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Improving communication from managers to fishers in Europe and the US

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Communication problems need to be solved if managers are to be more persuasive about the need for limitations on fishing, to protect and restore fish populations. The context is widespread scepticism about the effectiveness of management on both sides of the Atlantic. That scepticism is fuelled by assessment bias as seen in the case of the northern cod of Newfoundland, and by failure to take into account differences in perceptions of stock size and fishing mortality; differences in causal reasoning about fishing pressure and environmental factors influencing stock size; and differences in the capacity to read and understand the mostly graphic information that underlies and is often used to explain management decisions. This analysis is based on interviews and observations in the European Union and the northeastern USA.

Keywords: bias, causal reasoning, cod, Georges Bank, graphic displays, Gulf of Maine, North Sea, perceptions, plaice, time-series, uncertainty.

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Introduction

In many areas, fisheries management authorities appear to do little to improve the communication of the scientific basis of management to representatives of fishing industries and the fishers. In essence science has the role of providing managers with advice based on highly technical calculations. However, science is increasingly being invited not only to explain developments in stock size and in fishing mortality, but also to explain the rationale of management objectives and measures (Bryant and Huppert, 2006), and in doing so, to reach out to stakeholders. This challenge requires greater attention to distinguishing the roles of managers from scientists and to effective communication, well understood as one of the ways of bridging gaps between science and policy-making (Guston, 2001).

Our starting point is the decline in catches in many fisheries since around 1980, which made it necessary to communicate the need for stock recovery plans based on decreased fishing pressure. We sketch the organizational setting of management in European and US waters of the Atlantic Ocean, where stakeholder participation is involved, then focus on three major constraints on communication between managers and fishers: (i) differences in perception of patterns in stock size and fishing pressure; (ii) differences in causal reasoning about how stock size is affected by fishing pressure; and (iii) differences in the ability to read and interpret the graphic displays of stock assessments that accompany scientific advice. We document and discuss these constraints, and suggest ways for improvement, drawing from experiences with the use of management information in Europe and the USA.

Our analysis builds on discussions at the ICES Working Group on Fisheries Systems, on interviews with stakeholders held within the EU research programme "Policy and Knowledge in Fisheries Management" (Schwach *et al.*, 2007), and the US research programme "Experience-based Knowledge in a Science Policy Context" (McCay *et al.*, 2007), as well as on experiences with communications on the flatfish fishery in the Dutch F-project (ICES, 2003; Johnson and van Densen, 2007). The examples are taken from major sea fisheries in Europe, the USA, and Canada, focusing particularly on cod (*Gadus morhua*) and plaice (*Pleuronectes platessa*) fisheries.

Organizational setting

Stakeholder involvement in the management process has become a formal ingredient of the EU Common Fisheries Policy (CFP) and the US Magnuson–Stevens Fisheries Management Act, but this began earlier in the USA than in Europe. Although the structure of science-based management with its assessment groups and reviews, biological advice, and decision-making is much the same, public review is more important in the USA, where fishers participate as citizens in assessment groups and in formulating advice. Management focuses more on input regulation, and measures are mostly taken for longer periods than just one year ahead, as in Europe.

Europe

The annual assessments of stock status by ICES Working Groups are based primarily on landings statistics and national market sampling programmes with additional information derived from

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research vessel surveys. They are performed to infer the development of the stock in the near future for a range of catch options in the coming year (Reeves and Pastoors, 2007). Since 2002, the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK; responsible for the assessment of cod in the area, among other things) meets with representatives of the fishing industry and independent scientific reviewers to discuss the results, after its meeting. The fishing industry comments on and questions observed trends in stock size, specifically when they perceive that the trends presented differ from their own observations based on their catch rates.

Subsequently, the results of all working groups are used by the ICES Advisory Committee on Fisheries Management (ACFM) to formulate its management advice about catch options considered sustainable and given possible objectives by species agreed by the EU and other countries involved in the exploitation. The report serves a wider public and is downloadable from the ICES website. Since 2005, some stakeholders have been invited to attend ACFM meetings as observers.

