Integrated governance for managing multidimensional problems

Potentials, challenges, and arrangements

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Integrated governance for managing multidimensional problems: Potentials, challenges, and arrangements

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ABSTRACT

The implementation challenge of ecosystem-based (fisheries) management (EB(F)M) has entailed calls for integrated governance (IG) approaches in the marine field. We arranged an expert workshop to study the preconditions and applicability of IG, and to suggest how IG could be arranged in practice. Focusing on the management of the dioxin problem shared by the herring and salmon fisheries in the Baltic Sea, and using a coupled 'insight network'- SWOT (strengths, weaknesses, opportunities, threats) methodology, we evaluated two scenarios: 1) IG of herring and salmon fisheries to benefit from collaboration between these fisheries that suffer from the same problem, and 2) IG between the fisheries sector and the food/public health sector to incorporate food safety in fisheries governance. Our results demonstrate that a variety of societal, political, institutional, operational, instrumental, and biological factors affect the applicability of IG in marine contexts, and work as preconditions for IG. While societal needs for IG were obvious in our case, as major challenges for it we identified the competing cross-sectoral objectives, path dependencies, and limitations of experts to think and work across fields. The study suggests that establishing an IG framework by adding new aspects upon the current governance structures may be easier to accept and adapt to, than creating new strategic or advisory bodies or other new capacities. Viewing IG as a framework for understanding cross-sectoral issues instead of one that requires a defined level and form of integrated assessment and management may be a way towards social learning, and thereby towards the implementation of more sophisticated, open and broad EB(F)M frameworks.

1. Introduction

The need for integrated approaches in marine environmental and fisheries governance has been widely acknowledged [1–6]. The call for integrated governance (IG) stems from the implementation challenge of ecosystem-based (fisheries) management (EB(F)M) that entails viewing complex problems in their environmental and social context [7]. Understanding how ecosystem structures, processes and services, and

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human systems and activities, influence each other [8] requires broadening the sectoral "silo-perspective" of conventional governance towards one that enables transcending the boundaries of established policy domains.

IG, as such, is not a new concept. For example, the Brundtland report on sustainable development in 1987 [9] noted the tendency of sectoral organizations "to pursue sectoral objectives and to treat their impacts on other sectors as side effects, taken into account only if compelled to do so" and called for overcoming such fragmentation. However, progress towards IG has been slow, as it is poorly understood, difficult to define and achieve, and has low priority in administration [10]. In the marine and adjacent fields, research on and application of the concept of IG is also still scarce. The topic has been discussed e.g. in the context of marine spatial planning [11] and the multi-use of seas in general [12], as well as the regionalization of EU marine governance [13]. Assmuth and Lyytimäki [14] focused on knowledge brokering between health and environmental sectors, and Song et al. [15] provided a framework for analyzing inter-sectoral interactions to inform IG. Kelly et al. [2] and Stephenson et al. [5] elaborated guidelines for the shift towards IG in the marine context.

While the literature on IG is mainly theoretical, empirical studies focusing on the applicability or experiences of IG in the marine reality are rare, and the potentials of IG have been seldom tried or assessed. In particular, analyses of the barriers that impede the transition from sectoral and fragmented marine governance to integrated and holistic approaches are needed [2]. We contribute to this research gap by exploring expert views on the potential and challenges of IG in managing the problems that environmental pollutants induce in the Baltic Sea, a sea ecosystem severely contaminated by multiple harmful substances, and by identifying ways to arrange IG for the holistic management of these problems. We focus specifically on the problems that dioxins (polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) and dioxin-like polychlorinated biphenyls, (PCBs)) cause for the Atlantic herring (*Clupea harengus*) and the Atlantic salmon (*Salmo salar*) fisheries.

Dioxins accumulate in fatty tissues of marine species enriching towards higher trophic levels in food webs (biomagnification). They exert a variety of adverse impacts on top predators, including humans, with the chronic low-dose effects on reproduction and development after prenatal exposure as the most critical or most studied [16–21,29]. Dioxins are subject to regulation to protect human health in the EU, which implies that placing fish that exceeds the maximum allowable level of dioxins on the EU food market is not allowed. Thus, in addition to posing a risk to human health, the dioxin problem and its management can cause negative socio-economic consequences for the fisheries sector. Indeed, dioxins in Baltic Sea fish can be explored as an example of a pressing problem that transcends sectoral boundaries, and the management of which could benefit from a cross-cutting governance framework [17,22–24].

The aim of this paper is to study the preconditions and applicability of IG in managing multidimensional social-ecological problems in marine contexts, and based on this, suggest how IG could be arranged in practice. The paper seeks answers to three interrelated research questions: 1) What factors may facilitate or impede the transformation of governance towards integrated forms and based on this, what kind of preconditions can be identified for IG? 2) Do current governance structures have the potential to take up IG, and if, how can this happen in practice? and 3) Specifically, what kind of platforms, networks, or arrangements there may be for crossing sectoral boundaries in terms of IG?

The analysis is based on the results of an expert workshop that evaluated two scenarios for widening the governance of the dioxin problem from the food/public health sector to the fisheries sector, by using a Strengths-Weaknesses-Opportunities-Threats (SWOT) approach, and discussed ways to arrange IG. 'Scenario 1' concerned IG of Baltic Sea herring and salmon fisheries to benefit from collaboration between these fisheries that suffer from the same problem. 'Scenario 2' envisioned IG between the fisheries sector and the food/public health sector to incorporate food safety in fisheries governance. Evaluation of the two different Scenarios provided a wider perspective to IG, and thereby diverse and more generalizable results, than only focusing on one IG framework.

Section 2 outlines the case study; a more detailed problem framing is provided in the Supplementary material (I-VI). In Section 3, we deepen the conceptual analysis of IG. Section 4 explains the methods of the workshop. Section 5 presents the results. Section 6 contains discussion, and Section 7 conclusions.

2. The case of dioxins in herring and salmon fisheries and their governance

2.1. Herring and salmon fisheries

The Atlantic herring and the Atlantic salmon are two traditional target species and sources of food in the Baltic Sea area [25,26]. For brevity, these species are referred below as herring and salmon. Herring is together with the European sprat (*Sprattus sprattus*) and the Atlantic cod (*Gadus morhua*) by far the most important species considering the volumes of commercial catches in the Baltic Sea [27,28]. Herring is fished all over the sea, and in its southern parts and in the Gulf of Finland it comprises a mixed fishery with sprat [27]. The human consumption of herring has decreased during the past decades, and instead, the bulk of the catches has been directed to fur farms and to fish meal and oil industry [24,29–32]. Commercial salmon fishing has decreased considerably during the recent decades, mainly owing to tightened fishing restrictions since the 1990s to protect declined stocks from overfishing [33,34]. Thus, also the availability of salmon for consumers has decreased. In contrast, the share of non-commercial salmon catch has increased up to about half of the total fishing mortality [33]. (Cf. Supplementary material I for more details).

