



Navigating dilemmas with formalization of advisory processes: Views of practitioners in the International Council for the Exploration of the Sea (ICES)

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ARTICLE INFO

Keywords:

Formalization
Boundary organizations
Science-policy interface
Fisheries advice
Organizational theory

ABSTRACT

Formalization is an important aspect of the provision of scientific advice, which has received limited scholarly attention, and needs further conceptualization. Drawing on Adler and Bory's distinction between enabling and coercive formalization, we analyze advisory processes in a boundary organization. We do so with a case study of the provision of annual fisheries advice by the International Council for the Exploration of the Sea (ICES). Based on interviews, we describe advantages and drawbacks of formalization in the views of ICES practitioners. Our findings highlight the importance of formalization and reveals ongoing challenges with navigating trade-offs between formalization and *ad hoc* adaptation. Despite a high level of formalization, respondents generally perceive that formalization approaches in ICES provide suitable guidance for the processes of stock assessment and advice formulation. However, they also emphasize the needs for deviations from standard procedures, justified with reference to peculiarities of situations. Lessons from ICES' approach to formalization can be of use for other advisory contexts.

1. Introduction

Scientific advice has become an essential element of policy- and decision-making. It is therefore surprising, as [Lentsch and Weingart \(2011\)](#) claimed, that there is no well-developed theory on what constitutes an appropriate science-policy interface. While the literature on science policy-interfaces has grown substantially since this claim was presented, no single theory or evaluative framework for scientific advisory practice has gained wide scholarly support. For instance, [Sundqvist et al. \(2015\)](#) argue that studies on science-policy interfaces in the field of climate change differ in terms of whether they describe advisory practices as tightly integrated with, or separated from, policy processes and whether a close linkage or a clear separation is deemed appropriate.

Despite these gaps, research on science-policy interfaces and scientific advice has progressed conceptually and in terms of the availability of detailed case studies. An important aspect of science-policy interfaces concerns the institutional design and functioning of boundary organizations. Boundary organizations are established to bridge the realms of science and policy in a way that is perceived as constructive in both

realms ([Guston, 2001](#)). The concept of boundary organizations has been widely used in studies of science-policy interfaces, reflecting a broad recognition of its relevance ([Gustafsson and Lidskog, 2018](#)). It has been recognized, however, that the analytical value of the concept can be enhanced through further elaboration ([Wesselink and Hoppe, 2020](#)). Accordingly, [Sundqvist et al. \(2015\)](#) distinguished between formalization and separation, which they portrayed as two fundamental dimensions of providing science for policy. Separation here concerns the mandate and affiliation of those involved in the advisory activity, while formalization refers to "procedures for assessing and summarizing research" for policy. We note that formalization and separation in this sense are interdependent as aspects of mandates and affiliation can be formalized to different extents ([Wiegleb and Bruns, 2022](#)). For the purposes of this study, we conceptualize formalization as when an authority imposes the application of standardized prescriptions to processes of preparing and providing advice. This formulation considers that the strength of formalization can vary through the character and the degree of prescriptions (e.g., guidelines, instructions, protocols, and regulations) and through how their application is followed up.

[Wiegleb and Bruns \(2022\)](#) highlight that formalization and

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<https://doi.org/10.1016/j.envsci.2024.103833>

Received 15 July 2023; Received in revised form 10 July 2024; Accepted 10 July 2024

Available online 9 August 2024

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professional judgment are co-occurring and can be in tension with each other in scientific advisory organizations. The formalization of methods for developing scientific knowledge and advice is generally seen to enhance epistemic quality by minimizing individual judgement and thus potential bias, and by enabling transparency and repeatability. Yet, the idea of minimizing judgement has been questioned (Collins, 1992; cf. Sundqvist et al., 2015). Since there are always ambiguities, instabilities, and novelties involved that do not fit into established categories, “[f]ormal rules cannot by themselves determine behavior or eliminate individual judgment” (Sismondo, 2010, 143). Notably, the need for, and appropriateness of, professional judgement is usually evaluated internally within specific communities of experts and their organizations (Collins, 1992; 1998; Linell et al., 2022). Formalization may be evaluated differently from an external perspective, as advice recipients may see formalization as an important mechanism for enhancing the transparency and hence also the credibility and legitimacy of scientific advice.

In a systematic review of case studies, Jensen-Ryan and German (2019) present formalization of processes of developing and delivering scientific advice for policy-making as an important variable of boundary organizations. They conclude that the role of formalization is unclear, as researchers find that a high degree of formalization can both support and impede the impact of science in policy. This indicates a need to conceptualize and investigate formalization aspects in more detail within and across concrete advisory contexts.

We propose that organizational theory in general, and specifically concepts about workflow formalization developed by Adler and Borys (1996), can contribute to this objective. The process of developing scientific advice, from data collection, modeling and analysis to the formulation of advice for policy can be recognized as a “workflow” that can be formalized to different extents and in different ways.

We analyze formalization in advisory processes with a case study of the International Council for the Exploration of the Sea (ICES), which is the main provider of fisheries and ecosystem advice in the North-East Atlantic (Wilson, 2009; Linke et al., 2023). ICES’ fisheries advice results from a highly formalized process, which has evolved during more than a half century (Rozwadowski, 2002), and which hence provides a rich source of experience with formalization of scientific advice. Cvitanovic et al. (2021a,b) studied success factors of ICES’ science-policy interactions and find that trust, transparency and political neutrality are important enabling factors. As Cvitanovic et al. (2024) state, the role and identity of ICES as an adviser makes this organization “a unique case study for research into boundary organizations, transparency of advice, roles and responsibilities”. A case study of formalization in ICES therefore also provides lessons of potential relevance for organizations in other governance areas such as climate change or biodiversity (Sundqvist and Linke, 2024; De Donà and Linke, 2023).