The biological advice is reviewed by the Commission of the European Communities (CEC), one of ICES' major clients, through its Scientific, Technical and Economic Committee for Fisheries (STECF). In the course of the process of reviewing and preparing for EU decisions on total allowable catches (TACs), stakeholders are consulted. Since 2004, representatives of stakeholders have met formally in EU-initiated Regional Advisory Committee (RAC) meetings, which can be attended by administrators from both the EU and member states at their own initiative; scientists provide information on request. A main task of RACs is to discuss management strategies rather than short-term tactical issues. Ultimately, all decisions are taken by the Council of Ministers, within the legislative framework provided by the CFP, and after negotiating measures for shared stocks with non-EU countries.

United States

In the USA, the process for federal waters fisheries (3–200 nautical miles from the coast) is more participatory. It is governed by several laws, especially the Magnuson–Stevens Fisheries and Conservation Management Act (MSFCMA) of 1976, as subsequently revised (Buck, 1996; http://www.nmfs.noaa.gov). The MSFCMA established regional fishery management councils that include members of the public and provide opportunities for public participation and review. The councils work with the National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA), a federal agency, to plan and implement fishery management plans (FMPs). Our analysis is based on experience in the northeastern USA, which involves the New England Fishery Management Council (NEFMC) and the Mid-Atlantic Fishery Management Council.

The scientific basis for decision-making in our area of interest comes mainly from the Northeast Fisheries Science Center of NMFS. Center scientists produce information on stock status that is developed in stock assessment workshops and is peer reviewed by the Stock Assessment Review Committee. Since 2002, a biannual Groundfish Assessment Review Meeting has provided assessment updates (NOAA, 2005). Members are federal agency scientists, as well as academic, state agency, and independent scientists. Stakeholders participate directly in these workshops and review committees, as well as in the fishery management councils (McCay and Creed, 1999).

The assessments are considered by NEFMC through Plan Development Teams consisting of scientists, managers, and other experts, as well as a Monitoring Committee and an Advisory Panel of stakeholders. The NEFMC is composed of federal and state government representatives and private citizens representing various interests. It is responsible for a long-standing northeast multispecies FMP, as the framework for management rules including target TACs and effort limitations (i.e. limits on days at sea per vessel), as well as closed areas and other measures. When the assessment advice is unclear or disputed, the NEFMC may ask its Scientific and Statistical Committee to deal with it, whereas aspects of the social and economic impact assessments required are handled by its Social Sciences Advisory Committee. Ultimately, the NEFMC provides its recommendations within legal and administrative constraints, including a full public review process, to the NMFS Regional Administrator. The recommendations may be subject to further review and public comment before they become rules, implemented and enforced by NMFS.

Falling catches as a mindset

Regardless of the topic discussed by managers and fishers in the North Atlantic, the example of northern cod lurks in the background. In the early 1990s, total landings of Atlantic cod in Canada decreased by more than an order of magnitude, and there has been no stock recovery despite most commercial fishing ending in 1992 (Figure 1). This "tragedy of the commons" has reached the public arena and is still widely discussed, also in Europe. The message propagated by television and documentary films, however, is not always the same: did science fail to monitor the cod stock properly; was it mere overexploitation by an ever-expanding fishery; or have ecosystem changes created the problem and/or prevented restoration (Walters and Maguire, 1996; Finlayson and McCay, 1998). Many fishers in Europe interpret the recovery failure, despite a moratorium, as evidence that overexploitation has not been the main cause of the collapse. They reason from this case that reducing fishing pressure is not a promise of stock recovery.

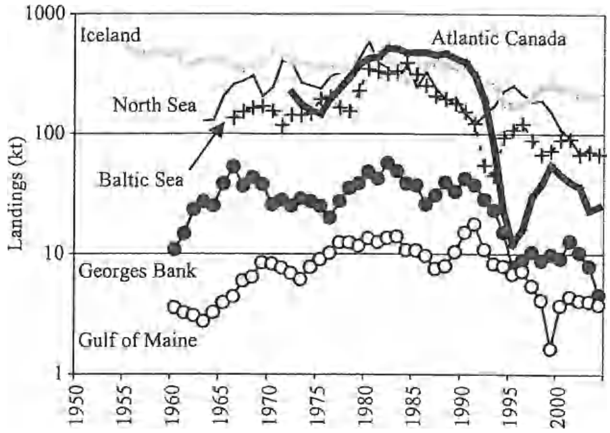

Figure 1. Cod landings from the Atlantic (European data from ICES, 2005b; US data from NOAA, 2005; Canadian data from http://www.dfo-mpo.gc.ca).