2.2. Governance of the fisheries

Herring and salmon fisheries are governed within the framework of the EU Common Fisheries Policy (CFP) [35]. Herring management is also guided by the *Multiannual plan for the stocks of cod, herring and sprat in the Baltic Sea and the fisheries exploiting those stocks* [36]. The main fisheries management tool is a single-species approach, the yearly defined total allowable catch (TAC), assessed in accordance with the aim to achieve maximum sustainable yield (MSY) for the stock, and shared between the member states by using a pre-defined allocation key, the so-called relative stability [37]. The TAC is decided by the Ministerial Council based on the scientific advice that the Directorate-General for Maritime Affairs and Fisheries (DG MARE) of the European Commission (EC) requests from the International Council for the Exploration of the Sea (ICES), and statements provided by the regional stakeholder organization Baltic Sea Advisory Council (BSAC) and the Baltic Sea Fisheries Forum (BALTFISH), which represents the EU Member States [37,38]. (Cf. Supplementary material II, Figure S1).

2.3. Dioxins as a food safety problem

Due to contaminants entering the Baltic Sea, fatty fish such as herring and salmon may contain high concentrations of harmful lipid-soluble substances, such as dioxins [17]. Herring is a key species in the diet of salmon; thus these fisheries share the dioxin problem. Herring and salmon acquire dioxins by feeding on species at lower trophic levels of the food web, the bioaccumulation depending on the availability of prey species, the diet preferences and growth rate of the fish, and the dioxin concentrations in the prey organisms [39–41]. As a general rule, dioxin concentrations are highest in large, old fish [40,42,43] (Cf. Supplementary material III, Figure S2). Dioxins also accumulate in humans consuming these fish, which poses a health risk especially to children and women at fertile age [17,18,21,29], and may specifically impair semen quality in young men [19]. This contrasts with the assumed benefits of fatty fish to human health, related to Omega-3 fatty acids and vitamin D [21,29,44–46] (Cf. Supplementary material IV, Figure S2, Figure S4).

2.4. Governance of food safety

The main tools to protect human health from the risks of dioxins in fish in the EU are the regulations [47,48,94,96], which restrict the selling of fish based on the maximum allowable levels of dioxins in food and feed. The regulation, prepared by the Directorate-General for Health and Safety (DG SANTE) of the European Commission (EC) is based on risk assessments conducted by the European Food Safety Authority (EFSA) [49–51]. The limit value functions as a reference point for restricting the selling of herring and salmon within the EU; the presence of dioxins in fish species of certain ages, sizes and geographical regions is assessed based on the available monitoring data [52,53]. Only fish that is considered safe-to-eat (i.e. dioxin levels are below the reference value) can be sold for human consumption, and the fish meal and oil factories must purify dioxins from their products [54] (Cf. supplementary material V, Figure S3).

Finland and Sweden opposed the selling restrictions, stressing the socio-economic and cultural importance of fishing and certain fish products in their national diets, and the health benefits of the consumption of fatty fish [17,26]. They applied for and have been granted an exemption of this regulation for domestic sale and consumption of these fish, provided that consumers are informed of the health risks by dietary recommendations; Latvia has an exemption for salmon. The dietary recommendations of Sweden and Finland differ significantly from each other, which has been considered problematic from the perspective of risk communication [26]. In Sweden, the exemption has been questioned as it has been learned that only a low proportion of the population follow the dietary recommendation, including people from the risk groups [26,29] (Cf. Supplementary material V).

2.5. Dioxins as a socio-economic problem - implications to the fisheries

The dioxin problem and its management has reduced the possibilities of fishers to sell the herring and salmon catches, and implied a need for the whole fisheries sector to adjust fishing practices as well as fish handling, processing and marketing to match the prevailing regulatory conditions [24,55–57]. This may have negatively affected the productivity and profitability of the fisheries [55–58] (Cf. Supplementary material VI, Figure S4). Also the CFP [35] acknowledges the importance of food and feed safety, yet fisheries governance in the EU does not address the dioxin problem specifically [24].

3. Integrated approach to govern the dioxin problem

Governance refers to the institutional framework and processes needed for making decisions on management [11,59]. More specifically, governance forms the system of interactions between actors for exchanging knowledge and deliberating management objectives for decision making, the institutional framework (organizations, norms, rules, policies, laws) enabling these interactions, and the values and principles guiding them [60,61]. Management, in turn, relates to decisions on strategies, measures, and tools, the implementation of these decisions, and the monitoring of their impacts [61–63]. In EB(F)M, governance involving multiple actor groups (public, private and civil society actors) is at focus [4], and separated from governing with government as the legitimate coercive power [11,60,64].

Compared to sectoral governance, IG adds value through supporting the sharing of knowledge, views, competencies and resources between policy sectors, in order to better address multi-dimensional problems, e.g. by understanding how decisions in one sector affect other sectors and form feedback loops between sectors [5,65–67]. Thus, through extending interactions beyond sectoral boundaries, IG can promote synergies and coherence between policy sectors, and even stimulate innovation in policy development and implementation [10]. A variety of concepts, such as multi-sectoral governance [66], integrated policy making/policy integration [10,67], integrated management [5], and several others [67,68] are used to refer to different types of inter-sectoral governance arrangements. In the following, our reference to IG encompasses a variety of ways of integration between sectoral governing frameworks, elements, processes, or outputs.

In the marine field, the concept of IG has been used in the contexts of 1) connecting policy domains to govern problems shared by them, 2) involving stakeholders and their views in governance, and 3) integrating socio-economic and ecological policy goals in governance [13]. Similar uses are found in other fields, notably environment, health, nutrition and chemicals control [69,70]. In this paper, IG primarily relates to linking policy domains to govern and manage the dioxin problem of herring and salmon fisheries, that is, a specific version of the meaning 1) above. The paper particularly explores whether the management of this dioxin problem could benefit from governance that addresses the multidimensionality of the problem instead of the current sector-specific approach focusing on the dioxin risk to humans.