ICES’ fisheries advice has significant implications for decision making. Decision-makers will often follow the primary advice statement from ICES. Even when decision-makers choose not to follow ICES’ advice, their decision will be based on ICES’ numerical catch projection, and it will normally represent one of several catch options presented in the advice. The linkage between advice and decision-making is closer in the context of ICES fisheries advice than in other domains of environmental governance such as within climate change (Beck, 2011; Hulme, 2023; Sundqvist and Linke, 2024), biodiversity (Borie et al., 2021; Wiegleb and Bruns, 2022) or land and soil governance (De Donà 2021). The tight linkage between ICES’ advice and the political decision-making it informs, and the need to provide annual advice for a high number of fish stocks, has necessitated formalization of the advisory process.

The advisory committee (ACOM) in ICES represents an in-house boundary organization which provides for, and oversees, the formal interface between ICES as a provider of scientific advice and the advice recipients (Nielsen, 2008). Scientific advice plays a pivotal role in the management of fisheries in the Northeast Atlantic, as annual advice

underpins decisions on the Total Allowable Catch (TAC) for each fish stock. Based on ICES’ advice, TAC decisions are made within individual countries, through bilateral or multilateral agreements or, within established arrangements for cooperation between states, including the European Union (EU) (Penas-Lado, 2016) and the North East Atlantic Fisheries Commission. TACs are divided between nations, fleet groups, vessels and are key instruments in fisheries management in the North-East Atlantic (Nielsen and Holm, 2008; Gezelius, 2008).

Broader changes in the governance of science-policy relations have in recent decades increased the need for formalization in processes of scientific advice provision in ICES as well as in other advisory contexts. Both sides of the science-policy continuum are subjected to increasing expectations in terms of demonstrating adherence to good governance principles, for instance as listed by the European Union (2001): openness, participation, accountability, effectiveness, and coherence. Providers of scientific advice like ICES are expected to demonstrate that they take account of such principles. The formalization of advisory processes represents one strategy for committing to such principles, for instance by building them into codes of conduct and standardized operational procedures that are made available to stakeholders and the wider public. This is consistent with research by Cvitanovic et al. (2021a), which found that a clearly documented process for generating advice is a key strategy for building trust in ICES as an advice provider.

While these findings suggest that formalization of advisory processes may be viewed positively externally, we are interested in how practitioners in advisory processes perceive formalization internally. On the positive side, formalization may help practitioners to reach a required consensus and it may contribute to de-politicize the advisory work by providing for a consistent approach. The requirement to reach consensus within advisory organizations has been discussed critically e.g., in the climate regime where a common belief is that “[s]cientists ‘reaching a consensus’ and ‘speaking with one voice’ are integral to science’s projection of epistemic authority” (Hulme, 2023: 178). On the negative side, practitioners may view formalization as constraining by imposing overly standardized approaches to be followed across cases and situations (Kraak et al., 2010).

The latter problem is exemplified by Wilson and Degnbol (2002) who described how the process of assessing a stock of bluefish (*Pomatomus saltatrix*) at the US East Coast was subjected to certain legal requirements. They argued that legal mandates had distorted assessment outcomes, as it prevented scientists from using their best judgement about the stock status. While such legal mandates may have had negative consequences in this case, mandates and procedures may serve in guiding assessment processes through challenging situations with high uncertainty and external pressures from interest groups. ICES advice is not constrained by such legal mandates but faces similar dilemmas between formalization and professional judgements in its advisory processes. Rather than legal constraints, formalization in ICES is embodied in internal procedures and guidelines that ICES has developed to support its processes of fish stock assessments and advice formulation.

We explore views of ICES’ practitioners on formalization in processes of assessment and advice with a focus on two questions: what are the perceived rationales and drawbacks of formalization? Under which conditions are exemptions to established procedures justified? Some of the procedures that support the current assessment and advice process were introduced a long time ago, while others are more recent. Accordingly, the exploration of rationales and drawbacks of formalization takes the shape of an oral history as well as representing reflections on current practices.

We see our study as a contribution to different literatures: Theoretically, the concept of workflow formalization has to our knowledge not been used in studies of formalization in boundary organizations and may thus contribute to further conceptualization and analysis on the role of formalization in such organizations. ICES’ experiences with formalization are relevant for studies on the development and use of scientific advice in support of fisheries management in other areas, but they are

also relevant for studies of science-policy interfaces in environmental governance in general.

In the following we present theory and concepts from organizational theory to guide the analysis of formalization in advisory processes (Section 2). We describe materials and methods (Section 3) and provide a combined presentation, analysis, and discussion of empirical findings (Section 4) followed by a conclusion (Section 5).

