TRANSDISCIPLINARY MARINE RESEARCH

Bridging Science and Society

Edited by Sílvia Gómez and Vera Köpsel

First published 2023

ISBN: 978-1-032-31760-1 (hbk)
ISBN: 978-1-032-31758-8 (pbk)
ISBN: 978-1-003-31117-1 (ebk)

8

STAKEHOLDERS' NORMATIVE NOTIONS OF SUSTAINABILITY

A survey for the co-design of a sustainable future of the Western Baltic fishery system

Viola Schaber, Marie-Catherine Riekhof, Michael Stecher, Rudi Voss, and Stefan Baumgärtner

DOI: 10.4324/9781003311171-10

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

earthscan
from Routledge

8

STAKEHOLDERS' NORMATIVE NOTIONS OF SUSTAINABILITY

A survey for the co-design of a sustainable future of the Western Baltic fishery system

Viola Schaber, Marie-Catherine Riekhof, Michael Stecher, Rudi Voss, and Stefan Baumgärtner

Introduction

Fisheries provide livelihoods for many people, are of enormous economic importance across the globe and are part of many socio-cultural traditions (FAO, 2020). Besides commercial fishing, recreational fishing has gained in importance and sometimes even surpasses commercial fishing in some of these aspects (Cooke and Cowx, 2006; Ihde et al., 2011). Together with increases in world population and consumption, fish and seafood removals have increased four-fold over the past 50 years (Ritchie and Roser, 2021; Crona et al., 2016). Especially when fishery management fails, stocks tend to be overfished (Hilborn et al., 2020), with a share of 35% (and rising) of global fish stocks being exploited above sustainable levels in 2017 (FAO, 2020). In addition to unsustainable fishing levels, climate change and socio-economic developments put additional pressure on marine ecosystems. To counteract this unsustainable trend, the United Nations (UN) formulated 17 Sustainable Development Goals (SDGs), all of which are connected to natural resource use. Returning fisheries to sustainable levels is a difficult challenge for fisheries management as fisheries are embedded in complex marine social-ecological systems (Lade et al., 2015). Therefore, fisheries management increasingly aims for stakeholder participation and co-design, which has become a fundamental component of many states' and local agencies' fisheries legislations worldwide (NOAA, 2015, Commission of the European Communities, 2013). The involvement of stakeholders is thought to secure access to local social-ecological knowledge of fishers to complement scientific data as well as to increase the legitimacy and support for management (Aanesen et al., 2014). The Western Baltic Sea (WBS) is an interesting case study to examine the challenges for returning to a sustainable use of fishery resources, as its social-ecological system is comparatively simple: the number of species harvested is relatively small (HELCOM, 2018c), user groups

DOI: 10.4324/9781003311171-10

are clearly defined, and regulation is straightforward as all bordering countries are members of the European Union employing a common fisheries policy. In addition, recreational fishing plays an important role (e.g. in 2020 for cod: 30% of the total catches originated from recreational catches) and is already included into fisheries management (ICES, 2021b). Existing management measures in the framework of the European Common Fisheries Policy (CFP) with its overarching goal to achieve the Maximum Sustainable Yield (MSY) (EU, 2013) have partly been unsuccessful, and many stocks are in a bad state. In the case of the European Union, advice on catch opportunities is given by the International Council for the Exploration of the Sea (ICES). ICES use a precautionary approach and the concept of safe biological limits to define the state of fish stocks (ICES, 1998). Stocks outside such limits suffer increased risk of low recruitment, causing impaired stock productivity and hence reduced harvesting potential.

While the role of stakeholders' different views on "sustainability" in general and on sustainability assessment in the building sector in particular has been recently taken up in the scientific literature (e.g. Soma et al., 2018; Oen et al., 2010), an explicit discussion of the normative dimension is rare. Withycombe-Keeler et al. (2015) and van der Heel (2018) are notable exceptions. Van der Heel (2018) stressed the need for more explicit engagement with the normative and political dimensions of sustainability research; survey data revealed that sustainability researchers generally acknowledge the value-laden and political nature of their work, yet perspectives on what this means and how to deal with such dimensions vary. To address the problem of freshwater shortages in Phoenix, Arizona, Withycombe-Keeler et al. (2015) suggested a transition to sustainable water governance based on different simulated scenarios including normative values and preferences derived from a stakeholder survey. In a questionnaire survey about direct and indirect impacts on benthic habitats through the capture fishing sector (conducted among others in the Baltic Sea), Soma et al. (2018) found that stakeholder preferences vary across European regions and stakeholder groups.

In this chapter, we explore the notion of sustainability as a normative goal for fisheries management from a societal perspective, using the (German) WBS as a case study. We aim to understand how a "sustainable development of the WBS" is perceived from different stakeholders of the Western Baltic fishery. Sustainable development refers to an ideal conception of how the WBS should be maintained and utilized in the long term – now and in the distant future – from a societal perspective. In particular, sustainability means ensuring opportunities for human use and income as well as achieving good ecological conditions. Political decisions and measures should be directed towards achieving this ideal.

To operationalize the idea of a sustainable development of the WBS, we employ the concept of stochastic viability (Béné et al., 2001; Baumgärtner and Quaas, 2009; Doyen and De Lara, 2010; Béné and Doyen, 2018). This allows us to inquire about the different components of sustainable development in a structured way, taking uncertainty explicitly into account. Using the concept of stochastic viability returns quantitative results which can be directly utilized in fisheries management. In addition, this scientifically guided elicitation process represents views from the

different stakeholder groups in a consistent way, providing a base for further discussion, and for co-designing a sustainable future for the WBS fishery. The elicitation process itself can be interpreted as co-producing insights for fishery management: science provided a clear and unified terminology regarding "sustainability" incorporated in a questionnaire, and stakeholders provided their insights.

We make use of the transdisciplinary set-up of the research project marEEshift, as a part of which a meeting with stakeholder groups relevant to the Western Baltic fishery was held. At this meeting, we carried out a questionnaire-based survey among stakeholders to elicit their specific ideas of different aspects of stochastic viability. In such a co-production process of transdisciplinary approaches, challenges emerge from the selection of stakeholder groups and their influence on the outcomes. One fundamental challenge that emerged from the study in that regard is that individual stakeholders may or may not represent their respective group well, since it is very difficult to gauge whether a stakeholder speaks for him- or herself, or on behalf of the whole group. Additionally, the seeming liberty to make choices based on a conceptual "ideal world" appeared to be confounded by the participants values that seemed to be based on their knowledge and experienced based perception of the problem area.

The WBS – a socio-ecological system in transition

The Baltic Sea is an ecologically unique inland sea of the North Atlantic Ocean and comprises one of the world's largest bodies of brackish water (Figure 8.1). It is subject to a multitude of anthropogenic impacts imposed by about 85 million

FIGURE 8.1 The Western Baltic Sea (dark grey) with its ICES subdivisions for management.

people living in its 14 bordering countries. Human activities related to the Baltic Sea range from fish and shellfish harvesting, aquaculture, tourism and recreation, renewable energy production and transport infrastructure to shipping (HELCOM, 2018a). The Baltic Sea contributes to human health and wellbeing and is of great socio-cultural, environmental and economic importance (Ahtiainen and Öhman, 2014; Hasler et al., 2016; HELCOM, 2018b). The Baltic Sea can be regarded as an example of negative impacts of human activities and climate change on ecosystem health, which, in turn, has a negative impact on its economic contribution (ability to provide goods and services) and also affects the general wellbeing of citizens (HELCOM, 2018a). Among the provisioning services, provision of food in terms of fisheries is highly important. In total, 230 fish species (including 30–40 freshwater species) have been reported in the Baltic Sea (including the transition areas to the North Sea – Kattegat and Öresund; ICES, 2020), of which only a few are of economic importance.