Integration across policy domains can materialize at different intensities and concern different governance levels and aspects [67–69,71]. At the lowest integration level, cooperation in terms of dialogue and information sharing broadens the knowledge base. Thus, it enhances the understanding of the shared problem and facilitates conflict resolution and negotiation on goals and means. The second integration level entails coordination of expertise or other resources between the policy domains, and it can increase the coherence and consistency of their policies or activities. At the third level, joint working or organizational elements are ways to create synergies and shared policy instruments, contents (agreements, laws, regulations, policies), or goals. Integrative actions can take place between policy domains (e.g. herring and salmon) within the same sector (e.g. fisheries sector) or between different sectors (fisheries and food/public health), and horizontally at the same administrative level or vertically between national, regional and EU levels [71].

4. Material and methods

4.1. Pre-workshop

The workshop consisted of group discussions; such interactions are known to produce novel openings, ideally among six to nine people [72]. In this study, the group discussions were organized in two parallel sessions. For this, 16 experts representing the key stakeholder groups related to the herring and salmon fisheries and the food/public health sectors, and environmental non-governmental organizations from Finland, Sweden, and Estonia were engaged[1] (Table 1). In Table 1, the workshop participants' expertise is broadly categorized; however, many of them covered more than one area of expertise (for example, those with expertise on food/public health were also knowledgeable on environmental toxicology). All the experts were familiar with the dioxin issue at least from one point of view, but they were not expected to have prior experience of the concept of IG. The workshop participants were invited based on the organizers' networks and knowledge, and sought from institutional webpages. In the cases where the first invited expert was unable to attend, (s)he was asked to recommend someone else with

[1] The study was part of the BONUS GOHERR project (Integrated governance of Baltic herring and salmon stocks involving stakeholders, 2015–18) that focused on four Baltic Sea countries: Finland, Sweden, Estonia and Denmark. Danish participants were also invited to the workshop, but they were unable to attend.

Table 1
Key issues and the respective methodological choices in designing the workshop.

Issue	Methodological choice
Problem	Dioxins in herring and salmon
Topic to be evaluated	Integrated governance (IG)
Approach to evaluate	Expert workshop
Participating experts (number and country FI=Finland, SWE=Sweden, Est=Estonia)	Baltic herring fishery science (1 FI + 1 SWE) Baltic salmon fishery science (2 FI) Marine ecology (1 FI) Food and public health science (2 FI) Environmental toxicology (1 FI) Fishing industry (1 FI, 2 SWE, 1 Est) Environmental non-governmental organizations (3 FI) National fisheries administration (1 FI)
Diagrams for shared understanding	Governance of Baltic Sea fisheries (Supplementary material II: Figure S1) Bioaccumulation of dioxins in herring/salmon (Supplementary material III: Figure S2) Governance of dioxins in food (Supplementary material V: Figure S3) Dioxins as a socio-economic problem (Supplementary material VI: Figure S4)
Workshop methods	Extended causal diagrams SWOT-analysis Group discussion
Topics of discussions	Strengths, Weaknesses, Opportunities, Threats Ways to arrange IG
Methods of analysis	Transcriptions of recorded discussions SWOT-driven content analysis Involving experts to article-writing
Analytical questions	What strengths, weaknesses, opportunities and threats did the experts identify in the scenarios: 1) IG of herring and salmon fisheries to manage their dioxin problem, 2) IG of the fisheries sector and the food/public health sector. How to implement IG?
Objective of work	Elaborate the potential and challenges of IG in managing the dioxin problem of herring and salmon fisheries Study the preconditions and applicability of IG in managing complex social-ecological problems in marine contexts, and based on this, suggest how IG could be arranged in practice

similar expertise. The participants were asked not to formally represent their reference groups or institutions, but rather to provide their personal expert views. Both of the parallel group sessions included experts representing the fisheries sector and the food/public health sector. All of the participants evaluated both scenarios. Table 1 summarizes the methodological choices of the study.

To enable a fluent start of the discussions, the workshop organizers created *extended causal diagrams* [73], also called *insight networks* [74] as proposals to frame the problem; that is, to capture the key processes related to the dioxin problem, and to describe its governance and that of herring and salmon fisheries (Cf. Supplementary Material I-VI: Fig. S1–S4). This information was communicated to the participants prior to the workshop and they were encouraged to modify the diagrams as needed to create a shared understanding [73,74]; the experts accepted the diagrams as they were. In the workshop, the diagrams formed the starting point of the discussions and were elaborated.

4.2. Workshop

The main method to facilitate the group discussions was a SWOT-analysis. SWOT categorizes the internal resources and capabilities of an organization or an arrangement by identifying its strengths and weaknesses in achieving its goals, and its external environment by identifying opportunities that can favor attaining the goals, and threats that may affect goal attainment negatively [75–78]. SWOT involves the idea of strategic planning to take actions to benefit from the strengths and opportunities while avoiding weaknesses and threats, in order to maintain or achieve desired outcomes [77,79].

In the parallel sessions, the two groups addressed both IG Scenarios: one of the groups started with Scenario 1, and the other with Scenario 2, and then they switched topics. The facilitator of each Scenario discussion was the same for both groups. For Scenario 1, the facilitator was a researcher with expertise in fisheries, and for Scenario 2, the facilitator was a researcher from the public health sector. Both sessions also involved two social scientists who took notes. The discussions were recorded. In order not to limit the discussions, we did not define the concept of IG, for example in terms of which organizations would be involved and how, or at what intensity they would collaborate. Instead, we let the experts envisage the character of the concept by themselves, which was one of the aims of the study. In fact, since IG is a varied and evolving concept as mentioned above, it could not have been defined unambiguously. The experts were first asked to conduct the SWOT analysis individually by paper and pen, and then discuss it in the groups. The discussions of the two groups naturally differed from one another to some extent. However, the aim was not to compare the separate conversations, but rather to identify all issues raised. Thus, after the group discussions, the most obvious SWOT results were summarized and written up in a joint session.

To identify the potential and challenges of a governance arrangement that does not exist, we defined 1) *Strengths* as the positive preconditions of the current sectoral governance system to be developed into an IG arrangement, which could facilitate addressing the dioxin problem in a more holistic way. Strengths also included the assumed advantages of such a system as compared with the current one; 2) *Weaknesses* as disadvantages of integration as compared to the current system in governing the dioxin problem; 3) *Opportunities* as external features that would facilitate the integration, or positive external outcomes of the suggested new arrangement in dealing with the dioxin problem; and 4) *Threats* as external, potentially uncontrollable factors or events that would make the IG arrangement worse or ruin it. In our case, "internal" issues were seen as those immediately related to the herring and salmon fisheries and their dioxin problem (e.g. assessment and management of the fisheries, livelihoods depending on herring and salmon fishing, consumption of these fish), whereas "external" referred to issues beyond these fisheries and their dioxin problem (EB(F)M, fisheries governance, model development).