2. Theory and concepts for analyzing formalization practices

ICES is an organization in the sense that it sets criteria to distinguish members from non-members, has established principles of who decides on what, as well as chains of command and a division of responsibilities (Hodgson, 2006). The role of formalization in boundary organizations can accordingly be analyzed with support in organizational theory. Pioneered by Herbert Simon (1997) and extended in cooperation with James March (March and Simon, 1993; March, 1988), organizational theory addresses how members of organizations cooperate to solve common problems and to achieve common goals by allocating and using resources and by coordinating efforts. The work by Simon and March and others has had multiple ramifications in theory about organizational decision making. Taking opposition to rational choice theories, it draws attention to how goal oriented organizational decision-making practices are subjected to information constraints, uncertainty, characteristics of the decision-making context, and are shaped through organizational cultures and norms (Egidi and Sillary, 2021).

Simon presented rules and procedures as important “levers of control” (Tessier and Outley, 2012), by which the organization aims to achieve its goals. An important aspect of organizational decision making is whether the decision context is repetitive and well structured, which allows the development of an elaborated and routinized response (March and Simon, 1993: 161; Egidi and Silari, 2021). Such an elaborated response, which they referred to as a “performance program”, includes a repository of rules and identifies conditions for when and how to apply them to a given situation, and prescribes the consequent behavior of the collaborating members in the organization (Egidi and Silari, 2021). ICES’ annual fisheries advice represents a repeated decision context, and we here investigate its performance program for fish stock assessment and advice.

2.1. Enabling and coercive formalization

Formalization can support employees by clarifying a division of labor and guiding an effective execution of tasks. However, employees may also feel that formalization is excessive and constraining. Adler and Borys (1996) examined attitudes of employees on formalization in bureaucracies. Used as a technical term without negative connotations, bureaucracies are hierarchically structured organizations, which rely extensively on specialization and on rules and procedures. With a complex hierarchical and highly formalized organization (see e.g. Wenzel, 2017; Stange et al., 2012; ICES, 2018), ICES is a clear example of a bureaucracy in this sense.

Adler and Borys’ review of research on formalization of workflows demonstrates discrepancies between studies that respectively found that employees tend to view formalization negatively or positively. Negative views on (excessive) formalization are associated with perceptions of a lack of autonomy, they tie in with a “mechanistic” understanding of highly specified and inflexible work functions, and an understanding that rules and procedures are instruments of control of employees. In turn, positive views on formalization— even when formalization is extensive – are associated with perceptions of appropriate rules, procedures, and instructions that support an effective execution of tasks and resolve role ambiguities. Further, Adler and Borys’ review draws attention to how the context of formalization matters; employees tend to regard that routine tasks are supported through extensive formalization, whereas they will tend to regard that formalization of non-routine tasks

is excessive.

Adler and Borys’ propose to resolve discrepancies between negative and positive views on formalization through a two-dimensional model (Fig. 1). The novelty of the model is that it includes two types of formalization as endpoints of a new dimension (horizontal axis) in addition to the traditional dimension representing the degree of formalization (vertical axis). The new dimension builds on a distinction between what they respectively refer to as “enabling” and “coercive” formalization. Formalization is enabling when “... procedures provide organizational memory that captures lessons learned from experience”. As such, enabling procedures support the performance of employees, enhancing their commitment to the goals of the organization. In turn, coercive procedures “...are designed to force reluctant compliance and to extract recalcitrant effort”. An advantage of this model is that it helps to explain differences in attitudes to comparable levels of formalization across different organisations.

Adler and Borys’ identified features of enabling and coercive formalization, respectively. Enabling procedures facilitate responses to contingencies: when problems are met with the application of procedures, this is taken to reflect needs and opportunities for improvement. Enabling procedures provide employees with an understanding of the technical rationales of the procedures (internal transparency) and an understanding of the overarching system and workflow that the procedures are a part of (global transparency). This allows employees to be resourceful and adaptive, and to provide qualified feedback on the further development of procedures. In contrast, coercive procedures are designed to ensure compliance, and deviation is considered suspect. Following a de-skilling logic, coercive procedures take on the shape of task lists without an explanation of underlying technical rationales, and information about the overarching workflow is only provided on a need-to-know basis.

3. Materials and methods

3.1. Case description: ICES advice on fisheries

ICES is an international marine science organization, which involves nearly 6000 scientists.¹ Founded in 1902, a main objective of ICES was to “...estimate the quantity of fish available to the use of

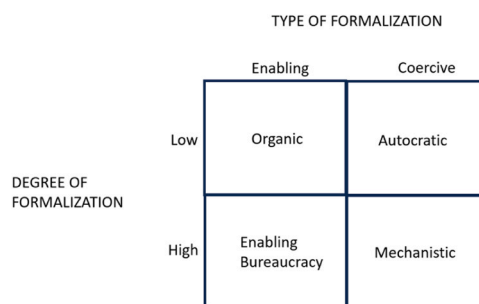


Fig. 1. Adler and Borys’ conceptual model of formalization in the view of members of an organization. On the horizontal dimension, the model differentiates between “enabling formalization”, which supports employee performance in the organization and “coercive formalization” which is oriented towards enforcing employee compliance. On the vertical dimension, the model differentiates between degrees of formalization. The combinations of the two states of each of the two dimensions result in a typology of 4 generic organization types regarding the degree and form of formalization. The figure is redrawn from the original figure in Adler and Borys (1996).

¹ <https://www.ices.dk/about-ICES/who-we-are/Pages/Who-we-are.aspx> (visited 15.06.2023)

man...”(Tambs-Lyche, 1978). ICES’ fisheries advice has co-developed with the demand for this advice by management authorities (Degnbol, 2003; Nielsen, 2008). During the 1960s and 1970s, the need for effective fisheries management became increasingly clear. When TACs became the key fisheries management instrument in the North-East Atlantic from the late 1970s, this created a demand for annual advice to support TAC decisions. Where the required data and models was available, this advice was based on stock projections for possible TAC levels (Rozwadowski, 2002; Nielsen and Holm, 2008).