The WBS is a comparatively small area in the south-west of the Baltic Sea (Figure 8.1) with distinct ecological dynamics and socio-economic characteristics. As for the whole Baltic Sea, tourism plays an important role for the local economy. Food web dynamics in the shallow Western Baltic differ from the larger and deeper Central Baltic, and it is home to regional cod (Gadus morhua) and herring (Clupea harengus) stocks. These two stocks, along with plaice (Pleuronectes platessa), form the backbone of the German fishery in the Western Baltic.

The German fishery in the WBS consists of a small artisanal fishing fleet, mainly composed of 12 m gillnet cutters and a few larger (up to 40 m) boats (BMEL, 2020; Döring et al., 2020; Papaioannou et al., 2012, 2014). In addition to these fleet segments, recreational cod and herring fishing also plays a crucial role (Hyder et al., 2017). Between 2004 and 2006, 113,000 to 147,000 anglers fished in the coastal waters of the Baltic Sea (Mecklenburg-Western Pomerania and Schleswig-Holstein), catching fish for personal consumption (BFAFI, 2007); in 2014/2015, about 161,000 anglers were identified (Weltersbach et al., 2021). They invest about €118 million annually for their angling-related activities. They have to be considered an important part of the fishery, as they take about one-third of the total cod quota in the case of Western Baltic cod (Hyder et al., 2017; ICES, 2021b).

While catches of the German Western Baltic fishery are comparatively low, the socio-cultural-economic value of fisheries to the local coastal communities is very high (e.g. HELCOM, 2018b; Döring et al., 2020). Local employment opportunities are supported, and tourism in the area is boosted in coastal fishing communities (Döring et al., 2020; Papaioannou et al., 2014).

In the past decades, the marine environment has deteriorated significantly for cod and herring reproduction (Mackenzie et al., 2007; Köster et al., 2017; Voss et al., 2019), and the Western Baltic cod and herring stocks are below safe biological limits (ICES, 2021a, b). As a consequence, strict catch limitations have been enforced for the commercial as well as the recreational fishery. Beyond the negative effects on the economic situation of the fisheries sector – the size of the German coastal gillnet fleet has decreased by more than 50% (e.g. Möllmann et al., 2021)

over the last three decades – these measures have damaged the livelihoods of coastal fishers and have a negative impact on their cultural identity.

Eliciting sustainability conceptions during engaged stakeholder workshop

Selection of survey participants and implementation

Based on a stakeholder mapping by Schwermer et al. (2021), representatives of relevant stakeholder groups in the Western Baltic fisheries were identified. In a second step, individuals who were interested in collaborating with the *marEEshift* project were identified within each of the stakeholder groups, resulting in a list of 61 possible participants. These included potential representatives from science, various practitioners and cooperatives, including commercial and recreational fishers (i.e. anglers), angling associations, fishing communities/protection associations and angling magazines, administration, politics and various NGOs.[1]

For the "Western Baltic Summit" workshop, two invitations were sent out in advance to these 61 people, the second containing a more detailed description and agenda of the workshop (see Appendices A and B). The "Western Baltic Summit" took place in November 2019 in Hamburg (Germany), which was easy to reach for most participants. The workshop was held in a small venue to establish a relaxed professional atmosphere. In total, 21 people attended the workshop and answered the questionnaire (see Table 8.1). We evaluated the selection of participants by asking for a self-assignment to different groups right at the beginning of the questionnaire (see further).

After a welcome reception, the leading scientists of the *marEEshift* project presented the aims and scope of the project in a short and concise manner. This input was given to communicate the research questions to the stakeholders and lay the foundation for a subsequent open discussion. The discussion was oriented along several guiding questions (see Appendix C), was guided by a professional moderator, and took approximately 60 minutes. Key discussion points were captured on a flipchart.

The survey took place immediately after the discussion. Before the questionnaire was handed out, we introduced and explained the survey (for key points, see Appendix D). In particular, we stated the survey aims, delineated the region under consideration, roughly explained the concept of sustainability and pointed to both the economic and ecological dimensions of the problem. Notably, we asked participants to focus on sustainability as an ideal objective and – to this end – ignore potential restrictions of conflicts and problems of implementation ("Imagine we could achieve everything that we wanted"). Also, participants were asked to take a non-partisan perspective rather than raising partisan claims, and they were also instructed in how to technically fill in and return the questionnaire.

Twenty participants answered the survey directly and individually filling out the questionnaire in a timeframe ranging from 15 to 25 minutes. One participant

submitted the questionnaire electronically after the workshop. After the time reserved for answering the survey, lunch was provided, and there were further discussions and feedback in smaller groups.

Sustainability under uncertainty: stochastic viability

We wanted to better understand the stakeholders' normative ideas of how the Western Baltic fishery system *should* look like. To capture the normative idea of strong ecological-economic sustainability under uncertainty about future developments, we built on the concept of stochastic viability (Béné et al., 2001; Baumgärtner and Quaas, 2009; Doyen and De Lara, 2010; Béné and Doyen, 2018). The basic idea of stochastic viability is that the continued existence of certain ecological-economic system components and functions is guaranteed for a determined time period with a sufficient probability. To specify stochastic viability for a given ecological-economic system, one therefore needed to specify the following: (i) which ecological and which economic services flow from ecological and economic stocks, and (ii) which levels of ecological and what economic stocks, should be maintained (iii) over what time horizon (iv) at what level of certainty, that is, at what minimum probability?

We supposed that stakeholders when thinking normatively about sustainability have, perhaps only implicitly, a concept of stochastic viability in mind. The survey questions are designed such as to explicate their specific concept of stochastic viability of the WBS system. While this concept captures the norm of sustainability, that is, how the future development of the WBS system *should* be, the management question of *how to implement* such a development subject to the various actual constraints is a conceptually different and independent question. With the survey questions we aimed at explicating stakeholder's normative concept of sustainability, and not any opinions about potential implementation.

Questionnaire

The questionnaire was formulated in German and consisted of a short introduction, which emphasized its normative nature, followed by seven questions (see Appendix E). Our aim was to keep the questionnaire as short as possible and at the same time collect all the information that, in addition to the stakeholder survey, also contains quantitative parameters that can be used in later quantitative analyses. We chose the questions accordingly and asked for minimum, optimum and maximum levels whenever needed. The first question asked the participants to self-assign themselves to a stakeholder group by offering several options, and the last question asked for further comments. Questions 2–5 aimed at specifying the different components of stochastic viability for the Western Baltic from a stakeholders' perspective, that is, of determining (i)–(iv) defined earlier. In terms of service flows, we asked in Question 2 for the ideal number of commercial fishers, the ideal catches for anglers, as well as the relative distribution of total harvest between commercial fishers and anglers.

Question 3 focused on economic stocks in terms of port infrastructure and distribution channels. Question 4 was related to management principles and thus to the ecological/biological stocks in terms of fish stocks and the entire ecosystem. Finally, Questions 5 and 6 related to the time frame and the level of certainty in fisheries management.

Questionnaire on the sustainable development of the Western Baltic Sea

[Introduction text, not translated, see Appendix E]

1) Which of the following groups do you belong to or represent?

- Commercial fishers, full-time
- Commercial fishers, part-time
- Recreational fishers, non-commercial
- Nature conservation
- Administration & Politics
- Commerce
- Fish processing
- Tourism
- Science
- Other group: _____

2) The ideal use of the western Baltic Sea from a societal perspective refers, among other things, to the roles of commercial and recreational fishers.

a) From a societal perspective, how many commercial fishing enterprises (main occupation) from Germany should permanently fish the Western Baltic Sea?

Minimum: _____ Ideal: _____ Maximum: _____

b) From a societal point of view, how many full-time employees should there be in these commercial fishing enterprises in addition to the owner?

(The answer does not have to be in whole numbers, e.g., 0.5 means a half-time position.)

