve the stakeholders (fishers), according to Holm (2003: 7), starts from the assumption that fishers' knowledge "about the marine environment can be useful for management purposes". As an amendment to this, Regional Advisory Councils (RACs) based on the five large EU sea areas were established in 2002 (Griffin 2013; Linke and Jentoft 2014).

After the most recent reform of the CFP, which entered into force in January 2014, RACs are now called Advisory Councils (ACs). The Advisory Councils (ACs) provide advice on the management of the fisheries on behalf of stakeholders in order to promote the objectives of the CFP, but also to facilitate a more direct knowledge-exchange between scientists and stakeholders (particularly between those professing scientific and lay knowledge) (Griffin 2013). The scientists often meet in the ACs' meetings but are not formally represented. Groups who are not ACs members are effectively excluded (Griffin 2013). As part of this exclusion, "some member groups are disempowered, while already privileged stakeholders can acquire even greater influence" (Griffin 2013: 113). Additionally to this, the European Commission under a Directorate-General of DG MARE (despite being the receiver of the advice as previously noted) approves the ACs' work (NSAC 2014). Notwithstanding the fact that the forum seeks to involve stakeholders in the fisheries management knowledge production and to be more involved in the decision-making process of fisheries management, "there are tangible and intangible limits to participation in practice" (Griffin 2013: 113). Primarily, however, the introduction of the ACs in fisheries management is in accordance with Mode 2. With the ACs, the fisheries governance system in Europe points to a shift from a traditionally linear relationship between science and policy-making to a more entangled governance system that involves stakeholders beyond scientists and policy-makers (Linke and Bruckmeier 2015; Linke and Jentoft 2014). Nevertheless, this modification is fairly modest, since it mostly gives stakeholders the opportunity to comment on ICES advice, but not involve them in the final decision-making (Griffin 2013).

According to Hatchard and Gray (2003: 6), the introduction of ACs have "not caused a substantive change in the existing power relations between stakeholder groups". The politicians still remain opaque and closed when it comes to the apex of the decision-making process – the Council of Ministers. According to Griffin (2013: 53) the Council of Ministers is a closed shop to stakeholder participation, and the final EU decision-making "are conducted behind the closed doors". Besides, the inclusion of society (stakeholder participation) in fisheries science has not always been favourably met by scientists (Griffin 2013). Reyntjens and Wilson (2004: 5) argue that the "common sense understanding of science, for good reasons, does not include the idea of "participation". Science is supposed to yield objective knowledge, not participatory compromise". Thus, what the divergence from Mode 1 to Mode 2 perception of science has done is not to make the gap between scientists and society disappear, but instead to have built a bridge across which stakeholders' knowledge could at least find its way for contribution to fisheries science. The society (which could be e.g. EU Commission) gets "to suggest the hypothesis, but science reserves for itself the privilege to accept or reject it"; and society's hypothesised idea "is accepted as (valid) knowledge only after science has done its job" (Holm 2003: 13). The question, however, is whether this step towards Mode 2 science, should better be seen as an attempt to keep a foot in Mode 1 science ideals under the disguise of Mode 2 science oratory.

Whether bringing together different types of actors and mixing knowledge is a real step towards stakeholder empowerment in the processes of knowledge production – only time will tell. The introduction of the ACs changes the perspectives from formal power relations to more encompassing knowledge practices (Linke and Bruckmeier 2015), and hence, the beginning of a governance structure for organising interested parties. The involvement of ACs in the system suggests that the new CFP's reform is moving the fisheries management in Europe to a more responsive direction, towards Mode 2 science. But, before we conclude that ACs developments assure stakeholder participation in knowledge production for policy-making within the context of science-based management, problems regarding representation, deliberation, decision-making authority and delegation of power need to be addressed (Linke and Bruckmeier 2015; Linke and Jentoft 2014; Msomphora 2015).

