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Local attitudes towards management measures for the co-existence of seals and coastal fishery - A Swedish case study

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ABSTRACT

Marine mammals and coastal fisheries are two features commonly associated with thriving marine environments, but it is also a case of wildlife impact on human interests. This paper analyses the seal-fisheries encounter in a Swedish Baltic Sea fishery. The problem concerns seals eating fish from the fishing gear which causes considerable economic losses to small-scale fishermen. This mixed-method study addresses local attitudes towards management measures that might be introduced. A questionnaire was sent to all households in three traditional fishing villages and interviews were conducted with local stakeholders. The results show a consensus that something needs to be done or the local fishery cannot continue. Economic compensation for lost catches is viewed as a short-term strategy, while investment subsidies for seal-proof gear are considered positive but problematic due to low efficiency of the new gear. The management measure viewed as most positive in the local context is hunting. In general, a more active management is perceived as urgent for the survival of the small-scale coastal fishery in the studied area.

1. Introduction

Impact of wildlife on human interests is a global phenomenon that has induced increasing interest over the past decades [1]. The problems range from wildlife interactions that might have fatal outcomes (large predators), to interactions that threatens the livelihood of humans (e.g. damages on crops). In Sweden, seals threaten the economic viability of small-scale coastal fishing fleets, which causes a conflict between seal conservation and fisheries in the Baltic Sea fishery. Seals are viewed as a symbol of a healthy Baltic Sea ecosystem and a highly appreciated symbol species in the area. All seal species in the area, i.e. the grey seal (*Halichoerus grypus*), the harbour seal (*Phoca vitulina*), and the ringed seal (*Phoca hispida*), are listed as species of community importance in the EU's Habitats Directive [2]. Seal management is thus required to generate a favourable conservation status. However, the coastal fishery has expressed great concerns about the seal abundance for years. The species mostly interacting with fisheries is the grey seal. The population was at a critically low level (about 4000 individuals) in the 1970ies (Swedish Agency for Marine and Water Management [3], but has increased rapidly since then, and in 2013 the total Baltic grey seal population was estimated to about 43 000 seals [4].

Small-scale coastal fisheries are viewed as important for coastal development at both the local [5], national [6], and EU [7] level. Despite this, coastal fisheries have declined continuously over the years and the economic viability is low (Scientific, Technical and Economic Committee for Fisheries [8]. This has caused concerns among representatives from Swedish regions facing the risk of having no coastal fisheries left (see e.g. [9]). Even though the impact from seals is only part of the reason for this development, it is clearly an issue of great importance for the economic viability of the sector [10–12]. The combination of seals historically being a threatened species but currently threatening local fisheries (and thereby cultural values) makes the topic of seal-fisheries interaction controversial. Decision makers need to consider not only EU and national regulations, but also strong stakeholder interests at both national and local levels.

The Swedish Baltic Sea coastline is long, reaching from the southern tip of the country to the brackish waters in the Bothnian bay in the north. Baltic Sea fisheries are very diverse, and for some fisheries, like the

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salmon fishery in the northern Baltic, seals have been present for decades and efficient seal-proof gears have been developed [13]. In other areas, like the Swedish south coast, seal populations are rapidly increasing and seal proof gear is still under development. This fishery is dependent on catching cod using gill-nets and hooks – gears that are heavily exposed to seal predation. Thus, in this area the seals currently have a high impact on coastal fisheries.

This paper contributes to the literature by drawing on multidisciplinary competence (environmental psychology, biology, and economics) to analyse potential management measures aiming to facilitate co-existence between seals and fisheries in a local Swedish Baltic Sea fishery. More specifically the aim is to study local attitudes towards management measures in terms of acceptance-opposition.

The paper continues as follows. In section 2 the management of both seals and fisheries are reviewed. These together form the regulatory framework for the seal-fisheries interactions. Section 3 is an outline of the approach describing the theoretical framework, the focus on the local perspective and relevant research on human-wildlife management measures. Section 4 describes the mixed-method approach combining a questionnaire to all households and in-depth interviews with local stakeholders in three adjacent fishing villages along the southern Swedish Baltic Sea coastline, and section 5 contains the results. In section 6, the local attitudes are discussed in the context of scientific research on efficiency and potential impact. Section 7 contains the main conclusions from the analysis.

2. Seal and fisheries management

2.1. Seals in EU regulations

The Habitats Directive [2] adopted by the EU in 1992 has the objective to promote the maintenance of biodiversity. Both the harbour seal, the ringed seal and the grey seal present in Swedish waters are listed in annex II of the directive. This implies that the seals shall have a favourable conservation status defined as 1) the population shall be viable, 2) the natural range of the species should not be reduced or be likely to be reduced in the future, and 3) there will continue to be a sufficiently large habitat to maintain the population. Core areas of their habitat are considered of EU importance should be included in the Natura 2000 network, which is also the case among existing Swedish Natura 2000 areas.

Further, seals are included in the Swedish definition of Good Environmental Status (GES) as stated in the EU's Marine Strategy Framework Directive [14]. GES is defined as a population floor of 10'000 individuals and minimum yearly growth of 7% for each seal population if the population falls below the ecosystem's capacity [15]. GES further includes the health status of the seals and access to habitats.

2.2. Seals in HELCOM

The Helsinki Commission (HELCOM, www.helcom.fi) is a regional sea convention in the Baltic Sea consisting of the countries around the Baltic Sea. HELCOM works as a platform for environmental policy making in the region, and seal conservation is one of the responsibilities. The recommendations for general management principles for the seal populations from HELCOM [16] are:

- ***populations size*** (with the long-term objective to allow seal populations to recover towards carrying capacity levels);
- ***distribution*** (with the long-term objective to allow breeding seals to expand to suitable breeding distribution in all regions of the Baltic); and
- ***health status*** (with the long-term objective of attaining the health status that secures the continued existence of the populations)

With these recommendations as umbrella, the individual countries have adopted seal management plans.