Minimum: _____ Ideal: _____ Maximum: _____

c) From a societal point of view, how many part-time commercial fishers from Germany should permanently fish the Western Baltic Sea, in addition to the number of commercial fishing enterprises mentioned above?

Minimum: _____ Ideally: _____ Maximum: _____

d) For recreational fishers, in addition to the fishing experience and the size of the fish caught, the number of fish caught is important. From a societal point of view, how many fish per day and species should an individual angler be allowed to take from the Western Baltic Sea in the context of sustainable use?

Cod (Gadus morhua): Minimum: _____ Ideally: _____ Maximum: _____

Herring (Clupea harengus): Minimum: ____ Ideally: _____ Maximum: _____

Plaice (Pleuronectes platessa): Minimum: ____ Ideally: ____ Maximum: _____

Sprat (Sprattus sprattus): Minimum: _____ Ideally: _____ Maximum: _____

Whiting (Merlangius merlangus): Minimum: ___ Ideally: ___ Maximum: ___

Sea trout (Salmo trutta): Minimum: _____ Ideally: _____ Maximum: _____

Else. _____ Minimum: _____ Ideally: _____ Maximum: _____

Else. _____ Minimum: _____ Ideally: _____ Maximum: _____

e) Commercial and recreational fishers fish the same fish stocks in the Western Baltic Sea. In what proportion should the two groups ideally use the fish stocks? That is, what relative proportion (in percent) of the total catch per species should be taken by commercial and recreational fishers?

	Share of catch	
	Commercial fishers	*Recreational fishers*
Cod:	%	%
Herring:	%	%
Plaice:	%	%
Sprat:	%	%
Whiting:	%	%
Seatrout:	%	%
Other: _____	%	%
Other: _____	%	%

3) Sustainable development of the Western Baltic Sea also includes an idea of how fishing should be organized. This is reflected e.g. in the type and number of fishing ports as well as the marketing possibilities of the fish.

a) From a societal point of view, how many fishing ports should there be permanently on the German Baltic coast that . . .

(i) . . . are geared to the needs of commercial fishing?
Minimum: _____ Ideally: _____ Maximum: _____

ii) . . . are geared to the needs of recreational anglers?
Minimum: _____ Ideally: _____ Maximum: _____

b) A variety of distribution channels are available to commercial fishers to market the fish. From a societal perspective, what percentage of fish should be marketed through which distribution channel?

_____% Direct marketing (e.g. restaurants, sales to local residents and vacation guests)
_____% Cooperatives
_____% Wholesale market
_____% Other: _____

4) Sustainable development also involves maintaining fish stocks and the entire ecosystem in a certain state. From a societal perspective, which of the following principles should ideally be applied? (Please select one answer.)

The ecosystem and fish stocks should . . . .

- be permanently maintained at current levels.
- permanently reflect the condition before industrialized fishing began in the mid-20th century.
- be in such a condition that all native species are permanently conserved.
- be in such a condition that the biologically maximum possible amount of fish can be taken per year on a permanent basis.
- be in such a condition that permanently the profit of the commercial fishery is maximized.
- be in such a condition that ideal use by recreational fishers is permanently possible.
- be in such a condition that a good ecological status of the Baltic Sea (i.e. with regard to eutrophication, pollutant load and biodiversity) is achieved.
- *Other:* _____

5) Sustainable use and conservation of ecosystems also refers to future generations. For how many years into the future should we consider the use and conservation of the Western Baltic Sea?

_____ years

6) Future developments are always uncertain. It may not be possible to achieve the minimum levels you mentioned in questions 2 and 3 every year, despite all efforts. The certainty with which the levels will be achieved can be increased by specified, but these are costly.

With what degree of certainty should all minimum levels mentioned in questions 2 and 3 be met each year within a time horizon of 10 years? (100% = absolute certainty, 0% = complete uncertainty).
_____ % certainty

7) Do you have any other comments or additions on what sustainable development of the Western Baltic Sea should look like from an overall societal perspective?

_____

Stakeholder views on the sustainable development of the Western Baltic Sea

We present the survey participants' answers according to self-selected groups (hereafter referred to as "stakeholder groups") the corresponding survey participants affiliated themselves with (Table 8.1).

Seven respondents represented non-commercial recreational fishers, three of whom also assigned themselves to the commercial and tourism sectors. Furthermore, two respondents represented the stakeholder of full-time commercial fishers, one person represented science, six participants represented the field of nature conservation and four persons represented the field of administration and politics. One person self-identified in both areas nature conservation and administration and politics. This person only answered Question 5 in numerical terms (the answer was counted to nature conservation) and otherwise put down comments.

Ecosystem services: recreational fishing

The provision of food is an important ecosystem service provided by the Baltic Sea. For individual anglers, in addition to the fishing experience and the size of the fish caught, the number of fishes caught is particularly important.

We asked, how many fish per day per species an individual angler should be allowed to catch in an ideal world regarding a sustainable use of the WBS Sea. Related to the viability concept, we asked for the minimum, optimum and maximum number. We observed the following three results: First, this question was only answered by half of all participants. While the answers from the group of recreational fishers were almost complete, only 1–2 participants from the other

TABLE 8.1 List of survey respondents, by self-allocation into stakeholder groups they represent*

Participant "P"	*Stakeholder Group*
1	Recreational fishers, non-commercial; commercial; tourism
6	Recreational fishers, non-commercial; commercial; tourism
4	Recreational fishers, non-commercial (non is crossed out); tourism
2	Recreational fishers, non-commercial
7	Recreational fishers, non-commercial
12	Recreational fishers, non-commercial
16	Recreational fishers, non-commercial
20	Other groups (working group fishery)
3	Commercial fishers, full-time
19	Commercial fishers, full-time
5	Nature conservation
10	Nature conservation
17	Nature conservation
18	Nature conservation
21	Nature conservation
8	Nature conservation, Administration and Politics
9	Administration & Politics
11	Administration & Politics
13	Administration & Politics
14	Administration & Politics
15	Science**

*Original question: "Which of the following groups do you belong to or represent?"
**Since only the results of the different stakeholder groups are relevant in the context of this work, the results of the participant from the scientific community have not been considered here.

groups answered this question. Second, the responses within the recreational fishers group were quite similar in terms of the optimal values being consistently between the minimum and maximum values. Third, the participants from administration and politics and especially from nature conservation on average consider a lower removal of fish from the sea to be more sensible than the two groups of fishers. One exception is the response for herring of one participant from administration and politics, who did not provide a numerical value, but rather a quantity of 10 kg (this value was converted into numbers by us on the basis of an average weight and corresponds to about 133 individuals). Numerical values for other fish species, such as sprat, whiting and sea trout, which were also included in the questionnaire, were only fully provided by the recreational fishers and the nature conservation stakeholders (see Appendix F).