4.3. Post-workshop

The post-workshop analysis included transcribing and structuring the recorded discussions, and combining the results of the sessions. The aim was not to highlight who said what and compare the views or the sessions, but rather to build a synthesis of the discussions. Owing to this, and to ensure their anonymity, the experts are identified only by numbers (Expert 1 etc.) in the results. Yet, any major differences between the experts' views were acknowledged. The analysis focused on 1) the identified strengths (S), weaknesses (W), opportunities (O) and threats (T) of IG in our case study, and 2) practical ways of arranging IG. Distinguishing between strengths and opportunities that often appeared to overlap with each other, and between weaknesses and threats, was difficult for both the workshop participants and the analysts. The final categorizations were decided in the analysis. The methodology also included involving voluntary workshop participants as co-authors of this paper; three participants contributed.

5. Results

5.1. Session 1: IG of herring and salmon fisheries

5.1.1. Strengths

The experts agreed that there is a need to govern the dioxin problem of Baltic fish more efficiently than what it currently is (S1): "*Fishermen cannot get their fish into the markets with a reasonable price…Due to the fact that these dioxin issues are very much influenced by… people's feelings and impressions about what is going on instead of knowing enough to be able to base their behavior on facts. That affects, all the time, the fisheries sector and also other sectors in the Baltic area. So something must be done and could be done with that but the question is…how to do this" (Expert 5)*. Expert 2 described the situation in Sweden: *"We have this kind of stigma: everything that comes from the Baltic is polluted, it is…questionable whether can you eat it or not"*.

The experts viewed IG between herring and salmon primarily as a framework for multi-species assessment and management (S2). Multi-species assessment would enable exploring the interactions between herring and salmon and other relevant species, such as sprat and cod in the food web, and it could be used for simulating the potential of different actions, such as varying fishing intensity and/or selectivity in managing the dioxin problem of both fisheries [40,41,80,81]: *"Maybe you could, by fishing pelagics, have less dense stocks and you could lower the dioxin content and consequence would also be to lower the content in salmon" (Expert 1)*. Increasing the quotas was considered possible if fish biomass is large, whereas if it gets less dense, the normal MSY range should be applied. This was, however, considered to require a revision in the CFP and/or in the multiannual plan. The experts agreed that even a small reduction of dioxins could help opening new consumer markets for the fish, and thereby improve the profitability of fishing: "*It is just a figure, if you are below it, fine, if you are one % above then it is dangerous" (Expert 7)*.

The experts discussed if multi-species assessment could also enable elaborating other questions arising from the food web, such as the causes of the diet-related thiamine deficiency of salmon (the so-called M74 syndrome) [82,83] or the declined survival of salmon during the first year at sea (post-smolt stage) [84] (S3).

5.1.2. Weaknesses

However, the experts did not see the predator-prey relationship between herring and salmon as a sufficient justification for IG (W1). The predation of the relatively small salmon population on the much more abundant herring was considered as insignificant in this regard. The effect of herring on salmon stocks was seen as significant only in the northern areas of the Baltic Sea where it feeds especially on young herring while in the middle and southern parts of Baltic Proper salmon mostly prey on sprat [85]. All of the experts were neither convinced of the need to put more effort in managing the dioxin problem of the salmon fishery, as salmon is rarely available for consumers (W2). Expert 6 pointed out that IG of herring and salmon would be a politically difficult affair adding pressures upon the two fisheries that already now suffer from controversies related to e.g. fishing rights and areas (W3).

A significant limitation for reliable multi-species analyses was seen in a lack of suitable models and slow model development, especially as an analysis of herring and salmon would also involve a need to include sprat, cod, and other relevant food-web species, such as seals [86] (W4): *"As far as I know from the ICES, multispecies assessment is not applied yet…. So if it would be something that herring and salmon would be in the multispecies assessment, I think that it is quite hard way….The assessment side" (Expert 8)*.

The experts brought up major obstacles in reducing dioxins through fisheries management. The MSY-based management was considered to limit the setting of higher TACs to reduce dioxins by increasing fishing mortality (W5): "*Quota or catch advice is…based on this MSY-thinking. So it is fixed. Now when it comes to these health issues… the question is whether it would be, if these health issues give motivation to keep these stocks smaller than this MSY thinking... MSY, it is just biology, growth, environmental circumstances. No toxic substances" (Expert 4)*. Deciding between conflicting objectives, such as the level of TAC and reducing dioxins, was considered as a difficult tradeoff, easily leading to political tensions between the stakeholder groups (W6): "*I mean we could have smaller cod TAC and bigger herring TAC and thereby reduce the amount of herring to increase their growth rate and have more cod, which also predates on herring. Because that is the idea to get little less herring and increase their growth rate and decrease their dioxin content. So in a way it is possible. But it is very demanding for us, because then you have these conflicting objectives" (Expert 1)*. The other identified option, size-selective fishing to target fish with lower dioxin concentration, was seen as impossible on gear basis. Changing fishing area e.g. from the Bothnian Sea to the Baltic Proper to target fish with lower dioxin concentrations was seen as possible given that a fisher has quotas on both areas, but could be difficult, in practice, due to distances between the home ports and landing sites, as well as the location of fish factories (W7).

5.1.3. Opportunities

The experts saw potential in IG to address the common problems of fisheries management, such as the scientific advice and management decisions lagging behind the real situation of the fishery, quotas going up and down, and the consequent instability in the fishing industry (O1). IG involving multi-species assessments would entail a longer-term perspective to assessment and management, which would enable better understanding of the yearly variations in fish stocks (O2). IG, assumed to enhance communication skills, negotiation mechanisms and social learning (O3), could also increase trust and thus facilitate collaboration between scientists and fishers (O4). Using fishers' observations in stock assessment was regarded as important for a timely and relevant scientific advice. IG was also considered to enhance the ability of the participants to deal with controversies and conflicts (O5).

The participants associated IG with the implementation of EB(F)M (O6). Expert 15 remarked that this would promote the inclusion of ecosystem knowledge in stock assessments *"for the estimation of the productivity of the sea"* (O7). Moreover, this was seen as an impulse to address issues such as marketing and prices, supply and demand, consumer needs, food security[2], and social aspects of the fishing industry, and the related objectives (O8). In general, IG was viewed as a framework that enables new ways of thinking in fisheries management (O9). As an example, Expert 16 referred to giving up the sprat quota in the mixed fishery of herring and sprat: "*…because it goes up and down…it doesn't make sense to try to regulate it…"*. IG was also considered to facilitate tradeoffs in the individual transferable quota (ITQ) based management that has become more common in both herring and salmon fisheries (O10), and to support the MSC certification of the herring fisheries (O11). In general, it was highlighted that a holistic IG framework involving a multispecies approach and socio-economic aspects would imply better implementation of the CFP (O12): *"…one of the*

[2] Stabile availability, accessiblity, and utilization of food [97].