2.3. Swedish seal management

Sweden has two management plans, one for grey seal in the Baltic Sea [3] and one for harbour seal in the Kattegatt and Skagerrak [17]. Both plans have the same objective: The seal population shall have "a favourable conservation status and the impact on human interests shall be neutral or positive" (translation by the authors), where the part about favourable conservation status can be tracked back to the EU's Habitats Directive. For both species, it is concluded that "The conservation objective is presently met but the impact of the grey [harbour] seal on human interests cannot unanimously be considered as neutral or positive" (translation by the authors; [3,17]. As mentioned above, the negative impacts on human interest are through the interaction with fisheries.

In the studied period (2017, see section 4. *The empirical study: Method*) the measures to reduce the impact on fisheries in the seal management plans were more or less identical for grey seals and harbour seals [3,17]. Focus is on four measures:

1. Measures to prevent seal damages on fisheries
2. Economic compensation for costs for fisheries incurred by seals
3. Measures to strengthen the seal as a valuable resource
4. Regulating the seal population size

Measures to *prevent seal damages* (fish lost from nets due to seal predation) focus on seal proof gear [18,19]. Seal proof gear is currently used in the salmon (*Salmo salar*) fishery in the northern Baltic Sea [13] but less so in other fisheries (e.g. the Baltic Sea cod fishery which is a central fishery in this study, [20]. Seal damages could also be prevented by protective hunting which is allowed for seals close to fishing gear. In 2018 the total quota for protective hunting of grey seals in Sweden was 600 individuals. Hence, this hunting does not have the purpose of reducing the seal population, but to remove individuals that interact with fisheries (individual seals are observed to specialize in eating from fishermen's nets, [21].

Economic compensation is paid for costs incurred by seals. The total compensation is approximately € 1'500'000 annually. The funding is allocated by the SwAM to the Local County Administrative Boards (CABs, Länsstyrelse) based on number of fishing trips with seal damages reported in the fishermen's logbooks and the catch value of those trips. The CABs then apply local allocation principles for fishermen within the county.

Measures to strengthen the seal as a valuable resource focus on tourism based on seal-watching, although there are no specific seal management measures for increasing seal watching in place. Using seal products commercially is not considered a way forward due to EU regulations prohibiting trade with seal products [22].

Regulating the seal populations (i.e. hunting) is not currently implemented in Sweden. However, the Swedish Parliament [12] has made population control through hunting legal, and the Swedish Environmental Protection Agency (EPA) is currently evaluating how this could be implemented in practice.

2.4. Fisheries policies

Swedish fisheries are regulated within the framework of the EU's Common Fisheries Policy (CFP; [7]. The objective of the CFP is to ensure that fishing is environmentally, economically and socially sustainable. Further, the CFP has an objective to "*promote coastal fishing activities, taking into account socio-economic aspects*" [7]; Article 2). The promotion of small-scale fisheries is important also in Swedish fisheries management, especially for coastal development and local markets as expressed in the Swedish strategy for commercial fisheries [6]. Impact of seals on fishery is primarily a problem for coastal fisheries and there is thus a

tension between objectives in the CFP and seal conservation targets. There are, however, measures within the CFP to reduce seal interactions since the European Maritime and Fisheries Fund (EMFF) provides funding for fishermen to invest in seal-proof gear. Further, Sweden has specific regulations applying to coastal fisheries, primarily quotas allocated to small-scale vessels [23].

2.5. Dialogue between managing authorities and local stakeholders

The Swedish Environmental Protection Agency has the national responsibility for Swedish wildlife policy and management. The CABs hold the regional and local responsibilities. In areas with large mammal carnivores, the CABs commonly initiate and invite to local *information meetings* with the objective to facilitate coexistence in situations when large carnivores are present close to human activities [24]. Each CAB has a Wildlife Management Delegation (WMD) to guarantee *collaboration* between stakeholders in wildlife management [25]:1474). The WMDs consist of stakeholder representatives from for example nature conservation, tourism, forestry and agriculture as well as politicians. In coastal areas WMDs may also include representatives from fisheries.

3. Theoretical approach to opposition and acceptance of management measures

The presence of seals does in various ways affect people living in coastal areas, and so does the introduction of any seal management measure. Previous research on large mammal carnivores suggest that local views of seals may stretch from strong appreciation to the perception of seals as predators threatening small-scale fisheries and that the view is likely to colour their response towards management measures [26]; [27–29]. Determining local attitudes will make it possible to predict the possibility of successfully implementing different management measures [29,30]. Also, identification of attitudinal differences between sub-groups may display the presence of tensions in a local setting.

In order to understand locals' different responses to management measures the concept of *acceptance* is highly relevant. Theoretically, the degree of acceptance has been defined as an attitude, a behavioural intention, and an overt behaviour [31]. In the present context we define acceptance as an attitude e.g. "a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour" [32]; p.1). In our case the entities are constituted by the different management measures in relation to how they would influence the *balance* between local coastal fishery and the seal population. The attitudes towards the management measures are also discussed in relation to opposition – acceptance [33,34]. In conflicts around human interaction with large mammal carnivores, attitudes towards management measures are shaped by multiple factors [26], suggesting that cognitive, affective and behavioural components underlying the attitudes should be addressed to get a nuanced understanding of the attitudes. Previous research shows that the support for management measures may for some measures be congruent across stakeholders and the public, whereas for other measures the level of support heavily differs [30,34]. In order to avoid escalating conflicts by introducing a certain management measure such differences would be important to identify. The Potential for Conflict Index (PCI) provides two different quantitative analyses that could guide management decisions [35]. Firstly, the potential of conflict that a certain management measure implies in the local society, illustrated by attitudinal differences found between groups. Second, the method allows an analysis of the potential for conflict within a group, illustrated by the in-group variation.

4. The empirical study: method

The study was conducted in 2017 as a case study of three traditional fishing villages situated in Blekinge county by the southern part of the Swedish Baltic Sea Coast. The villages were chosen based on their characteristics as villages evolving from fishery as main income and activity, situated in an area with documented seal interference and a declining number of licensed fishermen. They are not chosen to be representative for Swedish fishing villages, but to put focus on the local situation in a specific setting with the above described characteristics. Historically the main fishery is for cod using nets and hooks, but also small-scale herring fisheries, eel fisheries, as well as fisheries for fresh water species like perch and pike is possible. A concurrent mixed-method research design was used for data collection combining quantitative and qualitative methods [36]. Information from interviews was used in the questionnaire construct and quantitative results were then used to strengthen qualitative findings and vice versa, thereby validating the findings [37]. The interview results are primarily presented in order to nuance and provide a better understanding of the questionnaire data, not describing the complete thematic analysis.