The fact that only half of the participants answered these questions suggests that many participants found it difficult to provide specific numerical values in relation to catching fish. As far as the almost complete responses to that question from within the group of recreational fishers and the similarity of responses within this

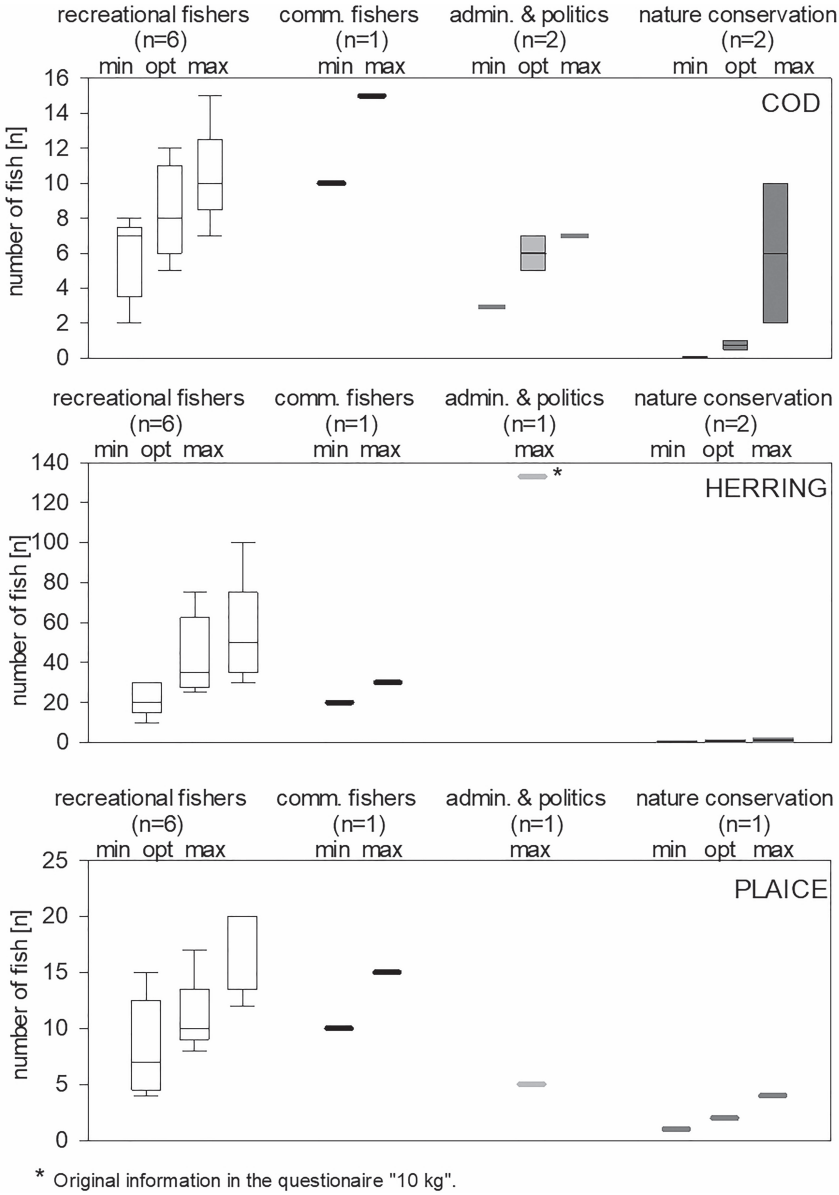

FIGURE 8.2 "How many fish should an individual angler be allowed to catch per day from the Western Baltic Sea?" Minimum (min), optimum (opt) and maximum (max) numerical values per target species are given. Answers are grouped by stakeholder groups. The box corresponds to the range in which the middle 50% of the answers are located. The lower line shows the absolute minimum value, the upper line the absolute maximum value, the line inside the box is the median.

group are concerned, we hypothesize that this is due to this group in particular being directly affected by fishing regulations measured in numbers.

Furthermore, we received interesting comments representing the different norms and values of the stakeholder groups. The questionnaire asked for a minimum, an optimum and a maximum value. With the exception of sprat (no answer), Participant P6 did not enter a numerical value for the maximum but commented with "only own consumption", which conveys the value that everyone should have the right to self-sufficiency, that is, to catch fish for their own consumption, but not for sale. Participant P19, representing the group of commercial fishers, conveyed the value of the freedom of each individual and commented that the ideal catches of a species should be determined by the angler himself "as much as he can/wants". Additionally, a third approach became apparent, where several participants (from all stakeholder groups except commercial fishers) referred to scientific fish stock assessments and made the removal of fish dependent on the results of such research.

For example, this was evident in commenting that catches should be managed according to "limit reference points" for spawning stock biomass (P16), as currently used in the assessment of the International Council for the Exploration of the Sea (ICES), or following scientifically advised catch scenarios when the stock status required (P14). In addition, one respondent (P9) argued in more detail that there should be no limit on catches except for temporal restrictions (no catch) during the spawning season of the corresponding fish species. The participant additionally raised the question whether taking fish also meant killing them – referring to sport fishers who sometimes catch fish and put them back into the sea ("catch and release"). This point obviously was not adequately addressed by the introduction and formulation of the questionnaire.

Distribution of ecosystem services among commercial and recreational fishing

Since commercial and recreational fishers largely exploit the same stocks in the WBS, we asked in what proportion the two groups should ideally use the fish stocks and share the services provided by the fish stocks (Figure 8.3).

We observed the following: First, all stakeholder groups allocated shares to both user groups. Second, shares allocated to the groups were positive for all considered species. This means that all groups, including the nature conservation group, agreed on the normative goal of a sustainable use of the sea, as in contrast to a complete protection by, for example, a no-take scenario. Third, all stakeholders ranked both groups in a qualitatively similar way, with an overall larger share allocated to the commercial fishery (40%–80% of the total harvest). In comparison, less than 40% of the total fishery harvest should be caught by recreational fishers. Fourth, commercial and recreational fishers each put a higher relative emphasis on their own group specifically related to cod catches. These results are highly interesting, as they show converging ideas on norms within and between stakeholder groups. The first two observations suggest that

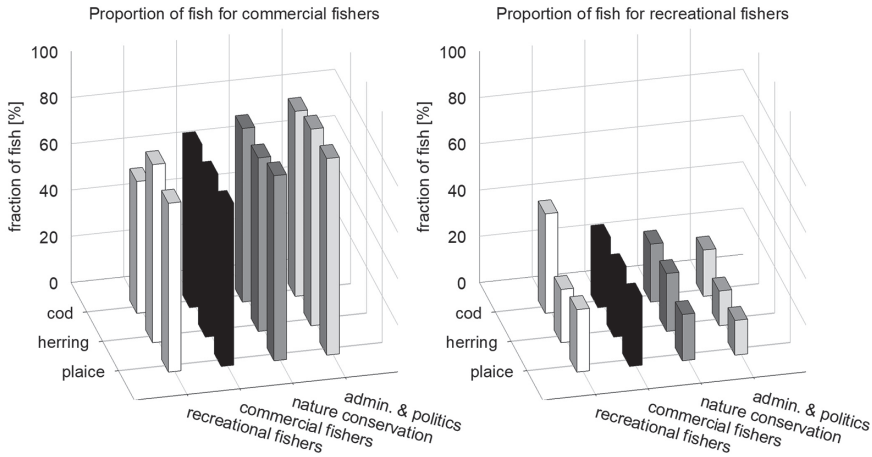

FIGURE 8.3 "What relative proportion (%) of the total harvest per species should be caught by commercial fishers and what by recreational fishers?" Answers grouped by stakeholder group and target species.

all stakeholder groups acknowledge the existence right of fisheries in general and for both user groups in an ideal world.

Economic stocks: marketing infrastructure

Sustainable development of the WBS also includes a vision of how fisheries should be organized, for example, in terms of infrastructure and thus in terms of economic stocks. This is reflected in the different marketing opportunities for fish. We asked what proportion of the fishery yields should be marketed through which distribution channel from a societal perspective. The three most important distribution channels in terms of allocated shares are: (i) direct marketing, such as restaurants or direct sale from the boat to tourists and consumers, (ii) marketing via cooperatives and (iii) the wholesale market. Table 8.2 shows how the different stakeholder groups would distribute the landed fish to the various marketing options in an ideal world.

We highlight two observations. First, all stakeholders were of the opinion that fish should be sold either directly or through cooperatives. The wholesale market or other marketing possibilities (see Appendix F) only played a minor role. Second, there is an interesting and clear discrepancy between the stakeholders "commercial fisheries" and "administration and politics". The commercial fishers opted to market the fish directly (95 %) and only to a small extent make it available to the cooperatives (5 %) as a marketing opportunity. "Administration and politics" chose the more traditional way of marketing the fish via cooperatives (between 40% and 80%, mean 63%).

The first observation shows, again, a general consensus on how an ideal state of the WBS fishery from an economic perspective would look like – the option of direct marketing – although chosen as an ideal marketing channel with different priorities – may be a way forward to support fisheries at a regional level.