Table 2
Results of SWOT.

	Internal		External	
Scenario	Strength	Weakness	Opportunity	Threat
1. IG of herring and salmon fisheries	Socio-economic dimension (S1)	Predator-prey relationship poor justification (W1)	Improve relevance, timeliness and stability of fisheries management (O1)	Complex governance system (T1)
	Multi-species assessment and management (S2)	Poor relevance for salmon (W2)	Long-term perspective (O2)	Mismatch between multi-species models and fish stock assessment (T2)
		Add pressures on fisheries governance and management (W3)	Enhance communication, negotiation and social learning (O3)	Institutional obstacles in model development (T3)
		Lack of multi-species models (W4)	Enhance trust and collaboration (O4)	Conflicting objectives (T4)
	Elaborate food-web questions (S3)	MSY restricts management alternatives (W5)	Enhance ability to deal with controversies and conflicts (O5)	Consequences to relative stability (T5)
		Difficult tradeoffs and political tensions (W6)	Implement EB(F)M (O6)	Wrong conclusions or compromises (T6)
		Management instruments difficult to implement (W7)	Include ecosystem knowledge in stock assessment (O7)	
			Address social and economic issues (O8)	EB(F)M a vague basis for assessment and management (T7)
			New ways of thinking (O9)	
			Support ITQ (O10)	
			Support MSC (O11)	
			Better implementation of CFP (O12)	
			Baltic Sea as a testbed (O13)	
2. IG of fisheries sector and food/ public health sector	Holistic approach (S1)	Sectors too different (W1)	Implementation of EB(F)M (O1)	Messy system with unclear frames (T1)
	Up-to-date benefit-risk assessments (S2)	Mismatch of time scale (W2)	Support holistic modelling (O2)	Political tensions and power struggles (T2)
		Mismatch of spatial scale (W3)	Implementation of CFP (O3)	Lack of models (T3)
	Address differences in risk perceptions, management and consumption (S3)	Dioxins in fish vs. dioxins in other foodstuffs (W4)	Support Blue Growth (O4)	
	Consider threshold limits for dioxin regulations (S4)	Lack of expertise (W5)	Social learning (O5)	
	Analyse consequences of selling restrictions (S5)	Difficult trade-offs (W6)		
	Analyse impacts of TACs on dioxin levels (S6)			
	Identify different ways to manage the dioxin problem (S7)			
	Develop products and markets (S8)			
	Increase consumption of herring (S9)			
	Improve communication (S10)			
	Increase awareness (S11)			

targets of the CFP is the integration… I don't see any other way than get it into that process…" (Expert 2). The Baltic Sea, as one of the most studied seas in the world, was regarded as the best possible testbed for developing new forms of governance (O13).

5.1.4. Threats

Although the experts identified problems in the current TAC and MSY-based fisheries governance system, they also regarded it as well-established and simple, in a positive way. Multi-species assessment and management associated with IG were seen as a threat to the current single-species models, potentially disrupting the ICES advice or leading to criticism and political tensions, and making the system too complex (T1): *"The problem is that as soon as we talk about the integration and ecosystem, we end up saying that everything depends on everything so it makes things very complicated. And…in the end of the day it is the question about setting the TAC. It is a figure. It is very simple. It is a figure… the problem is that we must have something very very concrete, and we need to be very very sure that this works" (Expert 2).* A fundamental mismatch between multi-species models and the traditional fish stock assessment focusing on past and future changes in single-species fisheries was identified, and considered to hamper the development of multi-species models (T2): "*Traditional fish stock assessment path doesn't necessarily go very far, as we have seen in this three species model that was not very welcomed*" *(Expert 5)* [95]. Expert 16 identified institutional obstacles for model development (T3): "*The ICES is…very strict in the way how they accept assessment models. So… it is very difficult to have model that predicts in acceptable way herring, sprat and salmon at the same time"*. A major threat was seen in conflicting objectives between different fisheries, the objectives of the management of other species, such as seals, and the dioxin issue (T4): "*And what are these conflicting objectives? Well one main is that should we fish the pelagics, the herring and sprat, or should we fish cod. And what about salmon then? And because there is already ongoing discussion of where we have the highest value: is it in the cod fishery or in the pelagics? The Member States around the Baltic Sea are quite divided depending on the fish and the fish distribution. And then it is not only about fish… It is also…seals…human health and so on…conflicting objectives which we need to sort out, and that is a threat"(Expert 1)*. It was considered that the trade-offs would even affect the relative stability of sharing TACs between countries, which would be a politically difficult situation (T5): *"… we are taking fish from Finland and Estonia to protect the cod for Denmark, Germany and Poland and some of Sweden…Here we come down to politics and it works that way. We don't change it in paper, the relative stability, but in practice we do it, in some way…" (Expert 14)*. Integrated assessment was assumed to potentially result in wrong conclusions or compromising actions (T6), owing to a lack of understanding of interspecies dynamics, or even politics. IG was associated with the implementation of EB(F)M, yet the concept of EB(F)M was regarded as vague, and therefore as an inadequate guideline for IG (T7). In the assessment side, EB(F)M was seen as a framework that requires putting together information without a clear understanding of how this information should be used: *"I have been… trying to understand where they are heading. So far… it [EB(F)M] is more like bucketing of issues which they have selected that somehow indicate some changes of human pressures in the ecosystems and they have certain procedure to follow. But it is quite arbitrary although the basic principles are there. And it doesn't really lead to any deeper analysis. So at present stage it is basically just collecting information together about some things and that's it" (Expert 5)*. In the management side, the experts identified missing guidance on how to take decisions between conflicting objectives: "*… do we have knowledge at the moment how to manage fisheries on ecosystem based model…let's take for instance that we should have strong grey seal population in the Baltic Sea in order to reduce dioxin in herring. Are we willing to take that decision?" (Expert 9)*. The results of the SWOT-analysis are summarized in Table 2.