The quantitative part was carried out as a questionnaire survey among all households in the three villages. The study included 357 participants between 18 and 77 years (mean age 59 years, 48% women and 52% men, corresponding to a response rate of 41.8%). Two hundred twenty-four of the residents reported that they were not involved in fisheries and 126 reported that they themselves or someone in their family were personally involved in fisheries. Seven participants did not answer the question.

The qualitative part consisted of in-depth interviews with five small-scale fishermen, three stakeholder representatives (Rural Sweden and Swedish Society for Nature Conservation, SSNC), four local/regional officials, one local politician, and three focus group discussions with locals in respective village where they were interviewed in groups of 3, 5 and 6 individuals. The focus groups were composed with assistance from local cultural association representatives, with the ambition to include locals with no personal involvement in fishery. In total 27 people representing all three villages participated in the qualitative part. It is in particular the attitudes of the 19 fishermen and locals that are presented in this article. Interviewees were chosen strategically to ensure variation in perspectives on the subject.

Fourteen management measures aiming to support co-existence between seals and fisheries formed the common basis of the interviews and the questionnaire (see Appendix A). These cover a wide range of measures, from no measures to potentially high-impact measures, existing as well as possible measures, and with implications for individual fishermen, the specific local context or small-scale fishery as a whole. This was a deliberate choice in order to reflect the complexity of the situation. The choice of management measures was identified in current policy document and research. The final establishment of the studied measures was the result of several discussions and workshops within the multidisciplinary research group. The selection of measures and the descriptions of them, as well as the order of presentation, was tested in the initial interviews and subsequently determined as follows.

- A first group of measures is economic support, where the already operational economic measures *economic compensation for catch-losses* and *support of investments in seal-safe gear* are included, together with measures dependent on the same investments aiming at developing *seal-safe gear* and tools of *deterrence.*
- The second group is population control where *protective hunting* is included as already operational, supplemented with *licensed hunting* as a potential and feasible measure.
- In a third group a separate measure *no further action* was included as a status quo scenario.
- A fourth group of measures is based on the management plan to strengthen seals as a resource including the measures *seal tourism* and *seals as a local recreational value.*
- Based on research on human-wildlife conflicts measures dialogue, describing *information* and *collaboration between authorities and locals* form the fifth group.

- Finally, a sixth group of measures is alternative management that may capture potentially increased coping capabilities for the fishermen, including *small-scale fishery special regulations, consumer labelling* and *transition to trawling.*

In the questionnaire the participants were presented with each one of the measures, briefly described, and asked to assess their attitude towards the influence from negative to positive on the *balance* between seals and coastal fishery (1 = very negative, 2 = moderately negative, 3 = no influence, 4 = moderately positive, 5 = very positive). The responses were subject to analysis of variance with involvement/no involvement in fisheries as a grouping variable. Moreover, an analysis of the potential for conflict was introduced (PCI-analyses, [35,38]. This analysis serves to (by the placement and size of bubbles in a graph) visually illustrate how attitudes towards wildlife management differs within and between different sub-groups. The PCI value is represented by size of a bubble and corresponds to the dispersion within a sample, the maximum potential for conflict is represented by a 1, while the minimal conflict is represented by a zero. The position of the bubble in the graph indicates the general tendency (mean values) of how an intervention may be received by the sample. The maximum potential for conflict would in the present case be when responses are distributed equally towards maximum perceived negative and positive influence, and minimal conflict where responses are all at the same level of negative/positive influence.

All interviews were initially focused on a broad context concerning characteristics of the local society, important local values, small-scale fishery as a local value, attitudes towards seals and the seal-fishery situation. In the fishermen interviews focus was also on their experience of fishery as a legacy and personal identity. In the second part, the different management measures were presented and interviewees were asked to reflect upon and describe their views on each of them. In the focus groups the measures were displayed with an example image and explaining facts, and interviewees were asked to discuss pros and cons and possible impact of each measure in-depth. The objective was not consensus, rather to capture different views and the underlying reasoning of each statement. All interviews were recorded and transcribed verbatim. Reflexive thematic analysis [39,40] was used to identify and analyse patterns and variations in the interview material, enabling an understanding of the complexity of attitudes. The analysis initially focused on themes describing the perceived relevance and implication of the seal-fishery situation as such, and the perceived coping capabilities, providing an understanding of the local appraisal of the situation (under review). The attitudes towards different management measures were analysed in terms of *acceptance-opposition*, uncovering underlying reasoning based on themes such as *long-term sustainability*, *trust/distrust in technical innovation*, *lack of trust in authorities*, *hunting morale*, *resignation, etc.* in relation to establish balance between seals and coastal fishery. These themes are the basis of the presented results.[1]

5. Results

The results are described in two sections. Section 5.1 presents the quantitative results from the questionnaire, and in section 5.2 the qualitative findings based on interviews are used to nuance and deepen the understanding of the quantitative results.

5.1. Local residents' attitude towards management measures in the questionnaire

The results from the residents' assessments of their attitude towards the influence of management measures are presented in Table 1. The attitude towards a measure is considered neutral if the assessment of the influence on the balance between local coastal fishery and the seal population has a mean value (m) of 3. A mean value below 3 implies a negative attitude towards the influence on the balance and below 2 a strong negative attitude. A mean value above 3 is considered as a positive attitude and a strong positive attitude if the assessment has a mean value above 4.

Table 1 shows strong positive attitudes towards the influence on the balance between the local presence of seals and coastal fishery for the measures *hunting actions*, *collaboration* and *consumer labelling*. The attitudes towards support *of investment* and *economic compensation* as well as management measures such as *deterrence*, *seal-safe gear*, *special regulations*, and *local information meetings* tended be assessed as positive. Whereas *no further action* was the only measure that revealed a strong negative attitude. *Seal tourism* and *promoting seals as a local recreational value* were assessed as having a moderately negative influence. The mean value for a *transition to trawling* was very close to 3, which should be interpreted as the attitude towards the influence of this measure being neither a negative or positive for the balance between seals and coastal fishery.