With the ICES-CFP context, Wilson (2009) points out that the research data for scientific advice has never been open to the external scientific community or stakeholders, and so it has not been easy for the society to scrutinise the research-basis for policy-making

(Wilson 2009). However, data management in fisheries is a complex problem, and is not easily analysable in either a Mode 1 or Mode 2 science scheme. If anything, recent efforts in response to the reform of the CFP has made data production and availability more transparent, which I would think is in line with Mode 1 ideals. In March 2008 a new version of the ICES's Data Collection Regulation (DCR) was adopted, which is intended to prepare the system for the EAFM (Wilson 2009). However, as noticed by Wilson (2009: 99) "the current legislation does not allow the Commission department responsible for the implementation of the CFP and of the Integrated Maritime Policy to have its own database, and they are only allowed to use data for 20 days". Thus, the data provided to, and commissioned by, the Commission is not available to anyone after this period. Besides, Wilson (2009: 99) also observes that some ICES member states involved in conducting catch quota management (CQM) research-projects "specifically bar scientists from access to data from the vessel monitoring system (VMS) satellite tracking". Hence, fisheries data in Europe still raise questions about confidentiality, control and transparency for quality assurance.

As outlined in chapter 4 of Wilson's study, scientists are given a set of Terms of Reference (ToRs) based on client's requests that dictates the research questions to be addressed, whereas the task of developing the ToRs is assigned to expert groups of scientists, who are nominated by national delegates (ICES website). Hence, he holds that assurance for quality control in the ICES system is problematic. In this way the general rules of science by which to judge the validity of new ideas may easily get lost (Ziman 1996, 2000a).

With such a linkage between science and policy-making, it may not be wrong to assume that there is a danger that the policy-makers might just need the scientific justification to legitimise their problem idea, e.g. of how the fisheries should be managed, for instance, in order to reduce discards. DG MARE, in commissioning the research, could easily influence how or what knowledge to publicise and what not to, as advice for managing the fisheries in Europe. For example, Wilson (2009: 229) observes that "research has been placed on the ICES web page that in the eyes of many members of the public was inconsistent with what the official ACFM advice has said about cod" (ACFM means Advisory Committee on Fisheries Management).

According to Wilson (2009), many scientists participate in ICES because they are assigned to do so by their constituent (nominated by national delegates), even when sometimes referring to themselves as volunteers. Mobilising scientists' expertise is a real challenge, "and the attitudes of the constituent scientists make up an important part of the political environment of ICES" (Wilson 2009: 95).

Dankel et al. (2015) report that, in the ICES system, the same individual can take on multiple roles in producing scientific knowledge for policy-making (CFP reform). The same individuals could have the tasks as developers, reviewers, judges, and messengers in arenas where management plans are produced and evaluated (Dankel et al. 2015). The ambiguity with such a system of producing knowledge relates to Mode 2 science as its accountability is internalised, and self-organised to a degree of self-auditing (Gibbons 2000; Ziman 2000b). The potential concern in this context, is that fisheries science could be perceived as not being transparent to allow for criticism (Dankel et al. 2015; Lidskog 2008).

In Mode 2 science critical standards of peer review for quality-control of scientific knowledge produced is replaced with 'extended' peer-review,[5] where it is difficult for neutral outsiders (who are also science experts of the field) to evaluate the work (Hessels and Van Lente 2008; Irwin 2004, 2008). If this is indeed the truth, how can transparency and scientific credibility be ensured when scientists get involved in processes where they evaluate their own work? As Dankel et al. (2015) argues, the more the participatory approach in policy-relevant science becomes, the more the roles and work tasks of scientists becomes multifaceted; and stakeholder participation in science is a characteristic of Mode 2 science (Hackett et al. 2008). So, as we shall see in the Discussion Section, the main question is: What could the shift to more of Mode 2 ideas of science imply for policy-making in fisheries management?

Discussion

Fisheries management in Europe, with ICES in a pivotal role, illustrates that fisheries science is becoming even more remote from Mode 1 science. Fisheries research as a regulatory science is transforming towards a new kind of more applied 'Mode 2' ideals of science as described in Science and Technology Studies (STS). According to Amsterdamska (2008: 206) the shift from Mode 1 to Mode 2 science changes the focus of interest to answering "questions about the use of instruments or ideas in a particular location and situation rather than universal knowledge, in production and intervention rather than representation, and in science as a mode of working and doing things in and to the world rather than as a system of propositions arranged into theories". This description of Mode 2 science is reasonable for the way the European fisheries science has been practiced. In fact with Mode 2 there is no longer academic-freedom in research, but as demonstrated above, science is produced within the framework of client's requests (Dankel et al. 2015; Wilson 2009). As Etzkowitz and Webster (1995) notice, Mode 2 science increases 'capitalisation of knowledge'[6] across science as a whole; although it is argued that this issue is no more than an extension of Mode 1. The transition to Mode 2 signals the implication that scientists no longer unproblematically associate with their specialties and disciplines, but instead engage in a variety of interactions with a heterogeneous group of actors, from individuals to policy-makers to funding agencies (Hackett et al. 2008; Ziman 2000a). Therefore, as Edwards and Wajcman (2005) argue, such issues have implications not only for participation in decision-making processes, but also for the quality of knowledge produced and its justification, public access to produced information (Hilgartner 1998), or greater secrecy (Wright and Wallace 2000), and for the structure of authority in producing scientific knowledge.