The first principled basis for ICES fisheries advice was presented in 1976 (ICES, 1977), and ICES’ framework for fisheries advice has since been developed and revised iteratively (Hoydal, 2014, Lassen et al., 2014). Important developments concern the inclusion and refinement of reference points in relation to fisheries mortality and spawning stock biomass, i.e. the two key parameters of fish stock advice (Lassen et al., 2014). Notably, ICES’ advice has incorporated the Precautionary Approach from the late 1990s, with definition of limits and uncertainty buffers for these parameters (Hauge et al., 2007).

ICES advice is made relevant to its recipients by addressing key objectives and reference levels of international agreements, policies, and management plans. For instance, the EU, a major advice client, requests advice in relation to Maximum Sustainable Yield, which was included as a formal objective in the Common Fisheries Policy in 2013 (Earle, 2021). The EU’s advisory needs are specified in contractual agreements with ICES (Ballesteros et al., 2017; Linke et al., 2023).

A guide to ICES advice (ICES, 2023a) describes the process for different advisory products, and lists the policy frameworks and international agreements that provide the context of ICES’ advice. This document presents 10 principles for ICES advice. Principle 1, for instance, states that “The guidelines and procedures to produce ICES advice are documented, openly accessible, and up-to-date”. The guide includes links to the current “Guidelines for ICES Groups”. Amongst other things, these guidelines include “Guidelines for expert groups”, “ICES Code of Ethics and Professional Conduct”, and “Guidelines for the Advisory Committee (ACOM)”. The Guideline for ICES Groups is a comprehensive document, reflecting the significance of formalization of the advisory processes, and is a key reference for practitioners that engage with these processes.

ICES’ current framework for fish stock advice is described in detail in a document entitled “ICES approach to advice on fishing opportunities” (ICES, 2023b). The document describes the approach to fisheries advice in terms of reference points, decision rules for the advice provision, and the assessment approach for each of six assessment quality levels, referred to as “stock categories”. The ICES approach to advice on fishing opportunities represents a “performance program”, which predefines key aspects in the process of performing stock assessment and advice.

The process of ICES fisheries advice is outlined in Fig. 2. The first step is *requests formulation*. ICES advice is provided in response to requests formulated by ICES clients. These clients include the EU, the North-East Atlantic Fisheries Commission, and individual ICES member countries. Once an ICES client has formulated an advice request, ICES is obliged to respond. Requests for fisheries advice are recurrent, which means they are issued annually in highly similar ways (ICES, 2021).

The subsequent step, *knowledge synthesis* refers to the stock assessments produced in ICES assessment working groups (WGs). Each stock assessment presents a knowledge synthesis of the stock history and the stock status in relation to defined reference points. Together with a catch forecast that links possible TAC options to expected impacts on the stock, this synthesis provides the basis for the ICES advice on fisheries

opportunities. The WGs operate in parallel, specializing on different regions and species. This is essential as ICES provides annual advice for more than 200 fish stocks. WGs either do a “benchmark assessment” or an “update assessment”. Benchmark assessments are comprehensive processes, typically held every 3–4 years, which involve an overhaul of basic assessment elements, such as data series, model and model settings, key parameters, and reference points.

The outcome of the benchmark assessment is *reviewed* by external experts and is overseen internally by ACOM. The reviewers are external in the sense that they are “not involved in the expert group” and “have no conflicting interest in the matter” (ICES, 2016).

An approved benchmark assessment is described in detail in a “technical annex”, which provides the basis for subsequent “update assessments” that take place annually until the next benchmark assessment. The technical annex codifies the experience of the benchmark assessment, it defines which information is relevant for the update assessment, and how it will be used. Update assessments follow procedures described in the stock annex and are not externally per reviewed. Benchmark and update assessments provide the basis for the formulation of advice. In the final step, *advice production*, the advice is outlined by an advice drafting group (ADG) and is subsequently edited, approved, and published by ACOM. Our analysis of formalization focuses on the process from knowledge synthesis to advice production.

3.2. Methods

We conducted focus group interviews with ICES stock assessment practitioners and leading ACOM participants (Table 1). In May 2023, at least 17 regular stock assessment WGs were listed in ICES.² We focused on one WG due to resource constraints. We selected the Baltic Fisheries Assessment Working Group (WGBFAS), which we were acquainted with as observers in benchmark meetings and other meetings. To gain insight into long term formalization developments, we interviewed previous chairs of ACOM and of the Advisory Committee on Fisheries Management (ACFM), which was replaced by ACOM in 2007. This provided access to lived experiences from the advisory setting from the 1980s and until the time of writing.

The interviews were semi-structured, with questions prepared for each respondent type. Most questions were posed to all types, but some

Table 1

Focus group interviews and individual interviews. “Reference” depicts how the material is referred to in this article. WGBFAS: Working Group on Baltic Fish Stocks. ACOM: Advisory Committee. EXAC: Previous chair of either ACOM or the Advisory Committee on Fisheries Management (ACFM).