As presented Fig. 1 the Potential for Conflict Index (PCI-analysis) further illustrates similarities and differences in the participants' attitudes towards the influence on the balance between the local presence of seals and coastal fishery of the management measures. In this analysis the sample is divided into two sub-groups: participants involved in fishery and participants not involved in fishery. In Fig. 1 each of the 14 measures are presented. The brown bubbles represent the non-fishery sub-group and blue bubbles represent the fishery sub-group. The placement of the bubble along the y-axel illustrates the attitude from very negative = 1 to very positive = 5. The size of the bubbles (the PCI-value indicated in the bubbles) represents the variation within the sub-groups and can range from 0.0 to 1.0, with 1 representing maximum variation. When the brown and the blue bubbles are separated for a measure it shows that there is a difference in their attitudes and when the bubbles overlap for a measure this represents that the sub-groups hold a similar attitude towards the measure. This is analogous to the ANOVAs in Table 1.

The analysis shows two sources of potential conflicts. One is differences between sub-groups and one is differences within sub-groups. First of all, the PCI analysis suggests that between the groups (non-fishery sub-group and fishery sub-group) the differences are most noticeable for the measures promoting seals either via *tourism* or as a *local value*. Within the sub-groups the attitude to these measures is homogenous as indicated by the relatively small PCI-value. Introducing these two measures are thereby likely to hold the largest potential for conflict *between* groups.

Looking into differences within groups, there is no measure that is likely to spur huge conflicts as all PCI values are below 0.40 on the scale ranging from 0.00 = no potential for conflict to 1.00 = high potential conflict. Within the sub-group of participants not involved in fishery conflict is the relatively highest for *economic compensation*, *seal tourism*, support *of investments*, and *trawling*. Still, these measures have PCI values just above 0.20. Within the sub-group of fishery, the highest PCI values can be seen for *special regulations*, *transition to trawling*, support *of investment* and *seal-safe gear*, closely followed by *economic compensation*. These measures have PCI values close to or above 0.30. If introduced, these measures are the ones most likely to create tension within the sub-group of participants involved in fishery.

5.2. Interview findings

The qualitative material provides a nuanced understanding of opposition-acceptance towards different management measures as discussed in relation to the perceived influence on the balance between seals and coastal fishery locally. Each measure is shortly related to the

[1] The questionnaire and the interview guide are available in Swedish upon request.

Table 1
Overview of investigated management measures, number of respondents, sample mean value, standard deviation.[a].

No	Measure	N	m	SD	Group difference ANOVA	p	η_p^2	Most positive group
	Economic support							
1	Economic compensation for catch-losses	306	3.70	1.09	F(1, 304) = 1.98	n.s.	-	-
2	Support of investments in seal-safe gear	307	3.65	1.51	F(1, 305) = 30.03	>.001	.09	Non-fishery
3	Seal-safe gear	305	3.50	1.02	F(1, 303) = 25.12	<.001	.08	Non-fishery
4	Deterrence	311	3.45	1.02	F(1, 309) = 5.15	= .02	.02	Non-fishery
	Population control							
5	Protective hunting	307	4.10	0.92	F(1, 305) = 0.08	n.s.	-	-
6	Licensed hunting	308	4.08	1.00	F(1, 306) = 2.60	n.s.	-	-
	No further action							
7	No further action	308	1.38	0.66	F(1, 306) = 6.29	=.01	.02	Non-fishery
	Seals as a resource							
8	Seal tourism	302	2.89	1.17	F(1, 300) = 25.87	>.001	.08	Non-fishery
9	Seals as a local recreational value	304	2.78	1.11	F(1, 302) = 42.52	>.001	.12	Non-fishery
	Dialogue							
10	Information	309	3.58	0.96	F(1, 307) = 3.91	= .05	.01	Non-fishery
11	Collaboration between authorities and locals	315	4.03	0.97	F(1, 313) = 4.97	= .03	.02	Non-fishery
	Alternative management							
12	Small-scale fishery special regulations	311	3.42	1.13	F(1, 309) = 1.93	n.s.	-	-
13	Consumer labelling	310	4.11	0.88	F(1, 308) = 0.09	n.s.	-	-
14	Transition to trawling	299	3.04	1.26	F(1, 297) = 1.98	n.s.	-	-

*Test of group differences (ANOVA) between participants involved and not involved in fishery, p-value and effect size reported as partial eta-squared (η_p^2) The number of respondents varies due to internal-drop out, most likely due to the lack of a do not know response alternative. The colour code denotes the quality (m) of the influence of the measure on the balance between seals and coastal fishery, where red is very negative influence, orange is negative influence, yellow is neither negative nor positive influence, light green is positive influence, and green is very positive influence.

[a] Test of group differences (ANOVA) between participants involved and not involved in fishery, p-value and effect size reported as partial eta-squared (η_p^2) The number of respondents varies due to internal-drop out, most likely due to the lack of a do not know response alternative. The colour code denotes the quality (m) of the influence of the measure on the balance between seals and coastal fishery, where red is very negative influence, orange is negative influence, yellow is neither negative nor positive influence, light green is positive influence, and green is very positive influence.

quantitative results presented above, followed by a description of the underlying reasoning explaining the attitude, as expressed in the interviews. Quotations are used to illustrate this reasoning.

5.2.1. Economic support

Our two economic measures are operational and extensively used. They are specifically aimed to the individual fisherman either *compensating catch-losses* due to seals or supporting *investments in seal-safe gear*. They are both viewed as moderately positive measures on average in the quantitative analysis, but with relatively high PCI values for both subgroups (>0.2) indicating somewhat differing attitudes within the subgroups. The interviewed fishermen consider the compensation as necessary in order to continue their activity, but not sufficient to carry the extra costs from seal damages.