Around 1980, the cod fisheries in the North Sea, the Baltic Sea, and the sea around Iceland all produced yields similar to those in the Canadian Atlantic: around 500 000 t per year (Figure 1). They have all decreased markedly since then, as did cod landings from Georges Bank and the Gulf of Maine. Major flatfish fisheries are no better. Since 1980, landings of North Sea plaice have declined by 50%; landings of American plaice (*Hippoglossoides platessoides*) and winter flounder (*Pseudopleuronectes americanus*) from the Gulf of Maine have declined by 80%.

The concurrent fall in landings by up to an order of magnitude has influenced the mindset of fishers, who have become sceptical about accepting catch reductions with the promise of stock recovery. They, as well as the public and the politicians, demand more complete explanation of the impact of their fisheries relative to the effects of the broader environment (Delaney *et al.*, 2007).

Communication problems

The relevance, credibility, and legitimacy of science-based arguments for fisheries regulation depend, in part, on the distribution of power and authority and other aspects of the political and institutional framework (Alcock, 2004). Science-based arguments are further undermined by basic communication problems, the focus of our study. We examine three problems: differences in perceptions of stock size and fishing mortality as indicators of state and pressure; differences in causal reasoning on whether and how fishing pressure affects stock size; and differences in the capacity to understand risk and the (mostly graphic) information that underlies, and is used to explain, management decisions.

Differences in perception

Differences in perception originate in differences in the information environment in which the three main groups involved (scientists, managers, and fishers) operate, and from differences in the aggregation level of the information on stock size and fishing pressure reaching them. Miscommunication about developments in stock size and fishing pressure is aggravated further by annual adjustments to previous stock estimates, inherent in the model used, and to substantial bias in some estimates.

Aggregated information vs. individual experience

For the state of the stock, scientists and managers focus on the present biomass, as a figure aggregated over the whole resource area. Managers compare this stock size with some reference value. This value is either a limit value such as the precautionary level of spawning-stock biomass (SSB) in the case of the risk-averse management strategy of the EU, or a target value such as the biomass providing maximum sustainable yield (B_{MSY}) in the case of the target-orientated management strategy of the USA.

As for exploitation pressure, management evaluates annual estimates of fishing mortality (F) relative to agreed limits or target values. The focus is not on effort measures for the fleets, but on their ultimate effect on the stock. F is defined as an annual constant, but this concept is not broadly understood, even by students of the dynamics of exploited fish stocks (Ricker, 1975, p. 9). Its value as a public monitoring variable is further called into question by its non-generic calculation as an arithmetic mean of mortalities estimated by age group. Not all age groups are necessarily fully recruited to the fishery, and their abundance may be underestimated because discards have not been included in the analysis.

Fishers' experience is mostly area-specific and provides disaggregated information on changes in stock size over smaller time intervals and resource areas, which may not match developments in the total stock seen by scientists. Fishers appear not to sense that aggregated stock size at some point is a useful absolute figure, as managers do. They follow developments in stock size indirectly from their catch rates, knowing that they may vary through all kinds of environmental circumstances and through aggregations on the smaller spatial scales. Moreover, their evaluation of their own catch-rate series is constrained by limited facilities for turning logbook data into useful information.

The spatio-temporal variability in resource abundance experienced by fishers can easily lead to different perceptions of stock dynamics among the mostly nation-, area-, and gear-specific fisheries. For example, the North Sea cod stock is known for its large spatio-temporal variability, as are the fisheries targeting cod known for their local specificity (ICES, 2006).

Fishing mortality is difficult for fishers to sense, but changes in size composition over time provide a clue, although variations in year-class strength may partly obscure temporal trends. The northern cod case provides an example of how fishers became alarmed by a decrease in the average size of cod landed, while scientific monitoring was failing to detect that the stock was under fatal pressure (Steele *et al.*, 1992; Martin, 1995). Fishers may also generate more direct perceptions of changes in fishing pressure based on fleet changes (number of boats, total engine power), as well as from their own investment in engine power, gear, and fishing time. Overall, however, visual impressions and personal experience relate poorly to statistics on fleet capacity. Clear displays of actual changes and trends in fleet size, fishing power, and effort applied might support trends in fishing mortality, but, ironically, fisheries statistics often fail to document these crucial variables (ICES, 2005a). Therefore, fishers often have to rely on their memory and intuitive judgement, which suffer from inherent bias (Gilovich *et al.*, 2002).