Through the practical lens of the ICES performance and its scientific advisory system, we can see what Mode 2 of knowledge production in policy-making for fisheries management science could mean in practice. The empirical description of the case study above, which bases its analysis on Wilson's study (2009), illustrates that "many of the trends described by the Mode Two approach are present in fisheries science as it is carried out in Europe," (cf. Wilson 2009: 46), which, "makes ICES one of the earliest precursors of Mode Two science" (Wilson (2009: 108). Through Dankel et al. (2015); Hackett et al. (2008); Holm (2003) and Wilson (2009), it becomes even clearer that Mode 2 research can indeed be characterised with Ziman's acronym PLACE. However, given that ICES has for a long time (if not always) responded to its clients request, and has increasingly done so from the 1950s and 1960s onwards in response to the growing management ambitions of governments (Gezelius et al. 2010; ICES website); is the conceptualised shift from Mode 1 to Mode 2 ideals really relevant for fisheries science?

Fisheries resource management has been built on the ideals of Mode 1 science (Holm 2003), and considering ICES's current openness and transparency in a number of its functions in subsequent progress towards CFP reforms (ICES website), fishery science, as applied for management purposes, seems to be undergoing a transformation in the way the knowledge production takes place. This, therefore, portrays that the conceptual shift between the two models represents a relevant opportunity for exploring the role of science in an applied context of the EU fisheries.

Research for policy-making in fisheries management in Europe has become more and more of Mode 2, as Wilson (2009: 29) point out, when he refers to the science input (scientific advice) as a means of satisfying what Holm and Nielsen (2004) terms the TAC machinery of decision-making, which is mainly based on stock assessment models that are developed to solve the problem of "apportioning the fish among the various polities and stakeholders" rather than maintaining stocks of fish. This, Wilson (2009: 269) argues, "suggests a perversion of science born from an over-sized, tightly coupled, decision-making system that could never, in its current form, carry out an EAFM" (EAFM means Ecosystem Approach to Fisheries Management).

As the previous analysis suggests, the ICES procedure for advice focuses mainly on responding to the imperative short-term settings rather than on long-term basis (Wilson 2009). The response is based on the clients' request rather than the desire of scientist; and in Europe the largest fisheries client is European commission through DG MARE. As clients could have different understanding from that of scientists in terms of what constitutes adequate science in short-term and in a long-term with an EAFM strategy, and since the advice system is mainly confined to a narrow single-species focus overtaken by an atomistic conceptualisation of the precautionary approach driven by the single-species advisory needs of the TAC Machine (Holm and Nielsen 2004; Wilson 2009); Mode 2 science in the current EU fisheries management system may not be able to produce the scientific advice needed to satisfy client requests about ecosystem based management, as Wilson holds. With the current form of Mode 2 science, "both long-term management plans and the EAFM present new and extremely complex problems for scientific advice; the TAC Machine will soon be as politically inadequate as it is environmentally inadequate. How it can be changed, and what it can be changed into, is the challenge that European marine scientists are trying to meet" (Wilson 2009: 30).

With focus on fisheries research in Europe, specifically on how scientific knowledge is produced for management advice, the research could be generally perceived to be 'commissioned, while the knowledge produced as 'proprietary' and intrinsically 'local' (problem-oriented) rather than universal despite having the implications of being multinational and interdisciplinary. The perceived method for knowledge-assessment as Mode 2 sciences may mean that risk-assessment in the research output for decision-making in marine and fisheries management of Europe may not meet standards of scientific plausibility and technical adequacy (Dankel et al. 2015; Wilson 2009). It could be that the research results are not really evaluated according to the formal scientific control standards, i.e. the carefully controlled critical assessment that an independent and neutral peer review system provides; since the data, as Wilson (2009) holds, is not publically available and not open for inspection by researchers external to the advisory system. But more so, as identified in Dankel et al. (2015), individuals within ICES, could have multiple roles and or tasks in producing scientific advice where management plans are produced and evaluated for policy-making (CFP reform). Such a process of producing scientific advice has transparency problems (Hackett et al. 2008). Generally, lack of transparency and secrecy of research data shows to be an increasing trend in commissioned research (Mode 2 research), (Hong and Walsh 2009), as portrayed through the context of ICES-CFP research.