> It's not easy to build a business on support. It's not long-term sustainable. You could say it's a temporary solution in order to save some of it …

Economic compensation is accepted by the interviewed locals, but they are more in favour of subsidising a change in fishing methods than to endorse what they refer to as 'artificial viability'.

> I think that you sort of need to face reality, make the change. I think all that [economic compensation] is artificial viability somehow.

> There is no future in that [economic compensation]. It doesn't change the situation per se.

The measure to support *investments in seal-safe gear* is closely related to the perceived function of cod pots (baited pots where captured cod is

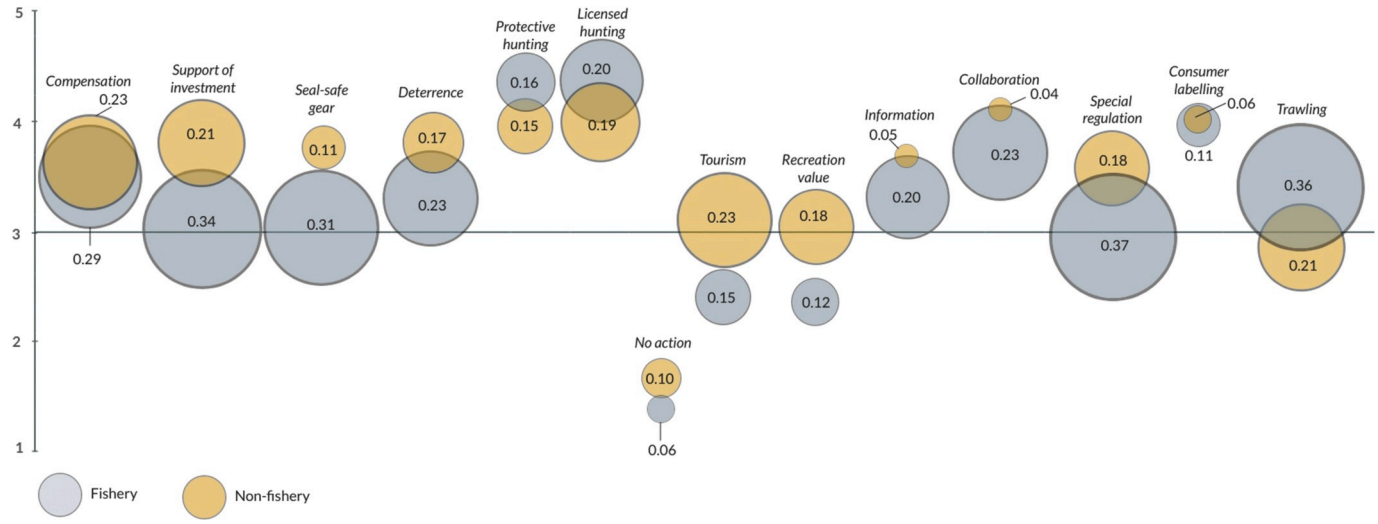

Fig. 1. Potential for Conflict Index for the 14 measures illustrated for respondents in the two sub-samples (Non-Fishery and Fishery). The placement of the bubble along the y-axel illustrates the influence of the measure from very negative = −2 to very positive = 2. The size of the bubbles (the PCI-value indicated in the bubbles) represents the variation within the sub-samples and can range from 0.0–1.0, with 1 representing maximum variation.

protected from seals, see Ref. [20] as alternative gears. There is a common view that it would be an effective measure if the pots work, but so far, they see little evidence of that.

> If you get it [cod pots] to work it would be good. But you must get something in it … so that it corresponds to what you can get in the net so to say.

They have invested so much money in the pot fishery. We're supposed to fish with pots … It is very hard to catch fish in pots. At least in the Baltic Sea. They have tried, the lads here, when there were lots of cod in the 80–90's. It didn't work. And it doesn't work today. (—) If it were a good way to catch fish, we would have used it.

Thus, these investments are accepted by some and opposed by others. Other measures aiming to *deter* seals from the fishing gear, for example by using sound, are viewed as very inefficient amongst the interviewees. They oppose the measures believing the seals to be far too intelligent to be duped by such methods and suspect the sound to act as a food-bell rather than as repelling.

5.2.2. Population control

As discussed in section 2, there are two lethal measures aimed to control the grey seal population and seal damages by means of hunting; *protective* and *licensed*. The attitudes towards both measures are positive and with relatively small PCI values for both sub-groups indicating low risk of conflict. Protective hunting is allowed, but limited to a fixed number of seals per county. The interviewed fishermen and locals unanimous agree that the protective hunting is pointless given the total number of seals in the Baltic Sea.

> Yes, but how much is it [protective hunting]? Perhaps fifty seals in Blekinge county. When there are three thousand new ones every year. That's like a drop in the ocean.

It should be noted that the intention of protective hunting is to remove specific troublesome individuals from fishing waters. The negative attitude towards the measure and expressions of pointlessness in the interviews indicate that the local situation is not viewed as caused by **specific individuals**, but by the **total number of seals** and their **overall presence**.

The other lethal measure suggested is licensed hunting. At the time of the study this was not allowed in Sweden and is therefore considered a *potential* management measure in this context. By the interviewed fishermen and locals, the attitude towards this measure reveals that it is highly accepted and seen as the only possibility to actually manage the seal situation. At the same time, they are hesitant to whether it is possible to affect the size of the seal population. This has to do with the large number of seals and the difficulties in hunting and handling of seals.

> It [licensed hunting] would be very good. But then it comes down to thousands. Because to shoot a hundred or two hundred, that's nothing. (—) They reproduce awfully.

It's too much work. Because I have to shoot a seal … and when I have shot it, I must bring it up, I must bring it home. What shall I do then, with the seal lying in the harbour at the dockside? I can't eat it. I'm not allowed to throw it in the sea. I'm not allowed to bury it. No.

5.2.3. No further action

As an alternative to the different management measures we use a scenario of status quo. The measures already in use remain, but no further actions are taken. The attitude towards this the measure is the most negative in the quantitative study and with the lowest potential for conflict. From the interviews it is clear that this is no option if small-scale fisheries are to survive. Fishermen as well as locals view this alternative as very negative.