5.2. Session 2: IG of fisheries governance and food/public health governance

5.2.1. Strengths

Assuming that IG of fisheries governance and food/public health governance would support holistic discussions, analyses and management of the dioxin problem, the experts generally considered IG as an idea worth pursuing (S1), especially if this could enable selling herring fresh on the market instead of selling it for industrial uses. They envisaged that instead of only focusing on the risk of dioxins to human health, IG would cover a wider variety of dioxin related issues. It would motivate analyzing not only risks of herring and salmon to human health, but also the health benefits, and keeping the risk-benefit assessments and the related eating recommendations up-to-date (S2). It would facilitate analyzing differences in risk perceptions, and the relationship between risk perceptions, limit values, eating recommendations, and the consumption of herring and salmon, and taking the underlying uncertainties and ambiguities into account (S3). In general, IG would support wider considerations of the threshold limits for dioxin regulations, potentially taking into account other toxic substances and the cocktail effects (S4). Also, the advantages and disadvantages of the selling restrictions, including the health outcomes and the socio-economic consequences (e.g. maximizing benefit/risk ratios from fish consumption; labor impacts) could be assessed (S5): "*it would be very interesting to see risk-benefit analyses of restricting fishing of herring. Because that has these economic and social risks" (Expert 12)*. The framework could also imply assessing the impacts of higher or lower TAC decisions on the dioxin levels (S6). This would imply that at least to some extent, both EFSA and ICES would have to adjust their scientific assessment and policy making closer to each other: *"About the potential gaps between the scientific assessment and the decision making process…. they try to focus on scientific aspects instead of going into this messy field of interests and decision-making and so on. But… maybe an opportunity might be…to cover better in the assessments also the risk-management options and goals, questions like that. Economic issues, that whole area, which oftentimes gets somehow neglected in the natural scientific assessments" (Expert 6)*.

Overall, the experts agreed that IG, by facilitating a broader approach, would enable identifying a wider variety of ways to manage the dioxin problem (S7). This could improve the perceived quality of Baltic fish as food, lead to developing new products and consumer markets, including export (S8), and increase the human consumption of the underutilized but often abundant herring (S9): "*…in fact the dioxin is not very big problem. …The fishermen are rather healthy. But…to gain the access to the EU market. If we come up with good product. And if it is below the maximum levels. Then we could maybe get some more value out of the catch…" (Expert 1)*. In addition, it was highlighted that IG between the fisheries sector and the food/public health sector would improve the communication between the fisheries stakeholders, fish consumers, and the decision makers (S10). It would also increase awareness of the dioxin problem and its origins (S11).

5.2.2. Weaknesses

It was considered that the objectives, procedures and tools of the fisheries sector and the food/public health sector might be too different to be combined, and that compiling an integrated scientific advice between these sectors would be complex and time consuming (W1). Several difficulties were identified. First, a mismatch of time scale between the yearly fisheries management processes and the much longer risk assessment cycle of EFSA was recognized, yet, a 5-year period of EFSA recommendation was regarded as appropriate for fisheries governance as the health issues do not change so rapidly (W2). Second, an even more complicated issue was identified in the mismatch of the spatial scale between the regional dioxin problem and the pan-European dioxin risk assessment conducted by EFSA [50] (W3): *"The EFSA is doing these common risk assessments… the data comes from the Member States, and then it is pooled, and then the concentration data is used for the whole*

Europe. And 50% of that comes from Germany, around…And that is the reason, why many countries do national estimations or risk-assessment, because they want to show that in the national level it is not really a big issue, the certain intakes…" (Expert 12). Third, it was asserted that the fact that dioxins do not only contaminate fish but also other foodstuffs that affect the limit values restricts dealing with dioxins within the fisheries sector (W4). Expert 12 warned that IG between the fisheries sector and the food/public health sector could even turn too much attention to dioxins in fish in relation to dioxins in other foodstuffs at high cost, eventually contradicting the aim of solving the dioxin problem. Fourth, dioxins and associated issues in environmental chemistry, toxicology, nutrition and health were considered as difficult to address by the fisheries stock assessment bodies (W5). Fifth, deciding between the risk of overfishing and the risk of dioxins to human health in fisheries management was seen as an imbalanced trade-off under uncertainty, and thus as an additional burden for both sectors (W6).

5.2.3. Opportunities

The experts widely agreed that integrating food safety – and security - into fisheries governance would imply steps towards EB(F)M by widening the scope of fisheries governance to better cover socio-economic, health and ecological issues (O1), which would also boost the development of holistic modeling approaches (O2). "*An opportunity would be to understand, better, the mechanisms and what is really happening, and what the actual relationships are*…" *(Expert 8).* It was remarked that processing and marketing fishery products is acknowledged in the CFP but largely ignored in governance. Thus, as in Scenario 1, also Scenario 2 would improve the implementation of CFP (O3). Paying more attention to the socio-economic side of fisheries was seen to additionally support Blue Growth, i.e. sustainable economic growth in the marine and maritime sector (O4): "*I agree it is difficult to market more herring in our areas, but I think it should be an objective and I am sure it is an objective for all of us. Because we also have this blue bio-economy, which we try to develop and new products, maybe, I mean fish meal for human consumption or things like this. And there is a lot of work going on. So therefore I think it is relevant to take into account this human health part..." (Expert 1).* Finally, as in Scenario 1, activating interaction between actors representing different disciplines and sectors was assumed to enhance deliberation on management goals and options, resolving tradeoffs and thus enhance social learning (O5).

5.2.4. Threats

The experts envisaged that EB(F)M implemented through IG would imply more people and more species involved, more opinions, perceptions and interests, and more interactions to address. This could lead to a messy system for which it would be hard to define the frames, e.g. whether only dioxins in fish should be included or all dioxin exposures: *"We know a lot to take the decisions. But as always it comes down to politics. Do we have a playing field in the whole Europe or shall we just have it in the Baltic?" (Expert 14).* (T1).

Involving a variety of viewpoints, IG was assumed to lead to political tensions, and power struggles, and eventually difficulties in decision making, especially in crisis situations. Overall, a management scenario involving several conflicting objectives in terms of species and their economic value and food/public health, was seen as a threat to the current management system, as it would make it too complicated (T2). "*I can see that it is easy then to move to a kind of fight of power between these different administrative sectors…. People easily start to talk past each other, and there is nothing else but destruction as a result." (Expert 5.)* Also missing models for integrated assessments and multi-objective management was seen as potentially ruining the framework (T3). The results of the SWOT-analysis are summarized in Table 2.

5.3. How to arrange IG?

The experts identified much potential in IG, but also a wide variety of challenges in both Scenarios. In order to benefit from the strengths and opportunities while avoiding the weaknesses and threats, they considered adding new dimensions upon the existing governance system as the most appropriate way to arrange IG. A cautious start would enable proceeding gradually towards higher intensity integration, if considered necessary and possible.