TABLE 8.2 "From a societal perspective, what proportion of fish should be marketed through which distribution channel?"*

stakeholder groups	*distribution channel (average %) (Stdev)*		
n=*number of answers*	*direct marketing*	*cooperatives*	*wholesale market*
recreational fishers (n=7)	39 (24)	33 (25)	15 (19)
commercial fishers (n=1)	95	5	0
nature conservation (n=3)	53 (6)	37 (12)	10 (10)
administration and politics (n=3)	30 (17)	63 (21)	7 (6)

*Answers grouped by stakeholder group for the three channels that resulted to be most important for the survey participants and are given in average percentages and Standard deviations (in brackets).

The second observation could be interpreted in terms of different values, namely individual freedom versus a more rule-based approach with support structures, and thus related to more security. It could also be related to different types of transaction costs: For administration and politics, it may be easier to distribute a quota to few cooperatives rather than too many fishers with potentially marketing strategies.

Ecological stocks: management principles

Sustainable development also primarily involves maintaining fish stocks and the entire ecosystem in a good, that is, healthy state. One question asked which overall principle (e.g. Good Environmental Status [GES] of the Baltic Sea, or management according to the Maximum Sustainable Yield [MSY] principle; see Table 8.3) should ideally be applied from a societal point of view. To this question we received 18 valid answers.

Here, seven observations can be clearly identified. First, almost everyone (16 answers) chose the principle of achieving "Good Environmental Status" (defined as "The environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive" by the EU MSFD [Marine Strategy Framework Directive]) in the Baltic Sea, which involves solutions to over-fertilization, pollution and biodiversity conservation. Second, the principle with the second largest number of selections and thus the dominant conception of sustainable fish stocks was Maximum Sustainable Yield. The MSY stock size is defined as the stock level that allows the maximum catch that can be taken from a fish stock forever, thus exploiting its maximum growth potential. Third, the principles of "preserving native species", "MEY" (Maximum Economic Yield), and "renaturation of areas" (specified in "other") were only seldomly selected.

Fourth, in administration and politics, all participants from this group answered and made identical choices. All chose both MSY and GES. Fifth, present level (i.e. status quo) was never selected. Sixth, within the group of recreational fishers, the range of answers was most diverse. Also, half of them chose "ideal use for recreational fishers" as answer. Seventh, the fact that participants gave more than one answer, although they were specifically asked to provide only one answer is an interesting observation and leads to the assumption that there seems to be no single objective, but a need for multiple objectives, and trade-offs.

TABLE 8.3 "Which of the following principles should ideally be applied from a societal perspective?" Answers grouped by stakeholder groups.

number of answers (n) per principles.	*recreational fishers (n=6)*	*commercial fishers (n=1)*	*nature conservation (n=6)*	*admin.& politics (n=4)*	*total (n)*
present level					**0**
pre-industrial condition	1				**1**
preserve native species	2	1	1		**4**
MSY (max. sustainable yield)	3	1	1	4	**9**
MEY (max. economic yield)			1		**1**
ideal use for recreational anglers	3				**3**
Good Environmental Status (GES)	6	1	5	4	**16**
renaturation of areas	1				**1**

The first and second, as well as the fifth, observations suggest a certain agreement between the different groups: MSY and GES are desirable, while this is not the case for the current situation. Both criteria, MSY and GES, are currently relevant in the management plans of these areas (European Commission 2020, ICES, 2021a), which may have triggered the choice of these options, especially for the administration & politics group. In contrast, one could also argue that both are relevant in management plans because the different groups agree on these principles. Regarding point three, somewhat surprisingly MEY was not selected, although it implies higher profits as well as lower catches and should thus be preferable for everyone (Voss et al., 2014; Voss et al., 2022). This implies that the participants were unfamiliar with this concept. In part, this might have to do with the wording, since "highest possible profit" doesn't sound as conservationist as "sustainable yield". The reason why the principles of "preserving native species", and "renaturation of areas" (specified in "other") were only seldomly selected could be due to the fact that "Good Environmental Status" might already imply these aspects.

Time horizon

Sustainable use and conservation of ecosystems also refers to future generations. The stochastic viability concept considers an explicit time horizon of finite length. Another question was therefore related to the time horizon that should be considered when utilizing and conserving the WBS. We asked "For how many years into the future should we consider the use and conservation of the Western Baltic Sea?" (Figure 8.4).

Two interesting results emerge. First, the representatives of all groups chose a positive finite number of 20 years or more. Second, there is a large variation of responses within all stakeholder groups and also between them in terms of maximum numbers, with the variation being highest for recreational fishers. Both nature conservation and administration and politics had an upper bound of 100 years. A reference to this upper level has also been reported in Schwermer et al. (2021) and may be related to a general principle in constitutional states that no use-rights are guaranteed for more than 99 years.

Regarding the second observation, the maximum value of 200 years was chosen by a stakeholder from the group of recreational fishers and thus exceeds the

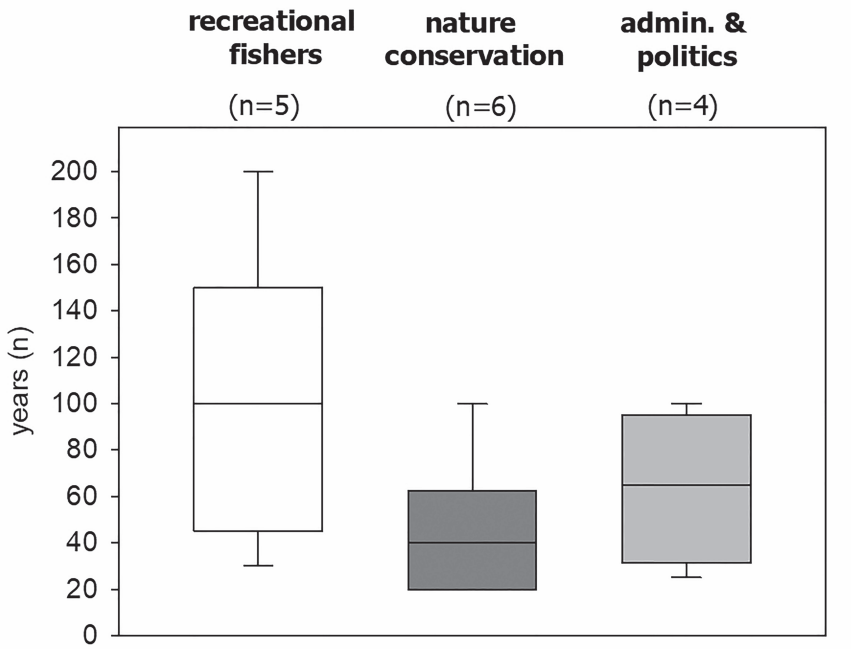

FIGURE 8.4 "For how many years in the future should we consider the use and conservation of the Western Baltic Sea?" Answers grouped by stakeholder group.

maximum values of the other groups by 100 years. The intra-group deviations were also highest here and values varied between 30 and 200 years.

The first observation suggests that respondents agree with the general idea of the stochastic viability concept that uncertainty increases with longer time horizons. The comments support this interpretation. For example, P14 mentioned that all considerations beyond 25 years are too doubtful due to high uncertainties. In a similar direction, P5 commented that for periods longer than 20 years, there is a lack of knowledge of future ecosystem relationships. Interestingly, commercial fishers did not answer this question but argued with a rather daring assessment that "everything beyond a few decades is astrology" (P19).

Certainty levels

Future developments are always uncertain. It may be that, despite all efforts, the minimum levels specified by the participants (see Figures 8.2 and 8.3; Table 8.2 and for more details, see Appendix F) cannot be reached every year. The certainty with which the levels will be achieved can be increased by measures. However, measures are associated with costs. Accordingly, the concept of stochastic viability explicitly considers uncertainty. To obtain an idea about the desired degree of certainty, we asked with what degree of certainty these stated minimum levels should be met each year within a ten-year time horizon (Figure 8.5).