They must do something. If we are to have any fisheries left.

As the development is now, there will be nothing left. Only three, four years then …

The interviews however reveal one possible upside effect of this scenario; that nature itself will solve the situation. This assumes that there is a natural limitation when a population reach a certain size, i.e. some disease reduces their number.

In fact, I believe in this 'no action' as well. Because any other day, suddenly a disease will hit the seals.

There is however a concern that this disease will come too late, when small-scale fishery is already gone and with it the local heritage and traditional fishing skills.

5.2.4. Seals as a resource

These management measures have a different approach, whereas seals are viewed as a resource or value in the local context. The value could either be economic, for example local entrepreneurs or former fishermen arranging seal-spotting excursions for tourists; i.e. *seal tourism*, or a quality enhancing well-being in the local community; i.e. *seals as a recreational value*. These measures are the ones with largest

attitude differences between the sub-groups. Participants not involved in fishery view them as neutral, while participants involved in fishery view them as having a strongly negative influence.

The interviewed locals express a positive attitude to *seal tourism* as a measure per se, but not on the balance between seals and fishery in the specific local context. There are no natural places, islets and rocks, where seals are exposed and easy to spot.

> I find the idea very good indeed, but not here. I don't think it [seal-tourism] works here.

The interviewed fishermen do not view this line of business as an option for them. They argue that they would need different boats and equipment, and most importantly, they would not be fishermen anymore. Also, the attitude towards seals as a value in the local context gets limited acceptance in the interviews. Two reasons are identified; first, that the seals are not visible and therefore not an acknowledged quality, and second, that many of the locals have a very negative attitude towards seals in general because of the seals' impact on coastal fishery.

5.2.5. Dialogue

Information and *collaboration between authorities and locals* in co-management initiatives are commonly used measures to solve conflicts from human-wildlife encounters [24]; 2019; [41]. Whereas information primarily is direct from managing authorities towards locals, co-management involves active participation of locals to make use of local knowledge and find broadly accepted measures. In the quantitative analysis, the attitude towards these measures are moderately positive. The interviewed locals however express low trust in local authorities and therefore a more negative attitude. This is due to previous situations where authorities, in their opinion, had shown little responsiveness. There is also a common view that it is too late for this kind of management measures.

> The way I see it, these [information and collaboration] are measures that should have been taken long ago. Not now, when there is almost no one to carry the heritage.

5.2.6. Alternative management

Three of our management measures can be described as more indirect and alternative; *small-scale fishery special regulation*, *consumer labelling* and *transition to trawling*.[2] The attitudes towards these measures are all neutral to moderately positive, and some of them have high potential for conflict (PCI>0.3). Today fishery is heavily regulated and amongst the interviewees there is a common opinion that there is already too much regulation. This could explain why questionnaire respondents were somewhat hesitant towards the regulation measure. The idea of the measure special regulation is however rather to ease some of the regulation and allow small-scale fishermen to be more flexible. Traditionally the local fishermen alternated between fishing for different species and between different fishing gears based on abundance in order to survive, whereas the current regulation, e.g. need for cod fishing permits [42], ban on fishing for salmon with drift-nets, and restrictions on the eel fishery, hampers this kind of flexibility. The measure would, in theory, make it possible for modern small-scale fishery to return to a more traditional fishery, as described by the interviewed fishermen. In the interviews there is strong positive attitudes towards this measure.

> It's fishing for those four species [eel, salmon, cod and herring] that is possible in the Baltic Sea. And if you could alternate between them … then you could live off it.

The measure *consumer labelling* is about enhancing small-scale local fishery by certifying high quality products. Thereby individual fishermen could be supported as local producers and possibly be able to sell their fish at a higher price.[3] The interviewees are positive towards some kind of labelling and in the local context there are plans to initiate a form of market where local producers could sell their products. However, they also express some hesitation concerning the individual fisherman's risks based on the principle of supply and demand, given that the seals are still a problem.

> It [consumer labelling] probably works well. But if you land eight cods, what are you supposed to do with them? You can't live off that no matter how well you get paid. The basis is the existence of seals. They put an end to all fishery.

Finally, the interviewees question the concept of condition of the fish and fish quality. They argue that fishes caught nearby are not necessarily of higher condition; fish can be thin and have lots of parasites, and due to pollution in the Baltic Sea not necessarily healthier to consume. The fishermen however claim that locally produced fish would be fresher which can increase quality and also more environmentally friendly.

6. Discussion

Human-wildlife encounters are inherently complex, and management will therefore require a carefully balanced use of measures. This paper uses a concurrent mixed-method research design where the multifaceted issue of sustainability is addressed within a local context using a questionnaire survey, focus groups and in-depth interviews. The mixed-method approach is advantageous as it provides both quantitative and qualitative insights that makes it possible to in parallel obtain a nuanced understanding of people's attitudes and get an assessment of the attitude [36].

In order to further explore the quantitative and qualitative results, some of the management measures are discussed and put in a wider context based on the results presented above. The first is *no further action* which is the measure viewed as the most negative and with the least potential for conflict. The second is *licensed hunting* which is the measure viewed as most positive. The third and fourth are the two economic measures *compensation for catch-losses* and *investments in seal-safe gear*. These are common measures currently used in Sweden, but the interviewees seem not to believe this to be a long-term strategy. The fifth is *seal tourism*. This measure has a large difference between those involved in fishery an those not involved. Furthermore, wildlife tourism is a growing business in an international perspective, but not viewed as possible in the local context. The sixth measure is *collaboration between authorities and locals*, whereas this measure is important in human-wildlife issues in general, it is a measure viewed as not functional in the local context.

6.1. No further action

The results from the questionnaire show that doing nothing is viewed as the most negative management measure by both groups of participants. It also has a low conflict potential. The result is confirmed by the interviews where fishermen and locals alike claim that the small-scale

[2] The idea of the measure *transition to trawling* was that individual fishermen would be able to change their line of business from using passive gear to trawling in order to survive as fishermen. Trawling permits are issued by SwAM and changing between fishing segments was not a possibility at the time for the study. The objective was rather to see if this was considered as an opportunity by fishermen and locals. The empirical study however showed that this measure was difficult to understand and interpret both by interviewees and questionnaire respondents. It is therefore not analysed further.