5.3.1. Dialogue and information sharing

Expert 12 highlighted that comprehensive understanding of the dioxin problem is the most important, and that this implies a need to share information and deliberate the issue among different actor groups. Expert 6 highlighted that this type of discussions could take place in a less formal way: "*Not everything has to happen based on regulatory and public sector driven type of governance…I can see some new ways you can explore in addition to the more traditional approaches to risk management*". The regional organizations BSAC, BALTFISH, and HELCOM (Baltic Marine Environment Protection Commission) were referred to as organizations that could take up the dioxin issue on their agenda and potentially come up with a suggestion to the EU Commission or the Ministerial Council, on how to take dioxins into account in the management of the herring and salmon fisheries: "*Regionally, voluntarily, as a pilot, we can search for solutions within the range we operate. And that could be one way to do it, with smaller risks of actually getting into bigger problems. In this specific question I think that way. Than try to open the whole box and organize it*" *(Expert 5).* Another suggestion concerned exchanging dioxin related information received from EFSA between DG SANTE and DG MARE within the EC, and disseminating the information to the Ministerial Council that takes the decisions on TACs.

5.3.2. Coordination of expertise to increase coherence and consistency

The experts remarked that already now, the dioxin problem is, to some extent, acknowledged in the ICES Advice for both herring and salmon fisheries management. They suggested that this could be made more formal by a request from the EC to add discussion on the potential effects of the recommended TAC on the dioxin levels of both fisheries. It was highlighted that as the scientific advice has to follow the MSY rules, dioxins could not be taken into account in the TAC recommendation as such, but only discussed in the scientific advice. The food/public health dimension could be deepened by involving a statement from the EFSA in the fisheries management advice. In addition, the idea of establishing a food/public health expert group within the ICES was brought up, to elaborate dioxins and other fisheries related food safety – and security - issues, and to contribute to the advisory work accordingly. These types of coordination of expertise would inform the decision makers about the dioxin issue, to enable them to make coherent and consistent decisions.

5.3.3. Joint working to create synergies and shared policy instruments, contents or goals

The experts commented that the TACs for herring and salmon are decided in the same meeting of the Ministerial Council and that sometimes the Council has used dioxins as an argument for setting higher TACs: "*We have seen for many years that also ICES mentions in its advice that there are high dioxin levels also as a consequence of low fishing mortalities. So in fact we have used this as an argument in setting the TAC, that we need to have higher fishing mortalities also in order to help out this issue about the dioxin content…And we have also…tried to keep rather high TAC level. And we have had higher catches also. So this integration is already a part of the current situation. But it can be of course developed even further and regulated also*" *(Expert 1).* So, including information regarding the potential effects of the recommended TAC in the scientific advice would enable the Ministerial Council to consider this in a systematic way: "*What can be done in the Council, is…that we can, when we set the TAC, there is this range, and then we can use the arguments of dioxins for instance and then motivate why we should use the higher end of these fishing mortality ranges. So…that is what we can do nowadays" (Expert 1).*

The *Multiannual Plan for the stocks of Baltic Cod, Herring and Sprat* was considered as a step towards integrated governance and management of the species included, and the possibility to incorporate dioxins in it was discussed. Several experts remarked that the multi-annual plan leaves only little room for varying fishing mortality, although some flexibility was seen: "*That is the bottom line: to stay on the safe level of fishing mortality. But then you have the flexibility there where you can move… So you can…set the TAC for cod on the lower F-range, and then for herring you set it to the F upper range. Then it could be some sort of integration within the limits that we have now." (Expert 9).*

However, as it currently is, the multi-annual plan would exclude salmon from the assessments, and most of the experts did not regard including salmon in the multi-annual plan as a realistic option. On the one hand, the effect of salmon on the other species was regarded as too small and including various salmon stocks in the plan would thus make it even more complex than it already is. On the other hand, the exclusion of salmon from the multiannual plan was also considered to be a political decision, as the management of salmon mainly takes place in the river valleys and river mouths, outside of the EU quota regime.

Expert 16 suggested a shared long-term dioxin strategy for herring and salmon fisheries. It would provide a framework for setting joint dioxin-related objectives for the fisheries for the long term, and for developing different, either separate or shared, ways to achieve the objectives: *"So you don't need to predict the dioxin levels next year, but you may want to look at it longer time of minimums and maximums in the concentrations"*. Another suggestion concerned the building of joint scenarios for herring and salmon in the ICES, for exploring the consequences of different management actions for the fish populations, the dioxin levels, and potentially also for the food safety of the fish.

6. Discussion

Our results demonstrate that a variety of societal, political, institutional, operational, instrumental, and biological factors affect the applicability of IG, and thus work as positive or negative preconditions for IG. This was noted also by Stead and Meijers [68] who categorized facilitators and inhibitors of policy integration in spatial planning. Our study also suggests that despite the major obstacles that the experts identified for developing IG, there may be multiple ways to arrange IG in ways that enable benefiting from the perceived strengths and opportunities while avoiding the weaknesses and threats. Thus, the study indicates that the applicability of IG can be enhanced by seeking cross-sectoral linkages from the different phases of an existing management process by considering how new aspects could be internalized, and by which organization. We found such linkages in several areas, notably advisory activities of regional stakeholder organizations, scientific management advice, policy making, and decision making. Below, we first discuss the factors affecting the applicability of IG, as identified in this study. Then we suggest ways for crossing the sectoral boundaries in terms of IG.

6.1. Societal factors

A societal need for IG, and a recognition of this need among key stakeholders and governance actors is a precondition for its adoption [5, 10]. In our study, the societal need for IG was agreed by the multidisciplinary and multinational group of experts. They recognized the need for IG to develop new strategies to address the dioxin problem of the Baltic fisheries, based on the negative effects of the dioxin problem on the fisheries sector, fish consumption, and public health. The experts envisioned that by combining expertise, knowledge, data, and viewpoints between the two fisheries policy domains and/or between the fisheries and the food/public health sector, IG could produce suggestions on new combinations of policies, regulations, information steering, and technical measures (e.g. processing of fish) for the management of this multidimensional problem. Yet, they identified several reasons why this might not succeed, as will be demonstrated in the following sections.

6.2. Political factors

The societal need for IG involves a requirement to acknowledge the competing political objectives that a fragmented single-sector governance may undermine – often to the detriment of the relatively weaker ones [87]. In this study, the importance of evaluating the socio-economic objectives of the fisheries sector alongside public health in the governance of the dioxin problem was acknowledged, and IG was considered as the way to broaden the variety of management objectives. However, the results show that a worry of the involved tradeoffs and pressure, power struggles, unintended impacts to third parties, and political friction may suppress the motivation to develop IG. A broader problem-framing and associated working towards a shared understanding of the values and facts underlying the competing objectives is, however, the strength of IG. Thereby IG enables the pursuit of different objectives by assessing the consistencies and inconsistencies between them, and the potential direct and indirect effects of alternative decisions [5,10].