Date	Reference	Interviews	Questions
03.02.21	WG1	Focus group interview with 5 WGBFAS participants	Annex 1 (1)
04.02.21	WG2	Focus group interview with 3 WGBFAS participants	Annex 1 (1)
04.02.21	WG3	Focus group interview with 5 WGBFAS participants	Annex 1 (1)
05.05.21	ACOM	Focus group interview with 4 ACOM participants	Annex 1 (2)
30.05.21	EXAC1	Interview with former chair of advisory committee	Annex 1 (3)
01.06.21	EXAC2	Interview with former chair of advisory committee	Annex 1 (3)
02.06.21	EXAC3	Interview with former chair of advisory committee	Annex 1 (3)
25.08.21	EXAC4	Interview with former chair of advisory committee	Annex 1 (3)



Fig. 2. Flow chart of the process of requesting and producing advice on fishing opportunities in ICES (adapted from ICES 2021).

² <https://www.ices.dk/community/groups/Pages/FRSG.aspx> (visited 10.05.2023).

targeted the specific role or competence of the respondents (Supporting Information, Annex 1). Prior to the interview, an information letter describing the purpose of the study, the discussion topics, and the handling of interview information was sent to the respondents together with a consent form. The Norwegian Centre for Research Data assessed the approach to be fully compliant with requirements of General Data Protection Regulations. The interviews were audio-recorded and transcribed. Transcripts were slightly edited to improve conciseness and clarity (e.g., removing false starts and word repetitions) and person identifiers were removed. Respondents were invited to further edit the transcripts. The interviews ranged between one and two hours, resulting in a combined text material of about 74 000 words.

The approved transcripts were coded by the first author in N-vivo 12. The coding started deductively from a limited number of pre-defined main nodes. Sub-nodes were added inductively through the coding process to capture recurrent themes highlighted by the respondents. The resulting coding tree (Supporting Information, Annex 2) enabled a structured analysis of the transcripts.

4. Results and discussion

This section presents views of ICES practitioners on rationales and drawbacks of formalization of the assessment process (Section 4.1) and of the advice formulation process (4.2). We address tradeoffs with formalization and how exemptions are handled within both processes (4.3). Based on this, we reflect on ICES' approach to formalization in relation to Adler and Borys' distinction between coercive and enabling formalization (4.4).

4.1. Rationales and drawbacks of formalization of the assessment process

A previous ACFM chair noted that assessment approaches varied considerably earlier, and that a WG on assessment methods had an important role in standardizing methods:

There was a period in the 1980s where all kinds of assessment methods were used. That was when the methods working group was created in 1981 or 1982, and it really standardized things [...] (EXAC2).

Another ACFM chair noted that "the outcome was very much depending on who was doing the assessment. If you had a new working group, and gave them the same data, they could come up with a very different result" (EXAC4). The person also emphasized the role of the methods working group to standardize assessment approaches. The statements by the former ACFM chairs reflect main rationales for standardizing the assessment process, namely, to improve assessment consistency between stocks and between years, and to reduce the extent to which the assessment outcomes depended on who was doing the assessment. This is important to enhance external perceptions of credibility.

The international context enhances needs for standardization of data collection in scientific surveys:

But when you standardize things, you have to make a compromise, so nobody can have their own way of having a survey [...]. I guess that is how it is when you have a lot of different nations, that all our scientists want to do it their own way. But somehow, we [...] need to have a common approach to move forward. And ICES is such a way (WG3).

This statement suggests that it is a key role of ICES to standardize and formalize research cooperation in an international context. Scientists contribute to ICES WGs as a part of the work they are expected to carry out within their positions at national marine laboratories or other organizations. Stock assessment is carried out by experts from institutions in countries with an interest in the stocks to be assessed. Most work in ICES WGs is therefore not carried out by direct employees of ICES, and

this limits the extent to which ICES can subject WGs to top-down control. A WG member observed:

[...]one of the challenges within ICES is also one of the strengths, and it is that we are community. And it is not super top down controlled [...]. When you have so many nations, and so many scientists [...] it is difficult to change things very fast. [...] if you are too controlling, people are getting upset because then they're not allowed to use their science and their best knowledge. [...] So you need to have some flexibility, and on the other hand, you can't make people go totally loose [...] So it is a dilemma (WG3).

Procedures and guidelines for WG participants are a key resource for achieving consistency and control in the context of voluntary work conducted by researchers from a range of countries. The statement reflects that the extent to which control can be exerted without undermining the interest in participation is limited. In the terminology of Adler and Borys (1996), this may promote development of enabling procedures rather than coercive ones.

We asked ICES practitioners to identify main elements of the framework for the assessment process. Respondents referred to the "handbook", i.e., the guidelines for ICES working group mentioned earlier (ICES 2021b). They also typically referred to the "stock annex" resulting from a benchmark assessment. The guidelines inform about ICES routines and procedures and establish a standard approach to the assessments. A WG member observed that the ICES guidelines can help WGs to reach consensus:

There is often disagreement between scientists on different aspects, and these guidelines help us to solve those conflicts. Otherwise, we would often be stuck in a situation where we are like 50–50, and it's impossible to proceed (WG2).

As ICES assessment and advice is consensus based, the ability to reach consensus is critical. In line with research summarized by Adler and Borys (1996), this observation identifies a constructive role of procedures in reducing and resolving conflicts, and in decreasing ambiguities about roles. On a critical note, a former chair of the advisory committee suggested that formalization had the drawback of undermining creativity in the assessment process, which may reflect a perception of a coercive aspect of formalization.