[3] See Blomquist et al. [57] and Blomquist et al. [58] for discussions about to what extent Baltic Sea cod fisheries have been able to benefit from consumer labelling using the Marine Stewardship Council (MSC).

fishery will vanish if no action is taken to change the situation.

Over the past years there has been a significant increase in the number of seals and the damage to the fisheries in the studied area. Grey seal predation in the cod fishery using gillnets has been estimated to be significant and a threat to the cod fishery already in 2009 in the central Baltic just north of the study area [43]. Fishermen's logbook reports from 2009 in southern Baltic showed that 28% of all reports included seal damage [44]; in preparation). Since 2009, the grey seal population has increased and expanded further south. In 2017, the grey seal population increased more than 18% per year in the south Baltic during the last 16 years and counted to around 38 000 seals in 2018 [3]. Along with the increase and spreading of the seal population the impact from seals has also increased and spread further south. Fishermen's logbook reports indicate that seal damage in cod gillnet fisheries in southern Baltic in 2017 were present in 63% of the fishing trips. In field experiments, Königson et al. [43] show that cod corresponding to between 26 and 82% of landed weight are eaten or damaged by seals in trips with seal interaction. With no hunting limiting the expansion of the population and no alternative fishing gear in place the impact from seals on fisheries is likely to increase even further and the views expressed in this study that if nothing is done the fisheries will vanish is a possible future scenario.

6.2. Licensed hunting

From the questionnaire it is clear that the attitudes towards both 'population control'- measures are positive. Both *licensed* and *protective hunting* are viewed as highly positive measures by both sub-groups. This corresponds to the interviewees' statements that hunting is the only possible measure to use. But as the quantitative data indicate similar results for the two measures, the qualitative data show a difference whereas protective hunting is viewed as too limited to be effective.

The measure licensed hunting has a low conflict potential with PCI of 0.20. It should be noted that the PCI only includes people in the fishing villages. The potential for conflict might be considerably larger at the national level. E.g. the Swedish Society for Nature Conservation (a major Swedish NGO within nature protection) clearly states that they do not want license hunting [45] which is a fundamentally different view than expressed in this study.

On the other hand, the Swedish Association for Hunting and Wildlife Management (an NGO within hunting) is positive to seal hunting. They have e.g. listed the following necessary points for an effective seal hunt that could control the seal populations (personal communication, Swedish Association for Hunting and Wildlife Management, Hans Geibrink):

- Management plans and actions should be coordinated between countries in the Baltic.
- As seal hunt is a difficult task [46], education is important.
- Licensed hunting should be allowed on the state's islands and open water as well as in seal sanctuaries during times when there is no reproduction.
- Protection hunting is maintained with liberal rules to protect fishing and the cooperation between hunters and fishermen should be encouraged.
- If the EU trade ban is not lifted to allow an economic value of seal products for the hunters, a financial compensation is required for an intensive hunt

As shown, the licensed hunting measure has a low potential for conflict within the studied fishing villages, but this might not hold true for Sweden as a whole. Different views on wildlife between stakeholder groups may create social conflicts [47,48], and thus it is important with dialogue with stakeholders before implementing additional hunting measures.

6.3. Compensation for catch-losses & investments in seal-safe gear

In the questionnaire, the attitude towards *compensation for catch-losses* and *investments in seal-safe gear* was neutral or moderately positive by both participants involved and not involved in fishery. Both groups had intermediate PCI values (>0.20) for both types of economic measures considered indicating that there may be potential for conflict. Also, the interviews show a split picture which can be exemplified by fishermen stating the compensation for lost catches to be economically important but not a long-term strategy since "you cannot build a business on subsidies". Thus, there is a tension between compensation as a short-versus long-term strategy. This might in part explain why some view the measure as more positive than others.

Ravenelle and Nyhus [49] find that direct payments for damages is the most common scheme (compared to e.g. insurance systems) and stressed that the schemes typically require documentation of the wildlife damage. Although documentation is required also in the Swedish seal compensation scheme, it is by definition not possible for the fisher to fully quantify the losses since they occur under water and are therefore not directly observable [43]. This clearly complicates the use of compensating direct damages (se section 2). In their literature review, Ravenelle and Nyhus [49] found that the most common recommendation from the scientific literature on how to improve compensation schemes was to link payments to conflict preventing measures. If full compensation is paid without this link, the scheme might introduce economic incentives not to prevent damages (see e.g. Ref. [50]. There are several potential ways to reduce seal damages; e g. using seal-safe fishing gear, changing fishing areas, or limiting the time that the fishing gear is in the water. However, these actions are not mandatory for receiving compensation for catch-losses. It might also be problematic to introduce such requirements in cases where e.g. seal-safe gear reduces the seal damages but the major problem with such gear is the low catch efficiency. E.g. seal-safe traps that are successful in salmon fisheries do not work yet for cod [51]. The interviews reveal conflicting attitudes towards the functioning of seal-safe gear, more specifically cod pots. Whereas some describe them as a potentially excellent measure, others refer to major previous investments resulting in no progress as a reason for their scepticism. Notably, economic compensation for catch-losses or investments in seal-safe gear does not compensate for current costs associated with broken gear and the additional working time spent on fishing in waters with high seal abundance. Such costs might have substantial effects on the economic performance [11,12].

6.4. Seal tourism

Results from the questionnaire indicate scepticism towards the 'seals as a resource'- measures. From the interviews this may be understood as an expression of differences in a more general versus local attitude. Interviewees are positive towards different forms of *seal tourism*, but state that in the local context there are no prerequisites for this measure.

Strengthening the value of the seal resource by e.g. enhancing seal-watching tourism is one of the objectives in the Swedish seal management plan. This topic splits the two groups studied. Participants involved in fishery are considerably more negative to this idea than the others. The fishermen do not view seal watching as an alternative to fishing for several reasons; it requires substantial investments, there are no islets and rocks in the area where you can see the seals, and least but not last it would imply that they give up their cultural identity as fishermen. Those not involved in fishery are more positive to an increased seal tourism, however not necessarily as an alternative to fishing, and primarily in other areas than the villages studied. Hence, in some local settings seal tourism may be a possibility to strengthen the local economy, but it is considered doubtful that this will benefit local fishermen.