Additionally to this, Wilson (2009: 269) argues that “research projects organised around time sheet and project deliverables that are subject to limited peer review are increasingly important”. This has become common even in the traditional scientific community also outside fisheries (Guggenheim 2006; Wilson 2009).

All these alterations makes fisheries science, as applied for management purposes, to be more remote from academic research practice. This remoteness of fisheries science from Mode 1 science, as portrayed by Wouters et al. (2008), will create profound changes throughout the entire system of scholarly communication and/or knowledge production. A failure to put into place effective new support structures or resolutions in response to these changes would pose tremendous risk to the enterprise of research and scholarship. It will put science at stake especially when considering how to qualitatively lead our institutions in addressing these new needs of science in the context of the described conceptual shift from Mode 1 (traditional academic science) to Mode 2 (modern post-academic) science (Goldenberg-Hart 2004). Therefore, a failure to address such issues with regards to secrecy, peer review and commissioned research could result into reducing the quality assurance of the produced knowledge and hence the legitimacy of science. It could undermine the assurance that all researchers work is according to the same quality standards with regards to reliability and trust-worthiness of research-outcomes.

The entanglement of science and policy-making, which is a characteristic of Mode 2, can be traced in the EU fisheries institutional system, as described above, and Wilson (2009) also discusses this at length. The driving force here is that society is learning to speak back to science (Fig. 2). Science is being transformed due to the demands that science should respond to specific societal problems and contexts where innovations require trans-disciplinary effort (Wilson 2009). The consideration of societal interest is central, otherwise a project may risk not being financed (Wilson 2009). It is possible that the scientist may choose the research methods that will orient the outcomes to meet the expectations of policy-makers or funders (Wilson 2009). These are also real dilemmas for research aimed at improving the CFP in Europe.

According to Wilson (2009), reliability in Mode 2 sciences has been redefined as what works, such that fisheries science is shifting from a search for truth to a more pragmatic aim of providing an empirical understanding of the world that functions in a practical sense or may be put to work. This reinforces Mode 2 science to move away from the search for general knowledge driven by curiosity and a felt need to understand basic processes in nature and society, to answering specific practical question on demand (Guston 2001). Thus, there is a possibility that Mode 2 research could be pre-defined by the contracting clients, for instance, DG MARE as the commissioning client in Horizon 2020 projects. Given the stakes as commissioning clients, there is a risk that answers could be already ordered from the beginning, especially where the research is meant to legitimise political decisions already made (Georghiou et al. 2009; Wilson 2009). All such issues are sources of challenges concerning the reliability, trustfulness, credibility, and proper quality assurance for the scientific findings used for advice in fisheries management of Europe and elsewhere. The direction to take in the creation of the new knowledge in Mode 2 science may strongly be influenced by the interests of policy-makers, e.g. what has proven useful to them in the past (Wilson 2009). The question is why transparency and a carefully designed peer review system as demanded in Mode 1 science should be replaced with multidisciplinary expert-skills and society or stakeholders.

Mode 1 science is not perfect either. Despite the rule of data sharing in Mode 1 science, withholding of data still happens (Committee on Science et al. 1995; Savage and Vickers 2009). Data may be withheld for legitimate reasons like anonymity, and this can be the case in either Mode 1 or 2. It may so happen also that in Mode 1 science, the status of the scientists involved may dictate the quality of knowledge produced, and this can be problematic. In fact Sulkunen (2013) has argued that Mode 1 science is not accountable at all in practical terms, such as outcomes in welfare or impact on policy effectiveness. But do we necessarily need to abandon all the values and principles of Mode 1 for Mode 2 science, even if there may be flaws associated with Mode 1? If not, can we maintain in Mode 2 science what is good in Mode 1 science, and vice versa?