4.1.1. Benchmark and update assessments

As described, the fundamental set-up for the assessment is defined within a benchmark meeting that typically take place once every three to four years: "Basically, the benchmark is producing a list of procedures that the update assessment should follow for that stock" (WG3). Key assessment decisions are made in the benchmark meeting, which then define and lock-in the setting for the update assessments:

...we recognize a certain stiffness in the system, at least in the benchmark group which is probably the important one because it is basically deciding about how to derive the reference points, modeling, and so forth – the core area of the ICES fisheries advise (WG2).

The word "stiffness" recognizes that the procedures that result from a benchmark assessment constrain options for *ad hoc* adaptations in the update assessments, an issue we address further below.

A former chair of the advisory committee explained that an important reason for the benchmark and update arrangement was to save resources in the assessment review process, a point that other committee chairs confirmed:

A main reason that the benchmark came into place was that having an annual peer review of the expert group reports turned out to be undoable. [...]. Therefore, we simply had to rationalize the process by saying that we only do this every three, four or five years, and then you are stuck with it (EXAC3).

The use of time and resources needed for reviewing benchmark processes was also considered at the WG level:

...it often happens that we are sitting in the update assessment group, and then something pops up that we would suddenly want to do a little bit differently than our description, or cookbook, states we should do. [...] If we are changing something in an update meeting, of course we can if it is really an improvement, but that means that ICES very quickly has to find somebody to review it. If it is a big change, then we can't. If it is a relatively small change then, we could. But that creates a lot of extra work. [...] then you start thinking: is it really this important? (WG3)

Several respondents pointed out that the benchmark-update arrangement came with the additional rationale of promoting inter-annual consistency in the assessment and the resulting advice:

...the discussion was very much about why do we make all these *ad-hoc* changes to the methods, this tinkering of say changing some small parameters of, let us say, catchability or the recruitment for this stock for this particular case? [...] we were thinking that we should get away from this annual tinkering, and we should just run the models that we have agreed on to run (EXAC4).

From a WG perspective the rationale for the benchmark-update arrangement of providing for inter-annual consistency was confirmed, for instance by a participant with long WG experience:

I was [...] a little bit annoyed with the restriction of the benchmark, but I see the benefit that we are not changing all the time. Because it makes it difficult for the managers to follow what we're doing (WG3).

This statement also reflects attention to how the advice is perceived by decision-makers. It recognizes a potential tension between epistemic quality and consistency in the assessments. Another person stated:

The dilemma is [...] that already in the first year after the benchmark we may have a little twist in data or something. And then [...] there is always this discussion: How far can you go before a new benchmark is required? And that is a very subjective thing (EXAC3).

Taken together, the statements reflect a dilemma with the benchmark-update arrangement. It is "restrictive" as it prevents participants from implementing changes in the update assessments. However, these restrictions promote interannual advice consistency, which helps clients to follow stock developments.

While the interviewed participants generally expressed that the benchmark-update arrangement is an important and needed element in the assessment process, some critique was raised. A former chair of the advisory committee had promoted the idea of a more standardized approach to the assessments for a long time but reflected that "I have a very double feeling about it, because what I see now is that it is sort of preventing an understanding of what is going on by just following the rules" (EXAC1). This view presents the benchmark system as a potentially coercive type of formalization, which ties in with concerns expressed by Kraak et al. (2010) that formalization of Management Strategy Evaluations in fisheries may lead to mechanistic approaches, that undermine the role of expert judgement. The former chair elaborated the concerns with the benchmark-update arrangements as follows:

I think that we are, by not responding to all these small changes that you could make, [...] limiting the scientific understanding of the groups. Because you are either in category A, which is update, do not change anything. Or you are in category B, which is you can do anything you like [...]. And both systems are not very desirable because you do not want to have [...] fiddling all the time, making small changes. But you also do not want to have a completely new understanding of what is going on every three or four years (EXAC1).

From this perspective, the benchmark-update is seen to create an

unhelpful dichotomy between no change and complete change. However, an intermediate option, a so-called "inter-benchmark", also exists as a possibility in ICES. A working group can, at a relatively short notice, request an inter-benchmark meeting for a specific purpose, such as reviewing a new data series for inclusion outside of the benchmark setting:

We had a new survey and we forgot to inform ICES that we wanted to include the survey, and then nearly first when we came to the assessment [...] we [...] realized that it had not been benchmarked. And then we had to ask for an inter-benchmark [...]. You can do a short inter-benchmark if it is only one data series (WG3).

The inter-benchmark is an example of an exceptional procedure that establishes some flexibility to deviate from the standard procedure. It illustrates how an elaborated system can achieve most of the benefits of formalized procedures, while avoiding serious drawbacks. Interestingly, a recent discussion in ACOM addressed a need to formalize the criteria for when an inter-benchmark is required (ICES, 2022). This is the case as an inter-benchmark is requested for about one stock in each WG, and the ACOM sees a need to avoid a further expansion of the use of this procedure. This illustrates that the dilemma remains between considerations of consistency and resource constraints on the one hand, and on the other hand, the interest in revising assessment settings between benchmark meetings. This brings us to the general issue of how deviations from standard procedures are justified, which we address subsequently.