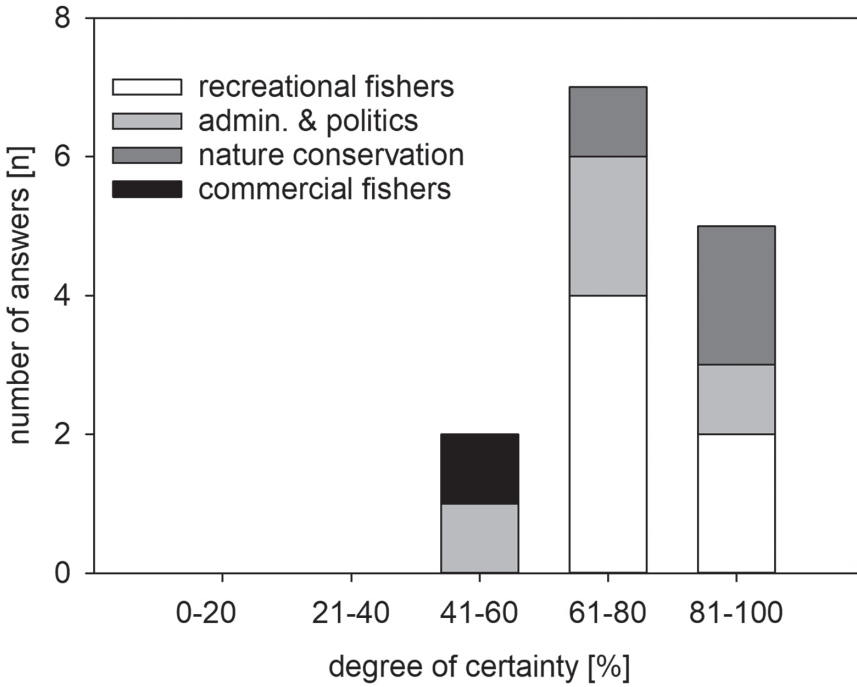

FIGURE 8.5 "With what degree of certainty should the minimum requirements be met each year within the next 10 years?" (100% = absolute certainty, 0% = complete uncertainty). Answers grouped by stakeholder group.

Two main statements can be made here: First, the mean value of all answers (79%) shows that there is an interest in an overall high level of certainty. Second, there is considerable heterogeneity between groups: Commercial fishers showed the lowest values (approx. 50%), indicating that they (as representatives) would accept conditions below the desired minimum on average every second year. The "nature conservation" group revealed highest values, and two participants selected 100% (absolute certainty). While many ideas on principles converge between stakeholder groups, the degree of acceptable uncertainty is quite different between them. This might be a major source of conflict in a situation when the ecological situation is bad and fish stock sizes are low. The conflict arises, as different principles will directly translate into politics via setting annual catch limits. Higher degrees of certainty imply less (or even no) catch, to quickly restore minimum levels, while less demand for certainty enables more flexible recovery pathways.

Insights from and challenges of stakeholder involvement

Based on the results and our interpretation of the answers to the individual questions, we identified five overarching substantive aspects. First, legitimacy of all the different stakeholder groups seems to be a broad consensus: For example, catch

opportunities were acknowledged for both recreational and commercial fishers, a "healthy" ecosystem was aimed for (MSY, GES) and future generations of users were considered. This also included consensus on marketing strategies. All this may be a result of already on-going dialogue formats (e.g. Baltic Sea Advisory Council, BSAC) und provide a base for future policy steps.

Second, it is often not clear to which extent the current situation influences or is even mixed-up with the normative ideas of stakeholders. Many respondents chose "MSY" as the principle that should be applied to manage the system. MSY is a goal of the European Common Fishery Policy and in that sense represents the normative status quo. "MEY" was picked only once, although it has scientifically been shown to be more effective in securing viable fisheries and high stock sizes (e.g. Voss et al., 2022). On the one hand, this might indicate that communication of scientific results to the public and wording of scientific concepts ("sustainable" vs. "economic") needs to be improved. On the other hand, the normative goal of stakeholder groups may just be MSY and not MEY, although this would not be rational. Related, one could also argue that MSY is reflected in actual management because so many stakeholders agree on this goal. Another observation that provides evidence for mixing normative goals with the current situation is the relatively low level of certainty specified by commercial fishers. In other studies, fishers have shown a preference for income smoothing (EC, 2007). Thus, the result may suggest that commercial fishers anticipate even lower catch quotas if minimum requirements should be met with a high degree of certainty. That being said, economic preferences for income smoothing are typically elicited on an individual level. Hence, a different interpretation would be that fishers aim for certainty as individuals, while from a societal perspective they allow more uncertainty and also more flexibility.

Third, answers varied not only between stakeholder groups, but also within groups. Thus, it is unclear whether an individual's answers can really be considered as representative for a stakeholder group, or only reflect that particular individual's preferences. This may be related to our choice of respondents and whether they understood themselves as representatives. The division into groups is usually somewhat artificial – groups may be diverse themselves and may not have a predetermined joint position, or no position at all, on the topics touched upon in the questionnaire. In this case, respondents may have had no choice other than resorting to their own personal view. One could argue that the diversity within groups calls for a broader dialogue to understand what a sustainable development of the WBS fishery looks like.

Fourth, answers may convey differences in underlying values: Many answers can be related to "individual freedom" or a "rules-based approach" in terms of how the WBS should be used (see especially result section on recreational fishing and marketing infrastructure). These two opposing approaches could be related to differences in underlying world views, for example, "egalitarianism", "hierarchy" and "individualism" as used by Chuang et al. (2020) to understand British peoples' attitudes to mobility. Further research may help to better understand the interrelations between underlying world views, normative ideas about the WBS and the current state of the system.

Fifth, the observed patterns of response rates to the different questions might reflect a cognitive bias known as the "availability heuristic": Individuals answer not all questions equally, or on the basis of which questions they care about most, but according to the relative ease with which they can answer the question (Tversky and Kahneman, 1973). For instance, mostly recreational fishers answered the questions related to recreational catches and the other respondents rejected putting down catch numbers or were unable to do so. Also, all four respondents from the administration and politics group answered identically with respect to the ideal sustainability principle – they all chose MSY and GES, which is the administration's official position they frequently encounter. This might explain why the agreement on ideal states between the different groups is greater for the ecological realm than the societal realm (e.g. MSY vs. marketing channel), since all stakeholder groups are concerned with the ecological realm, for which clear management goals exist.

Conclusion

Our study revealed a fundamental challenge inherent in transdisciplinary approaches, namely the choice of relevant stakeholders and their influence on outcomes. Individual stakeholders may or may not represent their respective group well – it is very difficult to gauge whether a stakeholder speaks for him- or her-self, or on behalf of the whole group. In fact, they may relate to several groups, and groups may be diverse themselves. Since the inclusion of everyone is usually not possible, some kind of bias is very likely to occur.

We also note that separating an imaginary, normative goal for the system from the current system state seems to be difficult for most stakeholders and may point to a general problem. On the one hand, normative goals cannot be set without taking some current system characteristics into account. On the other hand, already accounting for potential implications of achieving a certain goal (e.g. temporal closure of the fishery) when thinking about the normative ideal induces a bias, that is, the "true" normative goal may not be reported. Our results suggest that a clear separation of the normative goal and the current system state is difficult, but necessary.