Communication is therefore asymmetrical. Fishers start from personal and specific experiences regarding the state of the stock and fishing pressure, and then are confronted with aggregated graphic information on related but more abstract parameters. Managers, in contrast, focus on the spatially and annually aggregated information provided by scientists, and then are confronted with individual and conflicting experiences of fishers.

Adjusting history

Annual adjustments in time-series of fisheries data are inherent in the models used and provide a major challenge for effective communication. Changes in the historical series for fishing mortality may originate in changes in methods or assumptions in successive assessments (Figure 2a; Reeves and Pastoors, 2007), or just from the progressive build-up of more complete data sets (Figure 2b).

An analysis of the annual EU discussion of assessment results shows how annual adjustments can affect communication through disparate perceptions (Figure 3). The most recent stock estimate (e) for North Sea cod in the ACFM report from 2000 refers to the beginning of 2000. The stock size at the beginning of 2001 is a projection (p), assuming that fishing pressure remains the same as estimated for the previous year (*status quo*). When the catch options and the advice are released halfway through October, the CEC, national administrations, press, fishers' organizations, and other stakeholders assessed these annual changes in their own way.

(i) Managers focused on the projected stock (p) at the beginning of 2001 as its then "present" state, which became the basis for

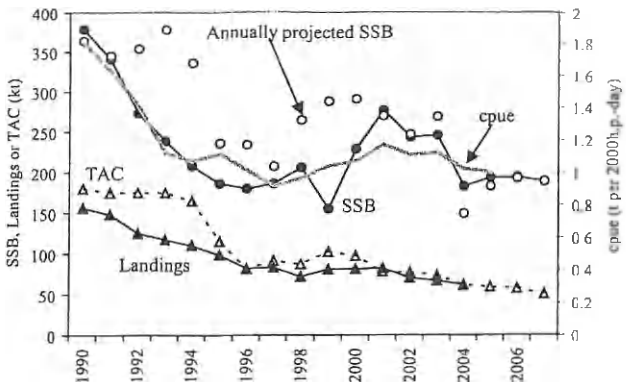

Figure 4. Developments in SSB of North Sea plaice at the start of the year as projected forwards in successive assessments since 1989 and as reconstructed in 2006 (ICES, 2006), in the commercial catch per unit effort (grey line; data first averaged by statistical rectangle before averaging over the entire resource area), in the agreed TAC, and in estimated total landings.

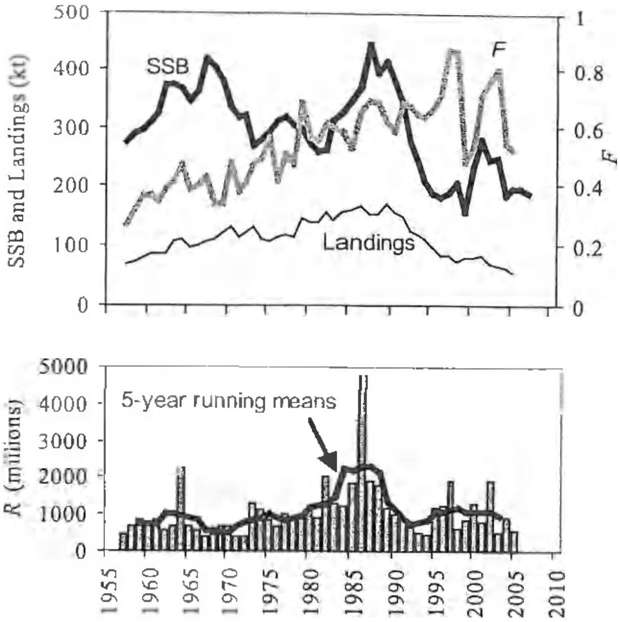

Figure 5. North Sea plaice: (top) SSB, total landings, fishing mortality rate (F), and (bottom) recruitment (R; numbers at age 1). Data from ICES (2006).