4.2. Rationales and drawbacks of formalization of the process of formulating advice

As the assessment process, the process of formulating the advice has been formalized to enhance the consistency of the advice across stocks and between years:

If you go back in time for the ICES system, there was no clear objective for the advice. Which meant that the ACFM could sit around the table and basically vote and say: I think the advice should be this. And someone would say: I think it should be this. By the end of the day, you reached consensus, but not based on objective criteria, and certainly not in terms related to management objectives. So the advice was very much depending on who was in the room" (EXAC4).

Similarly, a current ACOM member observed:

I was in ACFM back in the day, and when I reflect back on that, the key thing now is that we have got a lot of consistency across different stocks, which we probably did not have in the past. It was whoever shouted the loudest at the ACFM meeting that determined what the final advice would be, and there were lots of arguments thrown here there and everywhere, whereas now I think it is a lot clearer (ACOM).

In ACFM, consistency in the advice formulation was mainly achieved through interannual consistency in ACFM membership (EXAC4). Consistency, hence, would be achieved through personal memory as opposed to the more robust organizational memory achieved through codification of experiences into formalized procedures. Another former chair recalled the development and use of decision rules for the advice making in ACFM from the late 1980s, internally referred to as the "Green Sheets". Depending on the perceived stock status, the decision rules would pre-specify the ICES advice. These decision rules have become increasingly elaborated until the current introduction to ICES advice, which also includes a description of advisory principles (ICES, 2021). In part, this elaboration has happened in response to the development and use of additional reference points in the advice (Lassen et al., 2014). A member of ACOM observed that:

The whole idea of that [advisory] framework, I think, is to formalize or at least to guide a lot of the decision making so we can get a consistency across different stocks (ACOM).

We expected that the international context of ICES advice has accentuated needs for formalization of the advisory process. With shared fisheries between multiple nations, consistency in the assessment and advice processes is important as it helps to reduce the room for politization and enables consensus on the assessment and the advice. Asked whether the international context had emphasized need for formalization, a previous chair of the advisory committee replied:

Yes, absolutely. And it has also triggered a much more clear and transparent dialogue between science and managers because they are two different bodies. If they are in the same house and in the same room, you do not have the same dialogue, and you do not see the difference (EXAC4).

The statement confirms the importance of formalization in the international policy context and draws attention to the organizational setup where ICES as an advisory body is separate from policy making bodies. As the statement suggests, the dialogue between advisor and advisee, through formal processes of requesting and providing advice, provides for external transparency when the formal communication is publicly accessible.

The interview statements portray a historical development of the assessment and advice from flexibility and influence of individual judgements towards an increasingly formalized and principled process. This is a development that they perceive as beneficial, as it has supported the consistency and credibility of the advice. However, as an ACOM member explained, the advisory framework is subjected to challenges:

We have an inherently unstable system, which is so complicated as it involves changes on the human side, the data side, and the ecological one. This can result in examples that do not fit into our framework (ACOM).

Participants mentioned examples of events that led to a misfit between the context and the framework that guides assessment and advice practices, including changes in the fishing fleets, changes in the ecosystem, and lack of data delivery. This makes it important to address such challenges.

4.3. Dealing with formalization trade-offs in ICES' advice

As shown, ICES practitioners recognize a need for consistency when providing assessments and advice across fish stocks. Formalization in terms of guidelines and the advisory framework has been a key resource for achieving this consistency. However, ICES practitioners also see drawbacks, which implies that there are challenges and trade-offs with formalization. This is the case as there will often be situations where the normal procedure is not well suited:

I think, on average for every stock assessment expert group, at least one stock every year will fall down in terms of the guidelines. I reckon we get one challenge per expert group per year. Some huge, some small (ACOM).

This makes it important to address if participants perceive that standard operating procedures constrain their actions. Several participants expressed that they do not view ICES assessment procedures as binding:

I think that the key issue is that the procedures, as we call it here, should be interpreted as guidelines – in the sense that they should guide decisions but should not be interpreted as law. [...] if you as a scientist have a robust argument to provide something different that deviates from the guidelines, then you should be allowed to do so (WG2).

A former chair of the advisory committee stated that:

ACOM has tried to force a lot of these exemptions into a standard procedure, yes. That is a dilemma as I see it. Because it also makes what you are doing untransparent (EXAC4).

Hence, while formalization of the advisory processes provides for transparency, it also contributes to weaken transparency when it is difficult to ascribe an instance to one or more predefined categories that the guidelines and procedures relate to (Hauge et al., 2007).

Several participants, including participants from the WG as well as from ACOM, explained that ICES commitments to provide the best available science and advice overrides the commitments to follow established procedures:

No, I guess you can always argue for doing things. Also in ACOM, you quite often get the feedback if you ask them, that if this is the best scientific advice, then it is what you should put forward. [...] But they do boast that we have standard ways... [if] you have the same kind of stocks, [...] it can be really difficult to explain for the outside world why we have used different methods. So the idea behind it is of course that we are following the same principles. And then only if there's something special for this stock, that we can argue for, then we are allowed to use another method (WG3).

This statement describes how the application of standard procedures helps to provide for external perceptions of transparency and consistency of the advisory process, while also noting the possibility of making exceptions where they are deemed appropriate. Together with the previous statement, this shows that the assessment procedures are generally perceived as enabling, not coercive. In this context, decisions on the exemptions are enabled by a common organizational goal of providing the best available science.

While this may help to resolve issues in some cases, decisions on whether to follow guidelines may not be straightforward to make in others. Such decisions involve trade-offs between the advantages of following the framework, e.g. in terms of consistency and process efficiency, and the interests in adapting to special situations to provide for the "best available science".