Nevertheless, with unclear distinction between science and policy-making in Mode 2 science, policy-makers are in an operation-mode which fits ill with the needs of the knowledge economy (Gibbons 2000). They are becoming more of facilitators of research rather than keeping their primary function as funders responding to research initiatives and findings emerging within the academic community. Therefore, the approach in Mode 2 science makes measurement of the effectiveness of the contribution of research to policy-making difficult to be accepted within the traditional scientific community (university institutions). But what may be required, as Gibbons (2000: 47) points out, "are not policies which aim to orient research in a means-end relationship with same social objective, but rather policies which promote the generation of a range of contexts of application, that draw on the resources of the socially distributed knowledge production system, and that take advantage of the self-organising nature of Mode 2 research". Contracting clients, e.g. policy-makers and government agencies or industries or private organisations should, according to this view, act more as brokers than fenders, despite the fact that some level of public funding may still be vital (Gibbons 2000). Contracting clients may set the structure that can ensure quality, but not take on the burden of performing assessments themselves. So, basically the transformation of science from Mode 1 to Mode 2 science does not necessarily mean that it is a bad move. The good thing with Mode 2 science (just as in the current reformed fisheries science in Europe) is that it allows a wide range of stakeholder representatives to take part in knowledge production, which is a step towards a more democratic and transparent system.

Stakeholder involvement in the research arena results in transaction costs where findings are disputed and researchers must spend more time and effort in explaining their research methodology to stakeholders that are research illiterate (Wilson 2009). This may create substantial amount of conflicts. But conflicts, according to Coser (1956), may serve as an interaction arena for creation and modification of measures, as well as the development of new institutional network to facilitate information exchange and transparency in the management process, while enhancing compliance to the measures.

Perhaps, therefore, the solution to the conceptual shift could be something in-between the two ideal Modes, as a 'Mode 1.5 science' so to speak, with the ethos of science acronym: CULAVS. This ideally implies that science should be 1) communal (C) where the fruits of the scientific research should be regarded as 'public knowledge'; knowledge produced should be both, 2) universal (U) implying that scientific propositions should be general enough to apply in any cultural context, and 3) also local, i.e. should also be open to problem solving-oriented research (L), especially when it comes to welfare development or impact on policy effectiveness. Besides, 4) there should be academic-freedom in research (A), where scientists are self-winding in the choice of research problems and techniques and can still be inspired by their own curiosity. However, since research requires resources for it to be conducted, researches should become more accountable and responsible for quality and impact of their work, hence 5) assurance of value for money (V). To achieve this, funding must be provided from the society at large, i.e. government and thus a good reason for making such intellectual knowledge produced, 'open access'. To allow for 6) scepticism (S), research should be transparent, meaning that secrecy should be avoided in order to permit carefully controlled critical analysis of the knowledge produced. This is not just a matter of principle but also a means through which the quality of research is enhanced. Good science needs to allow criticism, so that the decision, e.g. for policy-making in fisheries management is based on rational quality, that is logical and have factual consistency, but also less based on economic or political elite definitions and priorities. Hence, the knowledge produced can actually be of value to the society, thereby improving the policy-making, also in fisheries management, while avoiding private biases and the dilution of science values and standards.

Concluding remarks

If reliability in Mode 2 science is really reduced to what works then it means that science is shifting from 'searching the truth' to a more problem-solving oriented-research. A critical question for Mode 2 science in fisheries and more generally is, therefore, whether it serves certain political interests and agendas. The move from Mode 1 to Mode 2 science makes the contribution of research to policy-making difficult to be accepted within the traditional scientific community because it easily breaks with established standards and perceptions about what science is and what it is for. It may also jeopardise the standing of research within the general public.

This does not necessarily mean that all in CUDOS is perfect and that a transformation within fisheries research in Europe to more of PLACE is all bad. Mode 1 and Mode 2 science both have their problems with transparency. Whereas Mode 1 has a tendency of retreating to the 'Ivory Tower', denying the public to really know of what is going on there, Mode 2 while compensating for that, has a problem of becoming exclusive to the contractors, i.e. those who can pay for it. As such the challenge is to maintain what is good about

Mode 1 to Mode 2 in order to benefit from the strength of both while avoiding their respective weaknesses.

To avoid the dilution and de-legitimisation of science, including fisheries science in the European context, peer review should remain important even within a Mode 2 system of stakeholder inclusion. As a principle, the research that is in the public interest should be publicly exposed and funded. If, for instance, the tax payer is funding the projects, then the tax payer should have the right to know how money is spent and what comes out of it. The ambiguity in Mode 2 science is that it is not transparent enough to facilitate criticism and public scrutiny. Instead, the production of knowledge could be easily embodied with political commitment of special interest. Hence, the loss of assurance for quality control (peer review) of knowledge produced, even with the best commissioned research. So, if this is the case, how can we be involved in Mode 2 without scrapping Mode 1 scientific values, procedures and standards?