There is currently no scientific information about the Swedish seal tourism. Though, several companies around the coast do offer seal-safaris as part of their activities. These companies are typically not

owned by fishermen, but offers a portfolio of nature tourism activities to their customers. Examples are canoeing, RIB-boats, sailing, and hiking. As a comparison, whale-watching and similar land-based activities are major sectors in many counties. Ryan et al. [52] showed that about 51 000 guests went whale watching in the west of Scotland in 2015 generating revenues of £ 2.3 million. However, the potential economic value of the Swedish Baltic Sea seal population will depend on the attractiveness of seals for tourists and to what extent local entrepreneurs are able to turn this into attractive products. A necessity for seal watching is that there are islands where seals haul out regularly in order to be able to get close to the animals. There are few suitable haul outs for grey seals in the southern Baltic Sea. In addition, some of these are seal reserves where no admittance is allowed. At the same time there has been concern for negative effects on the welfare of seal species with seal tourism [53].

6.5. Collaboration between authorities and locals

The attitude towards measures based on communication is in the questionnaire slightly favourable and the potential for conflict modest, but the interviews raise concerns regarding the feasibility of these measures. Importantly the interviews reveal that collaboration is in the present context undermined by lack of trust in managing authorities. Trust is a critical component of collaborative processes as recently shown in the Swedish moose management system [54]. Collaborative processes require efforts from concerned stakeholders over long-term (e.g. Ref. [41]. A first step in a collaborative process around seals and local coastal fishery would thus be to initiate dialogue and build trust between stakeholders. The Wildlife Management Delegations might be an arena to work further in such a direction. The interviews reveal that a collaborative process would be extremely urgent to establish otherwise there may be no fishermen left to further involve. Participation in information meetings may change people's appraisals of human-wildlife interactions *if* the source of information is perceived to be trustworthy [24]. Still, singularly such meetings cannot be expected to establish co-existence.

7. Conclusion

This study shows that the participants call for something to be done to solve the seal-fisheries situation if the local coastal fishery is to survive. Doing nothing is considered as the least attractive option in the quantitative analysis with a strong agreement both between and within the studied groups (participants involved/not involved in fishery). The result is confirmed by the interviews. In a comparison between seal conflict mitigation in Finland and Sweden Bruckmeier et al. [55] find that a combination of economic and technical measures is appropriate in a short-term perspective, but that a more long-term solution requires improved fishing methods, involvement from stakeholders, and in the Swedish case, lethal measures to control a rapidly increasing population of seals. The results from this study confirm the findings in Bruckmeier et al. from 2013 indicating that no solution has been reached during the last years. As mentioned above, a collaborative process involving local stakeholders is much needed, but would require development of local trust in authorities and careful attention to people's individual interpretation of the seal-fishery situation [59].

A measure put forward both in Bruckmeier et al. [55] and in this study is hunting. The Swedish Parliament [56] has recently made population control through license hunting of grey seals legal. Although this is a preferred measure, the results show that it might be too late to reduce seal populations since it might not be possible to increase hunting enough to actually have an effect. Further, although the potential for conflict of these measures might be small within the studied fishing villages, they might have a considerably larger conflict potential at the Swedish national level since different interest groups have different views on seal hunting.

The results show a great concern that without measures to manage the seal-fisheries situation the small-scale fishery will disappear in the region. This is not in line with the political objectives stated in e.g. EU's common fisheries policy and the Swedish strategy for commercial fisheries, but on the other hand, seal conservation is an equally important policy objective. The public debate on seal management is controversial and contains strong stakeholder views. The debate is primarily held at the national level, but this study brings input from an area where seals have recently entered the local fishing waters in larger numbers. The respondents live in fishing villages and will live with the management results for decades to come. An interesting topic for future research would be how incompatible political objectives could be managed in the local context.

CRediT authorship contribution statement

Åsa Waldo: Conceptualization, Methodology, Investigation, Writing - original draft, Writing - review & editing. **Maria Johansson:** Conceptualization, Methodology, Investigation, Writing - original draft, Writing - review & editing. **Johan Blomquist:** Conceptualization. **Torbjörn Jansson:** Conceptualization. **Sara Königson:** Conceptualization. **Sven-Gunnar Lunneryd:** Conceptualization. **Anders Persson:** Conceptualization. **Staffan Waldo:** Conceptualization, Writing - original draft, Writing - review & editing, Project administration.

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Appendix A

	No	Management measure	Content
Economic support	1	Economic compensation for catch-losses	The individual fisherman is compensated for catch-losses due to seal interaction.
	2	Support of investments in seal-safe gear	The individual fisherman receives funding for investments in seal-safe gear.
	3	Seal-safe gear	Fishermen use physical barriers to hinder seals to feed from the fishing nets.
	4	Deterrence	Fishermen use different devices to deter seals from fishing spots.
Population control	5	Protective hunting	Limited hunting is allowed in areas with much damage on fishing gears and catches.
	6	Licensed hunting	Hunters shoot a fixed quota of the seal population each year.
No further action	7	No further action	The seal population is allowed to grow unimpeded.

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	No	Management measure	Content
Seals as resource	8	Seal tourism	Tourists visit the area to watch seals.
	9	Seals as a local recreational value	The municipality market seal presence as a recreational value in the local natural environment.
Dialogue	10	Information	Authorities arrange local information meetings on the topic of seal presence and management.
	11	Collaboration between authorities and locals	Authorities facilitate long-term collaboration with local fishermen in order to develop alternative seal-safe fishing methods.
Alternative management	12	Small-scale fishery special regulations	The regulation of coastal fishery enables the fishermen to shift between fishing for different species in order to avoid seal-damages.
	13	Consumer labelling	Fish from the small-scale coastal fishery is labelled as local.
	14	Transition to trawling	The individual fisherman changes from coastal net fishing to trawling.

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