6.3. Institutional factors

The CFP [35] and the included requirement for the implementation of EB(F)M acknowledge the importance of integrated and inter-sectoral approaches to address the interrelationships between biological, social, and economic issues in the management of complex problems. Thus, in theory, they provide favorable institutional preconditions for IG. In practice, implementing cross-sectoral approaches within the CFP may be difficult, as highlighted by the workshop participants. The concept of MSY incorporated in the CFP guides fisheries management in biological terms, but it does not incorporate social, economic, health or other, also more purely "political" targets [88,89]. The MSY-driven fisheries management system is also poorly compatible with EB(F)M [6,88]. Whereas EB(F)M is an integrated approach that considers multiple species and the entire ecosystem, including humans [7], the MSY-based management deals with single-species assessment. Despite that the concept of EB(F)M has been elaborated in countless scientific articles and policy documents (see e.g. [7]), it is still considered as vague, especially in practical terms, as shown in this study. The results indicate that due to the path dependency in the MSY approach [2,6,90], the CFP has not kept up with the requirements of EB(F)M. This may function against the development of the governance system towards integration.

6.4. Operational, instrumental and biological factors

An operational-level precondition for IG is that the governance actors have a motivation to think in a cross-sectoral way, and a willingness to develop their expertise towards using cross-sectoral knowledge. However, the institutional path dependency noted above is related to the established expertise, which may imply rigidity in operational working practices [6,10]. A requirement of, for example, integrated modeling associated with IG may thus discourage or prevent the adoption of IG if the existing institutional framework favors single-species assessment. In the case analysed here, several challenges were identified in the potential modeling approaches to integrate data and knowledge across the policy domains. These related to the complexity of interactions between species in the food web, differing procedures and tools between the sectors, mismatch between the assessment and management scales, and as the most prominent – lack of models. Nevertheless, cross-sectoral knowledge and expertise is not only needed for assessment models, but also for practical governance, in the application of models, and in providing feedback for their development. Such expertise encompasses both operational and instrumental-technical considerations, and tacit (e.g., traditional and experiential) knowledge.

6.5. Large concepts have small beginnings

This study suggests that establishing an IG framework by adding new aspects upon the current governance structures may be easier to accept and adapt to, than creating new strategic or advisory bodies or other new capacities. A less radical approach can open the way for the benefits of inter-sectoral interaction, while avoiding the difficulties and pitfalls that a radical change might bring about. Incremental transformation also enables considering alternative pathways in the long term and building integrated approaches upon the know-how, expertise and experience built up in the organizations over time [6]. Here, the experts identified different phases of the governance process for internalizing the dioxin question in the fisheries management system.

Dialogue and information sharing within and between non-governmental regional and/or stakeholder organizations would represent a “soft” governance approach [91], to overcome the rigidity of the formal regulatory framework in designing and implementing new types of innovative governance practices or instruments [92,93]. In the case studied here, the BSAC, BALTFISH and HELCOM were seen as flexible enough for taking up the dioxin issue and for producing non-binding instruments or flexible rules for the management of the dioxin problem (see [24]). This would also imply a bottom-up initiative to broaden the formal and normative fisheries governance and management in an incremental way.

By incorporating cross-sectoral information in the scientific management advice or policy proposal for the decision makers on a “need to know” basis [87], the scientists or policy makers could promote policy coherence, although not ensuring that the information is taken into account in the decisions. High-level work by the Ministerial Council and EC towards the development of shared long-term strategies would represent a legally binding IG arrangement. Joint long-term strategies would facilitate avoiding the problems related to the mismatch between MSY and EB(F)M as they would leave room for seeking sector-specific solutions for jointly decided goals.

This study in general suggests that regardless of the strong link between IG and EB(F)M, viewing IG as a framework that facilitates holistic understanding of shared problems and that enables, but does not require, integrated assessment and management, may be more useful for adopting IG than considering it mainly as a framework for integrated modeling. The study also envisions that as IG promotes communication and social learning, it can, in time, evolve towards more sophisticated EB(F)M frameworks.

Finally, the study shows that IG does not have to imply an equal integration of sectors, as integration may be more relevant for one sector than another. Here, the potentials and challenges of IG were analysed from the perspective of the fisheries sector, while benefits arising from the framework for the food/public health sector were also recognized (Cf. [87]).

7. Conclusions

IG provides a synergistic framework to link sectors, ecosystem elements, actors, and administrative levels in order to base the governance and management of complex problems on co-created holistic knowledge and views, as required by EB(F)M. However, a variety of societal, political, institutional, operational, instrumental and biological factors – likely also economic ones - affect the applicability of IG in the marine field and work as preconditions for it. According to this study, major challenges for IG relate to 1) a societal need for IG, 2) competing cross-sectoral objectives, 3) path dependencies, and 4) limitations of experts to think and work in a cross-sectoral way. The challenges can be overcome by less radical IG approaches that add new aspects upon the current governance structures instead of creating new strategic or advisory bodies or other new capacities. Viewing IG as a framework for understanding cross-sectoral issues rather than a framework that requires integrated assessment and management, may be a way towards social learning, and thereby, towards the implementation of EB(F)M in a more sophisticated way.

CRediT authorship contribution statement

Päivi Haapasaari: Conceptualization, Methodology, Verification, Formal analysis, Investigation, Resources, Data curation, Writing - original draft, Writing - review & editing, Project administration, Funding acquisition. **Suvi Ignatius:** Conceptualization, Methodology, Validation, Investigation, Data curation, Writing - review & editing. **Mia Pihlajamäki:** Conceptualization, Methodology, Validation, Investigation, Writing - review & editing, Visualization. **Andreas Bryhn:** Investigation, Review and editing. **Simo Sarkki:** Conceptualization, Methodology, Validation, Writing - review & editing. **Jouni Tuomisto:** Conceptualization, Methodology, Validation, Investigation, Resources, Writing - review & editing, Visualization. **Lauri Ronkainen:** Writing - review & editing. **Annukka Lehikoinen:** Investigation, Writing - review & editing. **Timo Assmuth:** Writing - review & editing. **Atso Romakkaniemi:** Writing - review & editing. **Heikki Peltonen:** Writing - review & editing. **Sakari Kuikka:** Writing - review & editing.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.marpol.2020.104276.

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