Furthermore, the stakeholders participating in the workshop stressed the importance of clear and unified terminology regarding concepts like "sustainability". With our approach of using stochastic viability, we provide a suggestion to make "sustainability" more tangible. In terms of comparing different normative views of stakeholder groups, we have to observe quite some variation in answers within stakeholder groups as well as some doubt whether answers always reflect purely normative views, meaning that our results have to be interpreted with care. Still, the advantage of our study is that we provide concrete values such that outcomes can directly be related to management choices that need to be quantifiable in order to be monitorable (e.g. total allowable catch). Related to this, one can also use our results for the quantification of a model to examine management options and recommendations quantitatively (e.g. see Doyen et al., 2012). Obviously, the limitations discussed must be accounted for.

While we observe considerable distinctions between different stakeholder groups' perspectives on the sustainable development of the WBS, all respondents seem to acknowledge the legitimacy of the stakes held by the different actors in to the region. Thus, there is common ground on how to sustainably use and manage the WBS, and a well-designed transdisciplinary approach with broad exchange between different stakeholders and scientists is an important step towards steering the WBS into a sustainable future.

Acknowledgements

We thank the members of the marEEshift project for their support, and especially Heike Schwermer, Robert Arlinghaus and Moritz Drupp und Björn Bos for their comments on the questionnaire. We thank also KMS (Kiel Marine Science, CAU Kiel) for their support.

Funding

The research leading to these results has received funding from the German Ministry for Education and Research (BMBF) under the projects SpaCeParti (03F0914A), marEEshift (01LC1826C) and balt_ADAPT (03F0863C).

Appendix A–F – supporting information

Supplementary data associated with this article is available at http://ssrn.com/abstract=4135478.

Note

1 NGO (Non-Governmental Organisation): Greenpeace, MSC (Marine Stewardship Council), NABU ("Naturschutzbund Deutschland e.V.", Living and breathing nature conservation), WWF (World Wide Fund For Nature).

References

Aanesen, M., Armstrong, C. W., Bloomfield, H. J. and Röckmann, C. (2014). What does stakeholder involvement mean for fisheries management? *Ecology and Society*, 19(4), 35. http://dx.doi.org/10.5751/ES-06947-190435

Ahtiainen, H., & Öhman, M. C. (2014). *Ecosystem Services in the Baltic Sea: Valuation of Marine and Coastal Ecosystem Services in the Baltic Sea*. TemaNord. https://doi.org/10.6027/TN2014-563

Baumgärtner, S., & Quaas, M. (2009), Ecological-economic viability as a criterion of strong sustainability under uncertainty. *Ecological Economics*, 68(7), 2008–2020.

Béné, C., Doyen, L., & Gabay D. (2001). A viability analysis for a bio-economic model. *Ecological Economics*, 36(3), 385–396. https://EconPapers.repec.org/RePEc:eee:ecolec:v:36:y:2001:i:3:p:385-396

Béné, C., & Doyen, L. (2018). From resistance to transformation: A generic metric of resilience through viability. *Earth's Future*, 6(7), 979–996. https://doi.org/10.1002/2017EF000660

BFAFI. (2007). Report of a pilot study of the National Fisheries Data Collection Program corresponding to Commission Regulation (EC) (Report No. 1581/2004, 7. Appendix XI (Section E):3.

BMEL. (2020). Bericht an die Europäische Kommission nach Artikel 22 der Verordnung (EU) Nr. 1380/2013 über das Gleichgewicht zwischen den Fangkapazitäten und den Fangmöglichkeiten der deutschen Fischereiflotte im Jahr 2020. Flottenbericht. www.portal-fischerei.de/bund/fischereiflotte.

Chuang, F., Manley, & E., Petersen, A. (2020). The role of worldviews in the governance of sustainable mobility. *Proceedings of the National Academy of Sciences*, 117(8), 4034–4042. https://doi.org/10.1073/pnas.1916936117

Commission of the European Communities (EC). (2013). Regulation (EU) No 1380/2013 of the European Parliament and of the Council. Brussels. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R1380

Cooke, S. J., & Cowx, I. G. (2006). Contrasting recreational and commercial fishing: Searching for common issues to promote unified conservation of fisheries resources and aquatic environments. *Biological Conservation*, 128(1), 93–108. doi.org/10.1016/j.biocon.2005.09.019

Crona B. I., Daw, T. M., Swartz, W., Norström, A. V., Nyström, M., Thyresson, M., Folke, C., Hentati-Sundberg, J., Österblom, H., Deutsch, L., & Troell, M. (2016). Masked, diluted and drowned out: How global seafood trade weakens signals from marine ecosystems. *Fish and Fisheries*, 17(4), 1175–1182. https://doi.org/10.1111/faf.12109

Döring, R., Berkenhagen, J., Hentsch, S., & Kraus, G. (2020). Small-Scale Fisheries in Germany: A Disappearing Profession? In: Pascual-Fernández, J., Pita, C., Bavinck, M. (eds) *Small-Scale Fisheries in Europe: Status, Resilience and Governance*. MARE Publication Series, Vol. 23. Springer, Cham. https://doi.org/10.1007/978-3-030-37371-9_23

Doyen, L., & De Lara, M. (2010). Stochastic viability and dynamic programming. *Systems & Control Letters*, 59(10), 629–634.https://doi.org/10.1016/j.sysconle.2010.07.008ff.ffhal-00453499f

Doyen, L., Thébaud, O., Béné, C., Martinet, V., Gourguet, S., Bertignac, M., Fifas, S., & Blanchard, F. (2012). A stochastic viability approach to ecosystem-based fisheries management. *Ecological Economics*, 75, 32–42. https://doi.org/10.1016/j.ecolecon.2012.01.005

EC (European Commission). (2007). Council Regulation (EC) No. 1098/2007 establishing a multi-annual plan for the cod stocks in the Baltic Sea and the fisheries exploiting those stocks, amending Regulation (ECC) No 2847/93 and repealing Regulation (EC) No 779/97. http://data.europa.eu/eli/reg/2007/1098/oj

EU (2013). Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC. http://data.europa.eu/eli/reg/2013/1380/oj

European Commission (2020). Report from the Commission to the European Parliament and the Council on the implementation of the Marine Strategy Framework Directive (Directive 2008/56/EC) Brussels, 25.6.2020 COM(2020) 259 final; {SWD(2020) 60 final} – {SWD(2020) 61 final} – {SWD(2020) 62 final}. Brussels: European Commission, 307.

FAO (2020). The State of World Fisheries and Aquaculture 2020. In Brief. Sustainability in Action. Rome. https://doi.org/10.4060/ca9229en

Hasler, B., Ahtiainen, H., Hasselström, L., Heiskanen, A.-S., Soutukorva, Å., & Martinsen, L. (2016). Marine Ecosystem Services: Marine ecosystem services in Nordic marine waters and the Baltic Sea – possibilities for valuation. https://doi.org/10.6027/TN2016-501

HELCOM. (2010). Ecosystem Health of the Baltic Sea 2003–2007: HELCOM Initial Holistic Assessment. *Baltic Sea Environment Proceedings* No. 122. www.helcom.fi/stc/files/Publications/Proceedings/bsep122.pdf

HELCOM. (2018a). Economic and social analyses in the Baltic Sea region – HELCOM Thematic assessment 2011–2016. www.helcom.f/baltic-sea-trends/holistic-assessments/state-of-the-baltic-sea-2018/reports-and-materials.