Currently evidence shows that policy-makers and scientists keep working together in research where the former raises the research ideas and funds it while the latter conduct the research reactively. Researchers want their work to be valued by the society and they are in need of funding, while the policy-makers are interested to know what works for their agenda and what does not. But is this where academic institutions really want to go? While trying to answer this question, we should keep in mind that Mode 1 and Mode 2 science, as initially mentioned, are 'ideal types' of science, which allow the author to demonstrate the implications of Mode 2 knowledge production for policy-making in fisheries management. In reality the Modes are always more mixed, and not that distinctive as what Mode 1 and 2 suggest. This is also the case with ICES-CFP context of management science. The important issue herein is that the role of science, even in policy-making research, must not be diluted if the produced knowledge should remain reliable, credible, and trustworthy. Somehow, the solution to the dilemma rests in what the present paper labels CULAVS, which seeks a middle ground between Mode 1 and 2 science. By so doing, we may secure that the produced knowledge will be of value to the users and lead to policies that are more evidence-based, without compromising the ethos of science as an institution, be it within fisheries or in other sectors of society.

Endnotes

[1]Commissioned research means research, the costs of which are wholly paid for by the contracting clients. It is also the contracting client who defines (to a greater or lesser extent) the issue to be addressed, the research questions, the methods, and the form of reporting. Usually the research is carried out in response to the client's need for information or in pursuit of the client's own agenda. The research results and intellectual property will be transferred under the ownership of the contracting client in accordance with the research agreement (Dyson; Lappeenranta University of Technolgy website).

[2]Metascientists herein, as adopted from Ziman (2000b: 3), include: "philosophers, sociologists, political scientist, economists, anthropologist and other scholars who study science as a human activity"

[3]Managing fisheries with an environmental management system approach "that recognizes the full array of interactions within a marine ecosystem, including humans,

rather than considering single issues, species, or ecosystem services in isolation" (Katsanevakis et al. 2011: 808).

[4]There is a difference in the ICES's advisory system before and after the changes that began, especially, in January 2008. The major difference is the creation of a single advisory committee (ACOM) in place of what had been the Management Committee for the Advisory Programme (MCAP) and the three previous advisory committees: the Advisory Committee for Fisheries Management (ACFM), the Advisory Committee for Ecosystems (ACE) and the Advisory Committee for the Marine Environment (ACME) (Wilson 2009). The current restructuring of ICES system happened because of the ascendance of ecosystem considerations (Griffith 2003; Wilson 2009).

[5]Extended peer review is the involvement of non-scientific actors in the quality assurance processes of knowledge production and assessment for policy making and risk management, as a response to the need to extend the assessment of relevant knowledge to those who contribute to its co-production, outside the boundaries of disciplinary science (Hessels and Van Lente 2008; Pereira and Funtowicz 2005). It is meant to involve all those with a desire to participate in the resolution of the issues (Pereira and Funtowicz 2005). According to Wilson (2009: 49), the idea of the extended peer review "is close to, but not synonymous with, stakeholder involvement in science". Accredited 'science experts' need the assistance of the extended community to addresses the problem that the traditional mechanisms for assuring quality (peer review) are not adequate (Wilson 2009). Nevertheless, Funtowicz and Ravetz (1990, 2003) notice that if extended peer review can be conducted systematically, it could lead to more reliable or applicable results than a peer review process conducted purely by academics.

[6]Capitalisation of knowledge is the awarding of research outcomes with economic values. Owen-Smith (2001) argues that the awarding of 'public research' dollars imperfectly map onto achievements in patenting. Capitalisation of knowledge is usually done through legally granting the knowledge produced (intellect) with Intellectual Property Rights. The term 'Intellectual Property Rights' refers to the legal rights granted with the aim to protect the creations of the intellect. These rights include Industrial Property Rights (e.g. patents, industrial designs and trademarks) and Copyright (right of the author or creator) and Related Rights (rights of the performers, producers and broadcasting organisations). According to Etzkowitz (1997: 141), "the advancement of knowledge was formerly primarily the concern of the university, whereas capitalisation of knowledge was the concern of industry. However, the growing interest of the university and its faculty members, often encouraged by government policies, in reaping capital from knowledge is moving academic institutions closer in spirit to the corporation, a type of organisation whose interest in knowledge has always been closely tied to economic utility".

Competing interests

The author declare that she has no competing interests.

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