4.4. Enabling and coercive formalization in ICES

The annual provision of fisheries advice in ICES both requires and enables a high level of formalization. The workflow from data collection, to stock assessment, and to advice formulation (Fig. 2) has become highly formalized. As respondents observe a need for further formalization of international data collection and of the provision of ecosystem advice, trends towards increased formalization continue and can be anticipated to extend to other areas of ICES advisory work.

A high degree of formalization might be expected to frustrate practitioners, as it limits the options for adapting the approach taken to a specific problem. However, our analysis shows that the interviewed participants recognize a need for procedures, and explain how they serve multiple purposes, including enhancing process efficiency, facilitating consensus formation, and enhancing consistency between stocks and years. This acceptance can partly be explained by that a high degree of formalization is generally accepted in contexts of routinized processes, but the approach taken to formalization also requires attention (Adler and Borys, 1996).

In the view of practitioners, ICES' approach to formalization of assessment and advice processes can be identified as "enabling", as it codifies past experiences, and serves as an organizational memory of best practices. In recent years, ICES has collated and made these guidelines accessible online, thus providing for internal as well as external transparency.

Participants in assessment WGs recognize the benchmark-update arrangement as an important approach. It is efficient in terms of the resource needs for external review, and it enhances the advice

consistency between years and across stocks. Practitioners' reflections on these aspects show that they are cognizant of the needs and rationales of the wider workflow that the benchmark assessments is part of. This awareness contributes to a positive perception of formalized procedures.

Our interviewees also articulated some drawbacks with formalization. This finding is in conjunction with studies addressing that tensions always exist between needs for formalization and expert judgement (Collins, 1992; Sismondo, 2010; Sundqvist et al., 2015; Linell et al., 2022). Formalization of the assessment process may restrict possibilities to adapt to special situations, it may limit the use of new information, and it may also constrain creativity and innovation. The tensions and potential conflicts between formalization and judgement are discussed in other areas of evidence-based practices and processes of synthesizing research for policy purposes, such as in medicine or educational research (Pistone et al., 2022; Linell et al., 2022).

However, we did not encounter overly negative attitudes on formalization, but rather sophisticated reflections about the trade-offs between benefits of adhering to standard procedures, and the need to deviate from these in specific situations. The special identity and organizational setup of ICES limits the stringency by which procedures can be defined and implemented top-down. Important elements of the formalization of ICES' assessment process are presented as "guidelines". Participants can justify deviation from these guidelines, when this is deemed necessary to provide for the "best available science". While this may help to resolve practical problems with the application of standard procedures in particular situations, it does not fully resolve the basic dilemmas with formalization. This is the case as there is a tradeoff between the tactical perspective of resolving issues with procedures in the specific problem context, and the strategic perspective of adhering to procedures and thereby increasing consistency between stocks and years. This finding is aligned with the work by Kraak et al., (2010), which identify dilemmas with a formalization of Management Strategy Evaluations in fisheries. It also ties in with the observation by Gibson et al. (2019) that formalization can support global integration in multinational organizations, but it may simultaneously limit the flexibility to tailor practices locally.

While our study confirms assumptions about the dilemma between formalization and judgement, our key result is that ICES practitioners view formalization as supportive of the advisory process. In Adler and Borys' terms, this result presents ICES as an enabling bureaucracy. The finding differs from the case of the blue fish assessment described by Wilson and Degnbol (2002). In this case, the legal formalization of the assessment process can be recognized as "coercive", as it prevented experts of making use of what they saw as relevant knowledge.

5. Conclusion

Mobilizing organizational theory of formalization, this article contributes to the understanding of the role of formalization in boundary organizations. Adler and Borys (1996) seminal article on workflow formalization highlights that the question is not just about arriving at the right level of formalization; the form of formalization is also important. With a long history of providing fisheries advice in an international context, ICES embodies a vast experience on formalization of advisory processes of potential value for other advisory contexts. Through an emphasis on guidelines rather than strict rules, and an organizational commitment to produce the "best available science", ICES appears to have succeeded in arriving at degrees and forms of formalization that are generally perceived as constructive by ICES participants. We can thus postulate that ICES' procedures to formalize the advisory process can be categorized as "enabling" in the sense of Adler and Borys (1996).

While noting drawbacks, interviewed participants recognize the need for standard procedures, and explain how they serve multiple purposes, including enhancing process efficiency, facilitating consensus formation, and enhancing consistency of assessments and advice

between stocks and years.

Our findings can be of immediate relevance for other routinized contexts of fisheries advice provision, e.g. within Regional Fisheries Management Organizations. The findings may also be useful for boundary organizations in environmental governance, where a stronger formalization of the advisory process might be beneficial to enable consensus building, increase internal and external perceptions of transparency, and enhance the impact of the advice on decision-making.

CRedit authorship contribution statement

Kåre Nolde Nielsen: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sebastian Linke:** Writing – review & editing, Project administration, Investigation, Funding acquisition, Conceptualization. **Petter Holm:** Writing – review & editing, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

The authors do not have permission to share data.

Acknowledgements

This study is an outcome of the project funded by Riksbankens Jubileumsfond "Science for environmental governance: dilemmas in advisory processes" (P16-0362:1). The authors are deeply indebted to the interviewees that supplied the empirical basis for this work, and to three anonymous reviewers that provided constructive feedback.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.envsci.2024.103833.

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