HELCOM. (2018b). State of the Baltic Sea – Second HELCOM holistic assessment 2011–2016. Baltic Sea Environment Proceedings 155. www.helcom.fi/baltic-sea-trends/holistic-assessments/state-of-the-baltic-sea-2018/reports-and-materials/

HELCOM. (2018c). Status of coastal fish communities in the Baltic Sea during 2011–2016 – the third thematic assessment. Baltic Sea Environment Proceedings No. 161

Hilborn, R., Amoroso, R. O., Anderson, C. M., Baum, J. K., Branch, T. A., Costello, C., de Moor, C. L., Faraj, A., Hively, D., Jensen, O. P., Kurota, H., Little, L. R., Mace, P., McClanahan, T., Melnychuk, M. C., Minto, C., Osio, G. C., Parma, A. M., Pons, M., . . . Ye, Y. (2020). Effective fisheries management instrumental in improving fish stock status. *Proceedings of the National Academy of Sciences of the United States of America*, 117(4), 2218–2224. https://doi.org/10.1073/pnas.1909726116

Hyder, K., Weltersbach, M. S., Armstrong, M., Ferter, K., Townhill, B., Ahvonen, A., Arlinghaus, R., Baikov, A., Bellanger, M., Birzaks, J., Borch, T., Cambie, G., de Graaf, M., Diogo, H. M. C., Dziemian, L., Gordoa, A., Grzebielec, R., Hartill, B., Kagervall, A., . . . Strehlow, H. V. (2017). Recreational sea fishing in Europe in a global context – participation rates, fishing effort, expenditure, and implications for monitoring and assessment. *Fish and Fisheries*, 19(2). https://doi.org/10.1111/faf.12251

ICES. (1998). Report of the Study Group on the Precautionary Approach to Fisheries Management. ICES CM 1998/ACFM:10. ICES.

ICES. (2020). Ecosystem overviews – Baltic Sea ecoregion. https://doi.org/10.17895/ices.advice.7635.

ICES. (2021a). Fisheries overviews Baltic Sea ecoregion. https://doi.org/10.17895/ices.advice.9139.

ICES. (2021b). Cod (Gadus morhua) in subdivisions 22–24, western Baltic stock (western Baltic Sea). ICES Advice on Fishing Opportunities, Catch, and Effort – cod.27.22–24. Baltic Sea Ecoregion, https://doi.org/10.17895/ices.advice.7744

Ihde, T. F., Wilberg, M. J., Loewensteiner, D. A., Secor, D. H., & Miller, T. J. (2011). The increasing importance of marine recreational fishing in the US: Challenges for management. *Fisheries Research*, 108(2–3), 268–276. https://doi.org/10.1016/j.fishres.2010.12.016

Köster, F., Huwer, B., Hinrichsen, H-H., Neumann, V., Makarchouk, A., Eero, M., Dewitz, B. V., Hüssy, K., Tomkiewicz, J., Margonski, P., Temming, A., Hermann, J-P., Oesterwind, D., Dierking, J., Kotterba, P., & Plikshs, M. (2017). Eastern Baltic cod recruitment revisited – dynamics and impacting factors. *ICES Journal of Marine Science*, 74(1), 3–19. https://doi.org/10.1093/icesjms/fsw172

Lade, S. J., Niiranen, S., Hentati-Sundberg, J., Blenckner, T., Boonstra, W. J., Orach, K., Quaas, M. F., Österblom, H., & Schlüter, M. (2015). An empirical model of the Baltic Sea reveals the importance of social dynamics for ecological regime shifts. *Proceedings of the National Academy of Sciences of the United States of America*, 112(35), 11120–11125. https://doi.org/10.1073/PNAS.1504954112

MacKenzie, B. R., Gislason, H., Möllmann, C., & Köster, F. W. (2007). Impact of 21st century climate change on the Baltic Sea fish community and fisheries. *Global Change Biology*, 13(7), 1348–1367. https://doi.org/10.1111/J.1365-2486.2007.01369.X

Möllmann, C., Cormon, X., Funk, S., Otto, S., Schmidt, J.O., Schwermer, H., Sguotti, C., Voss, R., & Quaas, M. (2021). Tipping point realized in cod fishery. *Scientific Reports*, 11 (14259). https://doi.org/10.1038/s41598-021-93843-z

NOAA. (2015). *Introduction to Stakeholder Participation. Office for Coastal Management*. Charleston, SC: NOAA Office for Coastal Management Agency. Available at: https://coast.noaa.gov/data/digi-talcoast/pdf/stakeholder-participation.pdf

Oen, A. M. P., Sparrevik, M., Barton, D. N., Nagothu, U. S., Ellen, G. J., Breedveld, G. D., Skei, J., & Slob, A. (2010). Sediment and society: An approach for assessing management of contaminated sediments and stakeholder involvement in Norway. *Journal of Soils and Sediments*, 10(2), 202–208. https://doi.org/10.1007/S11368-009-0182-X

Papaioannou, E. A., Vafeidis, A. V., Quaas, M. F., Schmidt, J. O., & Strehlow, H. (2014). Using indicators based on primary fisheries data for assessing the development of the German Baltic small-scale fishery and reviewing its adaptation potential to changes in resource abundance and management during 2000–09. *Ocean & Coastal Management*, 98, 38–50. http://dx.doi.org/10.1016/j.ocecoaman.2014.06.005

Papaioannou, E. A., Vafeidis, A. T., Quaas, M. F., & Schmidt, J. O. (2012). The development and use of a spatial database for the determination and characterization of the state of the German Baltic small-scale fishery sector. *ICES Journal of Marine Science*, 69(8), 1480–1490. https://doi.org/10.1093/icesjms/fss096

Ritchie, H., & Roser, M. (2021). "Biodiversity". Published online at OurWorldInData.org. Available at: https://ourworldindata.org/biodiversity (Online Resource)

Schwermer, H., Blöcker, A. M., Möllmann, C., & Döring, M. (2021). The 'Cod-Multiple': Modes of existence of fish, science and people. *Sustainability*, 13(21). https://doi.org/10.3390/su132112229

Soma, K., Nielsen, J. R., Papadopoulou, N., Polet, H., Zengin, M., Smith, C. J., Eigaard, O. R., Sala, A., Bonanomi, S., van den Burg, S. W. K., Piet, G. J., Buisman, E., & Gümüş, A. (2018). Stakeholder perceptions in fisheries management – Sectors with benthic impacts. *Marine Policy*, 92, 73–85. https://doi.org/10.1016/J.MARPOL.2018.02.019

Tversky, A., & Kahneman, D. 1973. Availability: A heuristic for judging frequency and probability. *Cognitive Psychology*, 5(2), 207–232. https://doi.org/10.1016/0010-0285(73)90033-9

Van der Heel, S. (2018). Science for change: A survey on the normative and political dimensions of global sustainability research. *Global Environmental Change*, 52, 248–258. https://doi.org/10.1016/j.gloenvcha.2018.07.005

Voss, R., Quaas, M. F., Stiasny, M. H., Hänsel, M.C., Stecher J. P., Guilherme A., Lehmann, A., Reusch, T. B. H., & Schmidt, J. O. (2019). Ecological-economic sustainability of the Baltic cod fisheries under ocean warming and acidification. *Journal of Environmental Management*, 238, 110–118. https://doi.org/10.1016/j.jenvman.2019.02.105

Voss, V., Quaas, M., & Neuenfeldt, S. (2022). Robust, ecological – economic multispecies management of Central Baltic fishery resources. *ICES Journal of Marine Science*, 78(1), 169–181. https://doi.org/10.1093/icesjms/fsab251

Voss, R., Quaas M. F., Schmidt, J. O., & Hoffmann, J. (2014). Regional trade-offs from multispecies maximum sustainable yield (MMSY) management options. *Marine Ecology Progress Series*, 498, 1–12. https://doi.org/10.3354/meps10639

Weltersbach, M. S., Riepe, C., Lewin, W.C., & Strehlow, H.V. (2021). Ökologische, soziale und ökonomische Dimensionen des Meeresangelns in Deutschland (Thünen Report No. 83, ISBN 978-3-86576-221-4). Johann Heinrich von Thünen-Institut. https://doi.org/10.3220/REP1611578297000

Withycombe-Keeler, L., Wiek, A., White, D. D., & Sampson, D. A. (2015). Linking stakeholder survey, scenario analysis, and simulation modelling to explore the long-term impacts of regional water governance regimes. *Environmental Science & Policy*, 48, 237–249. https://doi.org/10.1016/j.envsci.2015.01.006