Communication problems arise especially where the fishing industry fails to detect correspondence between stock estimates and catch rates in the fishery, as for North Sea plaice (Figure 4). Since 1993, the catch rate of North Sea plaice has hardly varied, but stock estimates and the corresponding TAC advice have varied by factors of 2 and 4, respectively. After the latest adjustment, the correspondence between the time-series for SSB and average catch rate is striking, but the assessment bias has caused mistrust between fishers and scientists, and has eroded the legitimacy of the management system.

Managers do not always realize and certainly do not communicate how the overestimation of stock size affects the resource potential via TACs being set too high for years in succession. Although the management authorities in Iceland and Scotland did realize and quantified the losses caused by assessment bias for cod (Rosenberg *et al.*, 2002; Royal Society of Edinburgh, 2004), an overall evaluation of the effectiveness of management in the light of apparent bias is still pending. Not only would such an evaluation conform to the EU principles for good governance, but it might also build knowledge of how to operate under uncertainty, and perhaps even create more trust between fishers, managers, and scientists.

Causal reasoning and history

Management practices that focus on short-term predictions about the state of a stock and the next year's TAC have captured managers and fishers within a time window that may be too brief to show causality between fishing pressure and stock size. Moreover, the widely held view that fishing pressure affects stock size is not easily demonstrated from the static yield curves usually presented (Beverton and Holt, 1957; Schaefer, 1957). Their value in persuading fishers of the need for restrictive measures is tempered by the cognitive problems many fishers experience when they see such graphs and try to imagine how a change in exploitation pressure translates into actual yield over the years (Moxnes, 1998).

For fishers, tracking stock size, recruitment, and fishing mortality over a longer period is generally more instructive. Taking the North Sea plaice as an example (Figure 5), fishing mortality (or catch relative to SSB) has gradually doubled since the 1950s. As a consequence, the SSB should have declined steadily, if the greater recruitment in the 1980s had not caused a temporary increase in stock size. Fishers gained from this temporary, but unexplained, increase in natural productivity, and landings peaked around 1990. Because many fishers tend to rely on a short-term, selective memory, they explain the resource dynamics as being mainly attributable to environmental factors such as nutrient concentrations (Delaney *et al.*, 2007). Such graphics help fishers interact with managers and scientists to unravel the simultaneous effects of man and nature. Equally important, fishers might perceive the causality between total catch and fishing pressure and may be able to evaluate their current situation better from these temporal patterns than from static yield curves (Moxnes, 1998).

Second, effective management also requires recognition that the course towards some equilibrium target situation is bumpy and takes time. When fishing pressure can be reduced from one year to the next, it still would take as many years as the maximum age in the stock before reaching a new equilibrium. Additionally, recruitment variability will obscure the predicted course. Especially confusing then, and requiring clear explanation, is a temporary downward trend in recruitment as a consequence of environmental conditions and not fishery activities *per se*. When in such cases progress is only monitored through stock biomass, fishers justly question the effectiveness of catch or effort reductions.

Third, small steps in reducing fishing pressure in the course of ten years, as the CEC (2006) envisages for North Sea flatfish, are less persuasive in communicating the effectiveness and hence the legitimacy of management measures. They produce the noisy signal of a slow response, given environment-induced variability in recruitment (Caddy and Agnew, 2004). As the CEC (2006; article 11) rightly foresees, this warrants public evaluation of the progress being made towards the management target.

Managers understand the benefits of reducing fishing pressure from theoretical constructs such as a yield curve or from model predictions of an uncertain future. They accept and refer to the same set of graphs and tables provided in the scientific reports. Only the catch options for the next year show how fishing mortality and stock biomass are causally related. In responding to what they see as an alarming situation in fish populations, managers focus on fisheries, not only because they have been convinced by scientists that they can only manage human impacts, but also because the information supplied does not invite them to communicate on environmental influences as well. In contrast, fishers emphasize that both fisheries and environmental influences are at play. In addition, they often point to the positive effects of fishing, such as increased productivity of forage species thanks to the "ploughing" of the fishing grounds with heavy gear. In this sense, fishers are more inclined to think ecologically than fisheries scientists, whom many fishers believe create theoretical worlds that do not account for the complexity of nature with its multitude of interactions among ecosystem components and abiotic system drivers. As Smith (1990) noted in her study of the NEFMC, fishers, scientists, managers, and others bring different views of nature to the table, and fishers often see nature as less linear and deterministic than do scientists and managers.

Reading and application of graphic displays

Communication problems also arise from differences in the ability to read and interpret the graphic displays on stock assessment that accompany scientific advice. Nowadays, the advisory reports are supposed to serve a wider public, because informed participation by stakeholders is considered essential to governance on both sides of the Atlantic. Assessment and advisory reports can be downloaded freely, but is the information provided in its present structure and format accessible and meaningful, and to whom?

Assessment reports are prepared by scientists for other scientists to review and evaluate and, therefore, must include detailed background information and much else that challenges non-scientists. However, advisory reports are written upon request of management administrations, but are not readily accessible to many stakeholders. This might be a major reason that managers are inclined to leave communication with the fishing industry to the scientists, not only on the management variables and objectives, but also on the uncertainties therein and on the risks involved. The national management authorities in Europe do not always have the necessary knowledge of the basic technicalities of the risk-averse management system and may need a "translator" for in-house processing of biotechnical information. The CEC is much better equipped in this respect, with former ICES biologists employed within its ranks. In the USA, stakeholders sometimes contract experts for the translation of biotechnical information and for assistance during meetings. In addition, the regional management councils sometimes hire specialists in communication, generally improving their communication with the fishing industry, green organizations, and the public at large.

The problem, however, is not only that the graphic displays and texts are better understood by educated staff and contracted experts than by the average fisher. The displays and their formats have also troubled many in the discussions. There seems plenty of room for structural improvement in displaying and relating time-series, plots, model outcome, probability distributions, and other matters. For example, uncertainty features in various displays in advisory reports. Few fishers realize that the ratios between precautionary and biologically hard limit reference points indirectly reflect the estimation uncertainty for stock size and fishing pressure. The uncertainty is more directly depicted in historical series of parameter estimates and in retrospective analyses (Figure 2), but they are not yet part of systematic evaluation procedures. More important, their purpose in guiding management decisions is not articulated. Their current display at the back of ACFM reports (ICES, 2005b) is largely open-ended. Whether or how this type of uncertainty is included in defining precautionary reference levels is poorly documented, or even absent. Still, the graphic display of uncertainties is a key issue in communicating risk management to fishers, balancing the danger of stock collapse with societal values.

Differences in the ability to read and understand graphic displays arise partly from differences in educational background. With practice people can learn, but the complexity of the many parameters used, their various dimensions, their uncertain values, and in the eyes of many fishers and managers, their unstructured displays add considerably to the communication problem. Consequently, greater attention is needed to improve the use of graphic displays. A first step would be to scrutinize the present assessment and advisory reports for coherence and accessibility of the graphic information (Friel *et al.*, 2001; Tufte, 2001; Wainer, 2004). Much can be learned from the experiences gained within different management systems. For example, the US regional management council system has built up experience in multi-stakeholder management, and some councils and government scientists have developed effective ways of presenting scientific information. However, research is still needed into how managers, fishers, and other stakeholders interpret and use the information provided.

Conclusions

Effective fisheries management policy requires cooperation among scientists, managers, and stakeholders, and cooperation in turn depends on communication. We have identified three problems in communication afflicting fisheries management on both sides of the Atlantic.

Differences in perception result from differences in the information environment in which the three groups operate and from differences in the aggregation level of the information reaching them. One can expect large differences in perception if the first encounter comes from detailed data collections (scientists), from graphs that summarize information in highly condensed form (managers), or from personal fishing experience (fishers). There are also more specific differences suggesting a need to account for national, fleet, and fishery characteristics that shape local perceptions about changes in the system.

Differences in causal reasoning may arise from differences in educational background in analytical and environmental science, including criteria and standards for assessing claims of truth. One of the lessons we draw from the difficulties involved in demonstrating a persuasive causal relationship between fishing effort and stock size is the need to give more attention to the longer history of a fishery.

The information environment and the format in which information is provided also play a role. Uncertainty as an element of risk management that combines probabilities of state and pressure with societal values is an issue on its own. Communicating risks among the three groups involved is particularly challenging because it requires great transparency and benefits from clear graphic displays. Transparent displays of uncertainty are scarce in advisory reports. Still, communicating risk to fishers is crucial, because in the end the danger of stock collapse has to be balanced with societal values. Advances are being made as fisheries management becomes more driven by stakeholder participation.

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